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(57) **ABSTRACT**

CERAMIC OR
GEOPOLYMERIC
OR CEMENT
TILE BODY

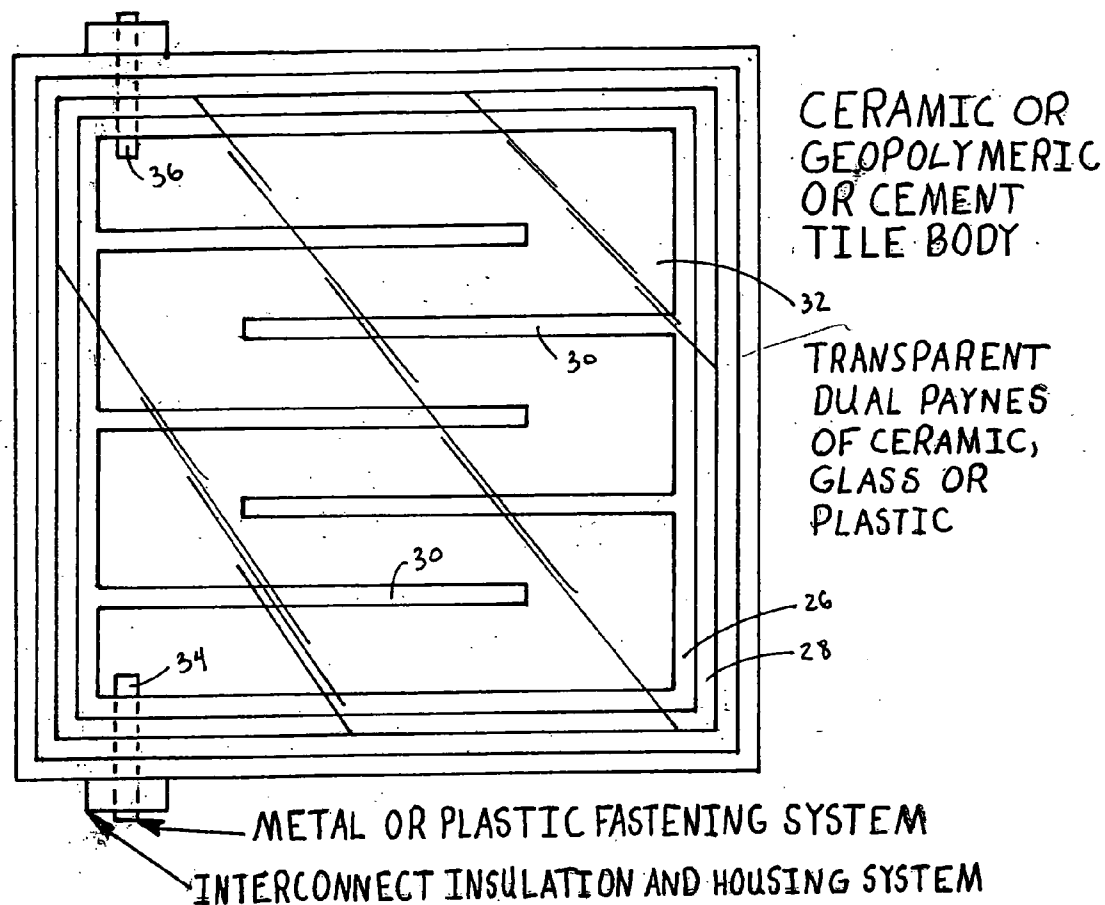
TRANSPARENT
DUAL PAYNES
OF CERAMIC,
GLASS OR
PLASTIC

