

June 7, 1960

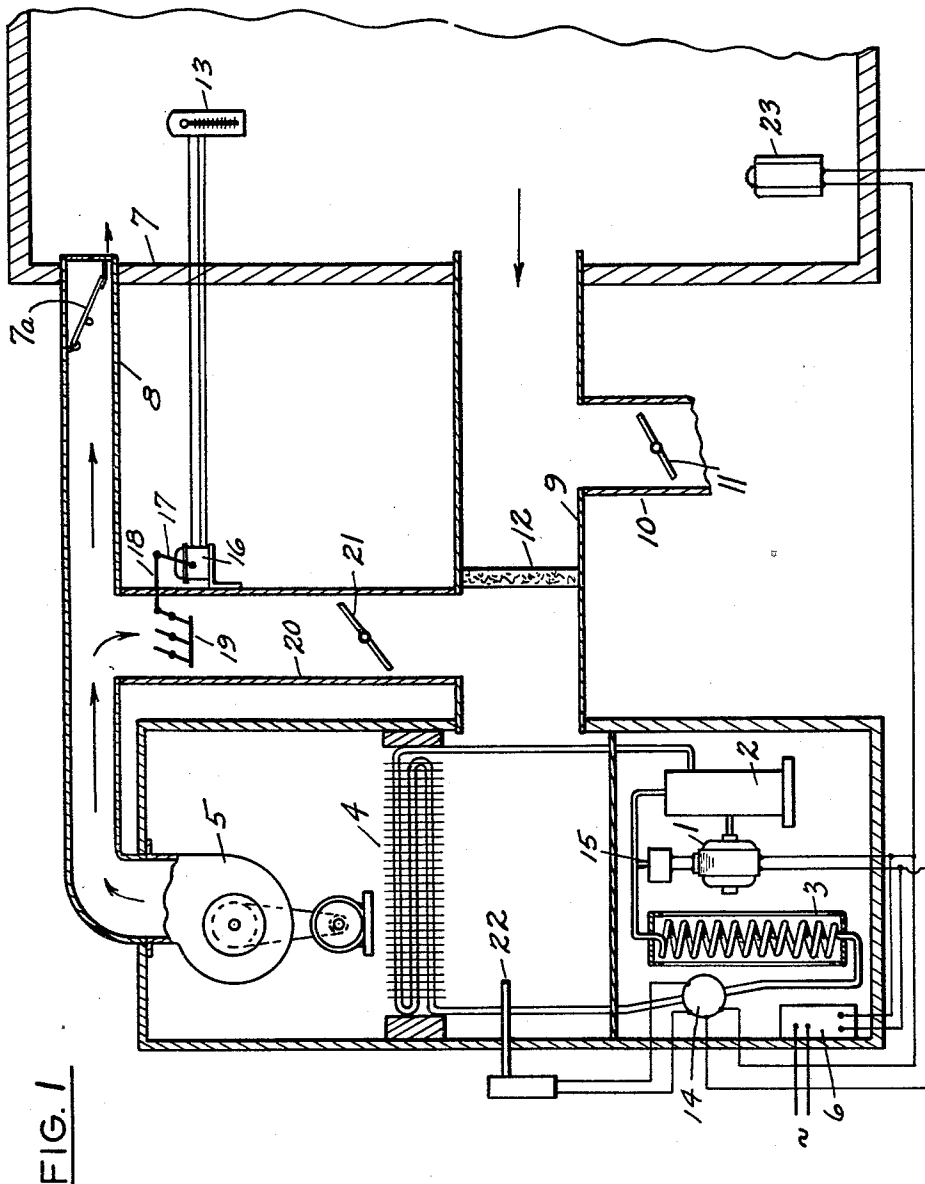
R. C. COBLENTZ

2,939,296

AIR COOLING SYSTEM

Filed Sept. 2, 1958

5 Sheets-Sheet 1



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2,939,296

AIR COOLING SYSTEM

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5 Sheets-Sheet 2

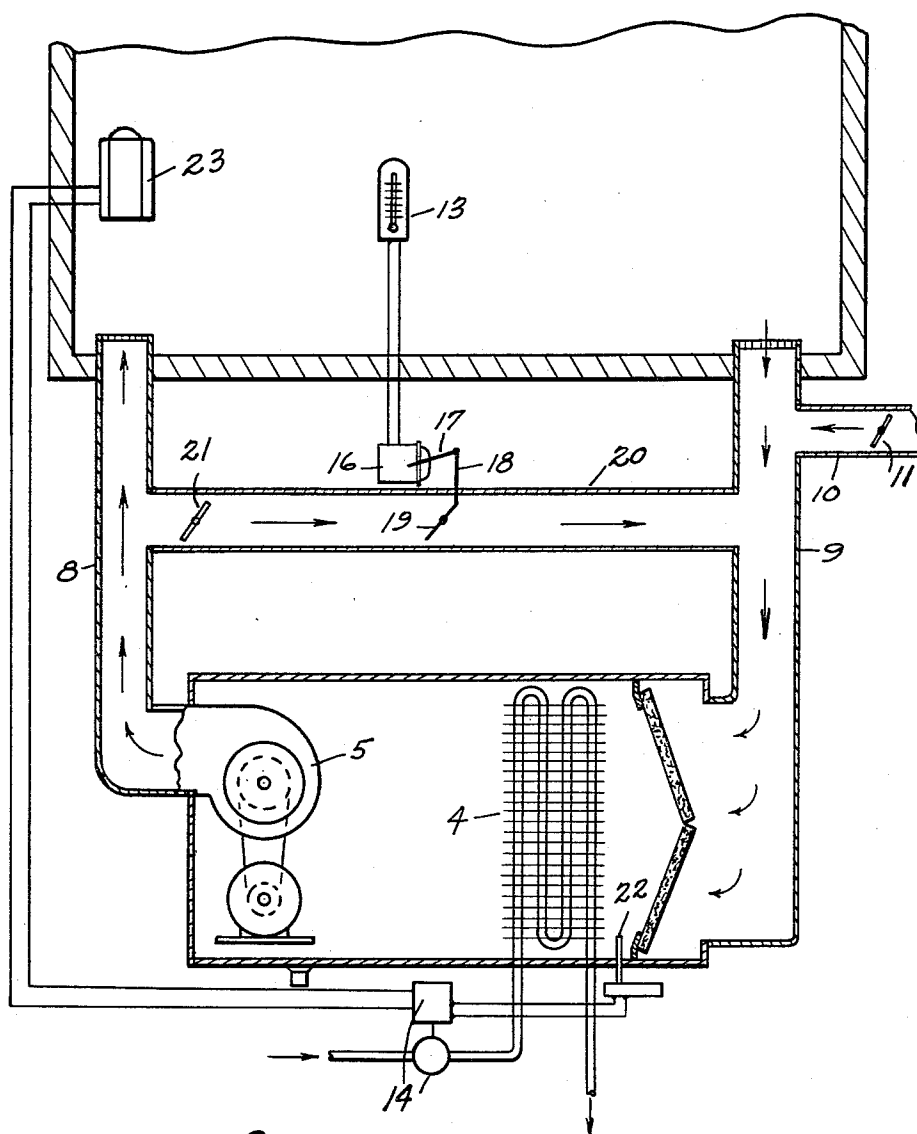


FIG. 2

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AIR COOLING SYSTEM

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5 Sheets-Sheet 3

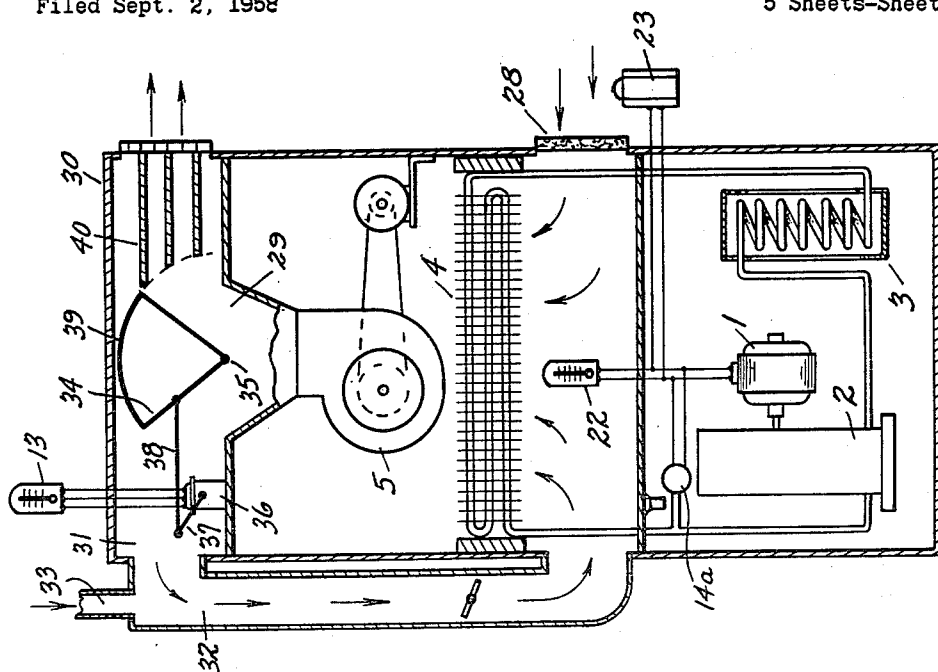


FIG. 4

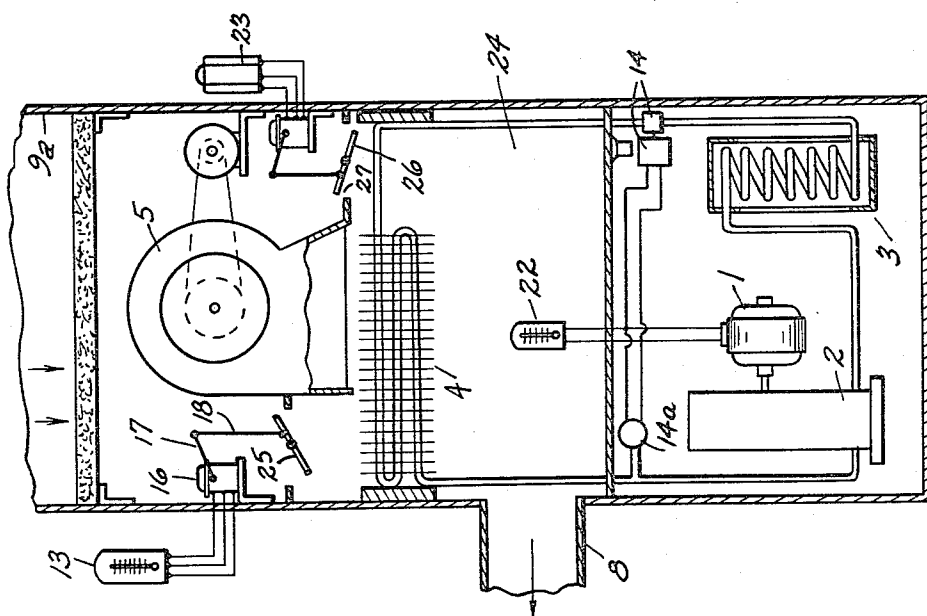


FIG. 3

