

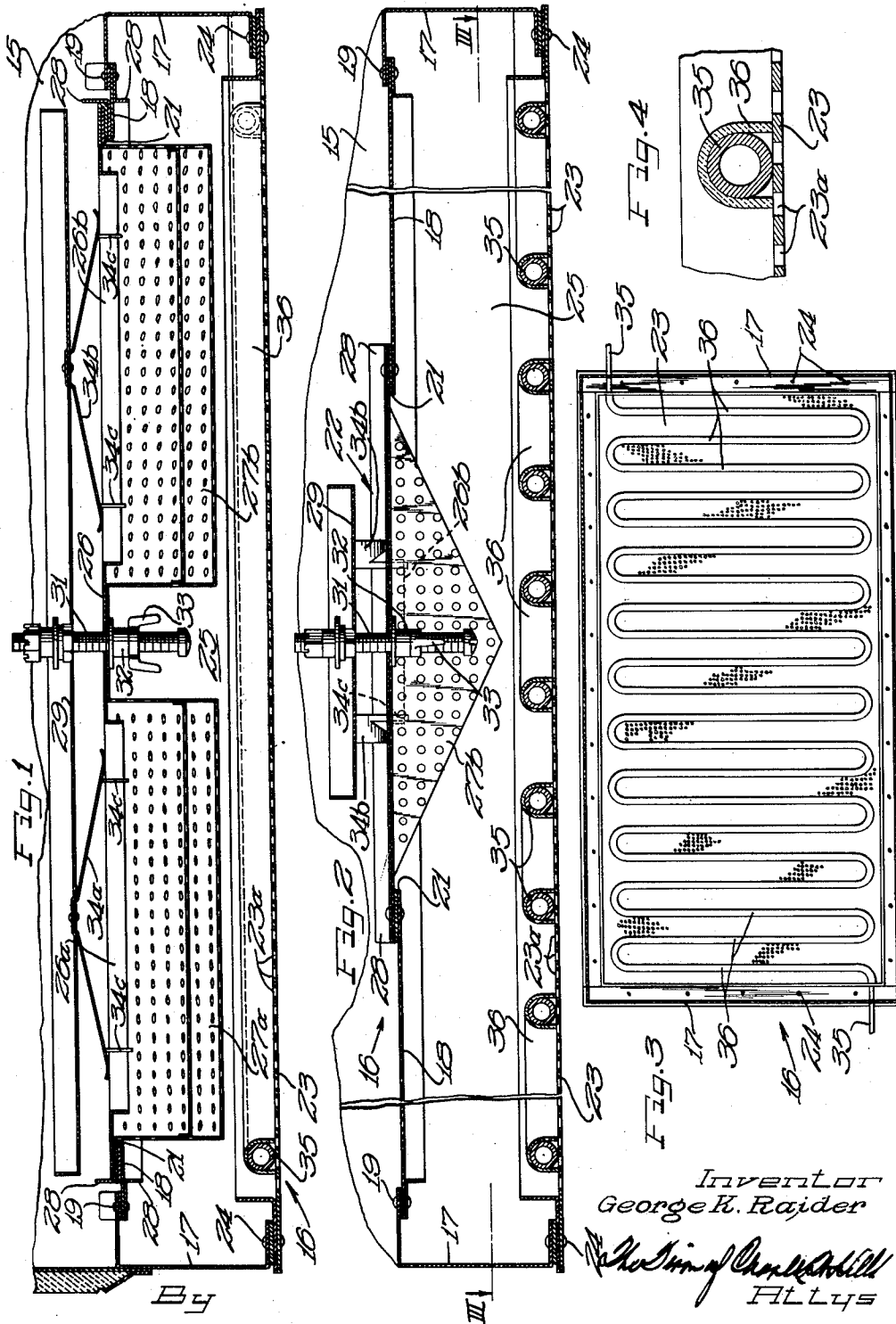
May 4, 1954

G. K. RAIDER
RADIANT HEATING SYSTEM

2,677,749

Filed Oct. 29, 1949

4 Sheets-Sheet 1



Inventor
George K. Raider

George K. Raider
Attys

May 4, 1954

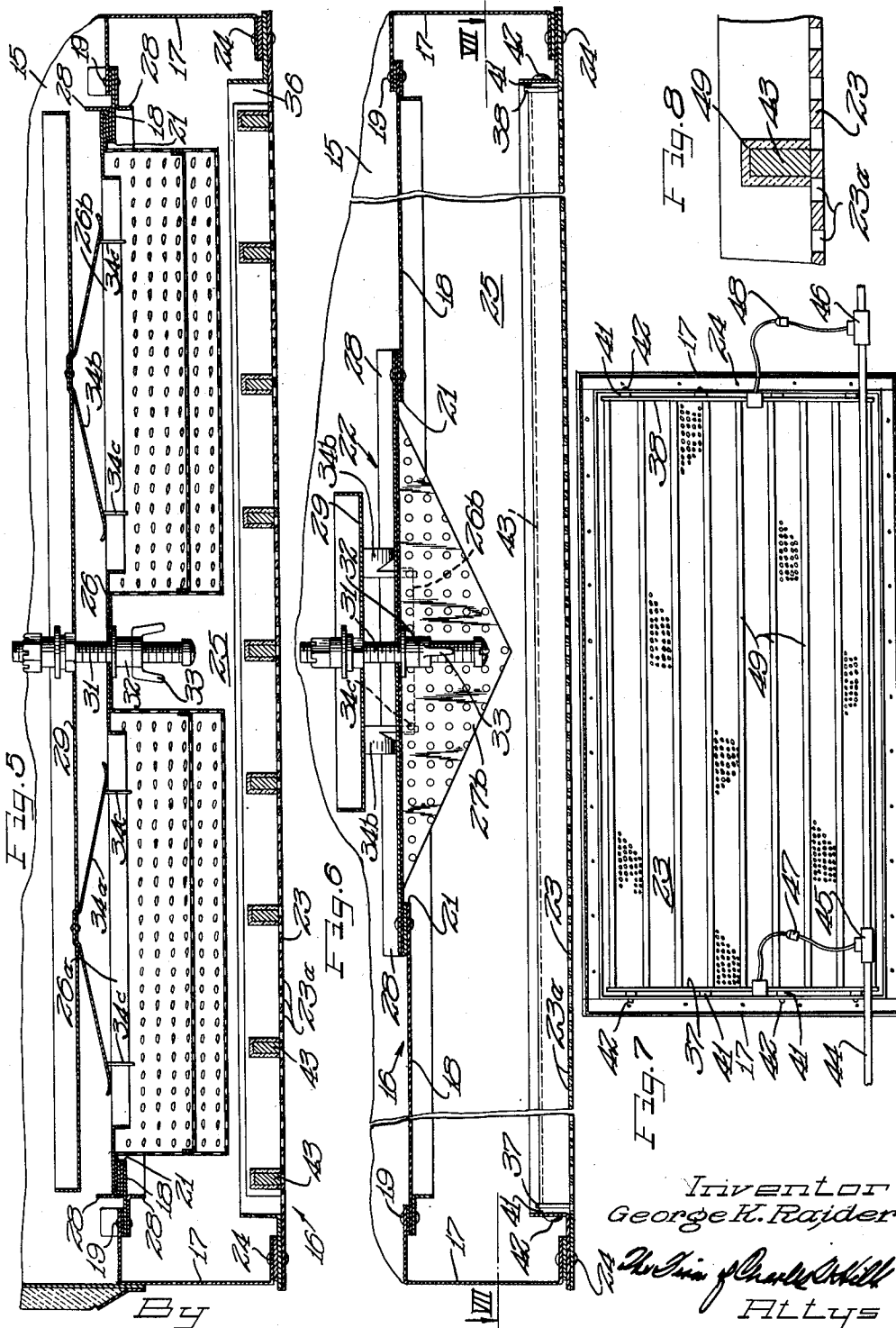
G. K. RAIDER

2,677,749

RADIANT HEATING SYSTEM

Filed Oct. 29, 1949

4 Sheets-Sheet 2



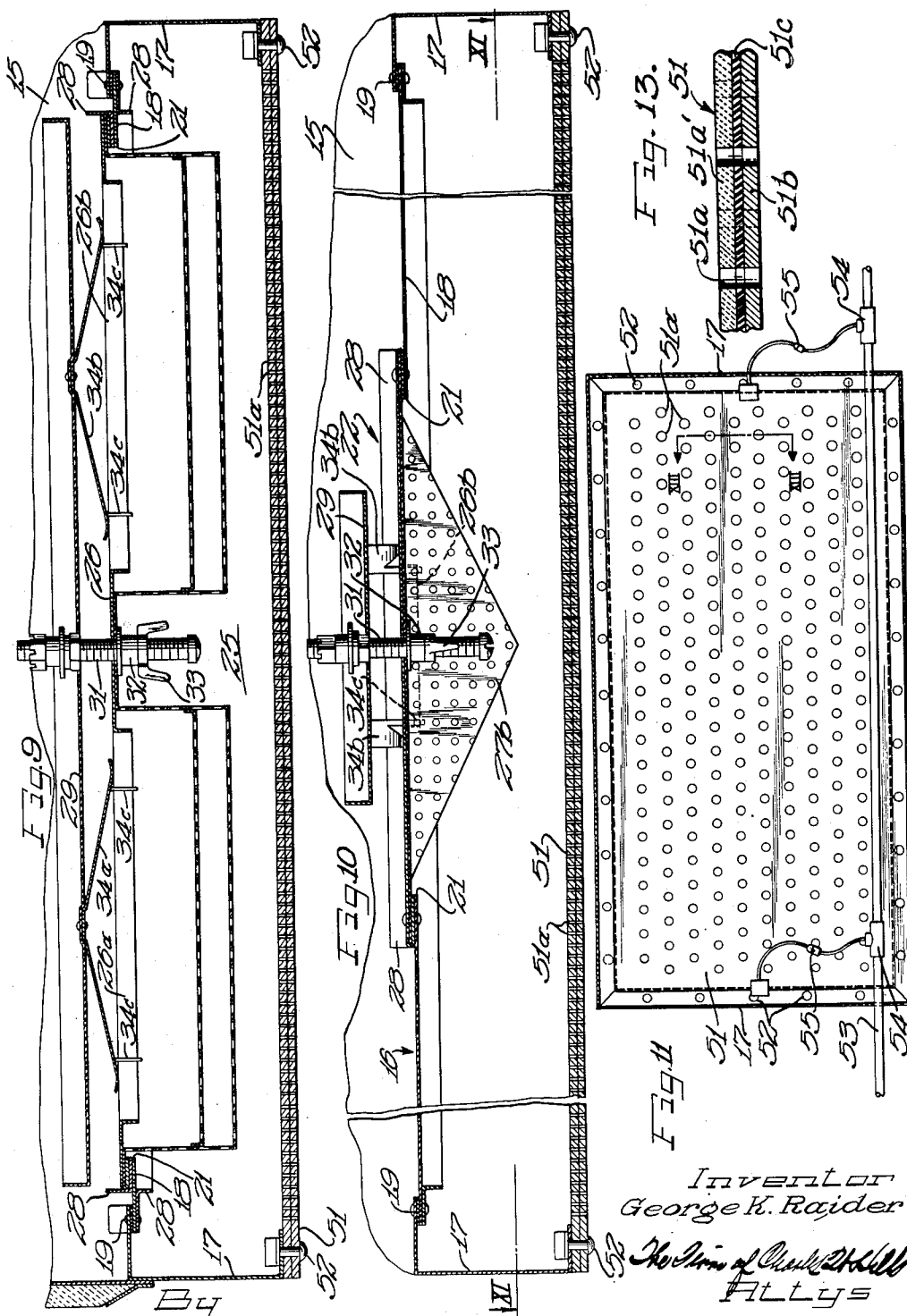
Inventor
George K. Raider

Attorneys
Charles C. Miller

2,677,749

Filed Oct. 29, 1949

4 Sheets-Sheet 3



May 4, 1954

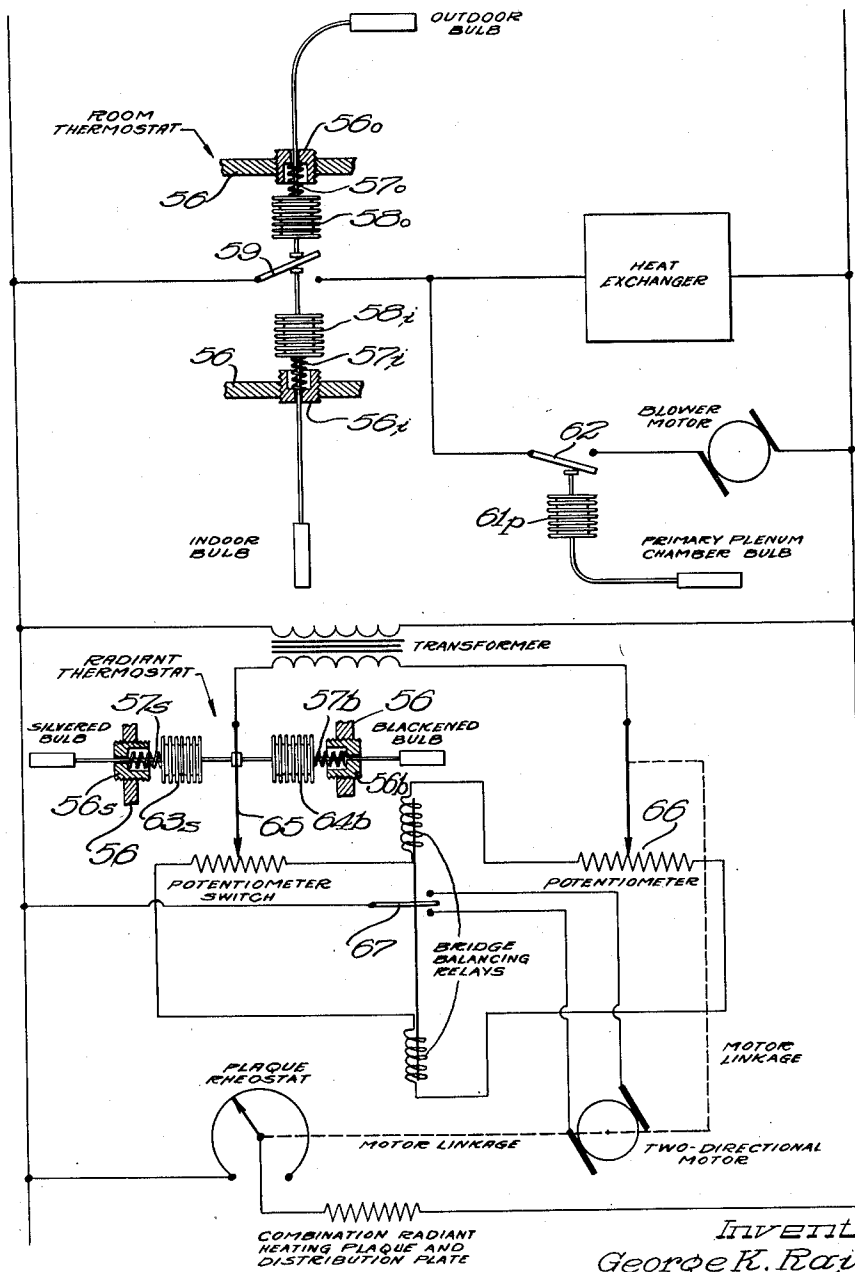
G. K. RAIDER
RADIANT HEATING SYSTEM

2,677,749

Filed Oct. 29, 1949

4 Sheets-Sheet 4

Fig. 12



INVENTOR
George K. Raider

By *The Firm of Charles H. Hill* Attys

UNITED STATES PATENT OFFICE

2,677,749

RADIANT HEATING SYSTEM

George K. Raider, Chicago, Ill., assignor to The Pyle-National Company, Chicago, Ill., a corporation of New Jersey

Application October 29, 1949, Serial No. 124,322

19 Claims. (Cl. 219—39)

1

The present disclosure constitutes a continuation-in-part of my copending application, Serial No. 58,090, filed November 3, 1948.

This invention relates generally to heating, cooling and ventilating systems, and more particularly relates to improvements in a ventilating system of the type which operates on the so-called pressure-displacement principle.

Conditioning equipment for the treatment of ventilating air which operates on the pressure-displacement principle has been found to be especially efficient where it is necessary to deliver to occupied spaces very large volumes of air required for crowded conditions under extremes of exterior temperatures without excessive air motion which would otherwise result in the production of detectable drafts or friction noise due to the sound of rushing air.

