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(54) ENERGY CHANNELING SUN SHADE SYSTEM AND APPARATUS

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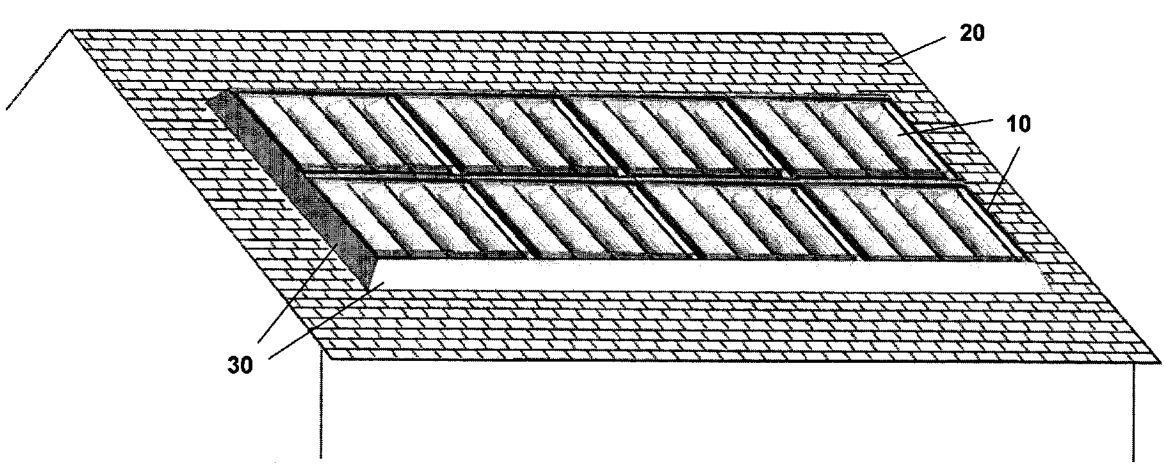
(57) **ABSTRACT**

An invention is disclosed that shades a building from solar energy gain while simultaneously channeling intercepted energy in the form of heat and electricity for useful purposes. The invention is mounted optimally on exterior building surfaces having some direct exposure to the sun. The invention may be installed on the building surface so that it integrates with the building envelope to provide cladding against the weather in addition to shade. The invention includes modular units, each having several louvers that track the movement of the sun to provide optimal shading, and optionally, lighting when the module is implemented as a skylight to allow daylight to pass through into the building interior. Each louver contains photovoltaic cells, a heat dissipating substrate to which photovoltaic cells are mounted, and an optional concentrator lens and/or reflector used to channel solar energy using inexpensive materials. Alternatively, the invention includes of stationary, modular units with reflective surfaces on the foreground that channel solar energy onto fixed solar receivers in the background. The effect is to avoid solar gain to the building surface and to concentrate solar flux onto solar receivers.

Surface integrated array of shading modules with energy channeling louvers



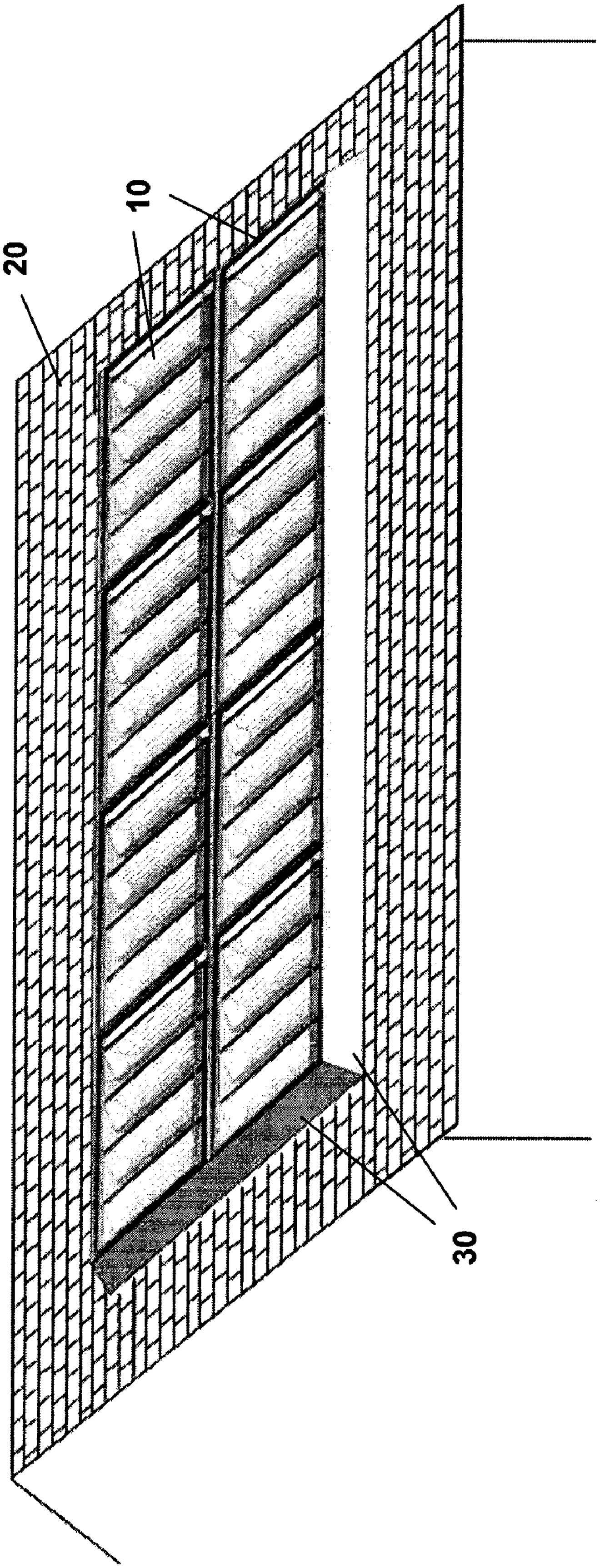



Figure 1 - Surface integrated array of shading modules with energy channeling louvers

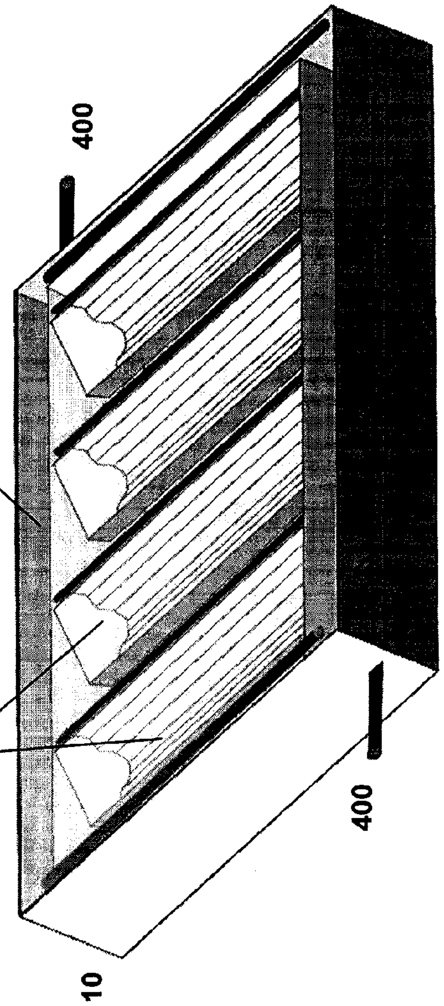



Figure 2a - Shading module with energy channeling louvers and connection interfaces

