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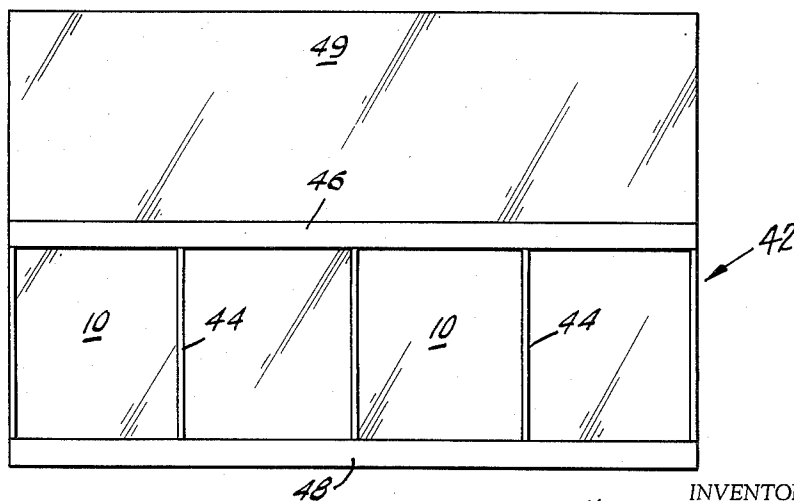
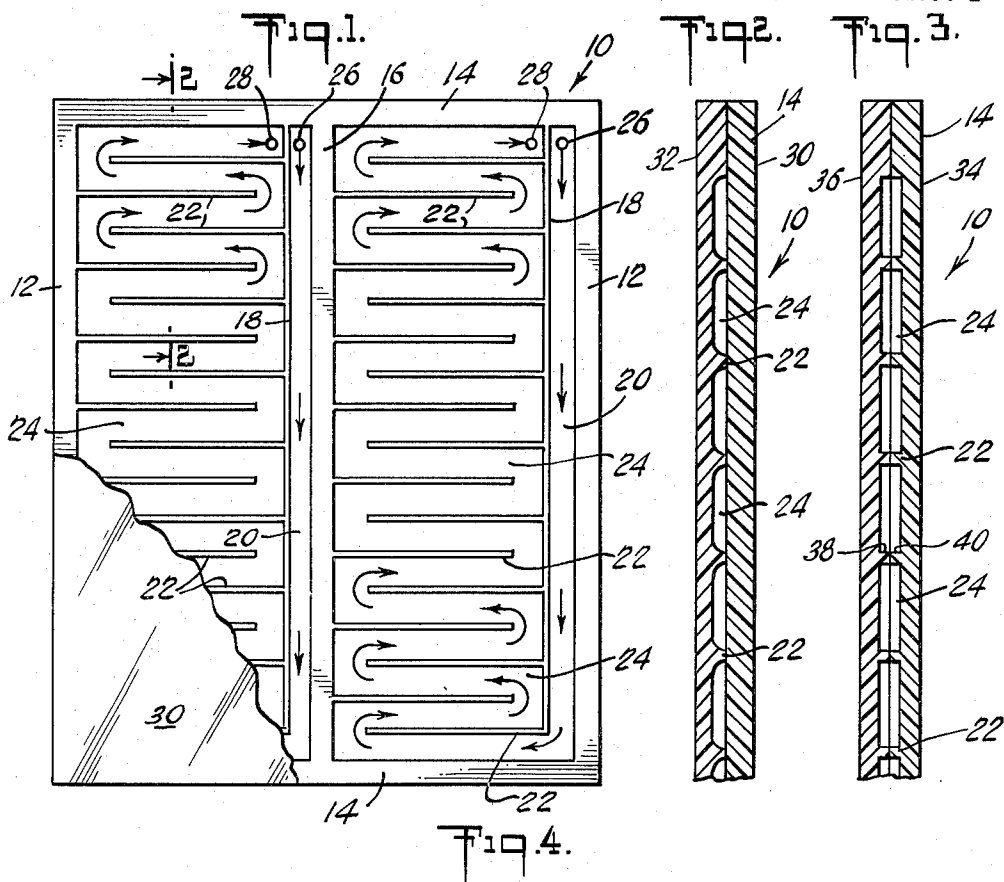
H. F. REMDE ETAL

