July 9, 1963 D. KNOLL ETAL 3,097,287

PANEL TYPE HEATING APPARATUS AND AIR CIRCULATING MEANS THEREFOR

Filed Feb. 9, 1959 3 Sheets-Sheet 1

Fig. 1.

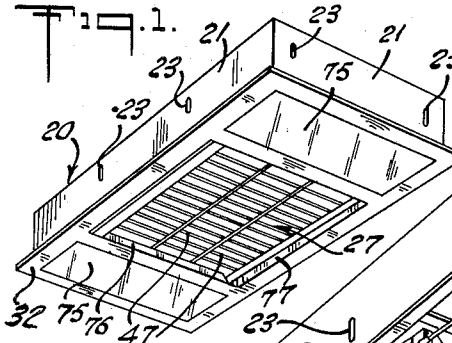
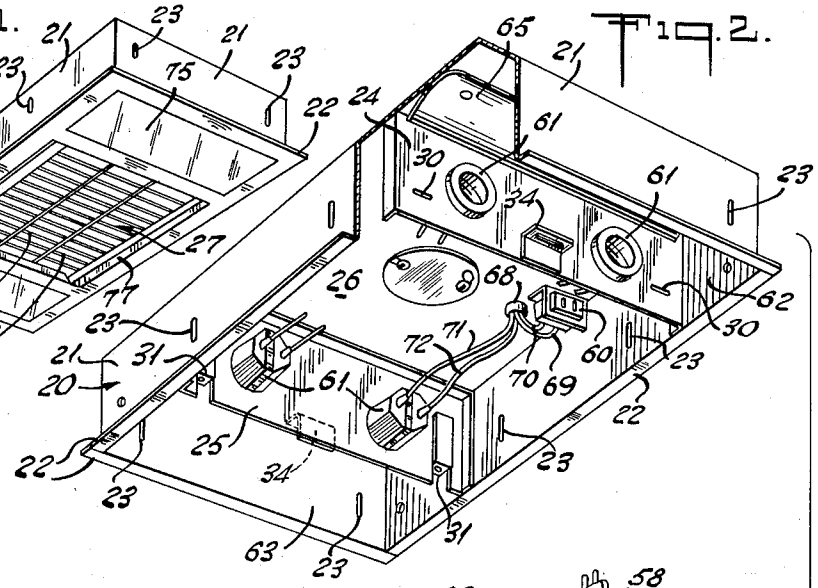
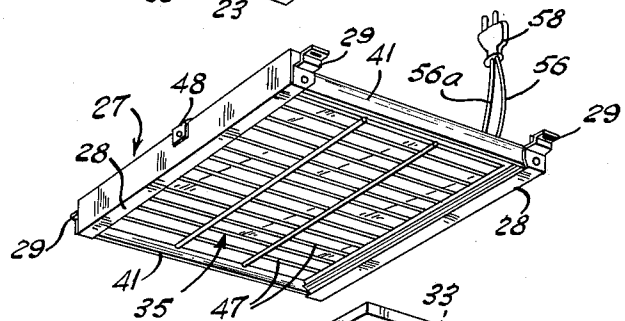


Fig. 2.





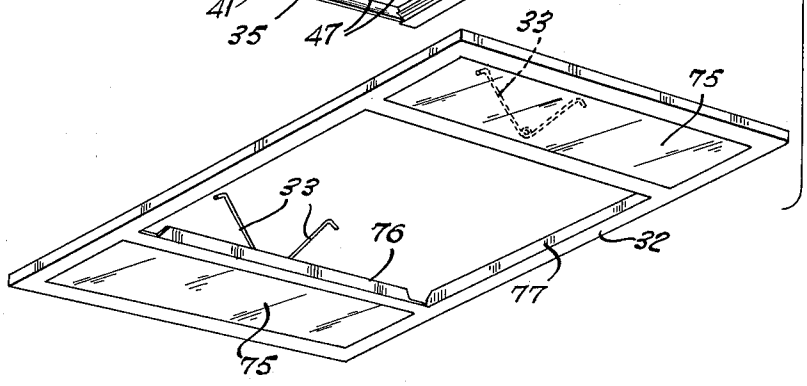
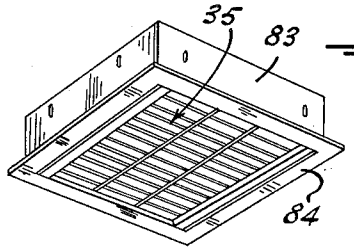


Fig. 3.