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5 Sheets-Sheet 4

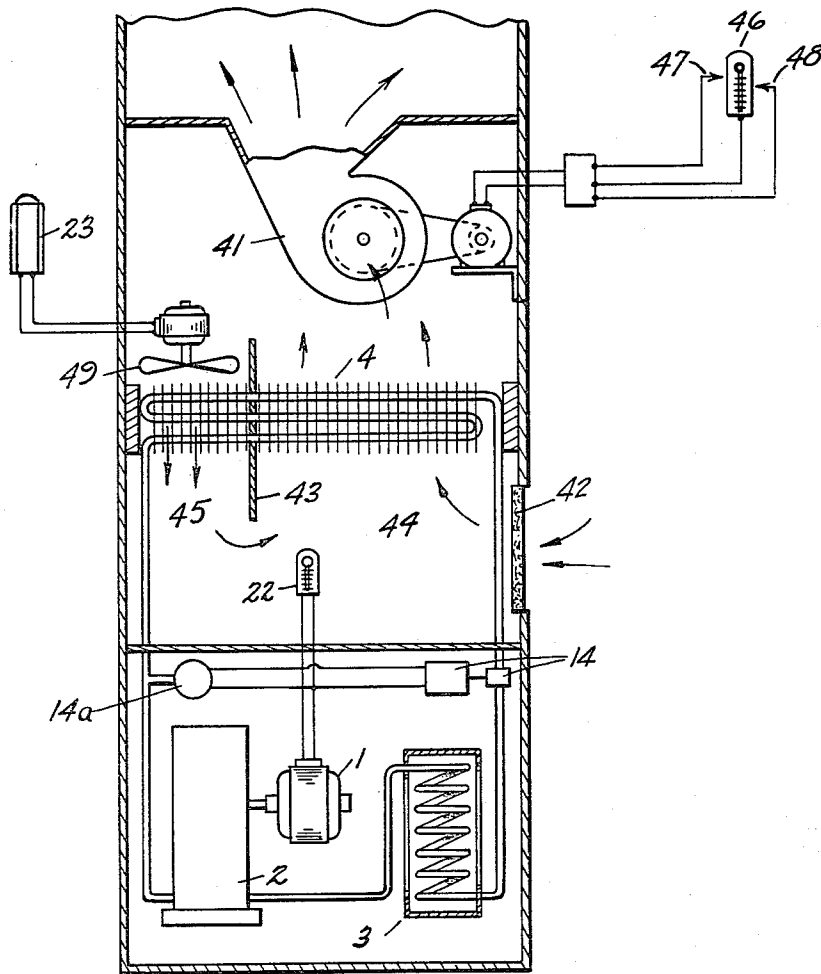


FIG. 5

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AIR COOLING SYSTEM

2,939,296

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5 Sheets-Sheet 5

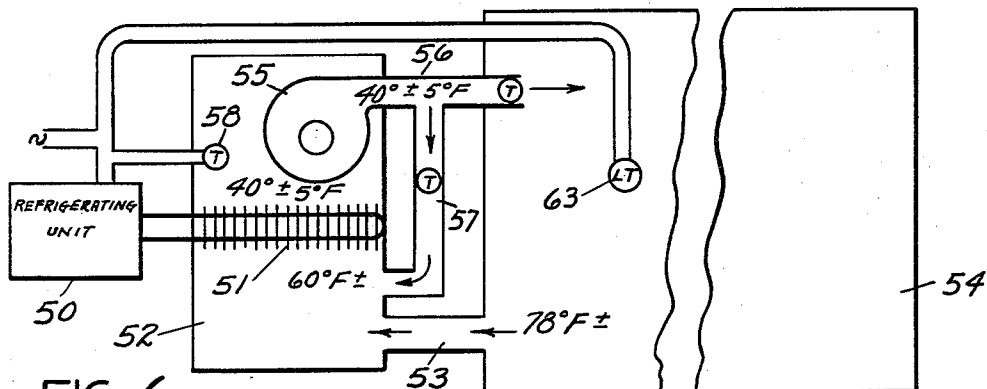


FIG. 6

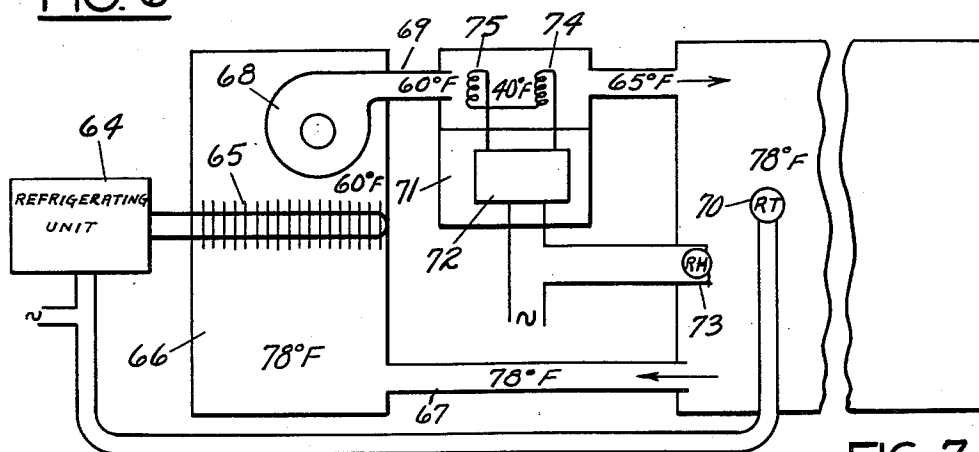


FIG. 7

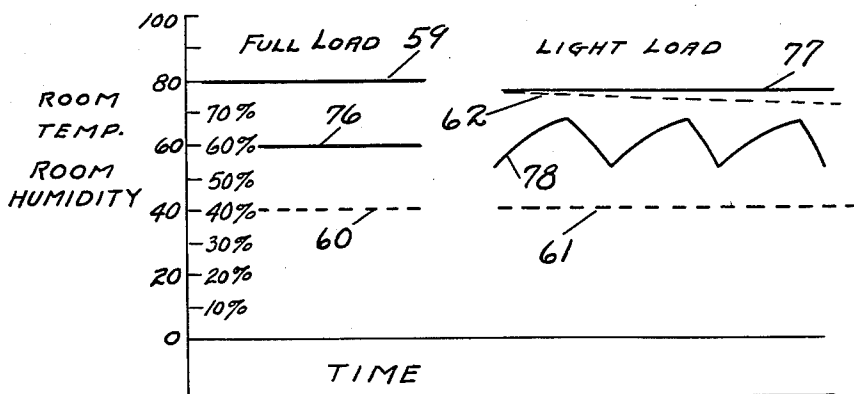


FIG. 8

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2,939,296

AIR COOLING SYSTEM

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Filed Sept. 2, 1958, Ser. No. 758,624

8 Claims. (Cl. 62—180)

This is a continuation in part of my application Serial No. 344,337 filed March 24, 1953, now abandoned.

In air conditioning systems where the unit is controlled by the room temperature, the predominant load on the unit is the removal of sensible heat. This invention is intended to achieve the same comfort level with smaller installed unit capacity by recirculation of part of the cooled air over the evaporator or cooling coil so the cooling capacity of the unit is more effectively used for removal of moisture and accordingly a smaller unit will achieve the same comfort level without as great a reduction in the room air temperature.

