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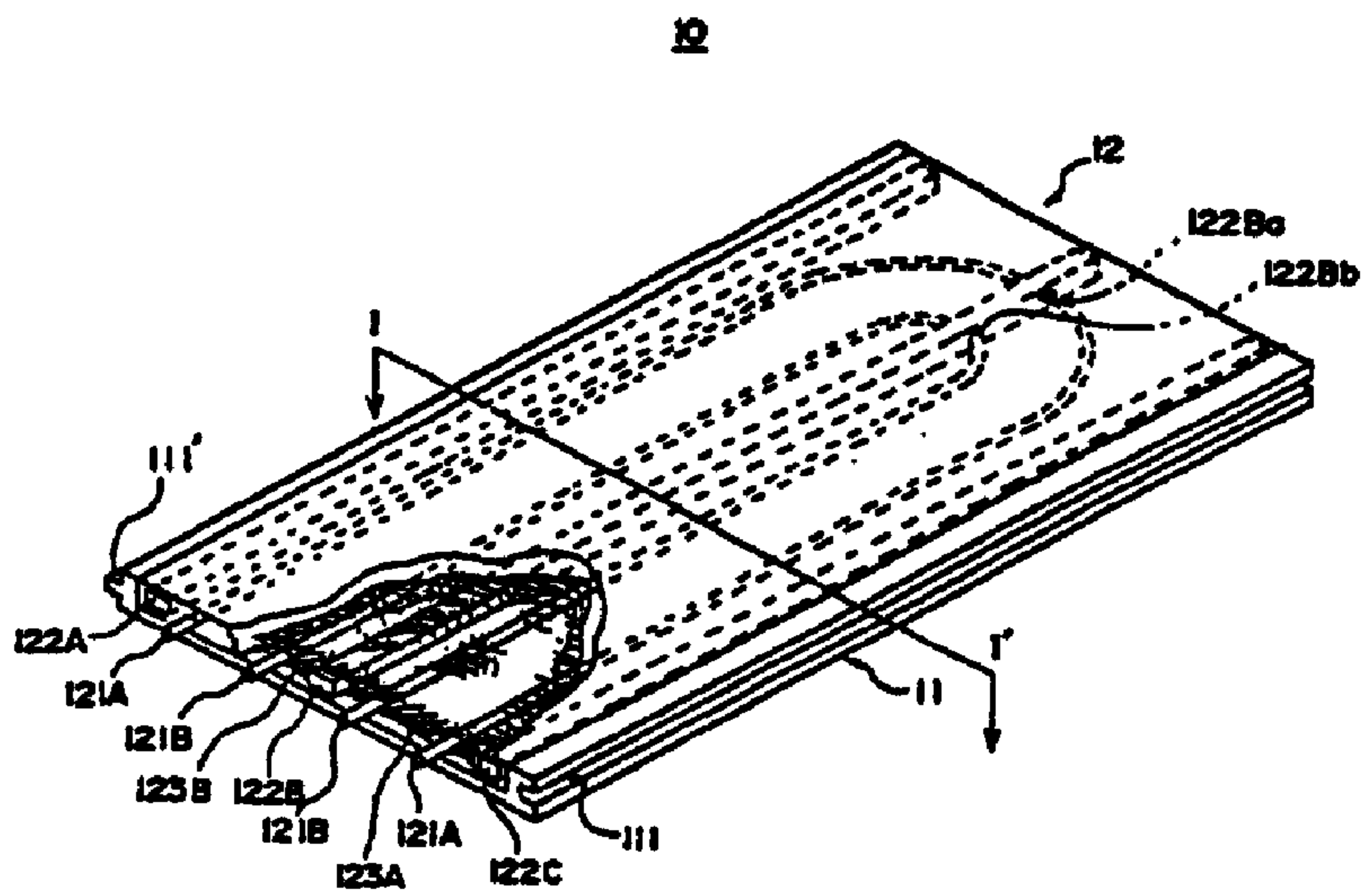
(54) **PANNEAU POUR CONDITIONNEMENT D'AIR NOTAMMENT DE LOCAUX ET SYSTEME L'UTILISANT**

(54) **PANEL FOR AIR CONDITIONING AND ROOM AIR CONDITIONING SYSTEM USING THE PANEL**



(57) L'invention porte sur un panneau pour conditionnement d'air consistant en plaques de ciment traversée par des tubes fixes courant le long de sa surface et disposés en couches et dont les extrémités s'ouvrent dans un élément de cadre extérieur comprenant un isolateur plat présentant une surface plane et une partie saillante située à l'extrémité de la surface plane et dont la forme permet l'insertion de la plaque de ciment à partir de ladite surface. L'invention porte également sur un système de conditionnement d'air par exemple de locaux utilisant de tels panneaux, par exemple à chauffage par le sol, léger par unité de surface, d'une faible épaisseur, assez robuste pour constituer des sols recevant des objets lourds, facile à monter, permettant des économies d'énergie et facile à entretenir.

(57) A panel for air conditioning in which a flat mortar plates through which heat conductor pipes are passed fixedly and along its flat surface are fitted in layers, with the end parts of the fixed heat conductive pipes open, into an outer frame mold which comprises a flat insulator having a flat surface and a projected part formed along the end part of the flat plate and which has such a shape that the mortar plates can be inserted from the flat plate surface and a room air conditioning system using the air conditioning panel, whereby a room air conditioning system, such as a floor heating system, which is light in weight per unit area, thin in construction unit, so robust as can be used in a space where heavy objects are installed on a floor, easy in construction itself, capable of energy saving, and easy in maintenance, can be implemented.

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(54)Title: PANEL FOR AIR CONDITIONING AND ROOM AIR CONDITIONING SYSTEM USING THE PANEL

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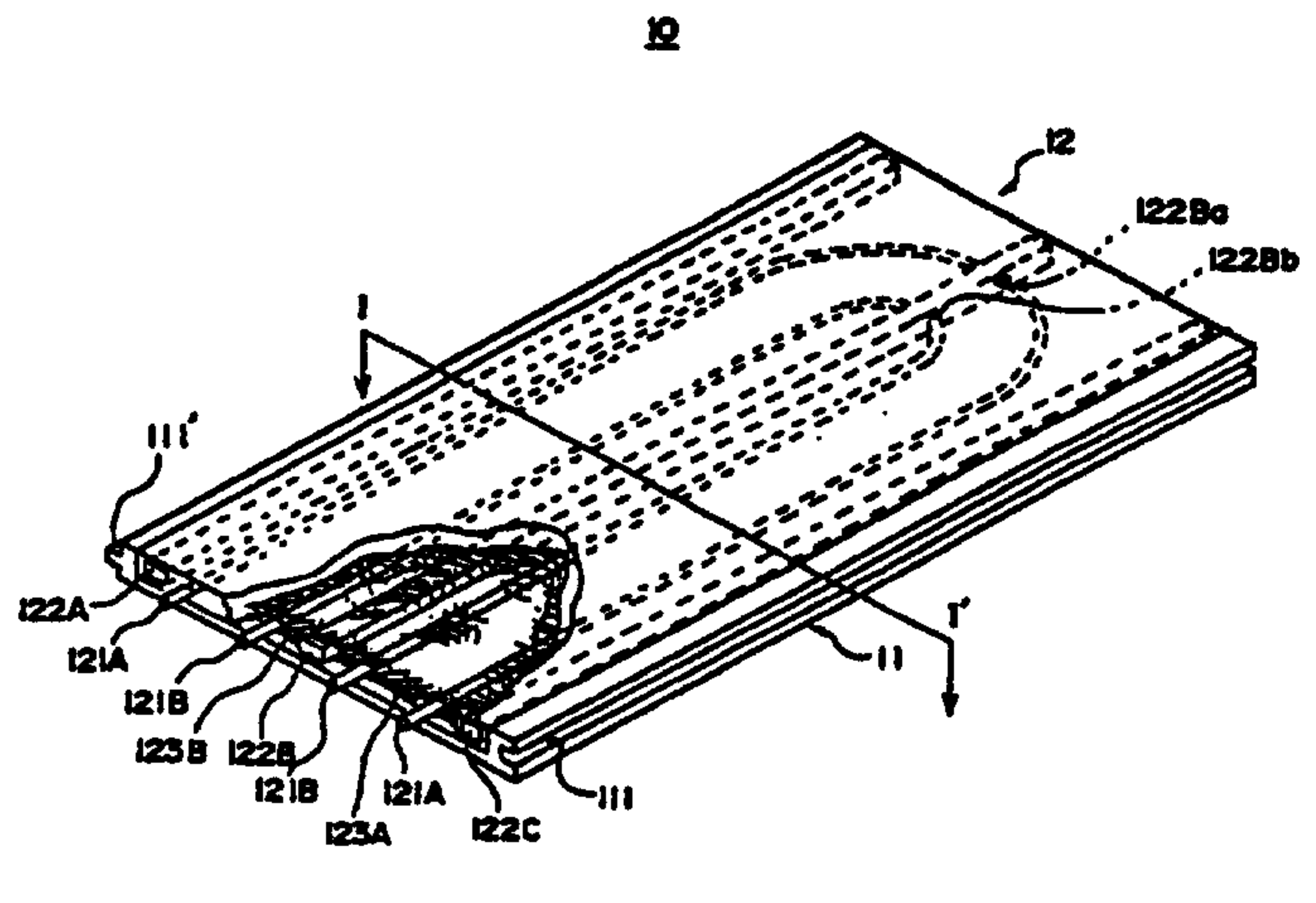


(57) Abstract

A panel for air conditioning in which a flat mortar plates through which heat conductor pipes are passed fixedly and along its flat surface are fitted in layers, with the end parts of the fixed heat conductive pipes open, into an outer frame mold which comprises a flat insulator having a flat surface and a projected part formed along the end part of the flat plate and which has such a shape that the mortar plates can be inserted from the flat plate surface and a room air conditioning system using the air conditioning panel, whereby a room air conditioning system, such as a floor heating system, which is light in weight per unit area, thin in construction unit, so robust as can be used in a space where heavy objects are installed on a floor, easy in construction itself, capable of energy saving, and easy in maintenance, can be implemented.