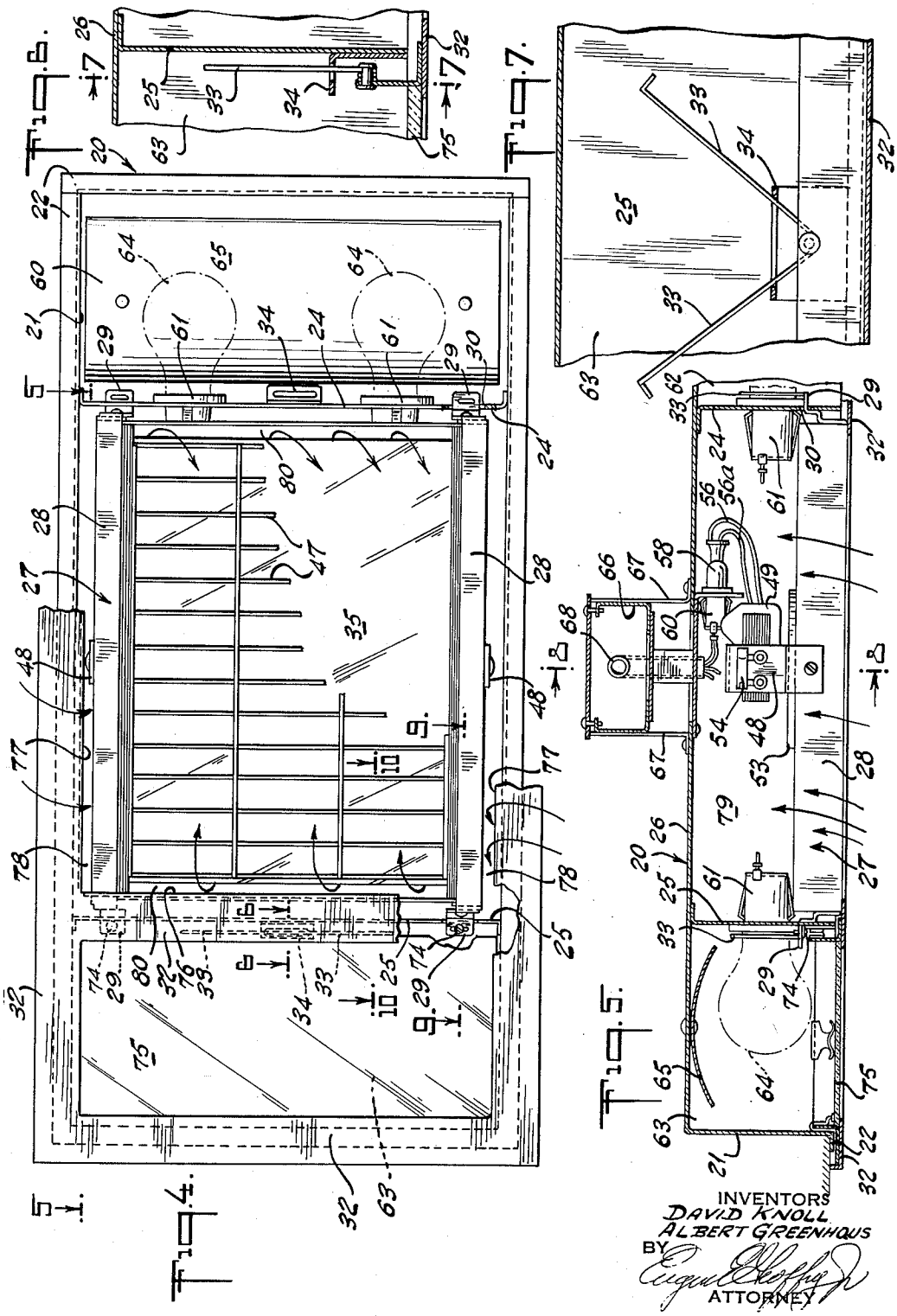


INVENTORS
DAVID KNOLL
ALBERT GREENHOUSE
BY
ATTORNEY

July 9, 1963 D. KNOLL ETAL 3,097,287

PANEL TYPE HEATING APPARATUS AND AIR CIRCULATING MEANS THEREFOR

Filed Feb. 9, 1959 3 Sheets-Sheet 2

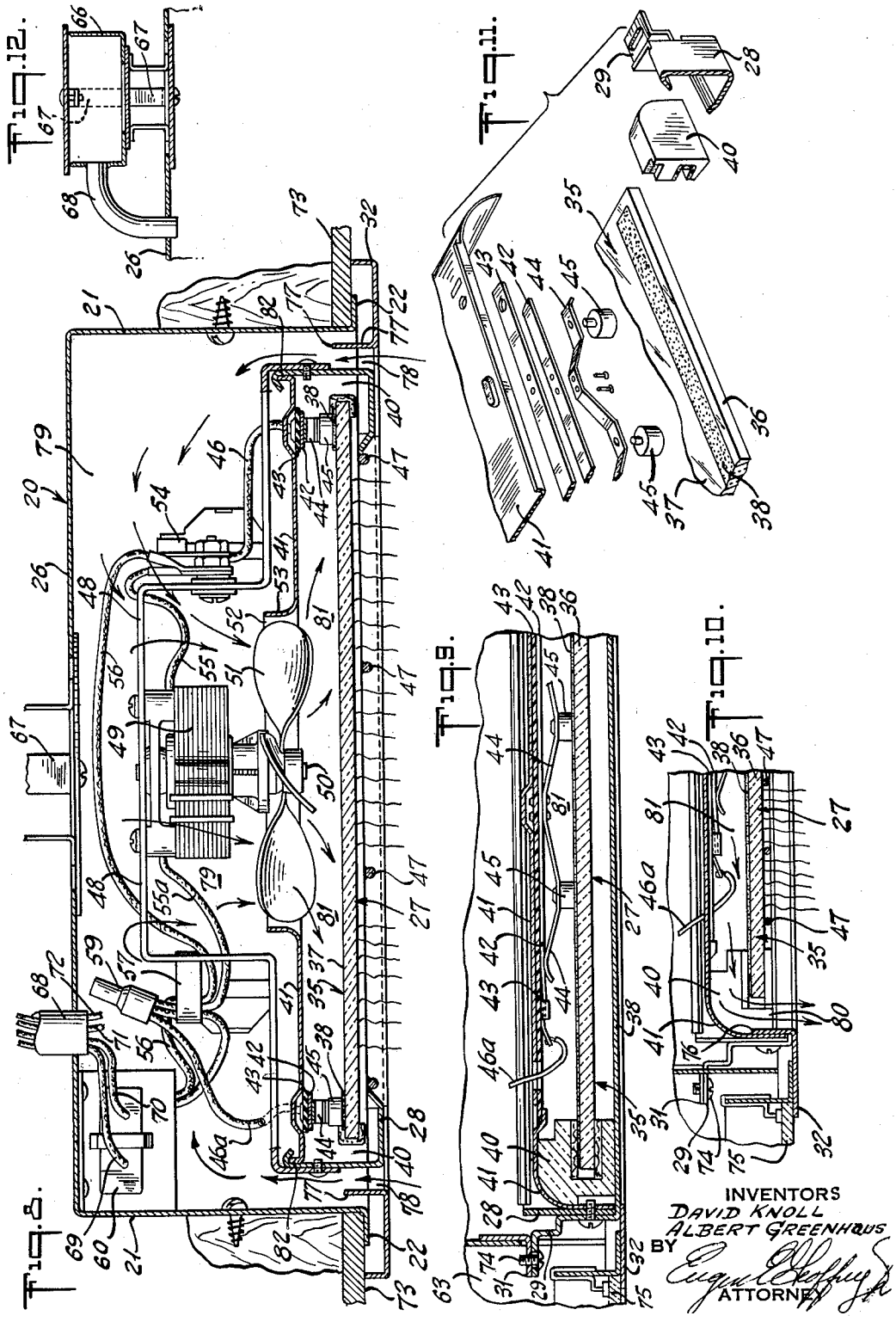


INVENTORS
DAVID KNOLL
ALBERT GREENHOUS
BY
ATTORNEY

July 9, 1963 D. KNOLL ETAL 3,097,287

PANEL TYPE HEATING APPARATUS AND AIR CIRCULATING MEANS THEREFOR

Filed Feb. 9, 1959 3 Sheets-Sheet 3



INVENTORS
DAVID KNOLL
ALBERT GREENHAUS
BY
ATTORNEY

United States Patent Office 3,097,287 Patented July 9, 1963

3,097,287

PANEL TYPE HEATING APPARATUS AND AIR CIRCULATING MEANS THEREFOR

David Knoll, Bayside, and Albert Greenhaus, Brooklyn, N.Y., assignors to Berko Electric Manufacturing Corporation, Queens Village, N.Y., a corporation of New York

Filed Feb. 9, 1959, Ser. No. 792,021
10 Claims. (Cl. 219—39)

The present invention pertains to improvements in heating apparatus and more specifically to heating equipment that may be recessed in walls and ceilings and the like.

The heater in accordance with the invention, while of general usefulness, is particularly adapted for installation in wall and ceiling recesses. By means of a new and improved combination of elements virtually all of the heat generated is dissipated into the space being heated, so that even in the case of ceiling mountings, the increase in temperature within the ceiling is so small that special wiring and other safety precautions are not necessary.