In the accompanying drawings, Fig. 1 is a diagram of an air conditioning installation; Fig. 2 is a diagram of basement installation; Fig. 3 shows the recirculation control applied to a vertical packaged air conditioning unit where the air is blown down over the cooling coil; Fig. 4 shows the recirculation control applied to a vertical packaged air conditioning unit where the air is sucked up over the cooling coil; Fig. 5 shows two fans, one for controlling the air delivery and the other for controlling the recirculation; Fig. 6 is a diagram of an air conditioning system; Fig. 7 is a diagram of a conventional air conditioning system for achieving results comparable to Fig. 6; and Fig. 8 is a performance diagram for the Figs. 6 and 7 systems.

The conventional elements of the air conditioning unit are readily identified, 1 being the motor driving the compressor 2, 3 being the condenser, 4 the evaporator or cooling coil, 5 the fan or blower for circulating air over the sub-freezing temperature evaporator, and 6 the control box. The fan 5 runs continuously discharging air to the room or air conditioned area 7 through a duct 8. A floating damper 7a opens at high rates of flow and closes at low rates of flow thereby insuring sufficient velocity to maintain the proper distribution in the room. Air is returned to the unit through a return duct 9 and through an outside air intake duct 10 controlled by a damper 11. A filter 12 is arranged in the return air duct downstream of the fresh air intake. At a suitable point in the room is a thermostat 13 which ordinarily would control the refrigerating unit either by a valve 14 in the line from the condenser 3 to the evaporator 4 or by directly controlling the motor 1. When the valve 14 is used to control the refrigerating unit, the motor 1 is controlled by a pressure switch 15 which shuts off the motor whenever the valve 14 is closed and causes a rise in pressure in the compressor output. With the ordinary connection of the thermostat the room air temperature will have to be set relatively low to obtain the desired comfort level on hot humid days and the relative humidity in the room will be high. In the present system, the thermostat 13 controls a reversible damper motor 16 having an arm 17 connected by a link 18 to dampers 19 in a bypass duct 20 which connects the cold air discharge duct 8 back to the intake duct 9. The dampers 19 may be supplemented by a hand damper 21. The combined effect of the dampers 19 and 21 is to recirculate from 10% to 90% of the cooled air

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back over the evaporator 4 thereby removing additional moisture without dropping the room temperature. This permits a higher setting of the thermostat 13 without lowering the comfort level.

5 The damper 19 is of the modulating or proportioning type, the motor 16 turning in the direction to open the damper 19 and increase the air bypassed through duct 20 when the room thermostat 13 is satisfied and turning in the reverse direction when the room thermostat calls for cold. The result of varying the amount of air bypassed through the duct 20 is to vary the quantity of cooled air discharged to the room and to thereby maintain the air flow to the room at the value required for the cooling load. Since the air bypassed through the duct 20 loses additional moisture as it again flows over the evaporator 4, the air discharged to the room will contain less moisture and the relative humidity of the room will be less. Furthermore, the capacity of the cooling unit will be materially less. In a typical installation utilizing a 10-ton unit with the fan 5 moving 4,000 c.f.m., the heat removal was 91,600 B.t.u./hr. sensible heat and 31,000 B.t.u./hr. latent heat. By changing to a 5-ton unit with the fan 5 moving 2,000 c.f.m., 800 c.f.m. being discharged to the room and 1,200 c.f.m. being recirculated through the duct 20, the heat removal was 31,000 B.t.u./hr. sensible heat and 31,000 B.t.u./hr. latent heat. While the room air temperature was higher with the 5-ton unit, the comfort level was the same because the relative humidity was lower with the recirculating system.

30 With the recirculating duct 20, the air conditioning unit is used more effectively for humidity removal. As the room thermostat 13 is satisfied, the unit keeps running lowering the humidity of the air. There are two controls which shut off the unit, a low temperature shut-off thermostat 22 which closes the solenoid valve 14 whenever the recycled air drops to 35° F. and a wet bulb thermostat or humidistat 23 which likewise shuts the solenoid valve when the room wet bulb temperature drops to the comfort level. At all other times, the unit runs and is utilized for cooling and humidity removal as determined by the setting of the damper 19. The low temperature shut-off, while primarily for preventing freezing or frosting of the evaporator, is to some extent a measure of the wet bulb temperature. As the proportion of air recirculated goes up, the air discharged to the room becomes drier and the recirculated air temperature becomes lower. The drier air discharged to the room drops the wet bulb temperature so both controls 22 and 23 are actuated to shut down the unit by the same factors. By varying the percentage of air bypassed or recirculated, the low temperature shut-off 22 can serve the same function as the humidistat or wet bulb thermostat 23. In fact, the low temperature thermostat 22 has proven to be a more reliable and more accurate control for humidity than a humidistat and the humidistat 23 has been omitted in actual practice. It will be noted that the air flowing over the evaporator is always at lower than room air temperature because it is a mixture of room air and of the cooler recycled air. This has an unexpected advantage in maintaining constant humidity under fluctuating loads and also in providing a modulated control. Under light loads, the recycled air is quickly cooled to the low temperature operating point and a longer time is required for the temperature of the recycled air to rise. 65 While the unit is shut down, reevaporation of moisture from the evaporator is minimized because the air flowing over the evaporator is always cooler than room air. Decreasing reevaporation prevents rise in humidity while the unit is shut down. Under heavy loads, the unit runs a long time before the recycled air drops to the low temperature operating point of thermostat 22 and upon shut-

ting down of the unit, the temperature of the recycled air quickly rises. This results in a modulated control.

In the basement installation shown in Fig. 2, the parts are differently arranged, but the construction and function are the same so the corresponding parts are designated by the same reference numerals. The room air thermostat 13 controls the motor 16 positioning the modulating or proportioning damper 19 in the bypass duct 20. This varies the amount of air recirculated from the discharge duct 8 back to the return air duct 9. As soon as the room thermostat 13 is satisfied, the amount of air bypassed is increased so the air discharged to the room becomes drier, and the relative humidity is dropped. When the relative humidity drops to the comfort level, either as indicated by the humidistat or wet bulb thermostat 23 or by the low temperature shut-off 22, the solenoid valve 14 cuts off the flow of refrigerant to the evaporator 4 shutting down the unit. As in the Fig. 1 installation, the fan 5 continues to run maintaining the necessary minimum air flow to equalize the room temperature.

