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2,887,564

COMBINED PANEL HEATING, COOLING AND LIGHTING SYSTEM

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Fig. 1

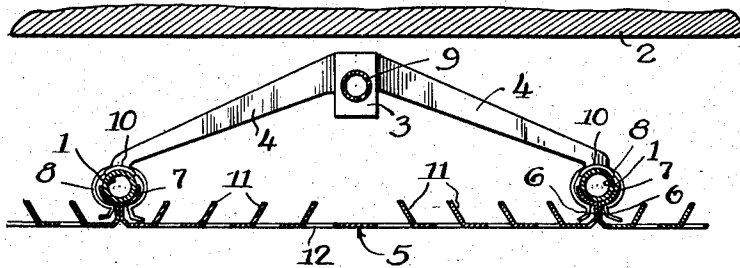


Fig. 2

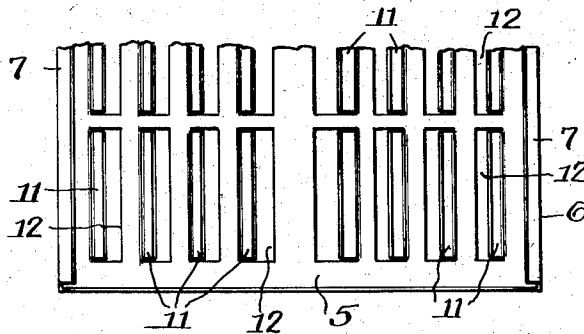


Fig. 3

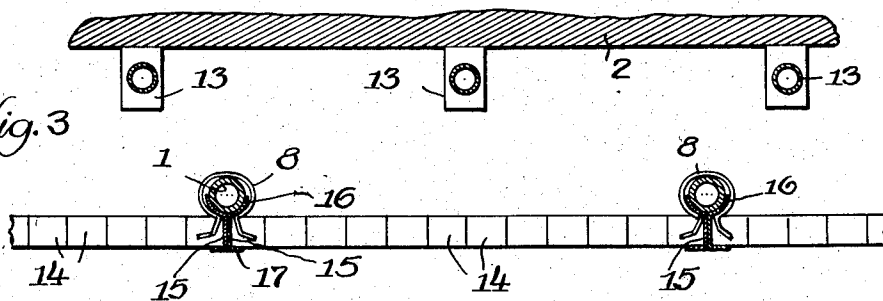
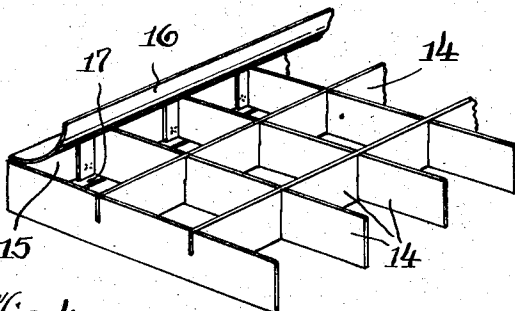


Fig. 4



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## COMBINED PANEL HEATING, COOLING, AND LIGHTING SYSTEM

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7 Claims. (Cl. 240—9)

This invention relates to functional ceiling structures; more particularly, to a ceiling system which includes means for heating or cooling a room and lighting the same.

The ceiling surfaces of rooms have long been used as the proximate source of heat for the room and its occupants. The ceiling surface is heated by suitable means and the radiant energy emitted from the heated surface is absorbed by all surfaces within the room to which the ceiling is exposed, or by multiple re-radiation therefrom, to supply the heat necessary for comfort. More recently, such panel heating systems have been employed for cooling purposes, the ceiling surface being cooled below the temperature of surfaces within the room with the result that radiant heat from the warmer surfaces is absorbed by the cooler ceiling surface.

With certain types of panel heating and cooling structures, as, for example, the suspended ceiling systems of Frenger Patent No. 2,718,383 and Baran application Serial No. 374,866, filed August 18, 1953, now Patent No. 2,818,235, dated December 31, 1957, acoustical correction for the room may be combined with the heating and cooling system by providing a suitable layer of sound absorbing material above the heating and cooling panels, the panels being pervious to sound whereby noise from the room may pass therethrough to the sound absorbing material.

Various lighting systems and types of lighting fixtures have been adapted for use with the ceiling panel heating system. It has been the practice to mount the desired type of fixture in the ceiling structure at distributed locations, the lighting element being either somewhat below the surface of the ceiling or approximately in the plane of the ceiling. Location of the lights below the ceiling surface is frequently considered to be undesirable from the standpoint of appearance in that the lights interrupt the continuity of the ceiling and give a trashy effect. Installation of the lights in the plane of the ceiling reduces the amount of surface effective for the radiation of heat into or absorption of heat from the room below, thus diminishing the heat exchange capacity of the ceiling.

The principal object of the present invention is to provide a ceiling panel heating (and/or cooling) system with which is combined the primary artificial lighting means for the room. A further object is to provide such a combined system of lighting and heating wherein the lighting elements are located entirely above the plane of the ceiling surface whereby the latter may be continuous and unbroken throughout the entire area of the ceiling. Another object is to design such a structure wherein the ceiling panels and the lighting fixtures are supported by common support elements to the end that installation costs of the combined system are minimized and a predetermined spacial relationship of the light sources and the panel elements may be readily achieved, if desired.

