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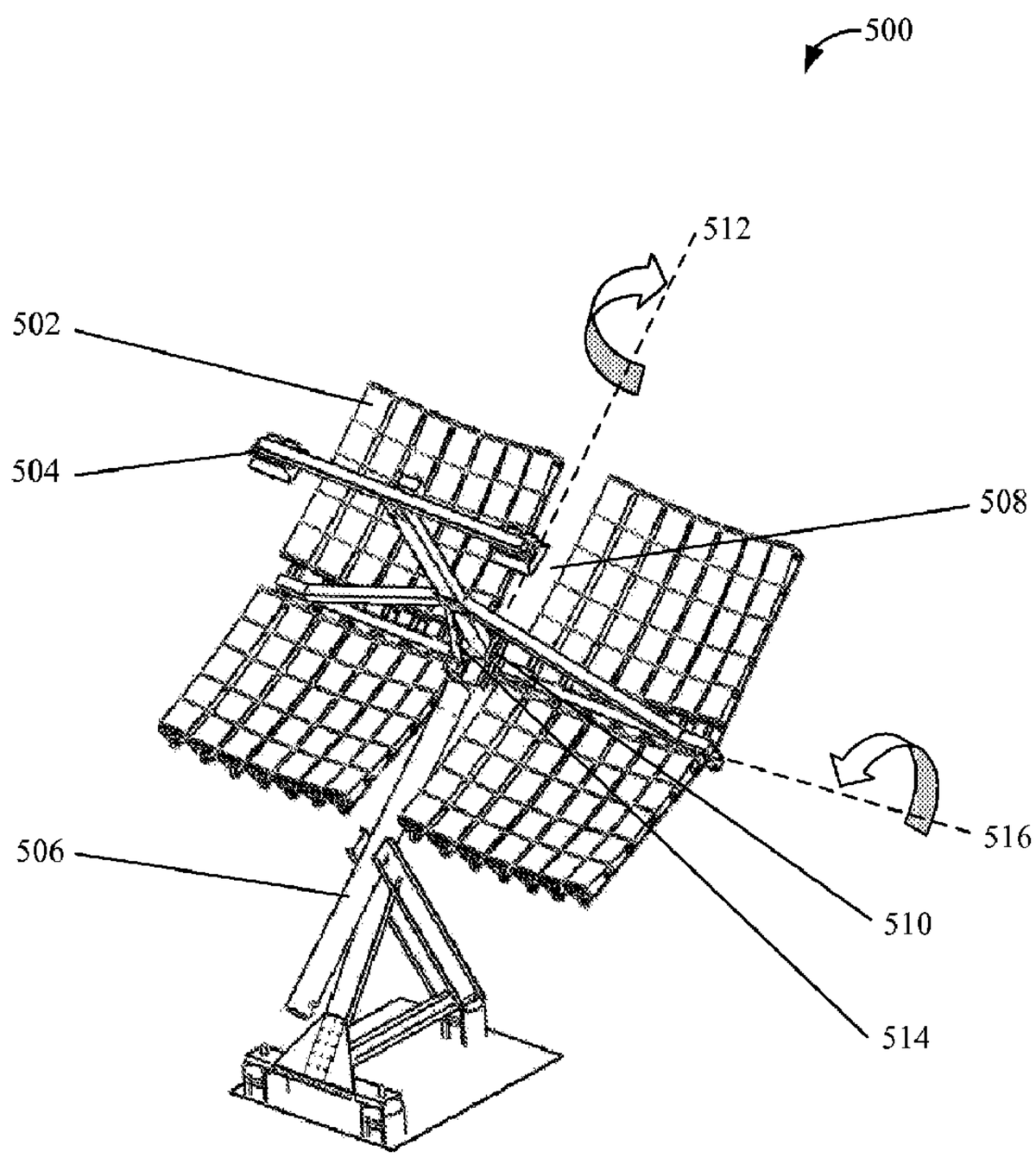


FIG. 5

(57) Abrégé/Abstract:
System(s) and method(s) for mounting, deploying, testing, operating, and managing a solar concentrator are provided. The innovation discloses mechanisms for evaluating the performance and quality of a solar collector via emission of modulated laser

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radiation upon (or near) a position of photovoltaic (PV) cells. The innovation discloses positioning two receivers at two distances from the source (e.g., solar collector or dish). These receivers are employed to collect light which can be compared to standards or other thresholds thereby diagnosing quality of the collectors. Receiver(s) includes photovoltaic (PV) module(s) for energy conversion, or module(s) for thermal energy harvesting. PV cell in PV modules can be laid out in various configurations to maximize electric current output. Moreover, a heat regulating assembly removes heat from the PV cells and other hot regions, to maintain the temperature gradient within predetermined levels.

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(54) Title: SOLAR COLLECTOR ASSEMBLY

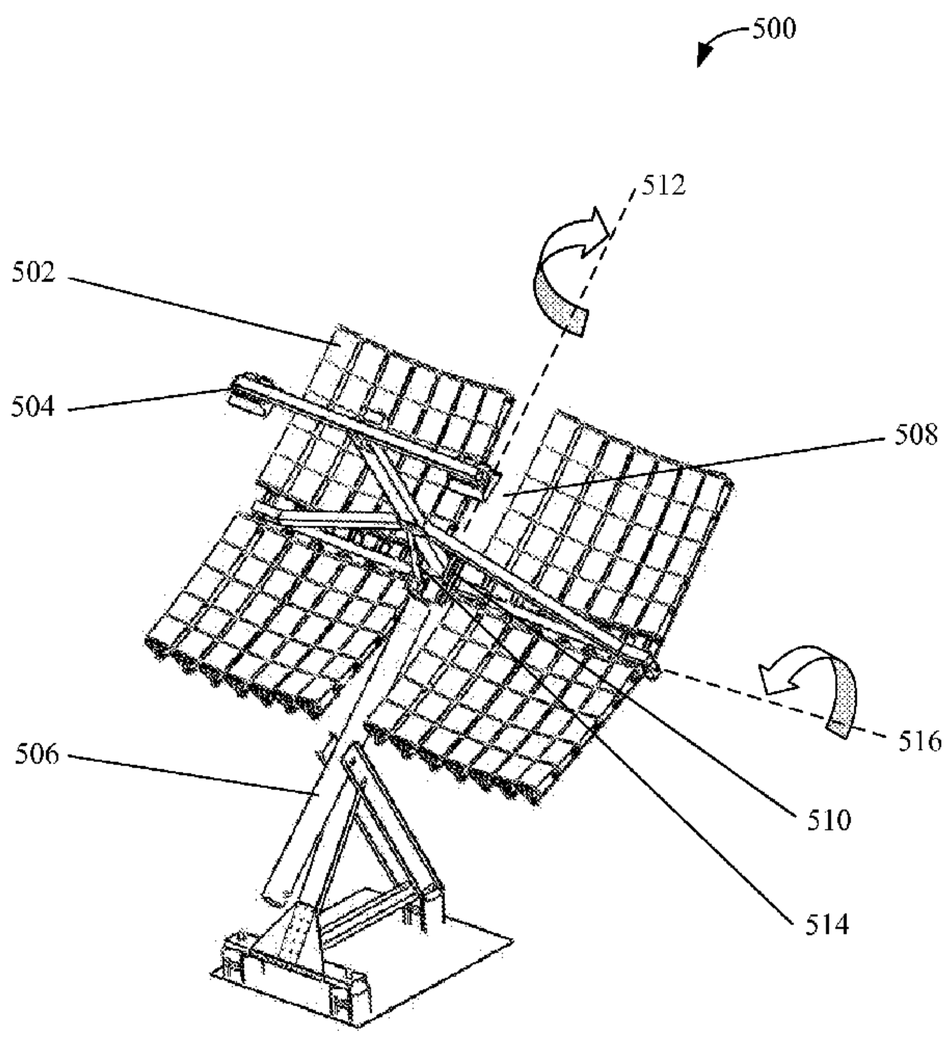


FIG. 5

(57) Abstract: System(s) and method(s) for mounting, deploying, testing, operating, and managing a solar concentrator are provided. The innovation discloses mechanisms for evaluating the performance and quality of a solar collector via emission of modulated laser radiation upon (or near) a position of photovoltaic (PV) cells. The innovation discloses positioning two receivers at two distances from the source (e.g., solar collector or dish). These receivers are employed to collect light which can be compared to standards or other thresholds thereby diagnosing quality of the collectors. Receiver(s) includes photovoltaic (PV) module(s) for energy conversion, or module(s) for thermal energy harvesting. PV cell in PV modules can be laid out in various configurations to maximize electric current output. Moreover, a heat regulating assembly removes heat from the PV cells and other hot regions, to maintain the temperature gradient within predetermined levels.

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SOLAR COLLECTOR ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/078,038 entitled "SOLAR CONCENTRATOR TESTING" and filed July 3, 2008; U.S. Provisional Application Serial No. 61/078,256 entitled "POLAR MOUNTING ARRANGEMENT FOR A SOLAR CONCENTRATOR" and filed July 3, 2008; U.S. Provisional Application Serial No. 61/077,991 entitled "SUN POSITION TRACKING" and filed July 3, 2008; U.S. Patent Application Serial No. 61/077,998 entitled "PLACEMENT OF A SOLAR COLLECTOR" and filed July 3, 2008; U.S. Provisional Patent Application Serial No. 61/078,245 entitled "MASS PRODUCIBLE SOLAR COLLECTOR" and filed July 3, 2008; U.S. Provisional Patent Application Serial No. 61/078,029 entitled "SOLAR CONCENTRATORS WITH TEMPERATURE REGULATION" and filed July 3, 2008, U.S. Provisional Patent Application Serial No. 61/078,259 entitled "LIGHT BEAM PATTERN AND PHOTOVOLTAIC ELEMENTS LAYOUT" and filed July 3, 2008, U.S. Patent Application Serial No. 12/495,303 entitled "SUN POSITION TRACKING" and filed June 30, 2009, U.S. Patent Application Serial No. 12/495,164 entitled "PLACEMENT OF A SOLAR COLLECTOR" and filed June 30, 2009, U.S. Patent Application Serial No. 12/495,398 entitled "MASS PRODUCIBLE SOLAR COLLECTOR" and filed June 30, 2009, U.S. Patent Application Serial No. 12/495,136 entitled "SOLAR CONCENTRATORS WITH TEMPERATURE REGULATION" and filed June 30, 2009, U.S. Patent Application Serial No. 12/496,034 entitled "POLAR MOUNTING ARRANGEMENT FOR A SOLAR CONCENTRATOR" and filed July 1, 2009, U.S. Patent Application Serial No. 12/496,150 entitled "SOLAR CONCENTRATOR TESTING" and filed July 1, 2009, and U.S. Patent Application Serial No. 12/496,541 entitled "LIGHT BEAM PATTERN AND PHOTOVOLTAIC ELEMENTS LAYOUT" and filed July 1, 2009. The entireties of the above-noted applications are incorporated by reference herein.

BACKGROUND

[0002] Limited supply of fossil energy resources and their associated global environmental damage have compelled market forces to diversify energy resources and related technologies. One such resource that has received significant attention is solar energy, which employs photovoltaic (PV) technology to convert light into electricity. Typically, PV production has been doubling every two years, increasing by an average of 48 percent each year since year 2002, making it the world's fastest-growing energy technology. By midyear 2008, estimates for cumulative global solar energy production capacity stands to at least 12,400 megawatts. Approximately 90% of such generating capacity consists of grid-tied electrical systems, wherein installations can be ground-mounted or built upon roofs or walls of a building, known as Building Integrated Photovoltaic (BIPV).

[0003] Moreover, significant technological progress has been achieved in design and production of solar panels, which are further accompanied by increased efficiency and reductions in manufacturing cost. In general, a major cost element involved in establishment of a wide-scale solar energy collection system is cost of support structure, which is employed to mount the solar panels of the array in proper position for receiving and converting solar energy. Other complexities in such arrangements involve efficient operations for the PV elements.

[0004] The PV elements for converting light to electric energy are often applied as solar cells to power supplies for small power in consumer-oriented products, such as desktop calculators, watches, and the like. Such systems are drawing attention as to their practicality for future alternate power of fossil fuels. In general, PV elements are elements that employ the photoelectromotive force (photovoltage) of the p-n junction, the Schottky junction, or semiconductors, in which the semiconductor of silicon, or the like, absorbs light to generate photocarriers such as electrons and holes, and the photocarriers drift outside due to an internal electric field of the p-n junction part.

[0005] One common PV element employs single-crystal silicon and semiconductor processes for production. For example, a crystal growth process prepares a single crystal of silicon valency-controlled in the p-type or in the n-type, wherein such single crystal is subsequently sliced into silicon wafers to achieve desired thicknesses.

Furthermore, the p-n junction can be prepared by forming layers of different conduction types, such as diffusion of a valance controller to make the conduction type opposite to that of a wafer.

[0006] In addition to consumer-oriented products, solar energy collection systems are employed for a variety of purposes, for example, as utility interactive power systems, power supplies for remote or unmanned sites, and cellular phone switch-site power supplies, among others. An array of energy conversion modules, such as, PV modules, in a solar energy collection system can have a capacity from a few kilowatts to a hundred kilowatts or more, depending upon the number of PV modules, also known as solar panels, used to form the array. The solar panels can be installed wherever there is exposure to the sun for significant portions of the day.

[0007] Typically, a solar energy collection system includes an array of solar panels arranged in form of rows and mounted on a support structure. Such solar panels can be oriented to optimize the solar panel energy output to suit the particular solar energy collection system design requirements. Solar panels can be mounted on a fixed structure, with a fixed orientation and fixed tilt, or can be mounted on a tracking structure that aims the solar panels toward the sun as the sun moves across the sky during the day and as the sun path moves in the sky during the year.

[0008] Nonetheless, controlling temperature of the photovoltaic cells remains critical for operation of such systems, and associated scalability remains a challenging task. Common approximations conclude that typically about 0.3% power is lost for every 1°C rise in the PV cell.

[0009] Solar technology is typically implemented in a series of solar (photovoltaic) cells or panels of cells that receive sunlight and convert the sunlight into electricity, which can be subsequently fed into a power grid. Significant progress has been achieved in design and production of solar panels, which has effectively increased efficiency while reducing manufacturing cost thereof. As more highly efficient solar cells are developed, size of the cell is decreasing leading to an increase in the practicality of employing solar panels to provide a competitive renewable energy substitute to dwindling and highly demanded non-renewable sources. To this end, solar energy collection systems can be deployed to feed solar energy into power grids.

[0010] Typically, a solar energy collection system includes an array of solar panels arranged in rows and mounted on a support structure. Such solar panels can be oriented to optimize the solar panel energy output to suit the particular solar energy collection system design requirements. Solar panels can be mounted on a fixed structure, with a fixed orientation and fixed tilt, or can be mounted on a moving structure to aim the solar panels toward the sun as properly orienting the panels to receive the maximum solar radiation will yield increased production of energy. Some automated tracking systems have been developed to point panels toward the sun based on the time and date alone, as the sun position can be somewhat predicted from these metrics; however, this does not provide for optimal alignment as the sun position can narrowly change from its calculated position. Other approaches include sensing light and accordingly aiming the solar panels toward the light. These technologies typically employ a shadow mask such that when the sun is on the axis of the detector, shadowed and directly illuminated areas of the cell are of equal size. However, such technologies detect light produced from many sources other than direct sunlight, such as reflection from clouds, lasers, *etc.*

[0011] For systems that concentrate light onto a receiver with photovoltaic cells for electricity generation or heat collection, a parabolic reflector is a technique that is utilized to achieve light concentration. Parabolic reflectors, formed in one dimension or two dimensions, are sometimes manufactured by pre-shaping or molding glass, plastic, or metal into a parabolic shape, which can be expensive. An alternative method is to form semi-parabolic reflectors attached to a frame made from bent aluminum tubing or other similar structures. In these and other conventional designs, the complexity of the structure limits mass production and ease of assembly of the design into a solar collector. In many cases, a crane is needed to assemble the structures and, as such, the assembly costs are high. Likewise, alignment of the mirrors can be difficult in the field. Further, the assembly itself can be difficult to service and maintain.

[0012] Parabolic reflectors are typically utilized to achieve light concentration. To produce electricity or heat, parabolic reflectors typically focus light into a focal area, or locus, which can be localized (e.g., a focal point) or extended (e.g., a focal line). Most reflector designs, however, posses substantial structural complexity that hinders mass producibility and ease of assembly of the design into a solar collector for energy

conversion. Moreover, structural complexity generally complicates alignment of reflective elements (e.g., mirrors) as well as installation and maintenance or service of deployed concentrators.

SUMMARY

[0013] The following presents a simplified summary of the innovation in order to provide a basic understanding of some aspects of the innovation. This summary is not an extensive overview of the innovation. It is not intended to identify key/critical elements of the innovation or to delineate the scope of the innovation. Its sole purpose is to present some concepts of the innovation in a simplified form as a prelude to the more detailed description that is presented later.

[0014] The innovation disclosed and claimed herein, in one aspect thereof, comprises a systems (and corresponding methodologies) for testing, evaluating and diagnosing quality of solar concentrator optics. Essentially, the innovation discloses mechanisms for evaluating the performance and quality of a solar collector by way of emission of modulated laser radiation upon (or near) a position of photovoltaic (PV) cells. In one example, this emission would be at (or substantially near) the focus of the parabola of a true parabolic reflector.

[0015] The innovation discloses positioning two receivers at two distances from the source (*e.g.*, solar collector or dish). These receivers are employed to collect modulated light which can be compared to standards or other thresholds. In other words, the strength of the received light can be compared to industry standards or some other preprogrammed or inferred value. Accordingly, performance-related conclusions can be drawn from the result of the comparison.

[0016] In other aspects, performance of the optics can be adjusted if desired to enhance results observed by the receivers. For instance, mechanical mechanisms (*e.g.*, motor and controller) can be employed to automatically 'tune' or 'fine-tune' the collector (or a subset of the collector) in order to achieve acceptable or desired performance.

[0017] Conventional methods of mounting a solar array in a solar collection system involve having the array mounted offset from a supporting structure. However,

during tracking of the sun by the array, larger capacity motors can be used to overcome the effects of the displaced center-of-gravity of the array, decreasing the efficiency of the system.

[0018] With the disclosed subject matter, an array is disclosed such that the array is mounted in a plane of a supporting structure allowing the center-of-gravity of the array about the axis of the supporting structure to be maintained. In comparison with conventional systems, smaller motors can be utilized to position the array as the effects of a displaced center-of-gravity are minimized. Further, the array can be rotated about the supporting structure allowing the array to be placed in a safety position to prevent damage of the components that comprise the array, *e.g.*, photovoltaic cells, mirrors, etc. The array can also be positioned to facilitate ease of maintenance and installation.

[0019] Tracking position of the sun is provided where direct sunlight can be detected over other sources of light. In this regard, solar cells can be concentrated substantially directly on the sunlight yielding high energy efficiency. In particular, light analyzers can operate in conjunction within a sunlight tracker where each analyzer can receive one of a plurality of light sources. Resulting photo-signals from the analyzers can be produced and compared to determine if the light is direct sunlight; in this regard, sources that are not determined to be direct sunlight can be ignored. In one example, the light analyzers can comprise a polarizer, spectral filter, ball lens, and/or a quadrant cell to effectuate this purpose. In addition, an amplifier can be provided to convey a resulting photo-signal for processing thereof, for instance.

[0020] According to an example, a number of light analyzers can be configured in a given sunlight tracker. For instance, the polarizers of the light analyzers can be utilized to ensure substantial non-polarization of the original light source, as is the case for direct sunlight. In an example, the spectral filter of the light analyzer can be utilized to block certain light wavelengths allowing a range utilized by sunlight. Moreover, ball lens and quadrant cell configurations can be utilized to determine a collimation property of the light to further identify direct sunlight as well as correct alignment of the axis to receive a high amount of direct sunlight. The resulting photo-signal from each light analyzer can be collected and compared amongst the others to determine if the light source is direct sunlight. In one example, where the light is determined to be direct sunlight, position of

a solar panel can be automatically adjusted, according to a position of the light through a ball lens and on a quadrant cell, so the sunlight is optimally aligned with the axis of the quadrant cells.

[0021] In conventional operation, a solar concentrator can be positioned through use of an encoder. The encoder can be programmed with solar position estimations based upon a time and date; a time and date can be gathered and based upon the gathered information an appropriate position for the concentrator can be determined. However, if a solar concentrator configuration is intentionally moved, movement occurs through natural occurrence, *etc.*, then the encoder can become less accurate without reprogramming.

[0022] With the disclosed innovation, a measurement of a force placed upon a solar concentrator with respect to gravity can be calculated and used in conjunction with placing the solar concentrator. A comparison can be made between the measurement and a desired value to determine where to place the solar concentrator. Accordingly, an instruction to move the receiver can be generated and transferred to a motor system. With regard to one embodiment, a pair of inclinometers can be firmly attached to a solar dish such that an angle that the dish is pointed with respect to gravity can be measured.

[0023] Further, various aspects are described in connection with simplifying production, shipment, assembly, and maintenance of solar collectors. The disclosed aspects relate to an inexpensive and simplified manner of producing solar collectors and solar collector assemblies that are easily assembled. Further, the aspects disclosed herein allow for inexpensive shipment of a large number of dishes (*e.g.,* solar assemblies) in a modular and/or partially assembled state.

[0024] One or more aspects relate to the manner in which the mirrors are formed into a parabolic shape, held in position, and assembled. Spacing is maintained between mirror wing assemblies to mitigate the effect wind forces can have on the collector during periods of high winds (*e.g.,* storm). The mirror wing assemblies are mounted to a backbone in such a manner that some flexibility is allowed so that the unit moves slightly in response to forces of the wind. However, the unit retains rigidity to maintain the focus of sunlight on the receivers. In accordance with some aspects, the mirror wing assemblies can be arranged as a trough design. Further, the positioning of a polar mount

at or near a center of gravity allows movement of the collector for ease of service, storage, or the like.

[0025] Another aspect of the subject innovation supplies a system of solar concentrators with a heat regulating assembly, which regulates (*e.g.*, in real time) heat dissipation therefrom. Such system of solar concentrators can include a modular arrangement of photovoltaic (PV) cells, wherein the heat regulating assembly can remove generated heat from hot spot areas to maintain temperature gradient for the modular arrangement of PV cells within predetermined levels. In one aspect, such heat regulating assembly can be in form of a heat sink arrangement, which includes a plurality of heat sinks to be surface mounted to a back side of the modular arrangement of photovoltaic cells, wherein each heat sink can further include a plurality of fins extending substantially perpendicular the back side. The fins can expand a surface area of the heat sink to increase contact with cooling medium (*e.g.*, air, cooling fluid such as water), which is employed to dissipate heat from the fins and/or photovoltaic cells. As such, heat from the photovoltaic cells can be conducted through the heat sink and into surrounding cooling medium. Moreover, the heat sinks can have a substantially small form factor relative to the photovoltaic cell, to enable efficient distribution throughout the backside of the modular arrangement of photovoltaic cells. In one aspect, heat from the photovoltaic cells can be conducted through thermal conducting paths (*e.g.*, metal layers), to the heat sinks to mitigate direct physical or thermal conduct of the heat sinks to the photovoltaic cells. Such an arrangement provides a scalable solution for proper operation of the PV modular arrangement.

[0026] In a related aspect, the heat sinks can be positioned in a variety of planar or three dimensional arrangements as to monitor, regulate and over all manage heat flow away from the photovoltaic cells. Moreover, each heat sink can further employ thermo/electrical structures that can have a shape of a spiral, twister, corkscrew, maze, or other structural shapes with a denser pattern distribution of lines in one portion and a relatively less dense pattern distribution of lines in other portions. For example, one portion of such structures can be formed of a material that provides relatively high isotropic conductivity and another portion can be formed of a material that provides high thermal conductivity in another direction. Accordingly, each thermo/electrical structure

of the heat regulating assembly provides for a heat conducting path that can dissipate heat from the hot spots and into the various heat conducting layers, or associated heat sinks, of the heat regulating device.

[0027] Another aspect of the subject innovation provides for a heat regulating device with a base or back plate that can be kept in direct contact with a hot spot region of the modular photovoltaic arrangement. The base plate can include a heat promoting section and main base plate section. The heat promoting section facilitates heat transfer between the modular photovoltaic arrangement and the heat regulating device. The main base plate section can further include thermo structures embedded inside. Such permits for the heat generated from a photovoltaic cell to be initially diffused or dispersed through the whole main base plate section and then into the thermo structure spreading assembly, wherein such spreading assembly can be connected to the heat sinks.

[0028] According to a further aspect, the assembly of thermo structures can be connected to form a network with its operation controlled by a controller. In response to data gathered from the system (*e.g.,* sensors, the thermo/electric structure assembly, and the like) the controller determines the amount and speed in which the cooling medium is to be released for interaction with the thermal structure (*e.g.*, to take heat out of the photovoltaic cells so that the hot spots are eliminated and a more uniform temperature gradient is achieved in the modular arrangement of photovoltaic cells.) For example, based on collected measurements, a microprocessor regulates operation of a valve to maintain temperature within a predetermined range (*e.g.*, water acting as a coolant supplied from a reservior to flow through the PV cells.) Moreover, the system can incorporate various sensors to assess proper operation (*e.g.*, health of the system) and to diagnose problems for rapid maintenance. In one aspect, upon exiting the heat regulating device and/or photovoltaic cells, the coolant can enter a Venturi tube, wherein pressure sensors enable a measurement of a flow rate thereof. Such further enables for verification of: the flow rate set, amount of coolant, blockages to the flow, and the like by a microprocessor of the control system.

[0029] In a related aspect, the system of solar concentrators can further include solar thermals – wherein the heat regulating assembly of the subject innovation can also be implemented as part of such hybrid system that produces both electrical energy and

thermal energy, to facilitate optimizing energy output. Put differently, the thermal energy accumulated in the medium employed for cooling PV cells during a cooling process thereof, can subsequently serve as preheated medium or for thermal generation (*e.g.*, supplied to customers - such as thermal loads.) The controller of the subject innovation can also actively manage (*e.g.*, in real time) tradeoff between thermal energy and PV efficiency, wherein a control network of valves can regulate flow of coolant medium through each solar concentrator. The heat regulating assembly can be in form of a network of conduits, such as pipelines for channeling a cooling medium (*e.g.*, pressurized and/or under free flow), throughout a grid of solar concentrators. The control component can regulate (*e.g.*, automatically) operation of the valves based on sensor data (*e.g.*, measurement of temperature, pressure, flow rate, fluid velocity, and the like throughout the system.)

[0030] Furthermore, the subject innovation provides system(s) and method(s) for assembling and utilizing low-cost, mass producible parabolic reflectors in a solar concentrator for energy conversion. Parabolic reflectors can be assembled by starting with a flat reflective material that is bent into a parabolic or through shape via a set of support ribs that are affixed in a support beam. The parabolic reflectors are mounted on a support frame in various panels or arrays to form a parabolic solar concentrator. Each parabolic reflector focuses light in a line segment pattern. Light beam pattern focused onto a receiver via the parabolic solar concentrator can be optimized to attain a predetermined performance. The receiver is attached to the support frame, opposite the parabolic reflector arrays, and includes a photovoltaic (PV) module and a heat harvesting element or component. To increase or retain a desired performance of the parabolic solar concentrator, the PV module can be configured, through adequate arrangement of PV cells that are monolithic, for example, and exhibit a preferential orientation, to advantageously exploit a light beam pattern optimization regardless of irregularities in the pattern.

[0031] To the accomplishment of the foregoing and related ends, certain illustrative aspects of the innovation are described herein in connection with the following description and the annexed drawings. These aspects are indicative, however, of but a few of the various ways in which the principles of the innovation can be

employed and the subject innovation is intended to include all such aspects and their equivalents. Other advantages and novel features of the innovation will become apparent from the following detailed description of the innovation when considered in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. 1 illustrates an example block diagram of a system that facilitates testing, evaluation and diagnosis of solar collector performance in accordance with an aspect of the innovation.

[0033] FIG. 2 illustrates an example alternative block diagram of a system that facilitates testing, evaluation and diagnosis of solar collector performance in accordance with an aspect of the innovation.

[0034] FIG. 3 illustrates an example flow chart of procedures that facilitate testing, evaluating and diagnosing solar collector performance in accordance with an aspect of the innovation.

[0035] FIG. 4 illustrates a block diagram of a computer operable to execute the disclosed architecture.

[0036] FIG. 5 illustrates a representative configuration of an energy collector aligned with an energy source in accordance with an aspect of the subject specification.

[0037] FIG. 6 illustrates the change in position of the sun with respect to the earth in accordance with an aspect of the subject specification.

[0038] FIG. 7 illustrates the variation in declination angle of the sun with respect to the earth throughout the year in accordance with an aspect of the subject specification.

[0039] FIG. 8 illustrates a solar array in accordance with an aspect of the subject specification.

[0040] FIG. 9 illustrates a solar array in accordance with an aspect of the subject specification.

[0041] FIG. 10 illustrates a representative system in which the solar array can be incorporated in accordance with an aspect of the subject specification.

[0042] FIG. 11 illustrates an assembly for connecting and aligning a polar mount a solar array in accordance with an aspect of the subject specification.

[0043] FIG. 12 illustrates an assembly to facilitate tilting of a solar array in accordance with an aspect of the subject specification.

[0044] FIG. 13 illustrates a prior-art system showing the displaced center-of-gravity of an array with respect to a support in accordance with an aspect of the subject specification.

[0045] FIG. 14 illustrates a solar array in a safety position in accordance with an aspect of the subject specification.

[0046] FIG. 15 illustrates a solar array in a position for safety, maintenance, installation, *etc.*, in accordance with an aspect of the subject specification.

[0047] FIG. 16 illustrates a representative methodology for constructing, mounting and positioning a solar array in accordance with an aspect of the subject specification.

[0048] FIG. 17 illustrates a representative methodology for positioning a solar array in a safety position in accordance with an aspect of the subject specification.

[0049] FIG. 18 illustrates a block diagram of an exemplary system that facilitates tracking and positioning a device into direct sunlight.

[0050] FIG. 19 illustrates a block diagram of an exemplary system that facilitates tracking position of the sun.

[0051] FIG. 20 illustrates a block diagram of an exemplary system that facilitates tracking the sun and appropriately positioning solar cells.

[0052] FIG. 21 illustrates a block diagram of an exemplary system that facilitates remotely positioning solar cells based on sun position tracking.

[0053] FIG. 22 illustrates an exemplary system that facilitates optimally aligning solar cells based on a position of direct sunlight.

[0054] FIG. 23 illustrates an exemplary flow chart for determining polarization of a light source.

[0055] FIG. 24 illustrates an exemplary flow chart for determining whether a light source is direct sunlight.

[0056] FIG. 25 illustrates an exemplary flow chart for positioning solar cells to optimally receive direct sunlight.

[0057] FIG. 26 illustrates a representative configuration of an energy collector aligned with an energy source in accordance with an aspect of the subject specification.

[0058] FIG. 27 illustrates a representative system for comparing a desired energy collector location against an actual location in accordance with an aspect of the subject specification.

[0059] FIG. 28 illustrates a representative system for aligning an energy collector with relation to gravity in accordance with an aspect of the subject specification.

[0060] FIG. 29 illustrates a representative system for aligning a gravity determination entity in accordance with an aspect of the subject specification.

[0061] FIG. 30 illustrates a representative system for comparing a desired energy collector location against an actual location with a detailed obtainment component in accordance with an aspect of the subject specification.

[0062] FIG. 31 illustrates a representative system for comparing a desired energy collector location against an actual location with a detailed evaluation component in accordance with an aspect of the subject specification.

[0063] FIG. 32 illustrates a representative energy collection evaluation methodology in accordance with an aspect of the subject specification.

[0064] FIG. 33 illustrates a representative methodology for performing gravity-based analysis concerning energy collection in accordance with an aspect of the subject specification.

[0065] FIG. 34 illustrates a solar wing assembly that is simplified as compared to conventional solar collector assemblies, according to an aspect.

[0066] FIG. 35 illustrates another view of the solar wing assembly of FIG. 34, in accordance with an aspect.

[0067] FIG. 36 illustrates an example schematic representation of a portion of a solar wing assembly with a mirror in a partially unsecure position, according to an aspect

[0068] FIG. 37 illustrates an example schematic representation of a portion of a solar wing assembly with a mirror in a secure position, according to an aspect.

[0069] FIG. 38 illustrates another example schematic representation of a portion of a solar wing assembly in accordance with an aspect.

[0070] FIG. 39 illustrates a backbone structure for a solar collector assembly in accordance with the disclosed aspects.

[0071] FIG. 40 illustrates a schematic representation of a solar wing assembly and a bracket that can be utilized to attach the solar wing assembly to the backbone structure, according to an aspect.

[0072] FIG. 41 illustrates a schematic representation of an example focus length that represents an arrangement of the solar wing assemblies to the backbone structure in accordance with an aspect.

[0073] FIG. 42 illustrates a schematic representation of a solar collection assembly that utilizes four arrays comprising a multitude of solar wing assemblies, according to an aspect.

[0074] FIG. 43 illustrates a simplified polar mount that can be utilized with the disclosed aspects.

[0075] FIG. 44 illustrates an example motor gear arrangement that can be utilized to control rotation of a solar collector assembly, according to an aspect.

[0076] FIG. 45 illustrates another example motor gear arrangement that can be utilized for rotation control, according to an aspect.

[0077] FIG. 46 illustrates a polar mounting pole that can be utilized with the disclosed aspects.

[0078] FIG. 47 illustrates another example of a polar mounting pole that can be utilized with the various aspects.

[0079] FIG. 48 illustrates a view of a first end of a polar mounting pole.

[0080] FIG. 49 illustrates a fully assembled solar collector assembly in an operating condition, according to an aspect.

[0081] FIG. 50 illustrates a schematic representation of a solar collector assembly in a tilted position, according to an aspect.

[0082] FIG. 51 illustrates a schematic representation of a solar collector assembly rotated in an orientation that is substantially different from an operating condition, according to aspect.

[0083] FIG. 52 illustrates a solar collector assembly rotated and lowered in accordance with the various aspects presented herein.

[0084] FIG. 53 illustrates a schematic representation of a solar collector assembly in a lowered position, according to an aspect.

[0085] FIG. 54 illustrates a schematic representation of a solar collector assembly in a lowest position, which can be a storage position, according to an aspect.

[0086] FIG. 55 illustrates another solar collection assembly that can be utilized with the disclosed aspects.

[0087] FIG. 56 illustrates an example receiver that can be utilized with the disclosed aspects.

[0088] FIG. 57 illustrates an alternative view of the example receiver illustrated in FIG. 56, according to an aspect.

[0089] FIG. 58 illustrates a method for mass-producing solar collectors in accordance with one or more aspects.

[0090] FIG. 59 illustrates a method for erecting a solar collector assembly, according to an aspect.

[0091] FIG. 60 illustrates a schematic block diagram of a cross sectional view for heat regulating device that dissipates heat from a modular arrangement of photovoltaic (PV) cells according to an aspect of the subject innovation.

[0092] FIG. 61 illustrates a schematic perspective for an assembly layout of the modular arrangement of PV cells in form of a PV grid in accordance with an aspect of the subject innovation.

[0093] FIG. 62 illustrates a schematic block diagram of a heat regulation system according to a further aspect of the subject innovation.

[0094] FIG. 63 illustrates an exemplary temperature grid pattern to monitor a PV grid assembly according to an aspect of the subject innovation.

[0095] FIG. 64 is a representative table of temperature amplitudes taken at the various grid blocks according to a further aspect of the subject innovation.

[0096] FIG. 65 illustrates a schematic diagram of a system that controls temperature of the photovoltaic grid assembly according to a particular aspect of the subject innovation.

[0097] FIG. 66 illustrates a related methodology of dissipating heat from PV cells according to an aspect of the subject innovation.

[0098] FIG. 67 illustrates a further methodology of heat dissipation for a PV grid assembly according to an aspect of the subject innovation.

[0099] FIG. 68 illustrates a schematic block diagram of a system that employs fluid as the cooling medium according to an aspect of the subject innovation.

[00100] FIG. 69 illustrates an exemplary solar grid arrangement that employs a heat regulating assembly according to a further aspect of the subject innovation.

[00101] FIG. 70 illustrates a related methodology for operation of the heat regulating assembly according to an aspect of the subject innovation.

[00102] FIGs. 71A and 71B illustrate, respectively, a diagram of an example parabolic solar concentrator and a focused light beam in accordance with aspects disclosed in the subject application.

[00103] FIG. 72 illustrates an example constituent reflector, herein termed solar wing assembly in accordance with aspects described herein.

[00104] FIGs. 73A and 73B illustrates attachment positions of constituent solar reflectors to a main support beam in a solar concentrator in accordance with aspects described herein.

[00105] FIGs. 74A-74B illustrate, respectively, an example single-receiver configuration and an example double-receiver arrangement in accordance with aspects described herein.

[00106] FIG. 75 illustrates a "bow tie" distortion of a collected light beam focused on a receiver in accordance with aspects described herein.

[00107] FIG. 76 is a diagram of typical slight distortions that can be corrected prior to deployment of a solar concentrator(s) or can be adjusted during scheduled maintenance sessions in accordance with aspects disclosed in the subject specification.

[00108] FIG. 77 illustrates a diagram of an adjusted focused light beam pattern in accordance with an aspect described herein.

[00109] FIG. 78 is a diagram of a receiver in a solar collector for energy conversion in accordance with aspects described herein.

[00110] FIGs. 79A-79B illustrates diagrams of a receiver in accordance with aspects described herein.

[00111] FIG. 80 is a rendition of a light beam pattern focused on a receiver in accordance with aspects described herein.