In the vertical packaged unit shown in Fig. 3, the motor 1, compressor 2, condenser 3, evaporator 4, and fan 5 are the same as in Fig. 1. The fan 5 runs continuously and draws air in through a top return air intake 9a and blows it through the evaporator 4 to a chamber 24 connected to the cold air discharge duct 8. There are two damper controlled bypasses from the chamber 24. The damper 25 controlled by the room air thermostat 13 through motor 16, arm 17, and link 18 controls the back flow through a section of the evaporator adjacent the discharge of the fan 5. Opening the damper 25 cuts down the air flow to the room and increases the dryness due to the greater recirculation. The air recirculated past the damper 25 has an extra pass over the evaporator on its way to the inlet to the fan 5. Another damper 26 controlled by the room humidistat or wet bulb thermostat 23 controls a bypass passage 27 around the evaporator. The damper 26 is normally closed and opens under low relative humidity. The low temperature shut-off 22 is shown controlling the motor 1 rather than the flow of refrigerant to the evaporator 4. The flow of refrigerant is controlled by the solenoid valve 14. The usual suction pressure switch 14a shuts down the motor when the evaporator becomes too cold.

In Fig. 4, the motor 1, the compressor 2, the condenser 3, the evaporator 4, and the fan 5 are the same as in Fig. 1. The return air from the room enters a grill 28 below the evaporator and after flowing through the evaporator is discharged by the fan into a T 29, one end 30 discharging to the room, and the other end 31 discharging to a bypass duct 32 leading back to the intake side of the evaporator. A fresh air intake 33 is connected to the bypass duct 32. The division of the fan air between the room and the bypass duct is controlled by a segmental damper 34 pivoted at 35 at the center of the fan discharge and actuated by a reversible damper motor 36 driving an arm 37 connected by a link 38 to the damper. The arcuate periphery 39 of the damper cooperates with spaced baffles 40 in the room air outlet duct 30 so that as the damper 34 is rotated in a clockwise direction, the discharge area of the room air outlet duct 30 is progressively cut down. This, of course, restricts the flow of air to the room, but it has the advantage of maintaining the room air discharge velocity which is advantageous in preventing stratification. As the arcuate periphery 39 of the baffle progressively blocks the outlet 30 to the room, the passageway to the bypass duct 32 is progressively opened so that more of the air is recirculated back through the bypass duct over the evaporator 4. This recirculation further lowers the humidity of the recirculated air so that the smaller amount of air which is discharged to the room contains less moisture and results in decreased humidity without as great a reduction in the room air temperature. As in the previ-

ously described constructions, the position of the damper 34 is controlled by the room air thermostat 13. As the room air temperature drops, and the room thermostat becomes satisfied, the damper 34 is moved in a clockwise direction so as to cut down on the flow of air to the room and to increase the flow of air to the room sufficient to maintain the room air temperature at the desired value, but because the smaller amount of air discharged to the room contains less moisture, the relative humidity of the room is lower than with the conventional air conditioning systems. After the relative humidity of the room has been reduced to the desired comfort level, the refrigerating unit is shut off either by the low temperature shut-off 22 or by a room humidistat or wet bulb thermostat 23. The humidistat will provide the more precise control, but the low temperature thermostat 22 can in many cases be adjusted to provide adequate control of the relative humidity.

In the Fig. 5 system, the motor 1, the compressor 2, the condenser 3, and the evaporator 4 are the same as in the previously described systems. Instead of the single-speed fan used in the other systems, there is a three-speed fan 41 which draws air in through the return air intake 42 beneath the evaporator and discharges air to the room out the top of the unit. There is a baffle 43 at an intermediate part of the evaporator which in effect provides two passageways 44 and 45 to the evaporator. The three-speed fan 41 draws air up through the portion of the evaporator included in the passageway 44. The speed of the fan 41 is controlled by a two-temperature thermostat 46 having a high temperature contact 47 and a low temperature contact 48. When the thermostat is closed on the high temperature contact 47, the fan 41 is driven at high speed. When the thermostat moves away from the contact 47, the fan is driven at medium speed and when the thermostat closes on the contact 48, the fan is driven at slow speed. By controlling the speed of the fan 41, the same effect is produced as though the air flow to the room were controlled by baffles. As the fan varies from high to low speed, the volume of air discharged to the room falls in the same manner as in the previous systems where baffles were used to restrict the flow. In a typical installation, the fan might discharge 2,000 cubic feet per minute at high speed, 1,000 cubic feet per minute at medium speed, and 500 cubic feet per minute at low speed. The recirculation of air to increase the rate of removal of moisture is obtained by a separate fan 49 located above the evaporator and discharging downward through the passageway 45 thereby returning part of the cooled air to the passageway 44 so that the air is recirculated over the evaporator. In a typical installation, the fan 49 may have an output of 2,000 cubic feet per minute so that the quantity of air recirculated over the evaporator will become larger as compared to the quantity of air discharged to the room as the room temperature air falls. This results in the discharge of progressively drier air to the room with the consequent lowering of the relative humidity. The fan 49 can be controlled by a room humidistat or wet bulb thermostat 23.

To prevent freezing or frosting of the evaporator, the low temperature shut-off 22 used in the previously described systems shuts off the motor whenever the temperature of the recirculated air approaches too close to the freezing point.

All of the systems show the refrigerator evaporator in direct heat transfer relation to the air. In some cases, for example where leaking of the refrigerant cannot be tolerated, a brine coil may be interposed between the evaporator and the air. The evaporator will then be in indirect heat transfer relation to the air and the operation will be the same. In the claims, the term "cooling heat exchanger" is used to include both the direct and indirect heat transfer relation of the evaporator to the air.

All of the systems require smaller refrigerating units for the same comfort level. The units are used more effectively for dehumidification and the same comfort level is achieved with a higher temperature of the room air. The amount of sensible heat removed is less and the amount of latent heat removed is greater than in conventional air conditioning systems. There is no need to reheat the air as in some installations where dehumidification is achieved by cooling the air to a low temperature and then reheating before discharge to the room. The dehumidification is particularly improved at light loads where the quantity of air discharged to the room is kept at a low value.