A particularly useful application of this type of conditioning equipment has been made in railway equipment wherein the apparatus may comprise a plurality of panel units each including a control plate and frame cooperatively related with a pressure-displacement air valve and a perforated ceiling plate.

In a typical installation, the panel units are spaced along the length of a railway car and the control plate and frame is installed in the bottom of an air supply duct or plenum chamber which preferably is located in the ceiling of the car.

The adjustable air valve functions as an orifice control valve and allows adjustment of each panel unit down the length of the air supply duct or plenum chamber so that uniform delivery and adjustment can be readily made throughout the length of the duct.

The perforated ceiling plate operates not only to further diffuse the low velocity air emanating from the panel units but also may form part of the interior of the occupied space so as to harmonize with the decorative treatment thereof.

According to the general features of this invention, a perforated radiant heating plaque made of thermally conductive material is adapted to comprise the distribution ceiling plate of the pressure-displacement type panel unit ventilating apparatus. One or more heat transfer elements are arranged within the low velocity secondary plenum chamber defined by the panel unit in heat conductive contact relationship with the radiant plaque so that the radiant plaque may be readily subjected to increases or decreases in temperature when the heat transfer elements are supplied with a temperature conditioning medium.

The heat transfer elements are preferably isolated from convection currents set up within the low velocity secondary plenum chamber by suit-

2

able insulation. In this manner, the primary heat loss compensation may be provided for by means of an air conditioning heat exchanger located at a central station and suitable control apparatus may be provided to control the temperature of the radiant plaque independently of the temperature flowing through the panel unit. Moreover, such an arrangement also makes it possible to control the temperature of the radiant plaque in sequence with the thermostatic temperature control of the air passing through the panel unit.

Inasmuch as the overall cooling effect of the atmosphere upon the human body depends upon variations in the temperature of the air, its humidity and its rate of motion, it will be apparent that the combination of all of these factors must be correctly controlled to establish the highest possible comfort condition, even though variations may occur between certain limits.

The provision of a radiant plaque in the manner described materially improves the measure of control attainable with a pressure-displacement panel unit of the type herein referred to. For example, if it is necessary to temperature condition an occupied space for warmth, the maintenance of a relatively high temperature in the radiant plaque permits the employment of a considerably cooler ventilating air for a high comfort condition. Thus, the humidity of the ventilating air may be more accurately controlled so as to approach the ultimate comfort level of the space. It is believed that the improved control of the inter-related factors afforded by the provision of a radiant plaque in accordance with this invention will be readily appreciated by those versed in the art.

It is the object of the present invention, therefore, to provide a plate made of thermally conductive material which serves the dual function of operating as a radiant heating plaque as well as the distribution plate of a pressure-displacement panel unit.

Another object of the present invention is to provide an arrangement whereby a radiant heating plaque may be adapted for use in a panel unit of a ventilating air system operating on the so-called pressure-displacement principle.

A further object of the present invention is to provide a radiant plaque type heating panel which may be selectively used either as a heater or as an air distribution panel.

Yet another object of this invention is to provide a combination radiant plaque type heating panel unit and air distribution panel which is suitable for use with a heating system or an air cooling system.

Another and further object of this invention

is to provide a combination radiant plaque type heating panel and air distributor panel which incorporates electrical temperature conditioning elements therein.

A still further object of this invention is to provide a combination radiant heat transfer path panel and air distributor panel which is constructed of an elastomeric material which, by proper compounding, is capable of conducting electricity either by transformation of thermal energy or by dissipation of electrical charges.

Another object of the present invention is to provide a method of controlling the temperature conditioning of an occupied space whereby the temperature of a radiant plaque may be controlled in sequence with a thermostatic temperature control of ventilating air.

Another object of the present invention is to provide a method of controlling the temperature conditioning of an occupied space whereby the temperature of a radiant plaque may be controlled independently of the temperature of ventilating air.

It is believed that the methods contemplated by the present invention will best be understood from a description of the apparatus provided for practicing such methods.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the annexed sheets of drawings in which the principles of the present invention are exemplified.

On the drawings:

Figure 1 is a fragmentary cross-sectional view showing the details of construction of a panel unit incorporating the principles of my invention;

Figure 2 is a fragmentary cross-sectional view partly broken away and taken on a plane transversely to the plane of Figure 1 showing additional details of construction of the panel unit;

Figure 3 is a cross-sectional view taken on line III—III of Figure 2;

Figure 4 is an enlarged fragmentary detailed view showing the cross-section of one of the heating elements in Figure 3;

Figure 5 is a view similar to that shown in Figure 1 but showing the details of construction of a modified panel unit according to the present invention;

Figure 6 is a fragmentary cross-sectional view partly broken away and taken on a plane transverse to the plane of Figure 5 showing additional details of construction of a modified panel unit;

Figure 7 is a reduced cross-sectional view taken on line VII—VII of Figure 6;

Figure 8 is a fragmentary detailed view showing the cross-section of the heating elements employed in the modified panel unit of Figure 7;

Figure 9 shows a further modification of the panel unit of Figure 1;

Figure 10 is a fragmentary cross-sectional view partly broken away taken on a plane transverse to the plane of Figure 9 showing additional details of construction of the modified panel unit;

Figure 11 is a cross-sectional view taken on line XI—XI of Figure 10;

Figure 12 is a diagrammatic view of a control system which may be employed according to the present invention;

Figure 13 is a vertical sectional view taken on line XIII—XIII of Figure 11.

As shown on the drawings:

The type of ventilating system described herein setting forth the principles of my invention

has many applications in residential, commercial and industrial air conditioning systems; furthermore, it may be noted that the present invention finds a particularly suitable application when employed in a ventilating system serving an occupied space such as a railway car or the like.