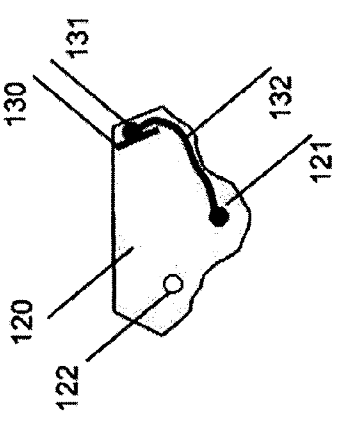



Figure 2c – End View of energy channeling louver and connection interfaces

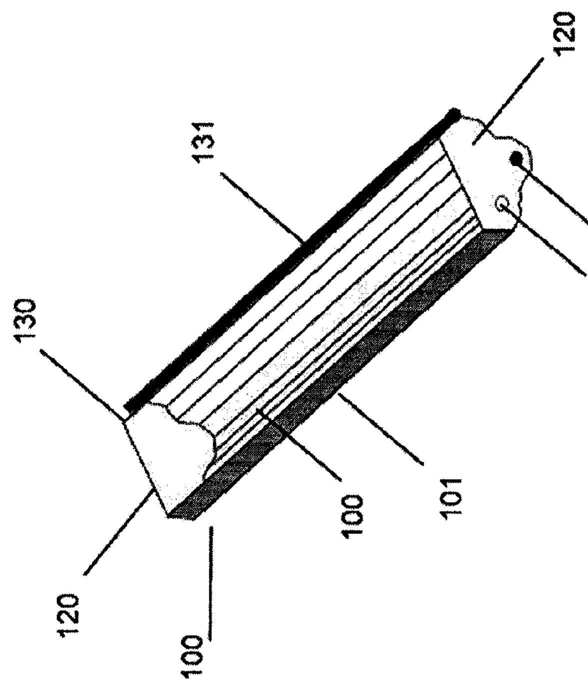
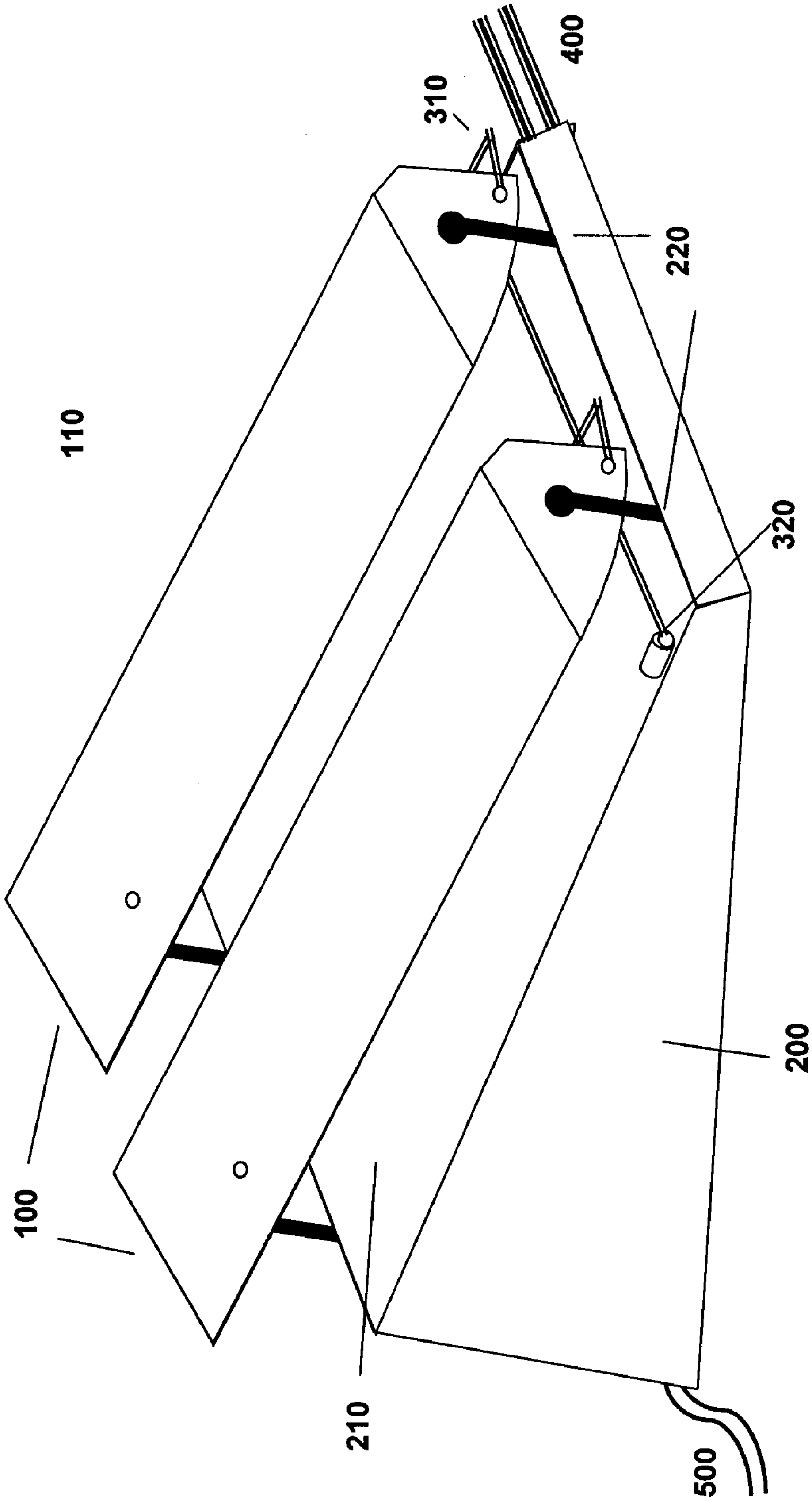