Another object of the invention is to provide radiant heating and cooling panels which also serve as louver systems for directional shading of the light sources.

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Additional features and the merits of the invention will become apparent as the description thereof proceeds.

In the accompanying drawings,

Fig. 1 is a cross-sectional view of a portion of a combined panel heating and lighting system illustrating one form of the invention;

Fig. 2 is a plan view of a portion of a ceiling panel of the system of Figure 1;

Fig. 3 is a cross-sectional view of a portion of a ceiling structure showing a different form of the invention;

Fig. 4 is a perspective view of a portion of a panel unit of the structure of Fig. 3.

In each of the several embodiments of the invention herein illustrated and described, the panel heating and cooling structure comprises a suspended ceiling supported from a gridwork of pipes which is hung below the slab or other building structure over the room to be heated or cooled and lighted. In the structure of Figs. 1 and 2, for example, a plurality of spaced pipes 1 are arranged in a horizontal plane below the slab or building structure 2 from which the pipes are suspended by suitable means not shown. The pipes 1 are parallel to each other and serve to support a lighting unit 3, by means of supporting arms 4, and also ceiling panels 5. The latter are formed from sheet metal, preferably aluminum or other metal having a high coefficient of thermal conductivity. Each such panel is an integral unit, self-supporting upon the pipes, which may, by reason of its unitary structure, be installed upon the supporting pipes or removed therefrom without disturbing the lighting units. Each panel includes a face portion forming a part of the ceiling exposed to the room below. Flanges 6 on opposite sides of each panel terminate in semi-cylindrical sections 7 which conform to the curvature of the pipes 1 and extend around approximately ninety degrees, or somewhat less, of the pipe. Spring clips 8 clamp the curved portions of the panel flanges to the pipes for the purpose of supporting the panels and also providing for good thermal contact between the panel flanges and the pipes.

The flange and the clip structure is more fully described in the above mentioned Baran application and patent. A plurality of panels 5 provide the radiant heating or cooling ceiling surface for the room, receiving heat from, or being cooled by, water circulated through pipes 1.

The light source 9 of the lighting fixture is an elongated element, such as a fluorescent tube. The fixture, including supporting arms 4, exactly spans the distance between a pair of adjoining pipes 1. It rests upon the pipes, arms 4 advantageously terminating with curved seat portions 10 adapted to rest snugly upon the supporting pipes. Clips 8 are arranged at locations which avoid interference with the arms 4 of the lighting fixture, or, if desired, the clips may be somewhat larger and pass over the curved seating elements 10 at the extremities of the arms to hold the fixture firmly to the pipes.

A series of louvers 11 are formed from the metal of panel 5 by partially cutting and turning rectangular strips of metal to the inclined position shown. This leaves a series of rectangular openings 12 through which the light from the light source 9 may pass downwardly into the room. The light is above the median line of the panel and the louvers 11 are inclined in the general direction of the light source. This particular spacial relationship of the light with respect to the panel is automatically achieved with installation of the system since the lighting fixture is mounted upon the pipes 1 which also support the panels.

In this combined lighting and heating and cooling system, the surfaces of panels 5 exposed to the room are heated or cooled by conduction of heat through the metal of the panels, including flanges 6, from or to the pipes

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1 which, in turn, are heated or cooled by circulation of warm or cool water through the pipe grid system, and the room below the suspended ceiling is heated or cooled by radiation accordingly. At the same time, light from the lighting fixtures, mounted above the suspended ceiling, shines through the openings provided in the panels 5 to light the room. The intensity of the light in the room depends upon the number and intensity of lighting elements provided, it being contemplated that the lighting fixtures above the radiant panels will provide the primary artificial lighting for the room and not merely ornamental lighting. A light fixture may be provided for each panel, if desired, the fixture may be of such length as to span two or more panels, or only a portion of the ceiling may be used for lighting. If it is necessary to install lighting fixtures between adjacent runs of piping, they may be staggered to avoid interference of the supporting arms upon the pipes.

In the combined heating and lighting system illustrated in Figs. 3 and 4, lighting fixtures 13 are mounted on the undersurface of ceiling slab 2 and a somewhat different form of radiating panel unit is employed. The panel, in this example of the invention, consists of vertical louvers spaced apart as shown, and intersecting at right angles to form an integral unit including what is generally referred to as an egg crate louver system. To form the integral panel unit assembly of the invention, this egg crate louver system is fastened on opposite sides thereof to flange members 15 having integral curved elements 16 in the manner above described with reference to the structure of Figs. 1 and 2. Shallow flanges 17 may be provided, if desired, to give added strength and stiffness to the panel unit and to cover the panel supporting structure, including clips 8. Flanges 17 also serve to limit rotation of clips 8 upon the pipes as panel units are installed or withdrawn.