[00112] FIGs. 81A-81B display example embodiment of PV modules in accordance with aspects described herein.

[00113] FIG. 82 displays an embodiment of a channelized heat collector that can be mechanically coupled to a PV module to extract heat there from in accordance with aspects of the subject innovation.

[00114] FIGs. 83A-83C illustrate example scenarios for illumination of active PV element(s) through sunlight collection via parabolic solar concentrator in accordance with aspects described herein.

[00115] FIG. 84 is a plot of a computer simulation of the light beam distribution for a parabolic concentrator in accordance with aspects disclosed in the subject specification.

[00116] FIGs. 85A-85C illustrate examples of cluster configurations of PV cells in accordance with aspects described herein.

[00117] FIG. 86A-86B illustrate two example cluster configurations of PV cells that enable passive correction of changes of focused beam light pattern in accordance with aspects described herein. FIG. 86C displays an example configuration for collection of produced electrical current in accordance with aspects described herein.

[00118] FIG. 87 is a block diagram of an example tracking system that enables adjustment of position(s) of a solar collector or reflector panel(s) thereof to maximize a performance metric of the solar collector in accordance with aspects described herein.

[00119] FIGs. 88A-88B represent disparate views of an embodiment of a sunlight receiver that exploits a broad collector in accordance with aspects described herein.

[00120] FIG. 89 displays an example alternative or additional embodiment of a sunlight receiver that exploits a broad collector in accordance with aspects described herein.

[00121] FIG. 90 illustrates a ray-tracing simulation of light incidence onto the surface of a PV module that result from multiple reflections on the inner surface of a reflective guide in a broad-collector receiver.

[00122] FIG. 91 presents a simulated image of light collected at a PV module in a broad-collector receiver with a reflective guide attached thereof.

[00123] FIG. 92 presents a flowchart of an example method for utilizing parabolic reflectors to concentrate light for energy conversion in accordance with aspects described herein.

[00124] FIG. 93 is a flowchart of an example method to adjust a position of a solar concentrator to achieve a predetermined performance in accordance with aspects described herein.

DETAILED DESCRIPTION

[00125] The innovation is now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the subject innovation. It may be evident, however, that the innovation can be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing the innovation.

[00126] As used in this application, the terms "component," "system," "module," "interface," "platform," "layer," "node," "selector," are intended to refer to a computer-related entity, either hardware, a combination of hardware and software, software, or software in execution. For example, a component can be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a server and the server can be a component. One or more components can reside within a process and/or thread of execution, and a component can be localized on one computer and/or distributed between two or more computers. Also, these components can execute from various computer readable media having various data structures stored thereon. The components may communicate via local and/or remote processes such as in accordance with a signal having one or more data packets (e.g., data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems via the signal).

As another example, a component can be an apparatus with specific functionality provided by mechanical parts operated by electric or electronic circuitry, which is operated by a software, or firmware application executed by a processor, wherein the processor can be internal or external to the apparatus and executes at least a part of the software or firmware application. As yet another example, a component can be an apparatus that provides specific functionality through electronic components without mechanical parts, the electronic components can include a processor therein to execute software or firmware that confers at least in part the functionality of the electronic components. As further yet another example, interface(s) can include input/output (I/O) components as well as associated processor, application, or Application Programming Interface (API) components.

[00127] In addition, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or." That is, unless specified otherwise, or clear from context, "X employs A or B" is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then "X employs A or B" is satisfied under any of the foregoing instances. Moreover, articles "a" and "an" as used in the subject specification and annexed drawings should generally be construed to mean "one or more" unless specified otherwise or clear from context to be directed to a singular form.

[00128] As used herein, the term to "infer" or "inference" refer generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured *via* events and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic–that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are correlated in close temporal proximity, and whether the events and data come from one or several event and data sources.

[00129] Much of the capital cost required to produce solar power is in the silicon for the photovoltaic (PV) cells or photocells. However, now that suitable photovoltaic cells are available that can operate at 1000 suns, this cost can be reduced by concentrating the sunlight on a relatively small area of silicon. To do this successfully, the reflective material (*e.g.*, mirror) must perform very well indeed.

[00130] In most applications, this requirement is even more demanding since the concentrator is most often assembled in the field. Thus, the innovation discloses methods and devices (components) that can permit rapid evaluation of the quality of the concentrator optics and also provide diagnostics in the event of unacceptable performance. Additionally, the innovation enables tuning of the concentrator to achieve optimal or acceptable performance standards.

[00131] Referring initially to the drawings, FIG. 1 illustrates a system 100 that employs a solar concentrator testing system 102. In operation, the testing system 102 is capable of assessing or evaluating performance of the solar concentrator, or portion thereof, as illustrated. It is to be understood that the testing system can be employed to assess a single reflector (*e.g.*, parabolic reflector) as well as troughs of reflectors (*e.g.*, arranged parabolicly around the PV cells).

[00132] Generally, in aspects, the testing system 102 emits modulated light upon a reflector and employs receivers to measure and evaluate the reflected light. This received modulated light can be compared against standards or other thresholds (*e.g.*, benchmarks, programs) in order to establish if the performance is acceptable or alternatively, if tuning or other modification is required. The features, functions and benefits of the testing system 102 will be better understood upon a review of FIG. 2 that follows.

[00133] Referring now to FIG. 2, an alternative block diagram of a solar concentrator testing system 102 is shown. Generally, the testing system 102 can include a laser emitter component 202, receiver components 204, 206 and a processor component 208. Together, these sub-components (202-208) facilitate evaluation of solar concentrators.

[00134] The laser emitter component 202 is capable of discharging modulated laser radiation near the position where PV cells would be located. For example, in the case of a true parabolic reflector, this position would be at the focus of the parabola. In

the case of a trough of reflectors, the position would be at (or near) the centerline focus of the concentrator. In other words, where multiple reflectors are arrange upon a trough in a parabolic shape, the position would be at or near the centerline focus of the collective parabola. It is to be understood that, while a laser emitter component 202 is provided, other aspects can employ other suitable light sources (not shown). These alternative aspects are to be included within the scope of this disclosure and claims appended hereto.

[00135] As illustrated, two receivers 204, 206 can be arranged, for example, at different distances from the dish (or reflector). In examples, the receivers can be temporarily attached to the pedestals of two other dishes in an array of solar dishes. Both of the receivers 204, 206 as well as the dish itself can be communicatively coupled to a processor component 208. In one example, the processor component 208 can be a laptop or notebook computing device capable of processing received data and signals. In other examples, the processor component 208 can be a smartphone, pocket computer, personal digital assistant (PDA) or the like.

[00136] The processor component 208 can command the dish to scan thereby collecting data associated with the emitted modulated radiation. Similarly, the receivers (204, 206) can collect data associated with the emitted modulated radiation. Subsequently, the processor component 208 can build up two signal strength surfaces at two distances from the dish. These signal strengths can be compared to standard (or otherwise programmed) profiles by which quality of the concentrator collection optics can be determined.

[00137] FIG. 3 illustrates a methodology of testing solar concentrators in accordance with an aspect of the innovation. While, for purposes of simplicity of explanation, the one or more methodologies shown herein, *e.g.*, in the form of a flow chart, are shown and described as a series of acts, it is to be understood and appreciated that the subject innovation is not limited by the order of acts, as some acts may, in accordance with the innovation, occur in a different order and/or concurrently with other acts from that shown and described herein. For example, those skilled in the art will understand and appreciate that a methodology could alternatively be represented as a series of interrelated states or events, such as in a state diagram. Moreover, not all

illustrated acts may be required to implement a methodology in accordance with the innovation.

[00138] As described above, the innovation employs only simple and compact laser emitters (*e.g.*, 202 of FIG. 2) and detectors (*e.g.*, receivers 204, 206 of FIG. 2) which can be easily located at known positions. Motion can be accomplished by the dish itself using its declination and ascension axis motors to scan the dish back and forth to allow a pattern to be built up in a computer (*e.g.*, processor 208 of FIG. 2). The use of modulated laser light (*e.g.*, laser emitter component 202 of FIG. 2) can allow the exclusion of ambient sources of light from influencing the test results. Also, it is to be understood that modulation allows sensitive detection of low light levels. Moreover, the testing is essentially automatic and does not require highly trained personnel.

[00139] If light is detected where it should not occur, the system (100 of FIGS. 1 and 2) in diagnostic mode can automatically cause the dish to move to the position where this light is detected. By positioning at the detector (*e.g.*, receiver 204, 206 of FIG. 2), the operator can visually see where the light came from, indicating the part of the structure in need of adjustment. Alternatively, automated diagnostics can be performed in order to effect adjustment or tuning.

[00140] Referring now to the methodology of FIG. 3, at 302, modulated laser radiation is emitted upon a concentrator. The innovation provides for installing a means or device which emits modulated laser radiation near the position where the photovoltaic cells would normally be located. In one example, for a true parabolic reflector, this would be at the focus of the parabola. In an alternative concentrator arrangement, *e.g.*, where the concentrator is actually a collection of trough reflectors arranged parabolicly around the photovoltaic cells, the laser can be placed at or near the center of the line focus of the concentrator.

[00141] Modulated reflected light can be received at two disparate positions or distances from a reflector surface at 304, 406. Here, two receivers optimized for receiving the modulated light can be arranged at two distances from the dish. For example, these receivers can be attached (*e.g.*, temporarily attached) to the pedestals of two other dishes in an array of solar dishes. While aspects described herein employ two receivers (*e.g.*, 204, 206 of FIG. 2), it is to be understood that alternative aspects can

employ one or more receivers without departing from the scope of this disclosure and claims appended hereto. As well, while the aspect described positions the detectors (204, 206 of FIG. 2) at disparate distances, it is to be understood that all or a subset of the receivers can be positioned at an equal distances. These alternative aspects are to be included within the scope of this disclosure and claims appended hereto.

[00142] It is to be understood that the receivers and the dish itself could be in communication with another device, for example, a processor such as a laptop computer. This processor device can command the dish (or concentrators) to scan at 308, while, at 310, the receivers report the strength of signal which they receive from the laser. This allows the laptop computer to build up two signal strength surfaces at two distances from the dish. These signal strength surfaces could be compared to standard profiles at 312 and the quality of the concentrator collection optics could be judged or determined at 314.

[00143] As described above, this information can additionally be employed to diagnose and/or adjust the concentrator as desired or appropriate. While these acts are not illustrated in FIG. 3, it is to be understood that these features, functions and benefits are to included within the scope of the innovation and claims appended hereto.

[00144] Referring now to FIG. 4, there is illustrated a block diagram of a computer operable to execute the disclosed architecture. In order to provide additional context for various aspects of the subject innovation, FIG. 4 and the following discussion are intended to provide a brief, general description of a suitable computing environment 400 in which the various aspects of the innovation can be implemented. While the innovation has been described above in the general context of computer-executable instructions that may run on one or more computers, those skilled in the art will recognize that the innovation also can be implemented in combination with other program modules and/or as a combination of hardware and software.

[00145] Generally, program modules include routines, programs, components, data structures, *etc*., that perform particular tasks or implement particular abstract data types. Moreover, those skilled in the art will appreciate that the inventive methods can be practiced with other computer system configurations, including single-processor or multiprocessor computer systems, minicomputers, mainframe computers, as well as

personal computers, hand-held computing devices, microprocessor-based or programmable consumer electronics, and the like, each of which can be operatively coupled to one or more associated devices.

[00146] The illustrated aspects of the innovation may also be practiced in distributed computing environments where certain tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules can be located in both local and remote memory storage devices.

[00147] A computer typically includes a variety of computer-readable media. Computer-readable media can be any available media that can be accessed by the computer and includes both volatile and nonvolatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media can comprise computer storage media and communication media. Computer storage media includes both volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disk (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the computer.

[00148] Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism, and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of the any of the above should also be included within the scope of computer-readable media.

[00149] With reference again to FIG. 4, the exemplary environment 400 for implementing various aspects of the innovation includes a computer 402, the computer 402 including a processing unit 404, a system memory 406 and a system bus 408. The system bus 408 couples system components including, but not limited to, the system memory 406 to the processing unit 404. The processing unit 404 can be any of various commercially available processors. Dual microprocessors and other multi-processor architectures may also be employed as the processing unit 404.

[00150] The system bus 408 can be any of several types of bus structure that may further interconnect to a memory bus (with or without a memory controller), a peripheral bus, and a local bus using any of a variety of commercially available bus architectures. The system memory 406 includes read-only memory (ROM) 410 and random access memory (RAM) 412. A basic input/output system (BIOS) is stored in a non-volatile memory 410 such as ROM, EPROM, EEPROM, which BIOS contains the basic routines that help to transfer information between elements within the computer 402, such as during start-up. The RAM 412 can also include a high-speed RAM such as static RAM for caching data.

[00151] The computer 402 further includes an internal hard disk drive (HDD) 414 (*e.g.*, EIDE, SATA), which internal hard disk drive 414 may also be configured for external use in a suitable chassis (not shown), a magnetic floppy disk drive (FDD) 416, (*e.g.*, to read from or write to a removable diskette 418) and an optical disk drive 420, (*e.g.*, reading a CD-ROM disk 422 or, to read from or write to other high capacity optical media such as the DVD). The hard disk drive 414, magnetic disk drive 416 and optical disk drive 420 can be connected to the system bus 408 by a hard disk drive interface 424, a magnetic disk drive interface 426 and an optical drive interface 428, respectively. The interface 424 for external drive implementations includes at least one or both of Universal Serial Bus (USB) and IEEE 1394 interface technologies. Other external drive connection technologies are within contemplation of the subject innovation.

[00152] The drives and their associated computer-readable media provide nonvolatile storage of data, data structures, computer-executable instructions, and so forth. For the computer 402, the drives and media accommodate the storage of any data in a suitable digital format. Although the description of computer-readable media above

refers to a HDD, a removable magnetic diskette, and a removable optical media such as a CD or DVD, it should be appreciated by those skilled in the art that other types of media which are readable by a computer, such as zip drives, magnetic cassettes, flash memory cards, cartridges, and the like, may also be used in the exemplary operating environment, and further, that any such media may contain computer-executable instructions for performing the methods of the innovation.

[00153] A number of program modules can be stored in the drives and RAM 412, including an operating system 430, one or more application programs 432, other program modules 434 and program data 436. All or portions of the operating system, applications, modules, and/or data can also be cached in the RAM 412. It is appreciated that the innovation can be implemented with various commercially available operating systems or combinations of operating systems.

[00154] A user can enter commands and information into the computer 402 through one or more wired/wireless input devices, *e.g.*, a keyboard 438 and a pointing device, such as a mouse 440. Other input devices (not shown) may include a microphone, an IR remote control, a joystick, a game pad, a stylus pen, touch screen, or the like. These and other input devices are often connected to the processing unit 404 through an input device interface 442 that is coupled to the system bus 408, but can be connected by other interfaces, such as a parallel port, an IEEE 1394 serial port, a game port, a USB port, an IR interface, *etc.*

[00155] A monitor 444 or other type of display device is also connected to the system bus 408 *via* an interface, such as a video adapter 446. In addition to the monitor 444, a computer typically includes other peripheral output devices (not shown), such as speakers, printers, *etc.*

[00156] The computer 402 may operate in a networked environment using logical connections *via* wired and/or wireless communications to one or more remote computers, such as a remote computer(s) 448. The remote computer(s) 448 can be a workstation, a server computer, a router, a personal computer, portable computer, microprocessor-based entertainment appliance, a peer device or other common network node, and typically includes many or all of the elements described relative to the computer 402, although, for purposes of brevity, only a memory/storage device 450 is illustrated. The logical

connections depicted include wired/wireless connectivity to a local area network (LAN) 452 and/or larger networks, *e.g.*, a wide area network (WAN) 454. Such LAN and WAN networking environments are commonplace in offices and companies, and facilitate enterprise-wide computer networks, such as intranets, all of which may connect to a global communications network, *e.g.*, the Internet.

[00157] When used in a LAN networking environment, the computer 402 is connected to the local network 452 through a wired and/or wireless communication network interface or adapter 456. The adapter 456 may facilitate wired or wireless communication to the LAN 452, which may also include a wireless access point disposed thereon for communicating with the wireless adapter 456.

[00158] When used in a WAN networking environment, the computer 402 can include a modem 458, or is connected to a communications server on the WAN 454, or has other means for establishing communications over the WAN 454, such as by way of the Internet. The modem 458, which can be internal or external and a wired or wireless device, is connected to the system bus 408 *via* the serial port interface 442. In a networked environment, program modules depicted relative to the computer 402, or portions thereof, can be stored in the remote memory/storage device 450. It will be appreciated that the network connections shown are exemplary and other means of establishing a communications link between the computers can be used.

[00159] The computer 402 is operable to communicate with any wireless devices or entities operatively disposed in wireless communication, *e.g.*, a printer, scanner, desktop and/or portable computer, portable data assistant, communications satellite, any piece of equipment or location associated with a wirelessly detectable tag (*e.g.*, a kiosk, news stand, restroom), and telephone. This includes at least Wi-Fi and Bluetooth™ wireless technologies. Thus, the communication can be a predefined structure as with a conventional network or simply an ad hoc communication between at least two devices.

[00160] Wi-Fi, or Wireless Fidelity, allows connection to the Internet from a couch at home, a bed in a hotel room, or a conference room at work, without wires. Wi-Fi is a wireless technology similar to that used in a cell phone that enables such devices, *e.g.*, computers, to send and receive data indoors and out; anywhere within the range of a base station. Wi-Fi networks use radio technologies called IEEE 802.11 (a, b, g, *etc.*) to

provide secure, reliable, fast wireless connectivity. A Wi-Fi network can be used to connect computers to each other, to the Internet, and to wired networks (which use IEEE 802.3 or Ethernet). Wi-Fi networks operate in the unlicensed 2.4 and 5 GHz radio bands, at an 11 Mbps (802.11a) or 54 Mbps (802.11b) data rate, for example, or with products that contain both bands (dual band), so the networks can provide real-world performance similar to the basic 10BaseT wired Ethernet networks used in many offices.

[00161] To improve the efficiency of a solar array and its ability to capture the suns rays and turn the energy contained in the rays from solar energy to electrical energy, it is important to have the solar array optimally aligned to the sun. In the case of where the solar array is comprised of photovoltaic elements, the photovoltaic elements should be aligned optimally, *e.g.*, perpendicular, to operate at their peak efficiency. Similarly, when incorporated in to a solar concentrator system, the array can comprise of a mirror(s), which reflects and focuses the solar radiation for collection by a solar collector.

[00162] Turning to the figures, FIG. 5 illustrates a solar energy collection system 500 comprising of an array 502 aligned to reflect the suns rays on to a central collection apparatus 504. To facilitate harnessing energy from the suns rays the array 502 can be rotated in various planes to correctly align the array 502 with respect to the direction of the sun, reflecting the sun rays on to the collector 504. The array 502 can comprise of a plurality of mirrors, which can be used to concentrate and focus the solar radiation on the collector 504, where the collector can comprise of photovoltaic cells facilitating the conversion of solar energy in to electrical energy. The array 502 and the collector 504 can be supported on polar mount support arm 506. Further, the mirrors have been arranged so that a gap 508 separates the array of mirrors 502 into two groups. A motorized gear assembly 510 connects the array 502 and the collector 504 to a polar mount support arm 506. The polar mount support arm 506, is aligned to the earth's surface such that it is aligned parallel with the tilt of the earth's axis of rotation, as discussed *supra*. The motorized gear assembly 510 allows the array 502, and collector 504, to be rotated about the horizontal axis 512, the horizontal axis is also known as the ascension axis. The array 502, and collector 504, are further connected to the polar support 506, by an actuator 514. The actuator 514 facilitates the array 502, and collector

504, to be rotated about the vertical axis 516, the vertical axis is also known as the declination axis.

[00163] The efficiency of a solar array can be improved by enabling the solar array to be aligned to the sun to increase the amount of sun rays being collected by the array. Over the course of the year the position of the sun relative to the position of a solar array, where the solar array is in at fixed location on the earth, varies in both the horizontal (ascension) axis 512 and the vertical (declination) axis 516. During the day, the sun rises in the east and sets in the west, the movement of the sun across the sky is known as the ascension and the position/angle of the solar array 502 relative to the position of the sun needs to be such that the solar array 502 is aligned to the position of the sun. Further, throughout the year the sun also changes its position relative to the earth's equator. As shown in FIG. 6, the tilt of the earth's axis 602 in relation to the earth's orbital path 604 about the sun 606 is approximately 23.45 degrees. During the completion of one rotation about the sun 606 by the earth 608, which takes approximately one year to complete, the position of the sun 606 relative to the earth's equator varies by about ±23.45 degrees. FIG. 7, relates the variation in the path of the sun in relation to the earth's equator, throughout the year; with the sun being at it's highest position relative to the equator in June 702, and at it's lowest position relative to the equator in December 704. To correctly position an array such that it is aligned to the sun in the vertical axis, means should be provided to allow the solar array to sweep through an angle of about 47 degrees ((23.45 degrees above the horizon) + (23.45 degrees below the horizon)), the declination angle. Referring back to FIG. 5, the gap 508 in the collection panels allows the array 502 to be tilted through the required declination by the actuator 514, without the array 502 being obstructed by the supporting arm of the polar mount 506. The gap 508 in the panels also allows the array to rotated about the ascension axis 512, which runs parallel to the direction of the supporting arm of the polar mount 506, without the panels which comprise the array 502 being obstructed by the supporting arm of the polar mount 506.

[00164] In the case of where the solar radiation is being focused on a central collector by a mirrored array the efficiency of the collector can be maximized by ensuring that the reflected sun light falls evenly across the components that form the central collector. For example, the central collector can be comprised of a group of photovoltaic

cells. In some configurations the photovoltaic cells can be sensitive to variations in sun light intensity across the group of photovoltaic cells, it can be beneficial to ensure that each photovoltaic cell receives the same amount of solar radiation; use of a polar mount and positioning apparatus, as related in the disclosed subject matter, can be utilized to ensure this is the case.

[00165] While, throughout the discussion of the matter, the focus has been upon the collection of rays from the sun and reflecting them to a central collector that facilitates the conversion of the energy contained in the suns rays to electrical energy, this is used for explanation purposes and is not intended to limit the scope of the claims. The claimed subject matter can be used to facilitate the collection of energy from a multitude of energy sources that involve energy radiation, such energy sources include x-rays, laser, alpha-rays, beta-rays, gamma-rays, all electromagnetic radiation sources that can be found in the electromagnetic spectrum, *etc*.

[00166] It is to be appreciated that while the example system 500, as shown in FIG. 5, comprises of an array of mirrors utilized to focus sunlight on a central collector the subject disclosure is not so limited and can be used to provide positioning of a variety of collection devices. For example, as depicted by FIG. 8, system 800, in one embodiment, a polar mount 802 comprising of a polar mount support arm and means to provision alignment about the angles of ascension and declination of the support arm, could be used to locate an array of solar cells/photovoltaic devices 804, where the polar mount is used to maintain the array in alignment to the suns rays 806. As related in FIG. 9, system 900, in another embodiment the polar mount 802 can support an array of mirrors 902 that are used to reflect sunlight 904 to a remote collection device 906.

[00167] Turning to FIG. 10, system 1000 relates a more detailed system for collection of solar energy into which the claimed subject matter can be incorporated. A solar array 1002 is aligned in relation to the sun *via* the use of a declination positioning device 1004 and an ascension positioning device 1006, the operation of the positioning devices, 1004 and 1006, to align the collector is as discussed *supra*. The positioning devices, 1004 and 1006, are controlled by a positioning controller 1008, which provides instructions to the positioning devices, 1004 and 1006, regarding their respective positions and also receives feedback from the positioning devices to allow the positioning

controller 1008 to determine anticipated instructions and location of the array 1002. An input component 1010 can also be incorporated to facilitate interaction with the positioning controller 1008, and subsequently control the position of the array 1002, by a user or mechanical/electronic means. The input component 1010 can represent a number of devices that can facilitate transfer of data, instructions, feedback, and the like, between the position controller 1008 and a user, remote computer, or the like. Such input component devices 1010 can include a global positioning system that can provide latitude and longitude measurements to allow the array 1002 to be positioned and controlled based upon location of the array 1002. Further, the input device 1010 could be a graphical user interface (GUI) that allows a user to enter instructions and commands to be used to control the position of the array 1002, *e.g.*, an engineer enters commands during the installation process to test the operation of the positioning devices 1004 and 1006. The GUI can also be utilized to relay position measurements, operating conditions or the like, from the positioning controller 1008 describing the current position and operation of the array 1002. For example, during installation an engineer can review the position feedback displayed on the GUI and compare it with anticipated values. The positioning controller 1008 can also be operated remotely from the locality of the array 1002 through the use of remote networks such as a local area network (LAN), wide area network (WAN), internet, *etc*., where the networks can be either hardwired to the input component 1010 or wirelessly connected.

[00168] A database and storage component 1012 can also be associated with the system 1000. The database can be used to store information to be used to assist in the positional control of the array 1002 by the positioning controller 1008, such information can include longitudinal information, latitudinal information, date and time information, *etc.* The positioning controller 1008 can include means, *e.g.,* a processor, for processing data, algorithms, commands, *etc.*, where, for example, such processing can be in response to commands received from a user *via* the input component 1010. The positioning controller 608 can also have programs and algorithms running therein to facilitate automatic positional control of the array 1002 where the programs and algorithms can use data retrieved from the database 1012, with such data including longitudinal information, latitudinal information, date and time information, *etc.*

[00169] An artificial intelligence (AI) component 1014 can also be included in system 600 to perform at least one determination or at least one inference in accordance with at least one aspect disclosed herein. The artificial intelligence (AI) component 1014 can be used to assist the positioning controller 1008 in positioning the array 1002. For example, the AI component 1014 could be monitoring weather information being received at the position controller 1008 *via* the internet 1010. The AI component 1014 could determine that local weather conditions are potentially reaching a point of concern with regard to safe operation of the array 1002 and the array 1002 needs to be closed down until the weather system has passed. The AI component 1014 can employ one of numerous methodologies for learning from data and then drawing inferences and/or making determinations related to dynamically storing information across multiple storage units (*e.g.*, Hidden Markov Models (HMMs) and related prototypical dependency models, more general probabilistic graphical models, such as Bayesian networks, *e.g.*, created by structure search using a Bayesian model score or approximation, linear classifiers, such as support vector machines (SVMs), non-linear classifiers, such as methods referred to as "neural network" methodologies, fuzzy logic methodologies, and other approaches that perform data fusion, *etc.*) in accordance with implementing various automated aspects described herein. In addition, the AI component 1014 can also include methods for capture of logical relationships such as theorem provers or more heuristic rule-based expert systems. The AI component 1014 can be represented as an externally pluggable component, in some cases designed by a disparate (third) party.

[00170] System 1000 can further include an energy output component 1016 which can be utilized to convert the solar energy collected at the array 1002 to electrical energy. The energy produced by the output component 1016 can be fed in to the electrical grid 618 as well as into a power return 1020. However, the power return 1020 facilitates the use of power generated by the system 1000 to be used to power the system 1000. For example, some of the power generated by the output component 1016 can be fed back in to the system 1000 to provide power for the various components that comprise system 1000, such as to power the positioning devices 1004 and 1006, the positioning controller 1008, the AI component 1014, the input component(s) 1010, *etc*. However, while such a self-contained system could be considered a worthy goal for fail-safe concerns *etc*.,

means can also be provided to allow system 1000, and its components, to draw power from the electrical grid 1018. For example, when operating in a closed-loop mode there may be insufficient energy being produced by the array to fulfill the energy operating requirements of the system 1000, and energy can be drawn from the electrical grid 1018 to compensate for the energy deficiency.

[00171] Referring to FIG. 11, system 1100 relates an assembly, which can be used to connect a solar array (*e.g.*, such as solar array 502 of FIG. 5) to a polar mount support arm (*e.g.*, such as polar mount support arm 506 of FIG. 5). System 1100 can also be used to rotate the array about the central axis of the polar mount support arm, which provides ascension positioning of the array. System 1100 comprises of a connector 1102, which can be used to connect the polar mount support arm to the assembly 1100, the solar array connects to the assembly 1100 by attachment to the support brackets 1104. A motor 1106 in combination with gearing 1108 facilitates the rotation of the array about the polar mount support arm, where the assembly remains fixed at the connector 1102 and the support brackets 1104 and attached array rotates about the polar mount support arm.

[00172] Turning to FIG. 12, system 1200, illustrates an apparatus to tilt a solar array 502 through a declination axis in relation to a polar mount support arm 506. System 1200 comprises of a positioning device 514, *e.g.*, an actuator, which is connected to a positioning assembly 1100. The positioning assembly 1100, as discussed *supra,* facilitates rotating the solar array 502 about the ascension axis of the polar mount support arm 506. The positioning device 514 can tilt the array 502 to the required angle of declination with respect to the sun's position in the sky, as the positioning device 514 moves in relation to the positioning assembly 1100, the support 1202 to which the positioning device 514 is connected, also moves causing the array 502 to tilt through a range of declination angles. As the positioning assembly 1100 is rotated to track the ascension of the sun the positioning device 514 can be used to ensure that that the array 102 remains at the angle of declination to capture the suns rays. Use of a positioning device 514 in conjunction with the polar mount allows the array to be adjusted to the required declination angle at the commencement of solar collection as opposed to continually having to adjust the angle of tilt throughout the sun tracking process, reducing the energy consumption of the system as the actuator only has to be adjusted once per day

as opposed to continually. While the actuator can adjust the declination angle of the array once per day the claimed subject matter is not so limited with the actuator adjusting the declination as many times per day as is required to provide tracking of the sun.

[00173] Referring to FIGs. 11 and 12, while the actuator 514 and motor 1106 are shown as two separate components, alternative embodiments can exist where the actuator 514 and motor 1106 are combined in a single assembly that provides connection of an array 502 to the polar mount support arm 106 while facilitating the alteration of the position of the array 502 with respect to ascension and declination in relation to the position of the sun or similar energy source from which energy is to be captured. In other embodiments of the subject matter, various combinations of motors and actuators can be utilized to provide positioning of collection arrays and devices utilized to harness the capture of radiation, *etc.* while facilitating the adjustment of the position of the arrays and devices in relation to the energy source.

[00174] A variety of means to provide ascension/declination positioning of the array can be implemented into the system. Example means can include mechanical, electrical, electromagnetic, magnetic, pneumatic, and the like.

[00175] One embodiment of the subject innovation is the use of DC brushless motors, taking advantage of their low cost and low maintenance. In a further embodiment DC brushless stepper motors can be used, where the number of steps during operation of a motor is counted to provide highly accurate positioning of the array. For example, in one configuration it is known that there are 10 steps/1 degree of rotation, the position of the array can be adjusted in about 0.1 degree increments to track the passage of the sun through the sky.

[00176] Turning to FIG. 13, in conventional polar mount systems, for example as utilized with photovoltaic arrays, the array 1302 is supported off-axis in relation to the support arm 1304. Depending upon such factors as the size and weight of the components which comprise the array 1302 and associated devices (not shown) the center of gravity is displaced in relation to the support arm 1304, with the center of gravity being located anywhere along dimension x. In such a system, energy is wasted during the movement of the array as it tracks the sun, as the out of balance resulting from the displaced center of gravity has to be compensated for and overcome.

[00177] With reference to FIG. 5, in one embodiment of the subject innovation the gap 108 in the array negates the array 502 having to be offset from the polar mount supporting arm 506, with the array 502 being attached to the polar mount supporting arm 506 in the plane of the polar mount supporting arm. Such an arrangement allows the array 502 to be balanced about the axis of the polar mount supporting arm 512. In comparison with a conventional polar mount system (system 1300), the energy required to rotate the array 502 about the ascension axis 512 is reduced, the reduced energy requirements can facilitate the use of smaller capacity motors in the mounting and positioning assembly, as discussed with reference to FIG. 11, leading to reduced system costs.

[00178] If the array is to be placed in a position for storage, safety, or for maintenance purposes, as discussed *infra*, the motor can be stepped through the required number of steps to move the array from its current position to its storage or safety position. Further to this example, the number of steps required to move the array in a clockwise direction from its current position to the storage position can be determined, along with the requisite number of steps in the anti-clockwise direction, the two counts can be compared and the shortest direction is used to placed the array in the storage position.

[00179] In another embodiment, in response to potentially damaging weather conditions, *e.g.*, a passing hailstorm, the array can be placed in a safety position. A record of the number of steps required to move the array to the safety position from the current position of the array, prior to the command to move to the safety position being received, can be determined. After the hailstorm has passed the array can be repositioned to resume operation where the repositioning is determined based upon the last known position of the array plus the number of steps required to compensate for the current position of the sun, *e.g.*, last position of array prior to the hailstorm + number of steps to move the array to current position of the sun. The current position of the sun can be determined by the use of latitude, longitude, date, time information associated with the array and the position of the array. The current position of the sun can also be determined by the use of sun position sensors, which can be used to determine the angle at which the energy of sunlight is strongest and position the array accordingly.

[00180] Further, the gap 508 in the collection panels allows the panels to be positioned to minimize susceptibility of the mirrors, that form the array, to environmental damage such as strong winds and hail strikes. As depicted in FIG. 14, the array 502 can be rotated about the polar supporting arm 506, to place the array in a "safety position". The ability to rotate the array 502 about the ascension axis 516 and tilt about the declination axis 512 allows the array 502 to be positioned so that its alignment with any prevailing wind minimizes a sail effect of the solar array 502 in the wind. Also, in the event of hail strikes, snow, *etc*, the array 502 can be positioned such that the mirrors are facing downwards with the backside of the array structure being exposed to the hail strikes, mitigating damage to the mirrors.

[00181] Furthermore, in another embodiment of the claimed subject matter, rotation of the array 502 about the ascension axis 516 and the declination axis 512 can enable all areas of the array to be brought within easy reach of an operator. The operator could be an installation engineer who needs access to the various mirrors 502, collector 504, *etc.,* during the installation process. For example, the installation engineer may need to access the central collector 504 for alignment purposes. The operator could also be a maintenance engineer who requires access to the array 502 to clean the mirrors, replace a mirror, *etc*. FIG. 14 depicts an example embodiment of the polar supporting arm 506 located on a base support 1402. The base support 1402 can comprise of various footers, support structure, foundation structure, mounting brackets, positioning motors, and the like, as required to facilitate support, location and placement of the polar supporting arm 506 and other arrays components, *e.g.*, array 502, collector 504, *etc*. As depicted in FIG. 14, to facilitate access to the various components of solar energy collection system 500, *e.g.*, the array 502, collector 504, *etc*., the polar supporting arm 506 can be selectively disengaged (at least partially) from the base support 1402 enabling the solar energy collection system 500 to be tilted and lowered as required.

[00182] As described above, the polar supporting arm 506 can also be selectively disengaged (at least partially) from a supporting structure (*e.g.*, base support 1002) to facilitate positioning the solar energy collection system 500 as required, *e.g.*, a "safety position", maintenance, installation, alignment tuning, storage, *etc*. FIG. 15 illustrates a schematic representation 1500 of a solar energy collection system 500 in a lowered

position, which can be a position of safety, maintenance, installation, alignment tuning, storage, and the like.

[00183] FIG. 16 shows a methodology 1600 for constructing a solar array and positioning the array to track the sun. At 1602, a solar array is constructed where the array comprises of two planar sections of equal size. The array can be constructed from mirrors to facilitate reflection of solar rays to a central collector or, in an alternative embodiment, the array can comprise an array of photovoltaic devices to absorb the solar energy and provision the conversion of solar energy to electrical energy. The two arrays are connected by a central support, with the arrays placed on the support such that a gap is left between the arrays, the gap is of a known width in accordance with act 1604.

[00184] At 1604, a polar mount is constructed where the polar mount is positioned on the earth's surface such that it is aligned parallel with the tilt of the earth's axis of rotation. Returning to act 1602, the gap left between the two arrays is of sufficient width to allow the arrays to be located at the end of the polar mount, such that the arrays are positioned either side of the polar mount.

[00185] At 1606, means are provided to allow the array to be rotated about the polar mount along the angle of ascension. Such means can include a motor, actuator, or similar device and the means can form part of the connector that connects the arrays to the polar mount. At 1608, means are provided to allow the array to be tilted through a range of angles with respect to the polar mount along the angle of declination, where the range of angles includes the required degree of angle to keep the array in alignment with the sun and its variation of declination as well as a greater range of angles to allow the array to be tilted for installation, maintenance, storage, *etc*. Such means can include a motor, actuator, or similar device. The means can form part of the connector that connects the arrays to the polar mount.

[00186] At 1610, information is provided to the system to allow the array to track the sun as the sun traverses the sky. Such information can include longitude data, latitude data, date and time information, *etc*., based upon the location of the array. Using the information provided in 1610, at 1612 the array is aligned with respect to the sun to facilitate generation of energy from solar energy. The array is aligned to the sun by altering the angles of declination and ascension of the array with respect to the sun. In

one embodiment the angle of ascension can be altered throughout the day while the angle of declination is adjusted once in accordance with the height of the sun in the sky. In an alternative embodiment the angles of ascension and declination can be adjusted as required, *e.g.*, continually, to maintain the array in alignment with the sun.

[00187] At 1614, the solar array facilitates collection of energy from the sun whether it be by photovoltaic, reflected, or similar means.

[00188] FIG. 17 relates a methodology 1700 to facilitate placement of a solar array in a position of safety (*e.g.*, to prevent damage to the array and associated components due to weather conditions), maintenance (*e.g.*, the array needs to be inspected, cleaned, replaced, *etc.*), installation (*e.g.*, the array is moved through a variety of positions to determine that any positioning devices are functioning correctly), or the like.