METAL OR PLASTIC FASTENING SYSTEM

INTERCONNECT INSULATION AND HOUSING SYSTEM

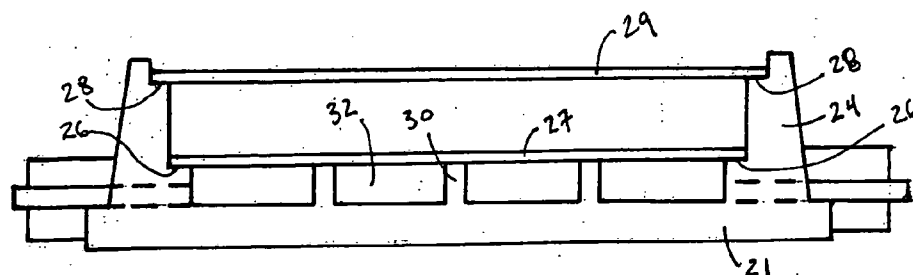
MODE ONE: TOP VIEW

FIG. 1



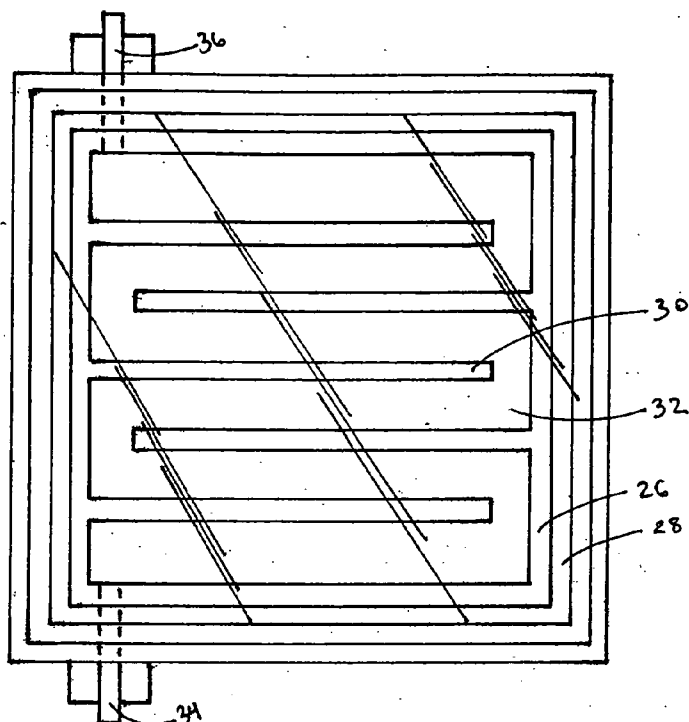
MODE ONE: SIDE VIEW

FIG. 2



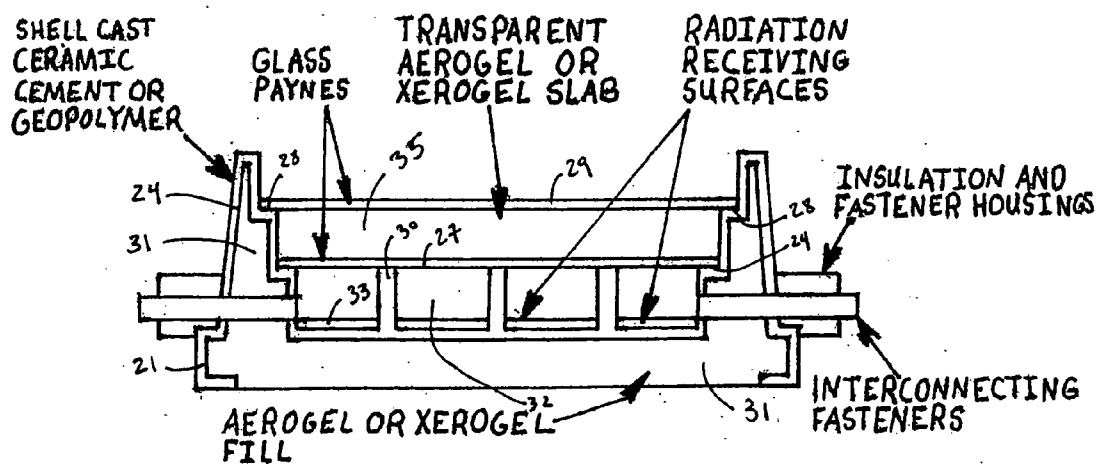
MODE TWO: TOP VIEW

FIG. 3



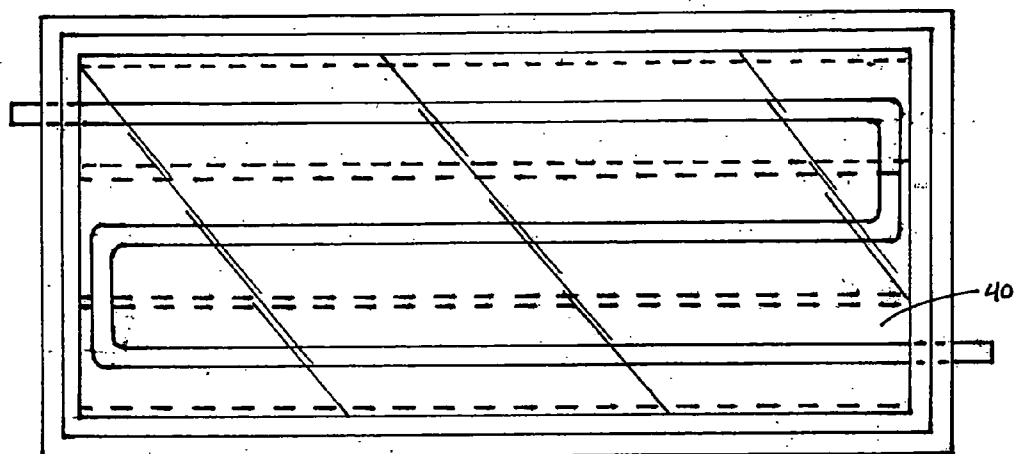
MODE TWO: SIDE VIEW CUTAWAY

FIG. 4



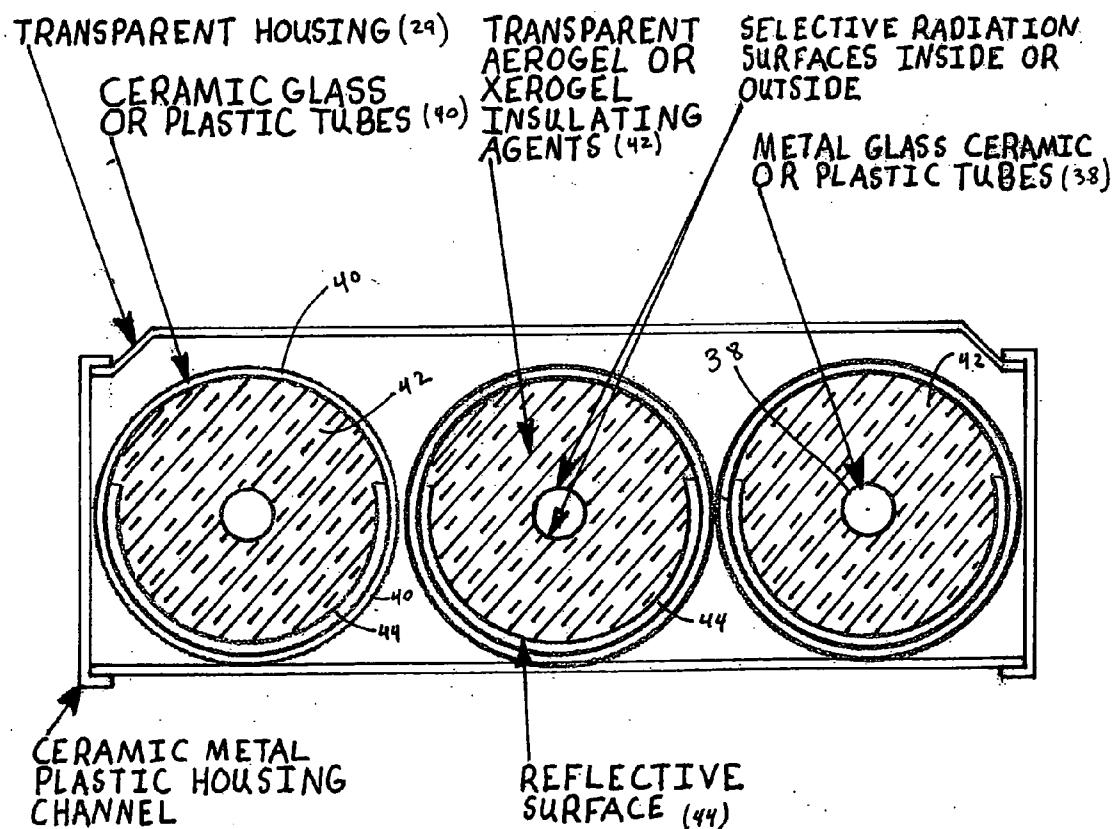
MODE THREE: TOP VIEW

FIG. 5



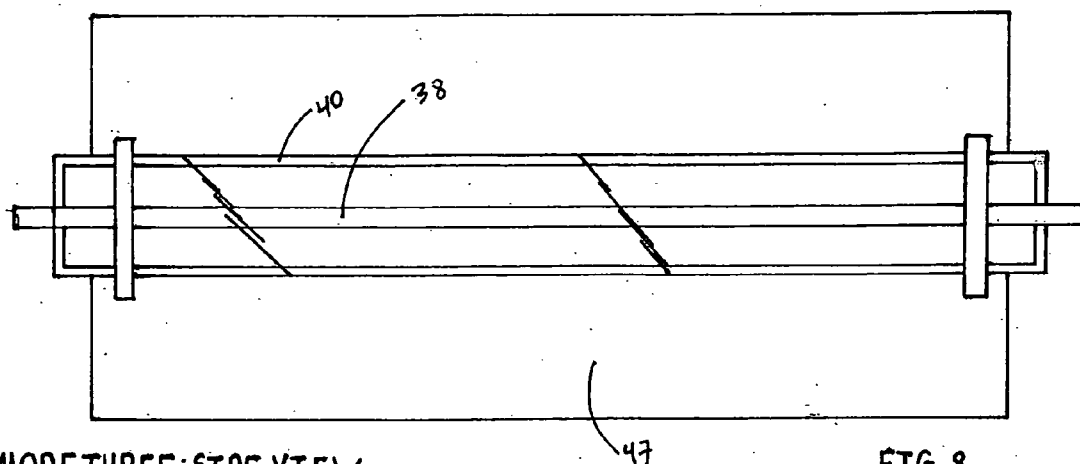
MODE THREE: SIDE VIEW CUTAWAY

FIG. 6



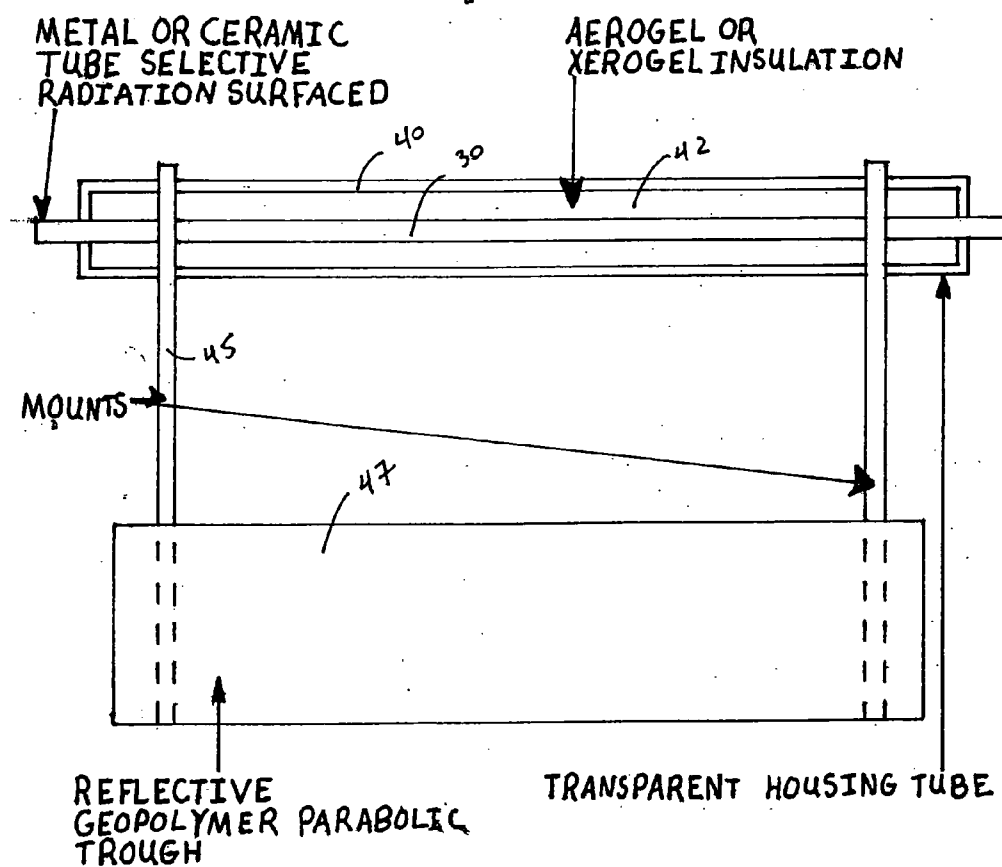
MODE THREE: TOP VIEW

FIG. 7



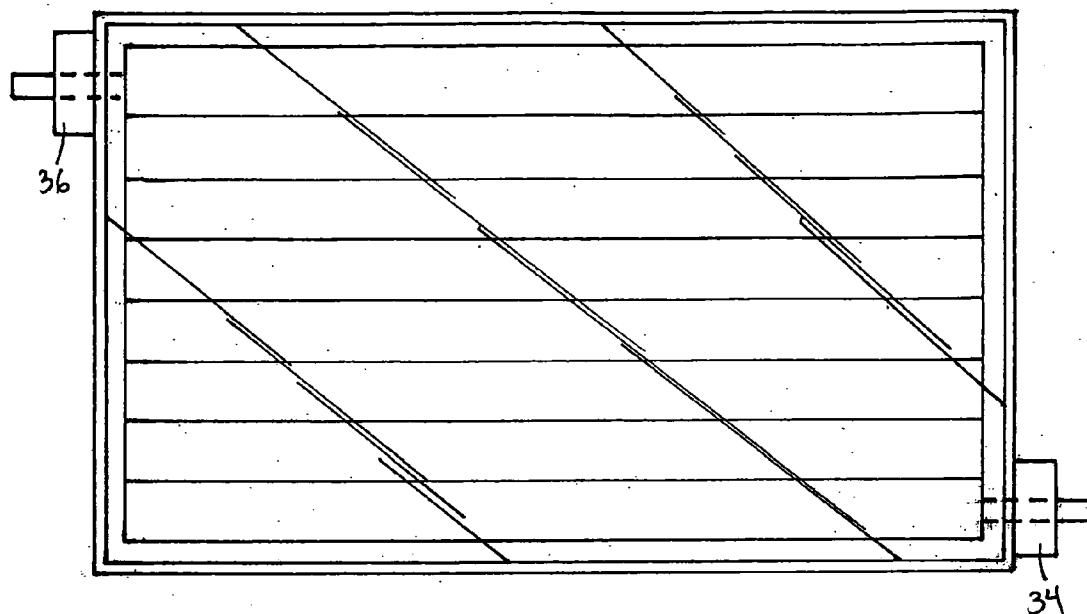
MODE THREE: SIDE VIEW

FIG. 8



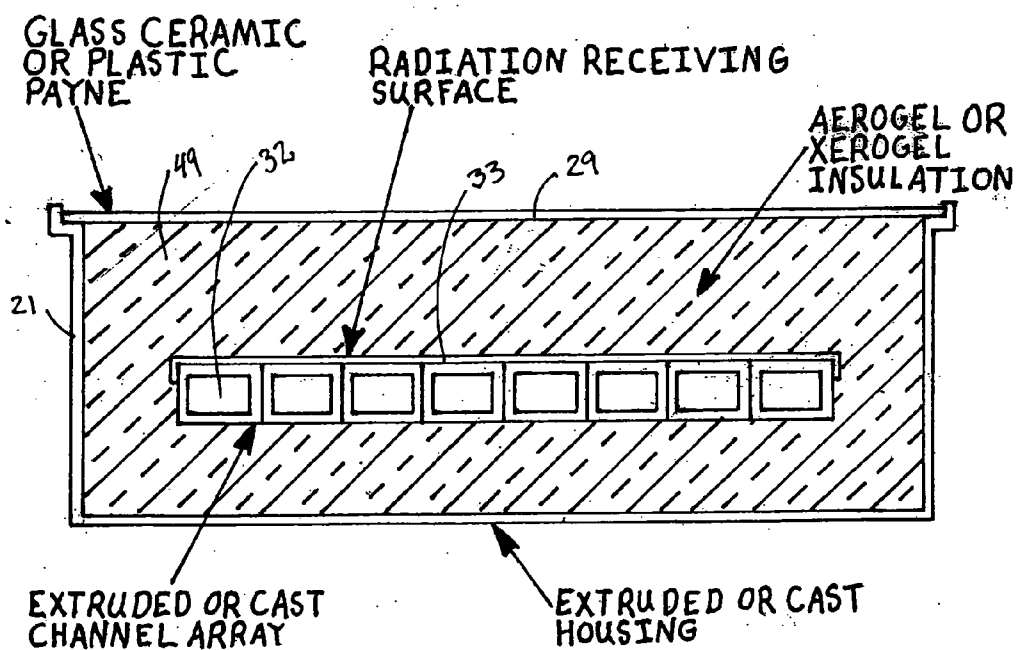
MODE FOUR: TOP VIEW

FIG. 9



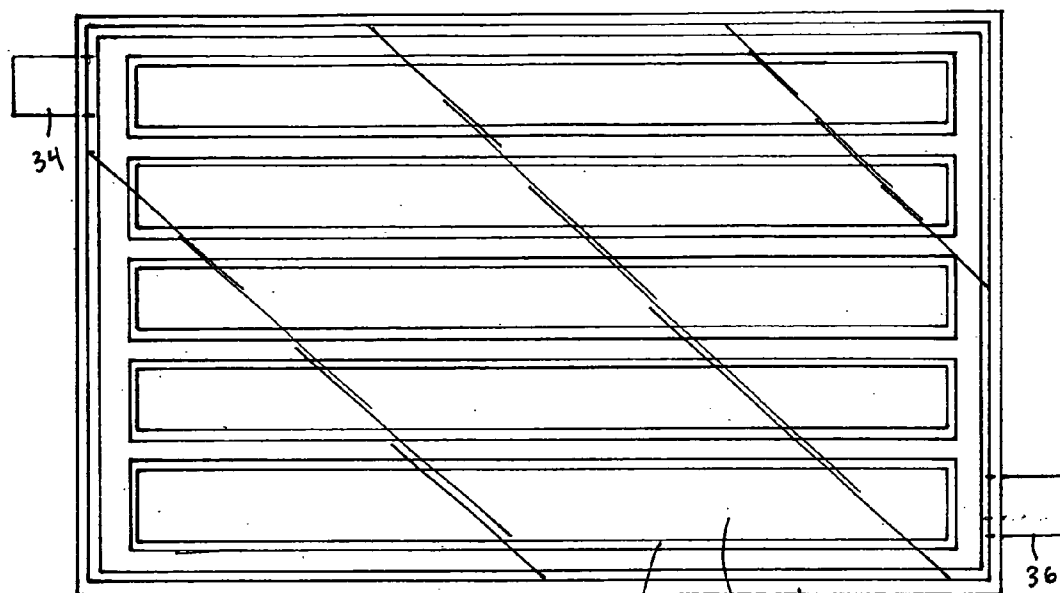
MODE FOUR: SIDE VIEW CUTAWAY

FIG. 10



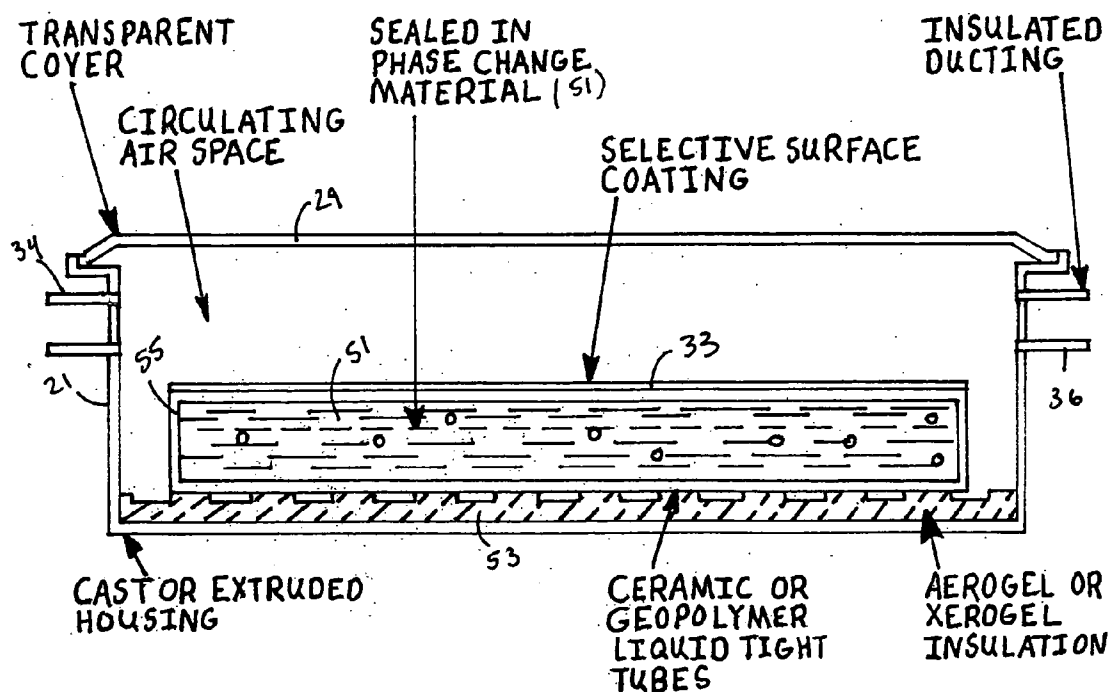
MODE FIVE: TOP VIEW

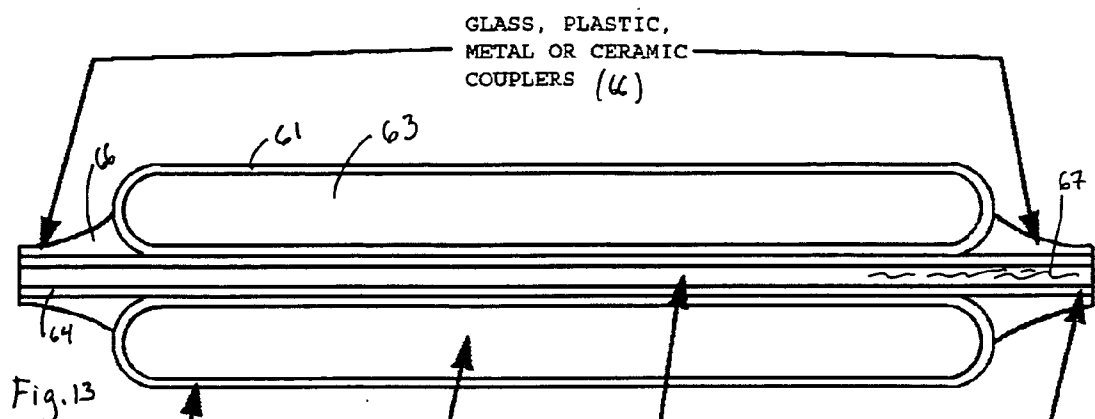
FIG 11



MODE FIVE: SIDE VIEW CUTAWAY