While overhead heating has a number of advantages, known systems employ remote heating units for water and air, and the heat is dissipated into the room by appropriate devices in or near the ceiling. Such systems, in addition to the obviously high cost of the equipment and installation of necessary ducts, blowers, etc., have the operational disadvantages of difficult regulation, dust accumulation, uneven heating of various parts of the room, and the creation of objectionable drafts.

On the other hand, the use of radiant heating devices attached to the ceiling of a room would also entail characteristic disadvantages largely due to lack of sufficient air circulation, these defects being in addition to the objectionable appearance of downwardly projecting devices, especially in modern low-ceilinged rooms. Thus, while the primary output of such devices is radiant heat, a considerable amount of transmission and convection heat also develops, with the result that a relatively stagnant pocket of hot air forms about the device and against the cealing. As this local heat retention is cumulative, it can readily lead not only to sooting and disfigurement of the ceiling finish, but also to hazardous overheating of the ceiling as well as the device and its connections themselves. Loss of heating efficiency is another result.

Accordingly, an object of the present invention is to provide novel radiant ceiling heater apparatus which eliminates the above and other disadvantages of prior known heating devices.

Another object is to provide a heating device including a radiant heating panel with means for positively diffusing the heat of convection and conduction within the room, to prevent local over-heating and to augment the desired effect of the radiant heat as well as the efficiency of the heating unit.

A further object is to provide heating apparatus of the above type in which a gentle flow of air is drawn inward along at least one side of the heating panel assembly, is moved evenly over and against the top of the heating panel and is discharged outwardly along another side.

A further object is to provide apparatus of the above nature which is adapted to be mounted in substantially flush relationship to the ceiling.

A further object is to provide a ceiling heater of the above type which is attractive in appearance and which may be readily and inexpensively installed and serviced.

Another object is to provide heating apparatus of the above nature adapted to furnish illumination as an adjunct to the main heating function.