In any event, whether adapted for architectural purposes or for use in a railway car, it will be apparent upon making reference to the drawings that an open bottomed duct or plenum chamber may be defined by a duct of ceiling structure 15 and a plurality of panel units one of which is indicated generally by the reference numeral 16 may be positioned subjacent thereto and in communication therewith.

Each panel unit 16 consists primarily of three main parts, a control plate and frame, a pressure displacement air valve and a perforated ceiling plate.

For clarity in understanding, the frame elements are indicated by the separate reference numeral 17 and the control plate indicated by the reference numeral 18 is shown as being installed in the bottom of the air supply duct or primary plenum chamber defined by the ceiling structure 15 in fixed assembly with the frame elements 17 by means of appropriate fasteners 19. It will be noted that the control plate 18 defines at least one large aperture indicated by the reference numeral 21.

The pressure-displacement air valve comprises an adjustable air valve indicated generally by the reference numeral 22 and functions as an orifice control valve to regulate the flow of air from the primary plenum chamber above the control plate 18 through the aperture 21 therein.

The perforated ceiling plate of this invention comprises a radiant heating plaque 23 made of thermally conductive material and is adapted to serve the dual function of acting as a distribution plate by virtue of a plurality of spaced apertures 23a formed therein. The combination radiant plaque and distribution plate 23 is attached in firm assembly to the frame element 17 by means of fasteners 24 and is supported by the frame element 17 in spaced relationship to the control plate 18 so as to define a secondary plenum chamber 25 therebetween.

The adjustable air valve 22 is a total pressure displacement valve and delivers air from the primary plenum chamber to the secondary plenum chamber 25 at very low pressures. The resultant low pressure leaving the adjustable valve 22 is preferably only what is required to send air through the perforated radiant heating plaque and distribution plate 23.

As shown on the drawings, the adjustable air valve 22 includes a valve frame 26 defining a pair of spaced orifices 26a and 26b which are flanged on their edges. A diffuser structure 27 including a pair of diffusers 27a and 27b, each diffuser comprising essentially a perforated V-shaped trough, is disposed subjacent the opening 26a and 26b respectively and in registry therewith.

The valve frame 26 together with the diffuser structure 27 rests on the edges of the aperture 21 defined by the control plate 18 and may be placed in firm assembly therewith by means of the fasteners 19. It will be noted that the diffusers 27a and 27b extend into the secondary plenum chamber 25.

Appropriate stiffeners 28 may be provided to add strength to the control plate 18 at the locale of the aperture 21.

An adjustable valve plate 29 is positioned

superjacent the orifices 26a and 26b and is carried by a threaded spindle or shaft 31 extending through a central portion of the valve frame 26. A threaded boss 32 is secured to the valve frame 26 so that any selected vertical position of the valve plate 29 effected by adjustment of the threaded spindle or shaft 31 may be securely locked by means of an adjusting nut 33 carried by the spindle or shaft 31.

A pair of resilient elements 34a and 34b having angularly disposed legs and depending guide portions may be affixed to the valve plate 29 in such a manner as to provide a resilient bias for the valve plate to prevent rattling thereof and to guide the valve plate along a vertical path relative to the valve frame 26. The depending guide portions, indicated by the reference numeral 34c, slidably engage the flanged edges of the apertures 26a and 26b formed in the valve frame 26.

It will be apparent that each valve plate 29 may be individually adjusted to permit a predetermined setting of individual panel units 15 down the length of an air supply duct or primary plenum chamber so as to effect a uniform delivery of air through each panel unit 15.

The description thus far has set forth an improved ventilating structure which has found wide application to air conditioning systems requiring the distribution of conditioned air without detectable draft.

To further achieve the objectives of the present invention, the structure thus far described may be modified by the provision of heat transfer elements associated with the radiant heating plaque and distribution plate 23 so as to permit the independent or sequential control of the radiant heating plaque temperature in connection with the temperature of the air flowing through the panel unit 15.

As may be seen in Figures 1 through 4 inclusive, a tubular element 35 is provided which defines a tortuous path on the hidden face of the radiant heating plaque and distribution plate 23 within the secondary plenum chamber 25. It will be noted that the tubular element 35 is placed in abutting relationship to the radiant heating plaque and distribution plate 23 so that conditions favorable to thermal conductivity may be established therebetween.

In order that possible transfer through convection heating phenomena be minimized, the tubular element 35 is completely cased on the surface exposed in the secondary plenum chamber 25 by means of suitable insulation indicated by the reference numeral 36.

A conditioning medium may be supplied to the tubular element 35 and, depending upon the type of conditioning required, may comprise a heating fluid such as steam or hot water or a suitable coolant. The radiant heating plaque will therefore be conditioned by virtue of its thermally conductive relationship to the tubular element 35.

In Figures 5, 6, 7 and 8 there is shown a modified form of the novel panel unit of the present invention.

The construction of the unit shown in Figures 5, 6, 7 and 8 is identical with that previously described in connection with Figures 1, 2, 3 and 4 with the exception of the heat exchange elements provided.

As may be seen on the drawings, a pair of headers 37 and 38 made of suitable electrically conductive material may be supported by and spaced from the stiffeners 39 formed on the end

of the panel unit 15 by means of suitable insulating spacers 41 and fasteners 42. A plurality of resistance elements 43 may be provided and are carried between the headers 37 and 38. Electric current may be supplied to the headers 37 and 38 from a conduit 44 having suitable outlets indicated by the reference numerals 45 and 46, respectively. For convenience, electrical connection to the headers may be made by suitable quick disconnect plug and socket receptacles indicated by the reference numerals 47 and 48.