FIG.12





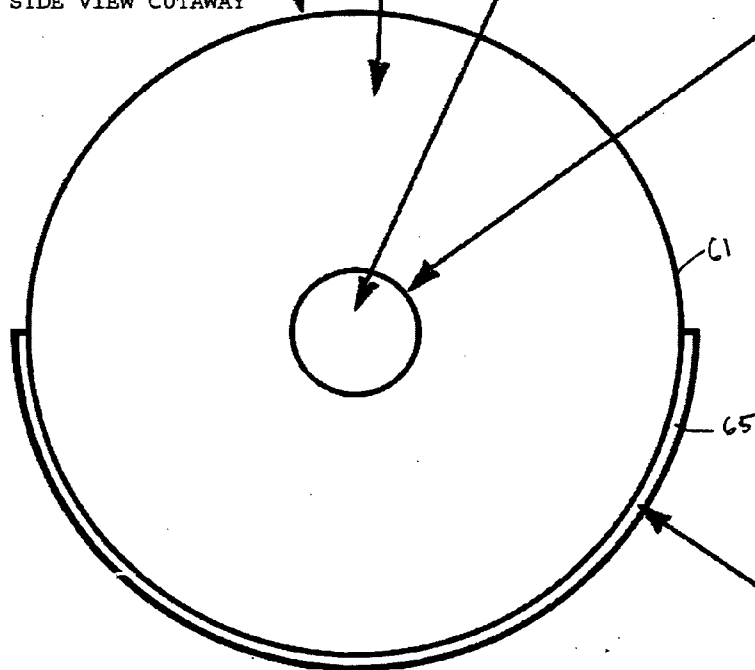
GLASS, PLASTIC, TRANSPARENT CERAMIC, OR TRANSPARENT GEOPOLYMER OUTER SHELL (61)

AEROGEL OR XEROGEL INSULATION

LIQUID SURFACE RADIATIONED MOTIVE FLUID

CARBON FIBER (BRAIDED OR NON-BRAIDED), TRANSPARENT CERAMIC, GLASS, METAL, TRANSPARENT GEOPOLYMER, OR PLASTIC; SELECTIVE SURFACE RADIATIONED OR NON-SELECTIVE SURFACE RADIATIONED INNER TUBE (64)

SIDE VIEW CUTAWAY



BOTTOM HALF OF OUTER SHELL MIRRORED (65)

SOLAR COLLECTOR

[0001] This application claims the benefit of U.S. Provisional Application Ser. No. 60/685,650 filed on May 31, 2005, which is incorporated herein by this reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to the collection and utilization of solar energy, and more particularly to highly efficient solar energy collectors that employ conductive fluids that contain special pigmentation or the like, related enclosures adapted for use with such fluids, and methods of use and production.