The above and other objects and advantages of the invention will become more evident during the course of the following typical description in connection with the accompanying drawings, in which:

FIGURE 1 is a bottom perspective view of a preferred form of the device;

FIGURE 2 is an exploded perspective view illustrating the disassembly of the casing, heating unit and bottom cover frame;

FIGURE 3 is a bottom perspective view of an alternative embodiment in which the illuminating means is omitted;

FIGURE 4 is an enlarged bottom assembly view of the embodiment of FIGURE 1, shown partially cut away to disclose over-lying structures;

FIGURE 5 is a partial vertical section in the plane 5—5, FIGURE 4;

FIGURE 6 is a fragmental sectional view in the plane 6—6, FIG. 4, showing the latching means for the cover frame;

FIGURE 7 is a longitudinal view of the same in the plane 7—7, FIGURE 6;

FIGURE 8 is a vertical cross sectional view in the plane 8—8, FIGURE 5;

FIGURE 9 is a fragmental detail section of the radiant heating plate or panel and its connections, taken in the plane 9—9, FIGURE 4;

FIGURE 10 is a fragmental detail section in the plane 10—10, FIGURE 4, illustrating the exit air passages;

FIGURE 11 is an exploded perspective view of the heater panel connectors and related parts; and

FIGURE 12 is a detail sectional view of the junction box, also taken in the plane 8—8, FIGURE 5.

Referring to FIGS. 1 and 2, the numeral 20 designates a rectangular casing adapted to be mounted in an aperture cut or initially formed in a wall, ceiling or other surface. The side and end walls 21 of the casing terminate at their lower edges in an outwardly turned rim or flange 22 adapted to underlie and form a support and finish for the edges of the ceiling aperture. Vertical slots 23 are provided in the walls 21 to accommodate screws for securing the casing to joists or to suitable framing structures. Lateral partitions 24 and 25, spaced inwardly from the ends of the casing and secured to the side walls 21 and top main sheet or wall 26 thereof, enclose a central chamber adapted to receive the main heater unit sub-assembly 27.

The heater unit 27 has outer frame members 28 along a pair of opposing edges and the frame members carry small stepped and slotted lugs 29 extending longitudinally outward therefrom. The casing partition 24 has a pair of slots 30 spaced and positioned to receive the lugs 29 on the adjacent end of the heater frame members 28, while similarly spaced outwardly bent angle brackets 31 are provided on the partition 25 to be engaged by the second pair of lugs 29 in the manner further explained hereinafter in reference to FIGURE 5.

A cover 32, formed to overlie and constitute a finishing closure for the casing 20, has secured thereto a pair of latching springs 33 adapted to engage slotted angle brackets 34 on the partitions 24 and 25 during assembly of the device, as also explained hereinafter in greater detail, though it is evident that any suitable type of latch may be used.

The construction of the heater unit 27 is illustrated in detail in FIGURES 8, 9, 10 and 11. The heat source or panel 35, as shown in these figures, is preferably of the conductive glass plate type generaly shown and described in U.S. Patent No. 2,795,682, the source consisting of a glass plate 36 carrying a high-resistance conductive coating 37 on its upper or back surface and low-resistance strips 38 along the longitudinal borders of the coating for distributing current uniformly to the latter. The heating panel 35 is retained by corner members 40 of insulating material within the frame 28.

A reflector 41 cooperates with the frame members 28 and the corner blocks 40 to hold the heater panel 35 in position. The reflector is in spaced relation to the heater plate 35 and its ends are curved forwardly at substantial distances beyond the ends of the heater panel, as shown in FIGS. 9 and 10, with the curved portions engaging and conforming to the curved contours of the corner blocks 40. Longitudinal conducting strips of buss bars 42, fastened to the reflector 41 but electrically insulated therefrom by strips 43 of fiber glass or the like, carry spring members 44 which press contact electrodes 45, preferably of carbon, firmly but resiliently against the low-resistance distributing strips 38. Thus, when current is supplied to the buss bar 42 via leads 46 and 46*a* attached thereto, the high-resistance conductive coating of the heater plate is energized to produce the desired radiant heat. In addition to the retaining means already described, further support as well as protection for the glass plate 36 is furnished by an overlying grill formed of slender rods 47 secured in the lower face portion of the frame 28.

Referring to FIGURE 8, it will be seen that a bracket 48, extending transversely of and secured to the frame members 28 supports a small electric motor 49 having a shaft 50 on which is mounted a fan 51. A central opening 52 in the reflector 41 has an upwardly extruded rim 53 forming a short conduit or shroud around the blades of the fan.

