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(54) **SOLAR HEAT COLLECTION AND STORAGE SYSTEM**

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(57) **ABSTRACT**

An active solar air heat storage system slowly transfers heat into water, providing heat while keeping mold and dust out of a building. A series of bidirectional air ducts separated by periodic wind gaps reduces an overhead collector array's uplift in high winds. Splitting a rock bed's airflow into multiple air channels slows air velocity and reduces air friction in the rock bed. A circular rock bed made partly of concrete blocks is held together by bands around the circle's outside. Solar heat may be gathered under driveways and walkways. A standard set of driveway bricks will allow gentle curves in the driveway while retaining a closed airflow under the driveway. Radiant heat may be trapped inside a collector.

A solar heating system

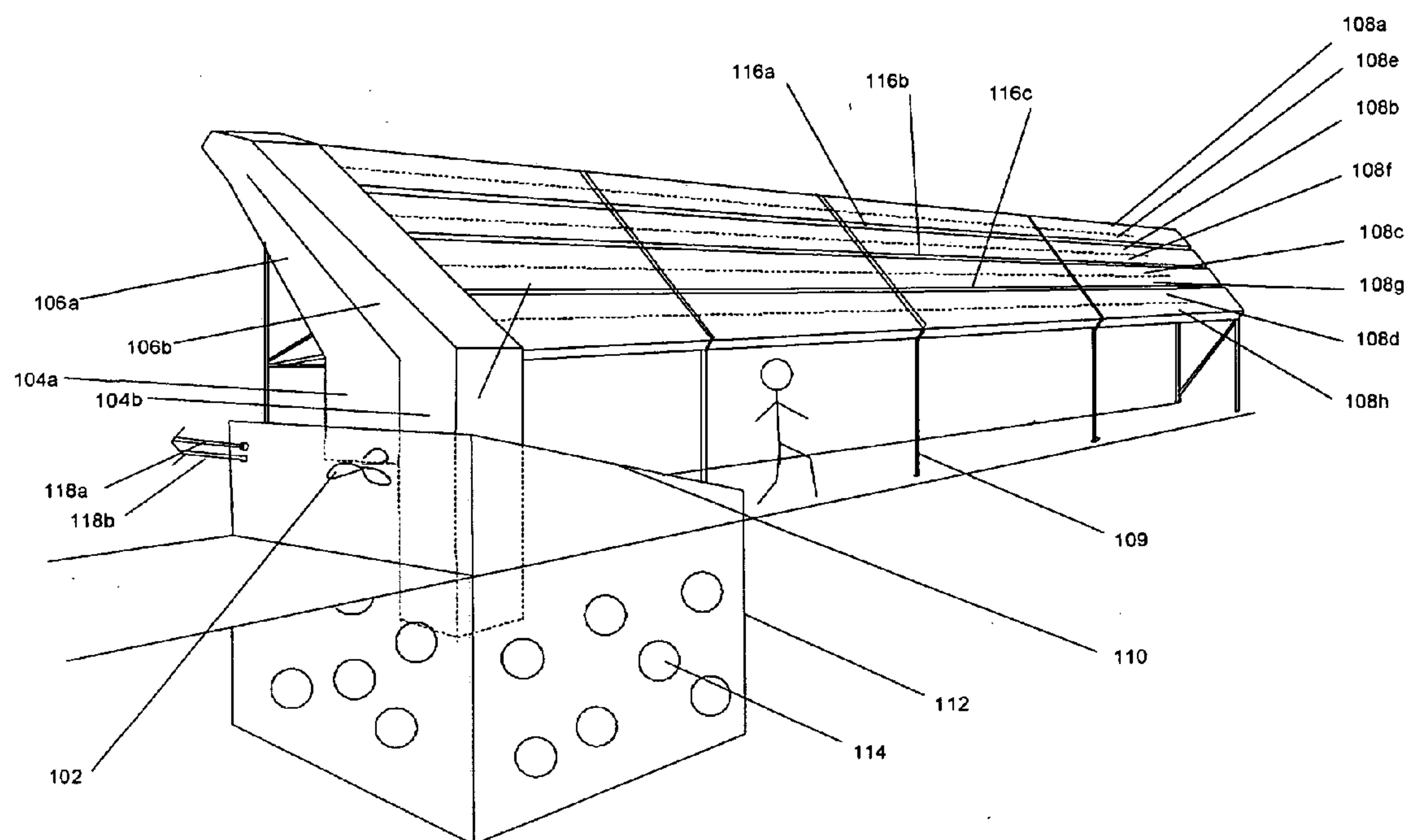


Figure 1: A solar heating system

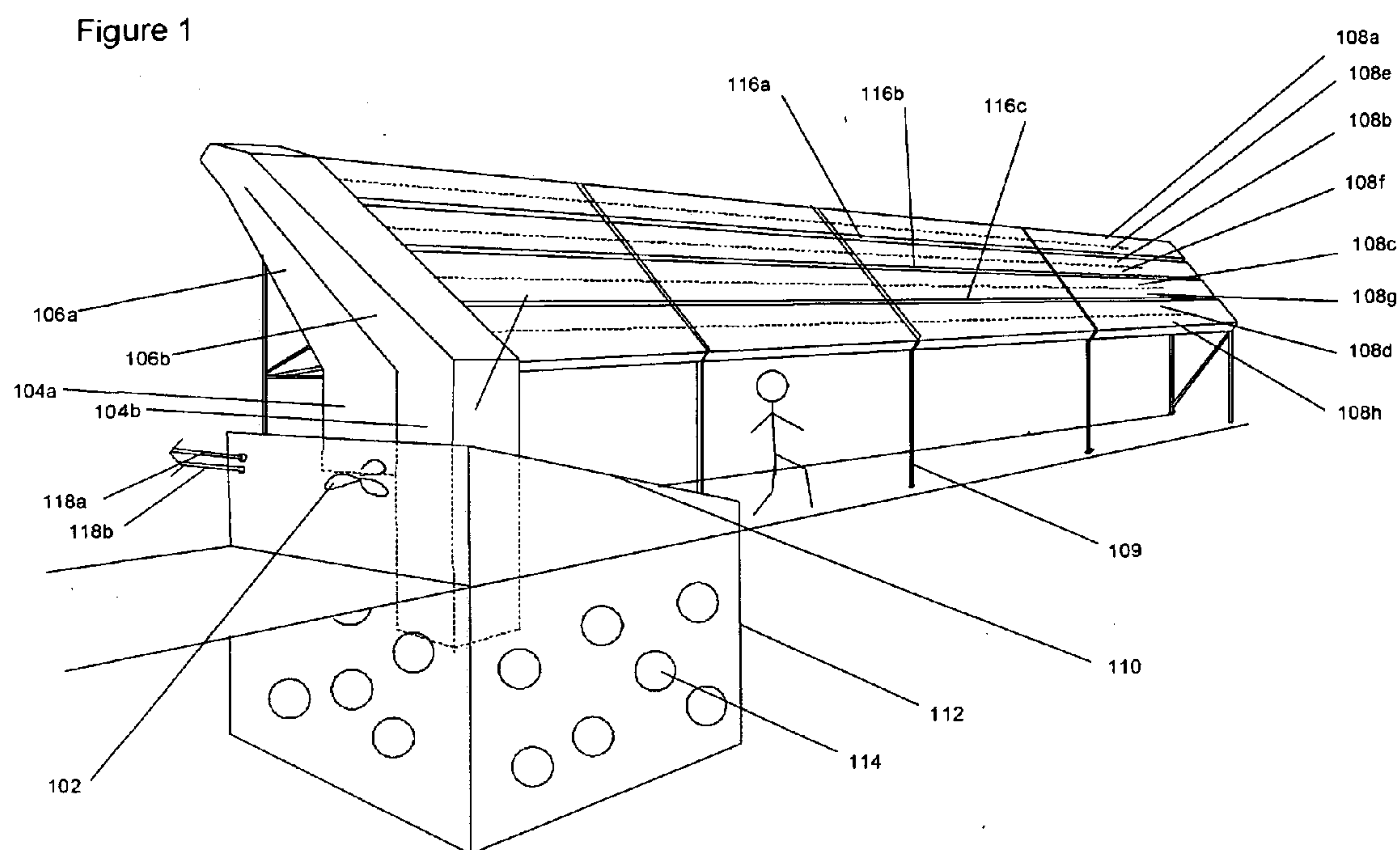


Figure 2: A solar heat-collecting air raceway module

Figure 2

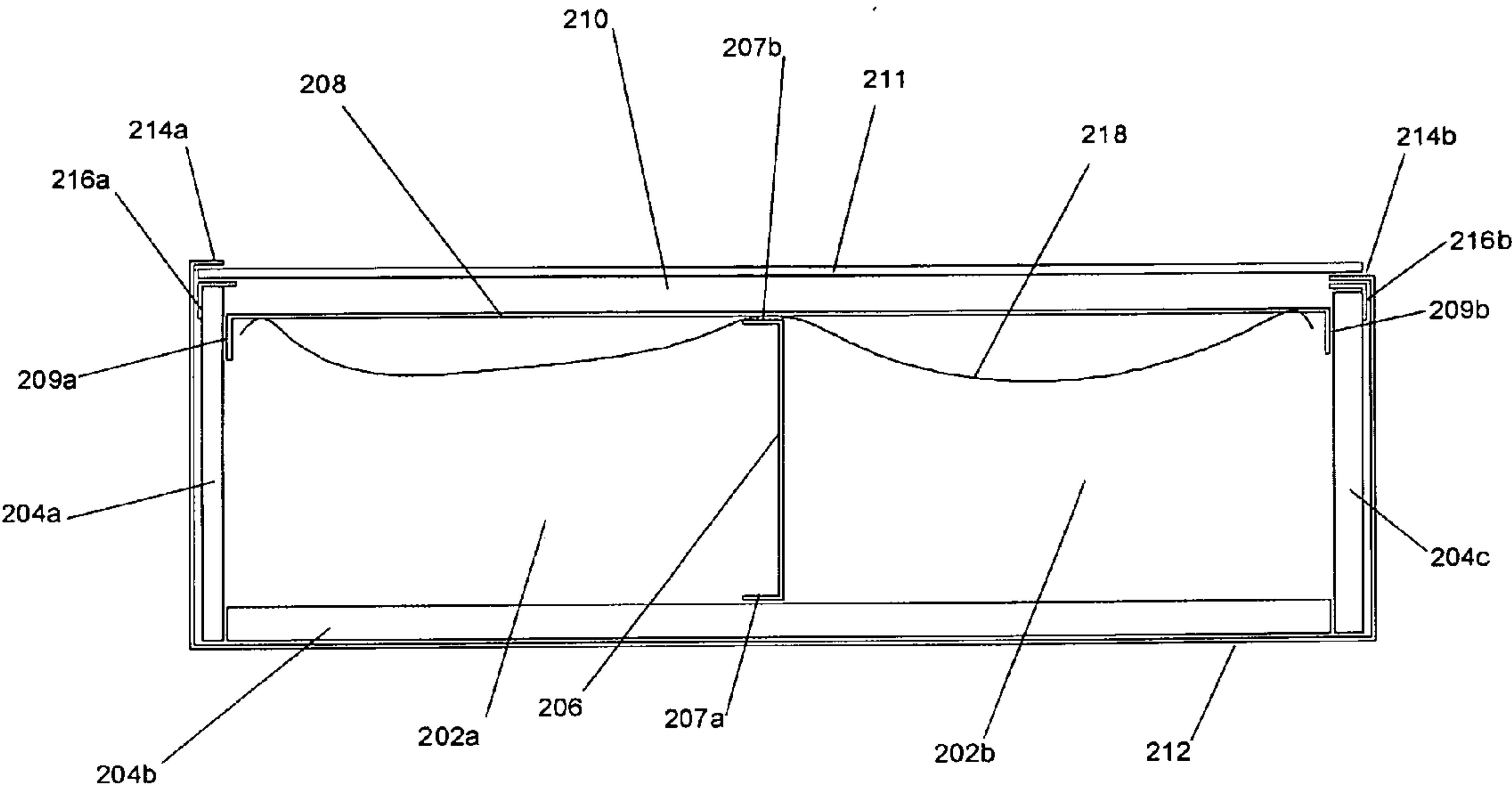


Figure 3: A radiant heat preservation system

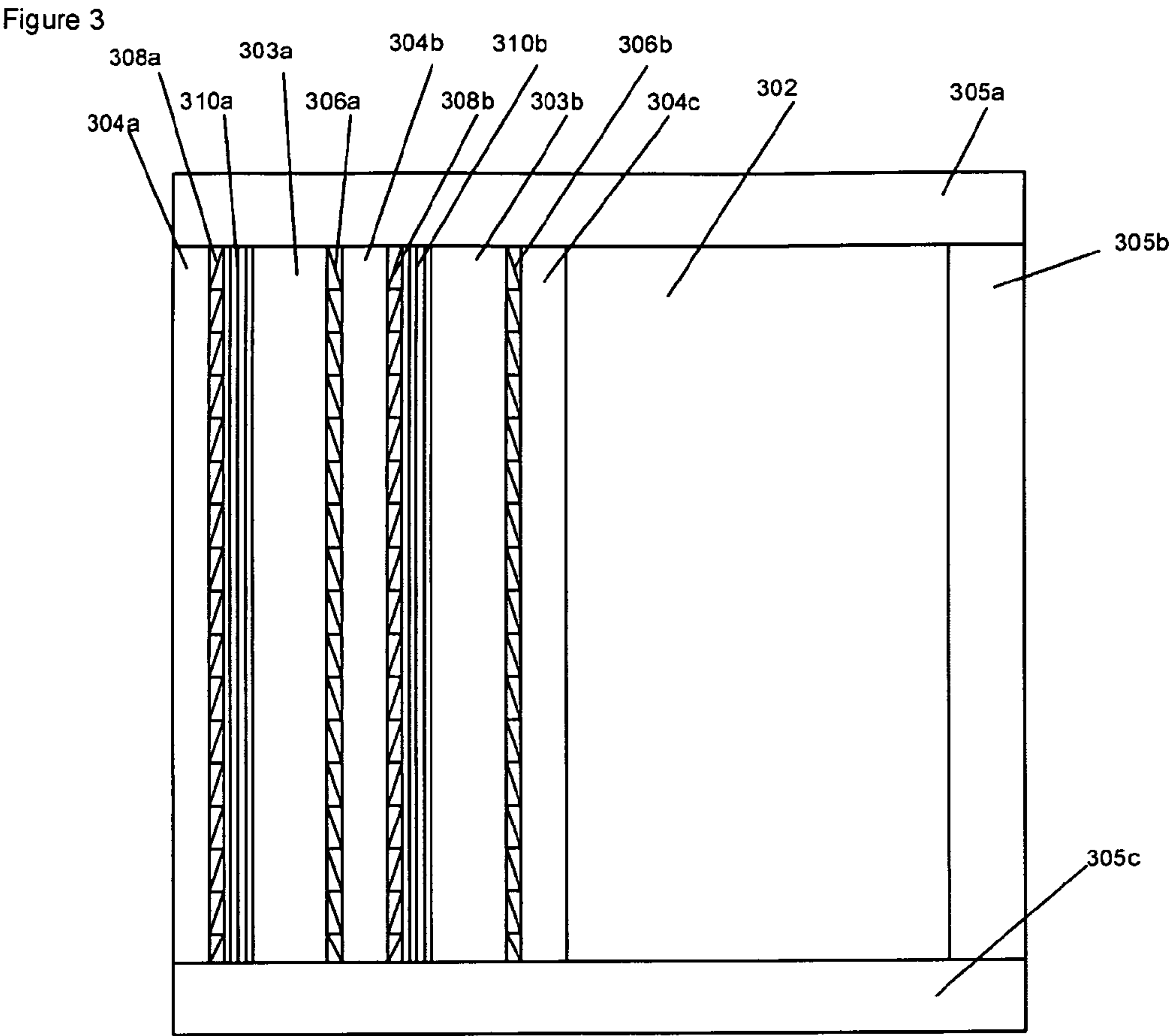


Figure 4: The end of a two-duct solar heat collecting air raceway

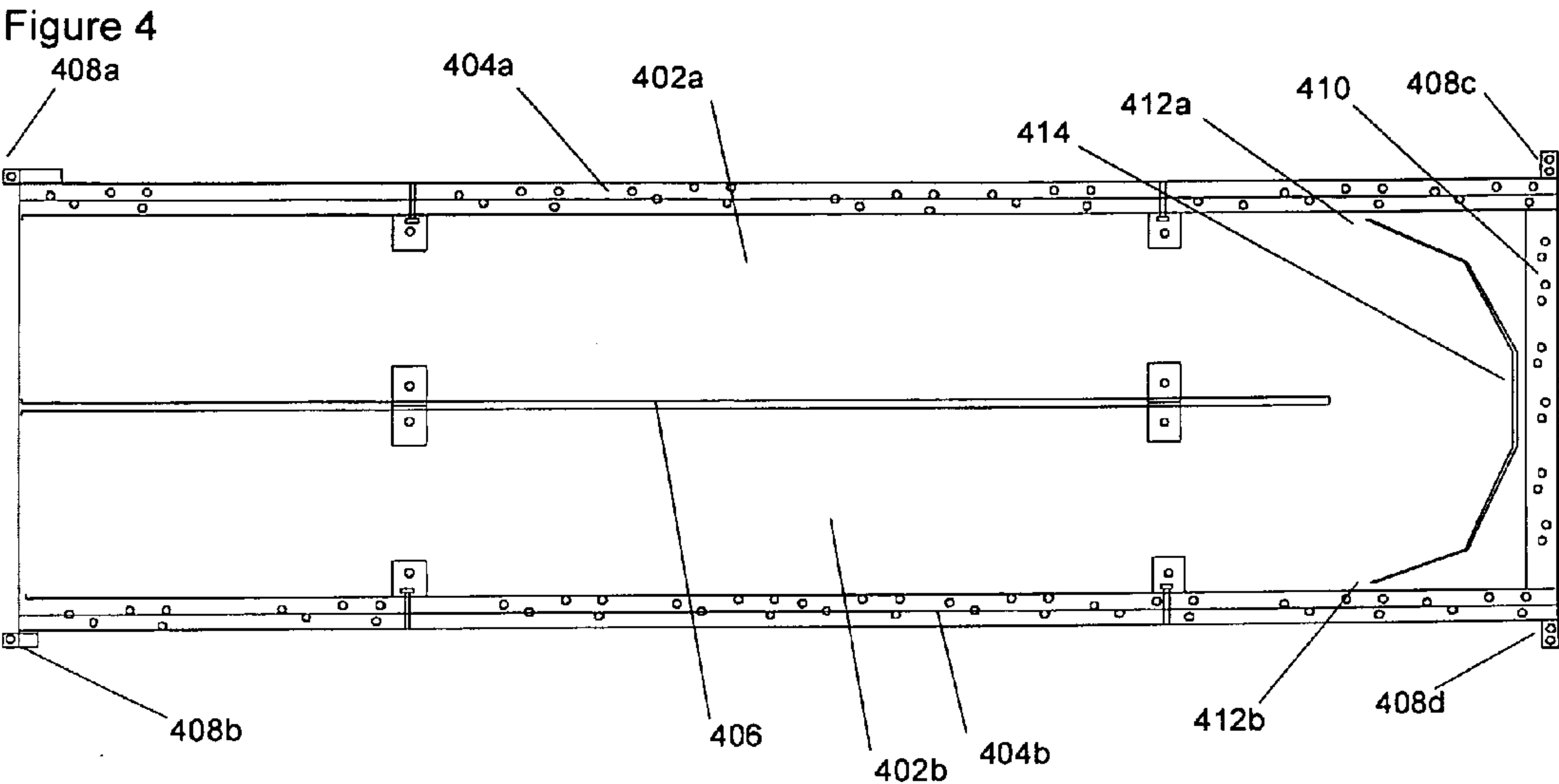