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HEATING OR COOLING WALL PANELS

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2 Sheets-Sheet 1



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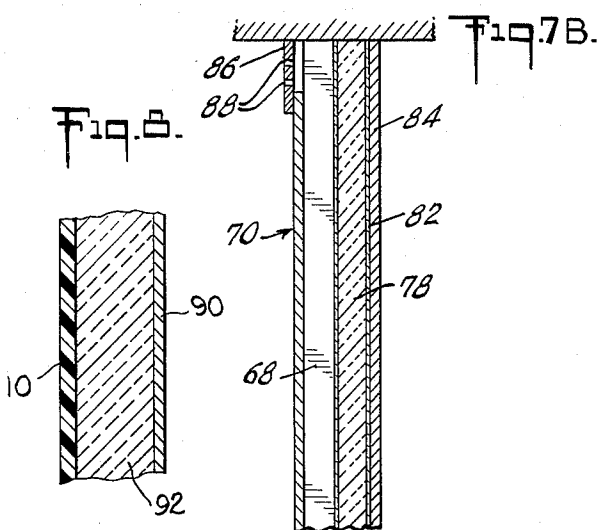
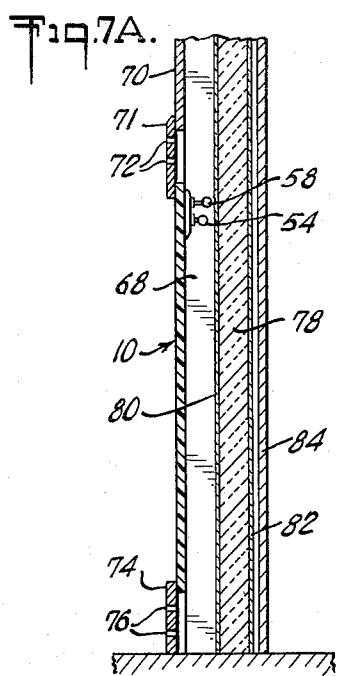
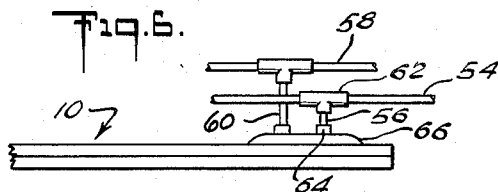
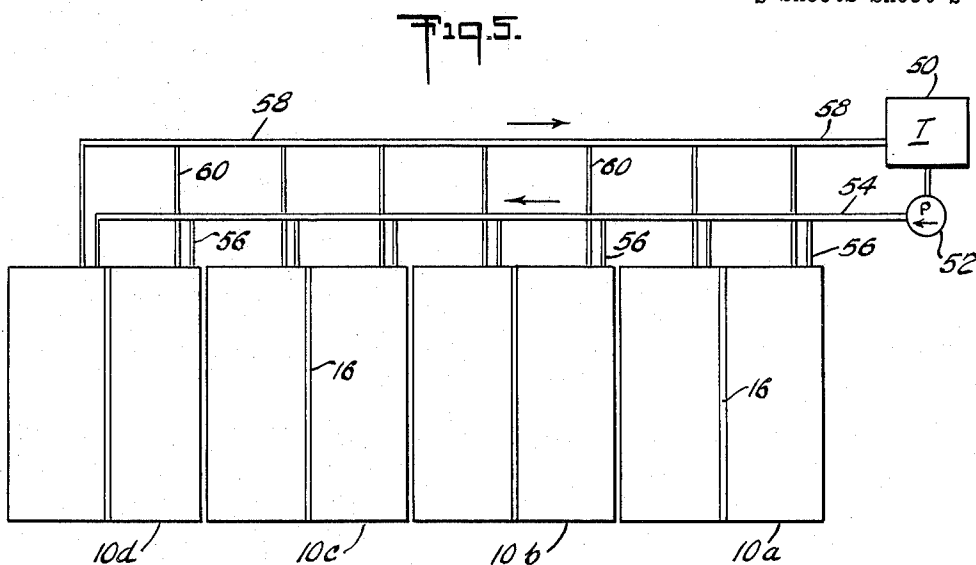
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HEATING OR COOLING WALL PANELS

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This invention relates to heating and cooling panels, and more particularly, it relates to such panels which are adapted to be installed with similar panels in a heating or cooling system to form a wall or partition in a building structure.

