

Feb. 11, 1964

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3,120,866

REFLECTIVE RADIANT CONDITIONING SYSTEM FOR HUMAN COMFORT

Filed Aug. 11, 1960

3 Sheets-Sheet 1

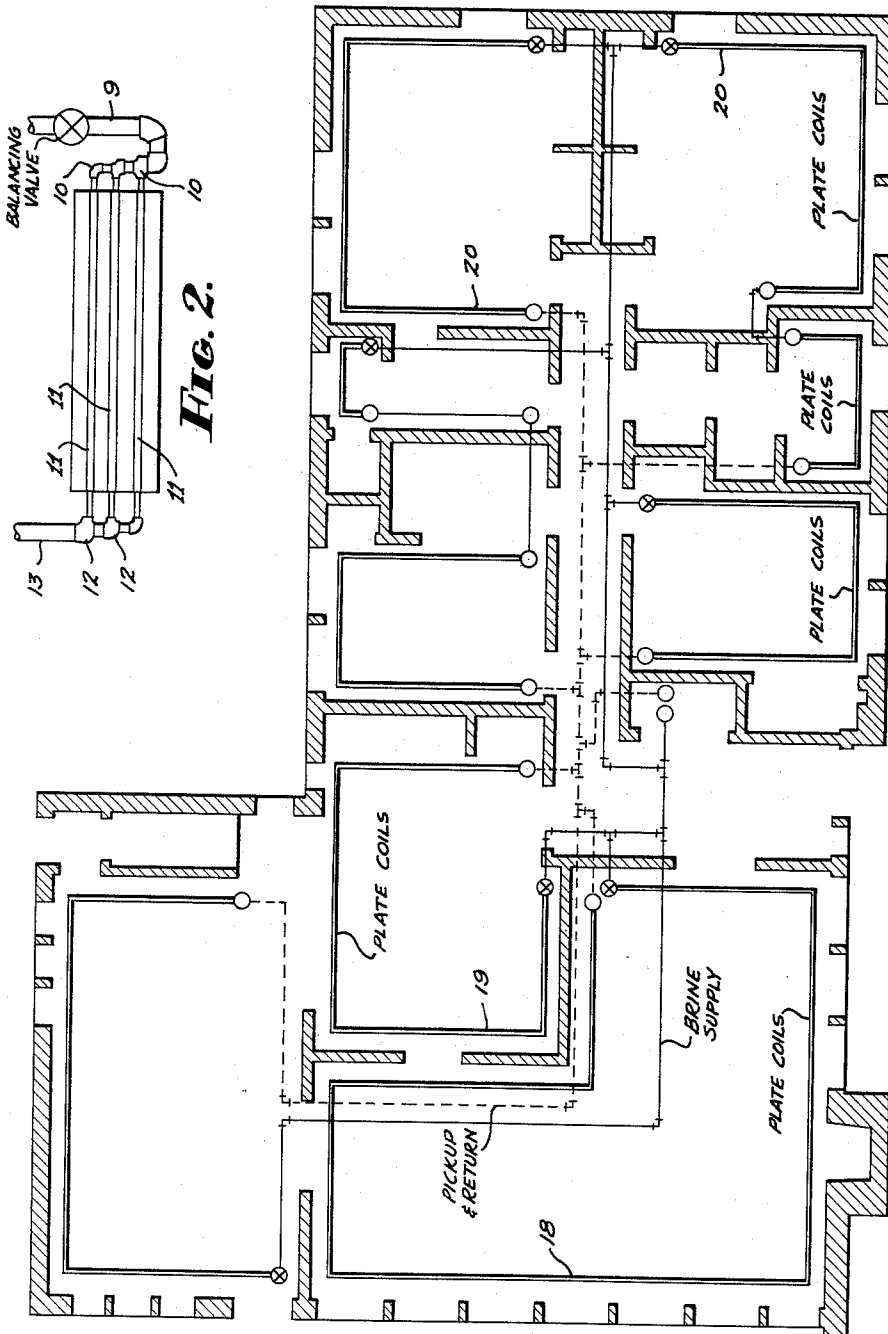


Fig. 1.