Figure 5: A low air friction rock bed heat storage unit

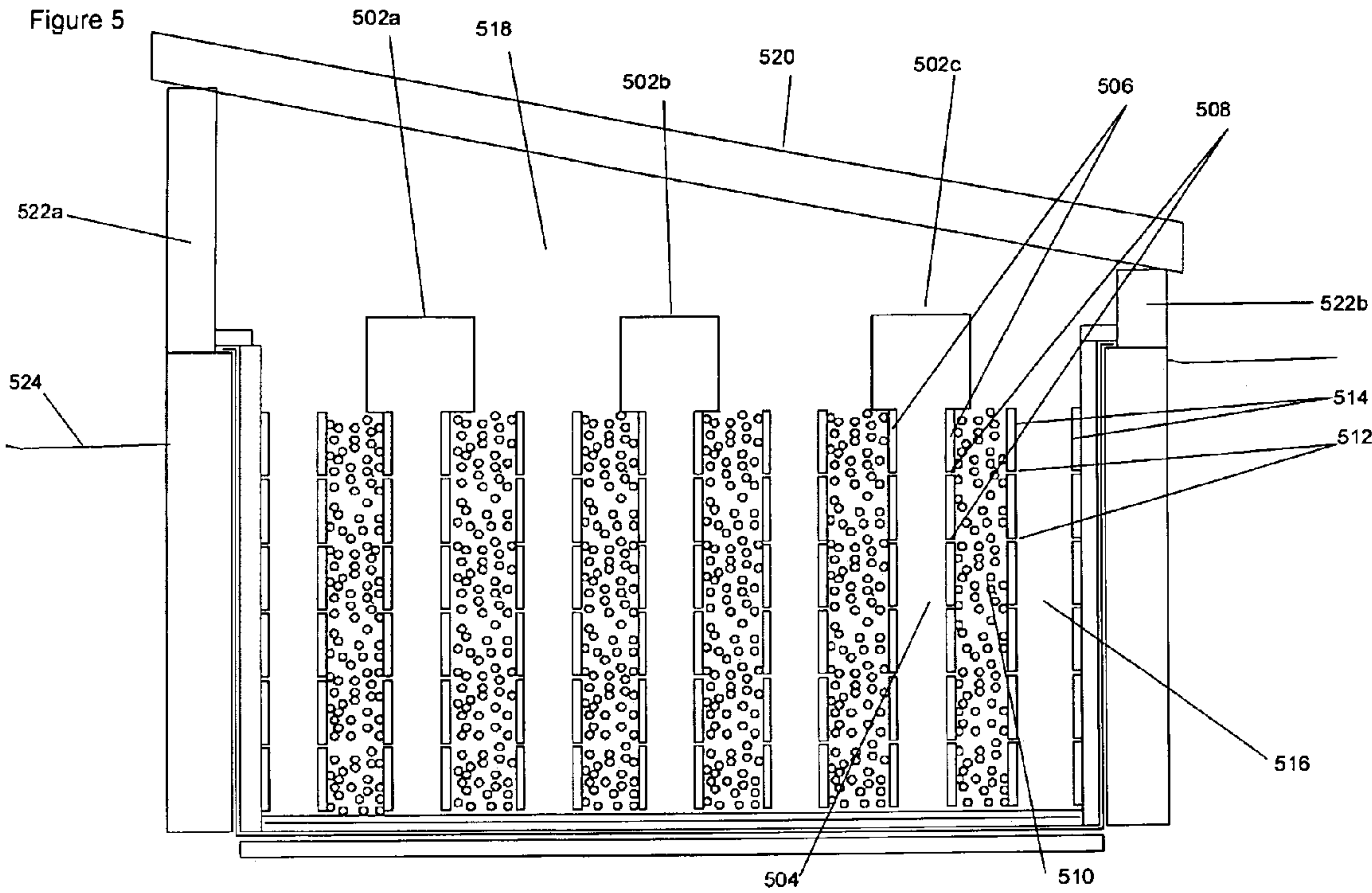


Figure 6: A concentric rock bed heat storage unit

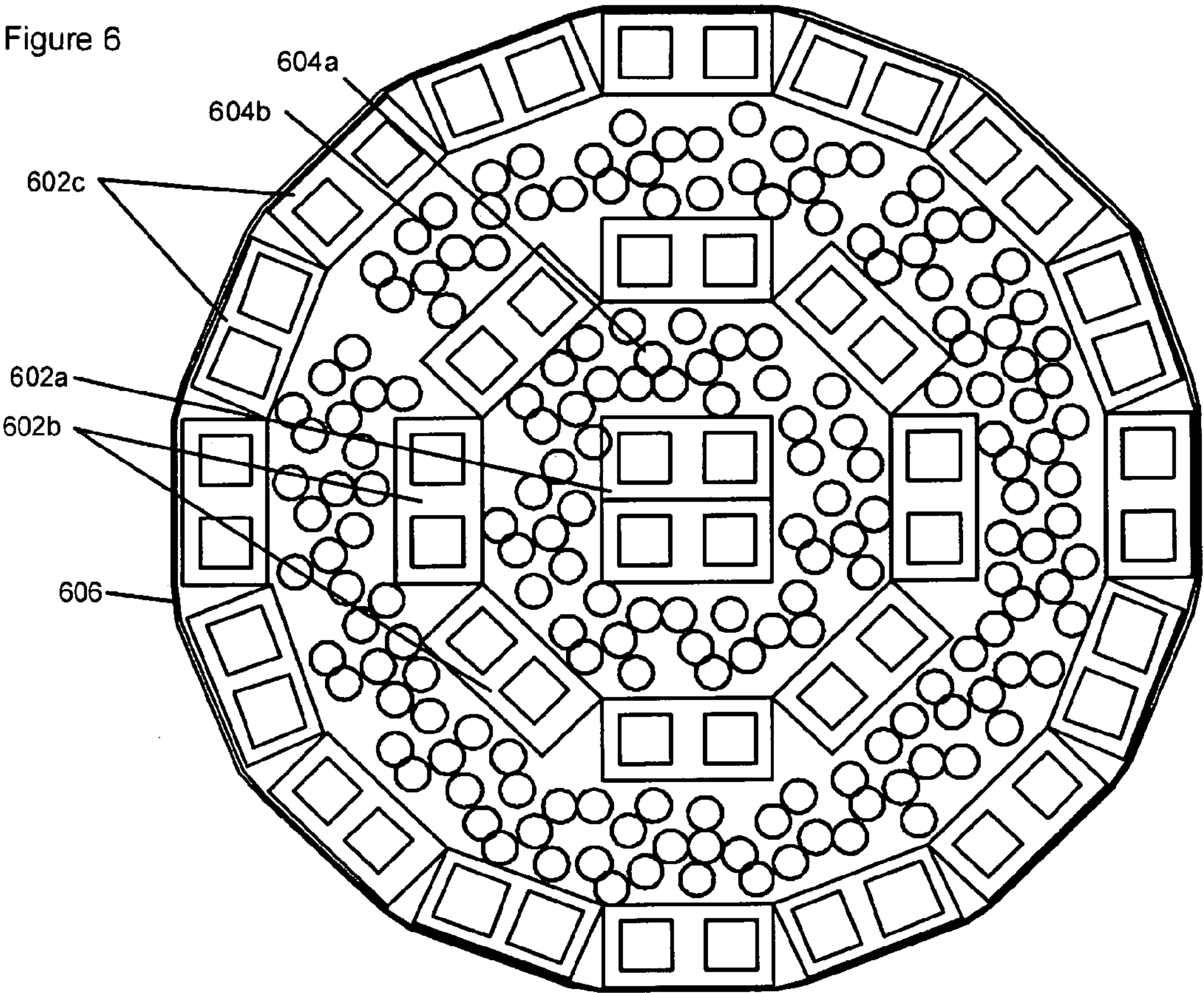


Figure 7: A solar heat-absorbing walkway brick

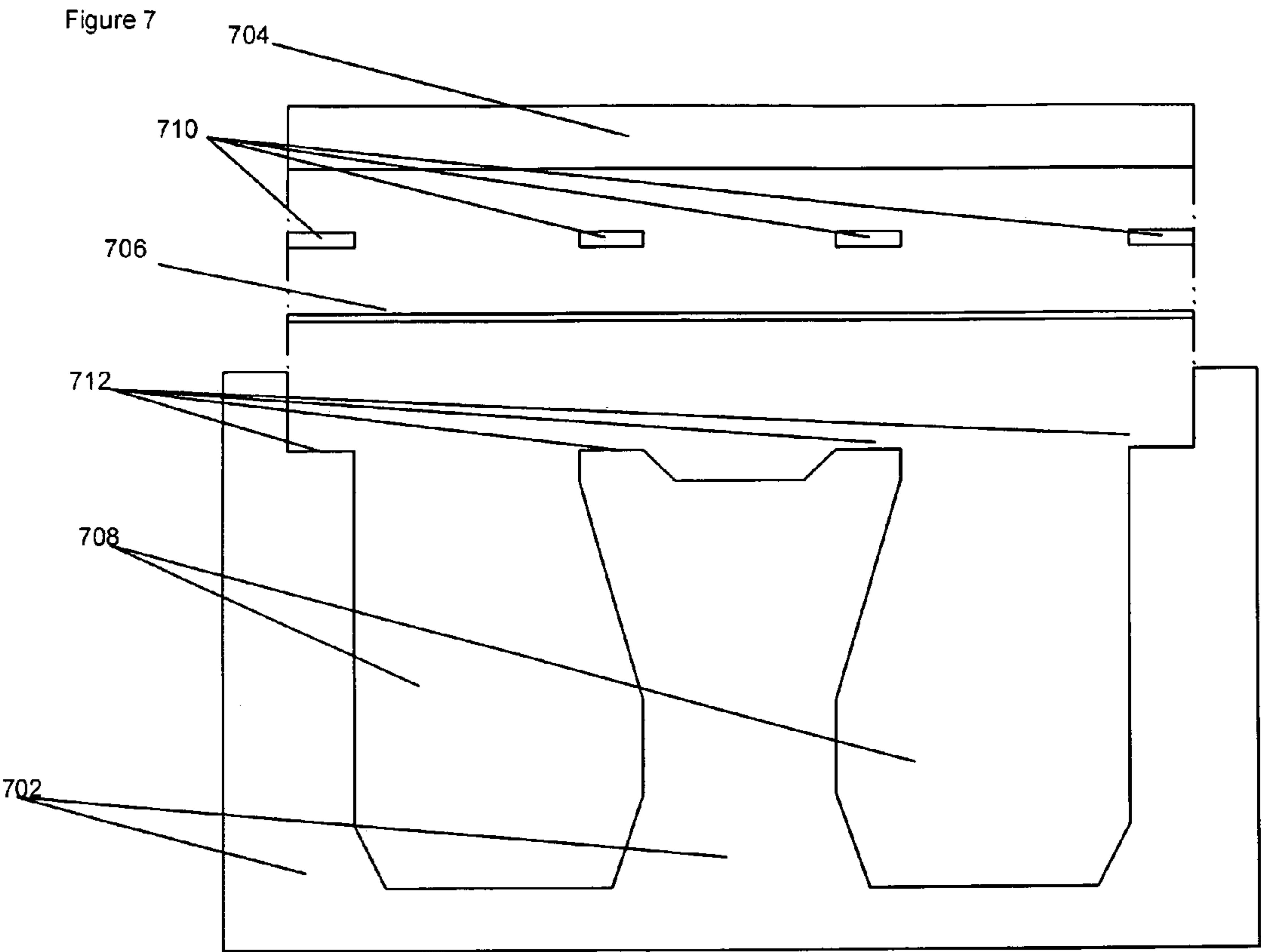


Figure 8: Indentations in a solar heat-absorbing walkway brick

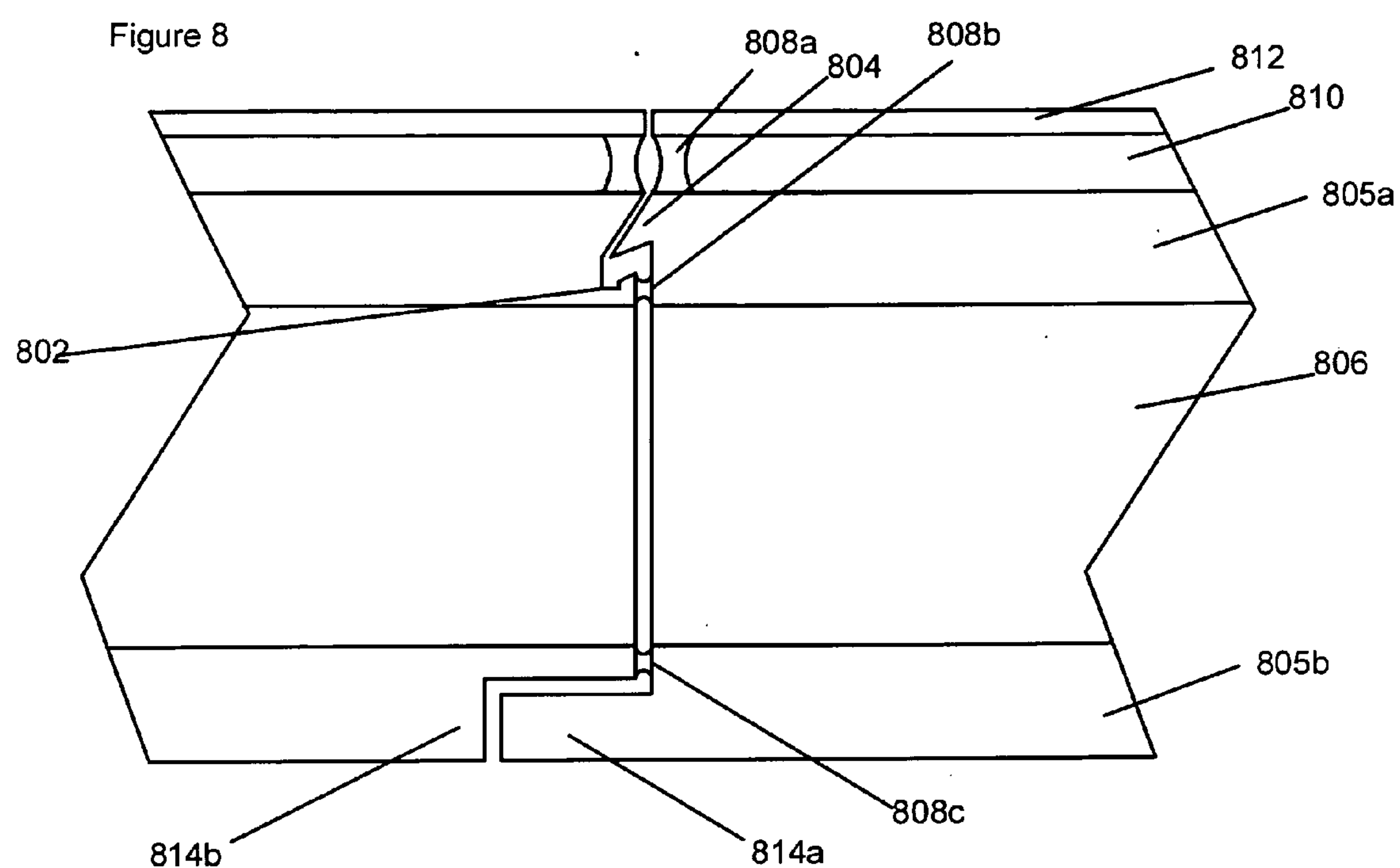
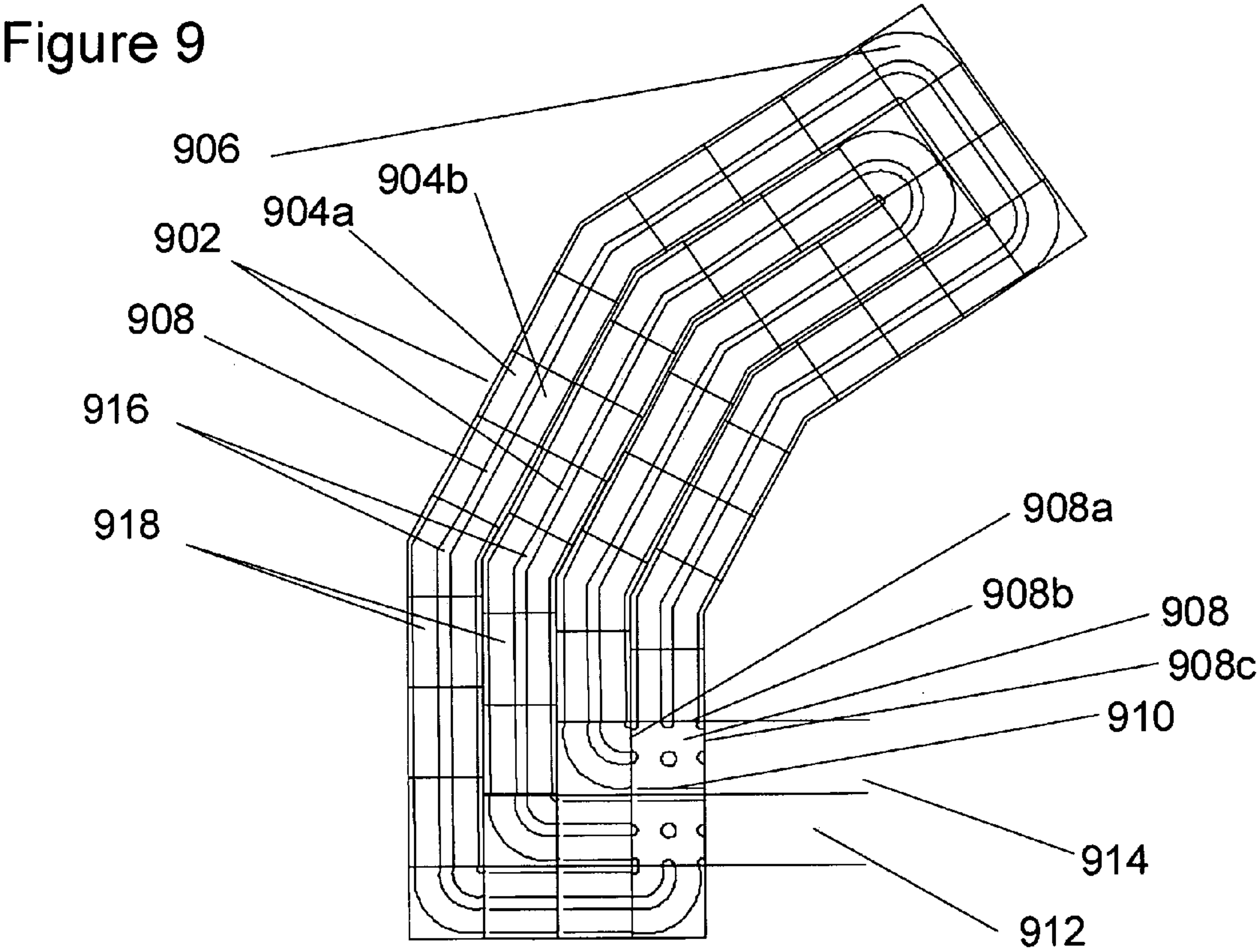
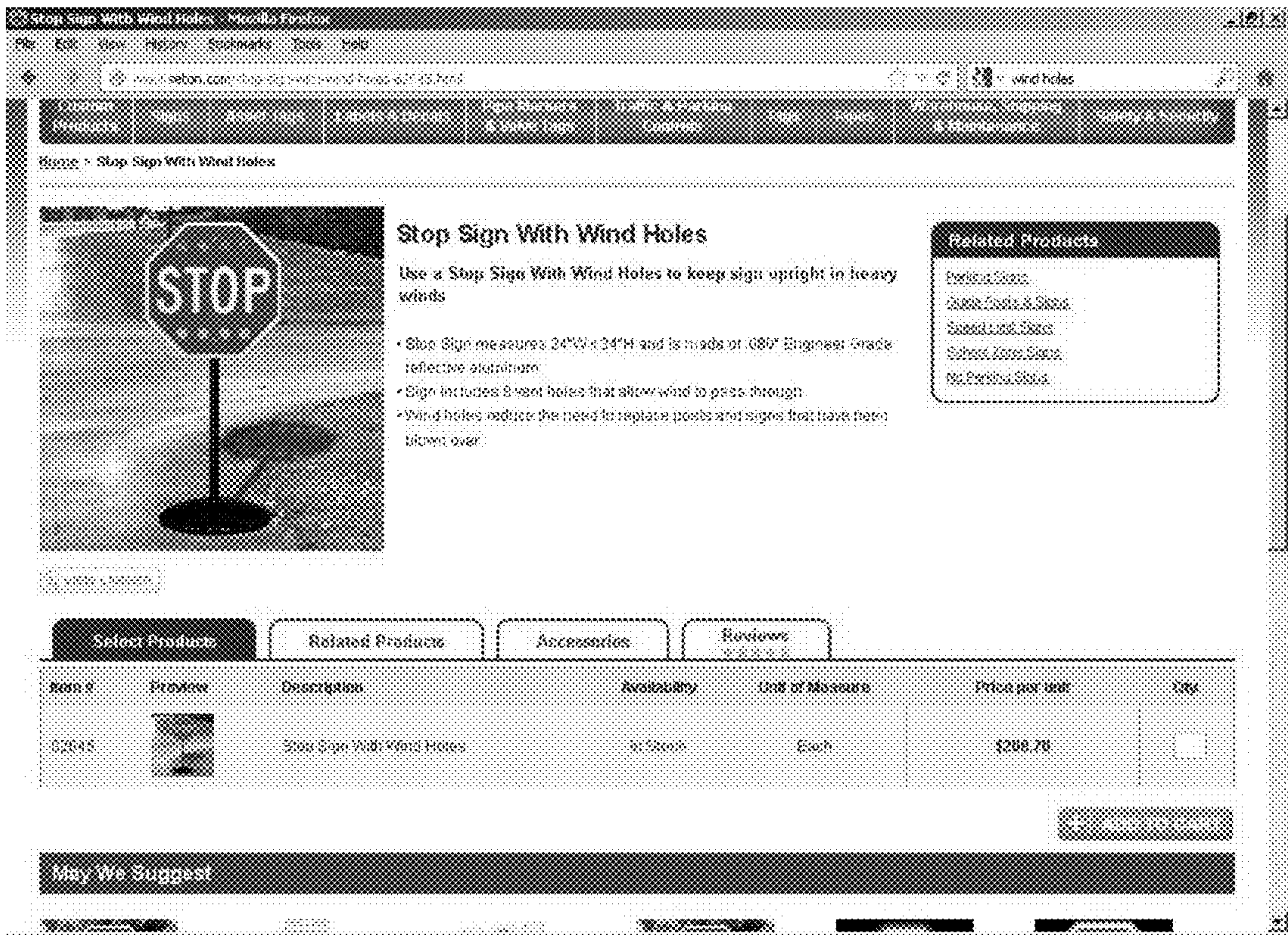