Figure 2b – Top View of energy channeling louver and connection interfaces

Figure 3 - Building Envelope Integrated Configuration with Longitudinal Tracking



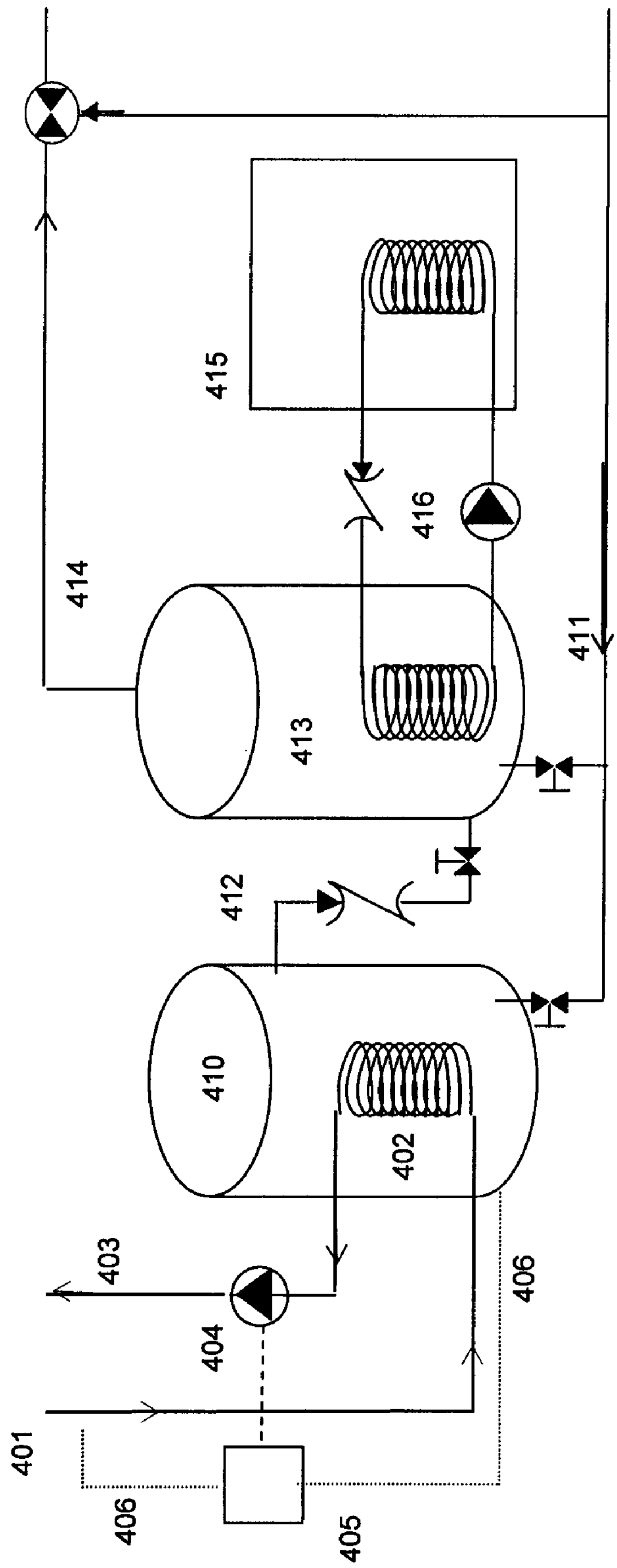
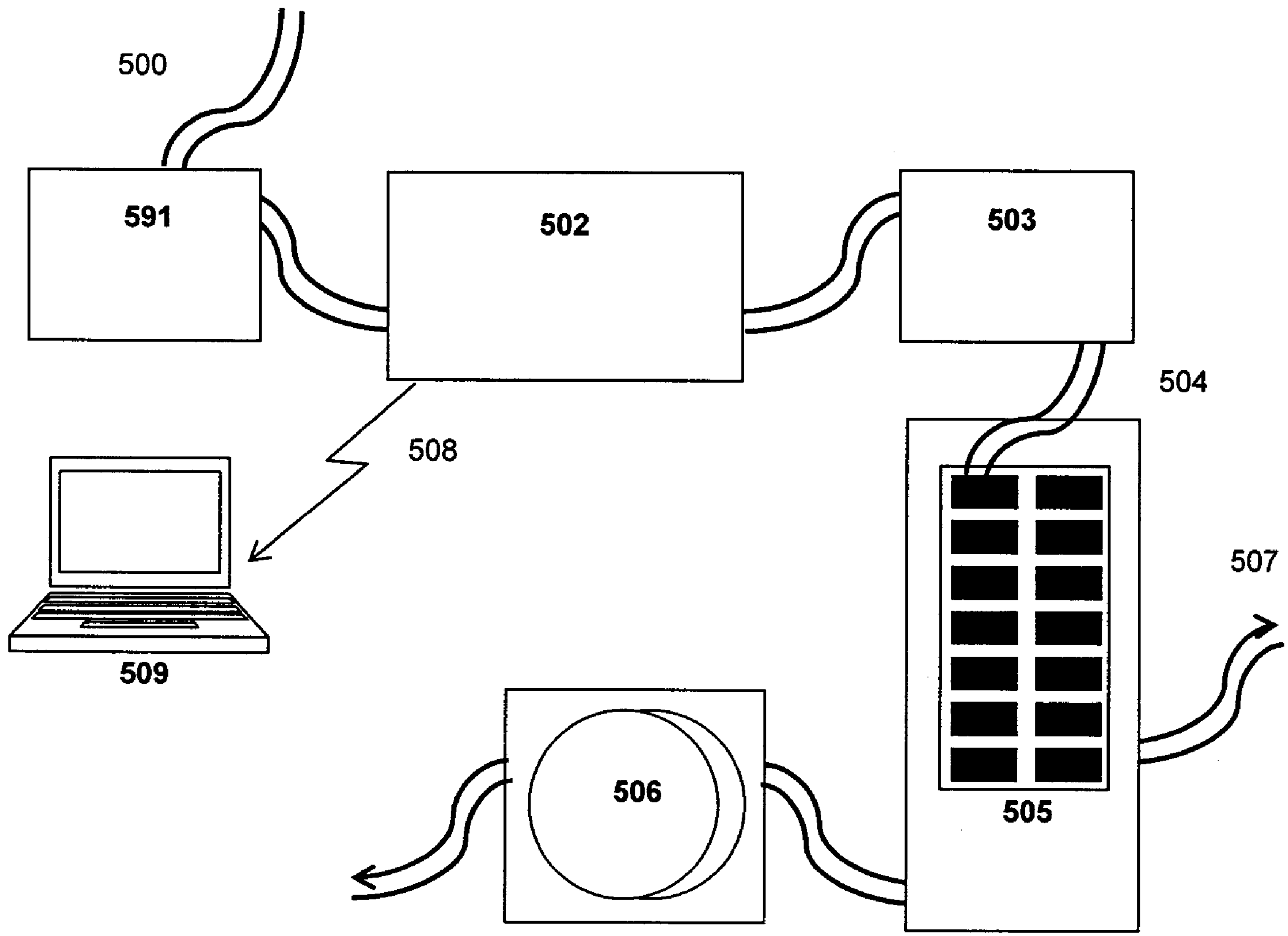