For years, buildings have been heated by hot water systems which comprise a water tank, furnace, metallic piping, and metallic upright wall radiators or baseboard radiators. Because of the relatively small surface area of the radiators, the water in the radiators must be maintained at a temperature in the range of about 160° F. to 195° F. in order to heat the room adequately. As the water is alternately heated and allowed to cool in the ordinary course of maintaining the room temperature at or above a predetermined minimum level, the room temperature may vary considerably. This temperature fluctuation can be uncomfortable and annoying.

Conventional hot water systems are expensive, not only due to the cost of the components, but also due to the long time required for installation. The installation time often is lengthened by obstacles around which the plumbing must be installed. Furthermore, metal piping becomes very hot and is the source of sometimes undesirably large heat losses from the system.

Hot water heating systems heretofore have been unsuitable for use in temporary constructions because the systems have required permanent installation. Even if a conventional hot water system, despite its cost and permanent nature, were installed in a temporary structure, with the intention of dismantling it at a later time, the time of installation would be prohibitive in most cases, since a premium on speed of erection is often placed on such structures.

It is an object of the present invention to provide a heating system which effectively utilizes a heating fluid of relatively low temperature.

Another object of the present invention is to provide a heating and cooling system which can be installed in a very short period of time, and which transfers heat in a highly effective manner.

Another object of the invention is to provide a heating and cooling system which is inexpensive and which requires little space.

A further object is to provide a heating and cooling system incorporating hollow wall panels which can be readily installed, dismantled, and used again.

Another object is to provide a novel wall panel for use in a heating and cooling system.

A further object is to provide a composite wall assembly for use in a heating system, which assembly can be employed as a structural unit in an exterior wall.

Briefly, the invention comprises a heating or cooling system comprised of a plurality of wall panels, each having a hollow core containing relatively narrow spacing means dividing the core into a relatively wide tortuous path. Each panel has an inlet at one end of the tortuous path and an outlet at the other end, both the inlet and outlet being connected by conduits to a source of heating or cooling fluid.

The panels are secured to suitable supports to form all or part of the wall, and they may be painted, papered or otherwise decorated in the same manner as ordinary wall panels. Because the area of the panel sur-

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face heated by the fluid is large, the temperature of the fluid need not differ from the room temperature more than about 50° F. for any installation. The panel surface thus does not become so hot as to have a detrimental effect on decorative wall coverings. Because the heating fluid is not required to be nearly as hot as that used in conventional hot water systems, metallic plumbing is not required, and flexible plastic or rubber tubing may be employed, thereby minimizing the amount of heat loss from the conduits as the fluid is in transit to the panel.

The panels may be extremely thin, in the order of $\frac{3}{4}$ inch, and preferably not more than about one inch, although thicker panels may be used if desired. The hollow core may be very thin also, in the order of about $\frac{1}{4}$ inch, and preferably not more than about $\frac{1}{2}$ inch, although if relatively thick panels are made, the core may be correspondingly thicker. The panels preferably are made of plastic, and are very light in weight when manufactured in standard modular sizes. For example, a 4-ft. x 4-ft. x $\frac{3}{4}$ -inch panel of reinforced polyester resin weighs only about 20 pounds. Installation of the system merely requires that the panels be secured to wall supports by any suitable means, and that the inlet and outlet conduits be connected from the panels to the source of fluid.

The plumbing is very simple to connect because the preferred flexible tubing can be connected to the panels by hand, and the tubing can be bent around obstacles which in conventional heating or cooling systems would require the use of special fittings.

The spacing means in the panel cores preferably are ribs, which impart a great deal of stiffness and strength to the panels, enabling the panels to contribute structurally to the building wall. A composite exterior, interior wall assembly combining an outer or exterior facing, insulation, and an inner or interior heating or cooling panel can be used to provide a complete exterior and interior wall of a building, thus enabling the system to be almost fully in place by the time the building is erected.