[00189] At 1702, the solar array is positioned in the normal operating position to collect the suns rays with the angles of ascension and declination of the array with respect to the sun being adjusted throughout the day to maintain the array in alignment with the sun; the array facilitates collection of energy from the solar rays, 1704.

[00190] At 1706, a determination is made as to whether the array is to be placed in a safety position, *e.g.*, in response to information being received that a weather system is moving into the area. If the weather system is deemed to not pose a threat to the operation of the array the method 1700 returns to 1702 and solar energy continues to be collected. If it is determined that the solar array needs to be shut down and placed in a safety position, *e.g.*, a hail storm is approaching which could damage the mirrors/photovoltaics, a command can be placed to position the array in the safety position, 1308.

[00191] While the array is in the safety position, at 1710, a determination can be made as to whether the array needs to be maintained in this position. If the determination is 'Yes', *e.g.*, the weather system still poses a threat to the array and collection components, the method proceeds to 1712, with the array being maintained in the safety position.

[00192] At 1714, a further determination is made regarding whether the array can return to a position to recommence collection of the solar energy. If the response is 'No', *e.g.*, the weather system is still a threat to the array components, the method returns to

1712. If, at 1714, it is determined that 'Yes' it is safe to resume operations then the method returns to 1702, and the array is realigned with respect to the sun to recommence collection of the solar energy.

[00193] Returning to act 1710, if the determination as to whether to maintain the current safety position is 'No', *e.g.*, the weather system no longer poses a threat to the array and collection components, the method returns to 1702 and collection of the solar energy by the array resumes.

[00194] Tracking sun position by optimally analyzing sunlight is provided where direct sunlight can be substantially distinguished from other light sources, such as sunlight reflections off certain objects, lasers, and/or the like. In particular, the direct sunlight can be identified according to its non-polarization, collimated property, light frequency, and/or the like. Once the direct sunlight is detected, in one example, solar cells can be automatically adjusted to receive the sunlight in an optimal alignment allowing highly efficient harnessing of maximal solar energy while avoiding alignment with other weaker light sources. The solar cells can be adjusted individually, as part of a panel of cells, and/or the like, for example.

[00195] According to an example, solar panels can be equipped with components to differentiate and concentrate in on sunlight. For example, one or more polarizers can be provided and positioned such that a light source can be evaluated to determine polarization thereof. As direct sunlight is substantially not polarized, similar radiation levels measured across the polarizers can indicate a direct sunlight source. Moreover, spectral filters can be included to filter out light having merely a substantially different color spectrum as the sun, such as green lasers, red lasers, and/or the like. In addition, a ball lens and quadrant cell can be provided where the light source passes through the ball lens and onto a quadrant cell; the size of a focal point on the quadrant cell can be utilized to determine collimation of the light. If the light is collimated beyond a threshold, it can be determined as direct sunlight. In this case, the ball lens and quadrant cell can further determine optimal positioning for the cell to receive a maximal amount of sunlight based at least in part on a position of the focal point on the quadrant cells. Thus, the solar cells can be automatically adjusted to receive direct sunlight without confusion of disparate light sources.

[00196] Now turning to the figures, FIG. 18 illustrates a system 1800 that facilitates tracking sunlight for optimally aligning a device based on the position of the sunlight. A sunlight tracking component 1802 is provided to determine if light received is direct sunlight or light from another source and can track the direct sunlight based on the determination. Additionally, a positioning component 1804 is provided that can align a device according to the sunlight position. In one example, the device can comprise one or more solar cells (or panels of solar cells), which can be optimally aligned with respect to the direct sunlight to receive a substantially maximal amount of light for conversion into electricity *via* photovoltaic technology, for example. According to an example, the sunlight tracking component 1802 can track the sunlight and convey positioning information to the positioning component 1804 so that the device can be optimally positioned (*e.g.*, the solar cells can be moved into a desirable position to receive substantially optimal direct sunlight).

[00197] In one example, the sunlight tracking component 1802 can evaluate a plurality of light sources to determine which source is direct sunlight. This can include receiving the light through multiple polarizers angled such that polarized light can yield different results at each polarizer whereas non-polarized light, such as direct sunlight, can yield substantially the same result at the polarizers. Moreover, according to an example, the sunlight tracking component 1802 can differentiate light sources based on wavelength, which can provide exclusion of lasers or other light sources distinguishable in this regard. In addition, the filter can provide attenuation in substantially all wavelengths such that when combined an amplifier, sunlight can be detected based at least in part on strength of the lights source. Additionally, the sunlight tracking component 1802 can determine a collimation property of the light source to determine whether the light is direct sunlight. Furthermore, the sunlight tracking component 1802 can evaluate the alignment of one or more devices, with respect to the axis of the light source thereon, to determine movement required to optimally align the device with the determined direct sunlight, in one example.

[00198] Subsequently, the position information can be conveyed to the positioning component 1804, which can control one or more axial positions of a device (*e.g.*, a solar cell or one or more panels of cells). In this regard, upon receiving the location

information from the sunlight tracking component 1802, the positioning component 1804 can move the device and/or an apparatus on which the device is mounted to align the axis of the direct sunlight in an optimal position with respect to the device. The sunlight tracking component 1802 can analyze the direct sunlight on a timer, or it can follow the sunlight as it moves by constantly determining the optimal alignment with respect to the light axis. In addition, the sunlight tracking component 1802 can be configured as part of a solar cell or panel of cells (*e.g.*, behind or within one or more cells or affixed/mounted to the panel or an associated apparatus). In this regard, the sunlight tracking component 1802 can move with the cells to evaluate the optimal position as the positioning component 1804 moves the cells and sunlight tracking component 1802. In another example, the sunlight tracking component 1802 can be at a separate location than the cells and can convey accurate positioning information to the positioning component 1804, which can appropriately position the cells.

[00199] Referring to FIG. 19, an example system 1900 for tracking position of the sun with respect to deviation from an axis of one or more related solar cells or substantially any apparatus is displayed. A sunlight tracking component 1802 is described that can track position of direct sunlight using a plurality of light analyzing components 1904 that can approximate a light source based at least in part on one or more measurements related to the light source. The sunlight tracking component 1802 can comprise the multiple light analyzing components 1904 to provide redundancy as well as to analyze a light source from disparate perspectives. In one example, as described, the sunlight tracking component 1802 can identify direct sunlight as it is positioned on various light sources and accordingly deliver information regarding positioning one or more solar cells to receive the direct sunlight at an optimal axis. Though the sunlight tracking component 1802 is shown as having 3 light analyzing components 1904, it is to be appreciated that more or less light analyzing components 1904 can be utilized in one example. Additionally, the light analyzing component(s) 1904 utilized can comprise one or more of the components shown and described as a part of the light analyzing component 1904, or can share such components among light analyzing components 1904, in one example.

[00200] Each light analyzing component 1904 includes a polarizer 1906 that can polarize a received light source, at which point a received radiation level from the polarizer 1906 can be measured. For each light analyzing component 1904, the polarizers 1906 can be configured at disparate angles. In an example having 3 light analyzing components 1904, and thus 3 polarizers 1906, the polarizers can be configured at substantially 120 degree angle offsets. In this regard, radiation measurements from each polarizer 1906 receiving light from the same source can be evaluated. Where a light source is at least somewhat polarized, once received by the polarizers 1906, the radiation levels of the resulting beam can differ at each polarizer 1906 indicating a somewhat polarized light source. Conversely, where a light source is substantially non-polarized, the resulting radiation levels subsequent to passing through differently angled polarizers 1906 can be substantially similar. In this way, since direct sunlight is substantially non-polarized, it can be detected over polarized light sources, such as sunlight reflected off many surfaces including clouds or other light sources, for example. It is to be appreciated that the radiation level can be measured once the light passes to lower layers of the light analyzing component 1904 by a processor (not shown) and/or the like to determine the levels and differences therebetween.

[00201] In addition, the light analyzing components 1904 can include spectral filters 1908 to filter out light sources of substantially disparate or more focused wavelength than direct sunlight. For example, the spectral filters 1908 can pass light having wavelengths between approximately 560 nanometer (nm) to 600nm. Thus, most laser radiation (*e.g.*, commonly used 525nm green and 635nm red lasers) can be substantially rejected at the spectral filters 1908 whereas a majority of a direct sunlight source can still pass. This can prevent tampering with a collection of solar cells as well as locking on to a weak and/or intermittent light source. Light sources passing through the spectral filter 1908b can be received by a ball lens 1910 that can concentrate the light onto quadrant cells 1912. A somewhat collimated light source, such as direct sunlight, can come to a focus behind the ball lens 1910 on the quadrant cells 1912 at a point less than a threshold. Thus, this can be another indication of direct sunlight according to the level of collimation measured by the size of the focused point where diffuse light sources,

indicated by a larger or more than one focused point, for example, can be rejected. It is to be appreciated that other types of curved lenses can be utilized in this regard as well.

[00202] In addition, the quadrant cells 1912 can provide an indication of axial alignment of the light analyzing component 1904 (and thus solar cells or substantially any device or apparatus associated with the sunlight tracking component 1802) with respect to the position of the focused point on the quadrant cells 1912 from the light passing through the ball lens 1910. For example, the angle at which the light shines on the light analyzing components 1904 can be determined as it passes through the ball lens 1910 and comes to a point on the quadrant cells 1912. The point on the quadrant cells 1912 can indicate the angle and can be used to determine a direction and movement required to receive the light at an optimal angle. Additionally, an amplifier 1914 is provided at each light analyzing component 1904 to receive a photo-signal comprising the relevant information from the light as described.

[00203] In addition, light sources can be rejected based at least in part on brightness. This can be accomplished, for example, using the spectral filter 1908 to provide significant attenuation if substantially all wavelengths; this together with gain from the amplifier 1914 can be utilized to determine a brightness of the source. Light sources below a specified threshold can be rejected. Also, a time variation in the light intensity (*e.g.*, a modulation of the light source) can be measured. It is to be appreciated that direct sunlight is substantially not modulated, and sources indicating some modulation can be rejected in this regard as well.

[00204] As mentioned above, the inferred parameters and information can be conveyed to a processor (not shown) for processing and determination of source of the light, whether the associated solar cell, device, or apparatus needs repositioning according to the point on the quadrant cells 1912, and/or the like. The information can be conveyed to the processor by the amplifier 1914, in one example. In this regard, direct sunlight can be differentiated from disparate light sources based on the above parameters procured by the light analyzing component 1904 resulting in optimal positioning of solar cells to receive substantially maximal solar energy.

[00205] Turning now to FIG. 20, an example system 2000 is displayed for determining a position of the sun and tracking the position to ensure optimal alignment of

one or more solar cells. A sunlight tracking component 1802 is provided to determine a position of direct sunlight while ignoring other light sources, as described, as well as a solar cell positioning component 2002 that can position one or more solar cells or panels of cells to optimally receive direct sunlight, and a clock component 2004 that can provide an approximate sunlight location based at least in part on the time of day and/or time of year, for example. It is to be appreciated that the sunlight tracking component 1802 can be configured within one or more solar cells, affixed to or near the solar cells or representative panel, positioned on a device that axially controls position of the cells/panel, and/or the like, for example.

[00206] According to an example, the solar cell positioning component 2002 can initially position a solar cell, set of cells, and/or an apparatus comprising one or more cells to an approximate position of sunlight based at least in part on the clock component 2004. In this regard, the clock component 2004 can store information regarding positions of the sun at different times of day throughout a month, season, year, collection of years, and/or the like. This information can be obtained from a variety of sources including fixed or manually programmed within the clock component 2004, provided externally or remotely to the clock component 2004, inferred by the clock component 2004 from previous readings of the sunlight tracking component 1802, and/or the like. In this regard, the clock component 2004 can approximate a position of the sunlight at a given point in time, and the solar cell positioning component 2002 can move the cell or cells according to that position.

[00207] Subsequently, the sunlight tracking component 1802 can be utilized to fine-tune the position of the cells as described above. Specifically, once approximately positioned, the sunlight tracking component 1802 can differentiate between the supposed direct sunlight and sunlight reflected from disparate objects, including clouds, buildings, other obstructions, and/or the like. The sunlight tracking component 1802 can accomplish this differentiation utilizing the components and processing described above, including determining a polarization of the light source, inferring a collimation property of the light source, measuring a brightness or strength of the light source, discerning a level of modulation (or non-modulation) of the source, filtering out certain wavelength colors, and/or the like. Moreover, the ball lens and quadrant cell configuration described

above can be utilized to determine an axial movement required to ensure a substantially direct axis of light to the cells. It is to be appreciated that the clock component 2004 can be used to initially configure the cell positions. In another example, the cells can be inactive during nocturnal hours and the clock component 2004 can be utilized to position the cells at sunrise. Moreover, in the case of significant obstruction, where there can be substantially no direct sunlight for the sunlight tracking component 1802 to detect, the clock component 2004 can be utilized to follow the predicted path of the sun until sunlight is available for detection by the sunlight tracking component 1802, *etc*. In this example, where there is disparity in the clock component 2004 prediction of the sun and the sunlight tracking component 1802 actual determination and measurement, the disparity can be taken into account by the clock component 2004 to ensure more accurate operation when its utilization is desired.

[00208] Turning now to FIG. 21, an example system 2100 for tracking sunlight and positioning remote devices to receive the optimal amount of light is illustrated. A sunlight tracking component 1802 is provided for determining a position of the sun based on differentiating the sun light source from other light sources. Additionally, a sunlight information transmitting component 2102 is provided to transmit information from the sunlight tracking component 1802 regarding precise position of the sunlight as well as solar cell positioning component 2002 that can position one or more solar cells based at least in part on information from the sunlight information transmitting component 2102 sent over the network 2104.

[00209] In this example, the sunlight tracking component 1802 can be disparately located from the solar cells; however, based at least in part on known positions of the sunlight tracking component 1802 and the cells, accurate information can be provided to position the remotely located cells. For example, the sunlight tracking component 1802 can determine a substantially accurate position of the sun based on distinguishing direct sunlight from other sources of light as described above. In particular, light from different sources can be measured based at least in part on polarization, collimation, intensity, modulation, and/or wavelength to narrow the sources down to possible direct sunlight as described. In addition, optimal alignment on the axis of the light can be determined for maximal light utilization using the ball lens and quadrant cells. Once precise locations

are determined, the sunlight tracking component 1802 can convey the information to the sunlight information transmitting component 2102.

[00210] Upon receiving the precise alignment information, the sunlight information transmitting component 2102 can send the information to the remotely located solar cell positioning component 2002, over network 2104, to axially position a set of solar cells to receive substantially maximal direct sunlight. In particular, the solar cell positioning component 2002 can receive the precise alignment information, account for difference in location between one or more solar cells/panels and the sunlight tracking component 1802, and optimally align the cells/panels to receive optimal sunlight for photovoltaic energy conversion. It is to be appreciated that difference in position between the sunlight tracking component 1802 and the cells can affect the relative position of the sun at each location. Thus, disparity can be calculated according to the difference in location (*e.g.*, location determined using global positioning system (GPS) and/or the like). In another example, the disparity can be measured upon installation of the solar cells and/or the sunlight tracking component 102b and be a fixed calculation performed upon receiving the precise sun location information.

[00211] Referring to FIG. 22, an example system 2200 is shown for locking a solar cell configuration onto direct sunlight to facilitate optimal photovoltaic energy generation. In particular, an axially rotatable apparatus 2202 is provided, which can comprise one or more solar cells or panels of cells as well as an attached sunlight tracking component 1802 as described herein. In one example, the axially rotatable apparatus 2202 can be one of a field of similar apparatuses desiring to receive direct sunlight. In this example, the sunlight tracking component 1802 can be affixed to each axially rotatable apparatus 2202 or there can be a sunlight tracking component that operates a plurality of axially rotatable apparatuses in the field (and can be separate or attached to a single apparatus of the plurality in this regard), for example.

[00212] As shown, the axially rotatable apparatus 2202 can be positioned to receive an optimal axis of direct sunlight 2204. The sunlight tracking component 2202 can detect the direct sunlight 2204 to this end as described *supra*, and a positioning component (not shown) can rotate the axially rotatable apparatus 2202 according to an indicated position of the optimal axis of direct sunlight. As mentioned, the sunlight

tracking component 1802 can evaluate various sources of light in proximity to the direct sunlight, such as reflective light 2206 and/or laser 2208, to determine which source is direct sunlight 2204. As described, the axially rotatable apparatus 2202 can move among the light sources, thus similarly moving the sunlight tracking component 1802, allowing the sunlight tracking component 1802 to analyze the light sources determining which is direct sunlight 2204.

[00213] For example, the sunlight tracking component 1802 can receive light from one of the shown reflective light 2206 sources and determine whether to align the cells to optimally receive the reflective light 2206. However, the sunlight tracking component 2206 can determine the reflective light 2206 source is, indeed, reflective light, as described, by evaluating radiation levels upon polarization by a plurality of differently angled polarizers. The levels can differ at a level indicating the light is polarized and thus not direct sunlight; the sunlight tracking component 1802 can instruct a positioning component to move the axially rotatable apparatus 2202 to another light source for evaluation. In another example, the sunlight tracking component 1802 can receive light from the laser 2208, but can indicate the laser light is not direct sunlight as it can be substantially filtered out by a spectral filter as described. Thus, the sunlight tracking component 1802 can instruct to move the axially rotatable apparatus 2202 to another light source.

[00214] In another example, the sunlight tracking component 1802 can receive light from the direct sunlight 2204 source and distinguish this light as direct sunlight. As described, this can occur by processing radiation levels for the light upon polarization by the aforementioned polarizers, which can indicate similar radiation levels. Thus, the sunlight tracking component 1802 can determine the light source is substantially non-polarized, like direct sunlight; if the sunlight passes through the spectral filter, the sunlight tracking component 1802 can determine the light 2204 is direct sunlight. Subsequently, as described, the sunlight tracking component 1802 can utilize a ball lens and quadrant cell configuration to determine a collimation of the light source to ensure it is direct sunlight. The sunlight tracking component 1802 can additionally determine intensity of the light source using the spectral filter to provide significant attenuation for substantially all wavelengths that can be measured with a gain from an amplifier

receiving the photo-signal. The resulting signal can be compared to a threshold to determine a requisite intensity for sunlight. Moreover, the modulation of the photo-signal can be measured to determine time variation; where the light is substantially non-modulated, this can be another indication of direct sunlight. In addition, the ball lens and quadrant cell configuration can be used, as described, to optimally angle the axially rotatable apparatus 2202 to align on the axis of the direct sunlight 2204.

[00215] The aforementioned systems, architectures and the like have been described with respect to interaction between several components. It should be appreciated that such systems and components can include those components or sub-components specified therein, some of the specified components or sub-components, and/or additional components. Sub-components could also be implemented as components communicatively coupled to other components rather than included within parent components. Further yet, one or more components and/or sub-components may be combined into a single component to provide aggregate functionality. Communication between systems, components and/or sub-components can be accomplished in accordance with either a push and/or pull model. The components may also interact with one or more other components not specifically described herein for the sake of brevity, but known by those of skill in the art.

[00216] Furthermore, as will be appreciated, various portions of the disclosed systems and methods may include or consist of artificial intelligence, machine learning, or knowledge or rule based components, sub-components, processes, means, methodologies, or mechanisms (e.g., support vector machines, neural networks, expert systems, Bayesian belief networks, fuzzy logic, data fusion engines, classifiers…). Such components, inter alia, can automate certain mechanisms or processes performed thereby to make portions of the systems and methods more adaptive as well as efficient and intelligent, for instance by inferring actions based on contextual information. By way of example and not limitation, such mechanism can be employed with respect to generation of materialized views and the like.

[00217] In view of the exemplary systems described *supra*, methodologies that may be implemented in accordance with the disclosed subject matter will be better appreciated with reference to the flow charts of FIGs. 23-25. While for purposes of

simplicity of explanation, the methodologies are shown and described as a series of blocks, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the blocks, as some blocks may occur in different orders and/or concurrently with other blocks from what is depicted and described herein. Moreover, not all illustrated blocks may be required to implement the methodologies described hereinafter.

[00218] FIG. 23 shows a methodology 2300 for determining polarization of a light source to partially infer whether the light is direct sunlight. It is to be appreciated that additional measures can be taken, as described herein, to decide the source of the light. At 2302, light is received from a source; the source can include sunlight (*e.g.*, direct or reflected from clouds, structures, *etc.*), lasers, and/or similar concentrated sources. At 2304, the light is passed through differently angled polarizers. As described, varying the angle of the polarizers can render disparate resulting light beams over the polarizers where the original light is polarized. Thus, at 2306, a radiation level can be measured after polarization at each polarizer. The various measurements can be compared, and at 2308, the polarization of the original light from the source can be determined. As described, where the compared measurements differ beyond a threshold, it can be determined that the original light was polarized; however, where there is not much difference between the measurements, the original light can be non-polarized. Since direct sunlight is substantially non-polarized, this determination can indicate whether the original light is direct sunlight.

[00219] FIG. 24 illustrates a methodology 2400 that further facilitates determining whether light received from a source is direct sunlight. At 2402, the light is received from the source. As described, the source can include direct or indirect sunlight, lasers, and/or the like. Additionally, at 2404, the polarization of the light can be determined as described previously. Subsequently, at 2406, the light can be passed through a wavelength filter that rejects portions of light sources that are not within a specified wavelength. For example, the wavelength filter can be such that it rejects lights not in a range utilized by sunlight. The filter, thus, can reject some laser lights (*e.g.*, red and green lasers in one example) and only pass light that is in the range. In addition, the filter can provide significant attenuation in substantially all wavelengths. This can be taken,

together, with gain of the resulting photo-signal, to indicate an intensity of the light source that can additionally be utilized to determine if the source is direct sunlight. At 2408, it can be determined whether the light is direct sunlight; for example, this can be based at least in part on whether the light passed through the filter as well as the determined polarization. As described, where the light is not polarized, there is a possibility that it is direct sunlight as many reflected sunlight sources (*e.g.*, deflected from clouds, structures, and the like) are polarized. Furthermore, the wavelength filter can provide further assurance of direct sunlight if the light is substantially within the correct wavelength.

[00220] FIG. 25 shows a methodology 2500 for aiming solar cells to receive an optimally aligned axis of light for generating solar energy. At 2502, light is received from a source. As described, this light can come from many sources, and at 2504, it can be determined whether the light is direct sunlight. In this regard, other light sources, such as reflected light, lasers, *etc.* can be rejected as described herein. For example, a variety of polarizers, spectral filters, and/or the like can be utilized to reject unwanted light sources. This can be based at least in part on determining a polarization level of the light, a collimation of the light (*e.g.*, *via* measuring a size of a focal point on a quadrant cell of the light passing through a ball lens), an intensity of the light (*e.g.*, measured by gain from an amplifier receiving the light), a spectrum of the light (*e.g.*, measured through a spectral filter), a modulation of the light, and/or the like as described. At 2506, an optimal axial alignment is determined to receive the direct sunlight. This can be determined, as described, using a ball lens and quadrant cell configuration, for example, to focus a point from the light on the quadrant cell. The light can shine on the ball lens, which reflects the light as one or more points on the quadrant cell. Alignment can be adjusted based on position of the point on the quadrant cell. At 2508, one or more solar cells can be positioned according to the axial alignment. Thus, direct sunlight can be detected, and solar cells can be positioned optimally on the axis of the sunlight to receive a maximal energy for photovoltaic conversion, in one example.

[00221] Now referring to FIG. 26, an example solar disk configuration is disclosed in two different states 2600 and 2602. A configuration can present a solar dish 2604 that can be aligned with an energy source 106 (*e.g.*, the sun upon which the Earth revolves).

The solar dish 2604 can rest upon a base 2608 (*e.g.,* be coupled to the base) that sits upon ground, where the base 2608 is commonly constructed from metal, concrete, wood, and the like. To collect solar energy, the solar dish 104 can include a concentrator 2610 that can function as a solar cell. The first state configuration 2600 can represent a place in time immediately after construction of the solar dish 2604 with the base 2608. Conversely, the second state configuration 2602 can represent a place in time after construction where the base 2608 settles, the ground settles, the configuration 2600 is physically moved to a location that changes the configuration 2600 to the configuration 2602, *etc.* While the concentrator 2610 is show as part of a solar dish 2604, it is to be appreciated that various configurations can be practiced without use of a solar dish 2604, such as an independent unit.

[00222] Various circumstances can arise such that the configuration changes (*e.g.,* changes in a manner from first state configuration 2600 to second state configuration 2602). For instance, certain materials can settle over time (*e.g.,* concrete) and thus the solar dish 2604 (*e.g.,* a disk that includes a solar concentrator) no longer alights correctly with the energy source 2606. In one example, the solar dish 2604 can include a concentrator 2610 coupled to the middle of the dish 2604. As can be seen in FIG. 26, originally the energy source 2606 and solar dish 2604 are both aligned centrally (*e.g.,* configuration state 2600) which allows the concentrator 2610 to be completely within major energy bounds 2612 of the energy source 2606 (*e.g.,* being within the energy bounds enables maximum energy gathering). However, there is only partial alignment with the solar dish 2604 and energy source 2606 after movement (*e.g.,* configuration state 2602) and the concentrator 2610 is no longer completely within energy bounds of 2612 – thus the concentrator 2610 can be in a less than optimal position for gathering energy. If using a conventional encoder, the change in the configuration is not appreciated and thus the configuration does not operate as desired (*e.g.,* the energy source 2606 does not produce solar energy correctly upon the concentrator).

[00223] An inclinometer used in accordance with aspects disclosed herein can be a solid state sensor, commonly silicon-based. A mass can be suspended with small piece of silicon connecting the mass to a stable point (*e.g.,* a support structure). The mass can also include wings to improve functionality. Electrostatic force can move the mass such that

the mass is in center of an area. If an associated unit is pointed up at an angle, then the mass can be drawn down. Voltage can be supplied that counters forces to place the mass back in center. A measurement of the voltage used to place the mass back in the center of the area can be analyzed to determine an angle with respect to gravity.

[00224] Therefore, with the disclosed innovation, the solar dish 2604 can be adjusted automatically based upon alignment changes and thus the concentrator 2610 can be brought into the energy bounds of 2612 in configuration state 2602. A measurement can be taken of an angle of the solar dish 2604 and/or concentrator 2610 with respect to gravity to determine actual position and a calculation can be made of a desired position. If the actual position is not about equal to the desired position, the solar dish 2604, the base 2606, as well as other entities can move to correct alignment. According to one embodiment the configuration 2602 can remove alignment errors with the concentrator 2610 by searching for a maximum current from at least one photovoltaic cell. The solar dish 2604 can move in a pattern seeking a maximum output. A relative position of this maximum compared to an output of the concentrator 2610 can allow a misalignment to be corrected. This correction can also be incorporated to an open loop ecliptic calculation used to point at the energy source 2606 accurately even when hidden (*e.g.*, by clouds).

[00225] Now referring to FIG. 27, an example system 2700 is disclosed for determining if a receiver (*e.g.*, the solar dish 2604 of FIG. 26, a concentrator 2610 of FIG. 26, *etc.*) should be adjusted in accordance with positional change. In conventional operation, as an energy source changes position with the receiver (*e.g.*, change between the Earth's sun and a solar disk due to the Earth's rotation around the sun), the receiver can move along to follow the source. However, there can be times that the source cannot be physically tracked, such as on a cloudy day or during nighttime (*e.g.*, anticipating where the sun will rise). In these cases, anticipation can be used to determine where the receiver should be placed, such as positioning the receiver to be located where the sun is anticipated to rise.

[00226] To facilitate operation, a desired position for the receiver can be calculated based upon time, date, longitude, latitude, *etc.* Additionally, at least one inclinometer can be used to measure an angle of a receiver with respect to gravity. An obtainment

component 2702 can collect a position of a receiver with respect to gravity, commonly observed by the inclinometer. The obtainment component 2702 can function to gather metadata that pertains to a desired position of the receiver as well as an actual position.

[00227] The obtainment component 2702 can transfer collected data such as the desired location and gravity information to an evaluation component 2704. In addition, the obtainment component 2702 and/or the evaluation component 2704 can process the gravity information to determine an actual position of the receiver. The evaluation component 2702 can compare the receiver position (*e.g.,* actual position) against an desired position of the receiver in relation to an energy source, the comparison is used to determine a manner in which the receiver should be moved (*e.g.,* how to move the receiver, when to move the receiver, where to move the receiver, if the receiver should be moved at all, and the like). According to an alternate embodiment, raw gravity data (*e.g.,* representing receiver position) can be compared against an expected gravitational force (*e.g.,* representing desired position) by the evaluation component 2704. The evaluation component 2704 can transfer a result to an entity, such as a motor, e.g., a step motor, capable move moving the receiver from an actual position to a desired position.

[00228] Additionally, the evaluation component 2704 can update operation of the receiver and related units such that the desired result is attempted automatically. For instance, solar panel with concentrator can physically be moved about one mile and thus pre-determined calculations for positioning can be inaccurate. With measuring gravity (*e.g.,* angle of the receiver against gravity), it can be determined that the actual position of the receiver should move. With this new knowledge, a reset can occur such that receiver is moved according to the offset (*e.g.,* follows a path from after the move as opposed to before the move).

[00229] Thus, there can be an obtainment component 2702 that collects metadata of a position with respect to gravity of a concentrator (*e.g.,* an entity capable of collecting energy) capable of energy collection from a celestial energy source (*e.g.,* sun). According to one embodiment, the metadata is collected from an inclinometer. Additionally, an evaluation component 2704 can be used to compare the concentrator position against a desired position of the concentrator in relation to the celestial energy source, the comparison is used to determine a manner in which to make an alteration to

increase effectiveness (*e.g.*, maximize effectiveness) of the concentrator. For example, the alteration can be to move the solar dish 2604 of FIG. 26.

[00230] Now referring to FIG. 28, an example system 2800 is disclosed to assist in positioning a receiver in relation to an energy source. An obtainment component 2702 can collect a position of a receiver with respect to gravity (*e.g.*, collect position information). A computation component 2802 can calculate the desired position of the energy source (*e.g.*, a location of the energy source that allows for improved or maximum coverage toward a solar concentrator). According to one embodiment, the desired position is calculated by factoring date, time, longitude of the receiver, and latitude of the receiver. An internal clock can measure the time and date, as well as have the time and date transferred from an auxiliary entity (*e.g.*, a satellite) and latitude and/or longitude information can be gained from a global positioning system. In addition, an assessment component 304 can determine an actual position of the receiver through a measurement of an angle of gravity upon the receiver. Output of the computation component 2802 and/or the assessment component 2804 can be collected by the obtainment component 2702 and be used by an evaluation component 2704. The assessment component 2804 can function as means for calculating the location of a collector through analysis of metadata that relates to gravity exerted upon the collector. Moreover, the computation component 2802 can operate as means for computing the desired location of the collector, the calculation is based upon date, time, longitude of the receiver, and latitude of the collector. Additionally, the obtainment component 2702 can implement as means for obtaining the metadata that relates to gravity exerted upon the collector from a means for measuring.

[00231] The evaluation component 2704 can compare the receiver position against a desired position of the receiver in relation to an energy source, the comparison is used to determine a manner in which the receiver should be moved. However, it is possible that more efficient manners and/or manners that are more accurate can be used to adjust the receiver. For instance, if the energy source can be optically tracked, then it could be more beneficial not to use the system 2800. The evaluation component 2704 can function as means for comparing the calculated location of the collector against the desired location of the collector. Therefore, a locate component 306 can conclude if a

location of an energy source can be determined (*e.g.,* optically), where the evaluation component 204 operates upon a negative conclusion. Artificial intelligence techniques can be used to weight benefits of different manners of determining where the receiver should locate.

[00232] A conclusion component 2808 can decide if the receiver should move as a function of a result of the comparison. According to one embodiment, the conclusion component 2808 can consider multiple factors in addition to an outcome of the evaluation component 2704. In an aspect, conclusion component 2808 can generate a cost-utility analysis based at least in part on AI techniques and the considered multiple factors to assess viability of movement of the receiver. As an example, there can be a very slight discrepancy between an actual position and a desired position where power consumed, e.g., the cost, to move the receiver would outweigh what is anticipated to be gained, the utility, from a move. As another example, when the concentration is operated in adverse operational conditions such as weather condition(s), e.g., sustained high wind, cloudy atmosphere, cost of power consumed to move the concentrator can outweigh the benefit of operation in a desired position. Therefore, the conclusion component 2808 could determine that movement should not take place even if there is a positional difference. Additionally, even if there is a difference between actual and desired positions, if it is not estimated that there is to be any energy lost upon a concentrator, then the conclusion component 2808 can determine a move is not appropriate. The conclusion component 2808 can operate as means for concluding if the collector should move based upon a result of the comparison.

[00233] The system 2800 can use a movement component 2810 (*e.g.,* a motor, an entity that drives a motor, *etc.*) to power to move the receiver. Since different movement components 2810 can operate differently, a specific direction set can be generated upon how the receiver should be moved. A production component 2812 can generate a direction set, the direction set instructs how the receiver should be moved. The production component 2812 can transfer the directions set to the movement component 2810. The production component 2812 can operate as means for producing a direction set, the direction set instructs how the collector should be moved and is implemented by a collector shift entity.

[00234] It is possible that the direction set did not implement as anticipated. For instance, due to wear over time, parts of a motor can alter functionality and not perform as anticipated. A feedback component 2814 can determine if the direction set resulted in a desired outcome upon the direction set being implemented by the movement component 2810. In an aspect, the feedback component 2814 can exploit, and include, one or more inclinometers to determine if a collector or receiver has been moved as dictated by the direction set. For instance, if after the direction set has been implemented an angle of the collector with respect to the gravitational field is not a target angle, then feedback component 2814 can determine the outcome is not as intended. Accordingly, through utilization of one or more inclinometers, feedback component 2814 can diagnose, at least in part, integrity of a movement operation, which can be effected by movement component 2810. As an example of integrity of movement operation, feedback component 2814 can determine that a preferred position such as a non-production maintenance position is achieved. If the direction set results in the desired outcome (*e.g.*, movement of the receiver to the desired location), then a confidence rating can be increased that relates to operation of the production component 2812. However, if the feedback component 2814 determines that the desired outcome is not reached, then an adaptation component 2816 can modify operation of the production component 2812 with regard to the determination made that concerns direction set (*e.g.*, modify and test computer code used to generate the direction set). It is to be appreciated that the feedback component 2814 and/or adaptation component 2816 can alter operation of other components of the system 2800 or disclosed in the subject specification in a similar manner to improve operation. The feedback component 2814 can operate as means for determining if the direction set resulted in a desired outcome upon the direction set being implemented by the collector shift entity. The adaptation component 2816 can function as means for modifying operation of the means for producing concerning the determination made that concerns direction set.

[00235] Now referring to FIG. 29, an example system 2900 is disclosed for adjusting entities that measure gravity information in relation to a receiver. An obtainment component 2702 can collect a position of a receiver with respect to gravity, commonly produced by an inclinometer. An evaluation component 2704 can compare

the receiver position against a desired position of the receiver in relation to an energy source, the comparison can be used to determine a manner in which the receiver should be moved if an actual position and desired position are not substantially equal.

[00236] It is possible that at least one inclinometer can be misaligned such that an accurate result is not produced. A determination component 2902 can identify a misalignment or offset of an entity that measures position of the receiver with respect to gravity. The identification can take place through processing user input (*e.g.,* from a technician), though artificial intelligence techniques, *etc.* The determination component 2902 can operate as means for identifying a misalignment or an offset of the means for measuring the position of the collector with respect to gravity. A correction component 2904 can automatically determine a manner in which to adjust the misalignment or the offset and make an appropriate correction. The correction component 2904 can implement as means for correcting a misalignment or an offset of the means for measuring the position of the collector with respect to gravity.

[00237] Now referring to FIG. 30, an example system 3000 is disclosed for positioning a solar receiver with a detailed obtainment component 2702. The obtainment component 2702 can collects a position of a receiver with respect to gravity. To facilitate operation, the obtainment component 2702 can use a communication component 3002 to engage with entities (*e.g.,* the computation component 2802 of FIG. 28) to transfer information, such as to send a request for information, receiving information from an auxiliary source, *etc.* Operation can take place wirelessly, in a hard-wired manner, employment of security technology (*e.g.,* encryption), *etc.* Information transfer can be active (*e.g.,* query/response) or passive (*e.g.,* monitoring of public communication signals). Moreover, the communication component 3002 can utilize various protective features, such as performing a virus scan on collected data and blocking information that is positive for a virus. The communication component 3002 can operate as means for transferring the instruction set to the collector shift entity, the collector shift entity implements the instruction set.

[00238] A search component 3004 can be used to locate sources of information. For example, the system 3000 can plug into prefabricated solar dish with concentrator. The search component 3004 can identify a location of an inclinometer and perform

calibration. Additionally, the search component 3004 can be used to identify foreign sources of information. In an illustarive instance, if a configuration does not include an internal clock, then the search component 3004 can identify a time source and the obtainment component 2702 can collect information from the time source.

[00239] While the obtainment component 2702 can collect a wide variety of information, too much information can have a negative impact such as consuming valuable system resources. Therefore, a filter component 3006 can analyze obtained information and determine what information should pass to an evaluation component 2704 that can determine if a receiver should move. In one instance, the filter component 3006 can determine a freshness of a gravity reading. If there is little or no change from a previous reading, then information can be deleted and not transferred. According to one embodiment, the filter component 3006 can verify information and/or aggregate information. For instance, if a first time is produced by three sources and a second time is produced by one source, the second time can be discounted and one record can be transferred representing the time of the three sources.

[00240] Different pieces of information, such as collected metadata, component operating instructions (*e.g.,* communication component 3002), source location, components themselves, *etc.* can be held on storage 3008. Storage 3008 can arrange in a number of different configurations, including as random access memory, battery-backed memory, hard disk, magnetic tape, *etc.* Various features can be implemented upon storage 2708, such as compression and automatic back up (*e.g.,* use of a Redundant Array of Independent Drives configuration). In addition, storage 3008 can operate as memory that can be operatively coupled to a processor (not shown) and can implement as a different memory form than an operational memory form.