One lead 46 of the heater plate 35 and one lead from motor 49 are connected to one side of a thermal safety device 54 mounted on the motor bracket 48. The other terminal of the thermal device 54 forms a connecting point for one flexible supply conductor 56 which runs via a supporting clip 57 to a pronged connector plug 58, the latter being shown in FIG. 2. The second flexible conductor from the plug 58 is spliced in a common junction to the second motor lead 55*a* and the second heater lead 46*a* by any suitable means, illustrated in FIGURE 8 by an internally threaded compression connector 59 of well-known type. An outlet receptacle 60, adapted to receive the plug 58, is secured to the top or back plate 26 of the main casing 20 in convenient position as shown in FIGURES 2 and 8.

In the embodiment shown, which includes provision for illumination as an adjunct to the heating function, suitable lamp sockets 61 are positioned in the partitions 24 and 25 to support incandescent bulbs in the end cavities 62 and 63 of the casing 20. A pair of the bulbs 64 is illustrated in FIGURE 5. Curved reflectors 65 are disposed in the cavities 62 and 63 behind the lamp positions to reflect light outwardly of the cavities.

Referring to FIGURE 5, the numeral 66 designates a junction box of standard type, spaced a substantial distance from the casing wall 26 and removably secured thereto by means of strap legs 67. A short curved conduit 68, shown in detail in FIGURE 12, extends from the interior of the junction box 66 into the central chamber of the casing 20. Conductors 69 and 70, FIGS. 2 and 8, carry the current for the previously described parallel circuit connections of the heater 35 and motor 49, lead from the receptacle 60 through the conduit 68 into the junction box 66. Similarly, a second pair of wires 71 and 72 constituting supply conductors for the lamp sockets 61 are strung through the conduit into the box 66. It will be understood that all the sockets 61 are wired in the usual parallel arrangement to the conductors 71 and 72, but as such arrangements are well known as standard lighting practice, only one typical connection is illustrated in FIGURE 2 in order to avoid unnecessary complication of the drawings. Suitable supply conductors are coupled with the junction box 66 so that the main heating unit circuit and the adjunctive lighting circuit can be independently operated.

In the process of installation of a unit as described above in a ceiling recess, connecting supply lines are spliced to the circuit pairs in the junction box in the conventional manner, and the casing 20 is inserted in the ceiling cavity and secured therein by means of screws through the slotted holes 23. The lower casing rim 22 is brought into flush engagement with the ceiling 73 as illustrated in FIGURE 8 and the unit is secured in place. The heater unit 27 is next lifted sufficiently near the installed casing to permit the plug 58 to be inserted in the receptacle 60. The adjacent stepped lugs 29 on the heater frame members are inserted in the slots 30 of partition 24 and the unit is swung upward until the second two lugs 29 encounter the angle brackets 31, to which they are then secured by means of screws 74, as shown in FIGURE 5. Thus, by the use of only two screws, the entire heating unit is securely anchored in the casing 20, while the stepped lugs 29 assure accurate spacing. When the illuminating feature is to be employed, suitable lamp bulbs are inserted in the sockets 61 in the usual manner. To complete the installation, the hooked latching springs 33 on the bottom cover 32 are compressed laterally and inserted in the slotted angle brackets 34, the length of the springs permitting their manipulation through the central opening of the cover 32. The cover is then pushed upwardly until its outer rim engages the ceiling 73, the springs 33 spreading to hold the cover firmly in place as shown in FIGURES 6 and 7. In this position glass panels 75 underlie the lamp compartments while the central opening of the cover frames the heater unit 27 as shown in FIGURE 4.

By reference to FIGURE 2, it will be seen that the inner edges of the cover 32 are formed with end and side upturned angles 76 and 77, respectively. These angles, in addition to providing stiffness and finish to the frame, also, by their extent and relative spacing, constitute an important part of the novel ventilating system of the invention. The side angles 77, as shown in detail in FIGURE 8, are spaced outwardly from the heater frame 28, thus forming elongated slots or louvers 78 leading from the outer air into the space 79 within the casing 20 above the reflector 41. The end angles 76, as shown in detail in FIGURE 10, closely engage the downwardly directed ends of the reflector 41, but since, as previously noted, the reflector ends are spaced a substantial distance from the ends of the heater plate 35, the arrangement described forms transverse slots or louvers 80 connecting the outer air with the space 81 between the reflector and the heater plate. Thus the reflector 41, which at the sides is closely joined to the heater frame members 28 under small angular rims 82, FIGURE 8, divides the space above the heater plate into the upper chamber 79 having direct access to the outer air only through the downwardly directed side louvers 78 and the lower chamber 81 connecting with the outer air only through the end louvers 80.