The nature of the invention will be more fully understood and other objects may become apparent when the following detailed description is considered in connection with the accompanying drawings wherein:

FIG. 1 is a front elevational view of the heating or cooling wall panel of the present invention with the front face thereof only partially shown to better reveal the tortuous path in the hollow core, through which the circulating fluid flows;

FIG. 2 is an enlarged cross-sectional view taken on lines 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 2, but showing a modification thereof;

FIG. 4 is a front elevational view of an illustrative wall arrangement containing the panels of the present invention;

FIG. 5 is a flow diagram of a heating or cooling system including a plurality of heating or cooling wall panels;

FIG. 6 is an enlarged edge view of a portion of the panel showing the conduit connections;

FIG. 7A is a transverse cross-sectional view of the lower half of a wall, illustrating one arrangement in which the heating panels may be combined with the other structural members of the wall;

FIG. 7B is a transverse cross-sectional view of the upper half of the wall shown in FIG. 7A; and,

FIG. 8 is a partial transverse sectional view of a composite wall assembly incorporating a heating or cooling panel.

Referring to FIGS. 1 and 2 of the drawing, a panel 10 is provided with solid vertical borders 12 and solid horizontal borders 14 to provide portions which may be readily attached to wall supports. In the preferred embodiment, a vertical strip 16 extends centrally of the panel and is similar to the border strips 12 and 14, providing reinforcement and structural strength to the panel and permitting fastening means to be employed in the central portion of the panel. This arrangement is suited for panels having widths equal to twice the distance between wall supports. The portions of the panel enclosed by the borders 12 and 14 and the strip 16 each comprise a hollow core space which is divided into a tortuous path through which heating or cooling fluid may flow. In the right half of the panel shown in FIG. 1, the left half being similarly constructed, a rib portion 18 extends from the upper border 14 to a point spaced a short distance from the lower border 14. The space between the front face 30 and back face 32 of the panel, and enclosed by the rib portion 18 and border 12, provides a vertical flow path 20. A plurality of horizontal rib portions 22 are arranged in vertically spaced relationship between the upper and lower borders 14, and between the rib portion 18 and central border 16. Adjacent ribs 22 alternately begin at, and terminate a short distance from, rib 18 and side border 12 to provide, with the rib 18 and borders 12, 14, and 16, a relatively long tortuous path 24. An inlet opening 26 is provided at the upper extremity of the channel or flow path 20, and an outlet opening 28 is provided at the end of the tortuous path 24, so that after an initial downward flow through the channel 20, the fluid flows generally in an upward direction through the relatively long path 24, thus being in contact with the face of the panel for a relatively long time and transferring a large amount of heat.

Referring to FIG. 2, the tortuous path 24 may be provided by laminating the outer face 30 to the back face 32, which is provided with a plurality of the rib portions 22. The panel may be made from reinforced polyester resin, reinforced phenolic resins, polystyrene resins, polyvinylchloride resins, acrylic resins, or any other suitable material. The material may be pigmented or textured, or left in its natural state for subsequent decoration. One method of manufacture is to mold the back face or sheet 32 and allow it to cure, after which the front face or sheet 30 is molded and, while yet uncured, placed over the back sheet 32. Upon curing, the sheet 30 is bonded to the rib portions 22, the borders 12 and 14, and the strip 16.

Referring to FIG. 3, another embodiment is shown in which both the front sheet 34 and back sheet 36 are provided with rib portions, 40 and 38, respectively, extending therefrom a distance equal to one half the thickness of the core. The panel is preferably formed in the same manner as described in connection with the panel of FIG. 2. If desired, the panels could be formed by allowing both front and back sheets to cure, and then adhering them together by a suitable adhesive. In addition to the embodiments of the panel shown in FIGS. 2 and 3, various other types of panels may be utilized, so long as the basic elements of the present invention are included. For example, an expanded plastic bladder of the desired tortuous shape could be enclosed between two flat sheets to form a panel which would function in the same manner as the illustrated panel. Furthermore, it is not necessary that the panels be formed of plastic, since thin sheet metal would function suitably with respect to heat transfer properties. The plastic construction described above is preferred, however, because it provides high impact resistance, which is necessary in any wall installation, and the rib construction thereof provides the panel with sufficient stiffness so that the panel may be employed as a structural part of the building wall, if desired.

