Sept 10, 1957 H. ANDORFER 2,805,842

SOUND-DAMPING CLIMATIZING SYSTEMS

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Fig. 1

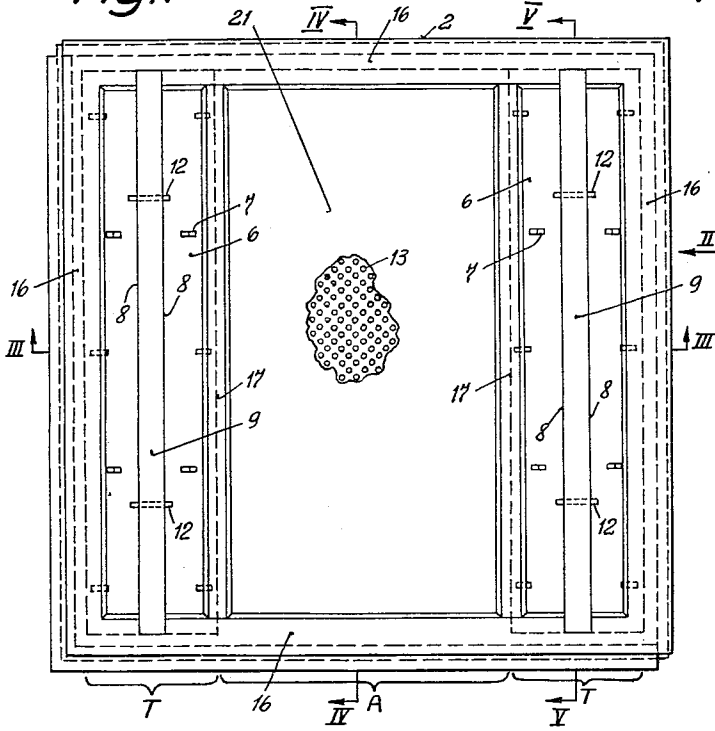
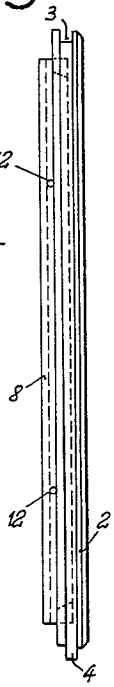


Fig. 2



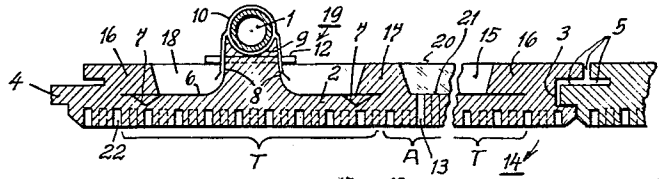


Fig. 3

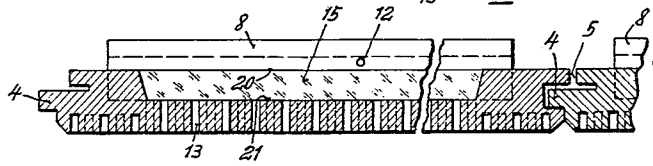


Fig. 4

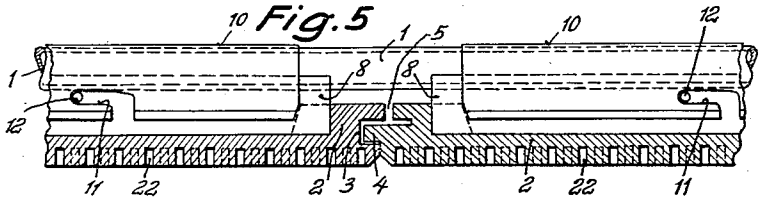


Fig. 5

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SOUND-DAMPING CLIMATIZING SYSTEMS

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8 Claims. (Cl. 257—124)

This invention relates to systems for heating rooms by radiation or cooling said rooms, such systems having preferably a set or tier of pipes or conduits built into the ceiling or the walls of each room within the frame or shell construction thereof, to which pipes heat conducting lamellae, such as thin sheets or plates, in thermal contact with the adjacent inner surface of the ceiling or wall are connected by means of suitable clamping arrangements.

It is an object of the present invention to provide means facilitating the establishment and control of suitable conditions of thermal equilibrium in rooms of a building in order to ensure the existence and maintenance therein of climatic conditions necessary to satisfy comfort and health requirements.