[00241] Now referring to FIG. 31, an example system 3100 is disclosed for positioning a solar receiver with a detailed evaluation component 2704. An obtainment component 2702 can collect a position of a receiver with respect to gravity. An evaluation component 2704 can compare the receiver position against a desired position of the receiver in relation to an energy source, the comparison is used to determine a manner in which the receiver should be moved.

[00242] An artificial intelligence component 3102 can be used to perform at least one determination or at least one inference in accordance with at least one aspect disclosed herein. For example, artificial intelligence techniques can be used for estimating an amount of power that can be gained from a move of a concentrator. As described above, the artificial intelligence component 3102 can employ one of numerous methodologies for learning from data and then drawing inferences and/or making autonomous determinations related to dynamically storing information across multiple storage units (*e.g.,* Hidden Markov Models (HMMs) and related prototypical dependency models, more general probabilistic graphical models, such as Bayesian networks, *e.g.,* created by structure search using a Bayesian model score or approximation, linear classifiers, such as support vector machines (SVMs), non-linear classifiers, such as methods referred to as "neural network" methodologies, fuzzy logic methodologies, and other approaches that perform data fusion, *etc.*) in accordance with implementing various automated aspects described herein. In addition, the artificial intelligence component 3102 can also include methods for capture of logical relationships such as theorem provers or more heuristic rule-based expert systems. The artificial intelligence component 3102 can be represented as an externally pluggable component, in some cases designed by a disparate (third) party.

[00243] A management component 3104 can regulate operation of the evaluation component 2704 as well as other components disclosed herein. For example, there can be relatively long periods of time where the sun cannot be detected. However, it can be pre-mature for the system 3100 to operate as soon as the sun cannot be detected since circumstances can change and multiple movements can occur (*e.g.,* while wasting energy). Therefore, the management component 3104 can determine an appropriate time for the obtainment component 2702 to collect information, to make the comparison, to generate a direction set for movement, *etc.* Once operating is determined to be reasonable to take place, appropriate instructions can be produced and enforced.

[00244] A compensation component 3106 can account for extraneous reasons for a result and make appropriate compensation. For instance, during nighttime repairs can be made to a configuration with a collector that is anticipated to complete before sunrise. While there is discrepancy between a desired value and actual, since there is likely going

to be an outside correction, it can be wasteful for the system 3100 to operate. Therefore, the compensation component 3106 can determine that operation should not occur.

[00245] A check component 3108 can determine that information is appropriately converted to ensure accurate operation. Since information pertaining to actual value or desired value can be collected from different locations, it is possible for the information to be in different formats. For example, desired location gravity information can be represented in feet per second while actual location gravity information can be represented in meters per second. The check component 3108 can determine an appropriate format and ensure correct conversion occurs automatically.

[00246] Now referring to FIG. 32, an example methodology 3200 is disclosed for managing an energy collector. A current location of an energy collector can be calculated at event 3202, commonly based upon gravity exerted upon the collector. Various metadata relating to the collector can be obtained at action 3204. Action 3204 can represent collecting date information, time information, longitude of the collector information, and latitude of the collector information. Based upon at least a portion of the obtained metadata, there can be act 3206 that can include computing an expected location of the collector, the calculation is based upon date, time, longitude of the collector, and latitude of the collector.

[00247] There can be making a comparison among the calculated location of the collector against an expected location of the collector at action 3208. Commonly, the calculated position is based upon gravity that is exerted upon the collector. A check 3210 can conclude if the collector should move based upon a result of the comparison. According to one embodiment, any difference between the calculated location and expected location can result in suggested movement. However, other configurations can be practiced, such as allowing slight tolerances.

[00248] If the check 3210 concludes movement is not appropriate, then the methodology 3200 can return to computing a desired location. A loop can be formed to keep checking until a movement is appropriate; however, there can be procedures for terminating the methodology 3200 upon this conclusion. If the conclusion is positive that movement is appropriate, then there can be producing an instruction set on how to move the collector to about the desired location at event 3212. Verification can take place

regarding the instruction set and at act 3214 there can be transferring the instruction set to a movement entity, the movement entity associated with the collector implements the instruction set.

[00249] Now referring to FIG. 33, an example methodology 3300 is disclosed for determining movement related to an energy collector. A measurement of gravity upon a collector can be taken at event 3302. For example, an inclinometer can measure a net force of gravity along two axes. A pair of inclinometers can be firmly attached to a solar dish in such a way that an angle that the dish is pointed with respect to gravity can be measured. This data serves as feedback to a microprocessor that compares the actual value against a desired value at act 3304. The desired value can be computed from latitude and longitude of an installation and/or time and date, which establishes the direction that the concentrator should point. This desired value can be expressed as a direction relative to the gravity vector.

[00250] It is possible that alignment of the concentrator should not be the only factor taken into account when determining if a move should occur. For instance, at event 3306 there can be estimating an amount of power that is appropriate to move the concentrator from an actual position to a desired position. Different factors (*e.g.,* energy loss from concentrator not being in desired position identified through an estimation, estimated power consumption, *etc.*) can be weighed against one another at act 3308 and a determination can be made if the dish should move at event 3310; weighing of the different factors can include implementing cost-utility analysis of the benefit of moving the concentrator versus expense(s) associated therewith, wherein the expense(s) can comprise power consumption, cost to implement maintenance configuration (e.g., a safe position of the concentrator), or the like. In an example scenario, when the concentration is operated in adverse weather condition(s), e.g., sustained high wind, cloudy atmosphere, cost of power consumed to move the concentrator can outweigh the benefit of operation in a desired position. If the dish should not move, then the methodology 3300 can return to measuring gravity. However, if it is determined that the dish should move, then parameters of a motor can be evaluated at act 3312 and a direction set can be produced to have the motor move the dish accordingly at event 3314.

[00251] For purposes of simplicity of explanation, methodologies that can be implemented in accordance with the disclosed subject matter were shown and described as a series of blocks. However, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the blocks, as some blocks can occur in different orders and/or concurrently with other blocks from what is depicted and described herein. Moreover, not all illustrated blocks can be required to implement the methodologies described hereinafter. Additionally, it should be further appreciated that the methodologies disclosed throughout this specification are capable of being stored on an article of manufacture to facilitate transporting and transferring such methodologies to computers. The term article of manufacture, as used, is intended to encompass a computer program accessible from any computer-readable device, carrier, or media.

[00252] MASS PRODUCIBLE SOLAR COLLECTOR

[00253] According to an aspect is a solar collector that comprises at least four arrays attached to a backbone support. Each array can comprise at least one reflective surface. Solar collector also includes a polar mount on which the backbone support and the at least four arrays can be tilted, rotated or lowered. The polar mount can be positioned at or near a center of gravity. Further, solar collector can include a polar mount support arm operatively connected to a movable mount and a fixed mount. The polar mount support arm can be removed from the movable mount for lowering of the solar collector. The backbone support can comprise a collection apparatus that comprises a plurality of photovoltaic cells that are utilized to facilitate a transformation of solar energy to electrical energy. Each of the at least four arrays comprise a plurality of solar wings formed in parabolic shape, each solar wing comprises a plurality of support ribs. Further, solar collector can include a positioning device that rotates the at least four arrays about a vertical axis.

[00254] According to another aspect is a solar wing assembly that comprises a plurality of mirror support ribs operatively attached to a shaped beam and a mirror placed on the plurality of mirror support ribs and secured to the shaped beam. Pairs of the plurality of mirror support ribs can be the same size to form a parabolic shape. Further, solar wing assembly can comprise a plurality of mirror clips that secure the mirror to the shaped beam.

[00255] Referring initially to FIG. 34, illustrated is a solar wing assembly 3400 that is simplified as compared to conventional solar collector assemblies, according to an aspect. The solar wing assembly 3400 utilizes a shaped beam 3402, which can be rectangular, as illustrated. In accordance with some aspects, the shaped beam can be other geometric shapes (*e.g.,* square, oval, round, triangular, and so forth). A multiple of formed mirror support ribs 3404, 3406, 3408, 3410, 3412, and 3414 are operatively attached to the shaped beam 3402. The mirror support ribs 3404-3414 can be of any suitable material, such as plastic (*e.g.,* plastic injection molded), formed metal, and so forth.

[00256] The mirror support ribs 3404-3414 can be operatively attached to the shaped beam 3402 in various manners. For example, each mirror support rib 3404, 3406, 3408, 3410, 3412, and 3414 can include a clip assembly, which can allow each mirror support rib 3404, 3406, 3408, 3410, 3412, and 3414 to be clipped onto the shaped beam 3402. However, other techniques for attaching the mirror support ribs to the shaped beam 3402 can be utilized, such as sliding the mirror under the mirror support ribs and securing the mirror in place with hooks or other securing components. In accordance with some aspects, the shaped beam 3402 and the mirror support ribs 3404, 3406, 3408, 3410, 3412, and 3414 can be constructed as a single assembly.

[00257] Pairs of the mirror support ribs 3404-3414 can be of a similar size in order to form (and hold) a mirror 3416 into a parabolic shape. The term "size" refers to the overall height of each mirror support rib 3404, 3406, 3408, 3410, 3412, and 3414 from the shaped beam 3402 to the mirror contact surface. Further, the size or height of each pair of mirror support ribs is of a different height than the other pairs (*e.g.,* the height of a middle support rib is shorter than the height of a support rib at either end of the shaped beam).

[00258] The distance from the mirror 3416 to the shaped beam 3402 can be different at various locations as a function of the overall height of each mirror support rib 3404, 3406, 3408, 3410, 3412, and 3414. Each pair of mirror support ribs are spaced and affixed at varying positions along the beam to achieve a desired parabolic shape. For example, a first pair comprises mirror support rib 3408 and mirror support rib 3410. A second pair comprises mirror support rib 3406 and mirror support rib 3412 and a third

pair comprises mirror support rib 3404 and mirror support rib 3414. The first pair of support ribs 3408 and 3410 has a first height, the second pair of mirror support ribs 3406 and 3412 has a second height, and the third pair of mirror support ribs 3404 and 3414 has a third height. In this example, the third height is taller than the second height, and the second height is taller than the first height. Thus, a first pair (*e.g.,* mirror support ribs 3408 and 3410) holds the mirror 3416 at a position that is closer to the shaped beam 3402 than the position at which second pair (*e.g.,* mirror support ribs 3406 and 3412) hold the mirror, which is further away from shaped beam 3402, and so forth.

[00259] In accordance with some aspects, the mirror support ribs 3404-3414 can be placed onto the shaped beam 3402 at a first end and can be slid or moved along the shaped beam 3402 and placed in position. According to other aspects, the mirror support ribs 3404-3414 can be attached to the shaped beam 3402 in other manners (*e.g.,* snapped into place, locked into place, and so forth).

[00260] FIG. 35 illustrates another view of the solar wing assembly of FIG. 34, in accordance with an aspect. As illustrated, solar wing assembly 3400 includes a shaped beam 3402 and a multitude of support ribs attached to shaped beam 3402. Illustrated are six mirror support ribs 3404, 3406, 3408, 3410, 3412, and 3414. However, it should be understood that more or fewer support ribs could be utilized with the disclosed aspects. Operatively connected to each support rib 3404-3414 is a mirror 3416, which will be discussed in further detail below.

[00261] FIG. 36 illustrates an example schematic representation 3600 of a portion of a solar wing assembly 3400 with a mirror 3416 in a partially unsecure position, according to an aspect. FIG. 37 illustrates an example schematic representation 3700 of a portion of a solar wing assembly 3400 with a mirror 3416 in a secure position, according to an aspect. For ease of explanation and understanding, FIG. 36 and FIG. 37 will be discussed together.

[00262] As illustrated, the portion of the solar wing assembly 3400 includes a shaped beam 3402. Mirror support rib 3404 and mirror support rib 3406 (as well as other mirror support ribs) are operatively connected to shaped beam 3402. Further, a mirror 3416 is operatively connected to mirror support rib 3404 and mirror support rib 3406.

[00263] The mirror 3416, which comprises reflective mirror material, can be supplied in a flat condition. In order to shape the mirror 3416 into a parabolic shape, the mirror 3416 can be placed on the top of each mirror support rib 3404 and 3406 (and so on). A mirror clip 3602 can hold the mirror 3416 against mirror support rib 3404 and mirror clip 3604 can hold the mirror 3416 against mirror support rib 3406. Only one mirror clip 3602, 3604 for each mirror support rib 3404, 3406 are illustrated in FIG. 36 and FIG. 37. However, it should be understood that each mirror support rib could include two (or more) mirror clips.

[00264] The mirror clip 3702 can be positioned over the mirror 3416 at a first position 3706 (as illustrated in FIG. 37). In order to lock the mirror 3416 against the mirror support rib 3404, the mirror clip 3602 is moved to a second position 3702 (as illustrated in FIG. 37) and operatively engaged with the mirror support rib 3404. The mirror 3416 is operatively engaged with each mirror support rib 3404-3414 along the length of the shaped beam 3402 in a similar manner (*e.g.,* as illustrated by mirror clip 3604).

[00265] The mirror clips (*e.g.*, mirror clip 3602) are illustrated as a donut shape with an opening in the middle (*e.g.,* female connector), allowing the mirror clip 3602 to engage with a male connector 3608 located at a first side 3610 of the mirror support rib 3404. A second mirror clip (not shown) can be engage with a male connector 3612, located on a second side 3614 of the mirror support rib 3404. It should be understood that while a female connector is associated with the mirror clip 3602 and a male connector 3608, 3612 is described with reference to the mirror support rib 3404, the disclosed aspects are not so limited. For example, the mirror clip 3602 can be a male connector. In accordance with some aspects, the mirror clip 3602 can be either a male connector or a female connector, provided that mirror clip 3602 can be operatively engaged to the mirror support rib 3404 (*e.g.,* the mirror support rib 3404 provides the mating connector).

[00266] It should be understood that the mirror clip 3602 is not limited to the design illustrated and described as other clips can be utilized, provided the mirror 3416 is securely engaged with each mirror support rib 3404-3414. Securing the mirror 3416 against each mirror support rib 3404-3414 can help enable that the mirror 3416 does not

come detached from the mirror support ribs 3404-3414 during shipment, assembly, or use of a collector assembly that utilizes one or more solar wing assemblies. It should be understood that any fastener could be utilized to secure the mirror 3416 to the mirror support rib 3404 and the fasteners shown and described are for example purposes.

[00267] In accordance with some aspects, the mirror clips 3602, 3604 are configured such that there is no rotation of the mirror clips 3602, 3604. For example, a nut and screw combination can be utilized, wherein screws protrude over a mirror contact surface 3616, which runs the length of the mirror support rib 3404 from the connector 3608 to connector 3612, for example. According to some aspects, the mirror clips 3602, 3604 can include anti-rotation features such that once placed in position, the mirror clips 3602, 3604 do not move (except from the first position 3606 to the second position 3702 and vice versa).

[00268] In accordance with some aspects, the size of each mirror clip 3602, 3604 is a function of the mirror 3416 thickness. Since the mirror 3416 is locked between the mirror support rib 3404 and the mirror clips 3602, 3604 a thicker mirror 3416 would necessitate the use of smaller mirror clips 3602, 3604. Similarly, a thinner mirror 3416 can necessitate the use of larger mirror clips 3602, 3604 to mitigate the chances that the mirror would slide along the support ribs 3404-3414. In accordance with some aspects, the size of the mirror clips 3602, 3604 are a function of whether a mirror with break resistant backing is utilized or if a different type of mirror (*e.g.*, aluminum mirror) is utilized.

[00269] Matching the mirror clips 3602, 3604 to the mirror thickness can further help enable that the mirror 3416 does not fluctuate its position between the support ribs 3404-3414 and the mirror clips 3602, 3604. If the mirror 3416 fluctuates (*e.g.*, moves), it can lead to breakage of the mirror 3416 during shipment, assembly in the field, or while a solar collector assembly that employs one or more solar wing assemblies 3400 is in use (*e.g.*, lowering the wings of the solar collector assembly, rotating the assembly, tiling the assembly, and so forth), as will be described in more detail below.

[00270] With reference again to FIG. 34, a collection of solar wing assemblies 3400 can be utilized to form a mirror wing array. For example, seven solar wings assemblies can be placed side-by-side to form a mirror wing array. Four similar mirror

wing arrays (each containing seven solar wing assemblies 3400, for example) can form a solar collector assembly. However, it should be understood that more or fewer solar wing assemblies 3400 can be utilized to form a mirror wing array and any number of mirror wing arrays can be utilized to form a solar collection assembly and the examples shown and described are for purposes of simplicity. Further information about the construction of an entire solar collection assembly will be described more fully with respect to the following figures.

[00271] FIG. 38 illustrates another example schematic representation 3800 of a portion of a solar wing assembly 3400 in accordance with an aspect. In this example, two hooks 3802 and 3804 are utilized to securely engage the mirror 3416 against the mirror support ribs (*e.g.*, mirror support rib 3404 and mirror support rib 3414 of FIGs. 34 and 35). To attach the mirror 3416, the mirror can be slid from a first end (*e.g.*, at mirror support rib 3404) to a second end (*e.g.*, at mirror support rib 3414, illustrated in FIGs. 34 and 35). The mirror 3416 can be slid under mirror clips, or stopper clips, associated with the mirror support ribs along the length of the solar wing assembly 3400. Sliding the mirror 3416 in an end loaded manner can be similar to installing a windshield wiper blade refill on an automobile.

[00272] In accordance with some aspects, the mirror clips can be preinstalled. Hooks, similar to hooks 3802 and 3804, can be located at second end of solar wing assembly 3400 (*e.g.*, at mirror support rib 3414) and can be utilized to stop the mirror at the desired location. When the mirror 3416 is engaged along the length of the solar wing assembly 3400, the hooks 3802 and 3804 can be utilized to secure the mirror in position.

[00273] FIG. 39 illustrates a backbone structure 3900 for a solar collector assembly in accordance with the disclosed aspects. As illustrated, the backbone structure 3900 can be formed utilizing rectangular beams 3902 and 3904, two supports 3906 and 3908, and a central collection apparatus 3910. However, it should be understood that other shapes can be utilized for the beams and the disclosed aspects are not limited to rectangular beams. The beams are attached together with plates or are welded to form the backbone structure 3900. In accordance with some aspects, common sized plates are used to simplify assembly. The central collection apparatus 3910 can comprise

photovoltaic cells that are utilized to facilitate the transformation of solar energy to electrical energy.

[00274] A multitude of solar wing assemblies 3400 can be attached to the backbone structure 3900. FIG. 40 illustrates a schematic representation 4000 of a solar wing assembly 3400 and a bracket 4002 that can be utilized to attach the solar wing assembly 3400 to the backbone structure 3900 (of FIG. 39), according to an aspect. A first end 4004 of the bracket 4002 can be operatively connected to rectangular beam 3902 (of FIG. 39). For example, the first end of bracket 4004 can have pilot holes, one of which is labeled at 4006, that allow bracket 4002 to be connected to rectangular beam 3902 with screws or other fastening devices. In accordance with some aspects, bracket 4002 is welded to rectangular beam 3902.

[00275] Solar wing assembly 3400 is operatively connected to a second end 4008 of bracket 4002, which is illustrated as a rectangular beam. Further solar wing assembly 3400 can be secured to rectangular beam 3902 in such a manner that, as the solar assembly is operated (*e.g.,* lowering the wings of the solar collector assembly, rotating the assembly, tiling the assembly, and so forth) the solar wing assembly 3400 does not become disengaged from the backbone structure 3900. In accordance with some aspects, simplified gusset mounting of the common wing panels allow for easy field assembly. The main beam can be factory pre-drilled with the gusset mounting holes so no field alignment is necessary. The angle formed in the gusset parts can help to keep the winged panel at the proper angle to the main beam.

[00276] FIG. 41 illustrates a schematic representation of an example focus length 4100 that represents an arrangement of the solar wing assemblies 3400 to the backbone structure 3900 in accordance with an aspect. It should be noted that the illustration represents an example of a common focal length mounting pattern of the gussets for the parabolic winged panels and the disclosed aspects are not limited to this mounting pattern.

[00277] The solar wing assemblies 3400 can be arranged such that each solar wing assembly has substantially the same focus length to the receivers. In accordance with some aspects, one or more receivers can be included. The one or more receivers can include a photovoltaic (PV) module that facilitates energy conversion (light to electricity)

and/or that harvests thermal energy (*e.g.*, through a serpentine with a circulating fluid that absorbs heat created at the one or more receivers). According to some aspects, the receiver(s) harvest thermal, PV, or both thermal and PV. It should be noted that the degrees and other measurements illustrated are for example purposes only and the disclosed aspects are not limited to these examples.

[00278] Illustrated at 4102 is an aspect wherein solar reflectors 4104 are operatively connected to a main support beam in a straight-line configuration or a trough design. In this aspect, the receivers are not necessarily at a similar focal distance from a receiver 4106. As illustrated, line 4108 indicates an attachment line on a support frame.

[00279] With reference now to FIG. 42, illustrated is a schematic illustration of a solar collection assembly 4200 that utilizes four arrays 4202, 4204, 4206, and 4208 comprising a multitude of solar wing assemblies 3400, according to an aspect. Each array 4202, 4204, 4206, 4208 can include, for example, seven solar wing assemblies 3400 arranged lateral to each other. For example, there are seven solar wing assemblies 3400 in array 4208, as labeled. Each array 4202, 4204, 4206, 4208 can be attached to backbone structure 3900, and more specifically, to rectangular beam 3902. In accordance with some aspects, more or fewer solar wing assemblies 3400 can be utilized to form an array 4202, 4204, 4206, or 4208 and more or fewer arrays 4202-4208 can be utilized to form a solar collection assembly 4200 and the disclosed aspects are not limited to four such assemblies.

[00280] Solar collection assembly 4200 can have a balanced center of gravity located on a receiver mast (not illustrated) about which the solar collection assembly 4200 can be tilted or rotated. FIG. 43 illustrates a simplified polar mount 4300 that can be utilized with the disclosed aspects. A center of gravity can be utilized as a mounting point for the solar collection assembly 4200 (of FIG. 42) on the simplified polar mount 4300. The positioning of the polar mount 4300 at this center of gravity allows movement of the collector for ease of usage, service, storage, or the like.

[00281] For example, the solar collection assembly 4200 can be tiled through a declination axis in relation to a polar mount support arm 4302. The polar mount support arm 4302 can be aligned to the earth's surface such that the polar mount support arm 4302 is aligned parallel with the tilt of the earth's axis of rotation, which will be

discussed in further detail below. A positioning device 4304, such as an actuator, is operatively connected to a positioning assembly 4306 and rectangular beam 3904 of backbone structure 3900. The positioning device 4304 facilitates the solar collection assembly 4200 to be rotated about a vertical axis (which is also known as the declination axis). The positioning device 4304 can be, for example, an actuation cylinder (*e.g.*, hydraulic, pneumatic, and so forth).

[00282] The positioning assembly 4306 facilitates rotating the solar collection assembly 4200 about the ascension axis of the polar mount support arm 4302. The positioning device 4304 can tilt the solar collection assembly 4200 to a desired angle of declination with respect to the sun's position in the sky, as the positioning device 4304 moves in relation to the positioning assembly 4306, supports 3906 and 3908 also move causing the solar collection assembly 4200 to tilt through a range of declination angles.

[00283] As the positioning assembly 4306 is rotated to track the ascension of the sun, the positioning device 4304 can be utilized to enable that that the solar collection assembly 4200 remains at an optimal angle of declination to capture the sun's rays. Use of a positioning device 4204 in conjunction with the polar mount 4200 allows the solar collection assembly 4200 to be adjusted to a desired declination angle at the commencement of solar collection as opposed to continually having to adjust the angle of tilt throughout the sun tracking process. This can mitigate the energy consumption associated with operating a solar collection assembly since the positioning device 4304 only needs to be adjusted once per day (or as many times per day, as needed, so as to provide an optimal tacking of the sun) as opposed to conventional techniques that continually adjust the positioning device 4304.

[00284] Referring now to FIG. 44, illustrated is an example motor gear arrangement 4400 that can be utilized to control rotation of a solar collector assembly, according to an aspect. Motor gear arrangement 4400 can be utilized to, at least partially, connect a solar collection assembly 4200 (of FIG. 42) to a polar mount support arm 4302 (of FIG. 43). Motor gear arrangement 4400 can rotate the solar collection assembly 4200 about a central axis of the polar mount support arm 4302, which provides ascension positioning of the array. Motor gear arrangement 4400 comprises a connector 4402 that can be utilized to operatively connect the polar mount support arm 4302 to the motor gear

arrangement 4300. The solar collection assembly 4200 can be operatively connected to support brackets 4404 and 4406. A motor 4408 in combination with a motor drive 4410 and a drive unit 4412 facilitate rotation of the solar collection assembly 4200 about the polar mount support arm 4302. The solar collection assembly 4200 can be fixed at the connector 4402 and the support brackets 4304 and 4306 and the solar collection assembly 4200 can rotate about the polar mount support arm 4302, according to an aspect.

[00285] It should be noted that although the positioning device 4304 (of FIG. 43) and the motor gear arrangement 4400 are illustrated and described as separate components, it is to be appreciated that the disclosed aspects are not so limited. For example, in accordance with some aspects, the positioning device 4304 and motor gear arrangement 4400 (or motor 4408) are combined in a single assembly. This single assembly can provide connection of a solar collection assembly 4200 to the polar mount support arm 4302 while facilitating alteration of the position of the solar collection assembly 4200 with respect to ascension and declination in relation to the position of the sun or another energy source from which energy is to be captured. In accordance with other aspects, various combinations of motors and positioning devices can be utilized to provide positioning of solar collection assemblies and devices utilized to harness the capture of radiation and the like while facilitating the adjustment of the position of the arrays and devices in relation to the energy source.

[00286] FIG. 45 illustrates another example motor gear arrangement 4500 that can be utilized for rotation control, according to an aspect. As illustrated, motor gear arrangement 4500 includes a polar mount support arm 4502. Also included are brackets 4504 and 4506. Gear arrangement 4500 also includes a motor 4508 and a motor drive 4510. Further, gear arrangement 4500 includes a drive unit 4512.

[00287] FIG. 46 illustrates an example polar mounting pole 4600 that can be utilized with the disclosed aspects. Polar mounting pole 4600 includes a first end 4602 that can be operatively connected to motor gear arrangement 4400 (of FIG. 44) or motor gear arrangement 4500 (of FIG. 45). A second end 4604 of polar mounting pole 4600 can be operatively connected to a mounting unit (not shown). Polar mounting pole 4600 can facilitate movement of a solar collector, according to an aspect.

[00288] FIG. 47 illustrates another example of a polar mounting pole 4700 that can be utilized with the various aspects. Polar mounting pole 4700 includes a first end 4702 that can be operatively connected to motor gear arrangement 4400 and/or 4500. A second end 4704 of polar mounting pole 4700 can be operatively connected to a mounting unit (not shown). FIG. 48 illustrates a view of a first end 4702 of polar mounting pole 4700. As illustrated, motor gear arrangement 4400 and/or 4500 can be operatively attached to polar mounting pole 4700 though various connection means, such as illustrated connection means 4800.

[00289] FIG. 49 illustrates a fully assembled solar collector assembly 4900 in an operating condition, according to an aspect. The assembled solar collector assembly 4900 comprises solar collection assembly 4200 that is aligned to reflect the sun's rays onto a central collection apparatus 3910. The solar collection assembly 4200 comprises a multitude of mirrors, which can be utilized to concentrate and focus solar radiation on the central collection apparatus 3910. The mirrors can be included as part of solar wing assemblies that are combined to form solar arrays, as illustrated by array 4202, array 4204, array 4206, and array 4208.

[00290] The central collection apparatus 3910 can comprise photovoltaic cells that are utilized to facilitate the transformation of solar energy to electrical energy. The solar collection assembly 4200 and the central collection apparatus 3910 are supported on polar mount support arm 4302. Further, the arrays 4202, 4204, 4206, and 4208 can be arranged so that a gap 4902 separates the arrays 4202, 4204, 4206, and 4208 into two groups, such as a first group 4604 (comprising arrays 4202 and 4206) and a second group 4906 (comprising arrays 4204 and 4208).

[00291] To facilitate harnessing energy from the sun's rays (or other light source), the solar collection assembly 4200 can be rotated in various planes to correctly align the mirrors of each array 4202, 4204, 4206, and 4208 with respect to the direction of the sun, reflecting the sun's rays (or other light source) onto the central collection apparatus 3910. FIG. 50 illustrates a schematic representation 5000 of a solar collection assembly 4200 in a tilted position, according to an aspect.

[00292] With reference now to both FIGs. 49 and 50, in accordance with some aspects, a motorized gear assembly can connect the solar collection assembly 4200 and

the central collection apparatus 3910 to a polar mount support arm 4302. The polar mount support arm 4302 is aligned to the earth's surface such that it is aligned parallel with the tilt of the earth's axis of rotation. The motor gear arrangement 4400 can allow the solar collection assembly 4200 and central collection apparatus 3910 to be rotated about a horizontal axis, which is also known as the ascension axis. The solar collection assembly 4200 and central collection apparatus 3910 are further connected to the polar mount support arm 4302 by positioning device 4304. The positioning device 4304 allows the solar collection assembly 4200 and central collection apparatus 3910 to be rotated about a vertical axis (also known as the declination axis). Rotating the solar collection assembly 4200 changes an orientation of arrays (*e.g.,* operating position, safety position, or any position there between).

[00293] When the solar collector assembly 4900 is to be assembled in the field (*e.g.,* in an operating location), the polar mount support arm 4302 is operatively connected to a footer 4908. Attached to the footer 4908 can be mounting brackets 4910 that allow the polar mount support arm 4302 to be selectively disengaged (at least partially) from the footer 4908 (*e.g.,* for tilting and lowering of the solar collector assembly 4900). Another footer 4912 can have thereon a mounting unit 4914 to which the solar collector assembly 4900 is attached. It should be understood that the footers 4908 and 4912 extend below a surface 4916 (*e.g.,* ground, earth) at a proper depth to anchor the solar collector assembly 4900.

[00294] With reference now to FIG. 51, illustrated is a schematic representation 5100 of a solar collection assembly 4200 rotated in an orientation that is substantially different from an operating condition, according to aspect. Rotating the solar collection assembly 4200 in such a manner allows for service and maintenance to be performed on the receivers.

[00295] If the solar collection assembly 4200 is to be placed in a position for storage, safety, or for maintenance purposes, such as the position illustrated in FIG. 51, the motor can be stepped through a number of steps to move the array from an operating position (*e.g.,* the position illustrated in FIG. 49) to the position illustrated in FIG. 51, sometimes referred to as a storage or safety position. Further to this example, the number of steps utilized by motor to move the solar collection assembly 4200 in a clockwise

direction from an operating position to a storage position can be determined, along with the requisite number of steps in the counter-clockwise direction. The two counts (*e.g.*, clockwise direction and counter-clockwise direction) can be compared and the shortest direction can be utilized to place the array in the storage position.

[00296] In another aspect, in response to a hailstorm the solar collection assembly 4200 can be placed in the safety position. A record of the number of steps required to position the array in the safety position from the operating position of the array (*e.g.*, its position prior to the command to move to the safety position was received) can be determined. After the hailstorm (or other danger) has passed, the array can be repositioned to resume operation. The repositioning can be determined based upon the last known position of the array plus the number of steps required to compensate for the current position of the sun (*e.g.*, last position of array prior to the hailstorm plus the number of steps to move the array to current position of the sun). The current position of the sun can be determined by the use of latitude, longitude, date, and/or time information associated with the array and the position of the array. The current position of the sun can also be determined by the use of sun position sensors, which can be used to determine the angle at which the energy of sunlight is strongest and position the array accordingly.

[00297] Further, the gap 4902 in the groups of arrays 4904, 4906 allows the arrays to be positioned to minimize susceptibility of the mirrors that form the array to environmental damage such as strong winds and hail. As depicted in FIG. 50, the solar collection assembly 4200 can be rotated about the polar mount support arm 4302, to place the array in a "safety position". The ability to rotate the solar collection assembly 4200 about an ascension axis and tilt about the declination axis allows the solar collection assembly 4200 to be positioned so that its alignment with any prevailing wind minimizes a sail effect of the solar collection assembly 4200 in the wind. Also, in the event of hail strikes, snow, and so forth, the solar collection assembly 4200 can be positioned such that the mirrors are facing downwards with the backside of the array structure being exposed to the hail strikes, mitigating damage to the mirrors.

[00298] In accordance with some aspects, the solar collection assembly 4200 can utilize an electronic device, such as a computer operable to execute the positioning (*e.g.*,

tilting, rotating, *etc.*) of the solar collection assembly 4200. For example, sensors located on or near the solar collection assembly 4200 can sense weather conditions and automatically place the solar collection assembly 4200 into a safety position. A multitude of solar collection assemblies located in a geographic area can utilize a common electronic device that is configured to control the movement of the multitude of solar collection assemblies. Further, the one or more electronic devices can intelligently operate the solar collection assemblies in order to mitigate damage to the devices.

[00299] For example, various aspects (*e.g.*, in connection with sensing adverse operating conditions, detecting movement of the sun and so forth) can employ various machine learning schemes (*e.g.*, artificial intelligence, rules based logic, and so forth) for carrying out various aspects thereof. For example, a process for determining if the solar collection assemblies should be placed in a safety position can be facilitated through an automatic classifier system and process. The machine learning schemes can measure various weather conditions, such as from a central collection device. In accordance with some aspects, the machine learning component can communicate (*e.g.*, wirelessly) with various weather command centers (*e.g.*, over the Internet) to obtain weather conditions.

[00300] Artificial intelligence based systems (*e.g.*, explicitly and/or implicitly trained classifiers) can be employed in connection with performing inference and/or probabilistic determinations and/or statistical-based determinations as in accordance with one or more aspects as described herein. As used herein, the term "inference" refers generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured through events, sensors, and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic - that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are correlated in close temporal proximity, and whether the events and data come from one or several event and data sources. Various classification schemes and/or systems (*e.g.*, support vector machines, neural networks,

expert systems, Bayesian belief networks, fuzzy logic, data fusion engines...) can be employed in connection with performing automatic and/or inferred action in connection with the disclosed aspects. Further information relating to electronic devices that can be utilized with the disclosed aspects will be provided below.

[00301] FIG. 52 illustrates a solar collector assembly 5200 rotated and lowered in accordance with the various aspects presented herein. Lowering the solar collector assembly allows for easy service, maintenance, and repair. Further, lowering the solar collector assembly 5200 can provide a safe storage position for severe weather. Rotation of the array solar collection assembly 4200 about the ascension axis and the declination axis can enable all areas of the solar collection assembly 4200 to be brought within easy reach of an operator. The operator could be an installation engineer who needs access to the various mirrors contained in the arrays, central collection apparatus 3910, and so forth, during the installation process. For example, the installation engineer may need to access the central collection apparatus 3910 for alignment purposes. The operator could also be a maintenance engineer who requires access to the solar collection assembly 4200 to clean the mirrors, replace a mirror, and other functions.

[00302] The polar mount support arm 4302 (and possibly also the mounting brackets) can be disengaged from the footer 4908. This allows the polar mount support arm 4302 to be pivoted on the mounting unit 4914 and, thus, the solar collection assembly 4200 can be brought into closer contact with the ground 4916.

[00303] FIG. 53 illustrates a schematic representation 5300 of a solar collection assembly 4200 in a lowered position, according to an aspect and FIG. 54 illustrates a schematic representation 5400 of a solar collection assembly 4200 in a lowest position, which can be a storage position, according to an aspect.

[00304] FIG. 55 illustrates another solar collection assembly 5500 that can be utilized with the disclosed aspects. In accordance with this aspect, solar collection assembly 5500 includes solar wing assemblies 5502 that utilize a single mirror 5504. As discussed with respect to the above aspects, each wing array 4204, 4206 has wing assemblies that comprise a separate mirror for each wing assembly. In this alterative aspect, a single mirror 5504 is utilized in place of the two separate mirrors. The single mirror 5504 extends across two wings 5502 and 5506 on opposite sides of the dish or

solar collection assembly 5500. Utilizing a single mirror 5504 can increase the reflective area of the mirror array. The single mirror 5504 can be attached to the wings 5502 and 5506 through various techniques (*e.g.,* sliding the mirror along the length of the wings 5502 and 5506, manually attaching the mirror at each mirror support rib, or through other techniques).

[00305] FIG. 56 illustrates an example receiver 5600 that can be utilized with the disclosed aspects. As illustrated the example receiver 5600 can be arranged with modules of photovoltaic cells, a few of which are labeled at 5602, 5604, and 5606. Also provided can be cooling lines 5608 and 5610 that can be utilized for heat collection. In accordance with some aspects, this heat can be utilized for a multitude of purposes. FIG. 57 illustrates an alternative view of the example receiver 5600 illustrated in FIG. 56, according to an aspect. The view in FIG. 57 illustrates how the cooling lines 5608 and 5610 can extend the length of the receiver 5600. The cooling lines 5608 and 5610 can have coolant therein in order to cool the photovoltaic cells (*e.g.,* operate as a heat exchanger). It should be understood that the various exemplary devices disclosed herein (*e.g.,* receiver 5600, motor gear arrangement 4400, and so forth) are for example purposes only and the disclosed aspects are not limited to these examples.