Figure 4 – Domestic Hot Water Interface for Channeling Intercepted Heat

Figure 5 – Building Electrical Interface for Utilizing Intercepted Photons



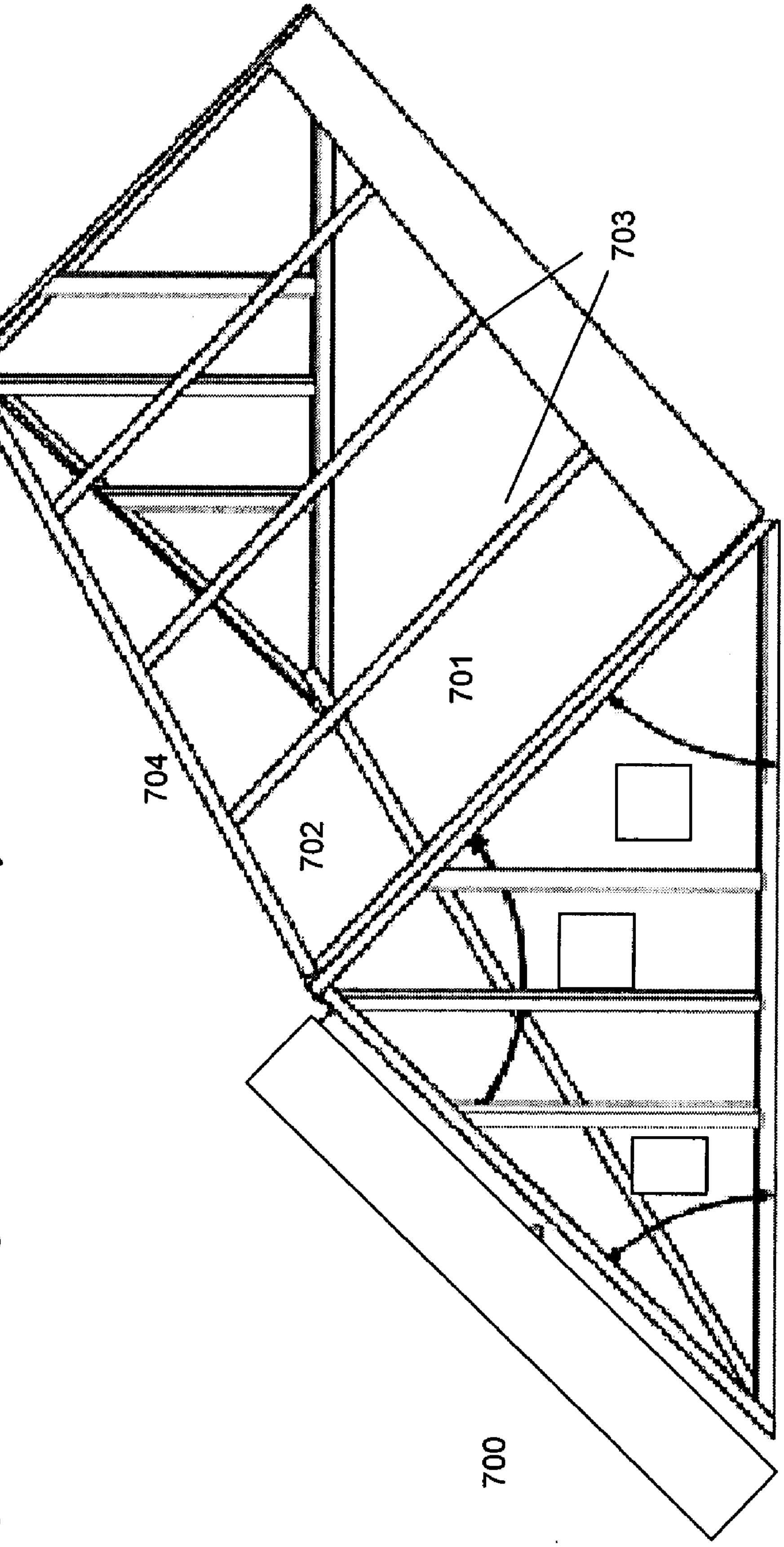



Figure 6 – Mounting structure for Shade System

Figure 7a – Mounting Structure Interface for Shade System

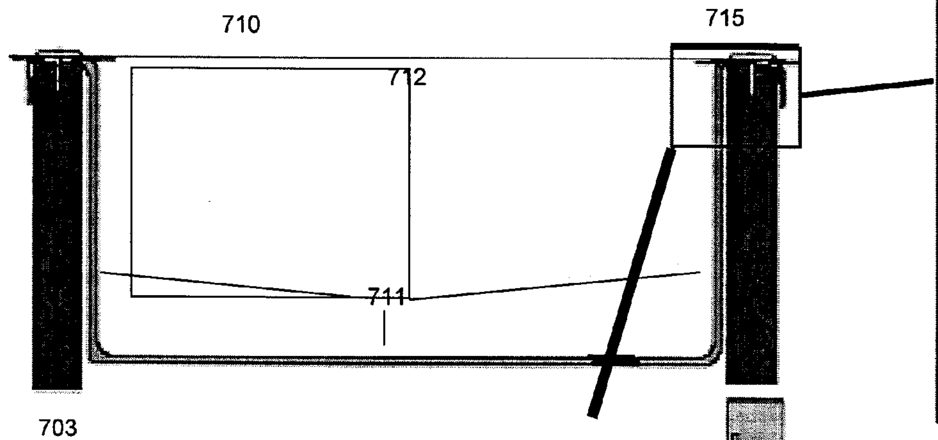



Figure 7b – Longitudinal Cladding Detail for Mounting Structure Interface

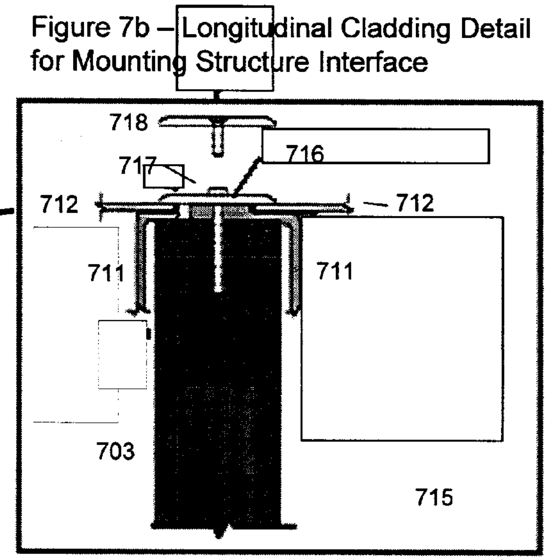



Figure 7c – Latitudinal Cladding Detail for Mounting Structure Interface

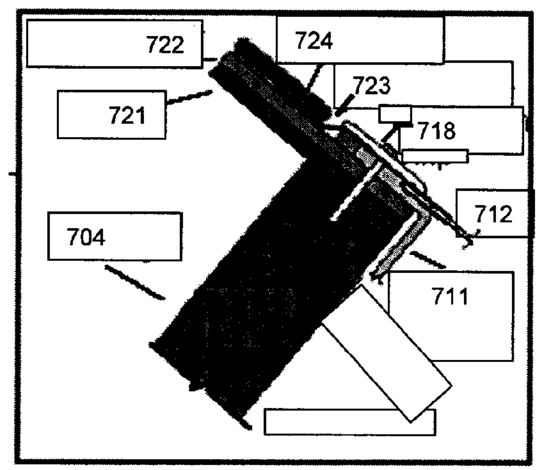
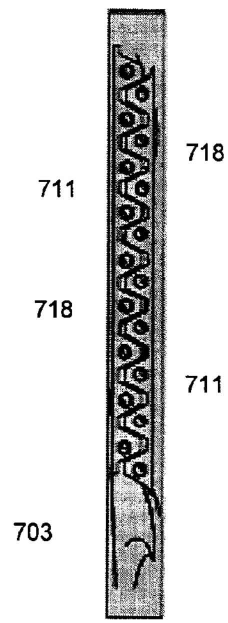