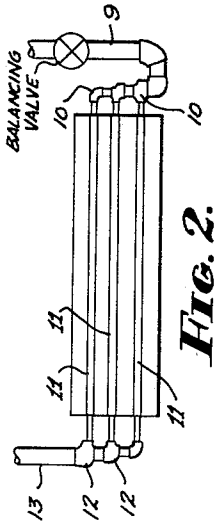


Fig. 2.

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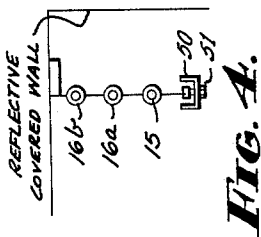


FIG. 4.

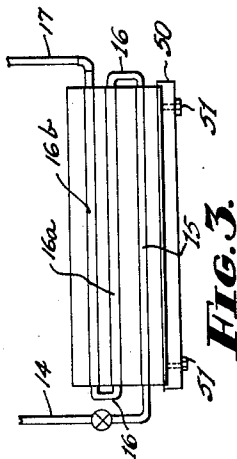


FIG. 3.

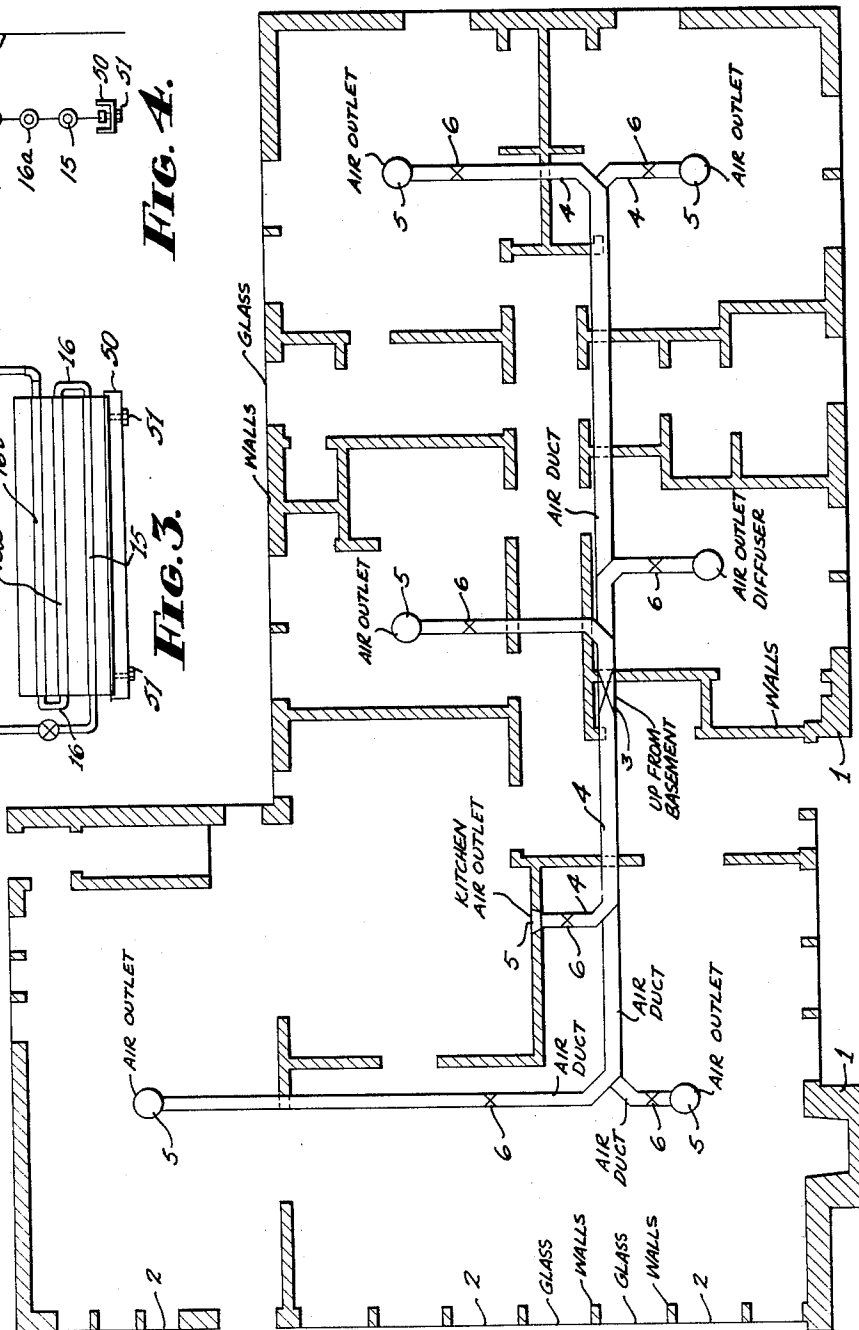