The evaporator or cooling heat exchanger can be physically smaller because of the higher air velocities which increase the heat transfer. This is due to the recirculated air.

No particular refrigerating system is required. Although the compression type has been illustrated, the absorption type is entirely equivalent and in many installations is preferable particularly if there is available heat which would otherwise be wasted.

This application claims features disclosed but not claimed in copending Patent 2,632,315, March 24, 1953.

Fig. 6 shows an air conditioning system embodying the basic features of the systems of Figs. 1 to 5 inclusive. In this system the refrigerating unit 50 supplies a cooling heat exchanger 51 mounted within a casing 52 between the return air duct 53 from the room 54 and the fan or blower 55 for discharging cooled air through duct 56 to the room. In some installations the casing 52 with the refrigerating unit 50 may be in the room while in other cases the casing and refrigerating unit may be a long distance from the room, both locations being common practice in air conditioning. No control is shown for the fan or blower 55 because it normally runs all of the time and discharges air to the room at a rate sufficient to provide a complete change of air every six to eight minutes. The parts so far described are standard air conditioning units.

In order to maintain constant low relative humidity in the room, as is desirable for comfort, there is connected between the cool air duct 56 and the return air duct 53 a bypass duct 57 which, for example, may return half of the cooled air entering the duct 56 to the return air duct 53. In practice, the duct 57 is usually made over size and the flow adjusted by a damper as is common in heating and cooling systems. Once this adjustment is made at the time of installation, no further adjustment is necessary. In packaged units, the manufacturer would make the recycling duct 57 to the correct size and would not need a damper because the length of the recycling duct would not be subject to variations in length encountered in field installations.

The refrigerating unit is controlled primarily by a thermostat 58 which monitors the cooled air temperature. This thermostat may, for example, be adjusted to respond to a temperature of 40° plus or minus 5° F. and when so adjusted will turn the refrigerating unit on when the cooled air temperature rises to 45° F. and will turn the refrigerating unit off when the cooled air temperature drops to 35° F. Other ranges of adjustment are possible, such as, for example, 45° plus or minus 5° F., 50° plus or minus 5° F. Because the temperature of the cooled air determines the moisture content, it provides an accurate control for the relative humidity of the room. Under commercial practice, there is a complete change of air every six to eight minutes which means that the moisture content of the air in the room quickly falls or approaches the moisture content corresponding to the temperature of the cooled air. It has been found that the cooled air has less moisture than would be expected if the cooled air had 100% relative humidity. This means that the moisture content of the room air is

ordinarily less than the theoretical maximum amount of moisture which could be suspended or retained in the cooled air.

There are many locations for the thermostat 58, all of which are equally acceptable because all monitor the cooled air temperature. The thermostat 58 may be placed above or on the downstream side of the cooling heat exchanger or evaporator 51 because the air leaving the heat exchanger is all at a temperature of 40° plus or minus 5° F. The thermostat 58 can also be placed anywhere in the fan housing 55 or in the duct 56 or in the recycling duct 57. In the case of a remote unit installation, the duct 56 might be 100 or more feet long and the thermostat 58 could be at the end of the duct 56 or 100 or more feet from the refrigerating unit. Although this could be done, it ordinarily would not be done because there is no need for having the extra wiring. The preferred locations for the thermostat 58 are above the cooling heat exchanger 51 or in the recycling duct 57. In these locations there is substantially no stratification of the air and there is little need for care in selecting the location of the thermostat. There is some stratification on the upstream side below the cooling heat exchanger 51 but there are locations on the upstream side where the thermostat 58 can be placed and will respond to the cooled air temperature and monitor the cooled air temperature. These locations require a great deal of skill in selection and are more difficult. These locations perhaps would be satisfactory for packaged units where the manufacturer could accurately control the position of the thermostat and could insure that no one would move the thermostat from the selected position. In other locations on the upstream side of the heat exchanger 51 the temperature will be the return air temperature or somewhere between the return air and cooled air temperatures. Those skilled in the thermostat art are able to make a thermostat respond to or monitor a temperature different than the actual air temperature at the thermostat location. Thermostat 58 should be placed to monitor the cooled air temperature, regardless of what the room air temperature may be.

In a typical installation where the thermostat 58 monitors the cooled air temperature to 40° plus or minus 5° F., the room temperature might be 78° F. plus or minus a very much smaller amount due to the much greater volume of the room as compared to the volume of the casing 52 and the average temperature of the mixture of recycled air from the duct 57 and return air from the room might be 60° F. plus or minus something less than 5° F.

The performance of the Fig. 6 system is shown in Fig. 8. Under full load corresponding to a very hot day when the unit has to run all of the time, the room temperature indicated by line 59 might be 80° F. while the room humidity indicated by line 60 might be 40%. These values remain constant so long as the air conditioning load remained at its maximum.

Under light load positions shown at the right in Fig. 8, the room humidity indicated by line 61 remains at the same value as that indicated by line 60. This is so because the moisture content is determined by the cooled air temperature which is monitored by the cooled air thermostat 58. The setting of the thermostat 58 determines the moisture content of the air whether the air conditioning load is light or heavy. The humidity accordingly remains the same under all load conditions. It should be noted that the thermostat 58 monitors the cooled air temperature and has no way of knowing what is the temperature in the room or the temperature on the upstream side of the evaporator or cooling heat exchanger 51. While it would be expected that under light load conditions the room temperature would fall to a very low value, surprisingly that has proven not to be the case. The room has so much greater volume than the casing 52 for the air conditioning unit that under

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light load conditions when the air conditioning unit might run, for example, one third or one quarter of the time, the thermostat 58 controls the room temperature in a practical manner even though it is not responsive to the room air temperature. The reason for this is the fly-wheel effect of the tremendously large mass of air in the room as compared to the air in the casing 52. Under light load conditions, the air cooled by the unit quickly drops to the lower limit of the thermostat 58 and the thermostat 58 does not turn the unit back on until the cooled air has warmed up, which takes a relatively long time. From one aspect, under light load conditions the air conditioning unit is in effect bringing the temperature within the casing 52 down to the operating point of the thermostat 58.