Figure 9: Various standardized solar heat-absorbing walkway brick shapes



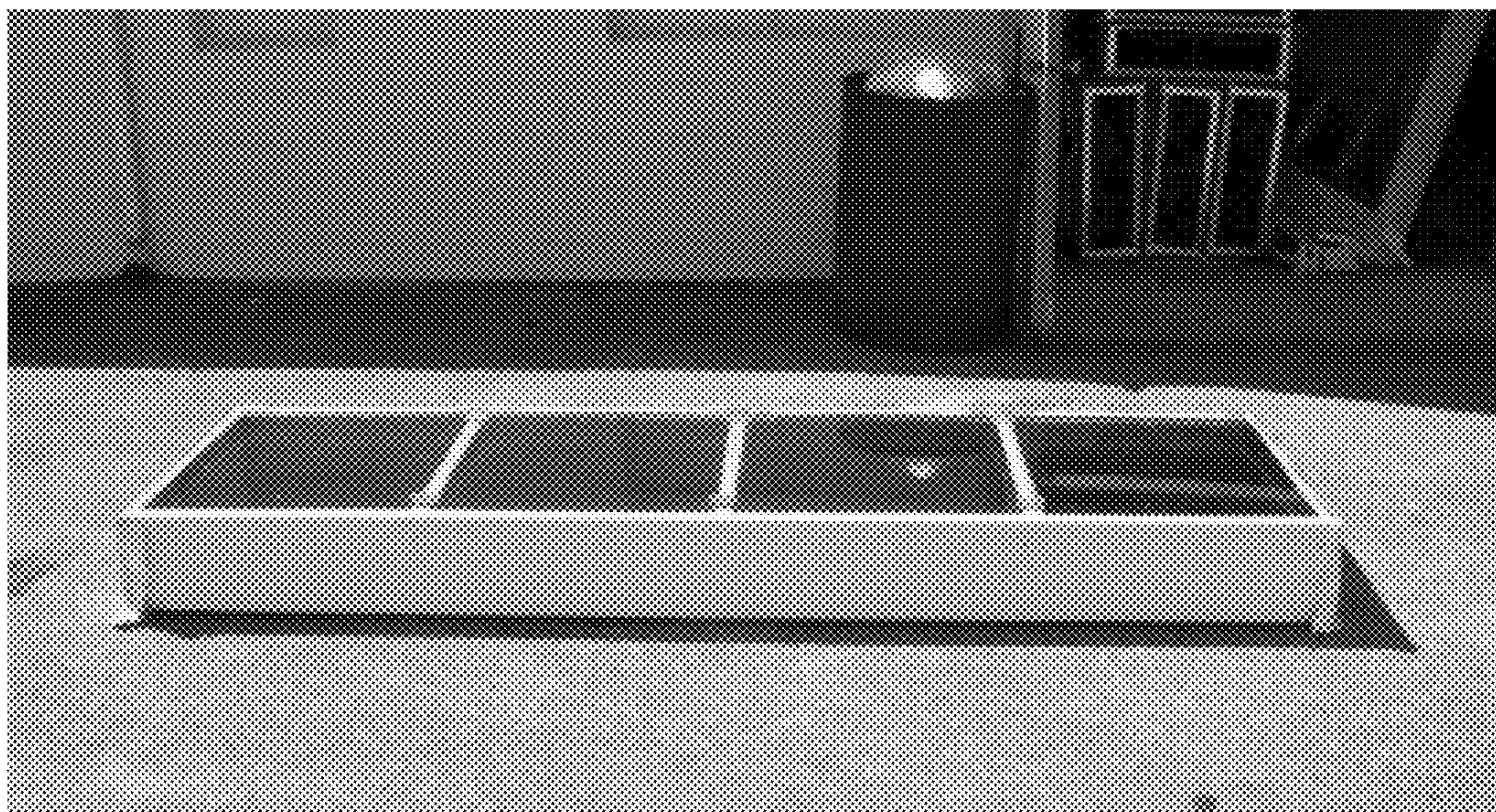
Item A, image of a product using wind holes to lower wind gust overpressures, downloaded on 3/13/2013 from <http://www.seton.com/stop-sign-with-wind-holes-62645.html>



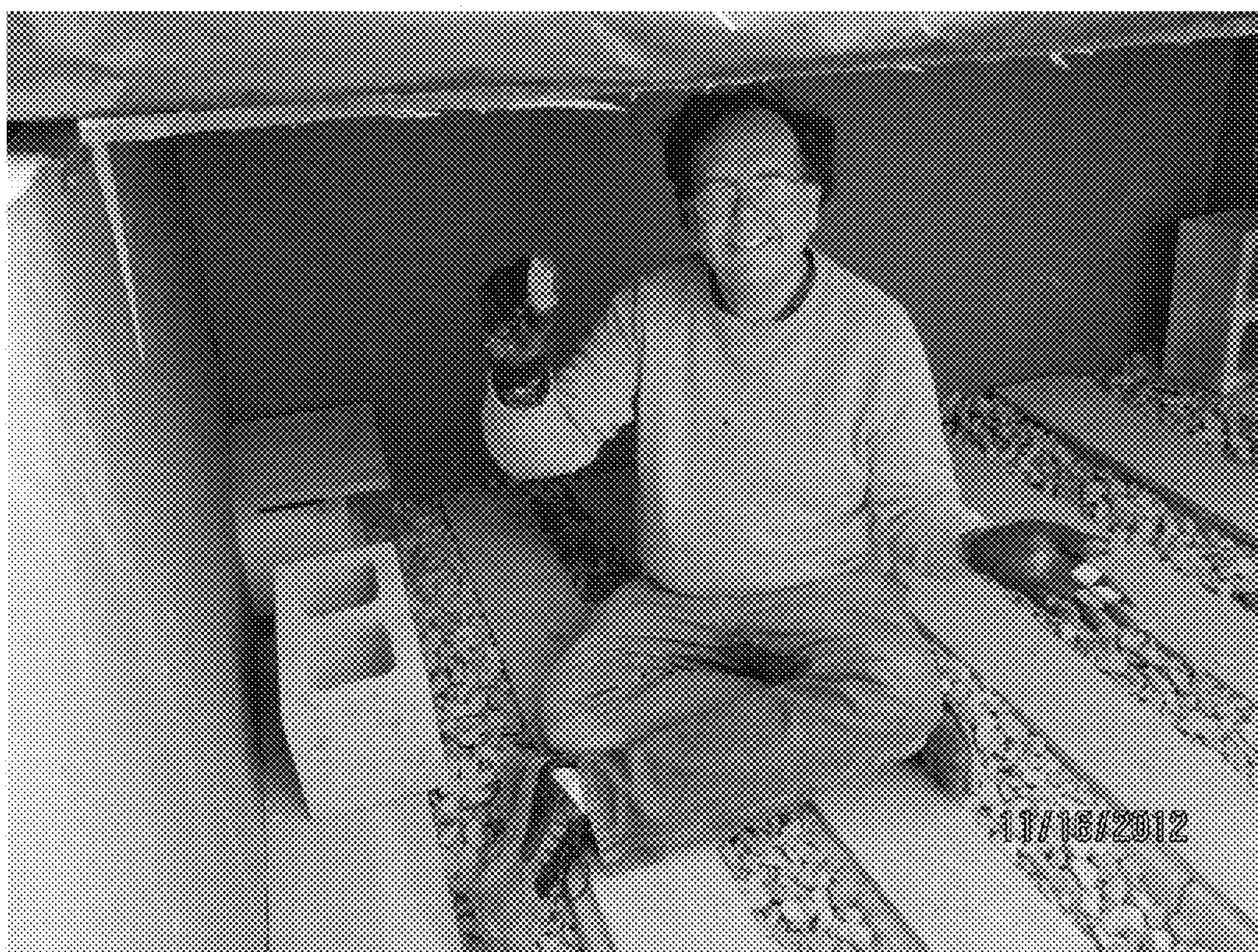
Item B, construction of a prototype of a frame-mount solar array and rock bed heat storage system, with the inventor, taken 1/29/13.



Item C, construction of prototype solar modules to fit on a frame-mount solar array, taken in April of 2012.



Item D, construction of a prototype rock bed heat storage system, with the inventor, taken 11/16/12. The inventor is holding 1/4" thick floor tiles that are being inserted as spacers between concrete blocks.



SOLAR HEAT COLLECTION AND STORAGE SYSTEM

[0001]

REFERENCES CITED		
U.S. Patents		
Pat.		
No.	Title	Issue date
3,902,474	Solar heat converter	Sep. 2, 1975
4,060,195	Solar heating control system	Nov. 29, 1977
4,207,868	Solar Energy System	Jun. 17, 1980
4,349,012	Solar heating control	Sep. 14, 1982
4,452,229	Thermal heat storage and cooling system	Jun. 5, 1984
4,469,086	Solar heated building structure and method of operating a solar-heat collector system	Sep. 4, 1984
4,478,210	Solar Heating System	Oct. 23, 1984
5,339,798	Modular home system	Aug. 23, 1994
6,701,914	Installation for storing thermal energy	Mar. 9, 2004
7,823,582	Method and apparatus for solar collector with integral stagnation temperature control	Nov. 2, 2010
7,954,321	Solar power plant and method and/or system of storing energy in a concentrated solar power plant	Jun. 7, 2011
8,181,642	Light absorber device	May 22, 2012
12/813,052	An Improved Diagonal Solar Chimney	Applied for Jun. 10, 2010

FIELD OF THE INVENTION

[0002] This invention relates generally to heating and air conditioning, and, more particularly, to solar-driven heating with massive storage.

BACKGROUND OF THE INVENTION

[0003] Key parts of solar technology are thousands of years old. Greek and Navajo structures were both aimed 5 degrees off of true south in order to gain maximum solar heat. Navajo houses used thick adobe walls to store heat for nighttime. At night the windows would be closed off with animal hides to keep heat inside. Archimedes taught that solar rays can be concentrated to fire-kindling temperatures.

[0004] Solar heat storage is key to having on-demand local energy. Active air-moving solar heat systems typically use a fan to transport solar-heated air into a storage area filled with rocks, with concrete or with dirt. Most forced air systems using rock beds have been susceptible to mildew growth in the rock bed, mildew caused by occasional warm, moist air filtering through a relatively cold bed of rocks in summer, so that water condenses onto all the rocks inside the rock bed. With forced air heat in a building, the mildew smell is later blown through the building. Some people are allergic or chemically sensitive to mildew. Also, granite rock beds can leach radon into the system's air.

[0005] For these reasons, liquid-based active solar heat systems have been more popular since the 1980s. However, a number of inherent engineering problems have been discovered with fluid-based heat collection. For starters, plumbing without any cracks is inherently more expensive to build than duct work with small cracks. Fluid in outdoor pipes can leak, and leaks are expensive. Water can cause rust and rot. Water cracks pipes open when it freezes. Finally, water can boil off or explode with too much heat.

[0006] For fluid-based rooftop systems, adding antifreeze to water is one way to prevent freezing pipes. However, some antifreeze compounds are toxic to pets when they leak out,

and other antifreeze compounds decay with time. Antifreeze levels must be carefully maintained to avoid disaster. Pure propylene glycol congeals at low temperatures, wearing out pumps. Finally, all fluids and pipes strong enough to hold fluids have mass, and many old roofs are unsuitable for heavy heat collection systems. An air-based system would avoid the aforementioned drawbacks of liquid-based systems. If an air-based system can be devised that also avoids the drawbacks found in traditional air-based systems, the cost of solar heat can be driven down.

[0007] One engineering problem with planar solar heat collector arrays is susceptibility to high wind gusts. People have long ago suspected that cutting holes through solid objects relieves some of the air overpressure on one side of the object. One example of reducing wind gust pressure with pressure release holes can be found at: <http://www.seton.com/stop-sign-with-wind-holes-62645.html>

[0008] Numerous solar air heat collector designs exist. Closed-loop heat collectors can be optimized for gathering heat at a certain temperature relative to the outside air. They can minimize heat losses or minimize costs.