The electrical resistance elements 43 are preferably arranged in thermally conductive relationship to the radiant heating plaque and distribution plate 23 in the same manner as previously described in connection with the tubular element 35. The electrical resistance elements 43 may be insulated against convection phenomenon in the secondary plenum chamber 25 by means of suitable insulation 49.

In Figures 9, 10, and 11 the construction of the panel unit 15 is modified through the employment of a combination radiant plaque and distribution plate 51 which may be perforated by a plurality of spaced apertures 51a and fastened in firm assembly to the frame element 17 by fasteners 52, the combination radiant heating plaque and distribution plate taking the form of an elastomeric material having appreciable electrical conductivity characteristics. Electrical current may be supplied to the combination radiant heating plaque and distribution plate 51 from the conduit 53 by means of outlet 54. For convenience, electrical connection to the plaque may be made by suitable plug and socket receptacles indicated by the reference numeral 55.

The radiant panel 51 is made of an elastomeric material, such as that known commercially as "Pliotherm" or "Uskon," which has the characteristics of being capable of conducting electricity and transforming it into thermal energy by the dissipation of electrical charges. It is contemplated that a panel made of such material, when energized, will form a very effective radiant heating panel.

The panel 51 has an upper surface 51a', Figure 13, of insulating material, a lower surface 51b of a material of high heat conductivity and a center film of the current-carrying elastomeric material. Thus, heat is passed to the lower surface 51b from which it is radiated to the enclosure therebelow.

In operation, the temperature of the radiant heating plaque and distribution plate may be controlled independently of the temperature of the air flowing through the panel unit. Moreover, it is further contemplated that the temperature of the radiant plaque may be controlled in sequence with thermostatic temperature control of the air passing through the individual panel unit. The diagrammatic drawing shown in Figure 12 illustrates a control system for accomplishing the type of regulation necessary to effect the ends stated.

By way of example but not by way of limitation, the sensing elements and actuators of the subject control system are shown as comprising a group of bulbs, bellows and connecting capillary tubes filled with a volatile liquid. It will be apparent to those versed in the art that the principles exemplified by the control system to be described may be equally applicable to control systems employing other types of sensing elements and actuators.

A room thermostat having an outdoor bulb

type sensing element and an indoor bulb type sensing element is indicated by legend. The sensing elements are arranged in opposition to one another to actuate a switch through thermostatic linkage. The thermostatic linkage may include fixed frame elements 56 carrying adjustable bushings 56o and 56i which, in turn, seat balancing springs 57o and 57i associated with actuators in a form of bellows 58o and 58i. The linkages are placed in control of a switch indicated by the reference numeral 59.

A difference in temperatures will be reflected by movement of the thermostatic linkage to a new equilibrium position, such motion causing the switch 59 to be operated. It will be apparent that the switch 59 responds primarily to indoor temperature variations, opening when the desired temperature is equalled or exceeded and closing to permit operation of the heat exchanger employed at a central heating station which is adapted to temperature condition the main air supply provided to the primary plenum chamber of the ventilation system.

The outdoor sensing element modifies the control point, allowing a lower indoor temperature to satisfy the room thermostat when the outdoor temperature is very low by progressively raising the indoor control point as the outdoor temperature rises.

Assuming, for purposes of explanation, the operation of the system in a heating cycle, the closing of the thermostatically controlled switch 59 will energize the operating controls of the heat exchanger which, in turn, will provide temperature conditioned air at the proper temperature to the primary plenum chamber of the ventilation system. When the proper temperature is attained within the ventilation system, the primary plenum chamber bulb acting through an actuator taking the form of a bellows 61p will close a switch 62 to energize the motor of a blower indicated on the drawings.

When the upper limit of room temperature is attained on the room thermostat, the switch 59 will open, thereby stopping the blower regardless of the position of the switch 62. It will be apparent, therefore, that the blower can never deliver cold air to the occupied space because it will not operate unless both the switches 59 and 62, electrically connected in series, are closed.

The control of the radiant plaque output is illustrated in Figure 12 in connection with the form of panel unit including electrically energized heating elements, however, it should be apparent to those versed in the art that the form of radiant plaque which is controlled by conditioning mediums other than electricity could be easily adapted by substituting valves or other equivalents for the resistance rheostat used to control the flow of electric current to the heating elements.

One particularly advantageous system for controlling the output of the radiant plaque employs an electric motor mechanically linked to a rheostat, the electric motor being responsive to changes in an adjustable potentiometer switch setting determined by two actuators acting in opposition to one another and controlled by sensing elements of a radiant thermostat.

The sensing elements of the radiant thermostat take the form of a silvered thermal bulb and a blackened bulb located adjacent one another and spaced proximate the radiant heating plaque and connected to actuators in the form of a bellows 63s and a bellows 64b. The bellows 63s and

64b control the adjustable arm 65 of a potentiometer switch. Adjustment of the radiant thermostat may be effected by means of the bushings 55b and 56s and the balancing springs 57b and 57s, the bushings being shown in adjustable assembly in the frame elements 56.

To those versed in the art it will be readily recognized that the silvered bulb may be polished so it will be least responsive to radiant heat exchange while the blackened bulb will be especially sensitive to radiant heat exchange. As the radiant effect in the occupied space changes because of temperature variations in the combination radiant heating plaque and distribution plate, the potentiometer switch position will be varied.

A second potentiometer 66 may be placed in electrical bridge relationship with the potentiometer switch so that variations in the potentiometer switch position will upset the bridge balance. Thus, either one of a pair of bridge balancing relays connected in series circuit in the bridge circuit will operate to immediately close a motor switch 67, thereby energizing the motor to be selectively operated in a given direction. The motor linkage simultaneously changes the setting on the potentiometer 66 until equilibrium is restored in the bridge circuit as well as the setting of the plaque rheostat.