Referring to FIG. 4, an illustrative wall arrangement 42 comprises a plurality of heating or cooling panels 10 attached to wall supports by vertical moldings 44. Horizontal molding 46 at the upper ends of the panels, and baseboard molding 48 may be utilized to provide a neat trim to the panels. If desired, the moldings 46 and 48 may be detachable to permit ready access to the conduits connecting the panels. The upper half of the wall 49 may be provided by any suitable interior wall facing, such as fibrous panels or plaster. It should be understood that the panels need not extend only partially from the floor or ceiling but may comprise the entire wall surface, if desired.

Referring to FIG. 5, a flow diagram is shown, illustrating a possible arrangement of a heating or cooling system which includes a plurality of panels 10a, 10b, 10c, and 10d. A fluid supply source 50, such as a water tank, is connected by a pump 52 to a conduit 54, from which inlet lines 56 extend to the inlets of the panels. A return conduit 58 is connected to the tank, and a plurality of outlet lines 60 connect the conduit 58 with the outlet openings of the panels, so that the panels are connected in a parallel arrangement in the system.

Referring to FIG. 6, the conduits 54 and 58 are connected to the inlet line 56 and the outlet line 60, respectively, by T's 62, and the lines 56 and 60 are connected to the hollow cores of the panels by threaded fittings 64. In order to provide the panel with sufficient thickness and strength to receive the threaded fittings 64, the back portion of the panel adjacent the inlet and outlet connections may be built up, as indicated by numeral 66, thus permitting the remainder of the panel to be relatively thin.

The panels may be made in any suitable size, preferably in modular sizes, such as 2 ft. x 4 ft., 4 ft. x 4 ft., or 4 ft. x 8 ft. In practice, panels manufactured from glass fiber reinforced polyester resin had a 3-inch wide border or nailing strip and a thickness of about $\frac{3}{4}$ inch. In a 4-ft. x 4-ft. panel, a hollow core of about $\frac{1}{4}$ -inch thickness can hold only about $\frac{1}{4}$ cubic foot of fluid. Because the core is so thin, most of the heating fluid comes in contact with the panel surfaces, thus permitting a minimum amount of fluid to transmit a maximum amount of heat. Because the system is designed to incorporate a number of panels, a very large total surface area of the heating panels is exposed, and the temperature of the heating fluid need not be nearly as high as the fluid in a conventional hot water heating system, a temperature of about 115° F. to 120° F. being preferred. This provides for more uniform and more comfortable heat. Flexible plastic or rubber tubing may be used since it can easily withstand the relatively low temperatures of the heating fluid, thus reducing the amount of heat loss which would normally occur with more highly conductive metallic plumbing. As mentioned previously, the flexible tubing permits extremely simple and rapid installation of the plumbing system. Because the temperature of the interior wall surfaces is maintained at a minimum, the panels may be decorated by paint or wall paper in the same manner as ordinary unheated wall panels.

Referring to FIG. 7A, which shows the lower half of an illustrative wall arrangement, the heating or cooling panels 10 are connected to wall supports 68 by any suitable means, not shown. The upper half of the wall may be comprised of suitable unheated wall panels 70. A horizontal molding 71 having a plurality of apertures 72 therein may be provided to cover the upper ends of the panels 10 and the lower ends of the panels 70. A baseboard 74 is provided at the lower ends of the panels 10 and contains a plurality of apertures 76, through which air may flow. The insulation 78 may be faced with dissimilar material 80 and 82, such as reflective foil or absorptive material, to provide maximum impendence to the flow of heat through the insulation. Any

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suitable external paneling 84 may be provided in the usual manner.

This arrangement is especially effective since the outer surface of the panel 10 heats the air in the room enclosure while the inner surface of the panel heats the air flowing upwardly, due to convection currents, between the panel 10 and the insulation 78. Air entering the space between the panel 10 and the insulation 78 flows in through the apertures 76 in the baseboard 74 and is heated by conduction from the back surface of the panel 10. The material 80 on the surface of the insulation 78 can act as a further source of heat for the air flowing upwardly.