PANEL FOR AIR CONDITIONING AND ROOM AIR CONDITIONING SYSTEM USING THE PANEL

FIELD OF THE INVENTION

This is an invention in the field of central heating and cooling system technology, which maintains comfortable room temperature by radiant heat or cold conducted from a liquid (heated to a higher temperature, or cooled to a lower temperature than the ambient room temperature) circulating through metal tubing encased in modular panels installed in the room. Specifically, this invention includes the panels and the overall central heating and cooling system that the panels comprise.

BACKGROUND

In the field this invention belongs to, the most prevalent type of heating system is the "hot water radiant floor heating system," which heats rooms by radiant heat conducted from hot water-circulating tubes installed in the floor. This type of "radiant floor heating system" has the following advantages over forced-hot-air systems utilizing blowers, forced-hot-water systems utilizing baseboard registers, radiators, space heaters and stoves:

1. The radiant heat energy conducted from hot water to people and objects in the room is clean and healthy, and it feels more comfortable because it's similar to warming from natural sunlight and radiates up from the floor, keeping feet and legs warmer, while the head stays slightly cooler. Also, the system provides more even distribution of heat throughout the room, while maintaining optimum temperature at all levels between the floor and ceiling. Additionally, when compared to conventional heating systems, it can effectively heat a room at a lower operative temperature (average of the air temperature and the temperature of the surrounding surfaces in the room) and thermostat setting because the warm surfaces in the room re-radiate the heat energy and keep people comfortable even when the air temperature is relatively low.

2. There is no danger of burning, or fire resulting from overturned heating devices, because the heat source is relatively low-temperature, and the heat radiating apparatus is installed in the floor–not exposed in the room.

3. There is no noise generated by blowers or motors when the system is running, so it promotes quieter surroundings. Also, the system promotes clean interior air because it doesn't blow heated air or steam into the room. It doesn't dry the air or pollute it, or cause dust to accumulate in the room.

4. Because the system is installed inside the floor, which itself is the heating device, there are no heating devices taking up space in the room, and there is more useable space in every room.

5. The system makes people feel warm even though the air temperature in the room is maintained at a level 4-6 °C lower than that with conventional heating systems, because the heat energy generated by the system is conducted directly to people, rather than heating the air. Also, the system saves energy when compared to conventional heating systems, because it operates at a lower thermostat setting, and heats people and objects directly–not only the air–and it concentrates heat at lower levels in the room, rather than near the ceiling where it isn't needed.

As explained above, the prevalent type of "radiant floor heating system" has many advantages, however, it has certain problems and requires improvements. Namely, it is relatively costly to install and maintenance can be problematic.

There are many different kinds of radiant floor heating systems. The type that is most appropriate for a specific installation is chosen based upon the building and type of place where it is to be installed, and the budget. For example, it is best to install the sturdiest type of floor heating system in hospitals, where heavy medical equipment is constantly transported across the floor, and in rooms in schools and dwellings where heavy objects like pianos are located.

The "install-in-place" type of installation is typically carried out for locations where heavy objects are placed on the floor. In this type of installation, the heat conducting tubing and associated pipe work is laid out and joined in place at the work site, and then embedded in the floor. This type of floor heating system installation involves laying a heat-insulating material, or a heat-insulating material that includes metal, followed by heat conducting tubing and associated pipe work, at the work site. Mortar is then poured over these materials, and after hardening, flooring surface material is laid over the mortar.

An "install-in-place" floor heating system is very sturdy and is ideal for floors that have to withstand heavy, concentrated weights. However, there are some disadvantages to this type of system. Namely, the cost per m^2 of floor heating for this type of system is very high because it is labor intensive and delays other work that needs to be done in the same area; therefore, this type of installation is not particularly efficient. The "install-in-place" system falls under the category of "wet type" installations, in which mortar is poured at the work site and requires significant time to harden; therefore, other work cannot proceed in the area until the mortar hardens completely. As a result, the floor heating system installation can cause a delay in the completion of an overall construction project.

In addition, the "install-in-place" system may be problematic for multistory structure installations because its weight per m^2 is very high, and it influences the overall structure of the building. For example, due to the heaviness of the materials (e.g., mortar) used, it may be difficult to install the system on the second or third floors of a wood-frame house. Furthermore, especially in the case of retrofitting, the "install-in-place" system raises the level of the floor, which in turn lowers the height of the ceiling.

Based on this analysis of the current state of radiant floor heating system technology, the objective of the invention disclosed herein is to provide a radiant floor heating system that is light, thin, able to support heavy objects without suffering damage, easy and quick to install, and easy to maintain.

SUMMARY OF THE INVENTION

The present invention provides radiant heating and cooling panels (hereafter referred to as "the panel(s)") comprising a uniformly flat-surfaced, planar, rectangular slab of mortar that encases heat- and cold-conducting tubing, which extends parallel to the surface, horizontally through the plane of the slab. The ends of the heat- and cold-conducting tubing fixed within the slab of mortar protrude from the mortar at the ends of the slab/panel and are open (not sealed).

The slab of mortar with encased tubing is fit into and affixed to a uniformly flat-surfaced, planar layer of heat- and cold-insulating material that conforms to the length and width dimensions of the slab, and covers the sides of the slab. The heat- and cold-insulating material layer has integrated tongue and groove joint parts on opposite sides, and forms a frame for the panel; the modular panels are fit together side by side by the integrated tongue and groove joint parts protruding from their sides. Each panel is assembled by fitting the mortar slab unit that encases heat- and cold-conducting tubing (extending parallel to the surface, horizontally through the plane of the slab) into the heat- and cold-insulating material frame unit (separately manufactured), which conforms to the length and width dimensions of the slab and covers its sides, and has integrated tongue and groove joint parts on opposite sides. The two units are affixed together to form an integrated panel.

The radiant heating and cooling system utilizing the panels is comprised of the modular panels fit together side by side by the integrated tongue and groove joint parts protruding from their sides, and connected to one another end-to-end by means of joining the ends of the heat- and cold-conducting tubing protruding from the mortar at the ends of the panels, and which are furthermore connected by supply (in-flow) and return (out-flow) tubes to a means of liquid circulation, forming a closed, interconnected liquid circulation system that can be placed directly underneath the surface material covering floors, walls and ceilings. The "means of liquid circulation" controls the temperature of the circulating liquid and its supply/distribution throughout the interconnected liquid circulation system.

This invention is based on the concept of "radiant heating," in which ambient warmth is produced by the introduction of a heat-conducting substance of a higher temperature than the ambient room temperature, into the room to be heated. It maintains comfortable room temperature by radiant heat conducted from the liquid (heated to a higher temperature than the ambient room temperature) circulating through its metal tubing. This invention can also be used for "radiant cooling," in which ambient coolness is produced by the introduction of a cold-conducting substance of a lower temperature than the ambient room temperature, into the room to be cooled. When used for this purpose, it maintains comfortable room temperature by radiant cold conducted from the liquid (cooled to a lower temperature than the ambient room temperature) circulating through its metal tubing.

The Inventive heating system consists of the mortar slab and the Insulating Frame. The mortar slab contains the heat- and cold-conducting tubing that circulates heated or cooled liquid. The mortar slab is fit inside the Insulating Frame and the two units are affixed together.

The heat-radiating plane/surface of the Inventive heating system would be completed by: preparing the panels in advance; bringing the panels to the work site; and fitting together/connecting the panels at the work site.

As mentioned above, the "install-in-place," or "embedded," type of floor heating system is used in applications where a sturdy floor structure is required in the area to be heated. The embedded system, however, presents many difficulties involving labor, time and skills for execution of installation, particularly with respect to the mortar, which needs to be prepared, poured and finished at the work site. In addition, other work cannot be efficiently carried out before the mortar hardens completely. Therefore, it has been recognized that installing an embedded system is time consuming, and can cause a delay in the completion of an overall construction project.

The Inventive heating system, on the other hand, makes it possible to achieve a sturdy floor structure in the area to be heated, reduce the amount of labor and time for installation dramatically, and to execute installation without skilled workmen. The inventive heating system also reduces overall construction completion time dramatically because the mortar in the panels is already hard, so other work can proceed immediately after installation of the panels, unlike the situation with the conventional embedded system.

Furthermore, the inventive heating system effects a reduced weight per-unit-of-area without sacrificing strength, because the mortar slab in the panels is very strong yet comparatively light and very thin (close to the diameter of the conduction tubing encased in the mortar), while the overall thickness of the panels is close to the diameter of the conduction tubing plus the thickness of the insulating frame. Therefore, the panels can be installed in the upper floors of conventional wood-frame houses. Another advantage of the inventive heating system is that an individual panel can be replaced if there is something wrong with it.

The mortar slab that is a component of the inventive heating system's heating and cooling panels consists of a uniformly flat-surfaced, planar, rectangular slab of mortar that encases heat- and cold-conducting tubing, which extends parallel to the surface, horizontally through the plane of the slab. The ends of the heat- and cold-conducting tubing fixed within the slab of mortar protrude from the mortar at the ends of the slab and are open (not sealed).

The method of manufacturing the mortar slab is not particularly restricted. One method, for example, is to place and fix the conduction tubing inside a panel mold, and then pour mortar into the mold, between the sections of conduction tubing. The mortar slab is later removed from the mold after the mortar hardens. A more detailed explanation of the method of manufacturing the mortar slab is presented herein.

The composition of the mortar that constitutes the mortar slab is not particularly restricted, but it is beneficial to incorporate infrared-emitting mineral powders and mica powder in the mortar in order to increase the efficiency with which the inventive heating system's heating and cooling panels accumulate and radiate heat energy.

Using metal, as opposed to plastic or rubber, as the material for the heat conducting tubing in the mortar slab is optimal in terms of maximizing the heat conducting capability of the tubing itself. Specific metals that can be used for the heat conducting tubing include: copper, iron, aluminum, lead, stainless steel and others. However, it is preferable to use copper, which is superior in terms of its efficiency of heat conduction and anti-corrosion characteristics.