It will be understood that a manual override (not shown) may be provided on the radiant thermostat to eliminate or modify the automatic control.

By virtue of the control system herein provided, the output of the radiant plaque may be controlled independently by effecting a selective adjustment of the radiant thermostat. Moreover, if it is desired to control the output of the radiant plaque in conformance with or in sequence with the thermostatic temperature control of the air passing through the primary plenum chamber, adjustment may be readily accomplished by making predetermined settings on each of the thermostatic mechanisms.

It will be understood, of course, that a person skilled in the art might suggest various minor modifications to the structure herein described by way of preferred embodiment and illustrative example only. I do not propose to be limited to the precise details of the structure shown but wish to embrace within the scope of this patent all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. An air distributor unit comprising, in combination, a control plate subjacent a supply duct and forming a bottom wall thereof, said control plate defining a plurality of openings therein, valve plate means positioned above said openings and movable relative to said control plate for controlling the rate of flow of air through said openings, diffusion means positioned below said openings for diffusing the air flowing through said openings, a perforated distributing panel made of elastomeric material having appreciable electrically conductive characteristics and being spaced from said control plate to form together therewith a secondary plenum chamber, said distributing panel operable to function as a radiant heating plaque when the temperature thereof is selectively varied.

2. In a ventilating air distributing system, in combination, a secondary plenum chamber superjacent an enclosure to be ventilated, a control plate defining one or more openings and form-

ing the ceiling of said chamber, a perforated diffuser positioned below each of said openings, an adjustable valve plate positioned above said openings and vertically adjustable relative to said control plate and a perforated distributing plate made of elastomeric material having appreciable electrical conductivity characteristics forming the floor of said chamber, whereby said perforated distributing plate will serve not only to more widely diffuse the air flowing to the enclosure to be ventilated but may be operated as a radiant heating plaque.

3. In combination, ventilating means for a compartment comprising, means formed to provide an air chamber adjacent the compartment to be ventilated and having a restricted inlet formed therein for admitting air under increased pressure, a valve in control of said restricted inlet to deliver air to the air chamber at reduced pressure, and a thin foraminated plate forming a common wall between said air chamber and the compartment, said plate having a plurality of uniformly spaced diffuser passages extending therethrough for supplying diffused air at a low velocity through the plate throughout its surface area to said compartment, one side of said diffuser plate presenting a smooth wall surface to the compartment, the opposite side of said diffuser plate having local heating means co-extensively spread thereover and secured thereon in thermally conductive relation with said plate for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel as well as an air diffuser panel.

4. In the combination defined in claim 3, said heating means more particularly comprising a tortuously twisted coiled tubular pipe.

5. In the combination defined in claim 4, insulation means conforming in shape to said pipe and covering the exposed areas thereof to maximize the transfer of thermal energy from the pipe to the plate.

6. In the combination defined in claim 3, said heating means comprising a plurality of electrical resistance elements and insulation means conforming in shape to said elements covering the exposed areas thereof to maximize the transfer of thermal energy from the electrical resistance elements to the plate.

7. In the combination defined in claim 3, said heating means comprising a continuous electrical resistance heating blanket having flow passages therethrough in register with said diffuser passages.

8. A temperature conditioning arrangement for a ventilated compartment comprising a secondary plenum chamber adjacent said compartment, a plenum chamber adjacent said secondary plenum chamber, means for supplying pressured air to said plenum chamber, a control plate disposed intermediate the plenum chamber and said secondary plenum chamber, said control plate defining a valve opening, adjustable valve means for controlling the flow of air from said plenum chamber into said secondary plenum chamber, a thin foraminated plate disposed intermediate said compartment and said secondary plenum chamber, said plate having a plurality of uniformly spaced diffusion passages extending therethrough for supplying diffused air at a low velocity through the plate throughout its surface area to said compartment, one side of said diffuser plate presenting a smooth wall surface to the compartment, the opposite side of said dif-

fuser plate having local heating means co-extensively spread thereover and secured on said plate in thermally conductive relation therewith for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel, as well as an air diffuser panel.

9. In a ventilating system, in combination with a ceilinged enclosure of a sheet-like control member spaced below said ceiling to form together therewith a plenum chamber subjacent thereto, said control member having an opening formed therein, a distributing panel spaced below said control member to form together therewith a secondary plenum chamber between said control member and said distributing panel, a valve plate adjustably movable relative to said control member and positioned above said opening, said valve plate operable to control the rate of flow of air through said opening, a diffusing element positioned below said opening for diffusing the air passing through said opening, said distributing panel comprising a thin foraminated plate having a plurality of uniformly spaced diffusion passages extending therethrough for supplying diffused air at a low velocity through the plate throughout its surface area to said enclosure, one side of said diffuser plate presenting a smooth wall surface to the enclosure, the opposite side of said diffuser plate having local heating means co-extensively spread thereover and secured thereon in thermally conductive relation with said plate for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel, as well as an air diffuser panel.

10. In a ventilating system, the combination of a ceilinged enclosure of a sheet-like control member spaced below said ceiling to form a plenum chamber subjacent thereto, said control member having an opening formed therein, a perforated distributing panel made of elastomeric material having appreciable electrical conductivity characteristics spaced below said control member to form together therewith a secondary plenum chamber between said control member and said distributing panel, said panel perforations providing a plurality of uniformly spaced diffusion passages for supplying diffused air at a low velocity through the panel throughout its area, one side of said panel presenting a smooth wall surface to the interior of the enclosure, a valve plate adjustably movable relative to said control member and positioned above said openings, said valve plate operable to control the rate of flow of air through said openings, a diffusing element positioned below said openings for diffusing the air passing through said openings, and conductor means connected to the perforated distributing panel for varying the temperature thereof and operating same as a radiant heating plaque.