Figure 7d – Top View Cladding Detail for Mounting Structure Interface



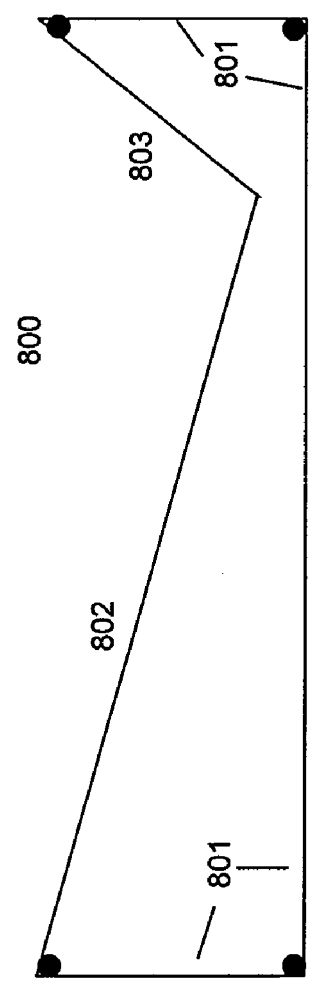



Figure 8a – Static Shading Module

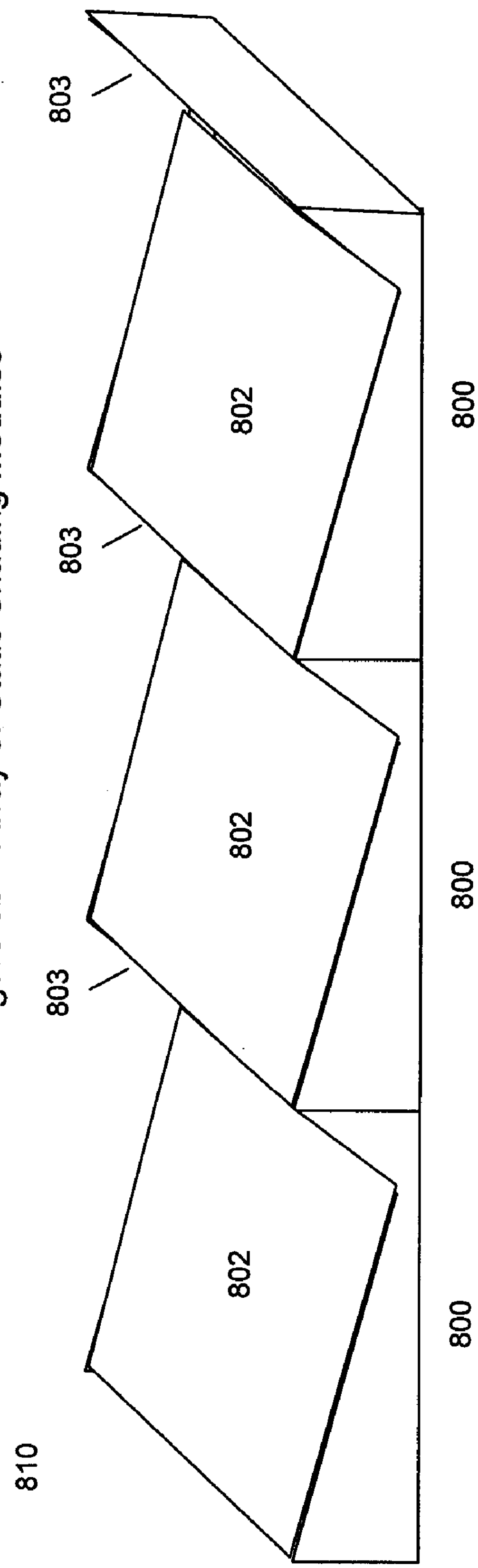



Figure 8b – Array of Static Shading Modules

# ENERGY CHANNELING SUN SHADE SYSTEM AND APPARATUS

## CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the priority benefit of U.S. provisional patent application Ser. No. 60/715,555, filed Sep. 9, 2005, of the same title by the same named inventor. The entire contents of that prior application are incorporated herein by reference.

## BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to energy saving. More particularly, the present invention relates to solar energy systems. Still more particularly, the present invention relates to systems and methods to enhance the effectiveness of solar energy gain through shade impact improvements.

[0004] 2. Description of the Prior Art

[0005] Solar energy gain in buildings creates climate control and lighting problems due to heat gain and lighting glare, respectively. Most approaches to managing solar energy gain are characterized by blocking or reflecting the continuum of infrared and visible spectra away from the building using reflective coatings on fenestration and other building envelope surfaces, especially the roof.

[0006] One approach to managing solar energy gain has been to optimize the building design to capture as much solar heat as possible for space heating in the winter while using shade and vent systems to redirect energy gain in the summer. Referred to as 'passive solar design', this approach is intended to capture solar energy in the building when it is needed to offset energy that must be purchased—electricity and fuel—to maintain the building environment. However, passive solar design usually involves large south facing windows and it is difficult to manage solar glare while optimizing heat gain that is absorbed indiscriminately. Also, passive solar design is only useful for new construction, as it must be incorporated into the basic architecture.

[0007] Traditional shading systems that completely or partially block solar energy including awnings, draperies, shutters, or landscaping may help limit the amount of energy absorbed by the building, but do nothing to capture the energy for useful purposes. Other systems exist for shading that simultaneously apply solar energy for useful purposes. In U.S. Pat. No. 6,421,966, a system is disclosed for wall-mounted louvered blades using a particular geometry to shade a wall only and having a covering of photovoltaic (PV) cells to produce electricity also.

[0008] Another energy-producing shading system is disclosed primarily for ground shading under US Application Publication No. 2005/0109384. The system is a particular construction for providing shade using a north-south oriented structure that tracks the sun's daily movement and also generates electricity. Integration with a building structure is a challenge due to live and dead loads created by wind and point loading when using load-bearing mounting poles at the interface to the mounting surface.

[0009] U.S. Pat. No. 4,418,684 discloses a system that actively controls the admission of solar energy into a building via an active shading mechanism to allow selective lighting or passive heating. The invention is building integrated but does not provide for power production or active collection and distribution of heat.