The egg-crate louver system, spaced below the lighting fixtures, shades the lights so that a person in the room does not ordinarily see the light sources unless he looks almost directly upwardly. As a lighting arrangement, the structure is well known. The number of lights employed depends on the lighting intensity desired for the room. The location of the lighting fixtures with respect to the heating or cooling panels and the supporting grid structure may be haphazard.

As in the system of Figs. 3 and 4, the panel structure, including flanges 15 and louver elements 14, is heated or cooled by conduction from pipes 1. In addition, surfaces of louvers facing each other radiate and absorb heat whereby conduction through the metal is augmented with advantage. The heated louver surfaces radiate heat to the room below. In this connection, it may be noted that although maximum radiation from a given surface is in a direction normal to the surface, or nearly so, radiation is also effective in other angular directions from the surface. Multiple re-radiation from the walls of the room and from the surfaces of objects within the room result in a relatively even distribution of heat energy from the panel units.

It will be understood from the foregoing that the structure of Figs. 3 and 4 constitutes a highly desirable functional system for lighting and heating or cooling the room.

In each of the several examples of the invention herein shown and described, a generally light-pervious heat radiating or absorbing panel is provided with light sources located above the panel or at least the face portion thereof exposed to the room, for lighting the room. The panel is light-pervious if it is capable of transmitting a major portion of light from the light sources into the room for the purpose of providing useful artificial light therein. Sheet metal panels with sufficient open areas therein are generally light-pervious, although solid elements between openings are, of course, light-opaque. Glass, or other plastic transparent or translucent panels are light-pervious and generally light-pervious. The latter, for purposes of

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the combined heating and lighting system, may be heated electrically by known means.

It should also be noted that the elongated light fixtures shown in connection with the embodiments of the invention of Figs. 1-4 may be arranged at right angles to the grid pipes and that the slots in the panels of Figs. 1-2 may extend at right angles to the pipes.

It will be appreciated that many other modified forms of the structure shown may be used in the practice of the invention as defined by the claims appended hereto. All of such modified structures are deemed to be within the scope of the invention.

Invention is claimed as follows:

1. A combined panel heating and cooling and lighting system for a room comprising a plurality of spaced horizontal pipes adapted to be heated or cooled by the circulation of liquid therethrough, said pipes being arranged overhead with respect to said room, a sheet metal panel extending between and supported by two of said pipes in thermal contact therewith, said panel being an integral unit having a plurality of spaced slots therein extending parallel with said pipes, and a lighting fixture mounted independently of said panel and arranged thereabove and having an elongated lighting element, said lighting element being oriented parallel with and located midway between said pipes to shine downwardly through said slots in said panel and into said room.

2. A combined panel heating and lighting system for a room comprising a plurality of spaced horizontal pipes adapted to be heated by the circulation of liquid therethrough, said pipes being arranged overhead with respect to said room, a heating panel extending between and demountably supported by two of said pipes in thermal contact therewith, said panel being an integral unit comprising an egg crate louver system of thermally conductive metal, and room lighting means separate from and independently mounted upon said pipes arranged above said panel.

3. An integral panel unit for a combined panel heating and cooling and lighting system comprising a sheet metal panel having upstanding flanges along opposite sides thereof, said flanges terminating in semi-cylindrical portions adapted to engage pipes for supporting said panel, said panel having a plurality of spaced slots therein of sufficient size to render said panel light-pervious, and louvers integral with the panel along the side of each slot which is closer to the nearest flanged side of said panel.

4. A panel unit for a combined panel heating and cooling and lighting system comprising an egg crate louver system of thermally conductive metal forming a rectangular unit, opposite sides of said unit having semi-cylindrical flanges rising up and back over the side portions of the unit, said flanges being adapted to engage pipes for supporting and heating or cooling said panel unit.

5. A combined panel heating and lighting system for a room comprising an integral radiant heat exchange panel including a face portion exposed to said room and forming a part of the ceiling thereof, substantially the entire area of said face portion being generally light-pervious and adapted when heated to radiate heat into said room, said panel being composed of sheet metal and having a plurality of distributed openings therein for the passage of light therethrough, means for heating said panel and particularly the face portion thereof, and primary room lighting means separate from said panel and so arranged above said face portion that light therefrom is transmitted through at least a major part of said face portion of said panel downwardly into said room.

6. A system in accordance with claim 5 wherein the openings in the radiant panel are provided with louvers extending upwardly in said panel toward the room lighting means.

7. A combined panel heating and cooling and lighting system for a room, said system comprising a plurality of spaced horizontal pipes for conducting a fluid medium

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and arranged overhead with respect to said room, an integral radiant heat exchange panel including a face portion forming a part of a ceiling exposed to said room, substantially the entire area of said face portion being generally light-pervious and adapted when heated to radiate heat into said room and when cooled to absorb heat therefrom, said panel extending between two of said pipes in thermal contact therewith and supported thereby, means for heating or cooling said panel, and primary room lighting means so arranged above said face portion that light therefrom is transmitted through at least a major part of said face portion of said panel downwardly into said room, said lighting means being wholly supported by said pipes independently of said panels.

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