Recent developments in construction techniques and related arts show to an increasing extent a tendency to provide human beings in their living or working quarters with an absolutely effective protection from harmful external influences. In order to attain a truly physiologically comfortable room climate, it becomes necessary to ensure existence of thermal equilibrium conditions. At the present time, the best manner of fulfilling this requirement resides in the use of radiation type heating systems, the conduits of which may be alternatively employed for cooling purposes. In a known construction of this type, the conduits which contain the heating water are provided with aluminum plates or sheets, the bottom or outer surfaces of which are coated with plaster subsequent to the attachment thereto of a plaster base or accepter. Such arrangements are usually employed as ceilings or walls externally of the frame construction. The thermal operation of such heating or cooling arrangements is in every respect perfectly satisfactory.

Besides a control of thermal equilibrium conditions required so as to maintain human comfort at suitable standards, protection against external nuisances, such as street noises and the like, necessitates, in present noise-filled times, to an increasing degree an installation of sound damping means in rooms of occupied buildings.

The spatial arrangement of such sound absorbing materials takes place ordinarily in the boundary surfaces of the rooms, such as the ceiling or the walls, which surfaces, therefore, can be reserved for heating, cooling or sound control purposes and need not necessarily be covered by means of furniture or other decorative elements. In standard radiant heating installation practice, the ceiling of a room is usually best suited for this purpose.

It is, therefore, another object of the present invention to provide means which, in addition to the protection against deleterious thermal effects afforded by radiation type heating or cooling systems in buildings, tend to protect inhabitants of said buildings from external conditions, such as street noises and the like, which are likewise inimical to their personal comfort and well-being.

It is still another object of the present invention to provide means presenting a novel and simplified construction of heating and/or cooling systems for rooms in buildings, which systems are easily installed upon the frame or shell of the building so as to constitute at the same time parts of the ceilings or of one or more of the walls of said rooms.

A further object of the present invention is to provide means affording highly efficient heating and/or cooling systems for rooms in buildings, in which rooms said systems form parts of one or more of the boundary surfaces thereof, wherein the sections of said systems facing the interiors of said rooms are suitably designed to blend with the overall patterns appearing on said boundary surfaces.

Yet a further object of the present invention is to provide means leading to effective heating and/or cooling systems for rooms in buildings, which systems are inexpensive to manufacture and easily installed either as complete units or as additions to existing systems.

More specifically, the invention contemplates the use of sound-absorbing plates arranged directly in the ceiling surface in required number or, if a greater acoustical efficiency be desired, spaced therefrom by means of an interposed hollow air space. It must be noted, however, that sound-absorbing materials suitable for the frequency ranges ordinarily encountered are usually porous materials and, thus, poor heat conductors, because of the great amounts of air trapped therein. In the case of ceiling heating panels, the arrangement of such materials in plate form directly on the ceiling surface or even spaced therefrom by means of an air space has the effect of markedly reducing or preventing the attainment of maximum efficiency of thermal transfer.

To overcome this defect, it has been proposed, in known constructions for the simultaneous attainment of efficient thermal transfer and sound-absorbing effects, to attach one side of each heating or cooling medium containing conduit set to the ceiling of the shell or frame of the building, each set having connected thereto on one side one or more heat conducting sheets, to mount underneath each conduit set a perforated cover plate traversing the entire conduit set, and to attach to the other side of each set a mat of mineral or slag wool.

The material of which these cover plates are made is usually gypsum, a corrugated asbestos cement roofing material known under the trade name "Eternite," wood or other diverse mortar-like materials.

Likewise, there are known other arrangements in which the perforated or slitted cover plates are made of metal. In one form of construction of this latter type, the cover plates are suitably constructed to receive the heating or cooling pipes in direct heat-conducting relationship, the mineral wool mats being directly attached to the rear side of the cover plates.

All these systems are unsatisfactory not only in thermal and acoustic respects, but also from a hygienic standpoint. In each of the previously described constructional forms, the location of the cover plates in spaced relation to and underneath the frame ceiling results in the formation of an air space underneath said ceiling, which space is constantly in communication with the air in the room to be heated or cooled by virtue of the perforations formed in the cover plates in accordance with standard sound techniques. During a heating operation of these systems, the high temperatures of the heating medium, e. g. water, involved give rise to an extraordinarily strong thermal diffusion, in which, besides the air present in the air space, suspended particles, dust particles and the like which have penetrated into said space over a period of time, take part.