FIG. 5.

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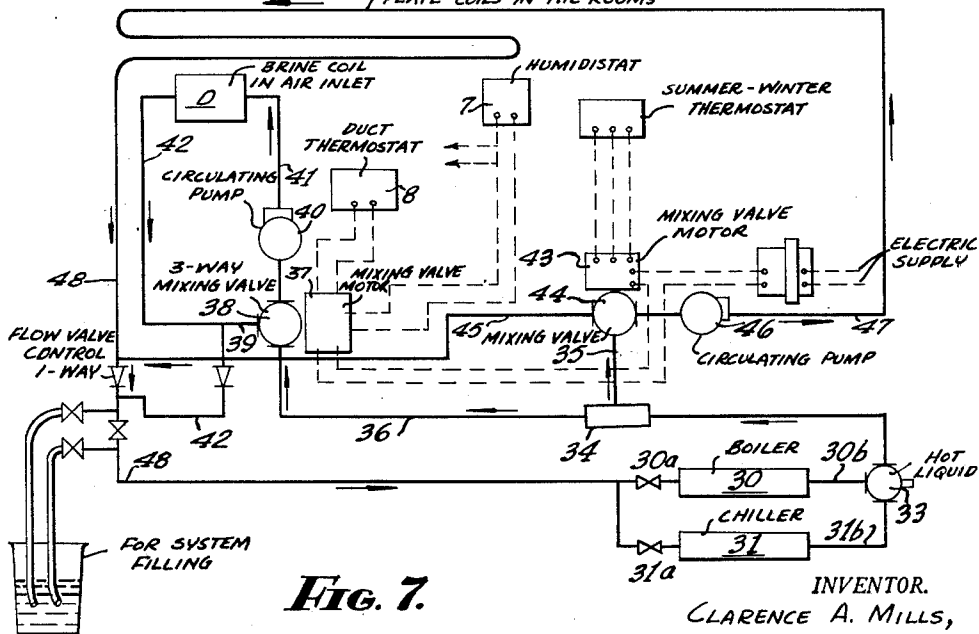
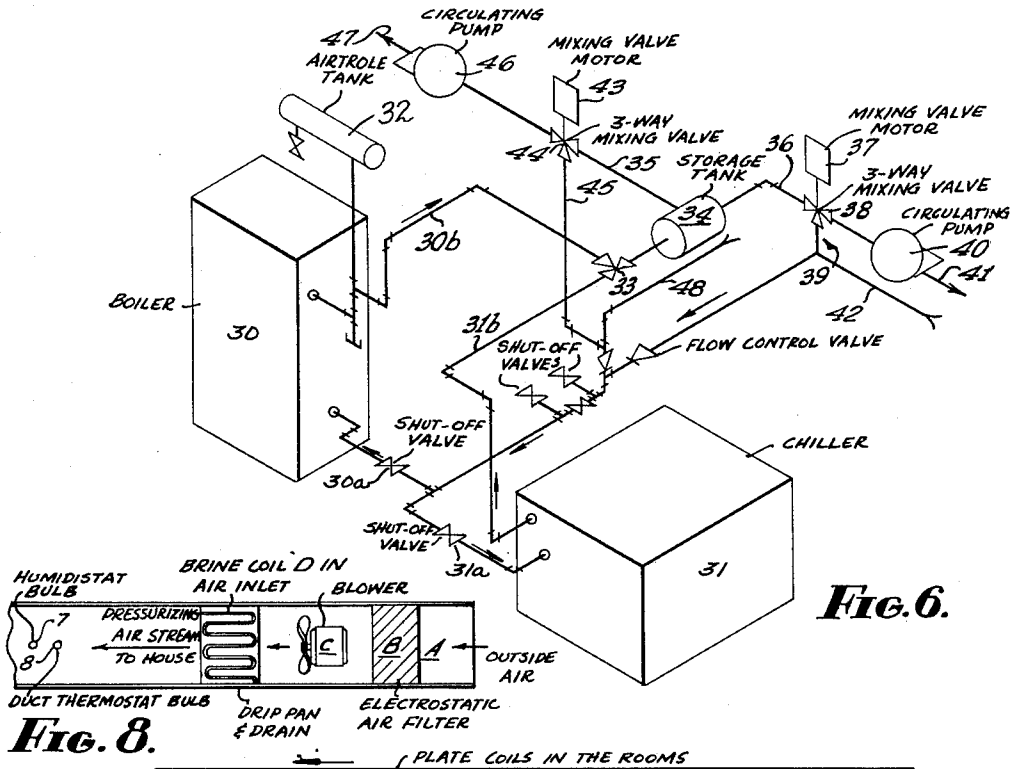
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3 Sheets-Sheet 3