When the heating device is placed in operation under control of any desired type of wall switch, thermostat, time switch or the like, the heater plate generates radiant heat and projects it downward throughout the space to be heated. At the same time the parallel-connected motor 49 operates the fan 51 to draw air upward through the side louvers 78 into the upper chamber 79 and then to impel the air downwardly into the lower chamber 81 where the air spreads evenly along the upper face of the heating plate, absorbing heat therefrom, and finally exits downwardly via the end louvers 80.

The fan and motor combination is preferably of the relatively low speed and silent type, adapted to provide circulation without violent blast. The overall operational result is a gentle and steady withdrawal of air from the room into the sides of the device and a similarly gentle return of the air via the end louvers to the room, where it spreads without noticeable draft to augment the comfort furnished by the primary radiant heat. At the same time the continuous steady cooling effect of the air circulating through the casing keeps the latter and the internal apparatus and connections at relatively low temperature which provides not only safety, but also maximum

efficiency and life of the radiant heater. The internal cooling effect extends to the lighting sections when the latter are used, as heat is picked up from the internal partitions and lamp sockets and put to useful purpose together with the other heat entrained in the air stream. The gentle but effective air circulation extending well below the room ceiling in all cases eliminates tendency to local sooting as well as overheating of the ceiling and damaging the painted or other surfaced preparation on the ceiling.

Another advantage of the panel type heater in combination with air circulation resides in the lowering of the panel temperature so that lower resistance panels of smaller dimensions may be utilized to produce a predetermined heat output without the danger of damaging the panel or adversely affecting the electric current supplying means.

As brought out in the previous description of the parallel wiring of the heater plate **35** and the motor **49**, it is evident that the thermal protective device **54** is connected in the heater circuit to disconnect the heater in the event excessive temperatures are experienced. The protective device **54** may also be connected in circuit with the motor **49** to disconnect the motor at the same time the heater is disconnected. While either arrangement may be used, the operation of the protective device to disconnect only the heater has the advantage that in the extreme case of excessive temperature, for example, by reason of high voltage or other cause, the safety device will cut out the heater, while the motor continues to run, furnishing continued circulation to drop temperature in minimum time.

As a further provision for maximum safety throughout the installation and use of the device, the spacing of the junction box **66** from the casing **20** ensures that the temperature within the junction box will remain well below permissible maximum under all conditions.

In the form of the apparatus described, in which the illuminating means is included as an adjunct, the lighting circuit is normally connected in its separate circuit via the junction box **66** and any desired type and location of wall switch or the like may be employed. For some installations it may be desired to confine the apparatus to the main heating function alone, in which case the structure contains the heating and circulatory features as already described, but the casing **83** and the bottom cover plate **84** may be shortened as shown in FIGURE 3 to omit the provision for the lamp chambers and their underlying windows. Either type, however, is well adapted to multiple arrangement when large rooms are to be served, and various combinations of the two types may be used to provide any desired proportion of heating and illumination. In any application, the previously described ease of installation is matched by ease of servicing, since the bottom cover may be removed without the use of tools simply by drawing it downward and releasing the latch springs **33**, while the entire heating unit may be released by removing the two screws **74** and and withdrawing the connector plug **58**.

From the foregoing it is believed evident that the invention presents a novel structure combining the advantages of flush mounting, attractive appearance, ease of installation and efficient radiant heat production, while at the same time eliminating the disadvantages inherent in prior devices and arising from either too much or too little air circulation, as previously pointed out. It will also be understood that while the invention has been set forth in preferred embodiment, it is not limited to the exact structures illustrated, as various modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a space heating device, in combination, a casing, an outer facially exposed air-impervious radiant heating panel mounted in said casing, electrical means heating said panel to radiate heat into the space being heated, means forming air inlets to said casing adjacent two opposite edges of said panel, means forming air outlets from said casing adjacent the other two opposite edges of said panel, and fan means in said casing to establish a positive current of air in through said inlets, against and along the inner face of said panel in said casing, and discharging it through said outlets, and into the space being heated.