[0009] One or more layers of metal wire screening are considered to be a standard method of transferring radiant heat into cool moving air, because a relatively large amount of air passes within one millimeter of a vast amount of wires. See, for example, <http://builditsolar.com/Experimental/ScreenAbsorber/ScreenAbsorber.htm>

[0010] Rock bed heat storage units often benefit from air circulation channels. In U.S. Pat. No. 4,207,868, Peterson teaches the use of hollow air passages at the centers of multiple concrete blocks lined side to side, with cracks set in place between adjoining blocks to circulate a stream of air underneath a bed of large rocks and gravel. In patent application Ser. No. 12/813,052, this patent's inventor, Klinkman, teaches a building with two parallel air tunnels that forces air through a specific distance of rocks.

[0011] In U.S. Pat. No. 7,954,321, Shinnar teaches that a solar heat collection closed loop can use carbon dioxide instead of natural air, and that the gas may be pressurized within a closed loop.

SUMMARY OF THE INVENTION

[0012] It is therefore a need to devise a rock bed based heating system that is inherently unable to pollute indoor air with mold fumes or with radon; and,

[0013] It is a further need to devise a solar heating system that conserves electricity by reducing system air friction.

[0014] The needs of the invention set forth above as well as further and other needs and advantages of the present invention are achieved by the embodiments of the invention described herein below.

[0015] For a better understanding of the present invention, together with other and further objects thereof, reference is made to the accompanying drawings and items.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS AND ITEMS

[0016] The figures depict several non-limiting preferred embodiments of the invention, wherein:

[0017] FIG. 1 is a schematic of a solar heating system;

[0018] FIG. 2 is a schematic cross-section of a solar heat-collecting air raceway module;

[0019] FIG. 3 is a schematic of a radiant heat preservation system;

[0020] FIG. 4 is a schematic of the end of a two-duct solar heat collecting air raceway;

[0021] FIG. 5 is a schematic of a low air friction rock bed heat storage unit;

[0022] FIG. 6 is a schematic of a concentric rock bed heat storage unit;

[0023] FIG. 7 is a schematic of a solar heat-absorbing walkway brick;

[0024] FIG. 8 is a schematic of indentations in a solar heat-absorbing walkway brick; and

[0025] FIG. 9 is a schematic of various standardized solar heat-absorbing walkway brick shapes.

[0026] Item A is a web screen shot of a device that uses wind holes to reduce wind gust pressure;

[0027] Item B is a picture of a prototype frame and heat storage system under construction;

[0028] Item C is a picture of a prototype solar heat module, and;

[0029] Item D is a picture of a prototype rock bed heat storage system under construction.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0030] In the embodiment shown in FIG. 1, air is blown by a fan (102) up a main insulated supply duct (104a), through the insulated supply duct in a manifold (106a) into one of several horizontal raceways (108a-d) mounted on a frame (109), back through a return raceway (108e-h), back through the insulated return duct in the manifold (106b), back down the insulated main return duct (104b), through the roof (110) of an insulated rock bed heat storage building (112), through the rock bed (114) and back to the fan. The dividers between adjoining supply and return ducts may be, but don't necessarily have to be, insulated dividers.

[0031] In this embodiment the air raceways are separated from each other by wind gaps (116a-c), designed to spill some of the uplift and lateral forces of extreme wind gusts. Regular small air gaps in a solid surface, constituting perhaps 10% of the surface's area, will reduce wind-generated overpressures on that surface by perhaps 40%.

[0032] In this embodiment, pipes filled with water (118a-b) carry heat through the rock bed heat storage building and carry heated water away for use. By controlling the building's maximum heat with an electronic controller similar to a solar hot water system controller, the building will never exceed the boiling point of water, and likewise an extended electrical blackout can never overheat the storage building. With a reasonable amount of thermal mass the building will never freeze, so that the water pipes are equally safe from boiling and from freezing. Different collector pipes inside a single rock bed storage unit can preheat cold water destined for a hot water heater, can heat water that gets circulated through baseboard radiator pipes to heat a building on demand, and can heat water circulated from a swimming pool or hot tub and back to the pool or tub. In typical use, heat gathered in winter heats the house but not the swimming pool, while heat gathered in summer heats the pool on demand but not the house.

[0033] In one embodiment, vent doors contain heat within the rock bed storage unit when the collectors aren't collecting heat. Even with such an arrangement, a slight amount of heat is likely to leak around the vent doors and flow back into the collectors. If snow builds up on a collector, the snow is going to insulate the solar side of the collector. With a small amount of heat flowing into the collector and with the collector insu-

lated by snow, the bottom layer of snow or ice touching the collector's surface is prone to melt. Then the snow is likely to slide off of the collector, even in the middle of a snowstorm. As such, this solar collector is more quickly self-clearing than most collectors.

[0034] With a closed circuit set of air ducts, any grey air in the closed circuit never gets into the building. Any radon given off by the rock bed stays in the closed circuit, away from human lungs, until the air leaks out to the atmosphere. For that matter, a moderately airtight set of air raceways would never admit moist air. As long as the rock bed temperature exceeds the inner air's dew point, moisture won't form on the rocks and mold can't grow on the rocks. If any moisture leaks into the air raceway system it will tend to evaporate, and then minor air leaks in the system will tend to vent the relatively humid air into the atmosphere. The long-time problem of moldy air in the rock bed is thus solved.

[0035] Also of note, any crack or, for that matter, a bullet hole in the ductwork won't stop the heating system from being 99% effective at heat capture. A closed loop air system is fundamentally more stable than an open loop air system because air pressure is equalized at the point of the single crack or hole. A fluid-based solar collection system would be crippled by a crack or hole in a pipe, and so closed-loop fluid-based systems have inherent construction, maintenance and repair expenses that air-based systems don't have.

[0036] In one embodiment, separate insulated heat collector rows are built for the air supply duct and the air return duct. An air gap is left between these two air raceways except at the far end where the raceways are connected. This embodiment allows for wider individual air raceways, with lower air friction, and/or for narrower collector rows, where the width of the collector row is related to uplift and other wind gust forces on a wall or array of collectors. Straight raceway air ducts have low air friction. In one embodiment, a 180 degree fairing is added at the end of each double air raceway for lower air friction.

[0037] In the embodiment shown in FIG. 2, an active solar collector module has two air raceways, one for air supply (202a) and one for air return (202b). The doubled raceway is surrounded on three sides by batts of flat insulation (204a-c). A wall (206) separates the two air raceways. The wall has flanges (207a-b) so that it attaches securely to the bottom insulation and to the heat absorbing wall (208) which is on the side of the collector facing the sun. The heat-absorbing wall has flanges (209a-b) on its sides that secure it to the insulation. The heat absorbing wall is surfaced on its top side with a solar heat absorbing material such as, say, for example, Solkote solar paint. The heat-absorbing wall is insulated by roughly 1 inch of dead air (210) from one sheet of sunlight-transmitting material (211).

[0038] A metal sheet (212) wraps around the entire solar collector module. A solar heat collector module is typically installed with its heat-absorbing wall facing south in the temperate northern hemisphere, and diagonally upward. The top edge of the metal sheet hooks over the sheet of light-transmitting material on top (214a) and slides under the light-transmitting material sheet on the bottom (214b), to shed precipitation when installed in its diagonal orientation. Angle irons (216a-b) act as a frame to stiffen the module and to support any engineering stresses on the light transmitting sheet. Metal screening (218) coated with an infrared-absorbing paint, coating or other material loops below the heat-absorbing wall. This hybrid heat collector design would be

considered a back-pass type of active air heat collector because the airflow is behind the primary collector sheet, but is a through-pass heat collector with regards to the metal screening.

[0039] In one embodiment, part of a building's roof is slanted roughly to the south at an angle productive for gathering solar heat. Mounts for the solar collector modules are built into the roof. This saves the added expense of a building a separate frame.

[0040] An air-based solar heat collector needs to work with radiant heat properly. The sun side of the heat-absorbing wall has a surface that absorbs solar radiation well. This solar surface also tends to emit heat in an infrared wavelength range that reflects off of certain types of visible light-transmitting material, back to the heat-absorbing wall. The inch of dead air between the heat absorbing wall and the light-transmitting material helps to minimize convective heat transfer.

[0041] At the same time, the back side of the wall is as hot as the front side and it also emits radiant heat. These heat rays reflect off of the insulated walls well. The radiant heat is reflected until the window screening absorbs it. Window screening, with its fine air holes, is highly efficient at turning radiant heat into air heat. The air stream convects heat down to the rock bed.

[0042] The light-transmitting material in this embodiment may be, but doesn't necessarily have to be, glass. Glass is good at reflecting certain wavelengths of infrared radiant heat. In one embodiment, a film or surface that selectively reflects the specific wavelengths of light most commonly emitted by the heat-absorbing coating is applied to the light-transmitting material.

[0043] When sunlight absorption is minimal and the collector's fan is off, any residual heat captured on the window screening within the air raceways becomes two walls away from escaping back into the atmosphere. On days with in-and-out clouds, low heat loss in cloudy periods means more net heat captured. In sum, this solar heat collector is designed to work more efficiently than any other single-pane air heat collector design now on the market.

[0044] The two straight air raceways create little air friction, other than air friction created by the window screens which are oriented in the direction of air flow for minimal friction. As a result, little airflow will exploit any cracks or air passages between the supply and return ducts. Modular design of the air raceways is facilitated by this relative lack of worry over air leakage.

[0045] In one embodiment, two panes of light-transmitting material, separated from each other by a roughly one inch air gap, are placed above the heat absorbing wall. This lowers heat loss, but the extra pane also causes an additional percentage of sunlight to be reflected away into the atmosphere. A double pane collector would be appropriate when a relatively high temperature differential between outside air and captured hot air is desired.

[0046] In one embodiment, sunlight is concentrated by reflection or by refraction into one or more such air raceways. This further increases the top limit of achievable air temperature within the ducts.

[0047] Any particular collector design in constant sunshine and with its fan disconnected will in time reach a state of equilibrium, where heat coming in from sunshine equals the heat exiting back out through the light-transmitting material and through the collector's insulated walls. At equilibrium the air inside the collector reaches a certain maximum tempera-

ture. In one embodiment the system's insulation is selected so that the insulation's destabilization temperature is above the collector's maximum equilibrium temperature. It can be assumed that at some point the fan's electric circuits will fail, and so an equilibrium temperature within the collectors on a July afternoon is a likely hazard. Thinner insulation or greater heat loss through the light-transmitting material may be an advantage, if it allows a more inexpensive type of insulation to be used.

[0048] In the embodiment shown in FIG. 3, an air duct (302) has multiple walls (304a-c) between air or vacuum gaps (303a-b) on its heat-absorbing side and is insulated elsewhere (305a-c). Walls have one type of heat-radiating coating (306a-b) applied to one side of the wall and a different type of heat-radiating coating (308a-b) applied to the other side. The second side is then further coated with a semi-transparent surface (310a-b) that selectively reflects certain wavelengths of infrared light emitted in quantity by the outside-facing surfaces only. The semi-transparent surface would be similar in optical qualities to, say, for example, low-emissivity film found in hardware stores.