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REFLECTIVE RADIANT CONDITIONING SYSTEM FOR HUMAN COMFORT

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therm, Inc., Cincinnati, Ohio, a corporation of Ohio
Filed Aug. 11, 1960, Ser. No. 48,893
4 Claims. (Cl. 165-22)

That environmental temperatures and ease of body heat loss exert a dominant effect over human comfort and many body functions has been well established. This matter is well covered in my book "Climate Makes the Man," published in 1942 by Harpers of New York City, and in my review article, "Temperature Dominance Over Human Life," published in Science, Sept. 16, 1949, vol. 110, pp. 267-271.

During these three decades of research on temperature dominance I developed a keen interest also in indoor climate control over body heat loss through radiant heat transfer channels rather than through the more conventional air transport of heat to or from the body and occupied spaces. My first article on these studies, "Control of Body Heat Loss Through Radiant Means," was published in the journal section of Heating, Piping and Air Conditioning, pp. 697-9, November 1937, and this article has been followed by many others as the studies progressed through the years. An application for Letters Patent was filed December 2, 1950 (Ser. No. 198,805) and Letters Patent No. 2,651,503 were granted thereon September 8, 1953, under the title "System of Radiant Heat Exchanging."

My studies in radiant heat transfer also spread over into the radiant heating and cooling of industrial products, giving rise to several more applications for Letters Patent and a new concept of radiant heat transfer in the infrared range of wavelengths. This new concept was best elucidated in a printed brochure entitled "Application of Quantum Mechanics to the Radiant Heating and Cooling of Products and People." This brochure covers essentially the material formally presented on April 15, 1959, before the Baltimore Chapter of the American Society of Heating and Air-Conditioning Engineers, before the Baltimore Chapter of the American Society of Mechanical Engineers on January 25, 1960, and at the U.S. Naval Academy at Annapolis on March 4, 1960, and which is to appear in print soon as a section of volume III of Medical Physics published by Year Book Publishers, Inc., Chicago.

What I shall now described, and desire to secure by Letters Patent is a new and improved system of reflective radiant conditioning for human comfort. The first complete installation of this system has now undergone successful operational testing through both severe summer moist heat and sub-zero winter cold in a residence located in Munster, Indiana.

My new system comprises certain features covered in my Letters Patent No. 2,651,503 as follows:

- (1) Infrared reflective, decorative foil wall coverings.
- (2) Aluminized, infrared reflective window drapery materials (although now aluminized only on the outward facing surfaces).
- (3) Pressurizing ventilation of the conditioned structure, with electrostatic cleansing of all incoming air and no air recirculation.
- (4) A single fluid line connecting in-the-room radiant heat transfer elements with the system's liquid-heating and liquid-cooling devices.