Another effect of the thermostat 58 is that it breaks the cycle of operation of the air conditioning unit up into shorter cycles under light load conditions. With a conventional air conditioning unit under conditions which required operation of the unit for one third of the time, the unit might be on for 20 minutes and off for 40 minutes. Under the same conditions the thermostat 58 might turn the air conditioning unit on for 5 minutes and off for 10 minutes.

Under heavy load conditions, it takes a long time to bring the cooled air in the casing 52 down to the operating point of the thermostat 58 while the heavy air conditioning load quickly brings the cooled air to the upper operating point of the thermostat 58 after it has shut the refrigerating unit off.

Under light load conditions, the room air temperature may follow a curve such as indicated at 62 where the room air temperature will gradually drop 2 or 3 or 4 degrees. This might happen during a cool spell or at night when the air conditioning load drops and is not serious. If this small change in room air temperature is objectionable, the user can turn the refrigerating unit off by disconnecting the power or can cut down the flow of air to the room by the usual damper. This form of self help is in general use in the air conditioning field. If the user wishes to avoid even these simple steps, a low limit thermostat 63 can be connected in series with the primary control thermostat 58. The function of the low limit thermostat 63 is to disconnect the power supply to the refrigerating unit 50 whenever the room temperature drops to an objectionably low value. At all other times the low limit thermostat is closed and the refrigerating unit is operating subject to the primary control of the thermostat 58. The low limit thermostat 63 does not control the fan or blower 55 which runs all of the time. The low limit thermostat during the summer months might not operate at all for a month at a time or possibly only during the occasional cooler days or nights. It would disconnect the air conditioning unit during a cool spell when little or no air conditioning was necessary. It would not control the room temperature or humidity.

In order to appreciate the advantages of the air conditioning systems of this application, there is shown in Fig. 7 a conventional air conditioning system set up to maintain the same low relative humidity. This conventional air conditioning system comprises a refrigerating unit 64 supplying a cooling heat exchanger 65 within a casing 66. The return air from the room enters the casing 66 through a duct 67 and is drawn over the cooling heat exchanger by a fan or blower 68 discharging cooled air through a duct 69. Under typical conditions the return air might be 78° F. while the cooled air leaving the heat exchanger 65 might be 60° F. 60° F. would correspond to a moisture content representing a relative humidity of about 60%. The refrigerating unit would be turned on and off by a room thermostat 70 which would hold a room temperature of 78° within the usual limits of room thermostats, e.g. 1-2 degrees.

Because of the relatively high humidity, the comfort

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level in the room would not be good particularly under light load conditions. Under light load conditions, the occupants actually feel more comfortable when the refrigerating unit is off than when it is on. When the refrigerating unit is off, the air within the room is circulated and the temperature is not too high because of the light air conditioning load. As soon as the air conditioning unit is turned on, the air is cooled but the moisture content is not reduced very much due to the 60° cooled air temperature and the increase in relative humidity makes the occupant less comfortable. This, of course, is highly objectionable to air conditioning manufacturers who dislike complaints that the user is more comfortable when the unit is off than when the unit is on.

In order to maintain a relative humidity of 40% which is desirable for comfort, the duct 69 is connected to a dehumidifier 71 consisting of a compressor 72 controlled by a room humidistat 73, a condenser 74 and an evaporator 75. The cooled air from the duct 69 is first cooled by the evaporator 75 and is then heated by the condenser 74 to a temperature higher than the temperature in the duct 69. In a typical dehumidifier the air from the duct 69 might have a temperature of 60° F. and be cooled by the evaporator 75 to a temperature 40° F. and then reheated by the condenser 74 to a temperature 65° F. The reason for the higher temperature of the air leaving the dehumidifier is that 100% efficiency is not obtainable.

By the combination of units shown in Fig. 7 under full load conditions, the room temperature can be held at the value indicated by the curve 59 in Fig. 8 and the room humidity can be held at the value indicated by the curve 60, or in other words, the same operation can be obtained as with the systems of Figs. 1 to 6 inclusive. If the dehumidifier is eliminated, then the relative humidity will be that indicated by the curve 76. As would be expected, under full load conditions both the temperature and humidity curves are constant. The unit is running at maximum capacity all of the time and the air conditioning load is at a maximum so there is no reason for any change.

Under light load conditions, the combination illustrated in Fig. 7 will maintain temperature in the room as indicated by the curve 77 and humidity in the room as indicated by the curve 61. Note that the room humidity will be held constant and the room temperature will also be held constant. If the dehumidifier shown in Fig. 7 is omitted, then under light load conditions the temperature will be held constant as indicated by the curve 77 but the humidity will fluctuate widely as indicated by the curve 78. When the humidity is rising, the refrigerating unit is off and the relatively warm air returning from the room reevaporates moisture condensed on the heat exchanger 65. This tends to bring the humidity to a higher than normal value. During the falling part of the curve the refrigerating unit is on and the cooling of the air decreases the moisture but not to a low enough value for comfort. Under light loads not only is the humidity too high, but it fluctuates.

Very few users of air conditioning are willing to pay for the additional dehumidifier which may cost as much as the air conditioning unit. With the dehumidifier omitted, reevaporation of the moisture from the cooling heat exchanger 65 is a serious problem because the air entering the casing 66 is relatively high in temperature. In applicant's system as shown in Fig. 6, while the air in the return air duct 53 is at the same temperature as the air in the return air duct 67, the air which flows over the cooling heat exchanger 51 is much colder due to the mixture of cooled air. This colder air has a much smaller tendency to pick up moisture and the reevaporation is accordingly greatly reduced.

With applicant's systems, neither a room thermostat nor a room humidistat is necessary. The thermostat monitoring the cooled air temperature does the work of

both. For those who do not know when air conditioning is not necessary, a low limit thermostat will disconnect the power supply to the air conditioning unit and will turn it back on when the need for air conditioning returns. The low limit thermostat is not a temperature control. The primary control of temperature and also of humidity is in the cooled air thermostat.

By primarily controlling the unit by the cooled air temperature, a single air conditioning unit does the work of an air conditioning unit plus a dehumidifier, a new result not heretofore achieved.