[0049] Radiant heat rays in certain specific wavelengths emitted from the coating on the outside of each wall will tend to be reflected by this coating, while radiant heat rays in different specific wavelengths emitted from the coating on the inside of each wall will tend to be transmitted by this coating. So, radiant heat rays in wavelengths emitted from the inside of each wall will tend to be transmitted to the next wall and absorbed as heat, while radiant heat rays emitted from the outside of each wall will tend to be reflected back to that wall and reabsorbed as heat. Heat will be transmitted through the walls so that both surfaces on each wall will have the same temperature. Because all matter on earth emits radiant heat, such a device will move radiant heat inward. It's a stretch to say that a radiant heat concentrating system might power a perpetual motion machine because that would violate known physical laws, but the embodiment does a fair job of preserving captured heat.

[0050] In the embodiment shown in FIG. 4, a solar collector module has supply and return ducts (402a-b) bounded by insulated walls (404a-b) and a central divider (406). It has flanges (408a-d) so that it can be easily bolted to a frame. The flanges on one end (408a-b) will fit the flanges on the other end (408c-d) when multiple modules are bolted together in a line to form a longer set of two raceways.

[0051] One end of the solar collector module shown here is capped with flat insulation (410). The end of the central divider has been partly removed to allow airflow between the return and supply ducts. A fairing assists airflow from the supply air raceway to the return air raceway. The ends (412a-b) and the middle (414) of the fairing are fixed a small distance away from the walls and end cap, so that in use a small amount of air travels behind the fairing, taking the relatively tiny amount of solar heat collected behind the fairing into the air stream.

[0052] In one embodiment the reflectors are tipped to face 40 degrees above the horizon at a latitude where the sun reaches a maximum elevation of 75 degrees above the horizon. This angle insures that reflected solar glare will always bounce upwards toward space at at least a 5 degree angle above the horizon, and will never shine solar glare on a neighbor on the ground.

[0053] When light hits many light-transmitting materials at an oblique angle, most of the light is reflected. In one embodi-

ment the outside face of a collector's light-transmitting material is scored in the vertical direction with, say, for example, a fine sandpaper. This creates microgrooves in the light-transmitting material with edges that catch the solar rays at a less oblique angle, refracting the rays more directly inward. A fixed south-facing solar collector would then gain more BTUs at 7:00 a.m. or at 5:00 p.m., with almost no less BTUs collected at noon. A wider range of hours of solar heat collection is important in cloudy regions where there might be no sun from dawn until 4:30 p.m. on any particular day. At the same time, microgrooves at a number of non-flat angles scatter any reflected sunlight in a range of directions. This greatly reduces the impact of blinding reflections from the solar array on the eyes of nearby homeowners and on airline pilots.

[0054] In one embodiment, a gas or mixture of gases other than atmospheric air, with substantially more heat carrying capacity than atmospheric air, is used in the closed loop.

[0055] In one embodiment an insulating gas mixture is sealed between the solar collecting surface and the light-transmitting material. The insulating gas mixture may comprise, but doesn't necessarily have to comprise, argon gas.

[0056] In one embodiment, substantially parallel solar collecting pairs of air ducts are attached on both sides of a central manifold duct.

[0057] In one embodiment, solar collecting pairs of air ducts are individually mounted on a roof or in a field. The collecting ducts are still connected to a common manifold duct. In one embodiment the individual air ducts are tipped into the sun for maximum solar collection. In one embodiment the individual air ducts or pairs of air ducts are mounted flat against the roof or flat on the field for minimum air resistance. The roof or field may be, does not necessarily have to be, flat.

[0058] In one embodiment, angled connector duct pieces connect raceways traversing over the peak of a building roof.

[0059] In the embodiment shown in FIG. 5, air flowing through a rock bed heat storage unit is directed through ducts (502a-c), down into the hollow center air channels (504) within columns of concrete blocks, bricks or other massive blocks with hollow air passages in their centers (506). From these center air channels, air is forced laterally through small gaps (508) between the concrete block sides, through a roughly fixed distance between concrete block columns filled with a porous heat storage medium that may comprise, but doesn't necessarily have to comprise, 1.5" diameter small rocks (510). The air then flows through more small gaps (512) between blocks in columns adjacent and parallel to the first wall of blocks (514) and up the hollow center air channels (516) in these other concrete block columns to a relatively open area (518) under the rock bed's insulated roof (520) and enclosed by insulated walls (522a-b). A fan then blows air from this open area back through the solar heat collecting duct system, in a closed loop. The rock bed may be, but doesn't necessarily have to be, partly below ground level (524).

[0060] Air friction is proportional to the fourth power of velocity. A well-distributed system of air movement through the rock bed pushes the air through the rock bed at a far lower velocity than forcing the whole volume of air through the entire rock bed, which greatly reduces air friction in the rock bed, reducing fan electricity costs, while still giving each cubic inch of air plenty of time adjacent to the rocks for effective heat transfers into the rocks. The concrete blocks also absorb their share of the heat. Air flow rates through

different parts of the rock bed are roughly equal, so that every part of the rock bed pulls its weight in the job of storing heat.

[0061] At night and on cloudy days when the collection process is shut down, currents of warm air can slowly rise through the rocks to the open area under the rock bed's roof. Currents of cooler air which have been cooled by contact with heat transfer pipes in the open area sink down the air channels within the concrete blocks. In this way a steady supply of warmed air is naturally applied to the heat transfer pipes until the heat stored in the rock bed is exhausted. In cases where water pipes are warmer than the rocks, little heat transfer will take place because the warmer air around the pipes will stay in the building's open top.

[0062] In one embodiment, rows of hollow concrete blocks are laid on their sides so that the hollow channels run horizontally through the rock bed. Stones are placed between the rows of hollow concrete blocks, and spacers keep small air channels open between concrete blocks as before. The ends of alternating rows of hollow blocks are sealed off at alternating ends of the rock bed. In use, air is forced into the hollow channels open at one end of the rock bed. As before, air flows through the hollow channels, is distributed out of these channels through the small air channels, air travels through a small distance of stone, and the air flows back into hollow channels in an adjoining next row of blocks. Air then flows to a second open area at the other end of the rock bed. The rock bed is designed so that no air can flow around the rock bed: all air must flow, however slowly, through a certain distance of stone.

[0063] In one embodiment, pressure pushing inward from the surrounding subsoil counterbalances the pressure pushing outward from the rocks, so that no concrete foundation is needed for the rock bed. However, underground waterproofing and underground insulation are needed to keep the rock bed from losing its heat, either by water movement or by heat convection through the walls and floor.

[0064] In one embodiment, cold frames are built adjoining a rock bed heat storage unit, in order to have the plants take advantage of the residual heat leaked all winter by the rock bed unit.

[0065] In one embodiment the rock bed is above ground. In one embodiment the rock bed is surrounded with one or more walls of inward-leaning concrete blocks, so that gravity helps to hold the rock bed's shape.

[0066] In the embodiment shown in FIG. 6, the rock bed comprises two or more concentric cylinders (602a-c) of hollow blocks, with layers of small rocks (604a-b) between these cylinders. The cylindrical shape strengthens the rock bed against constant inward pressure. Bands (606) are wrapped around the cylindrically shaped outermost wall at various heights to help hold the rock bed together. An insulated enclosure is built around the outermost cylinder, and air ducts are connected to alternate block cylinders. This aboveground embodiment benefits from a lack of expensive excavation. A system of inexpensive, sustainable solar heat on demand would be a seminal breakthrough in the solar field.

[0067] In one embodiment a duct leads to the set of alternating concentric circles of blocks not including the outermost circle by running through the bottom of the rock bed. These circles of blocks are blocked on their top ends. The air passages on the other concentric circles of blocks are open to the enclosure building's air on their top ends.

[0068] In one embodiment, subsoil is pushing the rock bed unit inward in all directions. In one embodiment, wedges are

added where adjoining rectangular blocks meet, in order to strengthen the rock bed's overall stability.

[0069] In one embodiment, blocks with hollow center air channels are constructed with small air lateral channels that assist in the movement of air from the inside air channels of the blocks to the outside, or from outside to inside. In one embodiment paper tubes are inserted when pouring the blocks and then the paper tubes rot out to create the air channels. In one embodiment wooden dowel rods are put into clay bricks and then are burned out when the bricks are fired, leaving air channels. In one embodiment, solid dowel rods with a low melting point are inserted in blocks and then melted out.

[0070] In one embodiment, pea stone or coarse sand replaces the previously mentioned 1.5" stones. If air velocity percolating through the rock bed storage unit is reduced to a low enough velocity, the additional electricity costs in forcing air through pea stone or sand might become acceptable.

[0071] In one embodiment, several inches of sand on the bottom of a rock bed, with no air flow through the sand, creates an insulating dead air spaces around the sand particles, which keeps heat from leaving the rock bed by its floor. This dead air space strategy also works outside of the outermost layer of concrete blocks.

[0072] In one embodiment, subsoil found in situ is formed into balls and solar-heated to create glassy-walled conglomerates, which are then used in a heat storage box as the equivalent of small rocks.

[0073] In the embodiment shown in FIG. 7, a line of walkway or driveway bricks comprising an insulated concrete base (702), a top of one or more layers of light-transmitting material (704), a solar absorbing surface (706) and one or more air ducts (708) absorbs heat. The advantage of walkway bricks is that they can survive any hurricane wind gust because they are flat against the ground. Flexible gaskets (710) above stanchions (712) keep precipitation out of the air ducts. Flexible gaskets also give the light-transmitting top some give, so that when a child falls and hits his head on the top the top bounces and the child better avoids head injury. The light-transmitting top may be comprised of, but does not necessarily have to be comprised of, glass. Glass and similar solar-transmitting materials can be fashioned to any thickness, can be flexibly supported at enough points on their bottoms and can be laid in small enough tiles so that even trucks can roll over a thick layer of glass without fracturing the glass.

[0074] In summer, the top surface of a line of walkway bricks need not get as hot as, for example; a blacktopped walkway. Most of the solar heat falling on the bricks passes through the layers of light-transmitting material. In use, most of this heat is converted into heated air and is blown away to a heat storage unit, whereas a blacktopped walkway captures solar heat and gets hot after an hour, so that people with bare feet can have trouble walking on blacktop in summer.

[0075] In winter, some of the walkway's collected heat will tend to heat the surrounding earth. This heat will tend to melt snow or loosen ice on the bricks. On fall evenings, a glass-topped heat-absorbing patio might feel notably warmer than the surrounding yard as residual heat radiates up onto people on the patio. Also, stored heat can be blown back underneath the walkway bricks as desired.

[0076] In one embodiment the top of the light-transmitting material is scored in one direction. This scoring process creates tiny water channels so that water can drain away through the channels. In contrast, a perfectly flat and wet surface may

constitute a slip and fall hazard. The scoring also improves solar ray absorption at oblique angles.