On the surface of the conduits there occurs additionally a phenomenon which may be called a dust combustion. Furthermore, infiltration of dust, dirt particles and in part also infectious floating particles (consider, for example,

the case of a hospital), as well as the influx of mosquitos, spiders and other vermin, into the usually uncontrollable air space through the perforated cover plates is unpreventable. Because of the possibility of air exchange between said air space and the room to be heated, all of these effects thus become noticeable in the room itself and lead to extremely unhygienic and physiologically harmful results.

The possibility of direct air exchange between the room and the air space located above the cover plates also leads to the result that use of such arrangements for cooling purposes during the summer months, which is of great technical and economic importance, becomes impossible. One prerequisite for an effective cooling of a room during the summer by means of ceiling panels is that the air volume surrounding the conduits which contain the cooling fluid be so small that condensation of even negligible amounts of moisture is prevented. Another condition which must be fulfilled is that the heat conducting sheets cannot be contacted by the room air.

Because of the continuous replacement of the air volume surrounding the cooling pipes or, alternatively, because of the continuous contact between the air in the room and the thermally conductive sheets, which is the case in all of the above described constructions, such continual condensation of drops of water from the air restricts the use of the arrangements for cooling purposes.

The very high heating water temperatures which are required for ceiling radiators provided with plates of building materials constitute another factor which prevents use of such systems for cooling and because of which the economic advantages of a ceiling radiator with regard to its cost of operation as opposed to other heating systems cannot be attained. All of these disadvantages led to the fact that the building industry, in considering the most modern physiological and hygienic requirements to be met in equipping or fitting out a building, was forced to proceed in one of two alternative paths, i. e., to provide a construction of better thermal than acoustic properties or vice versa. The long sought simultaneous attainment of both objects, however, has heretofore not been possible for the above set forth reasons.

It is, therefore, yet a further object of the invention to provide means which meet and overcome the previously encountered technical deficiencies and disadvantages and permit for the first time the use of one and the same construction element as a ceiling radiator capable of absorbing or damping sound reaching the ceiling from an external source.

For this purpose, according to the invention, the acoustically effective zones or surface areas of the radiating element which are provided with perforations are arranged outside of the region of the heat-conducting sheets, i. e., adjacent thereto but spaced therefrom, whereby the inner ceiling or wall part, at least in the region of its acoustically effective zone or surface area opposite the air space, which latter is bordered on the one side by the frame construction and on the other side by the ceiling or wall part, is hermetically closed in order to prevent circulation of air between the room to be heated and the space in which the heating conduits are located, and especially also to prevent circulation of air from the room in the vicinity of the heat-conducting sheets or lamellae.

These and other objects of the invention will become further apparent from the following detailed description, reference being made to the accompanying drawing, showing a preferred embodiment of the invention.

In the drawing:

Fig. 1 is a top view of a single plate element embodying the invention;

Fig. 2 is a side view of the plate element of Fig. 1 taken in the direction indicated by the arrow II;

Fig. 3 is a sectional view of the plate element of Fig. 1 taken in the direction of the arrows III—III;

Fig. 4 is a sectional view of the plate element of Fig. 1 taken in the direction of arrows IV—IV; and

Fig. 5 is a sectional view through two adjacent abutting plate elements of the type illustrated in Fig. 1 taken substantially in the direction of the arrows V—V.

Referring now more particularly to the drawing, there is shown in Fig. 3 a conduit **1**, which constitutes a part of a tier or set, for the heating or cooling medium. The ceiling or wall part arranged beneath these conduits is constituted by single prefabricated plate elements **2**, which, for example, can be constructed of gypsum or other mortar-like material and are laterally interlocked or joined by means of a groove **3** and tongue **4**.

By this means a completely even ceiling surface is ensured and unwanted circulation of air through the plate element contact grooves and also penetration of unhygienic particles into the spaces behind the plate elements is prevented. The plate elements are suspended from the shell or frame construction by means of continuous T-shaped carriers or supports (not shown) each of which is connected at one end by means of intermediate members (not shown) to the frame and at the other end engages in slits **5** which are formed by the parallelly running facing edges of each two adjacent plate elements.

Each plate element is divided into an acoustically effective zone or surface area A and into two thermally effective zones or surface areas T, the latter being spaced from each other and being located on opposite sides of acoustic zone A. In the thermal zones T two heat-conducting lamellae or sheets **6** are arranged on the rear surface of each plate element. These sheets are mounted with the sides thereof facing the room to be heated being in contact with the plate element and are anchored in said element by means of stamped out tongues **7**.