[00306] According to an aspect is a method of erecting a solar collector assembly. Method includes attaching a plurality of arrays to a backbone structure. Each of the plurality of arrays is attached to the backbone structure to maintain a spatial distance from each of the other plurality of arrays. Further, the plurality of arrays comprise at least one reflective surface. According to some aspects, method includes attaching the plurality of arrays such that the plurality of arrays rotate through a vertical axis as a function of the spatial distance. Method can also include connecting the backbone structure to a polar mount that is positioned at or near a center of gravity and attaching the polar mount to a fixed mounting and a movable mounting that enables lowering of the solar collector assembly. According to some aspects, method includes disengaging the polar mount from the movable mounting to lower the solar collector assembly. In accordance with some aspects, method includes rotating the plurality of arrays and the backbone structure around the center of gravity along the vertical axis to change an orientation of the plurality of arrays. Alternatively or additionally, method can include

rotating the plurality of arrays and the backbone structure around the center of gravity along the vertical axis to change one of an operating position, a safety position, or any position there between of the plurality of arrays. The plurality of arrays can be attached to the backbone structure at a same focus length. The solar collector assembly in transported in a partially assembled state, according to an aspect. In accordance with another aspect, the solar collector assembly in transported as modular units.

[00307] In accordance with some aspects, a method is provided for mass-producing solar collectors. Method includes forming a solar wing into a parabolic shape, the solar wing comprises a plurality of support ribs, attaching a reflective surface to the solar wing to create an assembly, and forming an array with a plurality of solar wing assemblies. Further, method can include attaching the array to a backbone structure. The backbone structure can be equipped with a plurality of photovoltaic cells that are utilized to facilitate a transformation of solar energy to electrical energy. In accordance with some aspects, forming the solar wing into the parabolic shape, comprises attaching the plurality of support ribs to a support beam, a height of each support rib is selected to create the parabolic shape. According to some aspects, attaching the reflective surface to the solar wing comprises placing the reflective surface on the plurality of support ribs and securing the reflective surface to the plurality of support ribs. In an aspect, method includes transporting the produced solar collectors in a partially assembled state. In another aspect, method includes transporting the produced solar collectors as modular units.

[00308] FIG. 58 illustrates a method 5800 for mass-producing solar collectors in accordance with one or more aspects. Method 5800 can simplify production of solar collectors in an inexpensive manner. The aspects related to mass-producing the solar collectors can also facilitate less expensive costs for shipment of a large number of solar collectors (*e.g.*, dishes). For example, the solar collectors can be composed of modular components, allowing for the shipment of these modular components. In accordance with some aspects, the solar collectors can be transported in a partially assembled state.

[00309] At 5802, a solar wing is formed into a parabolic shape. The solar wing can comprise a plurality of support ribs, which can be operatively connected to the support beam. The support ribs can be of various heights, wherein pairs of the support

ribs have substantially the same height. The height of the support ribs is the height measured from the support beam to a mirror contact surface (*e.g.,* the end of the support rib opposite the support beam). The heights of the support ribs at a middle of the support beam can be shorter than the height of the support ribs at the ends of the support beam, thus forming the mirror into a parabolic shape. A height of each support rib is selected to create the parabolic shape.

[00310] A reflective surface (*e.g.,* mirror) is attached on the solar wing to create an assembly, at 5804. This can include placing the reflective surface on the plurality of support ribs (or on a contact surface associated with each support rib) and securing the reflective surface to the plurality of support rights. An increasing height of the support ribs (from the center outward) facilitates forming the reflective surface into the parabolic shape. At 5806, a fastening means is utilized to attach the reflective surface to the solar wing. For example, the fastening means can be placed on top of the reflective surface and secured to an associated support rib. Two fastening means can be utilized for each support rib. The fastening means holds the reflective surface against the support ribs to mitigate the amount of movement of the reflective surface.

[00311] In accordance with some aspects, the fastening means can be hooks located at each end of a solar wing assembly. The hooks can function as stops to prevent a mirror, which is slid in place, from disengaging from the solar wing assembly. In accordance with this aspect, attaching the reflective surface to the solar wing includes sliding the reflective surface over the plurality of support ribs and under the mirror support clips and securing the reflective surface at both ends of the solar wing. In an example, the mirrors can be end loaded, similar to a windshield wiper blade refill. The wing can have a stopper clip on the end closest to the beam and the mirror slides between the clips to form the shape. A second set of stopper clips can be attached to secure the mirrors.

[00312] A multitude of solar wings are combined, at 5808, to form an array of solar wings. Any number of solar wings can be utilized to form the array. In accordance with some aspects, seven solar wings are utilized to form an array; however, more or fewer solar wings can be utilized. The solar wings can be arranged into the array such that the solar wings are at a similar focus length as receivers.

[00313] In accordance with some aspects, the arrays are connected to a backbone structure, at 5810. Method 5800 can also include equipping the backbone structure with a plurality of photovoltaic cells that can be utilized to facilitate a transformation of solar energy to electrical energy. Attaching the arrays to the backbone structure is optional and the arrays can be connected to the backbone structure after transport (*e.g.,* in the field). The solar collectors can be transported in a partially assembled state or as modular units.

[00314] According to some aspects, method 5800 can include transporting the produced solar collectors in a partially assembled state. According to other aspects, method 5800 includes transporting the produced solar collectors as modular units.

[00315] FIG. 59 illustrates a method 5900 for erecting a solar collector assembly, according to an aspect. The solar collector assembly can be assembled so that the assembly can be rotated, tilted, and lowered for various purposes (*e.g.,* construction, maintenance, service, safety, and so forth). Assembly of the collector is possible without the assistance of a crane. Further, once assembled, no further alignment of the panels is needed.

[00316] At 5902, a plurality of arrays are attached to a backbone support. The arrays can comprise a multitude of solar wings. However, in accordance with some aspects, the arrays can be constructed from a single solar wing. The plurality of arrays can comprise at least one reflective surface.

[00317] The arrays are attached to the backbone support to maintain a spatial distance from each of the other plurality of arrays. This spatial distance can mitigate the effect wind forces can have during periods of high winds. The arrays are also mounted to allow slight movement and flexibility while keeping rigidity to maintain the focus of sunlight on the receivers. In accordance with some aspects, the arrays are arranged as a trough design instead of being placed at a similar focal distance from a receiver. According to some aspects, the spatial distance allows the plurality of arrays to rotate through a vertical axis.

[00318] A backbone is connected to a polar mount, at 5904. The polar mount can be positioned at or near a center of gravity of the solar collector, which can allow movement (*e.g.,* tilt, rotate, lower) of the collector for ease of usage, service, storage, or

the like. In accordance with some aspects, the plurality of arrays are attached to the backbone structure at a same focus length.

[00319] The polar mount is attached to a fixed mounting and a movable mounting, at 5904. The polar mount can be selectively removed from the movable mounting to allow the solar collector to be lowered for service, repair, or for other purposes.

[00320] Additionally, method 5900 can include rotating the plurality of arrays and the backbone structure around a center of gravity along the vertical axis to change an orientation of the plurality of arrays. The orientation can be one of an operating position or a safety position. Alternatively or additionally, method 5900 can include disengaging the polar mount from the movable mounting the lower the solar collector assembly.

[00321] Another aspect of the subject innovation supplies a system of solar concentrators with a heat regulating assembly, which regulates (*e.g.*, in real time) heat dissipation therefrom. FIG. 60 illustrates a schematic cross sectional view 6000 for a heat regulation assembly 6010 that underlies a modular arrangement 6020 of photovoltaic (PV) cells 6023, 6025, 6027 (1 through N, where N is an integer), which has a variant temperature gradient. Typically, each of the PV cells (also referred to as solar cells) 6023, 6025, 6027 can convert light (*e.g.*, sunlight) into electrical energy. The modular arrangement 6020 of the PV cells can include standardized units or segment that facilitate construction and provide for a flexible arrangement.

[00322] In one exemplary aspect, each of the photovoltaic cells 6023, 6025, 6027 can be a dye-sensitized solar cell (DSC) that includes a plurality of glass substrates (not shown), wherein deposited thereon are transparent conducting coating, such as a layer of fluorine-doped tin oxide, for example.

[00323] Such DSC can further include a semiconductor layer such as TiO_2 particles, a sensitizing dye layer, an electrolyte and a catalyst layer such as Pt- (not shown)- which can be sandwiched between the glass substrates. A semiconductor layer can further be deposited on the coating of the glass substrate, and the dye layer can be sorbed on the semiconductor layer as a monolayer, for example. Hence, an electrode and a counter electrode can be formed with a redox mediator to control of electron flows therebetween.

[00324] Accordingly, the cells 6023, 6025, 6027 experience cycles of excitation, oxidation, and reduction, which produce a flow of electrons, *e.g.*, electrical energy. For example, incident light 6005 excites dye molecules in the dye layer, wherein the photo excited dye molecules subsequently inject electrons into the conduction band of the semiconductor layer. Such can cause oxidation of the dye molecules, wherein the injected electrons can flow through the semiconductor layer to form an electrical current. Thereafter, the electrons reduce electrolyte at catalyst layer, and reverse the oxidized dye molecules to a neutral state. Such cycle of excitation, oxidation, and reduction can be continuously repeated to provide electrical energy.

[00325] The heat regulating device 6010 removes generated heat from hot spot areas to maintain the temperature gradient for the modular arrangement 6020 of PV within predetermined levels. The heat regulating device 6010 can be in form of a heat sink assembly, which includes a plurality of heat sinks that can be surface mounted to a back side 6037 of the modular arrangement of photovoltaic cells 6020, wherein each heat sink can further include a plurality of fins (not shown) extending substantially perpendicular the back side. Such heat sinks can be fabricated from material with substantially high thermal conducting such as aluminum alloys, copper and the like. In addition, various clamping mechanisms or thermal adhesives and the like can be employed to securely hold the heat sinks without a level of pressure that can potentially crush the modular arrangement of photovoltaic cells 6020. Moreover, "tube" style elements circulated with cooling fluid (*e.g.*, water) therein can meander throughout the heat regulating device in a snake like formation, to further facilitate heat exchange.

[00326] The fins can expand a surface area of the heat sink to increase contact with cooling medium (*e.g.*, air, cooling fluid such as water), which is employed to dissipate heat from the fins and/or photovoltaic cells. As such, heat from the photovoltaic cells can be conducted through the heat sink and into surrounding cooling medium. Moreover, the heat sinks can have a substantially small form factor relative to the photovoltaic cell, to enable efficient distribution throughout the backside 6037 of the modular arrangement 6020 of the photovoltaic cells.

[00327] FIG. 61 illustrates a schematic perspective assembly layout 6100 of a modular arrangement of PV cells in form of photovoltaic grid 6110. Such grid 6110 can

be part of a single enclosure that converts solar energy into electrical energy. The heat regulating assembly can be arranged in form of a heat transfer layer 6115 that includes heat sinks, which are thermally coupled to PV cells 6102 on the PV grid 6110. Even though the subject innovation is primarily described as the heat transfer layer 6115 dissipating heat from the PV grid 6110, it is to be appreciated that such heat transfer layer 6115 can also be employed to selectively induce heat within segments of the PV grid 6110 (*e.g.*, to alleviate environmental factors, such as ice build up thereon.) The system 6100 receives light reflected from reflecting plates such as mirrors (not shown).

[00328] In one aspect, the heat transfer layer 6115 exists on a plane below the PV grid 6110 and is thermally coupled thereto. The heat transfer layer 6115 can include heat sinks that can be added to such layer *via* pick and place equipment that are commonly employed for placement of components and devices. In a related aspect, the heat transfer layer 6115 can further include a base plate 6121 that can be kept in direct contact with hot spots 6126, 6127, 6128 that are generated on the PV grid 6110.

[00329] In addition, the heat transfer layer 6115 can include a heat promoting section 6125. The heat promoting section 6125 facilitates heat transfer between the PV grid 6110 and the heat transfer layer 6115. The heat promoting section 6125 can further include thermo/electrical structures embedded inside. Such permits for the heat generated from a photovoltaic cell 6102 to be initially diffused or dispersed through the whole main base plate section 6121 and then into the thermo structure spreading assembly, wherein such spreading assembly can be connected to the heat sinks. The thermo structures can further include thermal conducting paths (*e.g.*, metal layers) 6131, to the heat sinks to mitigate direct physical or thermal conduct of the heat sinks to the photovoltaic cells. Such an arrangement provides a scalable solution for proper operation of the PV modular arrangement 6110.

[00330] FIG. 62 illustrates a schematic block diagram of a heat regulation system 6200 according to one aspect of the subject innovation. The system 6300 includes a heat regulating device 6262, which further comprises a thermo-electrical network assembly 6264 operatively coupled to a back plate 6263 that interacts with the photovoltaic grid assembly 6261. The thermo-electrical net work assembly 6264 can consist of a plurality of thermo-electric structures, (such as a trough formed within a layer of the heat

regulating device, and embedded with various electronic components), and can be operatively coupled to the heat sink 6265, which draws heat away from the thermo-electrical structure assembly 6264. In addition, the thermo-electrical structure assembly 6264 can be physically, thermally, or electrically connected to the back plate, which in turn contacts the photovoltaic grid assembly 6261. Such an arrangement enables the photovoltaic grid assembly 6261 to interact with thermo-electrical structure assembly 6264 as a whole, *via* the back plate 6263, as opposed to a portion of the photovoltaic grid assembly interacting with a respective individual thermo-electrical structure unit. A processor 6266 can be operatively coupled to the thermo-electrical network assembly 6264 and be programmed to control and operate the various components within the heat regulating device 6262. Moreover, a temperature monitoring system 6268 can be operatively connected to the processor 6266e and the photovoltaic grid assembly 6261, (*via* the back plate or base plate 6263). The temperature monitoring system 368e operates to monitor temperature of the photovoltaic grid assembly 6261. Temperature data are then provided to the processor 6266, which employs such data in controlling the heat regulating device 6262. The processor 6266 can further be part of an intelligent device that has the ability to sense or display information, or convert analog information into digital, or perform mathematical manipulation of digital data, or interpret the result of mathematical manipulation, or make decisions based on the information. As such, the processor 6266 can be part of a logic unit, a computer or any other intelligent device capable of making decisions based on the data gathered by the thermo-electrical structure and the information provided to it by the heat regulating device 6262. A memory 6267 being coupled to the processor 6266 is also included in the system 6200 and serves to store program code executed by the processor 6266 for carrying out operating functions of the system 6200 as described herein. The memory 6267 can include read only memory (ROM) and random access memory (RAM). The ROM contains among other code the Basic Input-Output System (BIOS), which controls the basic hardware operations of the system 6260. The RAM is the main memory into which the operating system and application programs are loaded. The memory 6267 also serves as a storage medium for temporarily storing information such as PV cell temperature, temperature tables, allowable temperature, properties of the thermo-electrical structure, and other data

employed in carrying out the present invention. For mass data storage, the memory 6267 can include a hard disk drive (*e.g.*, 10 Gigabyte hard drive).

[00331] The photovoltaic grid assembly 6261 can be divided into an exemplary grid pattern as that shown in FIG. 63. Each grid block (XY) of the grid pattern corresponds to a particular portion of the PV grid assembly 6261, and each portion can be individually monitored and controlled for temperature *via* the control system described below with reference to FIG. 65. In one exemplary aspect, there is one thermo-electrical structure for each temperature measured, allowing the temperatures of the various regions to be controlled individually. In FIG. 63, the temperature amplitudes of each PV cell or segment of the grid portion (X_1Y_1 ... X_{12}, Y_{12}) are shown with each respective portion of the being monitored for temperature using a respective thermo-electrical structure. Typically, the temperature of the PV grid at a coordinate (*e.g.* $X_3Y_{9)}$ that lies beneath a PV cell having a low dissipation rate and an unacceptable temperature (Tu), which is substantially higher than the temperature of the other portions XY of the PV grid. Similarly, during the operation of the PV grid, the temperature of a region of the PV arrangement can reach an unacceptable limit (Tu). The activation of a respective thermo-electrical structure for that region can lower the temperature to the acceptable value (Ta). Accordingly, in one aspect according to the subject innovation, several thermo-electrical structures can manage heat flow from such a region to reach an acceptable temperature for the region.

[00332] FIG. 64 illustrates a representative table of temperature amplitudes taken at the various grid blocks, which have been correlated with acceptable temperature amplitude values for the portions of the PV grid assembly mapped by the respective grid blocks. Such data can then be employed by the processors of FIG. 62 and FIG. 65 to determine the grid blocks with undesired temperature outside the acceptable range (Ta range). Subsequently, the undesired temperatures can be brought to an acceptable level *via* activation of the respective cooling mechanism such as the heat sinks and/or thermo-electrical structure(s).

[00333] According to a further aspect, during a typical operation of the photovoltaic grid assembly the location of the hot spots are anticipated, or determined *via* temperature monitoring, and the corresponding thermo-electrical structure that matches

the hot spots can be activated as to take away the heat from the hot spot regions and/or induce heat to other regions of the photovoltaic grid assembly to create a uniform temperature gradient (*e.g.*, mitigate environmental factors such as ice build up). Figure 65 illustrates a schematic diagram illustrating such a system for controlling the temperature of the photovoltaic grid assembly according to this particular aspect. The system 6500 includes a plurality of thermo-electrical structures (TS1, TS2 . . . TS[N]), wherein "N" is an integer. In one aspect, the thermo-electric structures TS are preferably distributed along the back surface of the PV grid assembly 6574, and corresponding to respective photo cells device. Each thermo-electrical structure can provide a heat path to a predetermined portion of the PV grid assembly 6574 respectively. A plurality of heat sinks (HS1, HS2, . . . HS[N]) are provided, wherein each heat sink HS is operatively coupled to a corresponding thermo-electrical structure TS, respectively, to draw heat away from the PV grid assembly 6574. The system 6500 also includes a plurality of thermistors (TR1, TR2, . . . TR[N]). Each thermo-electrical structure TS can have a corresponding thermistor TR for monitoring temperature of the respective portion of the PV grid assembly 6574 being temperature regulated by the corresponding thermo-electrical structure. In one aspect of the subject innovation, the thermistor TR may be integrated with the thermo-electrical structure TS. Each thermistor TR can be operatively coupled to the processor 6576 to provide it with temperature data associated with the respective monitored region of the PV cell modular arrangement. Based on the information received from the thermistors as well as other information (*e.g.*, anticipated location of the hot spots, properties of the PV cells), the processor 6576 drives the voltage driver 6579 operatively coupled thereto to control the thermo-electrical structure in a desired manner to regulate the temperature of the PV grid 6574. The voltage driver can further be charged by the electrical energy generated by the PV grid assembly.

[00334] The processor 6576 can be part of a control unit 6578 that has the ability to sense or display information, or convert analog information into digital, or perform mathematical manipulation of digital data, or interpret the result of mathematical manipulation, or make decisions based on the information. As such, the control unit 6578 can be logic unit, a computer or any other intelligent device capable of making decisions based on the data gathered by the thermo-electrical structure and the

information provided to it by the heat regulating device. The control unit 6578 designates which thermo-electrical structures should be taking away heat from the hot spots, and/or which thermo-electrical structure should induce heat into the PV grid arrangement and/or which one of the thermo-electrical structures should remain inactive. The heat regulating device 6572 provides the control unit with data gathered continuously by the thermo-electrical structures about various physical properties of the different regions of the modular arrangements of PV, such as, temperature, power dissipation and the like. In addition, a suitable power supply 6579 can also provide operating power to the control unit 6578.

[00335] Based on the data provided, the control unit 6578 makes a decision about the operation of the various portions of the thermo-electrical structure assembly, *e.g.* deciding what number of the thermo-electrical structures should dissipate heat away and from which hot spots. Accordingly, the control unit 6578 can control the heat regulating device 6572, which in turn adjusts the heat flow away from and/or into the PV grid 6574.

[00336] FIG. 66 illustrates a related methodology 6600 of dissipating heat from PV cells according to an aspect of the subject innovation. While the exemplary method is illustrated and described herein as a series of blocks representative of various events and/or acts, the subject innovation is not limited by the illustrated ordering of such blocks. For instance, some acts or events may occur in different orders and/or concurrently with other acts or events, apart from the ordering illustrated herein, in accordance with the innovation. In addition, not all illustrated blocks, events or acts, may be required to implement a methodology in accordance with the subject innovation. Moreover, it will be appreciated that the exemplary method and other methods according to the innovation may be implemented in association with the method illustrated and described herein, as well as in association with other systems and apparatus not illustrated or described. Initially, and at 6610 incident light can be received by a modular arrangement for grid assembly of PV cells. At 6620, temperature of PV cells can be monitored (*e.g.*, *via* a plurality of temperature sensors associated therewith.). Based in such temperature, at 6630 cooling of the PV cells can occur in real time, wherein dissipation of heat occurs from the PV cells at 6640, to ensure proper operation.

[00337] FIG. 67 illustrates a further methodology 6700 of heat dissipation for a PV grid assembly according to an aspect of the subject innovation. At 6702, the logic unit including the processor generates the temperature grid map for the PV grid assembly. Next, and at 6704, temperature for each region is compared to a respective allowable temperature for that region, which ensures efficient operation of the PV cells. Subsequently and at 6706, a determination is made, whether the temperature for the region exceed the respective allowable temperature. If so, at 6708 the region's respective thermo-electrical structure are activated in conjunction with the heat sinks, to dissipate the heat for that region on the PV grid assembly. Otherwise, the methodology 6700 proceeds to act 6702 to generate a further temperature grid map of the PV grid assembly, for a cooling thereof.

[00338] FIG. 68 illustrates a system 6800 according to a further aspect of the subject innovation, with a fluid (*e.g.*, water) as the cooling medium being employed to dissipate heat from the fins of the heat sinks and/or and photovoltaic cells of the PV system 6810. The system 6800 regulates fluid discharge from reservoir 6805 (*e.g.*, as part of a pressurized closed loop), wherein check/control valves 6820, 6825 can regulate liquid flow in a single direction and/or to prevent the flow directly from the reservoir into the heat regulating device of the PV system 6810. The system 6800 can mitigate thermal stress and material deterioration to prolong system lifetime, and provide for a cooled or heated liquid for other commercial uses. Various sensors associated with a Venturi tube/valve 6815 can provide data to the controller 6830. For example, sensor analog output signal can be interfaced to a process control microprocessor, programmable controller, or Proportional-Integral-Derivative (PfD) 3-mode controller, wherein output controls the check/ control valves 6820, 6825 to regulate liquid flow as a function of PV cell temperature.

[00339] According to a further example, valves 6820, 6825 can provide a pulsed delivery of the cooling medium. Such pulsing delivery of cooling medium can supply a simple manner for controlling rate of cooling medium application. Moreover, duty cycles can be obtained by controlling the valve for a short duration of time at a set frequency (*e.g.*, 1 to 50 milliseconds with a pulsing frequency of 1 to 50 Hz).

[00340] In a related aspect, the system 6800 can employ various sensors to assess a health thereof, to diagnose problems for substantially rapid maintenance. For example and as explained earlier, when the cooling medium exits photovoltaic cells it enters a Venturi tube where two pressure sensors permit a measurement of the flow rate of the coolant. Additionally, pressure sensors can further permit verification for existence of adequate coolant is in the system 6800, wherein upstream or down stream blockage can be sensed. Moreover, differential temperature computations can further verify heat transfer values for a comparison thereof with predetermined thresholds, for example.

[00341] In a related aspect, an AI component 6840 can be associated with the controller 6830 (or the processors described earlier), to facilitate heat dissipation from the PV cells (*e.g.*, in connection with choosing region(s) dissipating heat, estimating amount of coolant required, manner of valve operation, and the like). For example, a process for determining which region to be selected can be facilitated *via* an automatic classification system and process. Such classification can employ a probabilistic and/or statistical-based analysis (*e.g.*, factoring into the analysis utilities and costs) to prognose or infer an action that is desired to be automatically performed. For example, a support vector machine (SVM) classifier can be employed. A classifier is a function that maps an input attribute vector, x = (x1, x2, x3, x4, *xn*), to a confidence that the input belongs to a class - that is, f(x) = *confidence*(*class*). Other classification approaches include Bayesian networks, decision trees, and probabilistic classification models providing different patterns of independence can be employed. Classification as used herein also is inclusive of statistical regression that is utilized to develop models of priority.

[00342] As used herein, the term "inference" refers generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured *via* events and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic – that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are

correlated in close temporal proximity, and whether the events and data come from one or several event and data sources. As will be readily appreciated from the subject specification, the subject invention can employ classifiers that are explicitly trained (*e.g.*, *via* a generic training data) as well as implicitly trained (*e.g.*, *via* observing system behavior, receiving extrinsic information) so that the classifier(s) is used to automatically determine according to a predetermined criteria which regions to choose. For example, with respect to SVM's which are well understood - it is to be appreciated that other classifier models may also be utilized such as Naive Bayes, Bayes Net, decision tree and other learning models - SVM's are configured *via* a learning or training phase within a classifier constructor and feature selection module.

[00343] FIG. 69 illustrates a system plan view 6900 for a plurality of solar concentrators that employ a heat regulating assembly according to an aspect of the subject innovation. Such an arrangement can typically include a hybrid system that produces both electrical energy and thermal energy, to facilitate and optimize the energy output in conjunction with energy management. The heat regulating assembly can include a network of conduits (*e.g.*, pipe lines) in grid form of columns 6902, 6908 and rows 6904, 6910 – which can further include associated valves/pumps for channeling the cooling medium throughout the arrangement of solar concentrators. The system 6900 can further encompass a combination of concentrator dishes (which can collect light in a focal point - or substantially small focal line), and concentrator troughs (which can collect light to a substantially long focal line.) For example, troughs tend to require simple design and therefore can be well suited for thermal generation. As explained earlier, the thermal energy from dishes that are collected in the process of cooling cells can further serve as pre-heated fluids, which can be subsequently superheated in a dedicated trough or concentrator situated at an end of a coolant loop, for example. The trough or concentrator can superheat fluids to desired temperature level. The system 6900 can further include monitors of output temperatures (not shown) and control of a network of valves *via* the control component 6960 (*e.g.*,, supervisor system), which can be employed to achieve desired temperature. Accordingly, by regulating flow of the cooling medium within the columns 6902, 6908 and rows 6904, 6910 – the energy output

for both of electrical and thermal energy from corresponding solar concentrators can be optimized.

[00344] In one aspect, the control component 6960 can also actively manage (*e.g.*, in real time) tradeoff between thermal energy and PV efficiency, wherein a control network of valves can regulate flow of coolant medium through a solar concentrator. For example, coolant that flows through one PV receiver's heat sink can be routed into two thermal receivers and by splitting the coolant line downstream from the PV receiver, the flow of coolant is halved, hence allowing the coolant to be heated up to a higher temperature as it passes more slowly through the downstream thermal dish. The control component can take as input data such as: current electricity prices that vary based on market conditions (time of year, time of day, weather conditions, and the like); requirement for thermal energy for a particular application; specific current temperature differences between the ambient temperature and the fluid's temperature), and the like. Based on such exemplary inputs, the control component can proactively adjust the coolant pump speeds and opens and/or closes valves to redirect the routing of coolants throughout the thermal loop between dishes and/or troughs – to optimize and create balance between electrical output and thermal output based on predetermined criteria, such as current electricity prices that vary based on market conditions time of year, time of day, weather conditions, requirement for thermal energy for a particular application; specific current temperature differences between the ambient temperature and the fluid's temperature), and the like.

[00345] Moreover, the system 6900 can readily detect ruptures (*e.g.*, through a network of pressure sensors, flow rate sensors) distributed throughout the network of valves and columns/rows of conduits). For example, pressure and temperature at different parts of the system can be continuously monitored to detect any changes that can indicate a rupture and/or blockage that signifies a malfunction, *e.g.*, at concentrator 6914, wherein such component can be effectively isolated from the system (*e.g.*, a bypass valve selectively establishes a bypass path for the cooling fluid). It is to be appreciated that controlling and monitoring of the system 6900 can be performed on a dish-by-dish basis, or on any predetermined number of dishes that from a zone or segment of the system 6900. Such decision can be based on costs, response times, efficiency, location,

and the like associated with each dish or a group thereof. It is further to be appreciated that even though the methodologies described herein for cooling a dish are primarily described as part of a group of dishes, such methodologies are also applicable for a single dish and can be applied individually as suited.

[00346] In a related aspect, each of the solar concentrators can be in form of a modular arrangement that includes various valve(s), sensor(s) and pipe segment(s) integrated as part thereof, to form a module. Such modules can be readily attached/detached to the network of conduits 6902, 6908, 6904, 6910. For example, the solar concentrator 6950 can include a pipe segment with a valve and/or sensors attached thereto, hence forming an integrated module - wherein the sensors can include temperature sensors for measuring: temperature of the cooling medium, temperature of the surrounding environment, pressure, flow rate, and the like. Upon attaching such integrated module to the conduit network, and adjusting the associated valves, the cooling medium can subsequently flow to the solar concentrator 6950 for a cooling thereof. In addition, such integrated solar concentrator module can include a housing that partially or fully contains the solar concentrator, pipe segment(s), valves, sensor and other peripherals/devices associated therewith. Additionally, a Venturi tube can be directly molded in such housing to facilitate measurement procedures.

[00347] FIG. 70 illustrates a related methodology for operation of the heat regulating assembly according to an aspect of the subject innovation. Initially, and at 7010 an incoming radiation to the system can be measured (*e.g.*, *via* radiation sensors), and based thereupon a required flow rate for solar concentrators and/or PV cells can be estimated and/or inferred for operations of valves at 7020 (*e.g.*, extent that each valve should be opened and/or closed and flow rate required at each segment of the system.) Subsequently and at 7030, based on collected data (*e.g.*, temperature, pressure, flow rate) a control feedback mechanism is employed to adjust operation of valves at 7040. For example, such closed loop component can further employ a proportional–integral–derivative controller (PID controller) that attempts to correct error between a measured process variable and a desired set point by calculating and then outputting a corrective action that can adjust the process accordingly.

[00348] FIG. 71A illustrates a diagram of an example parabolic solar concentrator 7100. The example solar concentrator 7100 includes four panels 7130_1-7130_4 of reflectors 7135 that focus a light beam on two receivers 7120_1-720_2—panels 7130_1 and 7130_3 focus light on receiver 7120_1, and panels 7130_2 and 7130_4 focus light on receiver 7120_2. Receivers 7120_1 and 7120_2 can both collect sunlight for generation of electricity or electric power; however, in alternative or additional configurations receiver 7120_1 can be utilized for thermal energy harvesting while receiver 7120_2 can be employed for electric power generation. Reflectors 7135 are attached (e.g., bolted, welded) to a main support beam 7135 which is part of a support structure that includes a mast 7118, a beam 7130 that supports receivers 7120_1 and 120_2, and a truss 7125 (e.g. a king post truss) that eases the load of panels 7130_1-7130_4 on main beam 7115. Position of truss joints depend on load of panels 7130_1-7130_4. Supporting structures in example solar concentrator 7100 can be made of substantially any material (e.g., metal, carbon fiber) that provides enduring support and integrity to the concentrator. Reflectors 7135 can be identical or substantially identical; however, in one or more alternative or additional embodiments, reflectors 7135 can differ in size. In an aspect, reflectors 7135 of different sizes can be employed to generate a focused light beam pattern of collected light with specific characteristics, such as a particular level of uniformity.

[00349] Reflectors 7135 include a reflective element that faces the receivers, and a support structure (described below in connection with FIG. 72). Reflective elements are reliable, inexpensive and readily available flat reflective materials (e.g., mirrors) that are deflected into a parabolic shape, or through-shaped section, in a longitudinal direction and maintained flat in transversal direction to form a parabolic reflector. Therefore, reflector 7135 focuses light on a focal line in a receiver 7120. It should be appreciated that even though in example solar concentrator 7100 a specific number (7) of reflectors 7135 is illustrated, a larger or smaller number of reflectors can be employed in each panel 7130_1-7130_4. Likewise, any substantial combination of reflector panels, or arrays, 7130 and receivers 7120 can be utilized in a solar concentrator as described in the subject specification. Such combination can include one or more receivers.

[00350] Additionally, it should be appreciated that reflectors 7135 can be back coated with a protective element such as plastic foam or the like to facilitate integrity of

the element when example solar concentrator 7100 adopts a safety or service position (e.g., trough a rotation about main support beam 7115) and exposes the back of panel(s) 7130_λ, with l=1,2,3,4, under severe or adverse whether operation, for example.

[00351] It should be further appreciated that example solar collector 7100 is a modular structure which can be readily mass produced, and transported piecewise and assembled on a deployment site. Moreover, the modular structure of panels 7130_λ ensure a degree of operational redundancy that facilitated continued sunlight collection even in cases in which one or more reflectors become inoperable (e.g. reflector breaks, misaligns).

[00352] In an aspect of the subject innovation, receivers 7120_1-7120_2 in example concentrator 7100 can include a photovoltaic (PV) module that facilitates energy conversion (light to electricity), and it can also harvest thermal energy (e.g., via a serpentine with a circulating fluid that absorbs heat created at the receivers) attached to the support structure of the PV module. It should be appreciated that each of receiver 7120_1 and 7120_2, or substantially any receiver in a solar concentrator as described in the subject specification, can include a PV module without a thermal harvest device, a thermal harvest device without a PV module, or both. Receivers 7120_1-7120_2 can be electrically interconnected and connected to a power grid or disparate receivers in other solar concentrators. When receivers include a thermal energy harvest system, the system can be connected throughout multiple receivers in disparate solar concentrators.

[00353] FIG. 71B illustrates an example focused light beam 7122 onto receiver 7120_γ, which can be embodied in receiver 7120_1 or 7120_2, or any other receiver described in the subject specification. The focused light pattern 7122 displays non-uniformities, with broader sections near or at the endpoints of the pattern. More diffuse focused areas above and below the endpoint regions of the pattern generally arise from reflectors that are positioned slightly away from the focal distance thereof.

[00354] Details of example solar collector 7100 and elements thereof are discussed next.

[00355] FIG. 72 illustrates an example constituent reflector 7135, herein termed solar wing assembly. The solar reflector 7135 includes a reflective element 7205 bent into a parabolic shape, or through shape, in a longitudinal direction 7208 and remains flat

in a transversal direction 7210. Such deflection of reflective element 7205 facilitates reflective to focus light into a line segment located at the focal point of the formed parabolic through. It should be appreciated that for the length of the segment line coincides with the width of reflective element 7135. Reflective material 7205 can be substantially any low-cost material such as a metallic sheet, a thin glass mirror, a highly reflective thin-film material coated on plastic, wherein the thin-film possesses predefined optical properties, e.g., fails to absorb in a range of specific wavelengths (e.g., 514 nm green laser or a 647 nm red laser), or predefined mechanical properties like low elastic constants to provide stress endurance, and so on.

[00356] In example reflector 7135, six support ribs 7215_1-7215_3, attached to backbone beam 7225, bend reflective element 7205 into parabolic shape. To that end, support ribs have disparate sizes and are affixed at disparate locations in beam 225 to provide an adequate parabolic profile: Outer ribs 7215_3 have a first height that is larger than a second height of ribs 7215_2, this second height is larger than a third height of inner ribs 7215_1. It should be appreciated that a set of N (a positive integer greater than three) support ribs can be employed to support reflective element 7205. It is to be noted that support ribs can be manufactured with substantially any material with adequate rigidity to provide support and adjust to structural variations and environmental fluctuations. The number N and the material of support ribs (e.g., plastic, metal, carbon fiber) can be determined based at least in part on mechanical properties of reflective element 7205, manufacture costs considerations, and so on.

[00357] Various techniques to attach support ribs (e.g., support ribs 7215_1-7215_3) to backbone beam 7225 can be utilized. Moreover, support ribs (e.g., support ribs 7215_1-7215_3) can hold a reflective element 7205 through various configurations; e.g, as illustrated in example reflector 7135, support ribs can clamp the reflective element 205. In an aspect of the subject innovation, support ribs 7215_1-7215_3 can be manufactured as an integral part backbone beam 7225. In another aspect, support ribs 7215_1-7215_3 can be clipped into backbone beam 7225 which has at least the advantage of providing ease of maintenance and adjustment of reflective reconfiguration. In yet another aspect, support ribs 7215_1-7215_3 can be slid along the backbone beam 7225 and placed in position.

[00358] A female connector 7235 facilitates to couple example reflector 7135 to main structure frame 7115 in example solar concentrator 7100.

[00359] It should be appreciated that shape of one or more elements in example reflector 7135 can differ from what has been illustrated. For example, reflective element 7205 can adopt shapes such as square, oval, circle, triangle, etc. Backbone beam 7225 can be have a section shape other than rectangular (e.g., circular, elliptic, triangular); connector 7235 can be adapted accordingly.

[00360] FIG. 73A is a diagram 7300 of attachment of a solar reflector 7135 to a main support beam 7115. As illustrated in example parabolic solar collector 7100, seven reflectors 7135 are placed at focal distance from receiver 7120γ, with γ=1,2. Reflectors 7135 have the same focal distance by design and thus, a light beam is to be focused in a line segment (e.g., focal line). Fluctuations in attachment conditions (e.g., variations in alignment of reflector(s)) results reflector(s) positioned at a distance slightly longer or shorter than focal distance and therefore a light beam image projected onto receiver 120 can be rectangular in shape. It should be appreciated that in such configuration of reflectors, the pattern of a focused light beam on receiver 7120_γ differs substantially form point pattern of focused light obtained through conventional parabolic mirrors, or V-shaped patterns of collected light formed by a conventional reflector that is a parabola section swept along a second parabolic path.

[00361] Alternatively, in an aspect, solar reflectors 7135 can be attached to the main support beam 7135 on a straight-line configuration, or through design, rather than placed at the same focal distance from receiver 7120_γ. FIG. 73B illustrates a diagram 7350 of such attachment configuration. Line 7355 illustrates an attachment line on support frame 7135.