The configuration and shape of the heat conducting tubing within the panels is not particularly restricted, but it is required that the tubing is fixed in place, running parallel to the surface, horizontally through the plane of the slab, and that both of the open ends of the sections of tubing protrude from the mortar at the end of the slab. That is to say, the heat conducting tubing can for example be U-, T-, and J-shaped, in addition to straight. As discussed later in more detail, one of the goals of the inventive heating system is flexibility in manufacturing appropriately shaped panels (panels having a particular exterior shape, as well as internal tubing shape) corresponding to the particular area of installation. The panels are connected to one another end-to-end by means of joining the open ends of the conduction tubing protruding from the mortar at the ends of the panels, forming a closed, interconnected system. Conjunction parts (joint units) are used to interconnect the conduction tubing protruding from the ends of the panels.

Encased within the mortar slab, there is at least one joist running horizontally, longitudinally through the mortar, together with the conduction tubing, in order to reinforce the panel. The joist(s) also eliminates or reduces the need for adhesives or other chemicals to attach flooring surface material to the panel(s), because materials such as wood and plastic can be physically attached to the joist(s) with fasteners, rather than being chemically bonded to the panels. The absence of harmful, vapor-emitting glues and compounds that pollute inside air is another advantage of the inventive heating system.

The material of the insulating frame unit that the mortar slab unit is fit into and affixed to is not limited. Materials including wood, light stone, light mortar, plastic, and polystyrene can be used. It is preferable to use polystyrene, however, because it is easy to handle and it is the best material in terms of efficiency of heat insulation.

The panels have integrated tongue and groove joint parts on opposite sides by which they are easily fit together in the area to be heated. The specific shape of the tongue and groove joint parts on the panels is not restricted, provided that it allows the panels to be easily fit together.

Metal (e.g., metal wire mesh, solid metal sheeting) is affixed to the top of the conduction tubing within the mortar and the underside of the tubing facing the insulating material, in order to facilitate the efficiency of conduction of heat energy emanating from the heat conducting tubing. The material of the metal (e.g., metal wire mesh, solid metal sheeting) is not limited to a specific metal, but it is required to be an efficient heat conductor, such as stainless steel, copper, iron, or aluminum. Stainless steel and copper are ideal considering their efficiency of heat conduction and resistance to corrosion. The metal (e.g., metal wire mesh, solid metal sheeting) can be easily stapled onto the joist(s) described above that is incorporated in the panels, which is another advantage of the inventive heating and cooling system.

The inventive heating and cooling system is constructed in any room by fitting the panels together side by side and connecting them to one another end-to-end by means of joining the ends of the conduction tubing, forming an interconnected, continuous liquid circulation system that can be placed directly underneath the surface material of floors, walls and ceilings.

In the inventive heating and cooling system, the conduction tubing that is joined end-to-end between the panels is furthermore connected by supply (in-flow) and return (out-flow) tubes to a water heating, and/or cooling, and pumping apparatus (includes any apparatus that controls the temperature of the circulating liquid and its supply/distribution throughout the interconnected liquid circulation system).

The temperature of the circulating liquid is maintained at a level differing from the ambient room temperature, and the liquid is circulated through the panels placed inside of the floor, walls, and/or ceiling by the pumping apparatus described above. The temperature in the room is adjusted by the radiant heat or cold conducted from the circulating liquid (heated to a higher temperature, or cooled to a lower temperature than the ambient room temperature). The circulating liquid can be water or some other water-based solution that incorporates a chemical substance(s) that increases water's efficiency as a heat and/or cold conducting medium.

The inventive heating and cooling system is driven by the liquid temperature control apparatus, which maintains the temperature of the liquid circulating through the Liquid Circulation System at a level differing from the ambient room temperature. It is desirable to use the liquid temperature control apparatus that incorporates a liquid temperature control means utilizing at least two different energy sources for heating the liquid because it effects a reduction in energy consumption and reduces the running cost of the inventive heating and cooling system.

The sources of energy utilized by the liquid temperature control means incorporated in the Liquid Temperature Control System can be electricity, gas, solar, geothermal, and combustion of any type of fuel. However, it is desirable to utilize a combination of electricity and gas, considering the running cost realized by their use.

Using the liquid temperature control means that utilizes at least two different energy sources makes it possible to lower the cost of maintaining the temperature of the circulating liquid because the liquid temperature control apparatus alternately selects the source of energy which is comparatively inexpensive, based on the time of day, to use for the liquid temperature control means. For example, in the case of a combination of electricity and gas, gas is used during the day when it is comparatively inexpensive, while "nighttime electricity" is used during the night when it is comparatively inexpensive, which leads to a cost reduction in maintaining the temperature of the circulating liquid.

Furthermore, the inventive heating and cooling system effects further reductions in energy consumption and running cost by utilizing the heat accumulation and storage means that accumulates and stores heat energy generated by the liquid temperature control means incorporated in the liquid temperature control apparatus. Specifically, for example, a heat accumulating and storing chemical substance such as Ammonium Sulfate can be used as the heat accumulation and storage means. The method of incorporating the heat accumulation and storage means in the inventive heating and cooling system is not particularly restricted. For example, the heat accumulation and storage means can be set outside the liquid temperature control apparatus, or the heat accumulation and storage means can be set inside the liquid temperature control apparatus. However, it would be generally advantageous to set the heat accumulation and storage means inside the liquid temperature control apparatus since this configuration is more energy efficient and requires less space.

Energy consumption and the running cost of the inventive heating and cooling system can be reduced by utilizing the heat accumulation and storage means described above because heat energy generated at night using a comparatively inexpensive energy source like nighttime electricity is stored in the heat accumulation and storage means overnight and then used during the day when the unit price of energy is comparatively higher, therefore, less of the more expensive daytime energy source is used.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a drawing showing the external and internal appearance of a first embodiment of the inventive heating and cooling panel, diagonally oriented and as seen from above.

Figure 2 is a cross section of the inside of the first embodiment of the inventive heating and cooling panel.

Figure 3 is an exploded, diagonally oriented view of the first embodiment of the inventive heating and cooling panel.

Figure 4A shows a first step in a manufacturing process for the mortar slab of the first embodiment of the inventive heating and cooling panel.

Figure 4B shows a second step in a manufacturing process for the mortar slab of the first embodiment of the inventive heating and cooling panel.

Figure 4C shows a third step in a manufacturing process for the mortar slab of the first embodiment of the inventive heating and cooling panel.

Figure 4D shows a fourth step in a manufacturing process for the mortar slab of the first embodiment of the inventive heating and cooling panel.

Figure 4E shows a fifth step in a manufacturing process for the mortar slab of the first embodiment of the inventive heating and cooling panel.

Figure 5 is a drawing showing the external and internal appearance of a second embodiment of the inventive heating and cooling panel, diagonally oriented and as seen from above.

Figure 6 is a diagram of an embodiment of an inventive heating and cooling system incorporating one of the embodiments of the inventive heating and cooling panel.

Figure 7 shows an example of the method of connecting the inventive heating and cooling panels, diagonally oriented and as seen from above.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the inventive heating and cooling panels and the inventive heating and cooling system employing the panels are described below with references to the attached Figures 1 through 7.

Figure 1 shows the external and internal appearance of the inventive heating and cooling panel (10), diagonally oriented and viewed from above, and Figure 2 shows a horizontal view of a cross section of the inside of the inventive heating and cooling panel (10) bisected at line I–I' (Figure 1).

Regarding the inventive heating and cooling panel (10), in Figure 1 and Figure 2 it is recognized that the U-shaped sections of heat conducting tubing 121A and 121B extend parallel to the surface, horizontally through the plane of the flat mortar slab (12). Both ends of the sections of heat conducting tubing protrude from one end of the mortar slab (12A) (Figure 3), and the sections of tubing are fixed in the mortar, with both ends of the tubing remaining open. The mortar slab (12A) is fit into and affixed to the outer frame (11), which has a uniformly flat, planar surface (11A) (Figure 3) and outer parts (11B) and (11B') that protrude from opposite sides of the planar surface of the outer frame (11).

The mortar slab (12) contains the joists 122A, 122B and 122C, which are fixed in place, running horizontally, longitudinally through the mortar slab (12) in order to reinforce the inventive heating and cooling panel (10) and enable flooring surface material to be affixed to the inventive heating and cooling panel (10) by fasteners such as nails. The sections of heat conducting tubing 121A and 121B pass through the holes 122Ba and 122Bb respectively, which are drilled in the joist 122B.

The mortar slab (12) also contains metal (e.g., metal wire mesh, solid metal sheeting, made of any number of metals) 123A (upper part) and 123B (lower part), which is placed on top of the conduction tubing within the mortar and pressed against the underside of the tubing facing the insulating material, in order to facilitate the efficiency of conduction of radiant heat energy emanating from the sections of heat conducting tubing 121A and 121B, into the mortar. The metal 123A and 123B is pressed against the heat conducting tubing by the mortar, and in order to insure uniform contact with the tubing, the metal 123A and 123B is additionally fastened by Staple (124) to the joists 122A, 122B and 122C, which pulls the metal against the tubing. The metal 123A is stapled from the top, while the metal 123B is stapled from the underside facing the outer frame.

There are male and female joint parts 111 (tongue) and 111' (groove) integrated into the outer parts 11B and 11B' respectively on opposite sides of the planar surface (11A) of the outer frame (11), by which the panels are fitted together. Multiple panels are easily fitted together in this way at the work site, forming a uniformly flat structure. The joint parts are not necessarily limited to the indicated tongue and groove shapes.

Figure 3 shows, viewed from above, a diagonally oriented, exploded view of the two units comprising the inventive heating and cooling panel (10). As mentioned earlier, the inventive heating and cooling panel is comprised of the mortar slab (12), in which two U-shaped sections of heat conducting tubing 121A and 121B are encased, fit into and affixed to the outer frame (11). Various methods of affixing the mortar slab (12) to the outer frame (11) are possible, and various fasteners and glues can be used. When glue is used, it is preferable to use a non-toxic substance. This is the method of assembling the inventive heating and cooling panel in which a combination of two sections of U-shaped heat conducting tubing is employed.