[0077] In the embodiment shown in FIG. 8, a water channel (802) and a drip edge (804) built into the bases of blocks (805a-b) channels precipitation away from the air duct path (806). The water channels and drip edges fit together when blocks are assembled into air ducts. Every air duct is designed with one water channel on one half of a face and with one drip edge on the opposite half of the face, so that all air channels fit together into an array. In use, precipitation runs down through the crack between two blocks, into the water channel, then along the water channel to the corner of the block, where it runs down the corner or the side to the bottom of the block. Gaskets (808a-c) provide an extra layer of waterproofing protection for the air ducts and for the dead air space (810) beneath the sun-transmitting top (812). Blocks also have interlocking bottom edges (814a-b) so that hazards such as growing tree roots and the weight of vehicle tires standing on block edges are less likely to tip individual blocks out of position, breaking the continuity of the closed air channel.

[0078] In the embodiment shown in FIG. 9, several standard types of walkway, driveway or patio bricks with air channels are used to build a complete walkway. A standard square 1 unit by 1 unit brick (902), designed with one or more straight airways (904a-b), would be the most prevalent type of brick found in the average walkway or driveway. A 90-degree turn brick (906) allows airways to turn 90 degrees at the corners of patios or driveways, in conjunction with an array of 1 unit by 1 unit square bricks, and to turn 180 degrees around at the ends of walkways. All bricks are designed to have fairly wide bases, say, for example, 16 inches by 16 inches for a square brick, so that tree roots have a fairly tough time elevating airways out of alignment, and so that the weight of a vehicle tire on one edge of a brick doesn't tip any individual brick up on its side.

[0079] The manifold brick (908) has airways on three sides (908a-c), is closed on the fourth side (910) and is higher than the average brick, so that it carries a larger volume of air. In use, a deeper channel is dug before laying down a manifold brick. Manifold bricks connect to the supply duct (912) and return duct (914) leading to a heat storage unit. In one embodiment the manifold bricks connect directly to a rock bed storage unit next to the walkway or driveway.

[0080] The addition of 1 unit wide bricks with roughly 28.07-degrees of bend (916) and 1 unit×1.25 unit rectangular bricks (918), allows an entire driveway or walkway to gently turn 28 degrees at a time. Because 28-degree turn bricks would be relatively uncommon in a solar array and because light-transmitting material cut at odd angles may be more expensive than rectangular panes, this particular type of brick need not have a light-transmitting top for the entire array to function at a reasonable heating capacity. As with the other types of bricks, the 28-degree turn bricks are designed to have a broad base for stability.

[0081] The gentle turn bricks may be, but don't necessarily need to be, 28.07 degrees. As long as the rectangular bricks are 1 unit wide and 1+x units long, where x is an integer, and the corresponding gentle turn bricks cause the driveway or walkway to turn twice as far as (arctan(x)) degrees, the driveway or walkway can have gentle turns with no breaks. The gentle turn bricks would have a width of 1 unit at each airway connecting end. The inner two sides would each be a distance of y units long, and the outer two sides would each be a distance of x+y units long. Having rectangular bricks 1 unit

by 1.25 units long is somewhat preferable because these dimensions enable extremely wide driveways or patios to turn a reasonably gentle 28 degrees at a time, and furthermore multiple 28 degree turns can be stacked together at fairly close distances with the judicious use of 1 unit×1.25 unit bricks, in an arrangement similar to that shown in FIG. 9.

[0082] Typical heat collecting structures have heretofore been on roofs or on frames, and as such they have been subject to wind load engineering problems. A heat collecting driveway or walkway has no wind load problem, being flat with the earth, and it fits unobtrusively into most house and building lots, occupying only the acreage that a normal driveway, walkway and/or patio would occupy.

[0083] In one embodiment a heat collecting walkway, driveway or patio is laid on top of an existing walkway, driveway or patio and dirt embankments are built up on all four sides of the patio, where in use the existing patio's surface provides sufficient drainage for the heat collector bricks. In one embodiment a heat collecting walkway, driveway or patio is installed on a south-slanting slope of land for better solar absorption.

[0084] In one embodiment the bricks are designed so that the light-transmitting tops of bricks are tipped up, so that the tops are pointed roughly toward the south, for improved solar absorption. Bricks with tipped tops would be no longer appropriate for walking upon or for driving upon, but they would gather heat inexpensively.

[0085] Although said invention has been described with respect to various embodiments, it should be realized this invention is also capable of a wide variety of further and other embodiments.

What is claimed is:

1. A closed loop active solar heat collector using air as a heat transfer medium, comprising a fan, blower or other air moving device, with one or more vent doors or other devices to inhibit natural air flow when the fan or blower is off, a mounting frame, two or more parallel groups of two air raceways which absorb solar heat, where the top sides of these parallel raceways are substantially in the same plane or slightly offset from each other in this plane to take best advantage of sunlight, where this plane is tilted roughly diagonally and roughly toward the south in the temperate Northern Hemisphere, where these air raceways comprise one or more layers of solar transmitting material designed to gather solar heat on their southward-tilted top side, with straight wind spill gaps between adjoining groups of raceways for substantially all of the raceways' lengths, where the wind spill gaps constitute 2% to 20% of the total possible solar collecting surface, with a connecting air path between the two air raceways in each group of two air raceways at one end of each pair of raceways, one or more insulated manifolds containing both a supply and return air duct which connect to the multiple pairs of air raceways at the other ends of each pair of raceways, and an active solar air heat storage device, where in use forced air collects heat as it travels up the manifold supply ducts, out and back through the raceways, back down the manifolds and through the solar heat storage device in a loop, and where outside wind gust overpressures on the two or more parallel groups of raceways are alleviated by air blowing through the wind gaps.

2. Claim 1, with an air fairing at the far end of one or more of the pairs of air raceways that allows a relatively slight amount of air to circulate behind the fairing for solar heat collection behind the fairing.

3. Claim 1, where pieces of the groups of two parallel air raceways are manufactured in modular sections and attached to frames on-site.

4. Claim 1, where air raceways emanate from both sides of a manifold.

5. Claim 1, where the supply and return ducts in one or more groups of air raceways are themselves separated by a wind gap constituting 2% to 20% of the total possible solar collecting surface, for substantially all of the raceways' length except at the far end from the manifold where the air raceways are connected.

6. An active solar heat storage unit using air as a heat transfer medium, comprising a fan, blower, solar chimney or other air moving device, air raceways which absorb solar heat, supply and return air channels to the heat storage unit, two or more parallel walls comprising rows of hollow concrete blocks or other hollow bricks or pipe sections with air passages through their centers, where the blocks are laid so that interior air passages substantially connect between adjacent hollow blocks, spacer objects to create small lateral air passages between adjacent blocks, layers of gravel, small rocks, sand or any other heat storage medium containing small air passages, which is laid between any two adjacent parallel rows of blocks, enclosures leading from one of the ducts to the hollow passages in each second alternating row of blocks, and an insulated, reasonably airtight enclosure around the heat storage device, where the supply and return ducts penetrate through this enclosure, where in use air is forced through the solar collectors, through the return duct to the rock bed storage unit, through the hollow passages in alternating rows of blocks, relatively slowly through a roughly fixed distance of heat storage medium between alternating rows of blocks, out through the second group of alternating rows of blocks and out the supply duct.

7. Claim 6, where the blocks have been constructed with tiny lateral air passages running from their central large air passages to their outside walls.

8. Claim 6, where the rows of blocks are laid with their internal air passages running roughly vertically, where the bottom ends of all of the rows of blocks are substantially closed off except for tiny lateral air passages, where air ducts connect to the top ends of alternating rows of blocks, with an air space inside the enclosure and above the rocks and blocks, and with pipes, finned pipes or other devices for the transfer of heat to fluids within the pipes, where in use, warm air rises and cool air sinks using the air passages in rows of blocks not covered by ducts.

9. Claim 6, where the roughly parallel rows of blocks are roughly arrayed in concentric circles, with inner channels running vertically, and where the ends of the blocks in the outermost concentric circle are substantially touching each other, for stability.

10. Claim 9, where the rock bed heat storage unit is substantially underground, and where soil, other fill or insulation pushes in on all sides of the outermost concentric circle of concrete blocks.

11. Claim 9, with roughly circular bands wrapped around the outermost circle of concrete blocks holding one or more of the outermost courses of blocks in their circular shape.

12. Claim 9, where a duct leads to the alternating concentric circles of blocks not including the outermost circle by running through the bottom of the rock bed, where these circles of blocks are blocked on their top ends, and where the

air passages on the other concentric circles of blocks are open to the enclosure's air on their top ends.

13. Claim 6, where the rows of blocks are laid with their internal air passages running roughly horizontally, with open air spaces within the enclosure on each end, with substantially no connecting air channel between these two open air spaces, where the supply air duct connects with one of the open air spaces and the return air duct connects with the other open air space, where alternating rows of blocks are substantially closed off at one end from one open air space and where the second group of alternating rows of blocks are substantially closed off at their other end from the other air space, so that in use, air is forced into the first set of alternating rows of blocks, through a roughly fixed distance of heat storage medium, and out the second set of alternating rows of blocks.

14. Claim 6, where the walls created by the outermost two rows or the outermost circle of blocks substantially lean inward on the rock bed, so that adjacent walls are slightly less parallel, so as to better support the rock bed's stability.

15. Claim 6 with pipes, finned pipes or other fluid-holding heat transfer devices in the air enclosure.

16. A closed loop active solar heat collector using air as a heat transfer medium, with a fan, blower or other air moving device, with one or more vent doors or other devices to inhibit natural air flow when the fan or blower is off, with an air-based heat storage unit, with a supply duct, with a return duct, and with four or more insulated solar collector blocks or bricks laid in the ground or flat on the ground, each of which connect to air raceways or ducts in one or more adjoining insulated blocks, with substantially all blocks comprising a flat light-transmitting material on their tops and gaskets sealing the light-transmitting material onto the insulated block, and one or two inner air raceways, where raceways on the

majority of the blocks run horizontally straight through the block, where some of the blocks bend the raceways, and where some of the blocks contain manifold air ducts so that at least three of their sides branch into raceways in adjacent blocks or into the supply or return ducts, such that in use the blocks absorb solar heat, which heats air, which is convected between the collectors and the rock bed heat storage unit, where in use the blocks fit together to create a flat pathway or driveway capable of supporting the weight of people, and where in use water can run down through the cracks between non-raceway block sides.

17. Claim 16, where the blocks have interlocking indentations and protrusions on those lateral edges that have air raceway openings.

18. Claim 16, with flexible supports or gaskets connecting the light-transmitting layer with the block's base, where in use the light-transmitting material has some give when human beings fall on the blocks.

19. Claim 16, with substantially parallel grooves on the top surface of the light-transmitting material on top of the blocks, where in use the grooves provide traction by shunting water away and they catch sunlight at oblique angles.

20. Claim 16, with a standard type of air raceway block that is 1 unit wide by 1 and $1/x$ units long, where x is an integer greater than 2, and where standard square blocks are 1 unit wide, and with a standard type of air raceway block that bends air raceways around a bend of roughly $(\arctan(x))^2$ degrees, where in use, walkways, patios and driveways containing arrays of blocks in multiple parallel rows may bend seamlessly around one or more bends that are less than 90 degree bends.

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