[0004] 2. Description of the Prior Art

[0005] The ever-increasing cost of conventional fuel and energy has directed attention to the use of sunlight as a source of energy for heating. As a result, numerous different solar heating systems have developed. A conventional solar heating system is provided in the form of a box collector having a transparent glass plate as a top surface. One or more round black pipes are placed inside the box in a serpentine or other pattern to receive the solar energy that passes through the glass. See, e.g. U.S. Pat. No. 4,170,983. Such conventional solar heating systems are placed in a location exposed to the sun, such as on the roof of a home, and pipes are attached to either end of the pipe network inside the box. When the sun shines down through the glass on the top of the box or through the solar energy collector, heat energy is absorbed by the black pipes inside the box or collector. The heat energy is then transmitted to the fluid flowing inside the pipes. The heated fluid is cycled out of the collector to transfer the collected heat for an appropriate use (e.g. heating water), and cycled back into the collector to be collect more heat. Reflective surfaces may be placed inside glass tubes to reflect sunlight back into the tubes as shown in U.S. Pat. Nos. 4,416,264 and 6,619,283; or placed below opaque tubes to reflect sunlight onto the bottoms of the tubes, as shown in and U.S. Patent Application Publication No. 2002/0002972.

[0006] The most common forms of flat plate collection systems employ active, passive or draining systems. Typically they subdivide along the use of evacuated tubes, non imaging hyperbolic or linear collection systems, or the use of flat black plastic channel absorbers, and more conventionally, metal channel selective and non selective radiation absorbers backed with insulation, and fronted by a dual layer of glass or plastic. Known structures include molded units which contain a pre-formed path through which the fluid to be heated flows, such as that disclosed in U.S. Pat. No. 4,383,959. Insulation may provided in the box around the fluid path to help the fluid retain the absorbed heat as in U.S. Patent Application Publication No. 2003/0150444. Air, water, oil, gel, anti-freeze and other fluids have been used as the medium for receiving the heat absorbed by the collector.

[0007] Some solar collectors are provided in dark colors to maximize heat absorption. Different kinds of films or pigments may be placed on the collector tubes or collector surfaces to make them more absorbent, as disclosed in U.S. Pat. No. 6,997,981. Alternatively, the collector structures may themselves be formed from dark materials as disclosed in U.S. Patent Application Publication No. 2004/0255932.

[0008] The use of thermal energy reservoirs using heat storage materials such as inorganic salts are disclosed in U.S. Pat. No. 4,248,291.

[0009] These conventional solar water heating systems, however, have certain drawbacks. Conventional systems are inefficient in energy collection. In particular, the heat-absorbing structures may not collect and transfer solar energy efficiently and directly to the fluid. Thus, whatever form the solar energy absorbing element may take (e.g. a black water-containing tube; or a transparent oil-containing tube), it is inherently inefficient and is continually losing a significant portion of the absorbed energy by the well known mechanisms of convection, conduction and radiation. The interaction of these heat loss mechanisms limits both the amount of energy transmitted by the absorber to the internal adjacent fluid and the peak temperature attainable by that fluid. Many systems also suffer from drawbacks in the complexity of producing and installing them. In addition many of the systems once installed either fail to perform correctly or suffer from durability problems.

[0010] It is therefore desirable to provide solar energy collectors that are highly efficient, easy to use, and that can be constructed and installed at minimal expense.

SUMMARY OF THE INVENTION

[0011] The present invention addresses these needs by providing solar collectors that employ conductive fluids that contain unique absorption pigmentation or objects. The special pigmentation or objects are provided in the fluid stream itself so as to more readily absorb solar radiation, and make the absorbed radiation more readily available for transmission and use. Specially adapted enclosures are also provided for use with such fluids. Methods of use and production of the fluids and enclosures are also included.

[0012] In one aspect of the invention, a suitable high-temperature material such as silicone, synthetic oil, petroleum based oil, natural oil (such as jojoba oil) is used as the fluid medium provided in the solar collection channel. It is to be appreciated that any non-degradable high temperature solvent or fluorocarbon, or even some of the halogenated compounds, may alternatively be used. The high temperature material itself should be relatively clear, and of such a character that it does not break down or degrade at the high temperatures expected from direct exposure to sunlight. Other fluid media may also be used including water, water with anti-freeze, gels or the like.

[0013] The fluid channel may be provided in any of a number of forms including without limitation one or more pipes or tubes, an open-topped serpentine trough, a space between specially molded upper and lower plates, or the like.

[0014] A suitable dark pigment is mixed into the high temperature fluid that travels through the solar collection channel. This pigment darkens the appearance of the fluid, which acts as a radiation/heat absorption medium that is significantly more effective than the clear fluid itself. Any suitable semi-conducting low refractive index pigment with the correct bandgap may be mixed with the fluid, including without limitation copper oxide, copper sulfide, iron oxide, carbon, carbon bucky balls, chrome and nickel oxides and sulfide complexes of lead, copper and silver, nickel sulfide,

zinc sulfide; silicon carbide; carbon bound in silica gel; other metal oxide gels; and other inorganic binders including geopolymers, low melting point glass. Numerous potential pigmenting agents may be used. It is to be appreciated that this and other aspects of the invention are not limited to use with oil, and that other high-temperature fluids may also be mixed with pigment and used as the heat transfer medium.

[0015] In another aspect of the invention, specially formed nanobeads or nano-spheres are provided in the fluid. The nanobeads are generally made of a silicate base, but may also be made of metal such as copper, aluminum, brass, zinc alloy, etc., or any combination that can produce micro- or nanobeads that are not harmed by the carrier fluid or high working temperatures. In various embodiments, an optical to thermal energy conversion system is provided incorporating selective radiation surfaced microbeads or nanobeads or particulates or nano-particulates incorporated into a heat exchange system that may be expressed as a fluidized gas carrying said beads, as a liquid carrying said beads, or as a solid state to liquid interface in which the beads are incorporated into a solid state as a porous or non porous coating. Alternatively, the beads may be incorporated as an integral part of the structural substrate. In one embodiment, a polished metal such as silver or aluminum is provided on the surfaces of the nanobeads, and that this metal surface is then surrounded by a dark pigment such as copper oxide or copper sulfide, giving the beads a dark appearance. In another embodiment, the metal layer is omitted, and the dark pigment provided directly onto the nanobeads to form the outside surfaces. It is to be appreciated that this and other aspects of the invention are not limited to use with oil, and that other high-temperature fluids may also be mixed with the nanobeads and used as the heat transfer medium.

[0016] The selective radiation surface for the surface coating can be expressed in several modes. One such mode uses a polished metal layer over which a black pigment-laced oil flows. Another mode uses a coating of aluminum oxide or silicon dioxide nanobead with alternating layers of metal oxides and sulfides to secure a spherical dichoric surface with the current bandgap absorption properties and incorporate it as a solid layer, or into a gel or fluid. In a third mode a non-metal micro- or nanobead is generated, a metal surface is plated on it, and it is then coated with a black pigment, carbon or a metal sulfide or metal oxide. In a fourth mode, graded carbon bucky ball clusters are used to select bandgap absorption properties. These may be used in a free state in the fluid, as a solid pigment or as a photonic crystal surfaces orbit bound with a binder. In a fifth mode, solar gel nanobeads may be created with aluminum oxide, silicon dioxide or zirconia oxide mediums. The beads are graded into a blend of size ranges that match the desired bandgap absorption range, and then incorporated into photonic crystal layers to be deposited and used as a solid surface; or to be fragmented and incorporated as photonic crystal fragments and particulates in a flowing fluid gel or oil. It is to be appreciated that the photonic crystals referred to herein are pseudo-crystals in that they mimic a crystalline structure by the way they self order into cubic or hexagonally face centered three dimensional lattices. These nanobeads may be transparent aluminum oxide, silicon dioxide, or a combination of the two, or a zirconium or rare earth oxide.

[0017] In another aspect of the invention, specially formed crystals made of specific selections of nanobeads, nano-

spheres or nano-particulates are provided in the fluid. The selected nanobeads or nano-spheres have different heat reflection/absorption characteristics, and are selected in order to maximize heat transfer. They may be selected separately or selected in blends of specific size ranges and of selected material types all tailored to optimize band gap and photonic band gap adsorption properties, so as to maximize the use of available spectra. These materials may be incorporated as a liquid or solid solar radiation adsorption surface grown as photonic crystals either as a poly crystalline or mono crystalline form. The nanobeads may be selected in one of several ways, typically by size. If the size range of the beads incorporated into the photonic crystal lattice is offset by another bead grouping of a slightly different size also incorporated into the lattice, then it is possible to selectively cancel wavelengths with this diffraction lattice, and also absorb only the wavelengths desired. Thus, the diffracting lattice is tunable in this respect. The size of the microspheres in this lattice also can determine tunability to some degree, as can the refractive index differences between the nano-spheres and the surrounding voids.