The material of the heat conducting tubing 121A and 121B is not particularly restricted, but it must be impermeable to water and other water-based solutions that incorporate a chemical substance(s) that increases water's efficiency as a heat conducting medium when it circulates through the heat conducting tubing, and it must efficiently conduct the radiant heat energy emanating from the medium described above. For example, various metals and plastics can be used, however, it is preferable to use a metal, especially copper, which is superior in terms of its efficiency of heat conduction and anti-corrosion/durability characteristics in the inventive heating and cooling panel (10). Also, the diameter of the heat conducting tubing 121A and 121B is not limited, provided that the appropriate degree of heat conducting efficiency can be realized.

Figure 4 is a series of five figures (A–E) showing, in stages, an example of the manufacturing process for the mortar slab (12) described above. In Figure 4A, (12') indicates a mold corresponding to the shape of the mortar slab (12).

As indicated in Figure 4B, heat-conducting tubing 121A and 121B, joists 122A, 122B and 122C, and metal 123A and 123B are arranged/assembled in advance. The whole assembly is placed in the mold (12') as indicated in Figure 4C. (The metal 123A is fixed by staple to joists 122A, 122B and 122C from the top, while the metal 123B is fixed by staple to joists 122A, 122B and 122C from the underside.)

As indicated in Figure 4D, the mold (12') has accompanying tube insert metal Fittings (121') welded to its ends, with holes corresponding to the outer diameter of the heat conducting tubing and the positions and number of the sections of tubing set in the mold. The Fittings (121') hold the sections of tubing 121A and 121B in proper alignment when mortar is poured into the mold. By inserting the ends of heat conducting tubing 121A and 121B into the tube insert metal Fittings (121'), the heat conducting tubing is fixed in proper alignment within the mold (12'), and the whole tube/metal/joist assembly is fixed in the mold (12') in appropriate position.

As indicated in Figure 4E, the prepared mold (12'A) is stacked together with other prepared molds (12'B and 12'C). The stacked, prepared molds (12'A, 12'B and 12'C) are placed between two Holding Slabs (125) and (125'), which hold the stack together. Then mortar is poured into the gaps between the heat conducting tubing and the inner surfaces of the multiple, stacked prepared molds (12'A–C), as indicated in Figure 4E (the arrows in Figure 4E show the direction of mortar pouring). After the mortar hardens, the stack of molds is disassembled and the completed mortar slabs (12) are removed from the individual molds.

It is expedient to stand the stacked, multiple prepared molds (12'A–C) on end while pouring the mortar into the gaps between the sections of heat conducting tubing and inner surfaces of the molds, and while the mortar is hardening, in order to produce as flat a surface as possible on the finished mortar slab (12) (Japan patent number 1975766–method of manufacturing mortar slab, held by the Inventor herein). To expedite the hardening of the mortar after pouring, the outside of the molds can be sprayed with hot water or steam (or some other known method of expediting mortar hardening can be employed). Furthermore, it is beneficial to mix infrared-emitting mineral powders and mica powder into the mortar as mentioned earlier, in order to increase the heat energy accumulating and radiating capability of the inventive heating and cooling panel (10). The mortar slab (12) manufactured as described above can be used as the mortar slab component of the inventive heating and cooling panel.

As explained earlier, the configuration and shape of the heat conducting tubing set in the inventive heating and cooling panel is not particularly restricted, as long as the condition that, "the tubing is fixed in place, running parallel to the surface, horizontally through the plane of the slab," is satisfied.

Figure 5 shows the external and internal appearance of another version of the inventive heating and cooling panel (20), diagonally oriented and viewed from above, and in which the sections of heat conducting tubing are straight (not bent into any shape). The inventive heating and cooling panel (20) is the same as the inventive heating and cooling panel (10), except that in (20) the sections of heat conducting tubing are straight instead of U-shaped, and in (20) the number of sections of tubing is four instead of two. The ends of the four sections of heat conducting tubing (221A, 221B, 221C and 221D) protrude slightly from the End (22A) of the mortar slab (22), and the opposite ends of the four sections of heat conducting tubing (221A, 221B, 221C and 221D) protrude slightly from the End (22A') of the mortar slab (22). Both ends of the four sections of heat conducting tubing (221A, 221B, 221C and 221D) remain open (not sealed). The joists (222A, 222B and 222C) of (20) correspond to the joists (122A, 122B and 122C) of (10) as described above. However, the joist (222B) does not have holes drilled in it, unlike (122B). The metal (223A and 223B) of (20) correspond to the metal (123A and 123B) of (10) as described above. The outer frame (21) of panel (20) corresponds to the outer frame (11) of panel (10). The outer parts (22B and 22B') of (21) correspond to the outer parts 11B and 11B' of (11) as described above. The male and female joint parts 211 (tongue) and 211' (groove) on opposite sides of (21) that are used to connect panels together correspond to the male and female joint parts 111 (tongue) and 111' (groove) on opposite sides of (11) as described above.

In the process of manufacturing the inventive heating and cooling panel, it is possible to choose and set, as desired, various configurations and shapes of the heat conducting tubing in the mortar slab. The mortar slab (22) is produced according to the manufacturing process for the mortar slab (12).

Figure 6 is a diagram of the inventive heating and cooling system (300). In Figure 6, 10A–10E indicate five of the inventive heating and cooling panel, in each of which are set two U-shaped sections of heat conducting tubing; 20A–20E indicate five of the inventive heating and cooling panel, in each of which are set four straight sections of heat conducting tubing; 30A and 30B indicate two of the inventive heating and cooling panel, in each of which are set two straight sections of heat conducting tubing; 40A–40E indicate five of the inventive heating and cooling panel, in each of which are set two rather short U-shaped sections of heat conducting tubing; 50 indicates one of the inventive heating and cooling panel, in which is set one rather short U-shaped section of heat conducting tubing.

Each of the inventive heating and cooling panel, as shown in Figure 6, are interconnected and fixed to one another by joining the ends of the heat conducting tubing protruding from the ends of the panels, to form one, continuous span of heat conducting tubing. This is the process by which the heating and cooling plane/surface (310) directly related to and providing heating and cooling in the room is constructed.

The method of connecting the sections of heat conducting tubing combined in the inventive heating and cooling panel is not limited. Joint parts and glue can be used to make connections. However, it is advantageous and desirable to use some kind of joint parts, considering the stability and safety they provide after the installation.

Connecting the sections of heat conducting tubing combined in the inventive heating and cooling panel can be accomplished as depicted in Figure 7. In Figure 7, when the inventive heating and cooling panel (20) and (20') are connected, the Sections of Heat Conducting Tubing (221C and 221F) are connected by the joint part (226C), which has an inner diameter matching the outer diameter of the Sections of Heat Conducting Tubing (221C and 221F). Similarly, the Sections of Heat Conducting Tubing (221D and 221E) are connected by the joint part (226D), which has an inner diameter matching the outer diameter of the Sections of Heat Conducting Tubing (221D and 221E).

After connecting the sections of heat conducting tubing, the gap (indicated by (60) in Figure 6) between the inventive heating and cooling panel (20) and (20') can be filled by pouring mortar into the gap and allowing it to harden. The gap (60) filled by mortar helps increase the System's heating and cooling efficiency by accumulating and radiating heat/cold energy conducted from the heat- and cold-conducting tubing.

In the heating and cooling plane/surface (310), the Entrance (321) for the hot or cold medium and the Exit (322) are interconnected as one continuous, closed span of heat- and cold-conducting tubing. Specifically, by combining the Invention of a heating and cooling panels, the hot or cold medium entering through the Entrance (321) circulates through the conduction tubing extending throughout the heating and cooling plane/surface (310) and exits from the Exit (322).

The Entrance (321) and Exit (322) are interconnected by the Generator of Hot or Cold Medium (liquid temperature control apparatus) (323) (generally speaking, a water heating or cooling apparatus) and Pumping Device (324) outside of the Heating and Cooling Plane/Surface (310). As a result, the Entrance (321) and Exit (322) form the closed Liquid Circulation System (320). As indicated earlier, the liquid temperature control apparatus (323) preferably incorporates the liquid temperature control means utilizing a combination of at least 2 different energy sources selected from electricity, gas, solar, geothermal, and combustion of any type of fuel, for maintaining the temperature of the liquid in the Liquid Circulation System at a level differing from the ambient room temperature. The best combination of energy sources utilized by the Liquid Temperature Control System is electricity and gas. In order to save energy, it is desirable in the liquid temperature control apparatus (323) to incorporate the heat accumulation and storage means described above, which accumulates and stores heat energy generated by both the liquid temperature control means and liquid temperature control apparatus.

The inventive heating and cooling system is constructed in any room by fitting the panels together side by side and connecting them to one another end-to-end by means of joining the ends of the conduction tubing, forming an interconnected, continuous liquid circulation system that can be placed directly underneath the surface material of floors, walls and ceilings.

In the inventive heating and cooling system, both the entrance and exit ends of the conduction tubing are connected to a water heating, and/or cooling, and pumping apparatus (includes any apparatus that controls the temperature of the circulating liquid and its supply/distribution throughout the interconnected liquid circulation system). The temperature of the liquid is maintained at a level differing from that of the ambient room temperature, and the liquid is circulated by the pumping device described above through the panels placed inside of the floor, wall, and/or ceiling. The temperature in the room is adjusted by the radiant heat energy conducted from the circulating liquid. The circulating liquid can be water or some other water-based solution that incorporates a chemical substance(s) that increases water's efficiency as a heat and/or cold conducting medium.

In the inventive heating and cooling system, the heating and cooling plane/surface is comprised of mortar-based panels as described above, so it is thin and light, but strong. It is in fact strong enough to support heavy objects like medical equipment and pianos. Also, this System can be installed in wood-frame houses, generally speaking. It can be installed not only inside the floor, but also under the surface material of walls and/or ceilings, if necessary.

As mentioned above, this System makes maintenance easier. If a problem occurs with a panel of the inventive heating and cooling system, the individual panel can be easily replaced. Furthermore, the inventive heating and cooling system can be applied for various purposes. For instance, it is possible to use the System as a means of: snow and ice melting for roads, parking lots and driveways; melting snow on roofs, and heating breeding rooms for animals and growing rooms for plants.