[00362] FIGs. 74A and 74B illustrates, respectively an example single-receiver configuration 400, and an example double-receiver arrangement 450. In FIG 74A, a light beam pattern is schematically presented in receiver 120γ, the light beam pattern is substantially uniform, with minor distortions other than those associated with fluctuations that lead to a rectangular shape light projection. However, such uniformity is attained at the expense of a limited collection area; e.g., two reflector panels 7130_1-7130_2 with seven constituent reflectors in each panel.

[00363] FIG. 74B illustrates an example collector configuration 7450 that utilizes two receivers 7120_1-7120_2 that facilitate a substantial increase in sunlight collection through a larger area, e.g., four reflector panels 7130_1-7130_4 with seven constituent reflectors each. Configuration 7450 provides at least two advantages over single-receiver configuration 7400: (i) Double-receiver configuration collects twice as much radiation flux, and (ii) retains the substantial uniformity of focused light beam in single-receiver configuration. Example reflector arrangement 7450 is utilized in example solar collector 7100.

[00364] It is noted that implementation of a collection area as large as that in arrangement 7450 within a single-receiver configuration can lead to substantial distortion of the focused light beam pattern. Particularly, for a large area collector with a large array of constituent reflectors that includes outer reflectors substantially distant from the receiver, a "bow tie" distortion can be formed. Thus, added complexity stemming from utilization of a second receiver and associated circuitry and active elements, is overridden by the advantages associated with uniform illumination. FIG. 75 illustrates a "bow tie" distortion of light focused onto a receiver 7510 located in a center configuration for a solar concentrator with array panels 7130_1-7130_4.

[00365] FIG. 76 illustrates a diagram 7600 of typical slight distortions that can be corrected prior to deployment of a solar concentrator or can be adjusted during scheduled maintenance sessions. Such distortion(s) in the image focused on receiver 7610, which can be embodied in receiver 7120_1 or 7120_2, can be corrected by small adjustment(s) $\Delta\theta$ of the position of constituent reflectors, or solar wings, in a reflector panel (e.g., panel 130_1). The adjustment(s) aims to vary the panel attachment angle ϕ to the central support beam 7130. This adjustment(s) can be viewed as a rotational "twist" that alters ϕ from a value of 3.45 degrees to $3.45 \pm \Delta\theta$. Alternatively, or in addition, a second attachment angle φ, the angle between the backbone beam 225 and a plane that contains the main support beam 115, can be reconfigured to $\varphi \pm \Delta\alpha$, with $\Delta\alpha << \varphi$. (Typically, φ is 10 degrees.) The result of position adjustment(s) is to shift the light beam line formed by an individual common reflector panel (e.g., panel 7130_1) to more evenly illuminate receiver 7120 to take further exploits the advantage(s) of PV cell characteristics. FIG. 77

illustrates a diagram 7700 of an adjusted instance of the distorted pattern displayed in diagram 7600.

[00366] FIG. 78 is a diagram of example embodiments 7800 of a photovoltaic receiver, e.g., receiver 7120_1 or 7120_2, for collection of sunlight for energy conversion; e.g., light to electricity. In embodiment 7800, the receiver includes a module of photovoltaic (PV) cells, e.g., a PV module 7810. Sets or clusters of PV cells 7820 are aligned in the direction of a focused light beam (see, e.g., FIG. 71B). In addition, the sets of PV cells 7820, or PV active elements, are arranged in clusters of N constituent cells and M rows, wherein the constituent PV cells within a row are electrically connected in series and rows are electrically connected in parallel.; N and M are positive integers. In example embodiment 7800, N=8 and M=3. Such alignment and electrical connectivity can exploit aspects of PV cells such as vertical multi-junction (VMJ) cells to take unique advantage of the narrow light beam focused on the receiver, e.g., either 7120_1 or 7120_2, to maximize electricity output. It is noted that a VMJ cell is monolithic (e.g., integrally bonded) and oriented along a specific direction, which typically coincides with a crystalline axis of a semiconducting material that composes the VMJ cell. It should be appreciated that PV cells utilized in PV module 7810 can be substantially any solar cell such as crystalline silicon solar cells, crystalline germanium solar cells, solar cells based on III-V group of semiconductors, CuGaSe-based solar cells, CuInSe-based solar cells, amorphous silicon cells, thin-film tandem solar cell, triple-junction solar cells, nanostructured solar cells, and so forth.

[00367] It should be appreciated that example embodiment 7800 of a PV receiver can include serpentine tube(s) 7830 which can be utilized to circulate a fluid, or liquid coolant, to collect heat for at least two purposes: (1) to operate PV cell(s) in clusters or sets 7820 within an optimal range of temperatures, since PV cell efficiency degrades as temperature increases; and (2) to utilize the heat as a source of thermal energy. In an aspect, serpentine tube(s) 7830 can be deployed in a pattern that optimizes heats extraction. Deployment can be effected by embedding, at least in part, a portion of serpentine tube(s) 7830 in the material that comprises the PV receiver (see, e.g., FIG. 79A).

[00368] FIGs. 79A-79B illustrate diagrams 7900 and 7950 of a receiver 7120_{γ} in which a casing 7910 is attached to the receiver. Casing 7910 can shield a human agent or operator that installs, maintains, or services solar concentrator 100 from exposure to focused light beam(s) and associated elevated temperatures. Casing 7910 includes exit nozzles 7915 that develop a passive hot airflow across the PV cells in receiver 7120_{γ} in order to reduce the accumulation of concentrated hot air which may distort the light beam that reaches the PV module. Exhaustion or reduction of a hot air layer results in higher electrical output. Exhaustion can be improved by adding small active cooling fans in nozzles 7915.

[00369] FIG. 80 is a rendition 8000 of a light beam pattern 7122 focused on receiver 7120_{γ}, which includes PV active elements (illuminated) and serpentine 7830. Pattern fluctuations are visible; for example, light beam pattern 7122 is narrower in the central region of receiver 120γ while is widens towards the end(s) of the receiver 7120. Such pattern shape is reminiscent of the "bow tie" distortion discussed above. It should be appreciated that detrimental effects to performance caused by such fluctuations, or distortions, of light beam pattern 7122 can be mitigated through various arrangements of PV cells as discussed below.

[00370] FIGs. 81A-81B display example embodiments of PV modules in accordance with aspects of the subject innovation. In embodiment 8140 illustrated in FIG. 81A, the PV receiver is made of a metal plate 8145 onto which a PV module 8150 is attached, e.g., bonded through an epoxy or other thermally conductive or electrically insulating adhesive material, tape or similar bonding material, or otherwise adhered into the metal surface of the receiver. In illustrated embodiment 8140, PV module 8150 includes a layout of N=4 constituent cells, rendered as square blocks, and M=4 rows. In embodiment 8140, the PV module includes six cavities 8148 to bolt or fasten the PV module to a support structure, e.g., post 7110. In addition, the illustrated embodiment 1100 includes four additional fastening means 8152.

[00371] In example embodiment 8180, displayed in FIG. 81B, PV module 8190 is made of a metal plate 8185 onto which a cluster of PV cells 8150 is deployed. As described above, the cluster includes N=4 constituent cells, rendered as square blocks, and M=4 rows, and the metal plate includes four fastening means 8152. In an aspect, in

embodiment 8180, the metal plate the forms the PV module embodies a semi-open casing that can allow fluid circulation through orifices 8192 for refrigeration of the PV module or thermal energy harvesting .It should be appreciated that in embodiment 8180, the PV module doest not include a thermal harvesting or refrigerating apparatus such as serpentine tube(s) 7830 or other conduits, but rather the PV module 8190 can be assembled or coupled with a refrigerating or thermal harvesting unit as described below.

[00372] FIG. 82 displays an embodiment of a channelized heat collector 8200 that can be mechanically coupled to a PV module (not shown in FIG. 82) to extract heat there from in accordance with aspects of the subject innovation. Active cooling or heat transfer medium can be embodied in a fluid that circulates through the plurality of Q channels or conduits 8210, with Q a positive integer number. Channelized heat collector 8200 can be machined in an individual metal piece, e.g., Al or Cu piece, or substantially any material with a high thermal conductivity. In an aspect, a first orifice 8240 can allow coolant fluid to enter the channelized heat collector and a second orifice allows the coolant fluid to egress. Orifices 8220 or 8230 allow the channelized heat collector 8200 to be fastened, e.g., screwed or bolted, to the PV module (not shown). Additional fasteners 8252 can be present to enable attachment to the PV module. It is noted that a cover hard sheet (not shown) can be laid out on the open surface of the channelized heat collector 8200 to close and seal, in order to prevent leakage of coolant fluid, the channelized collector 8200; the cover hard sheet can be supported by a ridge 8254 in the internal side surface of the channelized heat collector 8200. The cover hard sheet can be a thermoelectric material that exploits the heat harvested by the fluid circulating through the channelized heat collector to produce additional electricity that can supplement electric output of a cooled PV module. Alternatively or additionally, a thermoelectric device can be attached in thermal contact with the hard cover sheet in order to produce supplemental electricity.

[00373] Channelized heat collector 8200 is modular in that it can be mechanically coupled to disparate PV modules, e.g., 8180, at a time to harvest thermal energy and cool the illuminated PV modules. At least an advantage of the modular design of channelized heat collector 8200 is that it can be efficiently and practically reutilized after a PV module operational lifetime expires; e.g., when a PV module fails to supply an electric

current output that is cost effective, the PV module can be detached from the channelized collector and new PV module can be fastened thereto. At least another advantage of channelized heat collector is that the fluid that act as heat transfer medium can be selected, at least in part, to accommodate specific heat loads and effectively refrigerate disparate PV modules that operate at different irradiance, or photon flux.

[00374] In an aspect, PV elements can be directly bonded to channelized collector 8200, on a surface opposite to surface of the hard cover sheet that closes and seals the channelized collector. Thus, the channelized collector servers as a support plate for the PV cells, while it provides cooling or heat extraction. It is noted that a set of channelized collectors 8200 can be fastened to a support structure to form a PV receiver; for example, 7120_1. At least an advantage of modular configuration of the set of channelized collectors 8200 is that when PV elements are bonded to each of the collectors in the set and one or more of the PV elements in a collector is in failure, the affected PV elements and supporting channelized collector can be replaced individually without detriment to operation of disparate collectors and associated PV cells in the set of channelized collector 8200.

[00375] FIGs. 83A-83C illustrate three example scenarios for illumination, through sunlight collection via parabolic solar concentrator 7100, of active PV element that can be part of PV module 7810 or any other PV module(s) described herein. In an aspect of the subject innovation, the active PV element is a monolithic (e.g., integrally bonded), axially oriented structure that includes a set of N (N a positive integer) constituent, or unit, solar cells (e.g., silicon-based solar cells, GaAs-based solar cells, Ge-based solar cells, or nanostructured solar cells) connected in series. The set of N solar cells is illustrated as block 8325. The solar cells produce a serial voltage $\Delta V \cong N \cdot \Delta V_C$ along the axis Z 8302 of the structure, wherein ΔV_C is a constituent cell voltage. Individual PV cells produce energy at low voltages; most cells output 0.5 V. Thus, to generate substantial electrical power, current tends to be high in view of low voltages available. However, substantive current can cause significant power losses associated with series resistance since such power losses are proportional to I^2, with I an electrical current transported through the series resistance. Accordingly, system level power losses can increase rapidly with high current and low voltages. The latter results in solar energy

conversion designs which utilize solar cells interconnected in a series configuration in order to increase voltage output.

[00376] Structure 8325 represents an example vertical multi-junction (VMJ) solar cell. In an aspect of a VMJ solar cell, a set of N constituent solar cells is stacked along a growth direction Z 8302, each constituent cell has a p-doping layer near a first interface of the cell with a disparate cell, and an n-doped layer near a second interface wherein the first and second interfaces are planes normal to the growth direction Z 8302. In an another aspect of a VMJ cell, under typical operation conditions, a 1 cm^2 VMJ solar cell can output nearly 25 volts because generally N ~ 40 constituent cells are connected in series. Thus, eight VMJ solar cells electrically connected in series can produce nearly 200 V. Furthermore, connection in series of the constituent solar cells in the VMJ solar cell can lead to a low-current state when the VMJ solar cell is not illuminated uniformly or a failure, open-circuit condition when one or more of the constituent solar cells in the VMJ solar cell is not illuminated, since current output of a chain of series-connected electrically active elements, such as the constituent solar cells upon illumination, is typically limited by a cell that produces the lowest amount of current. Under non-uniform illumination, produced power output substantially depends on the details of collected light incident on the VMJ cell, or substantially any or any active PV element. Therefore, it should be noted that solar concentrators are to be designed in such a manner as to provide uniform illumination of the VMJ solar cell, or substantially any or any active PV element (e.g., a thin-film tandem solar cell, a crystalline semiconductor-based solar cell, an amorphous semiconductor-based solar cell, a nanostructure-based solar cell …) interconnected in series.

[00377] FIG. 83A displays an example scenario 8300 in which an illustrative focused beam 8305 of oblate shape covers the entirety of a surface of PV element 8325. Thus, illumination is regarded as optimal. FIG. 83B presents an example scenario 8330 that is sub-optimal with respect to power or energy output as a result of partial illumination of the constituent solar cells, represented as rectangles, in PV active element 8325—e.g., full width of unit or constituent solar cells fails to be illuminated through focal region 8335. FIG. 83C is an example scenario 8340 of operation failure, e.g., zero-output condition, as focus region 8345 fails to illuminate a subset of the set of constituent

solar cells in PV active element 8325, and thus power output is null since no voltage occurs at non-illuminated constituent solar cells.

[00378] FIG. 84 displays a plot 8400 of a computer simulation of distribution of light collected through example parabolic concentrator 7100. The simulation (e.g., a ray-tracing model which can include optical properties of reflective material 7205) reveals a non-uniform pattern of light in direction Y 8405, normal to the axis of the VMJ cell, and in the orthogonal direction X 8407. The particular spread characteristics of light focal area originate from a distribution of positions about the focal point of multiple reflectors, e.g., reflectors 7135, that comprise a solar collector (e.g., solar collector 7100); the multiple reflectors generate multiple, relatively misaligned images that are superposed at the receiver. It should be appreciated that as the area of collection (e.g., area of panels 7130_1-7130_4) increases and additional mirrors, or reflectors, are added, the light distributed at the focal point can become increasingly non-uniform.

[00379] Additionally, FIG. 84 presents diagram 8450 which illustrates an example prescribed positioning and alignment of a pair of VMJ cells 8455 relative to the optical image (in dark grey tone) that a solar collector, e.g., 100, generates; image in diagram 8450 is same as that in diagram 8400. One or more VMJ cells, or substantially any or any PV active elements, can be added on the sides of VMJ cells 8455 along direction Y 8405; e.g., the direction parallel to top beam in support frame 7130; generally, a pattern or configuration of the VMJ cells is to be layout so as to have reflection symmetry through the main axis, e.g., axis parallel to directory Y 8405, of the optical image of the a focused light beam.

[00380] It is noted that in a solar concentrator that produces thermal energy, this non-uniformity of illumination predicted by simulations and observed experimentally does not affect performance because thermal energy is effectively integrated within an illuminated thermal receiver, e.g., back-mounted serpentine tube(s) 7830. However, when PV cells are located near a focal locus (e.g., a point or a line) of collected light, non-uniform illumination can result in a poor illumination of a portion of PV cells (see, e.g., FIGs. 83A-83C) and thus substantially reduce energy conversion performance; e.g., reduce power output of a set of PV cells within a PV module.

[00381] It should be appreciated that solar concentrators disclosed in the subject innovation, e.g., solar concentrator 7100, are designed tolerate spatial fluctuations (e.g., dimensional variations of various structural elements) within the structure's construction. In addition, the disclosed solar concentrators, e.g. 7100, also can tolerate environmental fluctuations such as (i) substantial daily temperature gradients, which can be a common occurrence in some deployments sites with desert-like weather conditions (e.g., Nevada, US; Colorado, US; Northern Australia; and so forth); and severe storm conditions like high-speed winds and hailstorms, or the like. It should be readily understood that environmental fluctuations can substantially affect structural conditions, which in addition to substantially any type of stress(es) can offset focused sunlight from a designed or intended focal locus. The fluctuations, or variations, typically shift portions of a focused light pattern up or down in the direction of a minor axis of a support beam for the solar receiver, and left or right in the direction of the major axis of the support beam vertical centerline. By positioning PV active elements (e.g., VMJ solar cells, triple junction solar cells) 7820 within an optimal location, e.g., a location referred informally as a "sweet spot," within the intended focal light pattern, for example, the light pattern overlapping the PV cell(s) pattern, detrimental effects associated with such variations in the light patterns can be mitigated because PV active element(s) can remain illuminated even though light focus may shift.

[00382] As discussed below, PV elements can be configured or arranged in layouts that ensure light incidence on the PV elements substantially irrespective of fluctuations of light focus. In an aspect of the subject innovation, by orienting PV cells (e.g., VMJ solar cells) on a receiver as discussed below, output of parabolic solar collector system 7100 can be substantially resilient to non-uniform illumination at the focal locus (e.g., point, line, or arc) because each unit cell within a VMJ cell can have at least a portion of its side section (e.g., width) illuminated; see, e.g., FIG. 83B and associated description. Accordingly, VMJ solar cells, or substantially any or any PV active elements, are to be oriented with their series connections aligned with the main axis (e.g., Y 8405) of the optical image.

[00383] FIGs. 85A-85C illustrate examples of cluster configurations, or layouts, of VMJ solar cells that can be exploited for energy conversion in a parabolic solar

concentrator 7100. While the description below refers to VMJ solar cells, it is noted that other alternative or additional PV active elements (e.g., thin-film tandem solar cells) can be configured in substantially the same manner. FIG. 85A displays three clusters 8520_1-8520_3 of K = 2 rows, or strings, 8535_1 and 8535_2 of VMJ solar cells, each row includes M = 8 VMJ cells which are connected in series and each can comprise nearly 40 constituent solar cells. Clusters 8520_1-8520_3 are connected through a wireline or negative voltage bus 8560 and a positive voltage bus (see also FIG. 86). Rows are connected in parallel to increase current output. It is noted that the number M (a positive integer) of VMJ cells in a row within a cluster can be larger or smaller than eight based at least in part upon design considerations, which can include both commercial (e.g., costs, inventory, purchase orders) and technical aspects (e.g, cell efficiency, cell structure). For example, clusters 8520_1-8520_3 can result from a design that aims to generate ΔV=200 V through VMJ cells that produce 25 V each. Likewise, K (a positive integer) can be determined in accordance with design constraints primarily related to spatial spread of light beam focused on a sunlight receiver 7120_γ (see also FIG. 84). Clusters of VMJ cells are connected in series. A wire 8524 is routed on the backside of the sunlight receiver.

[00384] As described supra, focused light tends to be non-uniform across the length of the receiver (oriented along Y 8405 direction) toward the ends of the focused pattern. Therefore, in an aspect, an additional cluster can be added in a "split" layout, with four VMJ cell pairs located at one end, and another four VMJ solar cell pairs making up the balance of the cluster being positioned at the other end. This "split cluster" configuration trades off performance in one cluster (the one split at either end), rather than 2 clusters (one at each end). The 2 halves of the split cluster may be interconnected with a wire 8560 that is routed through and along the backside of the receiver.

[00385] FIG. 85B illustrates a layout 8530 in which three rows 8565_1-8565_3 of PV active elements are configured. Configuration includes three PV clusters 8550_1-8550_3, connected through a wireline or bus 8560 (see also FIG. 86). Spatial distribution of the PV active elements is typically wider than an anticipated spatial distribution of a focused light pattern; such width can be estimated through simulations like those presented in FIG. 84. Configuration 8530 can be implemented when costs of PV active element(s),

e.g. (VMJ solar cells) are viable. Such configuration can retain desired system (e.g., solar concentrator 7100) tolerance to structural fluctuations, manufacture imperfection(s) (e.g., dimensional errors) and structural shifts, because it provides a larger target area for the shifted light to fall on. In this configuration scenario, additional VMJ solar cell area is introduced with the introduction of the third row, some of the area may not be illuminated and this be non-operational; however, a net increase in operational (e.g., illuminated area is attained and thus at least one advantage of configuration 8530 is that more radiation is utilized. It should be appreciated that the relative cost utility, or tradeoff, of utilization of a larger VMJ solar cell footprint and a larger light beam footprint is a function at least in part of relative cost(s) and efficiency of solar concentrator 7100 structure and reflective elements (e.g., mirrors) versus relative cost(s) and efficiency of PV active elements (e.g., VMJ cells).

[00386] FIG. 85C illustrates example configuration 8580 wherein clusters with disparate structure can adjust in accordance with expected (see FIG. 84) spatial variation of focused light beam pattern; e.g., variations in width along direction X 8407 of a focused image throughout the length of the receiver.

[00387] To adjust PV active elements layout, clusters can be varied in width (e.g., the number of VMJ solar cells in parallel, within a string, or row, can be adjusted throughout the length of the receiver). In an aspect, side clusters 8582_1 and 8582_3 comprise K=3 rows, 8585_1-8585_3, and M = 8 PV elements per row, while a center cluster 8580_2 may be K = 2 rows, e.g., 8595_1 and 8595_2, of PV active elements wide. Clusters 8582_1-8582_3 are connected in parallel through wireline, or positive voltage bus, 8590.

[00388] In example configuration scenarios 8500, 8530, and 8580, as well as in any configuration that utilizes PV active elements (e.g., VMJ solar cells) in a series-connected string, performance of a cluster is limited by the PV element with lowest performance because such element is a current output bottleneck in the series connection, e.g., current output is reduced to the current output of the lowest performing PV active element. Therefore, to optimize performance, strings of PV active elements can be current-matched based on a performance characterization conducted in a test-bed under conditions (e.g., wavelengths and concentration intensity) substantially similar to those expected normal operating conditions of the solar collector system.

[00389] In addition, current-matched strings can be arranged geometrically to optimize power generation. For example, when three strings (e.g., rows 8565_1-8565_3) are connected in parallel to form a cluster, a middle string (e.g., row 8565_2) can include the highest performance current-matched PV active elements, since the middle string is likely to be positioned in the optimal location of the focused collected light beam or optical image. Moreover, top string (e.g., 8565_1) can be the second highest performing string, and bottom string (e.g., 8565_3) can be the third highest performing string. In such arrangement, when the image shifts upward, the top and middle string can be fully illuminated while the bottom string is likely to be partially illuminated, providing higher power output than when the focused light beam image shifts downward thus illuminating the middle and lower string in full while the top string is partially illuminated. When substantially all clusters of PV active elements (e.g., VMJ cells) are configured with lower performing PV active elements in a bottom row, highest performing cells at the middle of the arrangement, and next highest performing elements in top string, a tracking system (e.g., system 8700) utilized to adjust position of collector panels (e.g., 7130_1-7130_4) to track, at least in part, sun's position can be employed to adjust the configuration of collector panels or reflector(s) therein so that the light beam focused image shifts towards the top of a receiver (e.g., 7120_γ) during concentrator operation in order to maximize electrical output—e.g., middle and top rows in configuration 8530 are preferentially illuminated. Additionally or alternatively, the tracking system can be employed to adjust position of collector panels or reflector(s) therein in order to maximize energy-conversion performance, or electrical output, in scenarios in which PV elements in a PV module, e.g., 7810, are not current matched or otherwise matched.

[00390] It should be appreciated that configurations or patterns, or cell size (e.g., length and width) and shape of the PV active elements are not limited to those illustrated in FIGs. 85A-85C or those generally discussed above. Solar cells size and shape can be varied to match concentrated light patterns generated by various possible mirror, or reflector, constructions. Furthermore, arrangements or configurations of PV elements can be lines, squares, bowties, arcs or other patterns to take advantage of unique features or aspects of the PV elements; for example, the monolithic, axially-oriented characteristic of VMJ solar cells.

[00391] FIGs. 86A-86B illustrate two example cluster configurations of PV cells that enable active correction of changes of focused beam light pattern in accordance with aspects described herein. Example cluster configurations 8600 and 8650 enables *passive* adjustment to variation(s) on focused pattern of collected sunlight, represented by shaded block 8605. In example configuration 8600, three clusters 8610_1-8610_3 are illuminated by focused collected beam 8605 in an initial configuration of a solar collector, e.g., 7100. Electrical output of each cluster is electrically connected to a +V (e.g., +200 V) voltage bus 8676. Likewise, wireline 8677 is a common negative voltage bus. In one or more alternative embodiments or configurations, connection to bus 8626 is accomplished through blocking diode(s); for instance, in configuration 8680 in FIG. 86C, a blocking diodes 8684, 1886, and 8688 is inserted between bus 8626 and output of modules 8610_1, 8610_2, and 1610_3, respectively. Blocking diodes can prevent backflow of current of bus 8626 into a PV cluster that is non-functional or underperforming due to internal failure or lack of illumination. Each cluster includes two rows (M=2) of eight (N=8) PV elements. Upon a variation, e.g., a structural change or fault condition onset such as breaking of a reflective element, e.g., 7205, focused beam 8605 can shift position onto a receiver, e.g., 7120_1; as illustrated by an open arrowhead in the drawing, focused pattern 8605 can be shifted sideways and as a result it can cease to illuminate the first pair 8615 of PV active elements, connected in parallel, in cluster 8610_1. To prevent the ensuing open-circuit condition that can arise from lack of illumination of the first pair 8615 of PV elements, an ancillary, or redundant, pair of PV cells 8620 can be laid out neighboring PV cluster 8610_3 and electrically connected in parallel with pair 8615; electrical connection illustrated by wires 8622 and 8624. Accordingly, illumination of ancillary pair 8620 leads to closed-circuit configuration of cluster 8610_1 and retains its energy-conversion performance albeit displacement of focused light beam 8615.

[00392] In example configuration 8650, three clusters 8610_1-8610_3 are illuminated by focused collected beam 8605 in an initial configuration of a solar collector, e.g., 7100. Ancillary, or redundant, pair of cells 8670 allows to retain performance of module 8660_3 even when a displacement (see open arrowhead) of the focused collected light beam 8605 results in the pair of PV cells 8665 being non-illuminated. As discussed above, electrical connection in parallel of ancillary pair of PV elements 8670 and cell pair 8665 leads to a

closed-current loop that enables performance of PV cell cluster 8660_3 to be substantially maintained with respect to nearly-ideal or ideal illumination conditions (see also FIGs. 83A-83C). Electrical connection among pairs 8670 and 8665 are enabled through wires 8622 and 8624. Electrical output of each cluster is electrically connected to a +V (e.g., +200 V) voltage bus 8626; in one or more alternative embodiments, connection to bus 1626 is accomplished through blocking diode(s).

[00393] In additional or alternative embodiments, a first blocking diode can be electrically connected in series between pair 8615 and the second pair of PV cells in module 8610_1, in addition to a second blocking diode electrically connected between the output of ancillary pair 8620 and the pair of PV cells 8615. In an aspect, the first blocking diode can be diode 8684, which can be disconnected from bus 8626 and output of cluster 8610_1 and reconnected as described. It is noted that the second blocking diode is additional to diodes 8684, 8686, and 8688. When clusters 8610_1-8610_3 are normally illuminated, e.g., collected sunlight pattern 8605 covers such three clusters, the inserted first blocking diode does not affect operation of cluster 8610_1 or the entire three-cluster PV module. As described above, ancillary cells 8620 are electrically connected with pair 8615 in an OR arrangement, which prevents open-circuit condition. When PV cell pair 8615 is not illuminated due to a shift of focused light pattern 8605, the first blocking diode prevents current backflow to pair 8615 due to it underperforming or non-performing condition, while the second blocking diode allows electrical current output from ancillary pair 8620 into the PV cells that remain illuminated, and thus functional, within cluster 8610_1. A similar embodiment that includes blocking diodes in configuration 8650 can be realized. However, in such embodiment, the first diode can be embodied in diode 8688 after reconnection in series among the first (leftmost) pair of PV cells in cluster 8610_3 and the remainder of PV elements in said cluster.

[00394] It is noted that for when VMJ cells comprise clusters 8610_1-8610_3, the large reverse bias breakdown voltage associated with the VMJ cells, render unnecessary connection of bypass diodes among sub-set(s) of VMJ cells within a cluster. However, for PV elements other than VMJ cells, for example, triple-junction solar cells, such bypass diodes can be included within each PV cluster such PV elements to mitigate non-operational conditions that may result from failing PV elements.

[00395] The passive nature of the adjustment arises from the fact that PV performance is substantially retained—the extent to which energy-conversion performance is retained is dictated at least in part by energy-conversion efficiency of ancillary pair 8620 with respect to efficiency of PV elements 8615. While passive adjustment is illustrated in cluster configurations 8600, 8650, and 8680 with single ancillary pairs, larger ancillary clusters, e.g., two pairs, can be employed to accommodate shift(s) in focused light beam pattern. It is noted that larger redundant pairs also can be utilized in configurations with blocking diodes in substantially the same manner as described supra. In an aspect, a PV module consisting of a set of PV clusters utilized for energy conversion can include ancillary cells 8620 and 8670, to accommodate shifts of focused light pattern in both directions along the axis of the pattern. Moreover, ancillary or redundant PV cells can be laid out in alternative or additional positions in the vicinity of clusters 8610_1, 8610_2 or 8610_3 to passively correct operation when focused pattern 8605 shifts in alternative directions. It should be appreciated that inclusion of one or a few ancillary, or redundant, pairs of PV cells can allow retaining operation of a larger cluster of PV cells; as described, a single ancillary pair of PV elements can protect a full module of N×M elements.

[00396] FIG. 87 is a block diagram of an example adjustment system 8700 that enables adjustment of position(s) of a solar collector or reflector panel(s) thereof to maximize a performance metric of the solar collector in accordance with aspects described herein. Adjustment system 8700 includes a monitor component 8720 that can supply operational data of the solar concentrator to control component 8740, which can adjust a position of the solar concentrator or one or more parts thereof in order to maximize a performance metric extracted from the operation data. Control component 8740, e.g., a computer-related entity that can be either hardware, firmware, or software, or any combination thereof, can effect the tracking or adjustment of position of the solar collector or portions thereof, e.g., one or more panels such as 7130_1-7130_4 or one or more reflector assemblies 7135. In an aspect, such tracking comprises at least one of (i) to collect data through measurements or access to a local or remote database, (ii) to actuate motor(s) to adjust position of elements within solar concentrator, or (iii) to report condition(s) of the solar concentrator, such as energy-conversion performance metrics

(e.g. output current, transferred heat …), response of controlled elements, and substantially any type of diagnostics. It should be appreciated that control component 8740 can be internal or external to the adjustment component 8710, which itself can be either a centralized or distributed system, and can be embodied in a computer which can comprise a processor unit, a data and system bus architecture, and a memory storage.

[00397] Monitor component 8720 can collect data associated with performance of the solar concentrator and supply the data to a performance metric generator component 8725, also termed herein performance metric generator 8725, which can assess a performance metric based at least in part on the data. A performance metric can include at least one of energy-conversion efficiency, energy-converted current output, thermal energy production, or the like. Diagnosis component 8735 can receive generated performance metric value(s) and report a condition of the solar concentrator. In an aspect, condition(s) can be reported at various levels based at least in part on granularity of the collected operational data; for instance, for data collected at a cluster level within a PV module, diagnosis component 8735 can report condition(s) at the cluster level. Reported condition(s) can be retained in memory 8760 in order to produce historical operation data, which can be utilized to generate operational trends.

[00398] Based at least in part on generated performance metric(s), control component 1740 can drive an actuator component 8745 to adjust a position of at least one of the solar concentrator or parts thereof, such as one or more reflectors deployed within one or more panels that form the solar concentrator. Control component 8740 can drive actuator component 8745 iteratively in a closed feedback loop, in order to maximize one or more performance metrics: At each iteration of position correction effected by actuator component 8745, control component 8740 can signal monitor component 8720 to collect operation data and feed back such data in order to further drive position adjustments until a performance metric is satisfactory within a predetermined tolerance, e.g., an acceptable performance threshold. It should be appreciated that position adjustments effected by adjustment system 8700 is directed to focusing collected sunlight in the solar concentrator in a manner that it maximizes performance of the concentrator. In an aspect, as described above, for PV module(s) that include array(s) of higher-performing PV elements in a top row within a cluster, tracking system 8700 can be configured to

mitigate shifts of the light-beam focused image towards the bottom area of the receiver (e.g., 7120) to ensure operation remains within a high output regime.

[00399] Adjustment component 8710 also can allow automatic electrical reconfiguration of PV elements or clusters of PV elements in one or more PV modules utilized in solar concentrator 8705. To at least that end, in an aspect, monitor component 8720 can collect operational data and generate one or more performance metrics. Monitor component 8720 can convey the one or more generated performance metrics to control component 8740, which can reconfigure electrical connectivity among a plurality of PV elements of one or more clusters associated with the generated one or more performance metrics in order to maintain a desired performance of solar concentrator 8705. In aspect, electrical reconfiguration can be accomplished iteratively, through successive collection of performance data via monitor component 8720. Logic (not shown) utilized to electrically configure or reconfigure the plurality of PV elements of the one or more clusters can be retained in memory 8760. In an aspect, control component 8740 can effect the electrical configuration or reconfiguration of the plurality of PV elements through configuration component 8747, which can at least one of switch on and off various PV elements in the plurality of PV elements, or generate additional or alternative electric paths among various elements within the plurality f PV elements to attain advantageous electrical arrangements that provide or nearly provide a target performance. In one or more alternative embodiments, reconfiguration of plurality of PV elements can be implemented mechanically, through movement of the various PV elements in the plurality of PV elements. At least one advantage of automatic reconfiguration of PV module(s) in solar collector 8705 is that operational performance maintained at substantial a desired level without operator intervention; thus, adjustment component 8710 renders the solar collector 8705 self-healing.

[00400] Example system 8700 includes one or more processor(s) 8750 configured to confer, and that confer, at least in part, the described functionality of adjustment component 8710, and components therein or components associated thereto. Processor(s) 8750 can comprise various realization of computing elements like field gated programmable arrays, application specific integrated circuits, and substantially any chipset with processing capabilities, in addition to single- and multi-processor

architectures, and the like. It should be appreciated that each of the one or more processor(s) 8750 can be a centralized element or a distributed element. In addition, processor(s) 8750 can be functionally coupled to adjustment component 8710 and component(s) therein, and memory 8760 through a bus, which can include at least one of a system bus, an address bus, a data bus, or a memory bus. Processor(s) 8750 can execute code instructions (not shown) stored in memory 8760, or other memory(ies), to provide the described functionality of example system 8700. Such code instructions can include program modules or software or firmware applications that implement various methods described in the subject application and associated, at least in part, with functionality of example system 8700.

[00401] In addition to code instructions or logic to effect monitoring and control, memory 1860 can retain performance metric report(s), log(s) of adjusted position of the solar concentrator, time-stamp(s) of an implemented position correction, or the like.

[00402] FIGs. 88A-88B represent disparate views of an embodiment of a sunlight receiver 8800 that exploits a broad collector in accordance with aspects described herein. As illustrated, the sunlight receiver 8800 includes a group of PV modules 8810, each with a set of PV clusters illustrated as squares; each set of PV clusters is bonded to a channelized collector 1240κ, with κ=1,2,3,4. The channelized collectors 8200_1-8200_4 are fastened to guide 8820, which is attached to, or an integral part of, support structure 8825, which can be coupled to a support mast such as 7130; while illustrated as having square section, support structure 8825 can be manufactured with disparate sections. Channelized collectors 8200_1-8200_4 can extract heat from the group of PV modules 8810. In addition, the sunlight receiver 8800 includes an open collection guide 8820, also referred to as guide 8820, with a gradually-opening side section (FIG. 18A) and a rectangular top section (FIG. 88B); the guide 8820 can be fabricated of metal, ceramics or coated ceramics, or cast materials, or substantially any solid material that is highly reflective in the visible spectrum of electromagnetic radiation. It is noted that external surface of guide 8820 can be coated with a thermoelectric material for energy conversion as a byproduct of heating of the guide that results from incident sunlight. As described above, electricity produced thermoelectrically can supplement electricity production of PV module 8810. In addition, guide 8820 can include one or more conduits 8815,

typically internal to the wall(s) of or embedded within guide 8820, that can allow circulation of a fluid for thermal harvesting; circulating fluid can be at least a portion of fluid that circulates through channelized heat collectors 8200K.

[00403] An advantage of the broad-collector receiver is that light incident in the inner walls of the broad guide 8820 is reflected and scattered in multiple instances, and thus produces a uniformization of the light incident in the group of PV modules 8810. It is noted that sunlight directly impinges in the PV module 8810, or can be reflected and scattered at the interior of guide 8820 and recollected after one or more successive scattering events. The angle formed among the major sides of guide 8820 and the platform formed by channelized collectors 8200_1-8200_4 can dictate, at least in part, a degree of uniformity of resulting light incident in PV module 8810.

[00404] FIG. 89 displays an example alternative embodiment of a solar receiver 8900 that exploits a broad collector in accordance with aspects described herein. Guide 8820 (shown in a section view) is attached to a set of two heat collectors or heat transfer elements 8920_1 and 8920_2; each of the heat collectors include a channelized structure substantially the same as 8210, and thus operate in substantially the same manner as channelized heat collector 8200. As described above, guide 8820 includes conduit(s) 8930 that allow circulation of fluid for cooling of the guide or heat collection. Likewise, heat collectors 8920_1 and 8920_2 have conduit(s) 8940 that allows passage of cooling fluid(s), which further enable refrigeration and heat harvesting. Heat transfer elements 8920_1 and 8920_2 are fastened to a supporting plate 8917 that is an integral part of support structure 8915. While two heat collectors 8920_1 and 8920_2 are illustrated, additional heat collectors can be present in the broad collector 8900, as allowed by the size of supporting plate 8917. Bolted or fastened to heat collectors 8910_1 and 8920_1 are a set of three PV modules 8140. It should be appreciated that each of the PV modules are in thermal contact with the heat collectors; however, are not bonded onto the heat collectors but rather fastened thereto through fastening means include in the PV modules (see FIG. 81). Moreover, additional PV modules 8140 can be deployed as permitted by space constraints imposed by size of each of the heat collectors. As described above, broad collector or receiver 8900 allows light to be nearly uniformly distributed onto PV modules 8400 and enables harvesting of thermal energy. In addition, each of the laid out

PV modules 8400 can be serviced or replaced independently, with ensuing reduction in operational cost(s) and maintenance.