[0010] Other building integrated devices for collecting solar energy without attention to shading and/or electricity production have been described. U.S. Pat. Nos. 4,215,675 and 4,296,740 describe systems affixed to the existing surface of a roof and may provide cladding. In U.S. Pat. No. 5,851,309 significant yet particular building integrated devices for production of heat and electricity are disclosed without attention to shading.

[0011] U.S. Pat. Nos. 4,296,736 and 4,020,827 describe similar but not identical sawtooth geometries for using reflectors to redirect solar gain onto an energy collecting surface without consideration of shading or building integration. For both of these systems, heat production is the primary objective. Although PV electricity production is mentioned in U.S. Pat. No. 4,020,827, the curved geometry of the reflector surface would created non-uniform angles of the reflected rays. As a result there would be no effective power increase from the apparent concentration since crystalline silicon (c-si) PV requires uniformity of direct beam sunlight to increase current.

[0012] The present disclosed invention is differentiated from these other systems by providing the benefits of shading, power and/or heat production and optional building integration using novel constructions and methods. The shading component is inherent and expressly intended in the disclosed invention for building and ground installations. Heat and/or power production is also expressly intended to provide economic value beyond avoiding solar gain due to shading. Finally, the disclosed invention considers requirements for wall, flat-roof, and/or pitched-roof integration with attention to wind loading, avoidance of point loading, and cladding.

[0013] The present invention includes the use of static or moveable louvers that optimize shading of the underlying surface; the use of reflective, refracting, transmitting, and/or transducing material on the surface of the shade system having exposure to direct or global irradiance; the use of multiple geometries to optimize redirection and channeling of solar energy; and the methods of distributing or dissipating energy loads.

## SUMMARY OF THE INVENTION

[0014] An invention is disclosed that shades a building from solar energy gain while simultaneously channeling intercepted energy in the form of heat and/or electricity for useful purposes. The invention is interfaced with the exterior of the building envelope on the walls and/or roof face where solar gain is most significant, notably a complete or partial southerly exposure. The invention is modular so that a number of modules are used together to block solar energy from directly striking building surfaces where solar gain is not managed otherwise. The modular units may be affixed to the building and joined together in such a manner that the system provides a portion of a building's cladding so that the shaded system becomes part of the building envelope.

[0015] Each module for the invention uses a number of louvers that that track the movement of the sun to optimally absorb solar energy so that it is channeled for useful purposes to effectively manage the building's solar energy gain. Modules may alternatively or additionally employ sheets of opaque material that may be comprised of solar receivers that directly generate electricity or dissipate heat. The modules may be implemented without a floor so that they act as windows or skylights with shutter louvers that allow light to enter the living space.

[0016] The louvers themselves are composed of electricity generating photovoltaic (PV) cells mounted to a heat absorbing substrate, i.e. a heat sink; conduits or ducts for dissipating heat from the heat sink in order to manage (PV) temperature and electrical resistance; and an optional solar energy concentrator that redirects solar energy entering the aperture of the louver onto the smaller area of the solar energy receiver described by the photovoltaic cells.

[0017] The heat dissipating conduits of the louvers are manifolded together in the shading system module that is connected to a building's Heating/Ventilation/AC (HVAC) systems. The heat produced as a waste byproduct of the PV cell operation is thus channeled for productive use. The heat channeled from the shading system modules reduces the amount of conventional energy required by the building thereby offsetting conventional energy costs. This energy savings is in addition to the electricity savings realized by not having to purchase from the utility grid since the PV cells on the louvers produce useable electricity. When the building is connected to the grid to supply electricity, the surplus produced by the shading modules turns the building's electric meter backwards and earns credits toward electricity consumed from the grid when the building's demand exceeds supply.

[0018] Modules within the shading system optionally have the means to track the sun's path in a single dimension, either latitudinally or longitudinally, so that the incident angle of solar energy absorbed by louvers within the modules strikes the louver face at or near 90 degrees in order to maximize energy absorption. The normal incident angle is maintained in the dimension that is orthogonal to the tracking axis about which the louvers rotate.

[0019] Modules may also be stationary and constructed with reflective material that redirects solar gain from a building onto stationary solar receivers. The reflective material sits in the foreground of a module in the space that is otherwise allowed for shadowing between rows of solar receivers mounted on a building surface, preferably a flat roof. The modules are oriented along an east-west axis. As the sun's altitude changes throughout a year, the southerly reflective surfaces in the "foreground" consistently reflect the sun's incident rays to energy channeling solar receivers on the north edge of the module. The effect is to avoid solar gain on the building surface, preferably the roof, and to increase the solar flux striking the solar receivers having the effect of concentration.

[0020] The shading system has multiple options for integrating with a building envelope. The invention may be mounted on the outside of the envelope where it has optional flashing to provide a weather tight surface, or it may be implemented to clad the building with a translucent surface over the energy generating modules attached between trusses, studs, or other parts of the building frame.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. **1**—Surface integrated array of shading modules with energy channeling louvers.

[0022] FIG. **2***a*—Shading module with energy channeling louvers and connection interfaces.

[0023] FIG. **2***b*—Top View of energy channeling louver and connection interfaces.

[0024] FIG. **2***c*—End View of energy channeling louver and connection interfaces.

[0025] FIG. **3**—Flat-roof shading configuration with longitudinal tracking.

[0026] FIG. **4**—Domestic hot water interface for channeling intercepted heat.

[0027] FIG. **5**—Building electrical interface for utilizing intercepted photons.

[0028] FIG. **6**—Mounting structure for shade system.

[0029] FIG. **7***a*—Mounting structure interface for shade system.

[0030] FIG. **7***b*—Longitudinal cladding detail for mounting structure interface.

[0031] FIG. **7***c*—Latitudinal cladding detail for mounting structure interface.

[0032] FIG. **7***d*—Latitudinal cladding detail for mounting structure interface.

[0033] FIG. **8***a*—Static shading module.

[0034] FIG. **8***b*—Array of static shading modules.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0035] FIG. **1** shows multiple modules **10** of a shading system affixed to a sloped roof **20**. An optional flashing **30** is also shown for purposes of cladding and integrating with the roof plenum. The flashing is depicted as an angled housing attached to sides of the entire shading system.

[0036] FIG. **2***a* shows details of one type of module **10** that may be used in the shading system invention. The module is covered with a transparent or translucent glazing **11** that protects the contents of the module and provides a weather tight seal especially when the system is integrated with the roof plenum. In this embodiment, energy channeling louvers **100** intercept solar energy thereby shading the building from uncontrolled solar gain. The energy channeling louvers are connected in a header-riser arrangement to parallel tubing that carries an antifreeze solution via a manifold **400** that integrate with a building's hot water, heating, or cooling system when used with an absorption chiller that converts heat load to cooling load.

[0037] FIG. **2***b* shows an embodiment of an energy channeling louver **100** that concentrates energy via a heliostatic reflective trough onto a projector **101** and a solar receiver **130** that is optionally comprised of a photovoltaic laminate assembly with heat dissipating tube **131**. Energy is channeled from the solar receiver via an antifreeze filled tube **131** that exits through hole **121**. End plates **120** maintain the structural integrity of the trough that rotates about a single axis **122**.