[0018] In one embodiment, two or more sizes of beads are incorporated into the nano-crystal lattice, one bead size being offset by the other. Thus, one can selectively cancel or reinforce wavelength absorption or reflection, thus making the lattice array tunable. In addition, the array may be crudely tuned using a single size carefully selected.

[0019] In another embodiment, tune nano-crystals may be constructed by growing bucky ball clusters in the correct size ranges. The surfaces are metal ion implanted, and in a mild acid solution adjusted to attractive electrostatic coulomb forces so as to cause the bucky ball clusters to be drawn toward one another and to self assemble into the desired photonic crystal lattice, as pseudo crystallites. They may then be calcined or otherwise sintered and so bound together.

[0020] In another embodiment, a polar/non-polar solution is used to grow silica gel micro- or nanobeads. However, instead of incorporating micro-particulates of carbon in situ as the bead forms, a semi conducting material is incorporated in this manner. In this case, the beads may be sized by centrifugation and then settled into photonic lattices by settling in a neutral solution. They are then hardened by a calcining operation. These crystallites can be ground and used in a liquid or as a solid layer in a binder material.

[0021] Several different but suitable methods exist for nanobead fabrication and use. Most nanobeads are made by the sol-gel method whereby a metal hydroxide solution is made to hydrolyze by the addition of an acid, the metal hydroxide nucleating out spontaneously and clustering into spherical clusters of nucleate particles. The clustered particulates are layered like an onion, and the size ranges may be easily regulated. A solution of tetraethylorthosilicate (TEOS) is precipitated by the addition of an aqueous ammonia solution which causes the spontaneous nucleation of nano-particles. These, in turn, cluster into onion layered spherical aggregates. The uniformity of size can be easily controlled as can the porosity. Sol-gel techniques can fabricate nanobead to microbead sizes in aluminum oxides, silicon dioxide, or combinations of the two. It may also incorporate zirconium or other rare earth oxides as well. These beads may then be metal plated and then coated with

one of the semi-conducting materials. These beads in turn provide the pigment for the selective radiation surface.

[0022] Micro- and nanobeads may also be formed by supersonic nozzle ejection or by spin plate technology. A thin molten stream of metal is blasted with an inert supersonic gas stream. The beads created are then graded by centrifugation, and coated with the desired semi-conducting agent. Gellation and surface tensioning of polar and non polar solvents may also produce spherical micro- and nanobeads.

[0023] Another method is to coat the beads with alternating layers of metal oxide and metal sulfide to specified thicknesses, thus creating a dichoric selective radiation surface of a spherical geometry around the surface of the beads. In another method, the circular agitation of polar and non-polar solvents incorporating sodium silicate solution hydrolyzed by a mild acid produces the desired micro- and nano-spheres. These beads may be graded by centrifugation, and solution plated with metal and re-introduced into a mother silicate liquor laced with carbon or semi-conducting nano-particulates. Upon heating and agitation, a silicate carbon or silicate semiconductor layer forms. The beads are dried and sintered for several hours at around 400 C in an inert atmosphere. Another method calls for producing a metal hydroxide nanobead, then calcine it into an oxide bead and then reduce it at a high temperature in a hydrogen stream into a metal nanobead which may then be coated with carbon silicate or a metal sulfide.

[0024] Surface coating of a photonic crystal is generally unnecessary. The periodicity of its blended and ordered lattice structure generally tunes its bandgap.

[0025] Once formed, the dark crystals are mixed with the fluid in the solar collector to absorb heat for use by the collector. It is to be appreciated that this aspect of the invention is not limited to oil, and that other high-temperature fluids may also be mixed with the crystals and used as the heat transfer medium. Geopolymers are typically characterized by cordierite or mullite mineral structures bound with metal silicates. The process permits the creation of a self-hardening extremely stable and inert cement (ceramic), which is cheap, moldable and processed cold. As set forth below, these selected nano-materials and/or the crystals formed therefrom may alternatively be incorporated into the absorption surfaces of the solar collector channels, troughs, and/or tubes.

[0026] It is to be appreciated that in different embodiments, different combinations and/or concentrations of pigmentation, nanobeads and/or crystals may be provided in the selected fluid medium.

[0027] In one aspect, a structure for a solar collector is provided in the form of a ceramic (fire cured) or geopolymeric (unfired) material that is pressed formed or molded to form a collector body having a base with contiguous shallow serpentine grooves forming the channel for the fluid medium. The upwardly facing surfaces of the channels/grooves are coated with a radiation receiving material for receiving and absorbing the sun's rays.

[0028] In some embodiments, one or more edge steps or shoulders are provided in the base, for supporting one or more transparent or translucent (e.g., glass) panels, with a dead air space between them providing insulation to prevent

heat from escaping. In some of these embodiments, aerogel or xerogel may be provided between these panels for insulation purposes. In alternative embodiments, a single panel may be provided on the collector body, supporting a layer of aerogel or xerogel that is provided above the panel.

[0029] The channel containing the dark absorption fluid may be provided in any of a number of forms including without limitation one or more pipes or tubes, a molded open-topped serpentine trough in a collector body, a space between specially molded upper and lower plates, or the like. The channel or space in the collector body may be in the form of contiguous serially connected linear or non-linear serpentine troughs that are impressed, cut, molded, extruded or assembled upon or within the collector body. Alternatively, the channel(s) may be provided in various forms such as a radial helice type channel, a manifold channel array, a radial to point output channel array, or interconnected polygonal grids of different sorts. The collector body may take the shape of a square, rectangle, circle, hexagonal or other polygon, and may be regular or irregular. Alternative shapes include oval or other regular or irregular curvilinear or pillow type shape, although the body is not limited necessarily to these configurations.

[0030] It is to be appreciated that the fluid channel(s) should be specially adapted in order to take advantage of the absorption characteristics of the dark fluid flowing through the channel(s). Molded embodiments of the collector body may be made from pozzolanic cements, geo polymers, filtered and unfiltered, fibered or unfibered, plastics, glasses hot press or cold glasses, or fired ceramics. In different embodiments, the collector body may be formed by extruding, pressing, molding, casting, slip casting, jiggering, roller shaping, stacked tape cutout assembling and press sintering or assembly, but such formation is not necessarily limited to these techniques.

[0031] The collector body may be provided with a hollow space between the exposed upper surface and the base. The collector body may be shell cast or slip cast having a hollow interior that is filled with suitable insulation such as foam, filler, xerogel, aerogel or nanobeads. The hollow interior may also be insulated using filler or spatial filling placed into hollows of the collector body including without limitation: hollow glass or porous microbeads or nanobeads or particulates or nano-particulates; hollow or porous ceramic microbeads or nanobeads or particulate or nano-particulates; hollow or porous plastic microbeads or nanobeads or particulates or nano-particulates; hollow or porous glass, ceramic or plastic fibers or strands; hollow or porous particulates or glass ceramic or plastic; or the use of xerogels or aerogels as a spatial fill form or as a particulate sheet or spherical form or filler.

[0032] Thus, in one embodiment of the invention, the channel is provided in the form of a serpentine path that is molded or extruded into the base of the solar collector that is open at the top. One or more transparent panels are provided above the serpentine channel to allow sunlight to reach the channel and the dark fluid flowing therein. The cover and closure panels may be in the form of reinforced or non-reinforced glass, diverse types of reinforced or non-reinforced plastics, rigid and non-rigid membranes, or transparent ceramics. Dual panels provide an insulation space between them that prevents the escape of heat and radiation.

The underside of one or more of the panels may also be coated with a special foil or other reflective surface that allows the desired sun rays to penetrate through, but traps them below by reflecting them back down into the collector.

[0033] In one embodiment, the surface of the channel is reflective so as to reflect the desired radiation onto the dark fluid flowing therein.

[0034] In alternative embodiments, the surface of the channel is provided with dark pigmentation that may be painted, adhered or molded thereon. In these embodiments, the channel absorbs radiation which is then transferred to the fluid flowing through. In such embodiments, black pigment, carbon or copper sulfide or copper oxide may be slip coated and/or fired onto the collector body. Selective surface foil or film may be glued or adhered, or mechanically, thermally or ultrasonically bonded to the collector body. The active collector surface may have chemically deposited vapor or plasma deposited or glow discharge deposited or plated metallic or non metallic layers as radiant energy absorbers, or as selective surface or non selective surface systems. The surface may include the deposition of shaped particulate layers of organic or inorganic materials designed to enhance light adsorption capacity, or the use of a pigmented spray with particulates in an organic or inorganic binder may also be utilized.

[0035] In other embodiments, the absorption channel may be made using a doctor blade and a slurry of a particulate and organic or inorganic binder, a geopolymeric binder holding the particulate, a cold glass or hot glass binder, or an elastomer binder and envelope. As a further alternative, the absorption channel may be made using a polished foil adhered or glued to the active collector surface over the top of which a clear high temperature oil laced with a black pigment will flow; or using a ceramic or aluminum oxide, plastic or glass microbeads, plastic or glass nanobeads, plastic or glass nano-particulates.

[0036] In other embodiments, one or more closed tubes or conduits are provided as the channel(s) for holding the dark flowing fluid. In one such embodiment, the upper portions of these conduits are transparent or translucent in order to allow the desired sun rays to penetrate to the fluid inside. However, the lower portions of these conduits are provided with reflective surfaces so as to reflect the desired radiation onto the dark fluid flowing through. In an alternative embodiment, the upper portion of the conduits may be provided with one or more a surfaces, films or coatings that selectively allow the desired sun rays to penetrate to the fluid inside, and/or selectively prevent desired radiation, heat or energy from escaping. In some embodiments, aerogel or xerogel may be provided (wrapped) around the tubes as insulation to prevent heat from escaping.