[00405] FIG. 90 illustrates a ray-tracing simulation 9000 of light incidence onto the surface of PV module 8810 that results from multiple reflections on the inner surface of guide 8820. In the simulation, light rays 9005 (rendered as dense lines) randomly oriented within a predetermined angular range is directed towards the broad collector, shown as contours 9030 and 9020, and can reach the PV module, modeled as region 9010. Collection of incidence events, e.g., accumulation of rays that reach the surface of the PV module in the model, illustrated as region 9010, enables generation of a simulated detector profile that reveal, at least semi-quantitatively. FIG. 91 presents a simulated image 9110 of light collected at PV module 8810 in a broad-collector receiver with guide 2020. The simulated image of collected light reveals that multiple reflections at the inner walls of guide 8820 provide a substantially uniform light collection, which can reduce complexity of clusters of PV cells in PV module 8810.

[00406] In view of the example systems and elements described above, an example method that can be implemented in accordance with the disclosed subject matter can be better appreciated with reference to flowcharts in FIGs. 92-93. As indicated above, for purposes of simplicity of explanation, example methods are presented and described as a series of acts; however, it is to be understood and appreciated that the described and claimed subject matter is not limited by the order of acts, as some acts may occur in different orders and/or concurrently with other acts from that shown and described herein. For example, it is to be understood and appreciated that a method can alternatively be represented as a series of interrelated states or events, such as in a state diagram or interaction diagram. Moreover, not all illustrated acts may be required to implement example method in accordance with the subject specification. Additionally, it should be further appreciated that the method(s) disclosed hereinafter and throughout this specification are capable of being stored on an article of manufacture, or computer-readable medium, to facilitate transporting and transferring such method(s) to computers for execution, and thus implementation, by a processor or for storage in a memory.

[00407] In particular, FIG. 92 presents a flowchart of an example method 9200 for utilizing parabolic reflectors to concentrate light for energy conversion. At act 9210 a

parabolic reflector is assembled. Assembly includes bending an originally flat reflective element (e.g., a thin glass mirror) into a parabolic section, or a through shape, through support ribs of varying size attached to a support beam. In an aspect, the initially flat reflective material is rectangular in shape and the support beam in oriented along the major axis of the rectangle. Various materials and attachment means, including an integrated option for support ribs and beam, can be employed for mass producing or assembling the parabolic reflector.

[00408] At act 9220 a plurality of arrays of assembled parabolic reflectors is mounted in a support frame. The number of assembled parabolic reflectors that are included in each of the arrays depends at least in part on a desired size of a sunlight collection area, which can be determined primarily by the utility intended for the collected light. In addition, size of the arrays is also affected, at least in part, by a desired uniformity of a light beam pattern collected on a focal locus in a receiver. Increased uniformity is typically attained with smaller array sizes. In an aspect of the subject innovation parabolic reflectors are position at the same focal distance from the receiver in order to increase uniformity of the collected light pattern.

[00409] At act 9230 a position of each reflector in the plurality of arrays is adjusted to optimize a light beam concentrated on a receiver. The adjustment can be implemented at a time of deployment of a solar concentrator or upon utilization in a test phase or in production mode. In addition adjustment can be performed while operating the solar concentrator based at least in part on measured operation data and related performance metrics generated from the data. Adjustment typically aims at attaining a uniform collected light pattern on the receiver, which includes a PV module for energy conversion. In addition to uniformity, the light pattern is adjusted for focusing substantially completely onto the PV active elements (e.g., solar cells in the PV module) to increase the performance of the module. The adjustment can be performed automatically via a tracking system installed in, or functionally coupled to, the solar collector. Such an automated system can increase complexity of the receiver because circuitry associated with a control component and related measurement devices is to be installed in the receiver in order to implement the tracking or optimization. Yet, costs associated with the increased complexity can be offset by increased performance of the

PV module as a result of retaining an optimal sunlight concentration configuration for the reflectors within the array(s).

[00410] At act 9240 a photovoltaic module is configured on the receiver in accordance with a pattern of concentrated light in the receiver. In an aspect of the subject innovation, even an optimal configuration of mounted parabolic reflectors can results in a non-uniform shape of a light beam pattern focused on the receiver due to at least one of imperfections on reflective surface(s) of the reflectors, torsional distortion of reflective surface(s) and associated distortion of pattern of reflected light, accumulation of stains on reflective surface(s), or the like Accordingly, PV cells such as VMJs, thin-film tandem solar cells, triple-junction solar cells, or nanostructured solar cells in the PV module can be arranged in clusters of disparate shapes, or units, (FIG. 15A-15C) so as to increase exposure to collected light and thus increase energy conversion performance. In addition, configuring the PV module can include laying out ancillary PV elements (e.g., 1620 or 1670) to passively correct shifts or distortions of a pattern of collected light.

[00411] At act 9250 a thermal harvesting device is installed on the receiver to collect heat generated through light collection. In an aspect of the subject innovation, the thermal harvest device can be at least one of a metal serpentine or a channelized collector that circulates a fluid to collect and transport heat. In another aspect the thermal energy harvest device can be a thermoelectric device the converts heat into electricity to supplement photovoltaic energy conversion.

[00412] FIG. 93 is a flowchart of an example method 9300 to adjust a position of a solar concentrator to achieve a predetermined performance in accordance with aspects described herein. The subject example method 9300 can be implemented by a adjustment component, e.g., 8710, or a processor therein or functionally coupled thereto. While illustrated for a solar concentrator, example method 9300 can be implemented for adjusting a position of one or more parabolic reflectors. At act 9310, performance data of a solar concentrator is collected through at least one of measurement(s) or retrieval from a database, which includes current and historical operational data. At act 9320, condition(s) of the solar concentrator are reported. At act 9330, a performance metric based at least in part on the collected performance data is generated. A performance metric can include at least one of energy-conversion efficiency, energy-converted current

output, thermal energy production, or the like. In addition, performance metric can be generated for a set of clusters of PV elements in a PV module, for a single cluster, or for a set of one or more constituent PV elements within a cluster. At act 9340 it is evaluated if the performance metric is satisfactory. In an aspect, such evaluation can be based on a set of one or more predefined thresholds for the performance metric, with satisfactory performance metric defined as performance above one or more thresholds; the set of one or more thresholds can be established by an operator that administers the solar concentrator.

[00413] When the outcome of evaluation act 9340 indicates that performance metric is satisfactory, flow is directed to act 9310 for further performance data collection. In an aspect, flow can be redirected to act 9310 after a predetermined waiting period, e.g., an hour, 12 hours, a day, elapses. In another aspect, prior to directing flow to act 9310, a message can be conveyed to an operator, e.g., via a terminal or computer, querying whether further performance data collection is desired. When outcome of evaluation act 2340 reveals performance metric is not satisfactory, or below one or more thresholds, a position of he solar concentrator is adjusted at act 9350 and flow is redirected to act 9310 for further data collection.

[00414] As it employed in the subject specification, the term "processor" can refer to substantially any computing processing unit or device comprising, but not limited to comprising, single-core processors; single-processors with software multithread execution capability; multi-core processors; multi-core processors with software multithread execution capability; multi-core processors with hardware multithread technology; parallel platforms; and parallel platforms with distributed shared memory. Additionally, a processor can refer to an integrated circuit, an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field programmable gate array (FPGA), a programmable logic controller (PLC), a complex programmable logic device (CPLD), a discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. Processors can exploit nano-scale architectures such as, but not limited to, molecular and quantum-dot based transistors, switches and gates, in order to optimize space usage or enhance

performance of user equipment. A processor may also be implemented as a combination of computing processing units.

[00415] In the subject specification, terms such as "store," "data store," data storage," "database," and substantially any other information storage component relevant to operation and functionality of a component, refer to "memory components," or entities embodied in a "memory" or components comprising the memory. It will be appreciated that the memory components described herein can be either volatile memory or nonvolatile memory, or can include both volatile and nonvolatile memory.

[00416] By way of illustration, and not limitation, nonvolatile memory can include read only memory (ROM), programmable ROM (PROM), electrically programmable ROM (EPROM), electrically erasable ROM (EEPROM), or flash memory. Volatile memory can include random access memory (RAM), which acts as external cache memory. By way of illustration and not limitation, RAM is available in many forms such as synchronous RAM (SRAM), dynamic RAM (DRAM), synchronous DRAM (SDRAM), double data rate SDRAM (DDR SDRAM), enhanced SDRAM (ESDRAM), Synchlink DRAM (SLDRAM), and direct Rambus RAM (DRRAM). Additionally, the disclosed memory components of systems or methods herein are intended to comprise, without being limited to comprising, these and any other suitable types of memory.

[00417] Various aspects or features described herein can be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques. In addition, various aspects disclosed in the subject specification can also be implemented through program modules stored in a memory and executed by a processor, or other combination of hardware and software, or hardware and firmware. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. For example, computer readable media can include but are not limited to magnetic storage devices (*e.g.*, hard disk, floppy disk, magnetic strips…), optical discs (e.g., compact disc (CD), digital versatile disc (DVD), blu-ray disc (BD) …), smart cards, and flash memory devices (*e.g.*, card, stick, key drive…).

[00418] In particular and in regard to the various functions performed by the above described components, devices, circuits, systems, and the like, the terms (including a

reference to a "means") used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (*e.g.*, a functional equivalent), even though not structurally equivalent to the disclosed structure, which performs the function in the herein illustrated example aspects. In this regard, it will also be recognized that the various aspects include a system as well as a computer-readable medium having computer-executable instructions for performing the acts and/or events of the various methods.

[00419] The word "exemplary" is used herein to mean serving as an example, instance or illustration. Any aspect or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects or designs. Furthermore, examples are provided solely for purposes of clarity and understanding and are not meant to limit the subject innovation or relevant portion thereof in any manner. It is to be appreciated that a myriad of additional or alternate examples could have been presented, but have been omitted for purposes of brevity.

[00420] What has been described above includes examples of the innovation. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the subject innovation, but one of ordinary skill in the art may recognize that many further combinations and permutations of the innovation are possible. Accordingly, the innovation is intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims. Furthermore, to the extent that the term "includes" is used in either the detailed description or the claims, such term is intended to be inclusive in a manner similar to the term "comprising" as "comprising" is interpreted when employed as a transitional word in a claim.

AMENDED CLAIMS
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What is claimed is;

1. A system that facilitates testing of solar concentrators, comprising:

a plurality of flat reflectors arranged a trough which concentrates light in a common focal length pattern; and

a solar concentrator testing system that emits light upon a subset of the plurality of flat reflectors, compares reflected light against a standard and determines quality of the subset of the plurality of flat reflectors based upon the comparison.

2. The system of claim 1, wherein the emitted light is laser radiation.

3. The system of claim 2, wherein the emitted light is modulated laser radiation.

4. The system of claim 3, further comprising a laser emitter component that emits the modulated laser radiation upon the subset of the plurality of flat reflectors.

5. The system of claim 3, further comprising a receiver component that retrieves the reflected modulated light for the comparison.

6. The system of claim 5, further comprising at least one additional receiver component that retrieves the reflected modulated light for the comparison.

7. The system of claim 3, further comprising a processor component that effects the comparison.

8. The system of claim 7, wherein the processor is at least one of a laptop computer, a notebook computer, a desktop computer, a smartphone, a pocket computer, or a personal digital assistant (PDA).

9. The system of claim 3, further comprising an artificial intelligence (AI) component that employs at least one of a probabilistic and a statistical-based analysis that infers an action that a user desires to be automatically performed.

10. A polar mount, comprising:

a panel mount that physically couples with an energy collection panel; and

a base mount that physically couples with a base and aligns the polar mount with respect to a tilt of Earth's axis, the panel mount is configured such that the energy collection panel is located in a plane of an axis of the base and rotates about an axis of the base and the center of gravity of the energy collection panel is about the polar mount.

11. The system of claim 10, further comprising a first positioning component to facilitate rotating the panel mount in the ascension axis with respect to the motion of the sun across the sky.

12. The system of claim 11, further comprising a second positioning component to facilitate tilting the energy collection panel through a range of angles to position the energy collection panel with respect to an angle of declination of the sun.

13. The system of claim 12, the first and second positioning components are DC brushless stepper motors.

14. The system of claim 10, further comprising a positioning controller that controls the position of the polar mount with respect to the sun.

15. The system of claim 14, the positioning controller determines the position of the polar mount based upon longitude of the polar mount, latitude of the polar mount, date and time information, calculated position of the sun.

16. The system of claim 10, the energy collection panel is rotated about the base mount to a position of safety, or to a position to facilitate access for maintenance or installation.

17. The system of claim 16, the alignment of the base mount is adjusted to facilitate location of the energy collection panel to a position of safety, or to a position to facilitate access for maintenance or installation.

18. The system of claim 1, the alignment of the base mount is adjusted to facilitate location of the energy collection panel to a position of safety, or to a position to facilitate access for maintenance or installation.

19. The system of claim 1, further comprising an artificial intelligence component to assist with determining the position of the polar mount.

20. The system of claim 1, the energy collection panel is a mirrored surface, is a photovoltaic elements, is a energy absorbing material, or a combination thereof.

21. A system for tracking the position of the sun to determine optimal positioning for direct sunlight, comprising:

a sunlight tracking component that distinguishes at least one light source as direct sunlight based at least in part on determining a collimation of the light source; and

a positioning component that modifies a position of a device associated with the sunlight tracking component based at least in part on a position of the light source distinguished as direct sunlight.

22. The system of claim 21, the sunlight tracking component comprises a ball lens that receives the light source and reflects the light source onto one or more quadrant cells, the collimation of the light source is determined at least in part by measuring a size of a focus point of the light source reflected on the one or more quadrant cells.

23. The system of claim 22, the positioning component modifies the position of the device based at least in part on a location of the focus point on the one or more quadrant cells.

24. The system of claim 21, the sunlight tracking component further distinguishes the light source as direct sunlight at least in part by measuring a wavelength and a level of polarization of the light source.

25. The system of claim 24, the sunlight tracking component comprises at least one filter that determines an intensity and/or spectrum of the wavelength of the light source based at least in part on rejecting passing of light outside of a range utilized by direct sunlight.

26. The system of claim 24, the sunlight tracking component comprises a plurality of differently angled polarizers that determine the level of polarization of the light source based at least in part on measuring a radiation level of the light source after passing through the each of the plurality of polarizers.

27. The system of claim 26, the measured radiation levels of the light source at each of the plurality of polarizers are similar indicating the level of polarization to distinguish the light source as direct sunlight.

28. The system of claim 24, the sunlight tracking component further distinguishes the light source as direct sunlight based at least in part on determining a lack of substantial modulation.

29. The system of claim 21, further comprising a clock component from which the position of a device associated with the sunlight tracking component is initially set according to a predicted position of the direct sunlight.

30. A system, comprising:

an obtainment component that collects metadata of a position with respect to gravity of a concentrator capable of energy collection from a celestial energy source; and

an evaluation component that compares the position against a desired position of the concentrator in relation to the celestial energy source, the comparison is used to determine a manner in which to make an alteration to increase effectiveness of the concentrator, wherein the desired position of the concentrator provides for a maximum obtainable current from at least one photovoltaic cell..

31. The system of claim 30, further comprising a conclusion component that determines if movement should occur as a function of a result of the comparison.

32. The system of claim 31, further comprising a production component that generates a direction set, the direction set instructs how movement should occur.

33. The system of claim 32, further comprising a feedback component that determines if the direction set resulted in a desired outcome upon the direction set being implemented by a movement component.

34. The system of claim 33, further comprising an adaptation component that modifies operation of the production component with regard to the determination related to the direction set.

35. The system of claim 30, further comprising a correction component that automatically corrects a misalignment or an offset of an entity that measures the position of the concentrator with respect to gravity.

36 The system of claim 35, further comprising a determination component that identifies the misalignment or the offset.

37. The system of claim 30, further comprising a computation component that calculates the desired position of the energy source used by the evaluation component in the comparison.

38. The system of claim 30, the metadata is collected from an inclinometer.

39. The system of claim 30, further comprising a locate component that concludes if a location of an energy source can be determined, the evaluation component operates upon a negative conclusion.

40. A method, comprising:

comparing a calculated location of an energy collector against a expected location of the energy collector, the calculated location is based upon gravity that is exerted upon the energy collector; and

concluding if the energy collector should move based upon a result of the comparison and a cost-utility analysis.

41. The method of claim 40, further comprising computing the expected location of the energy collector, the computation is based upon date, time, longitude of the energy collector, and latitude of the energy collector.

42. The method of claim 40, wherein the concluding occurs through implementation of at least one artificial intelligence technique.

43. The method of claim 42, wherein the at least one artificial intelligence technique enables a cost-utility analysis of a benefit of moving the energy collector versus an expense associated therewith, wherein the expense comprises power consumption.

44. The method of claim 40, further comprising producing an instruction set on how to move the energy collector to about the expected location.

45. The method of claim 44, further comprising transferring the instruction set to a movement entity, the movement entity is associated with the energy collector and implements the instruction set.

46. The method of claim 40, further comprising calculating the location of the energy collector through use of an inclinometer.

47. A system, comprising:

means for calculating a location of a solar power collector through analysis of metadata that relates to gravity exerted upon the solar power collector and based upon a maximum current from at least one photovoltaic cell;

means for computing a desired location of the solar power collector, the calculation is based upon date, time, longitude of the solar power collector, latitude of the solar power collector and an open loop ecliptic calculation;

means for comparing the calculated location of the solar power collector against the desired location of the solar power collector; and

means for concluding if the solar power collector should move based upon a result of the comparison and a cost-utility analysis.

48. The system of claim 47, further comprising means for obtaining the metadata that relates to gravity exerted upon the solar power collector from a means for measuring a force exerted by gravity.

49. The system of claim 47, wherein the means for concluding if the solar power collector should move comprising means for effecting cost-utility analysis of a benefit of moving the solar power collector and associated expense, wherein the expense comprises power consumption.

50. The system of claim 48, further comprising:

means for identifying a misalignment or an offset of the means for measuring a position of the solar power collector with respect to gravity; and

means for correcting the misalignment or the offset of the means for measuring the position of the solar power collector with respect to gravity.

51. The system of claim 48, further comprising:

means for producing a direction set, the direction set instructs how the solar power collector should be moved and is implemented by a collector shift entity;

means for transferring the direction set to the collector shift entity, the collector shift entity implements the direction set;

means for determining the direction set resulted in a desired outcome upon the direction set being implemented by the collector shift entity; and

means for modifying operation of the means for producing.

52. A method for mass-producing solar collectors, comprising:

forming a solar wing into a parabolic shape, the solar wing comprises a plurality of support ribs;

attaching a reflective surface to the solar wing to create an assembly, wherein each of the plurality of support ribs comprises a different height between the reflective surface and a contact point with the solar wing to create the parabolic shape; and

forming an array with a plurality of solar wing assemblies.

53. The method of claim 52, further comprising:

attaching the array to a backbone structure.

54. The method of claim 53, further comprises equipping the backbone structure with a plurality of photovoltaic cells.

55. The method of claim 52, forming the solar wing into the parabolic shape, comprising:

attaching the plurality of support ribs to a support beam, a height of each support rib is selected to create the parabolic shape, wherein a height of the support ribs at a middle of the support beam is shorter than a height of the supports ribs at each end of the support beam.

56. The method of claim 52, attaching the reflective surface to the solar wing comprising:

placing the reflective surface on the plurality of support ribs; and

securing the reflective surface to the plurality of support ribs.

57. The method of claim 52, attaching the reflective surface to the solar wing comprising:

sliding the reflective surface over the plurality of support ribs and under mirror support clips; and

securing the reflective surface at both ends of the solar wing.

58. A system for solar energy concentration comprising:

a plurality of solar concentrators having PV cells;

a heat regulating assembly having conduits that convey a cooling medium for dissipation of heat associated with the PV cells, flow of the cooling medium controlled by a plurality of valves; and

a control component that controls operation of the valves in real time based on data collected from the system and temperature of the plurality of solar concentrators.

59. The system of claim 58, a solar concentrator as part of the plurality of solar concentrators is a solar thermal.

60. The system of claim 58, a further solar concentrator as part of the plurality of solar connectors includes a modular arrangement of photovoltaic (PV) cells.

61. The system of claim 58, the data includes at least one of a temperature, pressure, or flow rate of the cooling medium.

62. The system of claim 60, the data is the temperature of the photovoltaic cells.

63. The system of claim 60 further comprising a pump(s) that facilitates flow of the cooling medium throughout the conduits.

64. The system of claim 58, the conduit is a pipeline.

65. The system of claim 58, the cooling medium free flows through the conduit.

66. The system of claim 58, flow of the cooling medium is pressurized.

67. The system of claim 58 further comprising an artificial intelligence component that facilitates heat dissipation from the plurality of solar concentrators.

68. A method of regulating heat flow comprising:

receiving radiation by a solar concentrator(s) having PV cells;

estimating by a heat regulation device amount of cooling medium required to dissipate heat of the PV cells; and

regulating operation of valves to facilitate flow of the cooling medium based on temperature measured from the solar concentrator(s) in real time.

69. The method of claim 68, the regulating act based on measurements of flow within a Venturi tube.

70. The method of claim 68 further comprising monitoring temperature of PV cells associated with the solar concentrators.

71. The method of claim 70 further comprising regulating in real-time heat dissipation from the PV cells based on the monitoring act.

72. The method of claim 68 further comprising supplying the cooling medium as a pre-heated fluid to customers or for subsequent heating thereof.

73. The method of claim 70 further comprising generating temperature grid map of an assembly for the PV cells.

74. The method of claim 68, the regulating act based on data collected from the cooling medium.

75. The method of claim 68 further comprising employing a closed loop control to mitigate errors.

76. The method of claim 68 further comprising detecting faults in circulation of the cooling medium *via* at least one of a change in pressure, flow rate, or velocity of the cooling medium.

77. A heat regulating assembly comprising:

means for cooling PV cells associated with a solar concentrator in real time *via* flow of a medium through valves; and

means for regulating operation of the valves.

78. A method of optimizing energy output from a plurality of solar concentrators, comprising:

generating energy from both solar thermals and PV cells;

absorbing heat from the solar thermals and PV cells *via* a cooling medium;

varying the absorbing act based on regulating valves that control flow of the cooling medium based on temperatures measured from the solar thermals or the PV cells, or a combination thereof; and

optimizing the generating act based on predetermined criteria.

79. The method of claim 78, the predetermined criteria includes one of electricity prices or temperature difference between an ambient temperature and temperature of the cooling medium.

80. An integrated solar concentrator module comprising;

a solar concentrator having PV cells;

a pipe segment with a valve; and

the pipe segment connected to the solar concentrator for a cooling in real time of the PV cells *via* a cooling medium regulated by the valve, the pipe segment attachable to a pipe line that transports the cooling medium.

81. The integrated solar concentrator module of claim 80 further comprising a sensor(s) that measures pressure, velocity, temperature, or flow rate of the cooling medium.

82. The integrated solar concentrator module of claim 80 further comprising a housing that one of partially or fully contains the integrated solar concentrator.

83. The integrated solar concentrator module of claim 82 further comprising a Venturi directly molded into the housing.

84. A solar concentrator comprising:

a plurality of arrays of parabolic reflectors, wherein each parabolic reflector comprises a reflective element deflected into a through shape via a set of support ribs attached to a backbone beam; and

one or more receivers that collect light from the plurality of arrays of parabolic reflectors, the receivers comprising at least one of a photovoltaic (PV) module for energy conversion or a thermal energy harvest system; and

an adjustment system to optimize light intensity distribution in a pattern of collected light in each of the one or more receivers that collect light from the plurality of arrays of parabolic reflectors in order to maximize a performance metric of the solar concentrator, wherein the performance metric is at least one of electric energy production or thermal energy production.

85. The solar concentrator of claim 84, wherein the PV module comprises a set of clusters of PV cells arranged to optimally utilize the collected light, the PV cells in the set of clusters include at least one of crystalline silicon solar cells, crystalline germanium solar cells, solar cells based on III-V group semiconductors, CuGaSe-based solar cells, CuInSe-based solar cells, amorphous silicon cells, thin-film tandem solar cell, triple-junction solar cells, or nanostructured solar cells.

86. The solar concentrator of claim 85, wherein each PV cell in the set of clusters of PV cells is monolithic and oriented along a specific axis normal to a plane that contains the PV module.

87. The solar concentrator of claim 85, wherein each cluster in the set of clusters of PV cells comprises one or more rows of a plurality of PV cells electrically coupled in a series connection.

88. The solar concentrator of claim 87, wherein at least one of the one or more rows of the plurality of PV cells comprises current-matched PV active elements, wherein the PV active elements are current matched based at least in part on a performance characterization conducted in a testing facility under simulated operating field conditions.

89. The solar concentrator of claim 84, wherein the adjustment system comprises:

a monitor component that assess the performance metric based on data on performance of the solar concentrator; and

a control component that adjusts a position of at least one of the solar concentrator or part(s) thereof based on the performance metric assessment.

90. The solar concentrator of claim 87, wherein one or more PV cells are laid out in the vicinity of one or more clusters in the set of clusters of PV cells and electrically connected with a PV element in the one or more clusters to mitigate performance degradation of the PV module.

91. The solar concentrator of claim 84, for receivers that include the thermal energy harvest system, the thermal energy harvest system resides in a back surface of the receiver.

92. The solar concentrator of claim 90, wherein the thermal energy harvest system further comprises a thermoelectric device that converts heat into electricity to supplement PV energy conversion.

93. The solar concentrator of claim 83, wherein at least one of the one or more receivers includes a casing to mitigate interaction of an operator with a concentrated light beam.

94. The solar concentrator of claim 84, wherein the casing comprises a set of nozzles to exhaust hot air from the vicinity of the PV module to increase energy conversion performance.

95. A method to assemble a solar collector, the method comprising:

assembling a parabolic reflector by bending a portion of a flat reflective material into a through shape via a set of set of support ribs attached to a backbone beam;

mounting in a support frame a plurality of arrays of assembled parabolic reflectors;

adjusting a position of each parabolic reflector in the plurality of arrays to optimize a light beam pattern collected on a receiver, wherein the adjusting act includes automatically tracking the position of each parabolic reflector to minimize fluctuations in the collected light beam pattern; and

configuring a photovoltaic (PV) module on the receiver in accordance with a pattern of concentrated light in the receiver.

96. The method of claim 94, further comprising installing a thermal harvest device on the receiver to collect heat generated through light collection.

97. The method of claim 94, automatically tracking the position of each parabolic reflector to minimize fluctuations in the collected light beam pattern comprises at least one of collecting data through measurements or access to a local or remote database; actuating a motor to adjust position of elements in the solar collector; or reporting condition(s) of the solar collector.

98. The method of claim 94, configuring a photovoltaic module on the receiver in accordance with a pattern of concentrated light in the receiver further comprising arranging a set of PV cells in the PV module in clusters of disparate units so as to increase exposure of the set of PV cells to collected light.

99. The method of claim 94, wherein the clusters of disparate units comprise one or more rows of a plurality of PV cells electrically coupled in a series connection.

100. The method of claim 98, at least one of the one or more rows in the cluster of disparate units comprises current-matched PV active elements, wherein the PV active elements are current matched based at least in part on a performance characterization conducted in a testing facility under simulated operating field conditions.

101. The method of claim 97, wherein arranging the set of PV cells in the PV module in clusters of disparate units so as to increase exposure to collected light includes positioning lower performing PV active elements in a bottom row within the PV module, highest performing cells at a middle section of the PV module, and next highest performing elements in a top row within the PV module.

102. The method of claim 94, adjusting a position of each reflector in the plurality of arrays to optimize a light beam collected on a receiver further comprising automatically configuring the position of each reflector to shift a pattern of collected light towards the middle section and the top row within the PV module to maximize electrical output.

103. The method of claim 95, wherein the thermal harvest device comprises a metal serpentine that circulates a fluid to gather and transport heat.

104. The method of claim 96, wherein the thermal harvest device further comprises a thermoelectric device that converts heat into electricity to supplement PV energy conversion.

105. A photovoltaic receiver, comprising:

a set of PV elements electrically and mutually coupled, and fixated on a first flat surface of a solid platform; wherein the set of PV elements are arranged in one or more clusters that maximize exposure to sunlight incident in the PV module, the set of PV elements include at least one of crystalline semiconductor-based solar cells, amorphous silicon cells, thin-film tandem solar cell, or nanostructured solar cells; and

a module that refrigerates the set of PV elements in order to maintain a cost-effective energy conversion performance.

106. The photovoltaic receiver of claim 104, wherein the module is removably attached to the solid platform, and includes a set of conduits through which a fluid for heat collection circulates.

107. The photovoltaic receiver of claim 104, wherein the solid platform is part of the module that refrigerates the set of PV elements.

108. The photovoltaic receiver of claim 104, further comprising a reflective light collection guide that allows uniformization of light collected at the set of PV elements, wherein the reflective light collection guide is fastened to the module that refrigerates the set of PV elements.

109. The photovoltaic receiver of claim 104, the module that refrigerates the set of PV elements consists of a serpentine tube through which fluid circulates, the serpentine tube is embedded is part of the solid platform.

110. The photovoltaic receiver of claim 104, wherein the module is coated with a thermoelectric material to supplement energy conversion generated through the photovoltaic receiver.

111. A method, comprising:

constructing a module that can retain at least two energy collection panels and separate the panels with a gap; the gap between the at least two energy collection panels is sufficient to facilitate locating the at least two energy collection panels such that the at least two energy collection panels are on either side of the polar mount; and

configuring the module to physically couple with a base.

112. The method of claim 111, further comprising positioning the at least two energy collection panels with respect to the ascension or the declination of the sun.

113. The method of claim 111, further comprising determining a position of the energy collection panels based upon the longitude of the energy collection panels, latitude of the energy collection panels, date and time information, calculated position of the sun, or a combination thereof.

114. The method of claim 111, further comprising positioning the energy collection panels in a safety position.

115. A system, comprising:

means for constructing a module that can retain at least two energy collection panels and separate the panels with a gap;

means for physically coupling the module with a base; and

means for positioning the at least two energy collection panels such that the center of gravity of the at least two energy collection panels and the module align with the axis of the base.

116. The system of claim 115, further comprising:

means for collecting external input for controlling the position of the at least two energy collection panels; and

means for controlling the position of the module with respect to the longitude of the at least two energy collection panels, latitude of the at least two energy collection panels, date and time information, calculated position of the sun, or a combination thereof.

117. The system of claim 115, further comprising:

means for positioning the at least two energy collection panels in a position of safety, and:

means for positioning the at least two energy collection panels such that there is access of the at least two energy collection panels for installation and maintenance.

118. The system of claim 117, means for positioning the at least two energy collection panels comprises at least one of rotating, tilting, lowering, or raising the module, the base, or combination thereof.

119. A system, comprising:

means for constructing a module that can retain at least two energy collection panels and separate the panels with a gap; and

means for physically coupling the module with a base.

120. A method for determining an optimal position of direct sunlight, comprising:

determining a collimation of a light source at least in part by measuring a focus point of a reflection of the light source through a ball lens;

distinguishing the light source as direct sunlight based at least in part on a size of the focus point; and

determining an optimal position for receiving the direct sunlight based at least in part on a position of the focus point on a quadrant cell.

121. The method of claim 120, further comprising aligning one or more solar cells or solar cell panels based at least in part on the determined optimal position for receiving direct sunlight.

122. The method of claim 120, further comprising determining polarization level of the light source to further distinguish the light source as direct sunlight at least in part by measuring radiation levels of the light source through a plurality of differently angled polarizers.

123. The method of claim 122, the polarization level is low where the radiation levels from the plurality of differently angled polarizers are similar.

124. The method of claim 120, further comprising allowing passage of light from the light source having a similar wavelength in a range utilized by sunlight through the spectral filter while rejecting passage of light from the light source having a wavelength outside of the range.

125. The method of claim 124, further comprising measuring an intensity and/or spectrum of the light from the light source passing through the spectral filter to further distinguish the light source as direct sunlight.

126. The method of claim 120, further comprising determining a collimation of a disparate light source at least in part by measuring a disparate focus point of a reflection of the disparate light source through the ball lens.

127. The method of claim 126, further comprising determining the disparate light source as diffuse where the size of the disparate focus point is greater than a threshold size.

128. The method of claim 127, further comprising and rejecting the disparate light source based at least in part on determining the light source as diffuse.

129. A system for tracking position of the sun, comprising:

means for detecting direct sunlight from one or more light sources based at least in part on a measured collimation of the one or more light sources determined from a size of a focus point of the light source received through a lens; and

means for determining an optimal axial position for receiving the detected direct sunlight based at least on part on a position of the focus point on one or more quadrant cells.

130. The system of claim 129, further comprising means for positioning one or more solar cells or solar cell panels on one or more optimum axes based at least in part on the determined optimal axial position for receiving the detected direct sunlight.

131. A computer-implemented method of diagnosing quality of solar concentrators, comprising:

employing a processor that executes computer executable instructions stored on a computer readable storage medium to implement the following acts:

emitting modulated laser radiation upon a concentrator;

receiving modulated light at a location;

scanning a source to establish signal strength;

comparing the modulated light to the signal strength as a function of a threshold; and

determining quality of the concentrator based upon result of the comparison.

132. The computer-implemented method of claim 131, further comprising receiving additional modulated light at a disparate location, wherein the act of comparing employs the additional modulated light as a function of the threshold.

133. The computer-implemented method of claim 132, wherein the threshold is at least one of pre-programmed or inferred.

134. The computer-implemented method of claim 132, further comprising adjusting a position of the concentrator, wherein the adjustment facilitates enhanced performance of the concentrator.

135. The computer-implemented method of claim 132, wherein the threshold is an industry standard.

136. The computer-implemented method of claim 132, further comprising inferring the threshold based at least in part upon environmental conditions.

137. A system that facilitates solar concentrator testing, comprising:

means for emitting light upon a plurality of reflectors in the solar concentrator;

means for capturing reflected light from at least a subset of the reflectors; and

means for assessing the quality of position of each of the subset of reflectors based at least in part upon characteristics of the reflected light.

138. The system of claim 137, wherein the light is modulated laser light.

139. The system of claim 138, wherein the plurality of reflectors are arranged in a trough collector arrangement.

140. The system of claim 138, further comprising means for dynamically adjusting the position of the subset of reflectors based at least in part upon the characteristics of the reflected light.

141. The system of claim 138, wherein the means for capturing the reflected light is at least two sensors positioned at disparate distances from the solar concentrator.

142. A method of erecting a solar collector assembly, comprising:

attaching a plurality of arrays to a backbone structure, the plurality of arrays are formed by individual solar wing assemblies placed adjacent to each other, wherein each of the plurality of arrays is attached to the backbone structure to maintain a spatial distance from

each of the other plurality of arrays, the plurality of arrays comprise at least one reflective surface;

connecting the backbone structure to a polar mount that is positioned at or near a center of gravity; and

attaching the polar mount to a fixed mounting and a movable mounting that enables lowering of the solar collector assembly.

143. The method of claim 142, wherein attaching the plurality of arrays comprises attaching the plurality of arrays such that the plurality of arrays rotate through a vertical axis as a function of the spatial distance.

144. The method of claim 143, further comprises rotating the plurality of arrays and the backbone structure around the center of gravity along the vertical axis to change an orientation of the plurality of arrays.

145. The method of claim 144, wherein the rotating the plurality of arrays and the backbone structure comprises rotating the plurality of arrays and the backbone structure around the center of gravity along the vertical axis to change one of an operating position, a safety position, or any position there between of the plurality of arrays.

146. The method of claim 142, further comprise disengaging the polar mount from the movable mounting to lower the solar collector assembly.

147. The method of claim 142, wherein attaching the plurality of arrays to the backbone structure comprises attaching the plurality of arrays to the backbone structure at a same focus length.

148. The method of claim 142, further comprises transporting the solar collector assembly in a partially assembled state or as modular units.

149. A solar collector, comprising:

at least four arrays attached to a backbone support, each array is formed by a plurality of individual solar wing assemblies placed side by side and comprises at least one reflective

surface formed in a parabolic shape as a function of support ribs that are attached to each solar wing assembly;

a polar mount on which the backbone support and the at least four arrays can be tilted, rotated or lowered, the polar mount is positioned at or near a center of gravity; and

a polar mount support arm operatively connected to a movable mount and a fixed mount.

150. The solar collector of claim 149, the polar mount support arm is removed from the movable mount for lowering of the solar collector.

151. The solar collector of claim 149, the backbone support comprises a collection apparatus that comprises a plurality of photovoltaic cells that are utilized to facilitate a transformation of solar energy to electrical energy.

152. The solar collector of claim 149, further comprising a positioning device that rotates the at least four arrays about a vertical axis.

153. A solar wing assembly, comprising:

a plurality of mirror support ribs operatively attached to a shaped beam, each of the plurality of mirror support ribs on a first half of the shaped beam comprise a height different than each of the other plurality of mirror support ribs on the first half and each of the plurality of mirror support ribs on a second half of the shaped beam comprise a height to replicate the height of the plurality of mirror support ribs on the first half of the shaped beam, wherein the height of the plurality of mirror support ribs are sized to form a parabolic shape; and

a mirror placed on the plurality of mirror support ribs and secured to the shaped beam.