This new system comprises in addition the following new features:

- (1) Plate coils (Revere Tube-in-Strip type), ceiling suspended in a manner similar to ornamental valences, positioned out from the side walls sufficiently to allow

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for radiant heat transfer from the back as well as front surfaces, coated with a dull-coat or matt-finish moisture-proof paint, and having small drip troughs attached to their lower edges by insulating connections so as to prevent summer chilling of the troughs and moisture condensation on their outer surfaces. These plate coils replace the cove structures described in the above numbered Letters Patent No. 2,651,503.

- (2) A brine coil through which incoming pressurizing air must pass for its pre-warming in winter or cooling and dehumidification in summer.

- (3) Control devices (humidistat and summer-winter thermostat in occupied area, thermostat with its sensing element in air supply duct, thermostats for boiler and liquid chiller, flow valves, mixing valves and circulating pumps) for fluid lines as indicated in FIGURE 1, FIGURE 7 and FIGURE 8.

- (4) Fluid pressure and storage tank from which circulating pumps draw as needed to satisfy the control devices for the air inlet brine coil and the in-the-room plate coils.

This is essentially a split system, with two separate brine circulating lines drawing from a common hot or cold liquid source. Circulation to the brine coil in the air inlet duct during the moist heat of summer is under control of a humidistat located in the occupied area, so that any desired degree of humidity may be maintained in the occupied area. When no dehumidification of incoming air is called for, the positioning of the mixing valve in the line to the air inlet coil is controlled by a thermostat whose bulb is sensing duct air temperature downstream from the brine coil.

Circulation of brine to in-the-room plate coils is under the control of a summer-winter thermostat located in the occupied area which positions the mixing valve in this supply line to draw in more or less of freshly heated or chilled liquid to meet temperature demands of the thermostat. There may, if desired to meet different heating or cooling load conditions or temperatures desired, be more than one brine supply line to in-the-room plate coils located in different areas, each such brine supply line having its own thermostat and mixing valve to control brine flow.

Customarily the humidistat is set to maintain about 50% relative humidity in the occupied areas during summer moist warmth, while the thermostat in the air supply duct is usually set to give a 60° F. incoming air temperature at all other times. Incoming air temperatures below 60° F. during winter cold have been found to exert a chilling effect on occupants as they move about in the conditioned areas.

The thermostat controlling the temperature of the fluid circulating through the in-the-room plate coils is customarily set so as to give a 73° F. reading on a stationary mercury thermometer in the occupied area during winter conditioning and to give a 76° to 78° F. reading during summer conditioning. Adjustments up or down from these temperatures can readily be made by changing the thermostat setting as desired.

Pressurizing ventilation of a structure with electrostatically cleansed air obviates the need for openable windows, window or door screens or weather stripping, and results in remarkable indoor cleanliness even in urban areas of severely polluted air. Infiltration of the structure with outdoor dust and dirty unconditioned air is sharply minimized.

Dehumidification of the incoming pressurizing air stream, together with the use of foil wall coverings on all outside walls and ceilings as a vapor seal, prevents the ingress of outdoor summer humidity into the humidity-controlled occupied areas.

Use of infrared reflective window draperies makes

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possible a high degree of control over radiant heat ingress through glassed areas in summer and radiant heat loss in winter; and, in association with lack of washing air currents across such glassed areas, it obviates the need for expensive double glazing and makes possible the use of whole glass walls if so desired.

Use of infrared reflective wall coverings and window draperies, in conjunction with the use of radiant channels for heat input or removal and the minimizing of air currents in the occupied areas, results in conditioning load reductions of about 50% for summer cooling-dehumidification and about 40% for winter heating as compared to conventional air heating and cooling systems.

The above and other objects to be explained in the following specification are illustrated in the following drawings, in which:

FIGURE 1 is a diagram of a layout of plate coils and supply lines in the residence referred to.

FIGURE 2 is a diagram of the supply and return headers to the plate coils in the living room.

FIGURE 3 is a diagram of the supply and return lines for plate coils in the other rooms in the house.

FIGURE 4 is a detail view of the ceiling suspension of plate coil and drip trough spaced outwardly 6 inches from the side wall.

FIGURE 5 is a diagrammatic layout of supply ducts and room outlets for conditioned air for humidity, ventilation and dirt control.

FIGURE 6 is a schematic diagram of the equipment and piping layout.