The Invention provides an efficient means of heating and cooling rooms because it has light per-unit-of-area weight, a thin radiating body/surface, and the ability to support heavy objects without damage, and it is easy and quick to install and maintain.

This invention is based on the concept of "radiant heating," in which ambient warmth is produced by the introduction of a heat-conducting substance of a higher temperature than the ambient room temperature, into the room to be heated. It maintains comfortable room temperature by radiant heat conducted from the liquid (heated to a higher temperature than the ambient room temperature) circulating through its metal tubing. This invention can also be used for "radiant cooling," in which ambient coolness is produced by the introduction of a cold-conducting substance of a lower temperature than the ambient room temperature, into the room to be cooled. When used for this purpose, it maintains comfortable room temperature by radiant cold conducted from the liquid (cooled to a lower temperature than the ambient room temperature) circulating through its metal tubing.

CLAIMS

1. A radiant heating and cooling panel comprising:

   a uniformly flat-surfaced, planar slab of mortar;

   heat- and cold-conducting tubing encased in the slab of mortar, wherein the tubing extends parallel to the surface, horizontally through a plane of the slab, and wherein ends of the heat- and cold-conducting tubing fixed within the slab of mortar protrude from the mortar at an end of the panel and are open; and

   a uniformly flat-surfaced, planar layer of heat- and cold-insulating material affixed to the slab of mortar, wherein the insulating material conforms to a length and a width dimensions of the slab, covers the sides of the slab, has integrated tongue and groove joints on opposite sides, and forms a frame for the panel.

2. The heating and cooling panel of claim 1 wherein the panels has, encased within the slab of mortar, at least one joist running horizontally and longitudinally through the mortar, together with the heat- and cold-conducting tubing.

3. The heating and cooling panel of claim 1 wherein the panel has metal covering a top of the heat- and cold-conducting tubing within the mortar and an underside of the tubing facing the heat- and cold-insulating material, and wherein the metal is metal wire mesh or solid metal sheeting.

4. The heating and cooling panel of claim 1 wherein the panel has heat- and cold-conducting tubing made of metal.

5. The heating and cooling panel of claim 4 wherein the panel has heat- and cold-conducting tubing made of copper.

6. The heating and cooling panel of claim 1 wherein the panel is connected to an adjacent panel end-to-end by means of joining the ends of the heat- and cold-conducting tubing protruding from the mortar at the ends of the panels.

7. The heating and cooling panel of claim 1 wherein the panel is fit together side by side with an adjacent panel by the tongue part protruding from its side, which is an integrated part of the heat- and cold-insulating material frame of each panel.

8. The heating and cooling panel of claim 1 wherein the panel has integrated tongue and groove joint parts protruding from their sides, by which it is connected to an adjacent panel.

9. The heating and cooling panel of claim 1 wherein the panel is assembled by fitting together the mortar slab and the heat- and cold-insulating material frame.

10. A central heating and cooling system comprising:

a plurality of modular panels each comprising:

a uniformly flat-surfaced, planar, rectangular slab of mortar,

heat- and cold-conducting tubing encased in the slab of mortar, wherein the tubing extends parallel to the surface, horizontally through a plane of the slab, and wherein ends of the heat- and cold-conducting tubing fixed within the slab of mortar protrude from the mortar at an end of the panel and are open, and

a uniformly flat-surfaced, planar layer of heat- and cold-insulating material affixed to the slab of mortar, wherein the insulating material conforms to a length and a width dimensions of the slab, covers the sides of the slab, has integrated tongue and groove joints on opposite sides, and forms a frame for the panel, wherein the plurality of panels are attached together side by side by the integrated tongue and groove joints protruding from their sides, and connected to one another end-to-end by means of joining the ends of the heat- and cold-conducting tubing protruding from the mortar at the ends of the panels; and

a means of liquid circulation connected to the plurality of panels by supply (in-flow) and return (out-flow) tubes to form a closed interconnected liquid circulation system that can be placed directly underneath a surface material covering floors, walls and ceilings and which controls the temperature of the circulating liquid and its supply/distribution throughout the interconnected liquid circulation system.

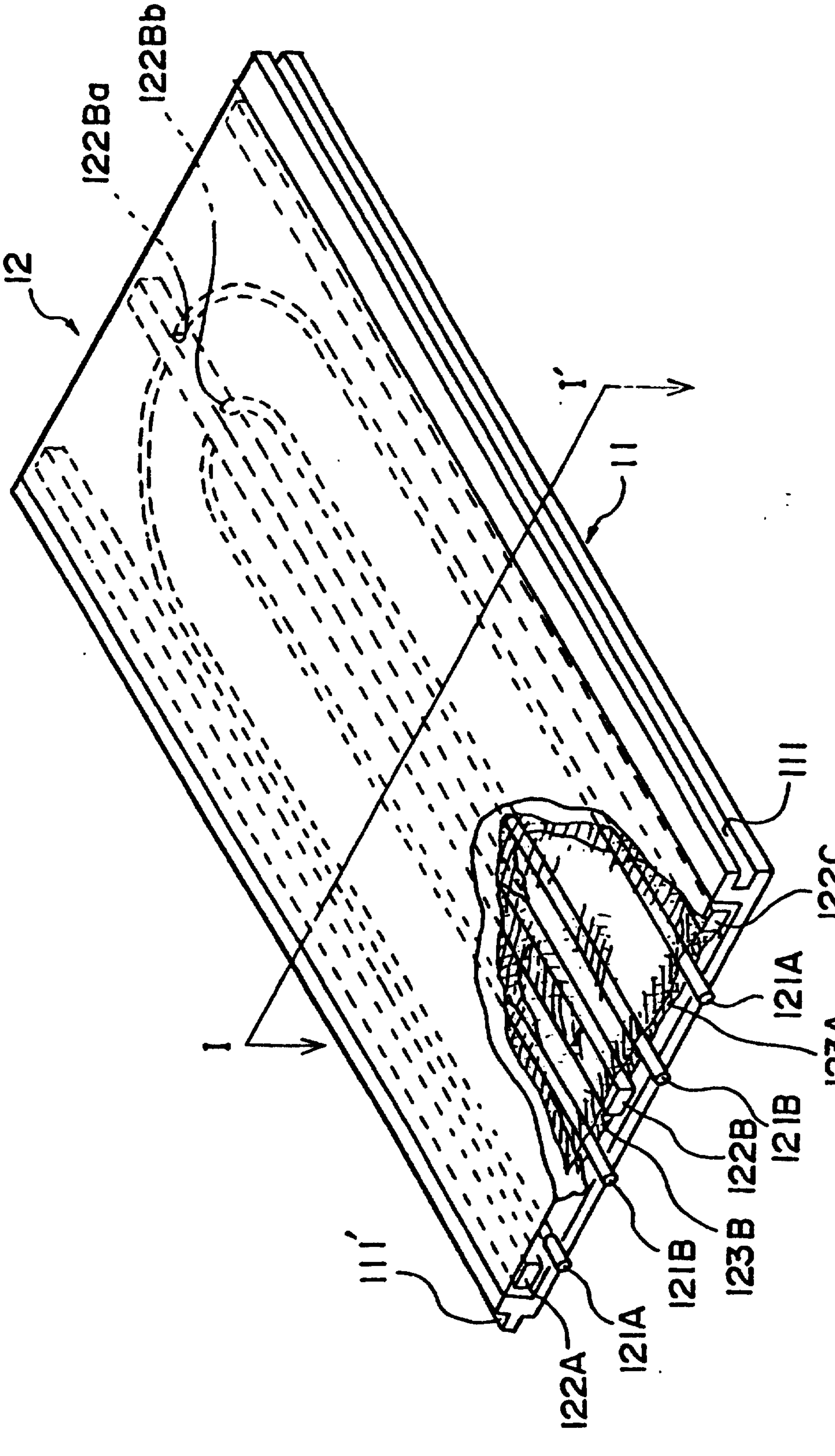
11. The central heating and cooling system of claim 10 wherein a liquid circulated through the heat- and cold-conducting tubing encased in the panels is water (H_2O).

12. The central heating and cooling system of claim 10 wherein the system's interconnected liquid circulation system is connected at both the liquid circulation system's liquid entrance and exit ends to a liquid temperature control apparatus, and wherein the liquid temperature control apparatus incorporates a liquid temperature control means utilizing at least two different energy sources for heating the liquid to maintain the temperature of the liquid in the liquid circulation system at a level differing from the ambient room temperature.

13. The central heating and cooling system of claim 10 wherein the system incorporates a combined liquid temperature control means utilizing a combination of at least two different energy sources selected from among electricity, gas, solar, geothermal, and combustion of any type of fuel.

14. The central heating and cooling system of claim 13 wherein the system incorporates a liquid temperature control means that uses a combination of electricity and gas.