The mid-section of each heat conducting sheet **6** is bent upwardly into two transverse webs **8** which are connected by a channel-like trough **9** for the purpose of receiving one of the conduits in which the heating medium flows. In order to affix these conduits to the plate elements and to the sheets, as well as to ensure a good heat conductive connection therebetween, the conduits **1** are provided with U-shaped metal sections or bridges **10** slidable thereon.

Bridges **10** have legs overlapping webs **8** which legs are formed with slots **11** which, in conjunction with rod-like abutments **12** protruding transversely from webs **8**, form a bayonet locking connection between said heat conducting sheets and said U-shaped metal bridges **10**. Because of the fact that the conduits **1** are not rigidly connected with the frame ceiling, a free dilatation of the set of conduits under the influence of thermal effects is possible.

In the acoustic zone A each plate element is perforated, i. e., it is provided with a plurality of circular holes **13** which place the room or region to be heated or cooled **14** in communication with a space or chamber **15** located behind the plate elements. In this space, which is bordered on two of its sides by means of a ledge **16** lined or reinforced with a fibrous or metal sheet (not shown) and by webs or ledges **17** which serve as dividing walls between space **15** and spaces or chambers **18** which contain the heat-conducting sheets **6** on the other two sides, there is provided a sound-absorbing or damping filling or mat (see Figs. 3 and 4) consisting, for example, of mineral wool, slag wool, glass wool or the like. The perforations thus permit sound waves to enter said sound-absorbing filling. To prevent an exchange of air between the room to be heated and region **19** in which conduits **1** are located there is arranged on the upper side of the sound-absorbing filling an air-tight sheet member **20** of aluminum foil which extends over the entire portion of the back face of the plate element **2** located opposite the acoustic zone A and tightly contacts the rear faces of ledges **17** as well as of the central portions of two of the oppositely located reinforced plate ledges **16** and thereby hermetically seals acoustic space or chamber **15** from thermal spaces or chambers **18**.

In order to prevent an infiltration of unhygienic particles into the sound-absorbing filling or a likewise hy-

gienically undesirable dropping of this filling through the perforations 13 there is provided between the filling and the perforations 13 in the plate element a thin synthetic plastic sheet 21 approximately 0.0015 mm. thick. Sheet 21 may be made of celluloid or polyvinyl chloride or air (aerated) glass. Such a sheet, because of its extreme thinness, only decreases the sound-absorbing efficiency of the mat in a negligible amount.

Plate elements 2 are provided with perforations simulating holes or indentations 22 for the purpose of ensuring the desired appearance or design of the ceiling or walls in which said elements are mounted or of which said elements are parts.

In operation of the system as a heating means, the heating medium in each conduit 1 heats the respective sheet 6 which distributes the heat over the plate element 2. In this manner, the latter is also heated and transfers heat by radiation and partly by convection into the room or space 14 which is to be heated. A part of the heat flow from sheet 6 is conducted into the perforated part of the plate element, i. e., into the sound-absorbing zone A which, being thermally insulated by the sound-absorbing material and hermetically sealed from the space 19, also transfers heat into the space 14 by radiation and convection. Sheets 20 and 21 completely prevent any interchange of air between spaces 14 and 19 and improve the insulation which prevents heat loss into the space 19.

The mineral wool in chamber 15 functions as a sound-absorbing means tending to damp out undesirable noises reaching space 19. For cooling purposes, it is only necessary to replace the heating medium by a cooling medium.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. In a heating system having at least one conduit for containing a heating medium; a plate element to be located between a first region in which said conduit is mounted and a second region to be heated, said plate element having first and second surfaces facing said first and second regions, respectively, a plurality of ledges protruding from said first surface of said plate element and defining a plurality of spaces thereon, thermally conductive sheet means lining at least a part of one of said spaces and provided with an intermediate portion arranged to receive said conduit in heat-conducting relationship, sound-absorbing means located within another of said spaces, said element being provided with perforations extending from said first surface to said second surface and within the boundaries of said other space to permit sound waves to enter said sound-absorbing means, synthetic plastic sheet means lining at least a part of said other space and closing said perforations so as to prevent movement of air therethrough, and foil means connected to said ledges and extending across at least a part of said first surface of said element to seal said other space hermetically from said first region and said one space, whereby heat imparted to said conduit by said heating medium is transferred to said thermally conductive sheet means and distributed by the latter over at least that portion of said element corresponding to said one space, said portion of said element further transferring its heat to said second region, said sound-absorbing means serving to absorb and damp out undesirable noises reaching said plate element and further constituting thermal insulation means preventing loss of heat from said second region into said first region.