2. A device according to claim 1 wherein said air-current establishing means includes an electric axial-flow fan and a reflector cooperative therewith in guiding relation to direct said air current along said inner face of said panel, said reflector re-directing radiant heat received from said inner face of said panel forwardly through said panel, whereby the portion of said casing behind said reflector is substantially insulated from said heat.

3. A device according to claim 1 wherein said radiant heating panel includes a glass plate carrying a high-resistance conductive coating forming said inner face, said air-current establishing means includes an electric fan and a reflector cooperative therewith in guiding relation to direct said air current along said inner face of said panel to said outlets, said reflector being adapted to re-direct radiant heat received thereby forward to and through said panel while insulating a cavity in said casing behind said reflector from radiant heat, said cavity being in direct communication with said air inlets, and wherein said outlets are formed to direct outgoing air current in a direction substantially parallel to the major direction of heat radiation from said panel.

4. A device according to claim 1 wherein said casing includes at least one illumination chamber laterally displaced from said panel and having a wall in heat exchange relation with said air current within said casing, and including lamp holding means secured to said wall.

5. In a device of the character described, in combination, a casing, a front facially exposed conductive glass radiant heating panel mounted in said casing, means forming air inlets to said casing adjacent two opposite edges of said panel, means forming air outlets from said casing adjacent the other two opposite edges of said panel, a shield in said casing overlying the inner surface of the panel and including a motor-driven electric fan cooperating therewith in guiding relation to maintain a positive air flow in through said inlets, between the inner face of said panel and said shield to said outlets, said shield further re-directing radiant heat received thereby outwardly through said panel while insulating a chamber in said casing behind said reflector from said heat, said chamber being in direct communication with said inlets and containing the motor of said fan, and connecting means forming parallel electric circuits for said motor and panel including junctions disposed in said chamber.

6. A device according to claim 5 including a thermal protective device disposed in said chamber and included in a leg of said circuit-forming means leading to said heating panel.

7. A device according to claim 5 including a frame holding said panel, motor and shield in a unitary structure bodily removable from said casing, and wherein said circuit-connecting means include attachment plug means wired to serve said parallel circuits, and receptacle means secured in said casing and adapted to cooperatively receive said plug means.

8. A space heating device comprising an air-impervious glass radiant heating panel, said glass panel including heating means associated therewith for heating said panel, a fan on one side of said panel and in spaced relationship thereto, said fan directing a flow of air against and intermediate the edges of said one side of said panel, means overlying said one side of said panel and guiding said air over said one surface, about at least one edge of said panel and discharging it in the space adjoining the

other side of said panel, said heating means in the absence of said air flow raising the temperature of said panel above a normal operating temperature, and said air flow lowering the temperature of said panel to at least said normal temperature.

9. A space heating device according to claim 8 wherein said fan directs said air flow against said one side of said panel at an angle substantially normal to said panel.

10. A space heating device according to claim 8 wherein said fan is positioned centrally of said one side of said panel and directs said flow of air against said panel at an angle substantially normal thereto.

References Cited in the file of this patent

UNITED STATES PATENTS

1,910,105	Herring	May 23, 1933
2,007,102	Wallace	July 2, 1935
2,022,332	Woolley	Nov. 26, 1935
2,382,340	Smith	Aug. 14, 1945
2,512,875	Reynolds	June 27, 1950
2,519,109	Callender	Aug. 15, 1950
2,573,121	Wandelt	Oct. 30, 1951
2,623,150	Boecher et al.	Dec. 23, 1952
2,689,906	Corbett	Sept. 21, 1954
2,700,095	Needham	Sept. 18, 1955
2,822,456	Glynn	Feb. 4, 1958
2,870,319	Ford	Jan. 20, 1959
2,984,728	Murphy	May 16, 1961