15. The central heating and cooling system of claim 10 wherein the system incorporates a heat accumulation and storage means that accumulates and stores heat energy generated by both the liquid temperature control means and the liquid temperature control apparatus.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121B
122B
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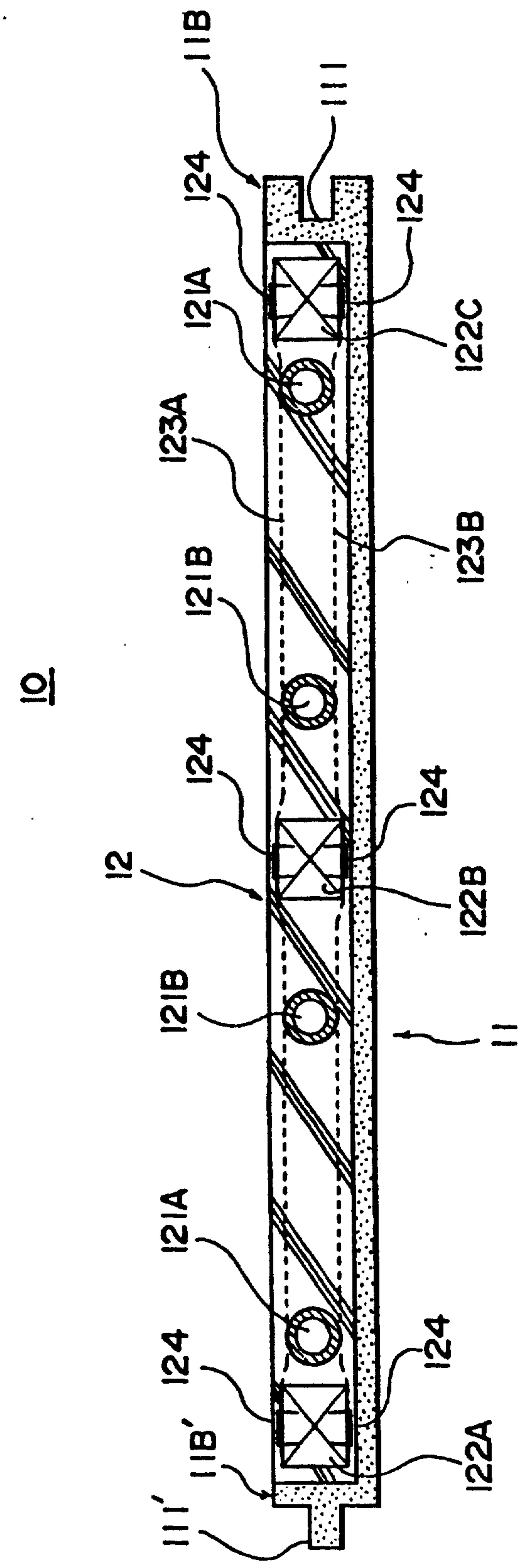
121B
121A
122A
111'
I