What is claimed as new is:

1. A room air conditioning system comprising a duct having an intake from the room and a discharge to the room, a refrigerating unit supplying a cooling heat exchanger in the duct intermediate the intake and discharge, a bypass passageway leading from the downstream side back to the upstream side of the cooling heat exchanger, a variable speed fan drawing warm air from the room into the intake and over the cooling heat exchanger and discharging cooled air to the room through the discharge, another fan for forcing cooled air back through the bypass passageway to the upstream side of the cooling heat exchanger, a room air thermostat, and means controlled by the room air thermostat for cutting down the speed of the variable speed fan as the room air temperature drops.

2. A room air conditioning system comprising a duct having an intake from the room and a discharge to the room, a refrigerating unit supplying a cooling heat exchanger in the duct intermediate the intake and discharge, a bypass passageway leading from the downstream side back to the upstream side of the cooling heat exchanger, a variable speed fan drawing warm air from the room into the intake and over the cooling heat exchanger and discharging cooled air to the room through the discharge, another fan for forcing cooled air back through the bypass passageway to the upstream side of the cooling heat exchanger, a room air thermostat, means controlled by the room air thermostat for cutting down the speed of the variable speed fan as the room air temperature drops, and means responsive to the room humidity for shutting down said other fan.

3. A room air conditioning system comprising a duct having an intake from the room and a discharge to the room, a refrigerating unit supplying a cooling heat exchanger in the duct intermediate the intake and discharge, means dividing the duct into two passageways through the cooling heat exchanger, fan means drawing warm air from the room into the intake and through one of the passageways over the cooling heat exchanger and discharging cooled air to the room through the discharge and including means for forcing cooled air back through the other passageway to the upstream side of the cooling heat exchanger, a room air thermostat, and means controlled by the room air thermostat for varying the proportion of the air discharged to the room relative to the air flow through the other passageway as the room air thermostat is satisfied.

4. A room air conditioning system comprising a duct having an intake from the room and a discharge to the room, a refrigerating unit supplying a cooling heat exchanger in the duct intermediate the intake and discharge, means dividing the duct into two passageways through the heat exchanger, a fan drawing warm air from the room into the intake and through one of the passageways over the cooling heat exchanger and discharging cooled air to the room through the discharge, another fan for forcing cooled air from the downstream side of the cooling heat exchanger back through the other passageway to the upstream side of the cooling heat exchanger, a room air thermostat, means controlled by the room air thermostat for cutting down the proportion of air discharged to the room relative to the air flow through

the other passageway as the room air thermostat is satisfied, and other means for controlling the other fan in response to the room humidity.

5. A room air conditioning system comprising a duct having an intake from the room and a discharge to the room, a refrigerating unit supplying a cooling heat exchanger in the duct intermediate the intake and discharge, means dividing the duct into two passageways through the heat exchanger, a fan drawing warm air from the room into the intake and through one of the passageways over the cooling heat exchanger and discharging cooled air to the room through the discharge, another fan for forcing cooled air from the downstream side of the cooling heat exchanger back through the other passageway to the upstream side of the cooling heat exchanger, a room air thermostat, means controlled by the room air thermostat for cutting down the speed of the first fan as the room air thermostat is satisfied, and other means for controlling the other fan in response to the room humidity.

6. A room air conditioning system comprising a casing within which air is cooled below room temperature, said casing having an intake from the room for the air to be cooled and a discharge to the room for the cooled air, a refrigerating unit supplying with coolant at sub-freezing temperature a cooling heat exchanger in the casing intermediate the intake and discharge, a bypass passageway leading from the downstream side back to the upstream side of the cooling heat exchanger, fan means drawing warm air from the room into the intake of the casing and over the cooling heat exchanger and discharging cooled air to the room through the discharge and for forcing part of the cooled air from the downstream side of the cooling heat exchanger back through the bypass passageway to the casing on the upstream side of the cooling heat exchanger whereby a portion of the air is recycled over the heat exchanger and is further cooled, the flow of air over the cooling heat exchanger being unrestricted, and a primary control for the refrigerating unit monitoring the cooled air temperature and turning the refrigerating unit off when the cooled air reaches a low limit and on when the cooled air reaches an upper limit, the low limit being well below room temperature but above freezing and the upper limit being of the order of 10° F. above the lower limit, said control operating independent of room air conditions.

7. A room air conditioning system comprising a casing within which air is cooled below room temperature, said casing having an intake from the room for the air to be cooled and a discharge to the room for the cooled air, a refrigerating unit supplying with coolant a cooling heat exchanger in the casing intermediate the intake and discharge, a bypass passageway leading from the downstream side back to the upstream side of the cooling heat exchanger, fan means drawing warm air from the room into the intake of the casing and over the cooling heat exchanger and discharging cooled air to the room through the discharge and for forcing part of the cooled air from the downstream side of the cooling heat exchanger back through the bypass passageway to the casing on the upstream side of the cooling heat exchanger whereby a portion of the air is recycled over the heat exchanger and is further cooled, the flow of air over the cooling heat exchanger being unrestricted, a primary control for the refrigerating unit monitoring the cooled air temperature and turning the refrigerating unit off when the cooled air reaches a low limit and on when the cooled air reaches an upper limit, the low limit being well below room temperature but above freezing and the upper limit being of the order of 10° F. above the lower limit, said control operating independent of room air conditions, and a low limit thermostat responsive to room temperature for cutting the system off at a low limit of room temperature.

8. A room air conditioning system comprising a casing within which air is cooled below room temperature, said

casing having an intake from the room for the air to be cooled and a discharge to the room for the cooled air, a refrigerating unit supplying with coolant a cooling heat exchanger in the casing intermediate the intake and discharge, a bypass passageway leading from the downstream side back to the upstream side of the cooling heat exchanger, fan means drawing warm air from the room into the intake of the casing and over the cooling heat exchanger and discharging cooled air to the room through the discharge and for forcing part of the cooled air from the downstream side of the cooling heat exchanger back through the bypass passageway to the casing on the upstream side of the cooling heat exchanger whereby a portion of the air is recycled over the heat exchanger and is

further cooled, the flow of air over the cooling heat exchanger being unrestricted, and a primary control for the refrigerating unit modulating the cooled air temperature at a value corresponding to the moisture content for the desired relative humidity of the room air independent of room air temperature.

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