FIGURE 7 is a schematic diagram of the electrical and control layout.

FIGURE 8 is a schematic diagram of the conditioning equipment for the air supply to the house.

Perhaps reference to the diagram in FIGURE 8 should first be made as this indicates a preferred manner of introducing outside air into the house. The inlet from outside is indicated in the conduit A. The outside air first passes through an electrostatic filter B which is of conventional structure. At C I have shown a blower which maintains the volume of air introduced into the house.

Referring now to FIG. 5, there is shown a diagrammatic layout of supply ducts and room outlets. It should be remembered that my reflective radiant conditioning system is a split system. This means that while an adequate supply of air, controlled as to temperature and humidity by the flow through the brine coil D in the air inlet duct, is maintained within the rooms of the house, there is no return or recirculation of this air supply. It is maintained with enough pressure to exceed that of the air outside the house so that all leakage around windows and doors will be from the inside to outside. This avoids any dust, dirt or high moisture laden air getting into the inside of the house. At the same time the temperature affecting people within the house is controlled not by the incoming current of air, but by the radiation from plate coils to room materials or cooling by radiation from room materials to plate coils.

In FIG. 5 the walls of the house and the partitions between the rooms are indicated by shaded areas. Generally speaking, 1 indicates house walls and 2, the single solid lines, indicate glass. At 3 is shown the duct conveying air coming up from the basement. The duct 3 feeds the air from the basement into a series of connecting conduits 4 which have at their ends air outlet diffusers 5 through which the air is passed to the living room, the kitchen, the bathrooms and bedrooms. Each conduit has an adjustment valve 6 by which the volume of air passing to a given room may be controlled.

The radiating plate coils may be of compound type as shown in FIG. 2 or of single coil type as shown in FIGS. 3 and 4. The compound type has a liquid supply line 9 which may be either heated liquid or chilled liquid

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brine. The brine may be a saline solution or it may be a water glycol mixture. The liquid passes through a series of reducing L's 10 and then moves through the plate coils 11 from which it discharges through another series of reducing L's 12 being then returned to the chilling device or boiler through a pipe 13.

The more simple type of radiant reflecting devices is shown in FIGS. 3 and 4. The brine pipe in this type is indicated at 14 and the tube in strip plate consists in the inlet tube 15 which is returned through several elbows 16 and the tubes 16a, 16b from which it connects to the return brine line 17. Drip troughs 50 are suspended from the plate coils by means of the heat insulative pins 51. It will be understood that the pins 51 will be suitably spaced over the entire length of the plate coils.

In FIG. 1 different types of plate coils are suggested such as that indicated at 18 in the living room, that indicated at 19 in the kitchen, and 20 in the bedrooms. Each plate coil as shown in FIG. 4 is suspended from the ceiling in a manner similar to an ornamental valence. The plate coils are so positioned out from the nearest side wall so that the infra red rays will be projected out from both surfaces of the plate coils. Since the nearest wall is coated with a reflective surface the rays will not only project downward from the left side of the plate coil but also from the right side so that there is a doubling up of the effect of cooling or warming room occupants.

FIGURES 6 and 7 present schematic diagrams of the split system of brine circulation contemplated by my invention, with the various components indicated in detail as installed in the Munster, Indiana, residence. The system includes the brine heater unit 30, with its shut-off valve 30a and air-trol tank 32, and the brine chiller unit 31 with the shut-off valve 31a. It will of course be understood that during the summer cooling season, the valve 31a will be open, and the valve 30a will be closed to isolate the heating unit 30; and during the winter heating season, the positions of these valves will be reversed. The brine flows from the heater 30 or the chiller 31 through the conduits 30b and 31b respectively, both of which lead to the manual three-way valve 33, which will be open to the conduit 30b during the winter or heating season and to conduit 31b during the summer or cooling season. At 34 I have shown a brine pressure storage tank, which will prevent the circulating pumps 40 and 46 from working against each other if they are of different capacity. Leading from the tank 34 are the conduits 35 (which supplies brine to the room plate coils 18, 19 and 20 and is one phase of the split system), and 36 (which supplies the brine solution to the coil D in the air inlet duct which is the other phase of the split system). In the conduit 36 I provide a three-way mixing valve 33, and a mixing valve motor 37, which as shown in FIGURE 7 will be operatively connected to the thermostat 8 in the air inlet duct, and to the humidistat bulb 7, also located in the air inlet duct. In general, the thermostat 8 will control the flow of the brine in the coil D, and hence the temperature of the air supply to the rooms at all times except when the humidistat 7 is calling for dehumidification. The circulating pump 40 operates at all times that the system is in use, continually circulating the liquid brine through the conduit 41, the coil D, the return conduit 42, and then back to either the heater unit 30 or the chiller unit 31, depending on the setting of the valves 30a and 31a. It will also be noted that I provide a by-pass system 39, through which excess brine may be by-passed to the return conduit 42.