Figure 1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111'
122A

Figure 2

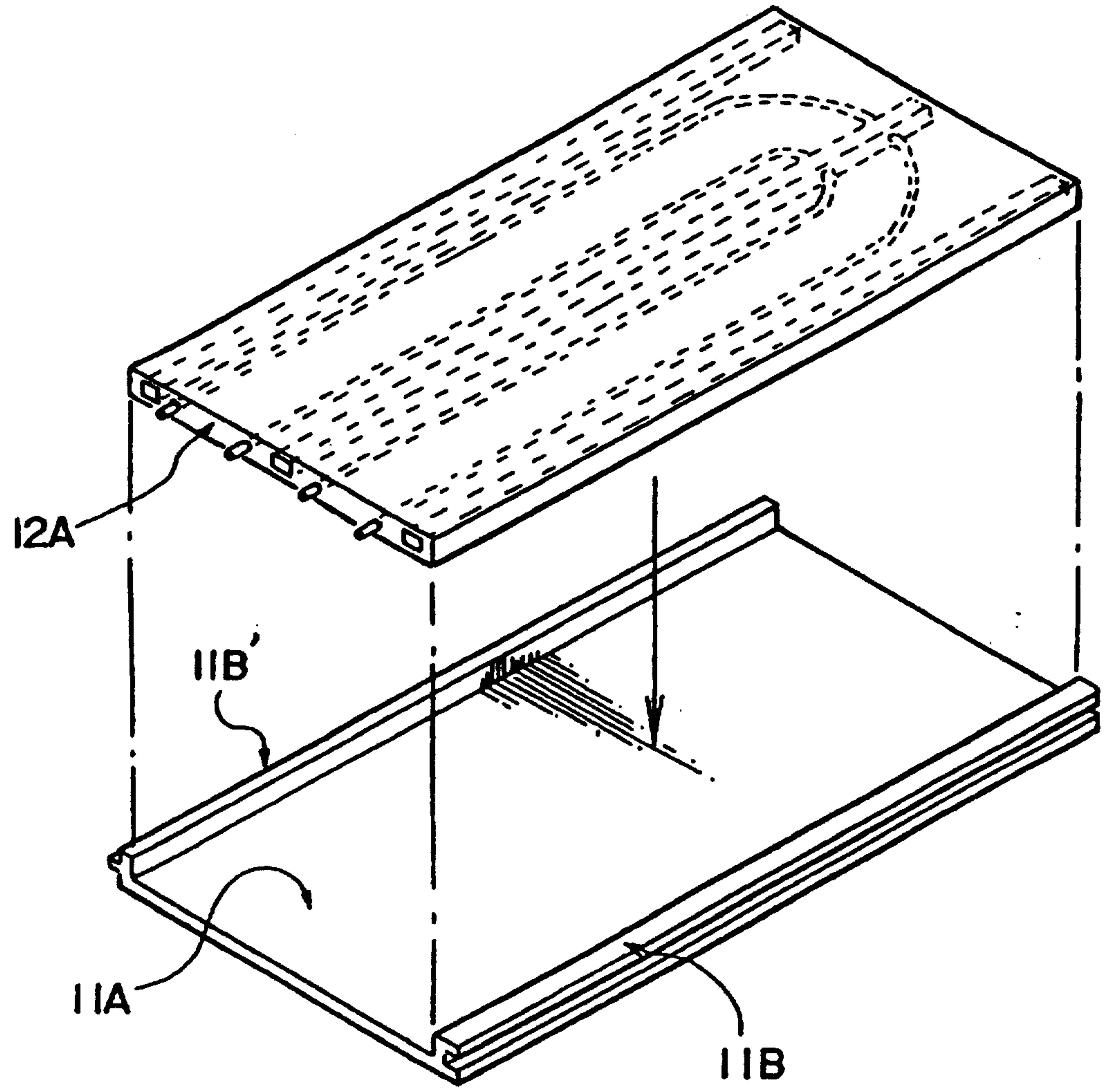


Figure 3

Figure 4A

Figure 4B

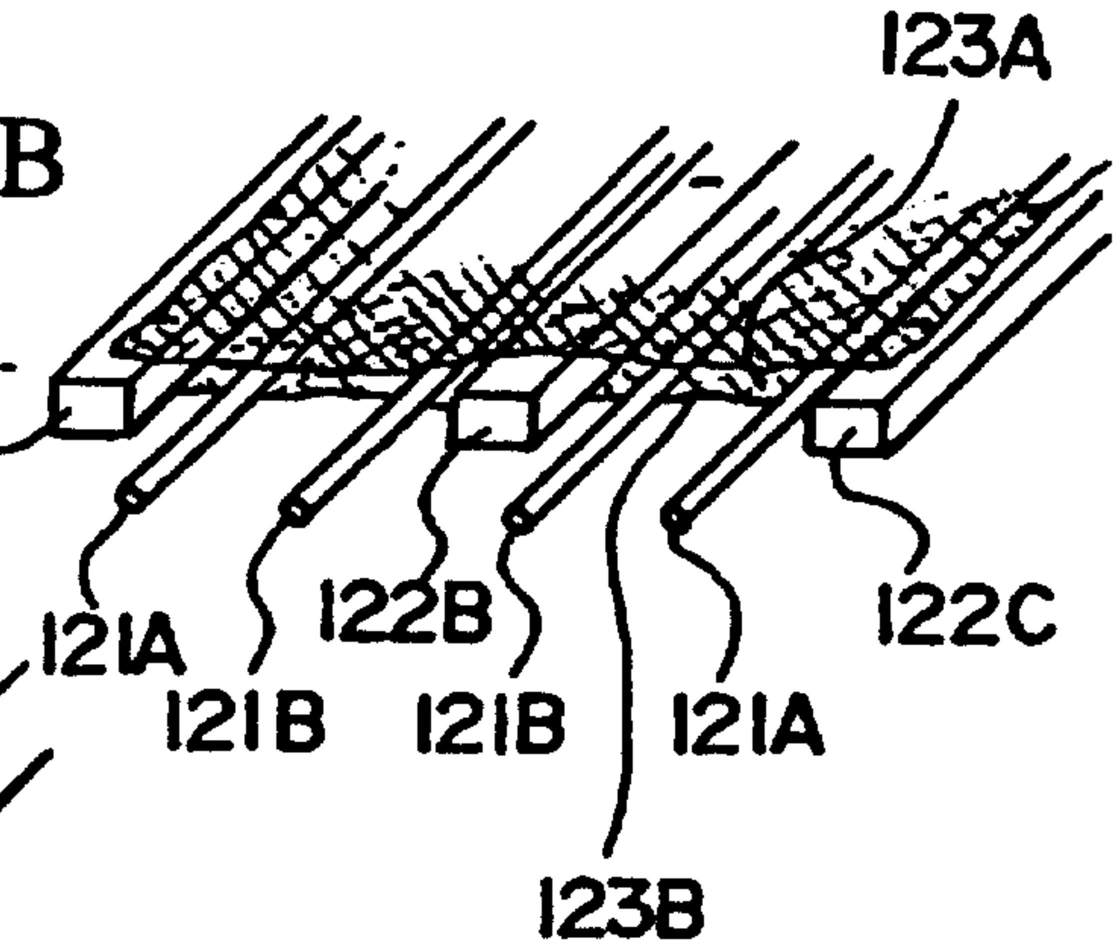


Figure 4C

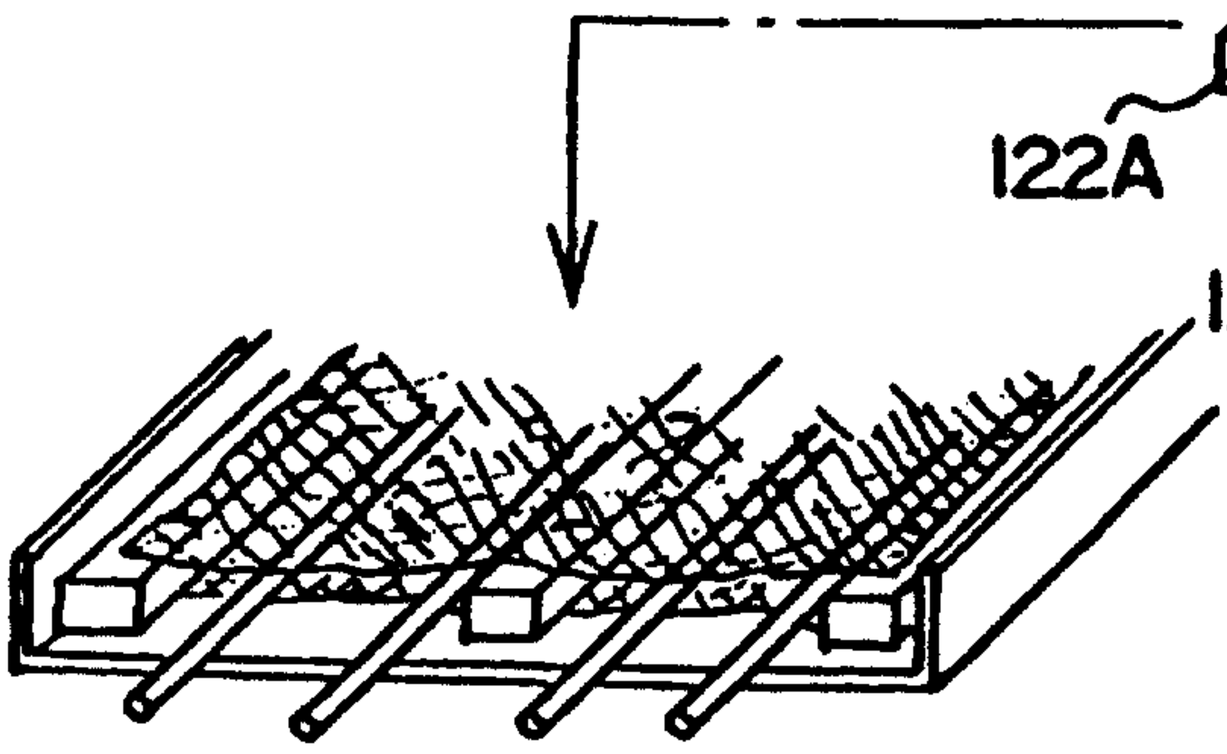


Figure 4D

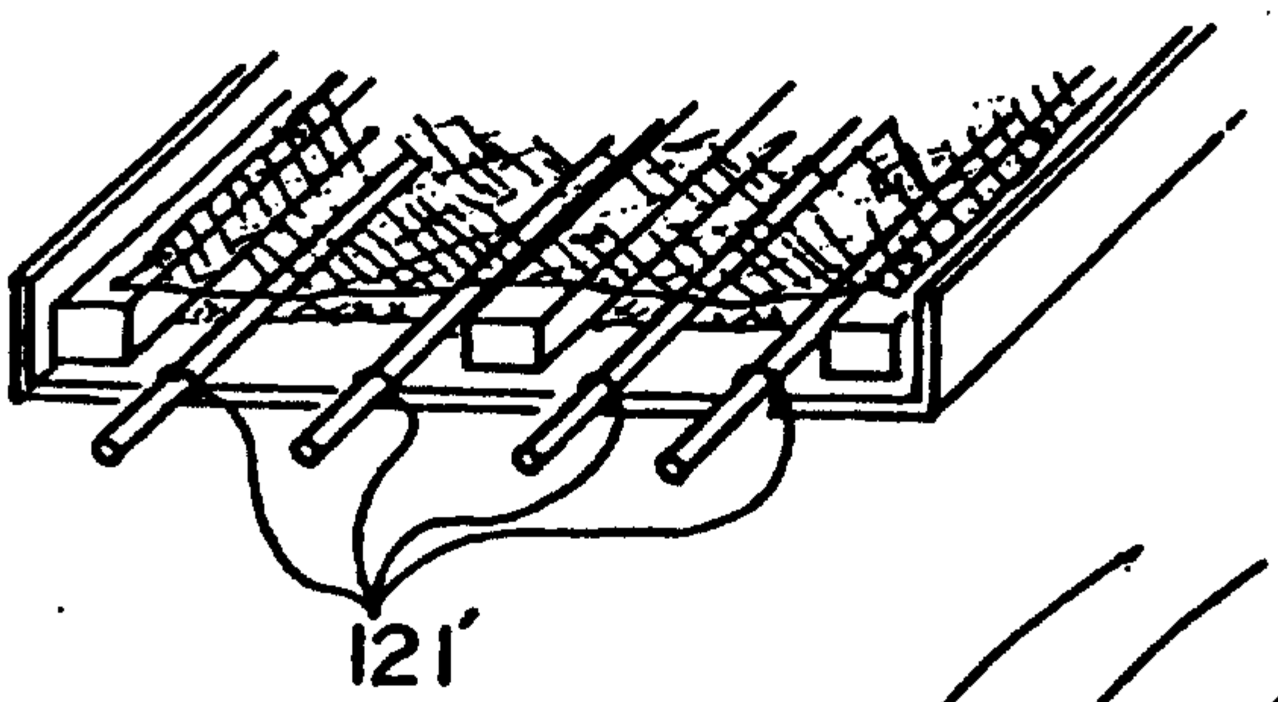
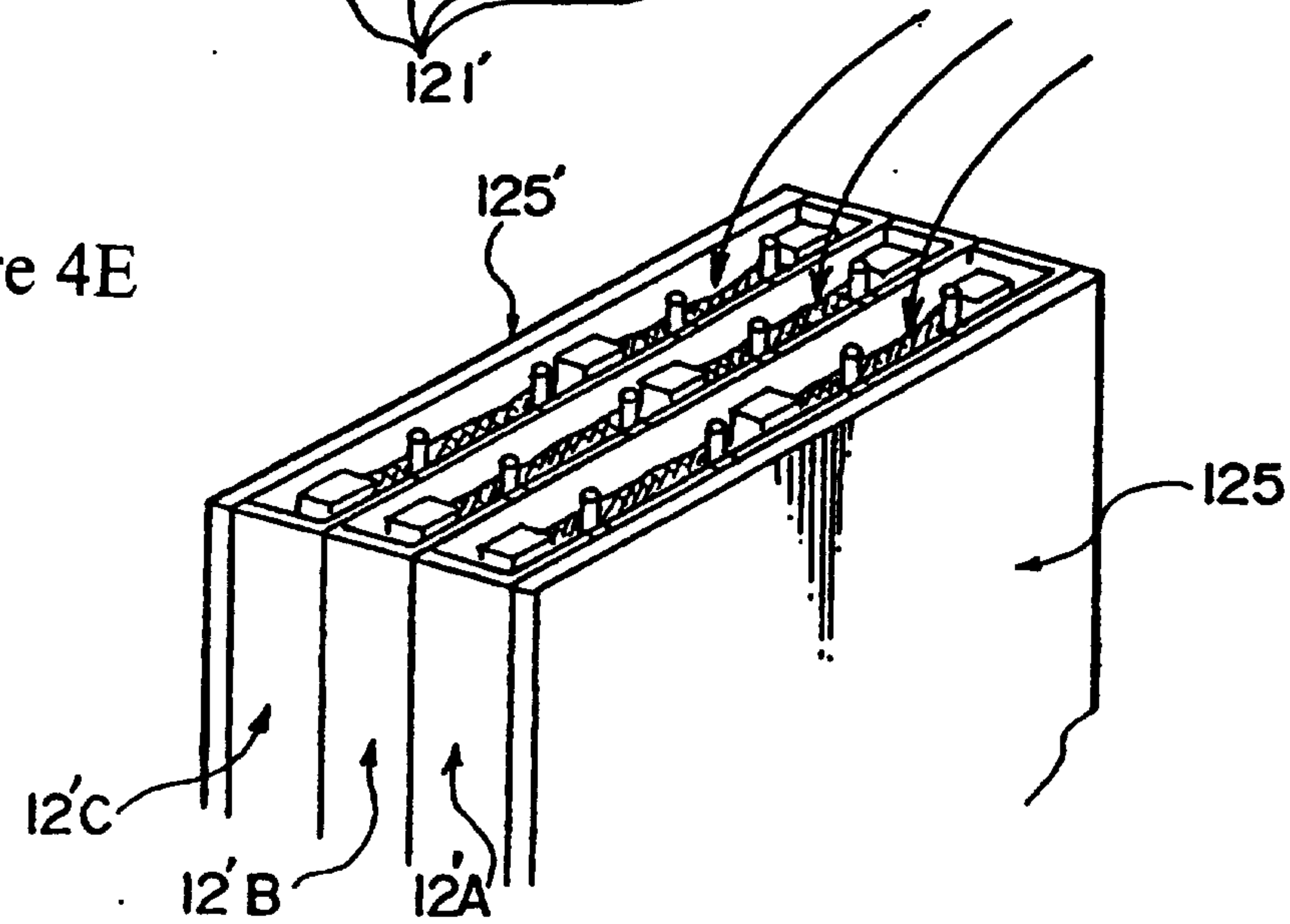
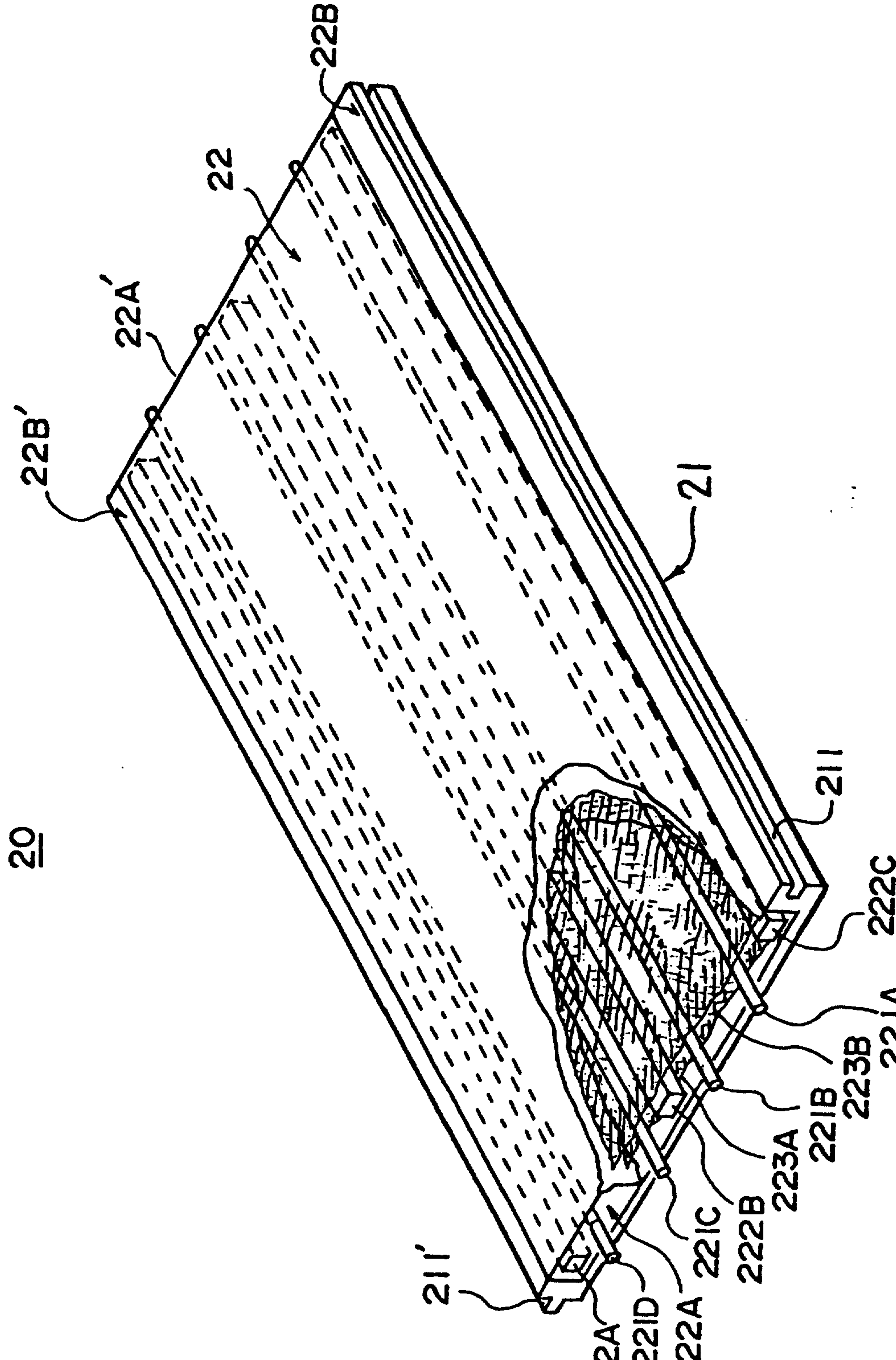