[0037] In one embodiment, at least the upper half of each conduit is transparent or translucent, and a reflective material or surface is provided on the lower half of each conduit. The lower reflective surface may be provided inside or outside of the conduit, or may be formed as the lower half of the conduit structure itself.

[0038] In other embodiments, the conduit tubes may include smaller inner tubes in concentric relationship, with the smaller inner tubes carrying the dark conductive fluid. In one such embodiment, transparent xerogel or aerogel is

provided in the space between the concentric tubes as insulation. In various alternative embodiments, the upper surfaces of the outer tubes and/or inner tubes may be provided with one or more a surfaces, films or coatings that selectively allow the desired sun rays to penetrate to the fluid inside, and/or selectively prevent desired radiation, heat or energy from escaping. The lower portions of one or both of these tubes are provided with reflective surfaces so as to reflect the desired radiation back onto the dark fluid flowing through the inner tube.

[0039] In other embodiments, instead of concentric tubes containing insulation, an elongated cylindrical body is provided having an outer edge diameter, the body including a central bore having a smaller diameter. The area between the outer edge and the central bore is sealed, and provided with a vacuum for insulation purposes. The dark conductive fluid is conveyed through the inner bore, with appropriate attachments at either end of the body for introducing and removing the fluid. In one such embodiment, the upper portion of the outer edge, and the upper portion of the central bore are transparent or translucent in order to allow the desired sun rays to penetrate to the fluid inside. However, the lower portions of these structures are provided with reflective surfaces so as to reflect the desired radiation onto the dark fluid flowing through. In an alternative embodiment, the upper portions may be provided with one or more a surfaces, films or coatings that selectively allow the desired sun rays to penetrate to the fluid inside, and/or selectively prevent desired radiation, heat or energy from escaping.

[0040] In one embodiment, the elongated cylindrical body is provided in the form of a sealed glass concentric dual tube vacuum jacket that is fully formed with sealed glass ends. In this embodiment, no silicone gaskets are necessary and once the vacuum is drawn it becomes permanent. The elongate toroid vacuum jacket may then be made reflective along its back half by any of the methods described previously, the assemblage thus becoming a substantial and permanent heat reflective and vacuum insulative substrate to the inner central tube.

[0041] In other embodiments, running the length of the interior of the body is an array of parallel carbon or ceramic or glass fibers which may be coated by a pigment or selective radiation surface again as described previously. The filaments of carbon, glass or ceramic run inside of the inner tube, and their large exposed surface area contacts the circulating fluid (oil, water, etc.) to conduct heat directly to the circulating fluid. These parallel stranded fibers serve a dual function both as a structurally efficient heat exchanger and as an effective energy-adsorbing surface.

[0042] In other embodiments, the vacuum may be replaced by xerogel or aerogel insulation. Alternatively, the body may be made from a green cast or extruded transparent ceramic, or a transparent geopolymer. Alternatively, superposed and adhered to the ends of the tube body are insulated ceramic plastic or glass manifold fasteners, liquid tight and readily installed or removed.

[0043] In different embodiments, dark heat absorption and transmission surfaces are provided in or inside the channels containing the fluid to expose the fluid to as much surface area as possible to maximize heat transfer. The transmission surfaces may be of different sizes and shapes, and may be honeycomb, porous, perforated, permeable or other material

that comes into contact with the fluid of the system. Such surfaces may be made or coated with the same material as the collector body, channel or trough as described previously, or they may be made of metal (such as strips of aluminum) or other conductive material. Alternatively, these surfaces may be provided as a slotted, stepped or louvered array of ceramic, plastic, glass or metal foil that is pigmented or selective radiation surfaced (or otherwise coated) into the moving water or oil stream adjacent to the interior collector surface. A stacked ceramic plastic glass or metal gauze, or honeycomb, lathing, or loose fiber wool may alternatively be used. Alternatively, an array of parallel strands a woven braid or braids of ceramic or carbon or glass fibers may be preferentially employed the object being and increase in surface area thus improving the heat exchange capacity to the flowing liquid or gas. These additional transmission surfaces may be provided in regular or irregular patterns in the fluid medium for the purpose of maximizing the exposure of the fluid to these surfaces for heat transfer.

[0044] In one aspect of the invention, a heat-absorbent phase-change material is provided inside the channels/tubes of the solar collector. In these embodiments a phase change salt (e.g. Glauber's salt) or heat retentive agent is used that melts when heated and hardens when cooled. Dark pigmented channels are provided in the collector body or tubes for carrying the phase change material. The channels are not completely filled with the phase change material so that air or other appropriate gases or fluids may circulate around the material when in the solid phase. When the solar collector is receiving the sun's rays, the heated gas causes the phase change material to melt. The heated, melted material then transfers heat during the daylight operation of the collector. Then, when the sun's rays are no longer available, the material continues to provide heat as it slowly cools and hardens, extending the useful operational time of the solar collector. This cycle is repeated on a daily basis. In alternative embodiments, transparent insulation or honeycomb material is provided around the absorption channels to retain heat.

[0045] In other embodiments, pigment could be mixed with the phase change (salt) material that is held in the transparent channels. The pigment would have to be in a colloidal state so as not to settle out.

[0046] It is to be appreciated that different combinations of one or more of the aspects and embodiments described herein may be provided, depending upon the objectives of the user. It is also to be appreciated that multiple collector bodies and/or tubular bodies (modules) may be provided in serial or parallel arrays, interconnected using such materials as, without limitation, metal, plastic or silicone tubing, bent or flexible type, sealed with a silicone elastomer, an epoxy or metal to glass solder. In some embodiments, the modular interconnects may include fiberglass batting and foil systems housed in plain, patterned or pleated foil. High temperature flexible plastic foams likewise may be incorporated in said housings, or alternatively may incorporate blown chemical foams in plain, patterned, or pleated plastics for flexibility and mechanical strength.

[0047] It is therefore a primary object of the present invention to provide solar energy collectors that are highly efficient, easy to use, and that can be constructed and installed at minimal expense.

[0048] It is also an object of the present invention to provide solar energy collectors that employ the use of dark conductive fluids that contain special pigmentation, particulates or the like as the absorption medium.

[0049] It is also an object of the present invention to provide highly efficient solar collectors utilizing a liquid radiation surface depending on the mode of the invention employed.

[0050] It is also an object of the present invention to provide enclosures for solar collectors that are adapted for use with dark or pigmented fluids, and methods of their use and production.

[0051] It is also an object of the present invention to provide methods and apparatus for the construction of modular solar collectors.

[0052] It is also an object of the present invention to provide solar collectors having efficient radiation collecting surfaces, and that provide efficient heat retention and heat movement through the system.

[0053] It is also an object of the present invention to provide modular solar collectors that can be constructed at minimal material and production costs.

[0054] It is also an object of the present invention to provide modular solar collectors that can be easily installed at minimal cost.

[0055] It is also an object of the present invention to provide solar collectors that can be made using greatly simplified manufacturing processes.

[0056] It is also an object of the present invention to provide solar collectors that employ inexpensive starter materials.

[0057] It is also an object of the present invention to provide solar collectors having improved durability by employing formable insulating non metallic or metalloid material in construction.

[0058] It is also an object of the present invention to provide solar collectors that accrue significant overall cost reductions by employing a stackable modular design.

[0059] It is also an object of the present invention to provide highly efficient solar collectors utilizing a liquid radiation surface depending on the mode of this invention employed.

[0060] It is also an object of the present invention to provide solar collectors for use in providing domestic or industrial hot water, or to sterilize or distill water.

[0061] It is also an object of the present invention to provide solar collectors for use in providing radiant heat for homes or buildings, or to heat air or other gasses as means for solar drying or solar heating.

[0062] It is also an object of the present invention to provide solar collectors that may be used at higher temperature modes as a means of collecting solar energy for the production of electric power.

[0063] Additional objects of the invention will be apparent from the detailed descriptions and the claims herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0064] FIG. 1 is a top view of an embodiment of the present invention.

[0065] FIG. 2 is a side view of the embodiment of FIG. 1.

[0066] FIG. 3 is a top view of an alternative embodiment of the present invention.

[0067] FIG. 4 is a cross-sectional side view of the embodiment of FIG. 3.

[0068] FIG. 5 is a top view of another embodiment of the present invention.

[0069] FIG. 6 is a cross-sectional side view of the embodiment of FIG. 5.

[0070] FIG. 7 is a top view of another embodiment of the present invention.

[0071] FIG. 8 is a cross-sectional side view of the embodiment of FIG. 7.

[0072] FIG. 9 is a top view of another embodiment of the present invention.

[0073] FIG. 10 is a cross-sectional side view of the embodiment of FIG. 9.

[0074] FIG. 11 is a top view of another embodiment of the present invention.

[0075] FIG. 12 is a cross-sectional side view of the embodiment of FIG. 11.

[0076] FIG. 13 is a cross-sectional top view of another embodiment of the present invention.

[0077] FIG. 14 is a cross sectional end view of the embodiment of FIG. 13.

DETAILED DESCRIPTION

[0078] Referring to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, and referring first to the exemplary embodiment of FIGS. 1 and 2, it is seen that the collector unit 20 of this embodiment includes a base section 22 and upwardly extending peripheral walls 24. The walls 24 in this embodiment are provided with a lower shoulder 26 and an upper shoulder 28 for supporting, respectively, panels 27 and 29. A plurality of ridges 30 are provided in base 22 which define a serpentine channel 32 that extends from an inlet 34 to an outlet 36. Panels 27 and 29 may be in the form of glass or other transparent or translucent material. The gap between panels 27 and 29 may be filled with air or other transparent or translucent insulation such as xerogel or aerogel. As described previously, the exposed surfaces of ridges 30 and channel 32 may be dark using surface pigmentation in the form of paints, films or the like that are adhered to or incorporated into base 21. Alternatively, channels 32 may be provided with reflective surfaces to reflect solar energy back onto the fluid flowing through the channel.