11. In combination in a ventilating system operable on the so-called pressure-displacement principle, a space to be ventilated, a secondary plenum chamber superjacent said space, a primary plenum chamber superjacent said secondary plenum chamber to carry pressurized air, diffusion means between said secondary and said primary plenum chambers to flow low-velocity, reduced-pressure air into the secondary plenum chamber, a thin foraminated plate forming a common wall between said secondary plenum chamber and the space, said plate having a plurality of uniformly spaced diffusion passages ex-

tending therethrough for supplying diffused air at a low velocity through the plate throughout its surface area to said space, one side of said diffuser plate presenting a smooth wall surface to the space, the opposite side of said diffuser plate having local heating means spread over and secured on said plate in thermally conductive relation therewith for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel, as well as an air diffuser panel, means for varying the temperature of the air flowing into the space, a radiant thermostat responsive to variations in the output of the radiant heating panel to control the local heating means, and a room thermostat responsive to variations in room temperature to control the air temperature varying means.

12. In combination in a ventilating system operable on the so-called pressure-displacement principle, a space to be ventilated, a secondary plenum chamber superjacent said space, a primary plenum chamber superjacent said secondary plenum chamber to carry pressurized air, diffusion means between said secondary and said primary plenum chambers to flow low-velocity, reduced pressure air into the secondary plenum chamber, a thin foraminated plate forming a common wall between said secondary plenum chamber and said space, said plate having a plurality of uniformly spaced diffuser passages extending therethrough for supplying diffused air at a low velocity through the plate throughout its surface area to said compartment, one side of said diffuser plate presenting a smooth wall surface to the compartment, the opposite side of said diffuser plate having local heating means co-extensively spread thereover and secured on said plate in thermally conductive relation therewith for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel, as well as an air diffusion panel, means for varying the temperature of the air flowing into the space, a radiant thermostat responsive to variations in the thermal output of the plate to control the local heating means, and a room thermostat responsive to variations in room temperature to control the air temperature varying means, said room thermostat including an outdoor sensing element to modify the effective control point of the room thermostat in response to atmospheric temperature variations.

13. Heating means for a compartment comprising a duct and a thin diffuser plate thereover for supplying diffused air at a low velocity through the plate throughout its surface area to said compartment, the diffuser plate presenting a smooth wall surface to the interior of the compartment and having a great number of small holes therethrough over its entire surface, and thin local heating means spread over the plate for heating said diffuser plate throughout its entire area without obstructing the air diffuser holes to make of it a radiant heating panel, as well as an air diffuser panel, said heating means comprising a continuous electrical resistance heating blanket secured on the back of said diffuser sheet and having holes "registering" with the holes in said diffuser sheet.

14. Heating means for a compartment comprising a duct and a thin diffuser plate thereover for supplying diffused air at low velocity through the plate throughout its surface area to said compartment, the diffuser plate presenting a

smooth wall surface to the interior of the compartment and having a great number of small holes therethrough over its entire surface, and thin local heating means spread over and in thermal contact with the entire rear surface of the plate but leaving its holes unobstructed and the exposed front surface smooth for heating said diffuser plate throughout its entire area to make of it a radiant heating panel while leaving the holes without impairment of their normal function of passing air in the usual manner, said heating means comprising electrical resistance heating elements disposed on the back of said diffuser sheet.

15. Heating means for a compartment comprising a duct and a thin diffuser plate thereover for supplying diffused air at low velocity through the plate throughout its surface area to said compartment, the diffuser plate presenting a smooth wall surface to the interior of the compartment and having a great number of small holes therethrough over its entire surface, and local heating means spread over and in thermal contact with the entire rear surface of the plate but leaving its holes unobstructed and the exposed front surface smooth for heating said diffuser plate throughout its entire area to make of it a radiant heating panel while leaving the holes without impairment of their normal function of passing air in the usual manner, said heating means comprising heating elements disposed on the back of said diffuser plate.

16. Heating means as defined in claim 15, said heating elements more particularly comprising a tortuously twisted coiled tubular pipe.

17. Heating means as defined in claim 16, insulation means conforming in shape to said pipe and covering the exposed areas thereof to maximize the transfer of thermal energy from the pipe to the plate.

18. Heating means as defined in claim 15, said heating elements comprising a plurality of electrical resistance elements and insulation means conforming in shape to said elements covering the exposed areas thereof to maximize the transfer of thermal energy from the electrical resistance elements to the plate.

19. Heating means as defined in claim 15, said heating elements comprising a continuous electrical resistance heating blanket having air flow passages therethrough in register with said diffuser passages.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,880,877	Dick	Oct. 4, 1932
1,997,559	Hajek	Apr. 9, 1935
2,044,729	Eggleston	June 16, 1936
2,172,771	Norris	Sept. 12, 1939
2,181,436	Madden	Nov. 28, 1939
2,251,682	Leadbetter	Aug. 5, 1941
2,382,340	Smith	Aug. 14, 1945
2,405,839	Ledwinka	Aug. 13, 1946
2,486,791	Mann	Nov. 1, 1949
2,509,607	Mussen	May 30, 1950
2,615,115	Watter	Oct. 21, 1952

FOREIGN PATENTS

Number	Country	Date
7,690	Australia	July 3, 1933
212,604	Switzerland	Mar. 17, 1941
501,592	Great Britain	Feb. 27, 1939