[0038] FIG. 2*c* is an end view of the same energy channeling louver **100** and shows a flexible tube **132** that connects the tube behind the solar receiver **131** to the exit hole **121** where the flexible tube **132** joins to the manifold **400** shown in FIG. 2*a*.

[0039] FIG. **3** illustrates a second embodiment of a shading system especially for flat roofs. Mounting platform **200** is affixed to the roof surface or is ballasted with masonry blocks or antifreeze filled containers. An optional transparent or translucent glazing **210** allows light to enter the platform **200** when the platform is mounted to a curb similar to a skylight. Mounting posts **220** support energy channeling louvers **100** that intercept solar energy by tracking the sun's daily longitudinal or latitudinal path via linkage **310** and signal actuated motor **320**. Anti-freeze is circulated in tubes in the louvers **100** that are connected via supply and return tubes **400** to the building's hot water, heating, or cooling system when used with an absorption chiller that converts heat load to cooling load. Negative and positive electrical conductors **500** connect optional strings of photovoltaic cells in the louvers **100** to the building's electrical load center.

[0040] FIG. **4** shows the interface between a shading system's supply and return **401** and **403** of antifreeze that carries heat intercepted by the shading system. In this embodiment, a circulator pump **404** moves fluid through a heat exchanger **402** that is submerged in a domestic hot water pre-heat tank **410**. The circulator pump runs when a differential controller **405** detects through thermistor sensors **406** that there is enough difference in temperature between the shading system's heat supply and the temperature of incoming cold water **411** that needs to be heated. When hot water **414** is required in the building, hot water is drawn from tank **413** that stores water at the required temperature via a boiler **415** that distributes its heat through loop **416**, Because a series of valves requires that incoming cold water **411** first be pre-heated by passing through tank **410** and into the stand-by tank **413** via pipe **412**, the shading system's channeled thermal energy is effectively used to reduce the usage of boiler **415** and its requisite fuel.

[0041] FIG. **5** shows a building's electrical interface for conducting electricity generated by optional strings of photovoltaic (PV) cells in a shading system. Positive and negative conductors **500** feed direct current (DC) electricity from the shading system into a DC disconnect **591** and into a grid-tied inverter **502** that inverts DC electricity to utility quality alternating current (AC) electricity. AC electricity passes through AC disconnect **503** and into a bi-directional circuit breaker **504** in an electricity service panel **505**. Electricity is then consumed by building load **507**, or if there is a surplus of electricity generation from the shade system relative to building load **507**, electricity passes through the utility meter **506** to generate credits for the electricity account holder. An optional Internet connection **508** allows inverter information about electricity production to be viewed from the World Wide Web **509**.

[0042] FIG. **6** shows a mounting structure **700** for another embodiment of the shading system. Mounting structure **700** may be constructed for a flat roof or it may itself be a building's pitched roof. When located on a flat roof, panel **701** on the bottom of the structure allows ballast to weight it down instead of having to penetrate the roof plenum and risk loss of plenum integrity. The ballast may be masonry block or containers filled with an antifreeze solution. A wind and snow shield **702** on the typically north back side of the structure **700** deflects wind load and prevents snow build-up from the underside of a non-cladding mounting structure. Trusses **703** and ridge pole **704** create bays for shade system modules to be installed, typically in a southerly facing direction. End walls **705** provide structural integrity for the entire structure **700** and are typically covered with a membrane or panel similar to **702**.

[0043] FIG. **7***a* describes a mounting structure interface **710** for the shade system. A module encasement **711** is a five-sided enclosure that contains energy channeling devices and has a translucent or opaque glazing **712** with a weatherproof sealant. The encasement **711** sits within framing **703** that is roof trusses in this depiction. A weather cladding interface **715** is described where a lip on top of the encasement walls sits on the framing **703**.

[0044] FIG. **7***b* shows the detail of the weather cladding interface **715**. The lip of the module encasement **711** sits on the framing **703** to support the weight of the module within framing members. Glazing **712** sits on a bead of weatherproof sealant within a recess of **711**. A hold-down strip **716** keeps the glazing in place while a lag bolt **716** attaches the entire assemblage to the framing thereby integrating the shading system as a unit. An alternate hold-down strap **718** reveals a screw fastener with a flush mount head that would not protrude above the plane of the shading system.

[0045] FIG. **7***c* depicts the weather cladding interface on the for the top and bottom ends of the module encasement **711**. The lip of the module sits on the framing, in this case a ridge pole or header **704**. The framing also has layers of plywood **721** and roofing paper **722** since the module will be interfacing with other cladding materials, notably roof shingles **724**. Hold-down strap **718** secures both glazing material **712** that seals the module encasement **711**, and also, a flashing strip **723** that maintains the cladding interface with the shingles against rain, snow and other elements.

[0046] FIG. **7***d* shows a top view of two adjacent module encasements **711** that share a common framing member **703** between them. A saw-tooth pattern is employed to allow the encasement to share available surface area on the framing member while fully supporting the weight of the encasement by alternately reaching across the entire width of the framing member. Hold-down strap **718** then fastens the entire system together by holding down one side of the glazing on each module.

[0047] FIG. **8***a* shows a side view of a single shading module **800** having a hinged frame **801** that unfolds on-site for ease of deployment. Reflective surface **802** intercepts and redirects solar energy onto solar receivers **803**. The geometry of reflective surface **802** is appropriate to redirecting solar energy arriving from different altitudes of the sun in a range that is specific to the latitude of the installation.

[0048] FIG. **8***b* shows array **810** of multiple shading modules **800** arranged so that a module to the south does not shadow a module to the north. Adjacent modules to the east or west are aligned so that reflective surfaces **802** are on the same plane, and so that solar receivers **803** are on the same plane.

[0049] In general, the present invention is a shading system that attaches to or integrates with a building envelope in order to intercept and channel solar energy gain for day lighting, heating/cooling, and electrical applications, and that includes one or more of:

shading unit modules that affix to the building individually or together to intercept, channel, and transmit solar energy that otherwise strikes the building directly;

a system and method for attaching the shading system to the building and optionally integrating with the building envelope to form a contiguous shield, or cladding, against weather elements;

a shade control system for optimizing the amount of solar energy intercepted and transmitted by the shading system;

a system for channeling electricity generated through the interception and redirection of solar energy; and

a system for channeling heat generated in the creation of electricity and/or through the interception and redirection of solar energy.