[0079] In one embodiment, the collector is made of a ceramic or filtered geopolymeric tile pressed or molded into a base 21 having an exemplary size of about eighteen by eighteen inches upon which are impressed a plurality of serially interconnecting shallow and contiguous serpentine

grooves 32 are provided in which to run fluid. The inner perimeter of the wall 24 is in turn impressed into two shallow steps 26 and 28, the lower step 26 being equal in height to the ridges 30 between the serpentine channels 32. The second and higher step 28 is separated from the first step by about half an inch. The purpose of these steps is to receive the sealing agent and in turn to support and seal the two panes set into the tile and onto the step edges. The first inner pane 27 seals and holds the fluid into the channels 32 and the second pane inset 29 holds and traps a dead air space as a form of thermal insulation.

[0080] In addition, this exemplary embodiment has mounted and sealed into their respective positions, two metal or plastic inlet 34 and outlet 36 fasteners both insulated and designed to communicate fluid into their adjacent modules respectively. Within the serpentine channels 32 through which the fluid is exposed to the sun and heated, there may be introduced a variety of radiation receiving surfaces designed to enhance the adsorption of solar flux. The simplest coating would be a matt black slip applied and fixed onto the surface of the tile with fluid being run over the top surface of the black glaze. Other approaches regarding the radiation adsorbing surfaces are discussed above.

[0081] Turning to the exemplary embodiment of FIGS. 3 and 4, it is seen that base 21 is shell cast or molded defining a hollow interior 31. Base 21 may be made of the previously described tile in any of the suitable materials previously mentioned. The interior hollow space 31 of the base is filled with a suitable insulator foam or filler, with a xerogel or aerogel being the preferred insulating substance. The use of dead air space between panels 27 and 29 may be employed, or a transparent slab of xerogel or aerogel 35 may be inserted in this space to partially or completely fill the space, thus significantly improving the front face insulating capacity without significantly impeding its capacity to pass solar flux. In the illustrated embodiment, the lower surfaces of channels 32 between ridges 30 are provided with reflective material 33 to reflect the solar radiation back into the fluid flowing through channels 32. Although a square or rectangular shape is shown, it is to be appreciated that base 21 may be provided in any suitable dimension or shape.

[0082] FIGS. 5 and 6 disclose an exemplary embodiment of the invention in which the fluid carrying channels are provided in the form of small central tubes 38. These tubes are surrounded by larger diameter tubes 40. Although round tubes are illustrated, it is to be appreciated that the cross section of these concentric tubes may have any other suitable shape including without limitation elliptical, hexagonal, rectangular, square, etc. and that the interior tube 38 need not have the same cross sectional shape as the exterior tube 40 (e.g., around tube 38 inside a hexagonal tube 40). The interior tubes 38 of this embodiment may be provided as porcelain, cement, ceramic, glass or metal tubes upon which is deposited a black pigmented or selective radiationed surface as described previously. If transparent tubes 40 of glass, plastic or ceramic are used, this embodiment may employ the dark radiation receiving surfaces 44 in the interior of said tubes, in any of the radiation receiving types of surfaces as mentioned previously. Alternatively, these surfaces 44 may be reflective to reflect the solar energy onto the inner tubes 38. In one embodiment, the area between tubes 38 and 40 is insulated using a layer of transparent aerogel or xerogel 42 of a uniform thickness concentric to

the tube's outer face. Inner tubes **38** may themselves be coated with dark radiation receiving surfaces to absorb heat. Alternatively, if one of the dark absorption fluids described previously is used in tubes **38**, the tubes themselves may be provided in a transparent or translucent form, in conjunction with transparent tubes **40** and reflective surfaces **44**. Reflective surfaces **44** may be mirror foiled with reflective plastic, metal, plated, electroplated or sputtered with a reflective metal surface. Tubes **38**, **40** may be connected serially or in a parallel manifold network.

[0083] The exemplary embodiment depicted in FIGS. 7 and 8 discloses a line focus system in which transparent tubes **40** are suspended above a reflective system **47**. In the illustrated embodiment, inner tube **38** is coated with dark radiation receiving surfaces to absorb heat. However, it is to be appreciated that if one of the dark absorption fluids described previously is used inside tubes **38**, these tubes **38**, as well as tubes **40**, are provided in a transparent or translucent form. The suspended tubes of this embodiment may be incorporated into a moving or non-moving parabolic trough or Fresnel lens systems. They may also be incorporated into hyperbolic non-imaging concentrating systems.

[0084] Another exemplary embodiment is shown in FIGS. 9 and 10. In this embodiment, the body **21** of the collector is provided in the form of a parallel contiguous extrusion or cast assembly containing a plurality of channels **32** of a uniform size and shape parallel and in plane to one another. The channels **32** may be capped endwise so as to allow the serial or parallel manifold flow of fluid or a combination thereof and in turn may be manufactured in any of the materials as described previously. These channel arrays of tubes are encased in a contiguous layer of xerogel or aerogel **49** for suitable insulation. For protection, these aerogel or xerogel encapsulated arrays may in turn be encased in a suitable material or material combinations as described previously (e.g., transparent cover panel **29**; molded body member **21**). It being understood that the materials protecting the front radiation receiving surfaces **33** (i.e., transparent panel **29** and layer **49**) are suitably transparent. It is to be noted that the radiation receiving surfaces **33** may be deployed within or on the outside surface of the channel array by methods previously indicated.

[0085] In an alternative to the embodiment of FIGS. 9 and 10, one of the dark fluids described previously is provided inside channels **32**, radiation receiving surface **33** is eliminated, and the material making up channels **32** is transparent. A reflective surface may also be provided on the underside of channels **32** to reflect radiation back into the channels where it can be absorbed by the dark fluid.

[0086] The exemplary embodiment of FIGS. 11 and 12 illustrates one use of a phase change material **51** in a solar collector. In the illustrated embodiment, air or a suitable gas is used as the working fluid. In this embodiment, larger tubular bodies **55** having a rectangular or other cross section are utilized. Bodies **55** are made from one of the materials described previously (ceramic, geopolymeric, etc.) and are liquid tight, and contain a phase change salt or heat retentive agent **51**. A dark pigment or selective radiation surface **33** is provided on the exteriors of bodies **55** for absorption of solar radiation. The parallel or contiguous attached channel arrangement of bodies **55** are in turn incased in an insulated housing such that the radiation receiving portions (e.g. panel

29) are rendered substantially transparent. In the illustrated embodiment, a large air space is provided above bodies **55** and below panel **29** in order to sustain a substantial flow of air or gas around and between said parallel tubular or contiguous channel arrays, so that an adequate amount of heated air or gas may be removed and recirculated through inlet/outlet ports **34** and **36**. Xerogel or aerogel may be used as an insulating agent underneath the bodies **55**. In use, during the daylight hours, the hot circulating gas causes the phase change material to melt, and heat is transferred out of the solar collector. After sunset, the hot material gives off heat as it solidifies, which continues to be circulated out of the solar collector for some time, until the phase change is complete. This cycle repeats each day.

[0087] In an alternative embodiment, a single serpentine channel **32** similar to that depicted in FIGS. 1-2, tubular channels **32** similar to those depicted in FIGS. 5-6, or multiple parallel channels **32** such as those depicted in FIGS. 9-10 may be employed. In each case, the phase change salt or other heat retentive agent **51** is placed in the channel **32** such that the channel is not completely filled, leaving a gap above the material inside the channel for the circulation of air or gas. In each case, the channels are provided with dark pigment or selective radiation surfaces **33** on their exteriors for absorption of solar radiation. The structures above the channels **32** are transparent to allow sunlight to penetrate to the absorption surface. Air or other gas is circulated in the space that is provided in each channel, to provide or remove heat from the phase change material, depending on the phase.

[0088] It is to be appreciated that pigment may be mixed with the phase change material **51** that is held in the channels **32**. Such pigment should be provided in a colloidal state so as not to settle out.

[0089] As can be seen many suitable modes exist for best carrying out this invention. The methods and construction are intimately related to the temperature regime desired, the use of a liquid or gaseous heat exchange medium and to the use these solar collectors are put to. In turn these influence the material selection and selection of manufacturing techniques employed. The need determines the collector and manufacture selection as described in detail by the above examples, which should not be construed as limiting the invention thereto.

[0090] FIGS. 13 and 14 illustrate another exemplary embodiment of the invention in which an elongated cylindrical body is provided in the form of a sealed glass concentric dual tube vacuum jacket **61** that is fully formed with sealed glass ends, defining a space **63** inside. The elongate toroid vacuum jacket may then be made reflective along its lower half **65** by any of the methods described previously, the assemblage thus becoming a substantial and permanent heat reflective and vacuum insulative substrate to the inner central tube **64**. Glass, metal, plastic or ceramic couplers **66** hold tube **64** in place inside jacket **61**.

[0091] Jacket **61** and space **63** are transparent or translucent. In one embodiment, central tube **64** is also transparent or translucent, and carries one of the dark absorption fluids described previously. In other embodiments, central tube **64** may have a dark pigmented or selective radiation surface as described previously, and the fluid inside may or may not be one of the dark fluids discussed previously. Although a

round structure is illustrated, it is to be appreciated that the cross section of these components may have any other suitable shape including without limitation elliptical, hexagonal, rectangular, square, etc. and that the interior tube **64** need not have the same cross sectional shape as the exterior of jacket **61**. However, it is preferred that the interior of jacket **61** and the exterior of tube **64** be the same.

[0092] In one embodiment, the bottom portion **65** of jacket **61** may be reflective to reflect the solar energy onto the inner tube **64**. The bottom portion of inner tube **64** may also be reflective.