In the conduit 35, I provide a three-way mixing valve 44, and a mixing valve motor 43, similar to the valve and motor 37 and 38 in the conduit 36. The motor 43 is operatively connected to the summer-winter thermostat located in the living area, and by controlling the brine flow controls the temperature in that area. The brine in this part of the system is circulated by the pump 46, through the conduit 47, to the room plate coils 18, 19 and 20, and

through the return conduit 48 to the heater unit or the chiller. Again, I provide a by-pass system indicated at 45, through which excess brine liquid from this part of the split system may be by-passed from the room plate coils back to the return conduit 48.

Thus it will be observed that in my system of indoor comfort conditioning, I have made provision for needed heat input or removal from occupied space through overhead radiant heat transfer plate coils and I have also made provision for humidity, dirt, fume, and ventilation control for such occupied space through the continuous introduction of a pressurizing stream of filtered and conditioned outdoor air.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A system for comfort conditioning an area enclosed by a ceiling and side walls comprising (a) a radiant heat exchange system, said system comprising a plate coil having a dull, matt finished coating disposed in the area to be conditioned, drip troughs suspended through heat insulative connections from the lower edge of said plate coil, said plate coil being suspended from the ceiling of said area and positioned a short distance from a side wall to facilitate a maximum of direct and reflected heat transfer between both sides of said plate coil, an aqueous brine system circulating through said plate coil, means for heating and cooling said brine, and means for controlling the flow of said brine through said plate coil whereby the temperature of said area to be conditioned is controlled, and (b) a pressurized, ventilating, non-recirculating air system, said air system comprising a duct communicating between said area to be conditioned and the outside air, means in said duct for conveying a supply of said outside air into said area to be conditioned, means in said duct for electrostatically cleaning said supply of air, a brine coil in said duct, said aqueous brine system circulating through said brine coil, and means for controlling the flow of said brine through said brine coil whereby the temperature and humidity of said supply of outside air is controlled; said brine system circulating through said plate coil and through said brine coil, and said means for heating and cooling said brine comprising a single split system includ-

ing a boiler, a chiller, a three-way valve, said boiler and said chiller each being in communication with said three-way valve, a brine storage tank in communication with said three-way valve, a first passageway from said tank communicating with said plate coil, a first circulating pump in said first passageway, a second passageway leading from said tank, said second passageway being in communication with said brine coil, a second circulating pump in said second passageway, a return duct communicating at one end with both said plate coil and said brine coil, and communicating at the other end with both said boiler and said chiller, and valve means in said return duct adapted to selectively control the flow of said brine through said boiler and said chiller.

2. The system claimed in claim 1 including means for maintaining said supply of outside air at a pressure which exceeds the outside air pressure.

3. The system claimed in claim 2 including infrared-reflective surfacing materials on said side walls.

4. The system claimed in claim 2, wherein said means for controlling the flow of the brine in said radiant heat exchange system comprises a summer-winter thermostat disposed in the area to be conditioned, a valve in said first passageway, and a valve motor for adjusting said valve, said valve motor being operatively connected to and actuated by said summer-winter thermostat, and wherein said means for controlling the flow of said brine in said pressurized air system comprises a thermostat in said duct, a humidistat in said duct, a valve in said second passageway, and a valve motor for adjusting said valve, said valve motor being operatively connected to and actuated by said humidistat and said thermostat.

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