Figure 4E




20
22B'
22A'
22
22B
21
211
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222B
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221D
222A
211'

Figure 5

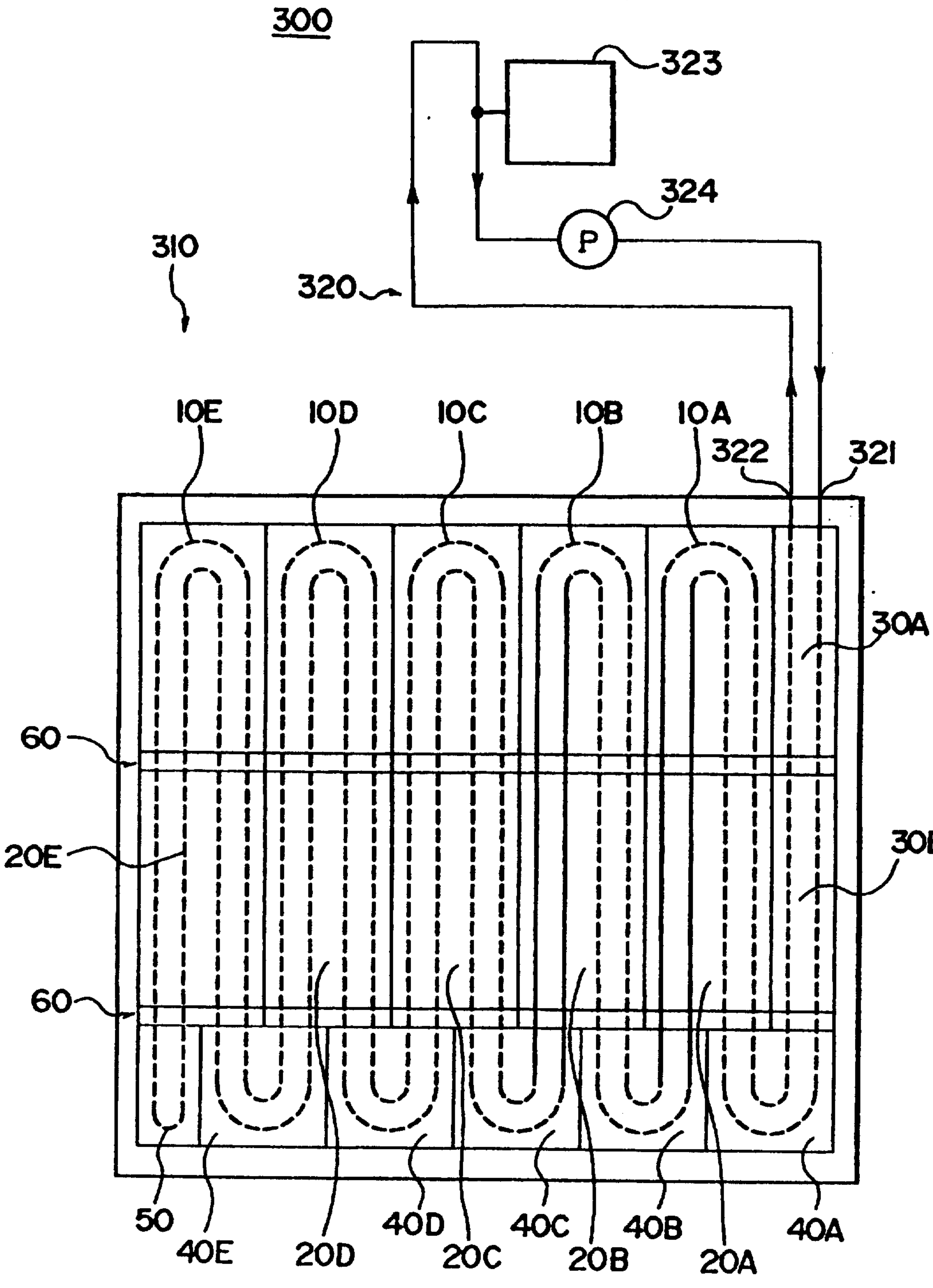
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Figure 6

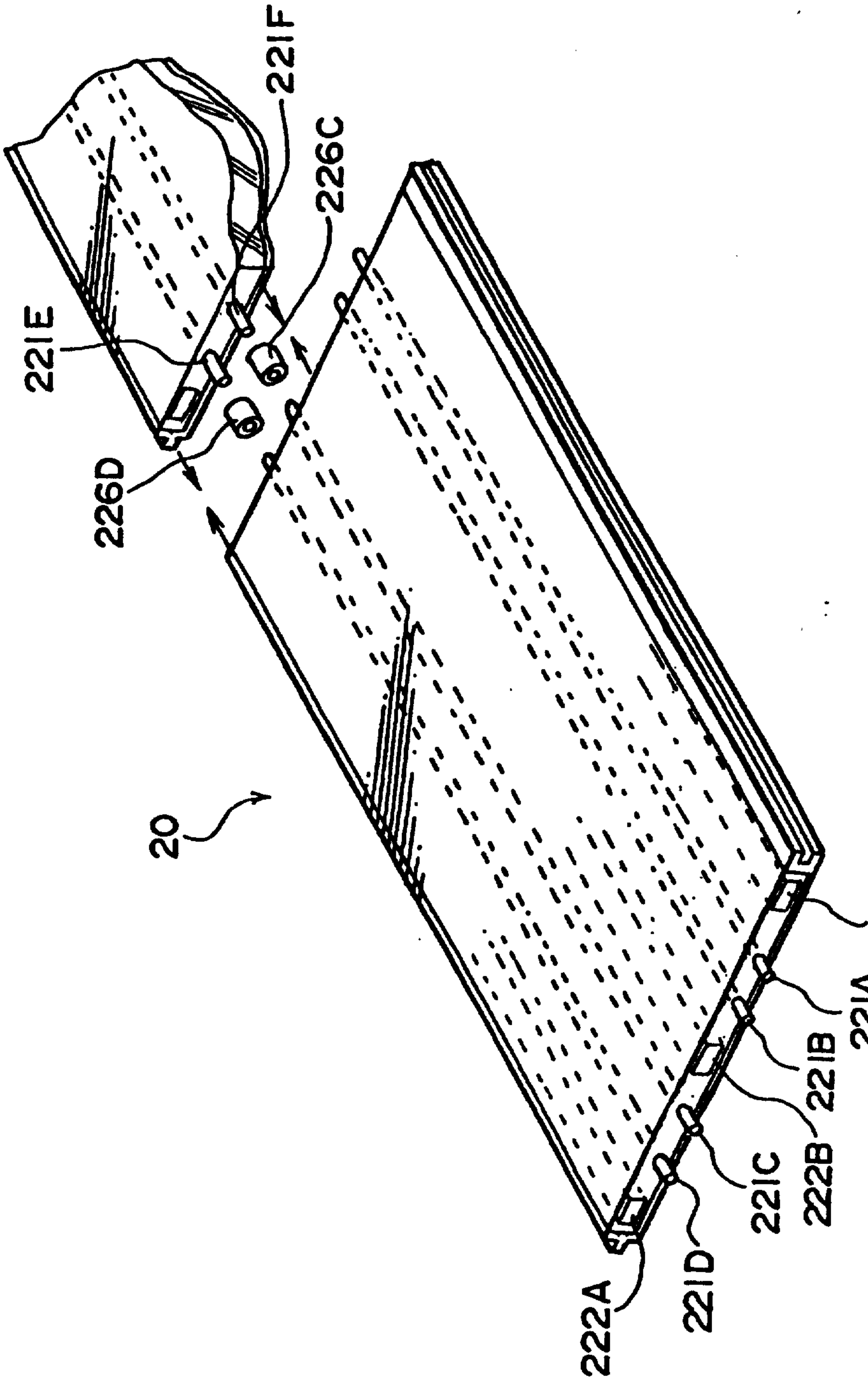

Figure 7