[0050] The invention as described in the previous paragraph may further include one or more of the following:

The shading unit modules described, each module being a folding rack assembly with a stationary, reflective surface that redirects solar energy onto opposite solar receivers attached to rails;

The solar receivers described, which contain photovoltaic cells, thermally conductive materials that dissipate heat, or a combination of both;

The shading unit modules described, each module being an encasement with a translucent or transparent top surface and a translucent, transparent, or opaque bottom surface;

The shading unit modules described, each module having louvers and/or opaque sheets of material, both of which intercept solar energy to provide shade;

The louvers described, each louver intercepting solar energy to provide shade while using the solar energy to generate electricity and heat by means of a solar receiver in the louver;

The solar receiver described, in which contains photovoltaic cells mounted to a substrate that dissipates heat by means of pipes or ducts carrying a flowing liquid or gas;

The louvers described, each louver intercepting solar energy to provide shade by means of an optional concentrating reflector that redirects solar energy onto the solar receiver as described;

The louvers described, each louver intercepting solar energy to provide shade by redirecting solar energy onto a solar receiver and/or an optional concentrating reflector as described;

[0051] The louvers described, each louver intercepting solar energy to provide shade, and each being an assemblage of the solar receiver, optional reflector, and optional lens as described, the assemblage having means to attach to the shading unit module and shade control mechanisms described and having an optional reflective underside to redirect diffuse skylight toward the building interior when the louvers are in an open position;

[0052] The opaque sheets of material described, with the sheets being comprised of light blocking material or solar receivers which contains photovoltaic cells mounted to a substrate that dissipates heat by means of pipes or ducts carrying a flowing liquid or gas;

[0053] The shading unit modules described, each module having an electrical wiring harness that is located within the walls of the module and that provides interconnects among solar receivers within the module as well as interconnects to other modules within the shading system;

[0054] The shading unit modules described, each module having pipes or ducts located within the walls of the module to conduct heat dissipating fluid through a module's solar receivers and to connect to other modules within the shading system to conduct the same fluid;

The shading unit modules described, each module having mechanisms to connect louvers within the module to the shading control of the entire system;

[0055] The shade control system and assemblage described having mechanical linkages, screws, pulleys, sprockets and gears to drive the louvers in several shading unit modules by means of one or more motors and rotating the louvers about a single axis that runs the length of the louver and that has either latitudinal or longitudinal orientation; and/or

[0056] The shade control system and assemblage described further having a circuit board with logic to control the motor that drives the opening and closing of louvers, the logic being based on solar gain signal processing or calculations for solar positioning per time of year and geographic location.

[0057] The invention may further be described as a system and method for attaching the shading system to the building and optionally integrating the shading system with the building envelope to provide cladding by means of interlocking and weatherproof seams between the shading unit modules described above. Alternatively, the invention may be described as a system and method for attaching the shading system to the building and optionally integrating the shading system with the building envelope to provide cladding by means of flashing that flashes to the cladding material on the wall or roof to provide a weatherproof installation and interlocks with the shading unit modules described above. Further, the invention may be described as a system and method for attaching the shading system to the building by means of rack mounts that are affixed or ballasted through the use of masonry blocks or containers filled with an antifreeze solution.

[0058] While the present invention has been described with particular reference to certain embodiments of the energy channeling sun shade system and methods of its use, it is to be understood that it includes all reasonable equivalents thereof and as considered by the following descriptions.

What is claimed is the following:

1. A shading system that is attachable to, or that may be integrated with, a building envelope in order to intercept and channel solar energy gain for heating/cooling, electrical applications, and daylighting, the system comprising one or more shading unit modules affixable to the building indi-

vidually or together to intercept, channel, and transmit solar energy that otherwise strikes the building directly, wherein the one or more shading modules are arranged to provide one or more of:

a. forming a contiguous shield, or cladding, against weather elements;

b. optimizing the amount of solar energy intercepted and transmitted by the shading system;

c. channeling electricity generated through the interception and redirection of solar energy; and

d. channeling heat generated in the creation of electricity and/or through the interception and redirection of solar energy.

**2**. The shading system as described in claim 1, wherein each module is a rack assembly with a stationary, uncurved reflective surface that redirects solar energy onto opposite opaque panels in the form of solar receivers attached to rails.

**3**. The shading system as described in claim 2, wherein each of the opaque panels is in the form of a solar receiver containing one or more photovoltaic cells, one or more thermally conductive materials that dissipate heat, or a combination of both.

**4**. The shading system as described in claim 1, wherein each module is an encasement with a translucent or transparent top surface and a translucent, transparent, or opaque bottom surface.

**5**. The shading system as described in claim 1, wherein each module includes louvers and/or opaque sheets of material, both of which intercept solar energy to provide shade.

**6**. The shading system as described in claim 5, wherein each louver is arranged to intercept solar energy to provide shade while using the solar energy to generate electricity and heat by means of a solar receiver in the louver.

**7**. The shading system as described in claim 6, wherein the solar receiver includes one or more photovoltaic cells mounted to a substrate that dissipates heat by means of pipes or ducts carrying a flowing liquid or gas.

**8**. The shading system as described in claim 5, wherein each louver intercepting solar energy to provide shade includes a concentrating reflector that redirects solar energy onto a solar receiver.

**9**. The shading system as described in claim 5, wherein each louver intercepting solar energy to provide shade by redirecting solar energy onto a lens and onto a concentrating reflector.

**10**. The shading system as described in claim 5, further comprising an assemblage to attach the one or more modules and one or more corresponding control mechanisms, and wherein each louver intercepting solar energy to provide shade includes a reflective underside to redirect diffuse skylight toward the building interior when the louvers are in an open position.

**11**. The shading system as described in claim 5, wherein the opaque sheets of material include light blocking material or solar receivers having photovoltaic cells mounted to a substrate that dissipates heat by means of pipes or ducts carrying a flowing liquid or gas.

**12**. The shading system as described in claim 1, wherein each module includes an electrical wiring harness that is located within the walls of the module and that provides interconnects among one or more solar receivers within the module as well as interconnects to other modules within the shading system.

**13**. The shading system as described in claim 1, wherein each module includes pipes or ducts located within walls of the module to conduct heat dissipating fluid through one or more solar receivers thereof and to connect to other modules within the shading system to conduct the same fluid.

**14**. The shading system as described in claim 1, wherein each module includes one or more mechanisms to connect louvers within the module to one or more control modules.

**15**. The shading system as described in claim 1 further comprising mechanical linkages, screws, pulleys, sprockets and gears to drive one or more louvers of one or more shading unit modules by means of one or more motors and rotating the louvers about a single axis that runs the length of the louver and that has either latitudinal or longitudinal orientation.

**16**. The shading system as described in claim 15 further comprising a circuit board with logic to control the one or more motors driving the opening and closing of the louvers, the logic being based on solar gain signal processing or calculations for solar positioning per time of year and geographic location.

**17**. The shading system as described in claim 1 arranged for attachment to the building and integration with the building envelope to provide cladding by means of interlocking and weatherproof seams between each of the one or more modules.

**18**. The shading system as described in claim 1 arranged for attachment to the building and integration with the building envelope to provide cladding by means of flashing that flashes to cladding material on a wall or a roof of the building to provide a weatherproof installation and interlocks with one or more shading unit modules.

**19**. The shading system as described in claim 1 arranged for attachment to the building by means of rack mounts that are affixed or ballasted through the use of masonry blocks or containers filled with an antifreeze solution.

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