[0093] In other embodiments, running the length of the interior of the body **64** is an array of parallel carbon or ceramic or glass fibers **67** which may be coated by a pigment or selective radiation surface again as described previously. The filaments of carbon, glass or ceramic run inside of the inner tube **64**, and their large exposed surface area contacts the circulating fluid (oil, water, etc.) to conduct heat directly to the circulating fluid. These parallel stranded fibers serve a dual function both as a structurally efficient heat exchanger and as an effective energy-adsorbing surface. Such strands may be provided in the channel of any of the embodiments of the invention.

[0094] In other embodiments, the vacuum in space **63** may be replaced by xerogel or aerogel insulation. Alternatively, the jacket **61** may be made from a green cast or extruded transparent ceramic, or a transparent geopolymer. Alternatively, superposed and adhered to the ends of the tube body are insulated ceramic plastic or glass manifold fasteners **66**, liquid tight and readily installed or removed.

[0095] It is to be understood that variations and modifications of the present invention may be made without departing from the scope thereof, and that the invention includes different combinations and permutations of the various elements disclosed herein, even if not specifically discussed or illustrated. It is also to be understood that the present invention is not to be limited by the specific embodiments, components or parts disclosed herein, nor by any of the exemplary dimensions set forth in the attached illustrations, but only in accordance with the appended claims when read in light of the foregoing specification.

What is claimed is:

1. An absorption medium for use in a solar energy collector comprising a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid.

2. The absorption medium of claim 1 wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof.

3. The absorption medium of claim 1 wherein said dark material is a pigment selected from the group of copper oxide, copper sulfide, iron oxide, chrome oxide, nickel oxide, carbon, chrome oxide, nickel oxide, silicon carbide and combinations thereof.

4. The absorption medium of claim 1 wherein said dark material is a pigment selected from the group of a sulfide complex of lead, copper and silver; nickel sulfide; zinc sulfide; carbon bound in silica gel; a metal oxide gel; carbon bucky balls, and combinations thereof.

5. The absorption medium of claim 1 wherein said dark material is a low refractive index pigment.

6. An absorption medium for use in a solar energy collector comprising a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material is a pigment selected from the group of copper oxide, copper sulfide, iron oxide, chrome oxide, nickel oxide, carbon, chrome oxide, nickel oxide, silicon carbide and combinations thereof.

7. The fluid of claim 1 wherein said dark material is a member selected from the group of nanobeads having selective radiation surfaces, nanospheres having selective radiation surfaces, nano-particulates having selective radiation surfaces, microbeads having selective radiation surfaces, microspheres having selective radiation surfaces, microparticulates having selective radiation surfaces, and combinations thereof.

8. The fluid of claim 7 wherein said member is provided with a surface coating selected from the group of carbon sulfide, copper oxide, copper sulfide, iron oxide, chrome oxide, nickel oxide, carbon, chrome oxide, nickel oxide, silicon carbide and combinations thereof.

9. The fluid of claim 7 wherein said member is provided with a surface coating selected from the group of a metal oxide, a metal sulfide, and combinations thereof.

10. An absorption medium for use in a solar energy collector comprising a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material is a member selected from the group of nanobeads having selective radiation surfaces, nanospheres having selective radiation surfaces, nano-particulates having selective radiation surfaces, microbeads having selective radiation surfaces, microspheres having selective radiation surfaces, microparticulates having selective radiation surfaces, and combinations thereof, and wherein said dark material member is provided with a surface coating selected from the group of a metal oxide, a metal sulfide, and combinations thereof.

11. An absorption fluid for use in a solar energy collector comprising a mixture of an oil that does not break down at high temperatures, a dark pigment having a low refractive index, and at least one member selected from the group of nanobeads having selective radiation surfaces, nanospheres having selective radiation surfaces, nano-particulates having selective radiation surfaces, microbeads having selective radiation surfaces, microspheres having selective radiation surfaces, microparticulates having selective radiation surfaces, and combinations thereof.

12. The fluid of claim 1 wherein said dark material comprises a plurality of photonic crystals, each such crystal comprising a lattice of differently sized nanobeads for selectively canceling certain wavelengths and allowing absorption of other wavelengths.

13. The fluid of claim 1 wherein said dark material comprises a plurality of photonic crystals, each such crystal comprising a lattice of nanospheres and voids wherein the differences between the refractive index of said nanospheres

and their surrounding voids cancels certain wavelengths and allows absorption of other wavelengths.

14. An absorption medium for use in a solar energy collector comprising a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material comprises a plurality of photonic crystals, each such crystal comprising a lattice of differently sized nanobeads for selectively canceling certain wavelengths and allowing absorption of other wavelengths.

15. A solar energy collector comprising a body having at least one channel therein that is exposed to sunlight, a phase-change material provided in and partially filling said channel, and at least one fluid provided with said material in said channel, such that when the collector is receiving the rays of the sun the fluid transfers heat to the material causing it to melt.

16. The collector of claim 15 wherein said phase change material is mixed with a dark material for increased absorption of solar energy.

17. In combination, a solar energy collector and an absorption medium wherein said collector comprises a body defining at least one channel that is exposed to sunlight, and said absorption medium comprises a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid, said medium being provided in said channel.

18. The combination of claim 17 wherein said channel further comprises a lower reflective surface that reflects solar energy onto the medium provided therein.

19. The combination of claim 18 wherein said reflective surface material is selected from the group consisting of aluminum, silver, foil, metal-coated film, and combinations thereof.

20. The combination of claim 17 wherein said channel comprises at least one tubular member.

21. The combination of claim 20 wherein the upper portion of said tubular member allows the rays of the sun to enter, and wherein the lower portion comprises a surface that reflects the rays of the sun into said tubular member for absorption by said medium.

22. The combination of claim 17 wherein said channel comprises a first tubular member having a perimeter, and a second tubular member having a smaller perimeter provided inside said first tubular member wherein said absorption medium is provided in said second tubular member.

23. The combination of claim 22 wherein the upper portions of said tubular members allow the rays of the sun to enter, and wherein the lower portion of at least one of said tubular members comprises a surface that reflects the rays of the sun into said second tubular member for absorption by said medium.

24. The combination of claim 22 wherein insulation is provided between said first tubular member and said second tubular member that allows the rays of the sun to enter, but prevents heat from exiting.

25. The combination of claim 24 wherein said insulation is selected from the group of a xerogel, an aerogel and combinations thereof.

26. The combination of claim 22 wherein a vacuum is provided between said first tubular member and said second tubular member.

27. The combination of claim 17 wherein said dark material is a pigment selected from the group of copper oxide, copper sulfide, iron oxide, chrome oxide, nickel oxide, carbon, chrome oxide, nickel oxide, silicon carbide and combinations thereof.

28. The combination of claim 17 wherein said dark material is a pigment selected from the group of a sulfide complex of lead, copper and silver; nickel sulfide; zinc sulfide; carbon bound in silica gel; a metal oxide gel; carbon bucky balls, and combinations thereof.

29. The combination of claim 17 wherein said dark material is a member selected from the group of nanobeads having selective radiation surfaces, nanospheres having selective radiation surfaces, nano-particulates having selective radiation surfaces, microbeads having selective radiation surfaces, microspheres having selective radiation surfaces, microparticulates having selective radiation surfaces, and combinations thereof.

30. The combination of claim 17 wherein said dark material is a plurality of photonic crystals, each such crystal comprising a lattice of differently sized nanobeads for selectively canceling certain wavelengths and allowing absorption of other wavelengths.

31. In combination, a solar energy collector and an absorption medium wherein said collector comprises a body defining at least one channel that is exposed to sunlight, and said absorption medium comprises a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid, said medium being provided in said channel, wherein said channel further comprises a lower reflective surface that reflects solar energy onto the medium provided therein, and wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material is a pigment selected from the group of copper oxide, copper sulfide, iron oxide, chrome oxide, nickel oxide, carbon, chrome oxide, nickel oxide, silicon carbide and combinations thereof.

32. In combination, a solar energy collector and an absorption medium wherein said collector comprises a body defining at least one channel that is exposed to sunlight, and said absorption medium comprises a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid, said medium being provided in said channel, wherein said channel further comprises a lower reflective surface that reflects solar energy onto the medium provided therein, and wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material is a member selected from the group of nanobeads having selective radiation surfaces, nanospheres having selective radiation surfaces, nano-particulates having selective radiation surfaces, microbeads having selective radiation surfaces, microspheres having selective radiation surfaces, microparticulates having selective radiation surfaces, and combinations thereof, and wherein said dark material member is provided with a surface coating selected from the group of a metal oxide, a metal sulfide, and combinations thereof.

33. In combination, a solar energy collector and an absorption medium wherein said collector comprises a body defining at least one channel that is exposed to sunlight, and said absorption medium comprises a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy in the fluid, said medium being provided in said channel, wherein said channel further comprises a lower reflective surface that reflects solar energy onto the medium provided therein, and wherein said fluid is a member selected from the group of an oil, a silicate, a synthetic silicone, a fluorocarbon, a halogenated solvent, water and combinations thereof, and wherein said dark material comprises a plurality of photonic crystals, each such crystal comprising a lattice of differently sized nanobeads for selectively canceling certain wavelengths and allowing absorption of other wavelengths.

34. The combination of claim 17 further comprising a plurality of dark surface coated strands are provided in said channel with said medium for further absorption and transfer of energy from the sun.

35. A method for collecting solar radiation comprising the steps of:

- a. positioning a solar collector having a body defining at least one channel therein such that said channel is exposed to sunlight during the day, said channel having a lower reflective surface for reflecting solar energy;
- b. providing an absorption medium in said channel, said medium comprising a fluid that does not break down at high temperatures mixed with a dark material for increased absorption of solar energy; and
- c. causing said medium to flow through said channel such that solar energy is absorbed by said medium when it is in said channel, and removed from said medium when it is outside of said channel.

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