2. A plate element according to claim 1, said ledges further defining a third space, said hermetically sealed other space being located between said one space and said third space, and further thermally conductive sheet means lining at least a part of said third space and provided with an intermediate portion to receive another conduit for containing a heating medium, whereby said third space substantially functions like said one space.

3. A plate element for climate systems having at least one conduit for containing a thermal medium, said plate element being adapted to be located between the region in which said conduit is located and the region to be treated, means defining a plurality of spaces on one surface of said plate element, thermally conductive sheet means lining at least a part of one of said spaces and provided with an intermediate portion constructed to receive said conduit in thermally conductive relationship, said element being provided with perforations extending from said one surface to the opposite surface of said element and within the boundaries of another of said spaces, protective plastic sheet means lining at least a part of said other space and closing said perforations so as to prevent movement of air therethrough, foil means connected to said one surface of said element and extending across said other space to seal the latter hermetically from said region in which said conduit is located, to thereby define a sound-absorbing chamber within said other space between said plastic sheet means and said foil means, and sound-absorbing means located within said chamber and protected by said plastic sheet means against contamination, said perforations providing access for sound waves to said sound-absorbing means, whereby said thermally conductive sheet means imparts to at least that portion of said element corresponding to said one space a thermal condition corresponding to the thermal condition of said medium and said element in turn imparts said thermal condition to said region to be treated, said sound-absorbing means serving to damp out undesirable noises reaching said plate element and serving concurrently as thermal insulating means for preventing adverse thermal transfer between said regions and through said perforations and said chamber.

4. A climate system comprising in combination, conduit means for a thermal medium, plate means located adjacent said conduit means, means releasably interconnecting said conduit means with said plate means, said plate means being provided with a plurality of spaces facing the region in which said conduit means is located, thermally conductive means lining at least a part of one of said spaces and in contact with said conduit means to thereby transfer the effect of said medium to that portion of said plate means corresponding to said one space, said portion in turn transferring said effect to a region to be climatized, a further portion of said plate means corresponding to another space adjacent said one space being provided with perforations, sound-absorbing means in said other space, and means hermetically sealing said other space from the second region and from said perforations and enclosing said sound-absorbing means, said perforations affording access for sound waves to said sound-absorbing means, whereby the latter effects absorption of undesired noises and prevents adverse thermal transfer through said perforations and said other space.

5. A system according to claim 4, said interconnecting means comprising a substantially U-shaped bridge adapted to be mounted astride said conduit means and having at least one slot, and rod means mounted on said plate means, said slot and rod means cooperating to form bayonet locking means to secure said plate means to said conduit means.

6. A system according to claim 4, said plate means comprising a plurality of plate elements, and groove and tongue means on respective adjacent plate elements for joining the same.

7. A plate element for climate systems adapted to be located between two regions from one to the other of which a thermal condition is to be transferred; said plate element being made of structural materials having low

thermal conductivity, at least one chamber formed and located on one surface of said plate element, sound-absorbing means located within said chamber, said element being provided with perforations extending from said one surface to the opposite surface of said element and within the boundaries of said chamber to permit access of sound waves to said sound-absorbing means, protective plastic sheet means lining at least a part of said chamber over said perforations so as to prevent movement of air therethrough and to protect said sound-absorbing means against contamination, and air tight, metallic foil means mounted on said one surface of said element to seal said chamber hermetically, whereby said plate element transfers said thermal condition from said one region to the other, said sound-absorbing means simultaneously serving to absorb and damp out undesirable noises reaching said plate element and to prevent adverse thermal transfer through said perforations and said chamber.

8. A plate element for climate systems adapted to be located between two regions from one of which a thermal condition is to be transferred to the other, said plate element being made of structural material having substantially low thermal conductivity, at least one chamber formed in one surface of said plate element, sound-absorbing means in said chamber, said element being provided with perforations extending from said one surface to the opposite surface of said element and within the boundaries of said chamber to permit sound waves to encounter said sound-absorbing means in said chamber, and means hermetically sealing said chamber to prevent circulation of air therethrough, whereby said thermal condition is transferred from said one region to the other by said plate element, said sound-absorbing means simultaneously serving to damp out undesirable noises reaching said plate element and thermal insulating means preventing adverse thermal transfer through said chamber and said perforations.

References Cited in the file of this patent

UNITED STATES PATENTS

2,172,771	Norris	Sept. 12, 1939
2,662,743	Frenger	Dec. 15, 1953

FOREIGN PATENTS

399,681	Great Britain	Oct. 12, 1933