As shown in FIG. 7B, the upper ends of the panels 70 may be covered by a ceiling molding 86 provided with a plurality of apertures 88. This creates a convection current of air flowing between the panel 70 and the insulation 78 in the same manner as the air flow between the panel 10 and the insulation 78, so that the panel 70 is heated by the rising air, and it acts itself, to some degree, as a heating panel.

In addition to its use as an interior wall panel, the heating or cooling panel may be part of a composite wall structure such as that illustrated in FIG. 8. In this arrangement, the heating or cooling panel 10, constructed as described above, with the tortuous internal fluid transmitting paths, comprises one face of a sandwich assembly, the opposite face being a sheet of suitable exterior siding material 90, such as, for example, asbestos-cement, and the core being a suitable insulation material 92. The layers of the composite assembly may advantageously be adhered together by adhering the panel 10 and the facing 90 to opposite sides of insulating foam before the foam has hardened. With this arrangement, after the outer walls of a building are erected, it is merely necessary to connect the fluid inlets and outlets of the panels to a source of fluid, as explained previously, and the heating or cooling system will be installed.

It should now be apparent that the present invention provides a fluid system utilizing hollow wall panels which can be employed either to heat or cool a room enclosure. Because the panels are thin and flat, they may be handled and shipped easily, and their installation is as simple as that of conventional wall panels. By merely installing the panels in the manner of a conventional wall panel arrangement, and by merely attaching the fluid conduits to the inlets and outlets of the panels, the conduits having been connected to a source of fluid, the entire heating or cooling system of a building can be installed in a very short time, amounting to only a small fraction of the installation time that a conventional hot water heating system or cold water cooling system would require. The arrangement permits not only rapid installation, but also allows the panels to be removed and utilized again in another location. By incorporating the panels in a laminate or composite wall assembly adapted for use as an outside wall, both the building and the heating or cooling system can be in place in a very short time.

It is to be understood that variations and modifications of the present invention may be made without departing from the spirit of the invention. It also is to be understood that the scope of the invention is not to be interpreted as limited to the specific embodiments disclosed herein but only in accordance with the appended claims, when read in the light of the foregoing disclosure.

What we claim is:

1. A heat transfer system for a building structure having a plurality of wall supports comprising,

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- (a) a plurality of relatively thin plastic wall panels attached to the wall supports,
- (b) each panel having a hollow core, the thickness of which core is in the range of about $\frac{1}{4}$ inch to about $\frac{1}{2}$ inch,
- (c) relatively narrow spacing means in the hollow core of each panel dividing the core into a relatively wide tortuous path,
- (d) a source of fluid,
- (e) an inlet in each panel at one end of the tortuous path thereof,
- (f) flexible conduits connecting the inlet of each panel with the source of fluid,
- (g) an outlet in each panel at the other end of the tortuous path thereof,
- (h) flexible conduits connecting the outlet of each panel with the source of fluid, and
- (i) means to circulate the fluid through the system.

2. A heat transfer system as recited in claim 1, wherein the hollow core in each panel is spaced from the edges thereof to provide a border, the panels being attached to the wall supports by fastening means engaging the borders of the panels.

3. A heat transfer system as recited in claim 1, wherein the spacing means are comprised of relatively narrow ribs connecting the opposite faces of the hollow core.

4. A heat transfer system as recited in claim 1, wherein the flexible conduits are comprised of plastic.

5. In a heat transfer system,

- (a) a plurality of composite wall assemblies, each wall assembly comprising,

- (1) a plastic panel having a hollow core, the thickness of which core is in the range of about $\frac{1}{4}$ inch to about $\frac{1}{2}$ inch,

- (2) the core being provided with a relatively wide tortuous path having an inlet at one end and an outlet at the other end,

- (3) a layer of insulating material adhered to the panel, and

- (4) an exterior facing sheet adhered to the insulating layer,

- (b) a source of fluid,

- (c) flexible conduit means connecting the inlet of each panel with the source of fluid, and

- (d) flexible conduit means connecting the outlet of each panel with the source of fluid.

6. A heat transfer system as recited in claim 5, wherein the flexible conduits are comprised of plastic.

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