154. The solar wing assembly of claim 153, further comprising a plurality of mirror clips that secure the mirror to the shaped beam.

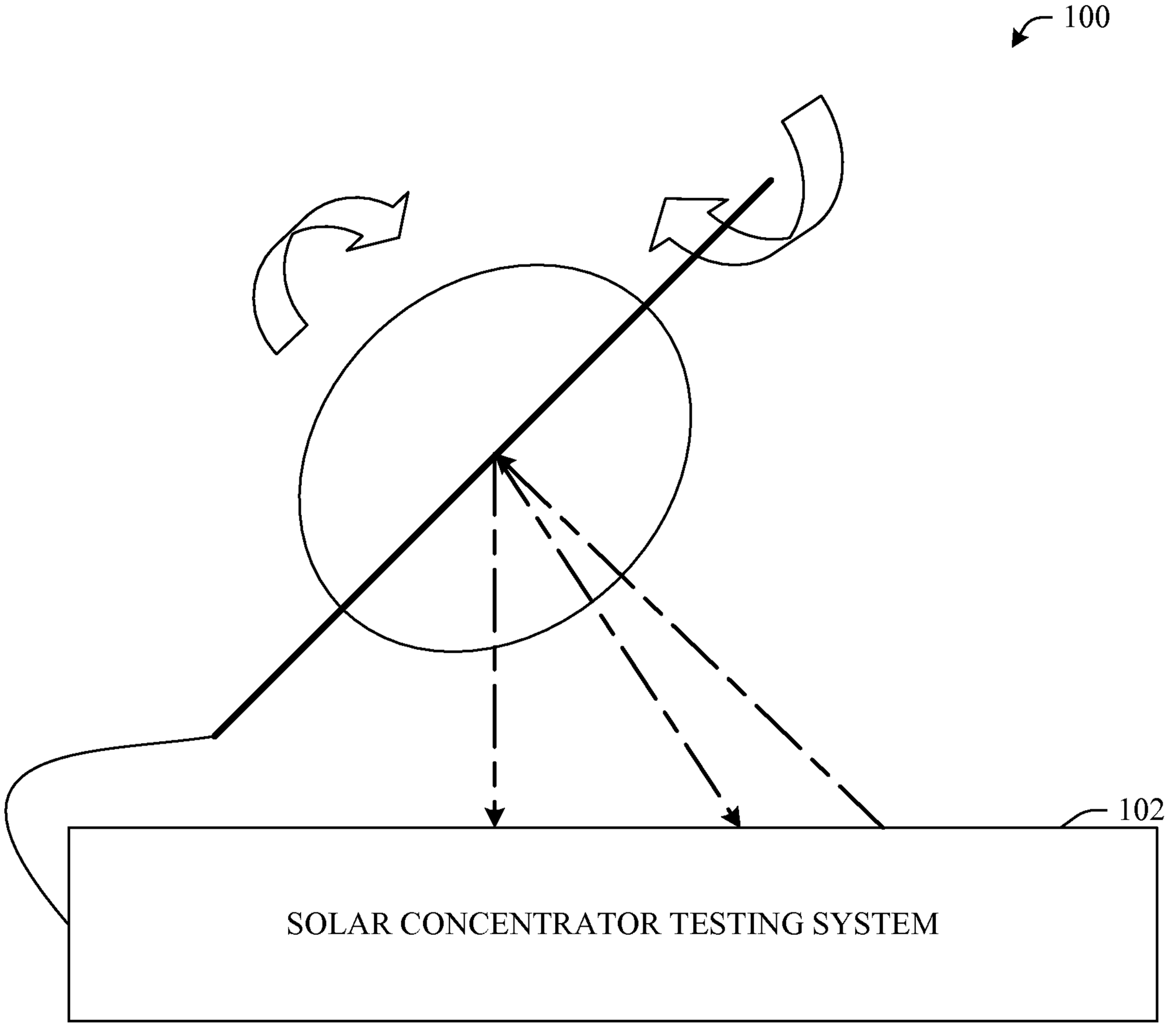


FIG. 1

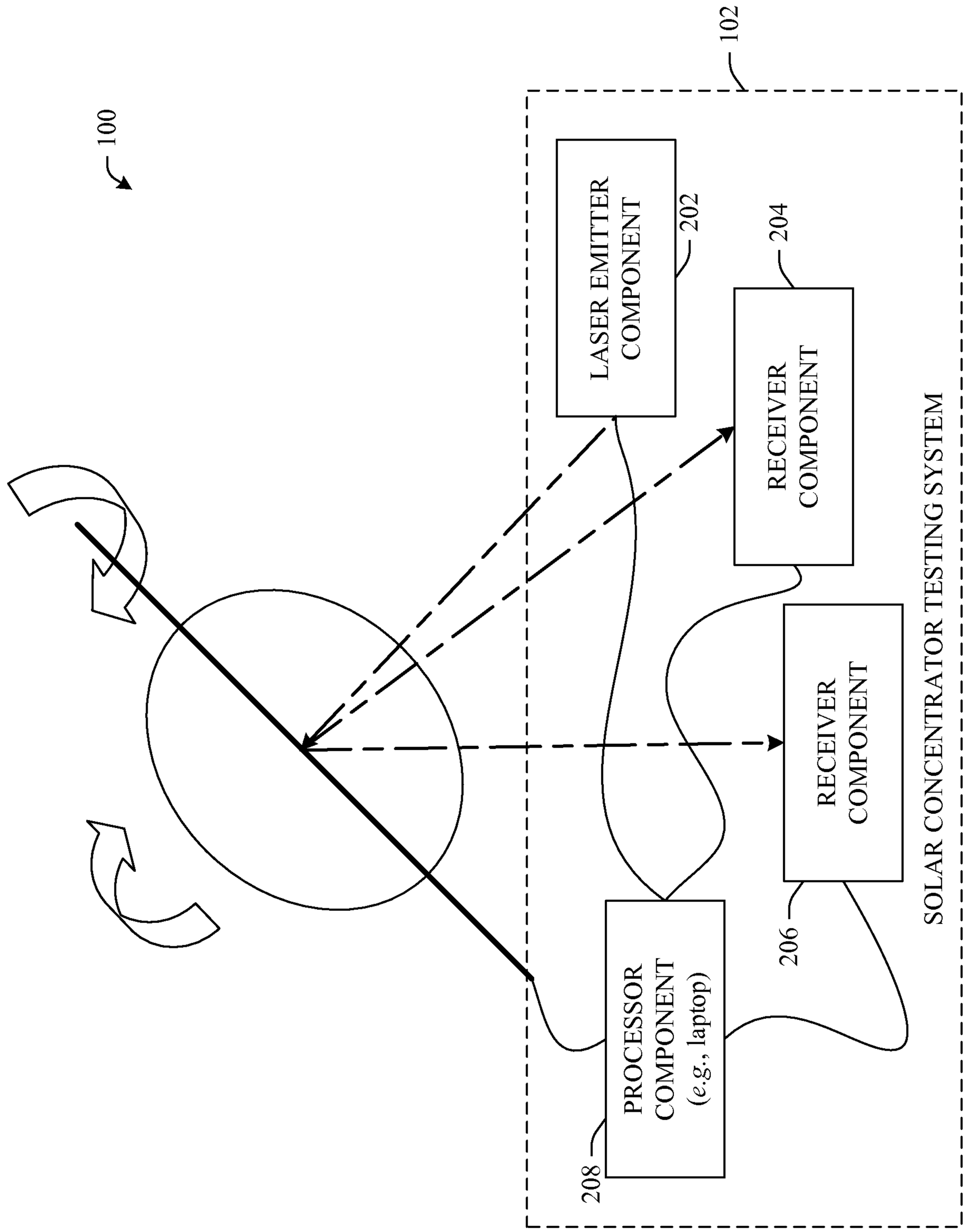

100
102
LASER EMITTER COMPONENT
202
204
RECEIVER COMPONENT
RECEIVER COMPONENT
206
PROCESSOR COMPONENT (e.g., laptop)
208
SOLAR CONCENTRATOR TESTING SYSTEM

FIG. 2

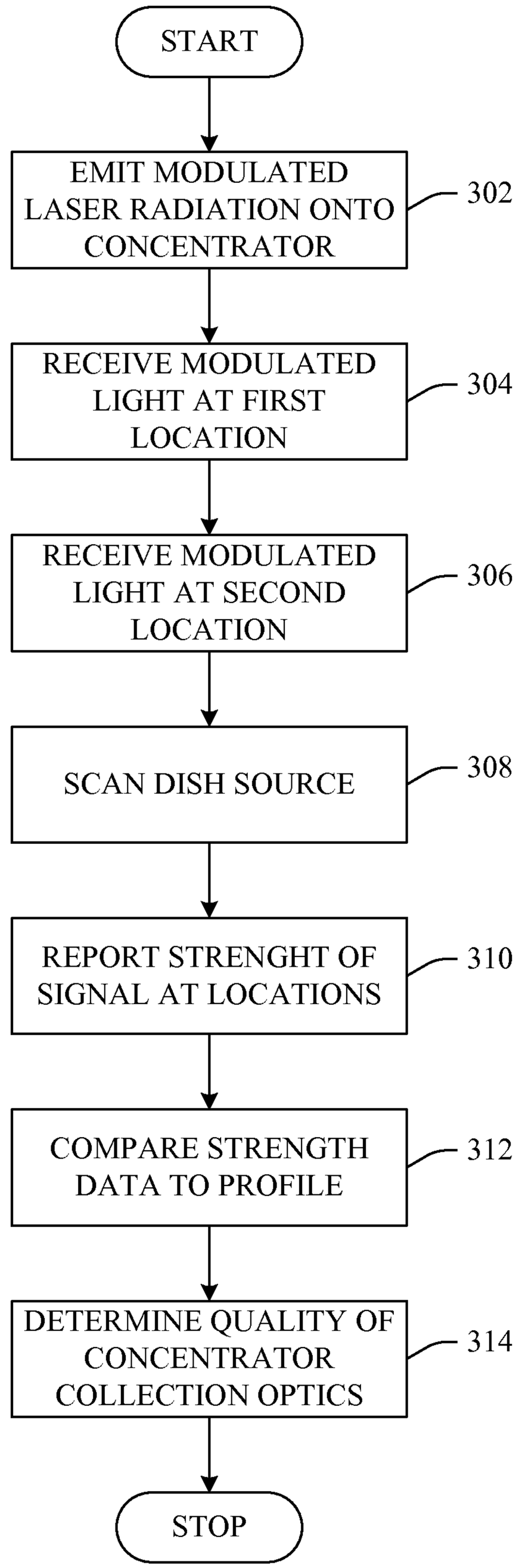

START
EMIT MODULATED LASER RADIATION ONTO CONCENTRATOR
302
RECEIVE MODULATED LIGHT AT FIRST LOCATION
304
RECEIVE MODULATED LIGHT AT SECOND LOCATION
306
SCAN DISH SOURCE
308
REPORT STRENGHT OF SIGNAL AT LOCATIONS
310
COMPARE STRENGTH DATA TO PROFILE
312
DETERMINE QUALITY OF CONCENTRATOR COLLECTION OPTICS
314
STOP

FIG. 3

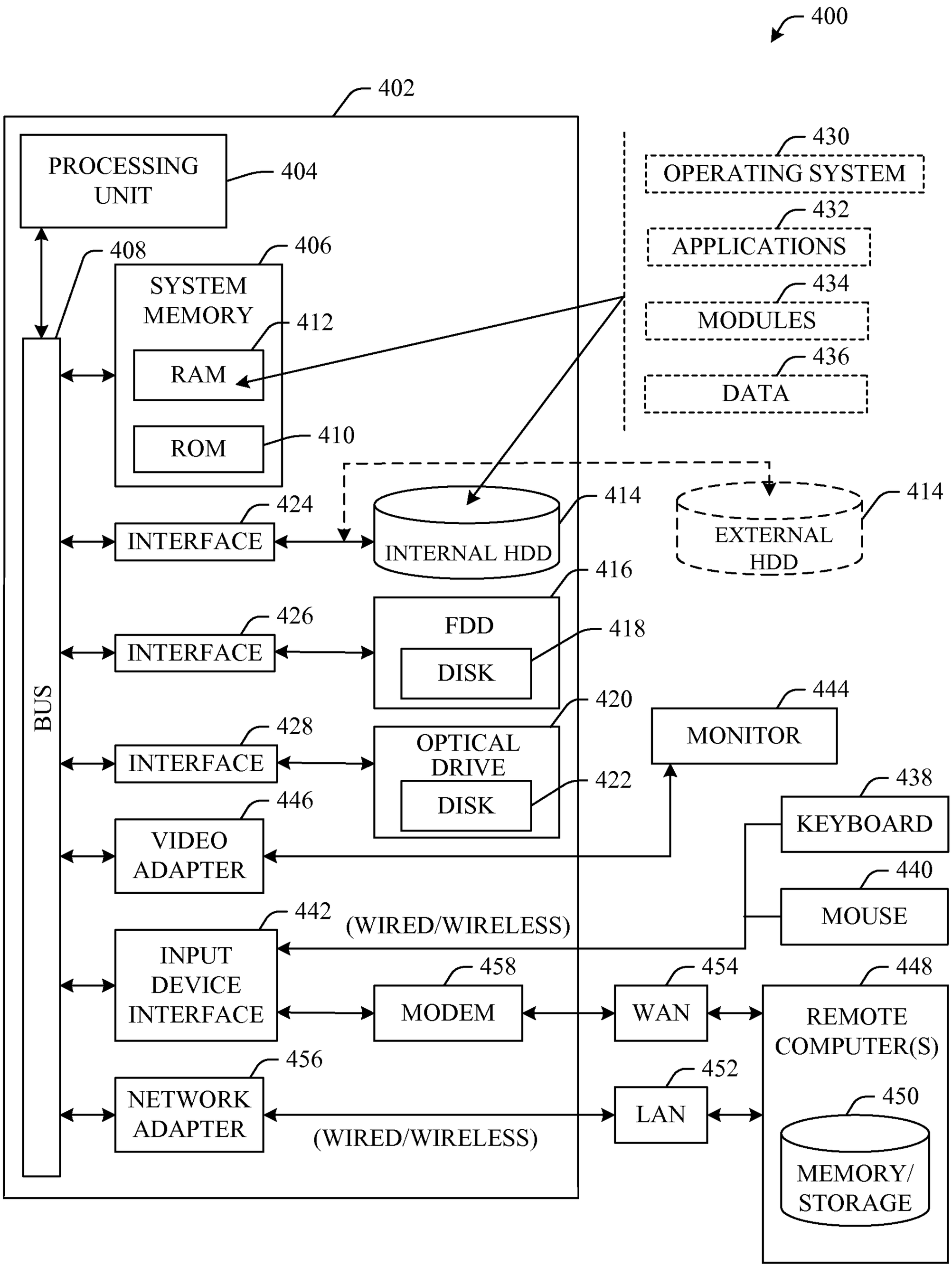

400
402
PROCESSING UNIT
404
408
406
SYSTEM MEMORY
412
RAM
ROM
410
BUS
424
INTERFACE
414
INTERNAL HDD
416
426
INTERFACE
FDD
DISK
418
428
INTERFACE
OPTICAL DRIVE
DISK
420
422
446
VIDEO ADAPTER
442
INPUT DEVICE INTERFACE
(WIRED/WIRELESS)
458
MODEM
456
NETWORK ADAPTER
(WIRED/WIRELESS)
430
OPERATING SYSTEM
432
APPLICATIONS
434
MODULES
436
DATA
414
EXTERNAL HDD
444
MONITOR
438
KEYBOARD
440
MOUSE
454
WAN
448
REMOTE COMPUTER(S)
452
LAN
450
MEMORY/ STORAGE

FIG. 4

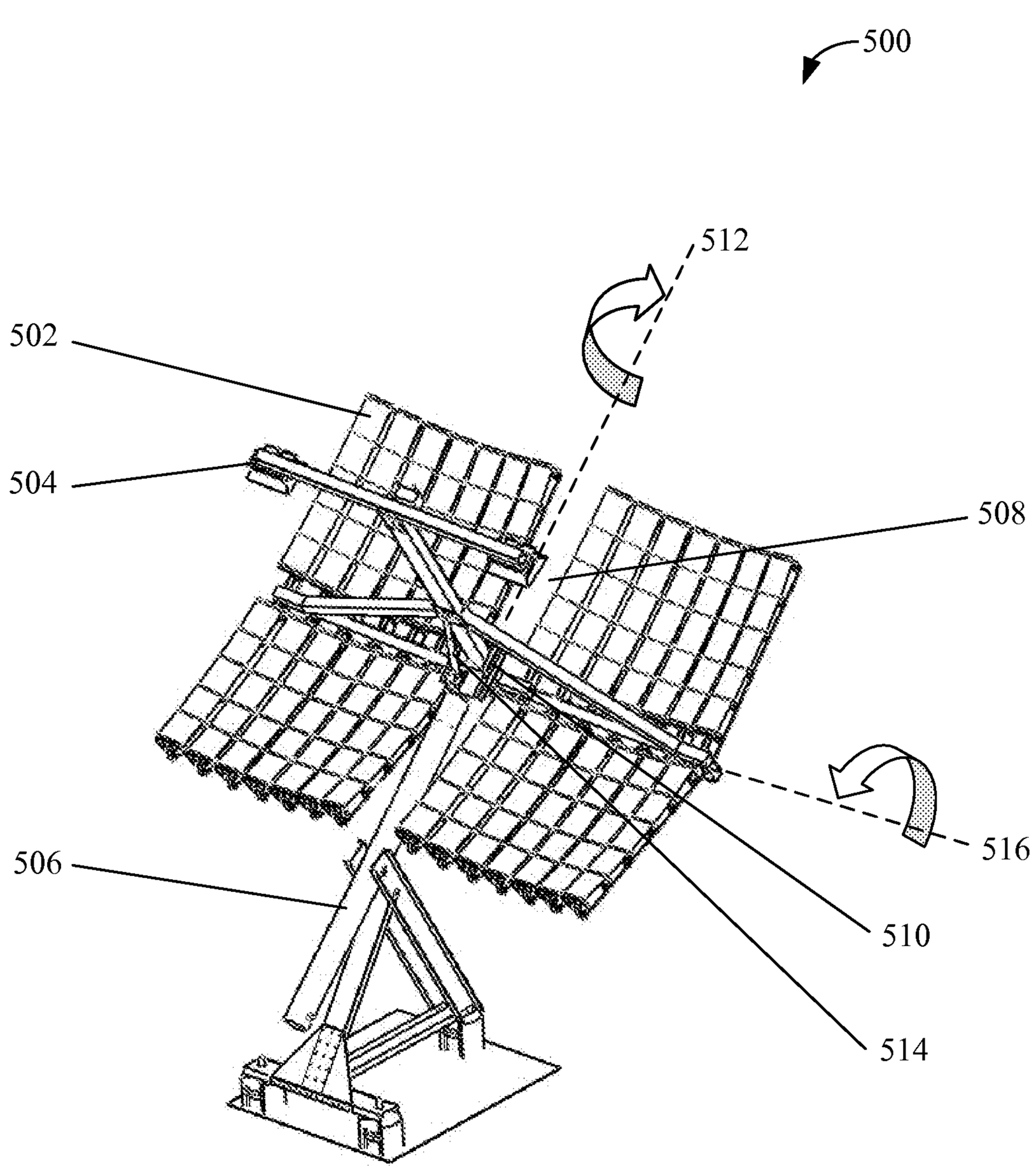


FIG. 5

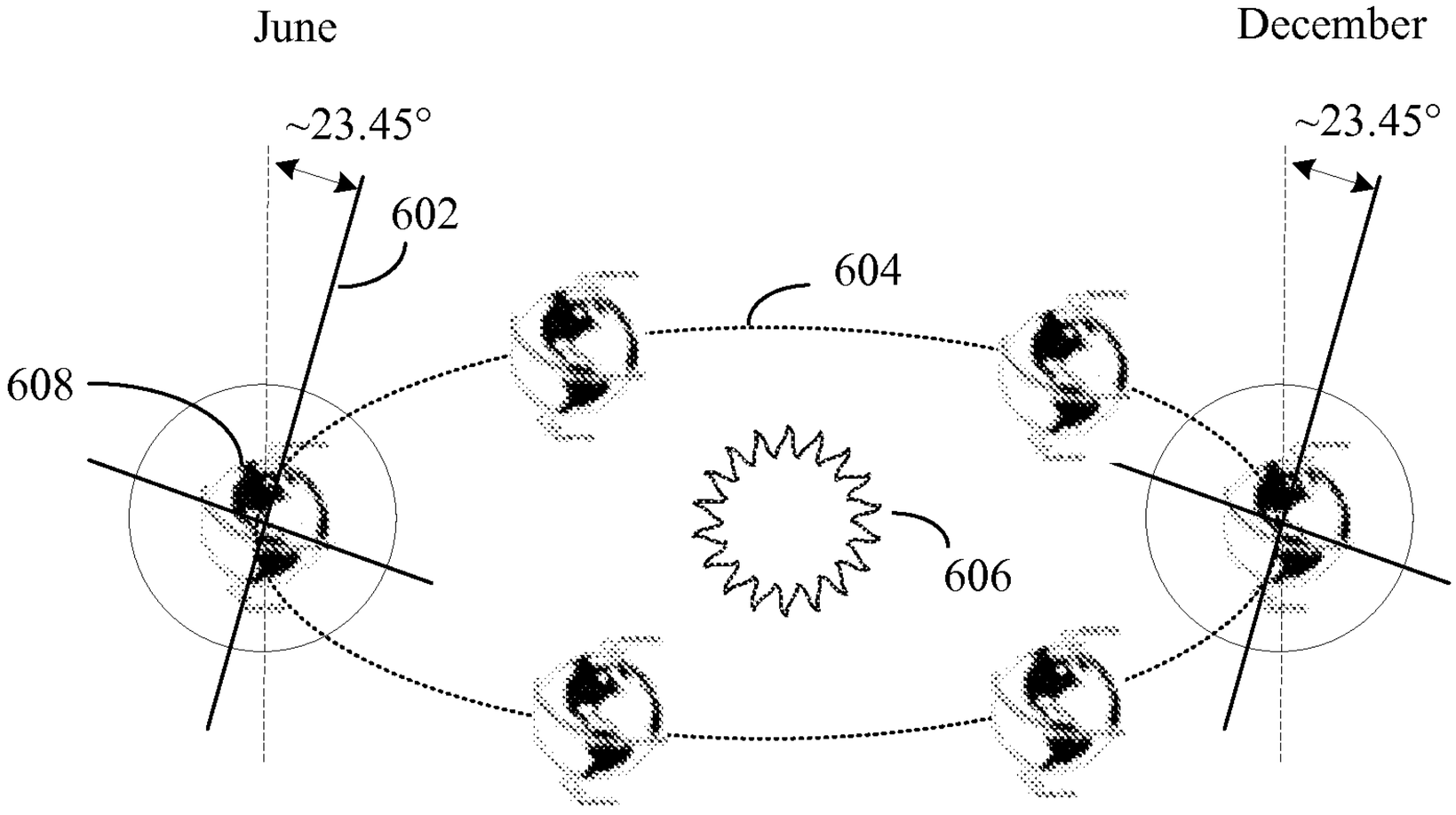

June
December
~23.45°
~23.45°
602
604
608
606

FIG. 6

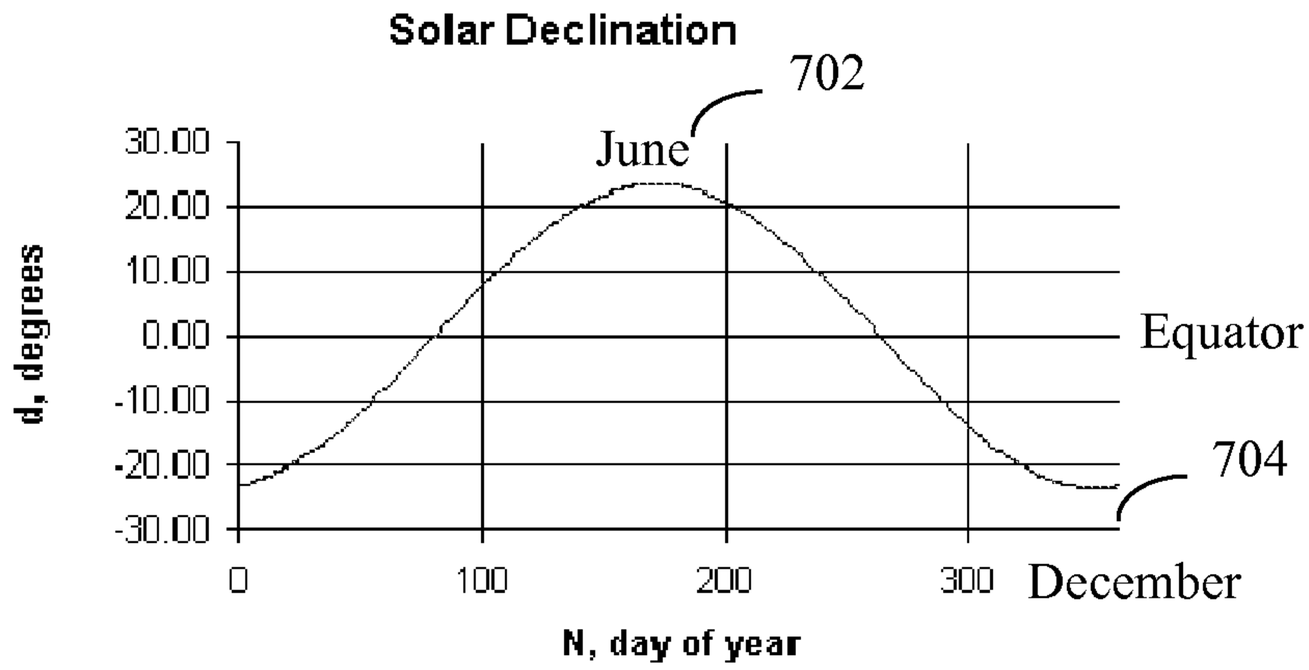

Solar Declination
702
June
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
d, degrees
Equator
704
December
0
100
200
300
N, day of year

FIG. 7

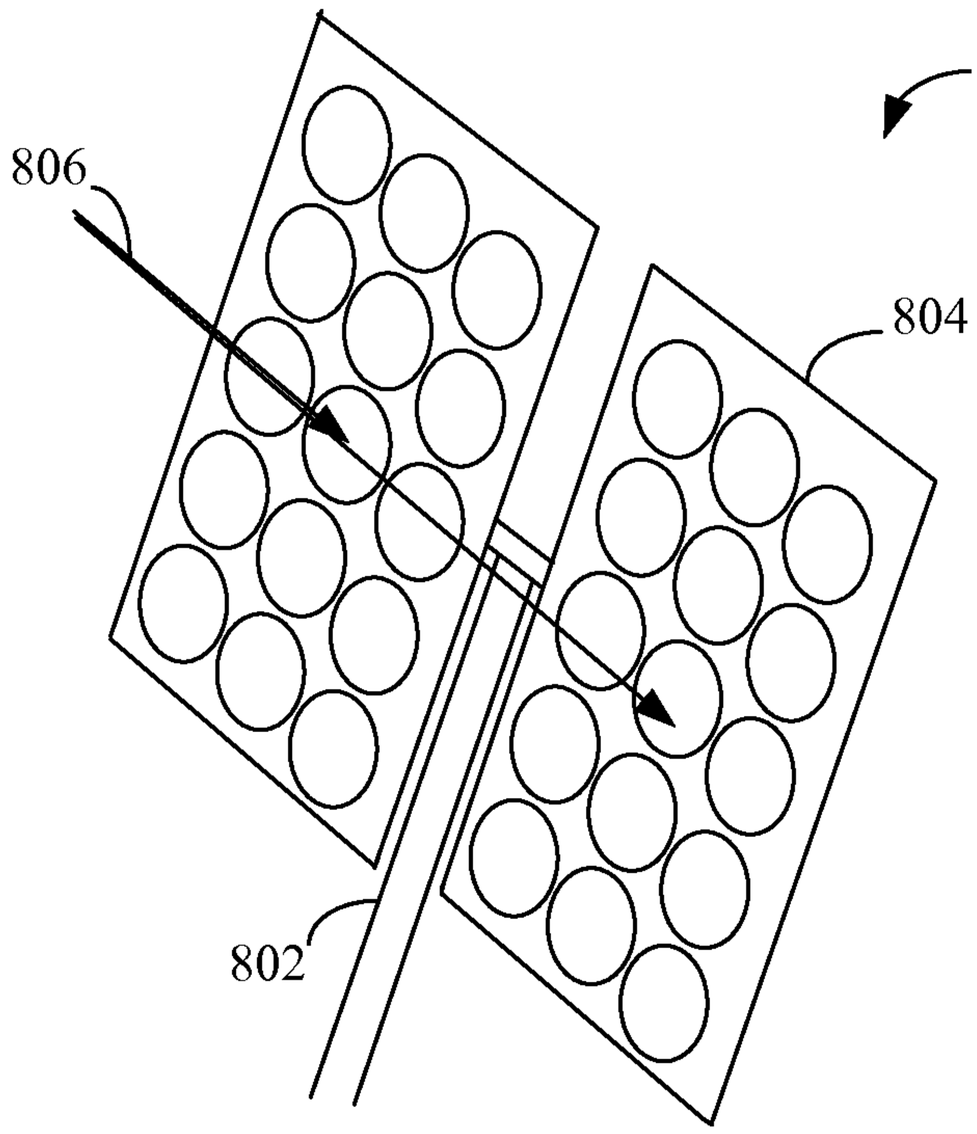


FIG. 8

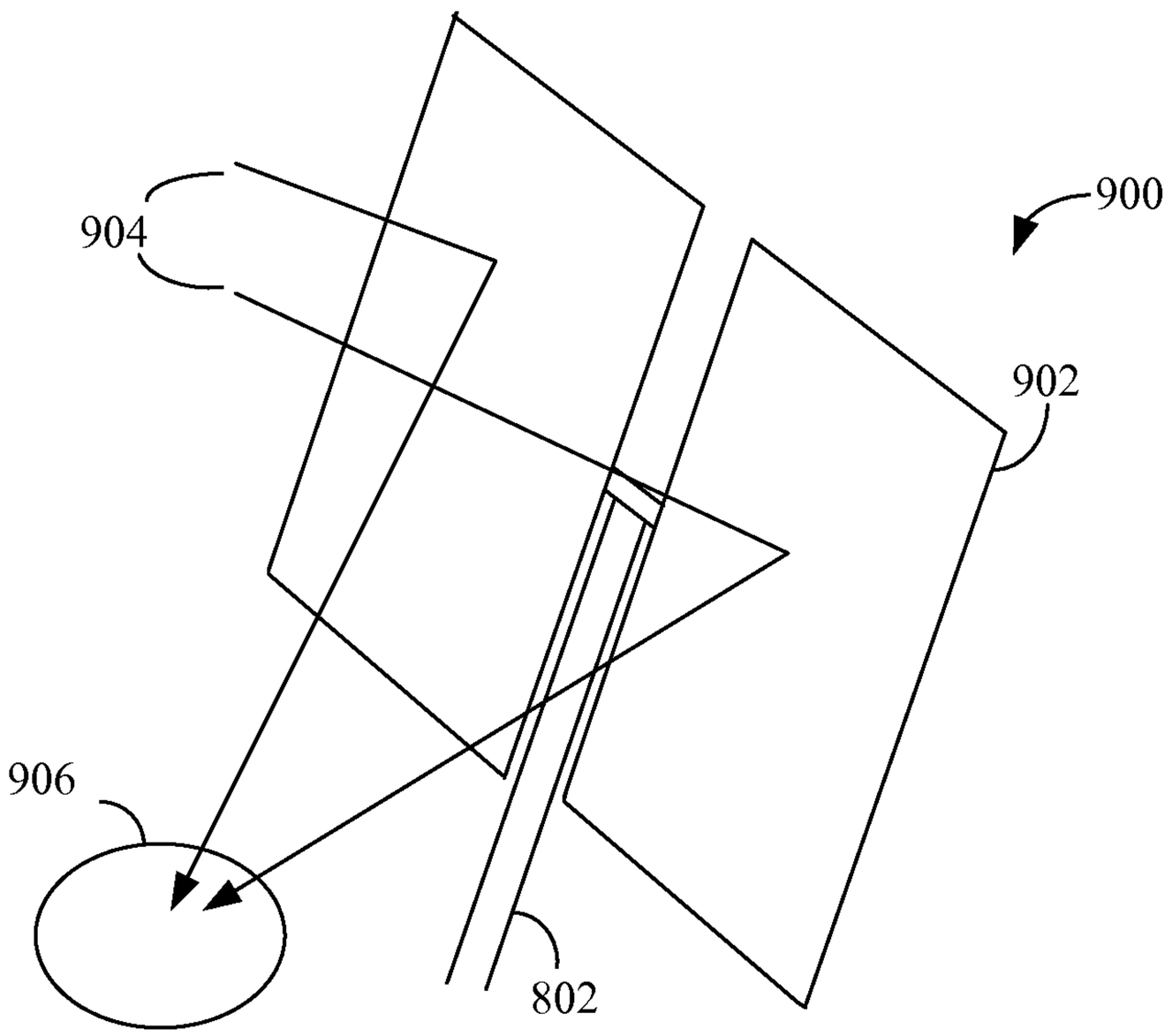


FIG. 9

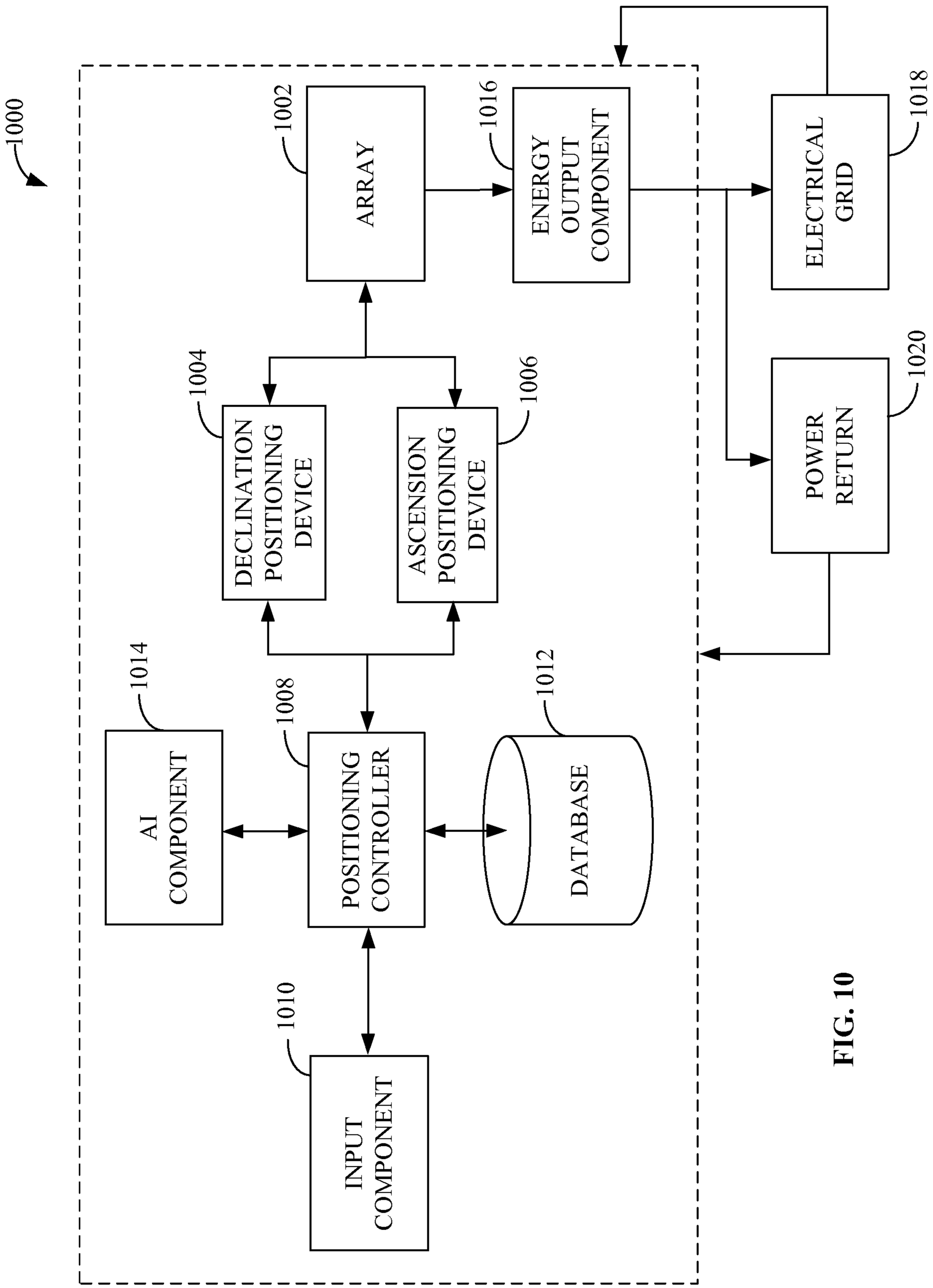

1000
1002
ARRAY
1004
DECLINATION POSITIONING DEVICE
1006
ASCENSION POSITIONING DEVICE
1008
POSITIONING CONTROLLER
1010
INPUT COMPONENT
1012
DATABASE
1014
AI COMPONENT
1016
ENERGY OUTPUT COMPONENT
1018
ELECTRICAL GRID
1020
POWER RETURN

FIG. 10

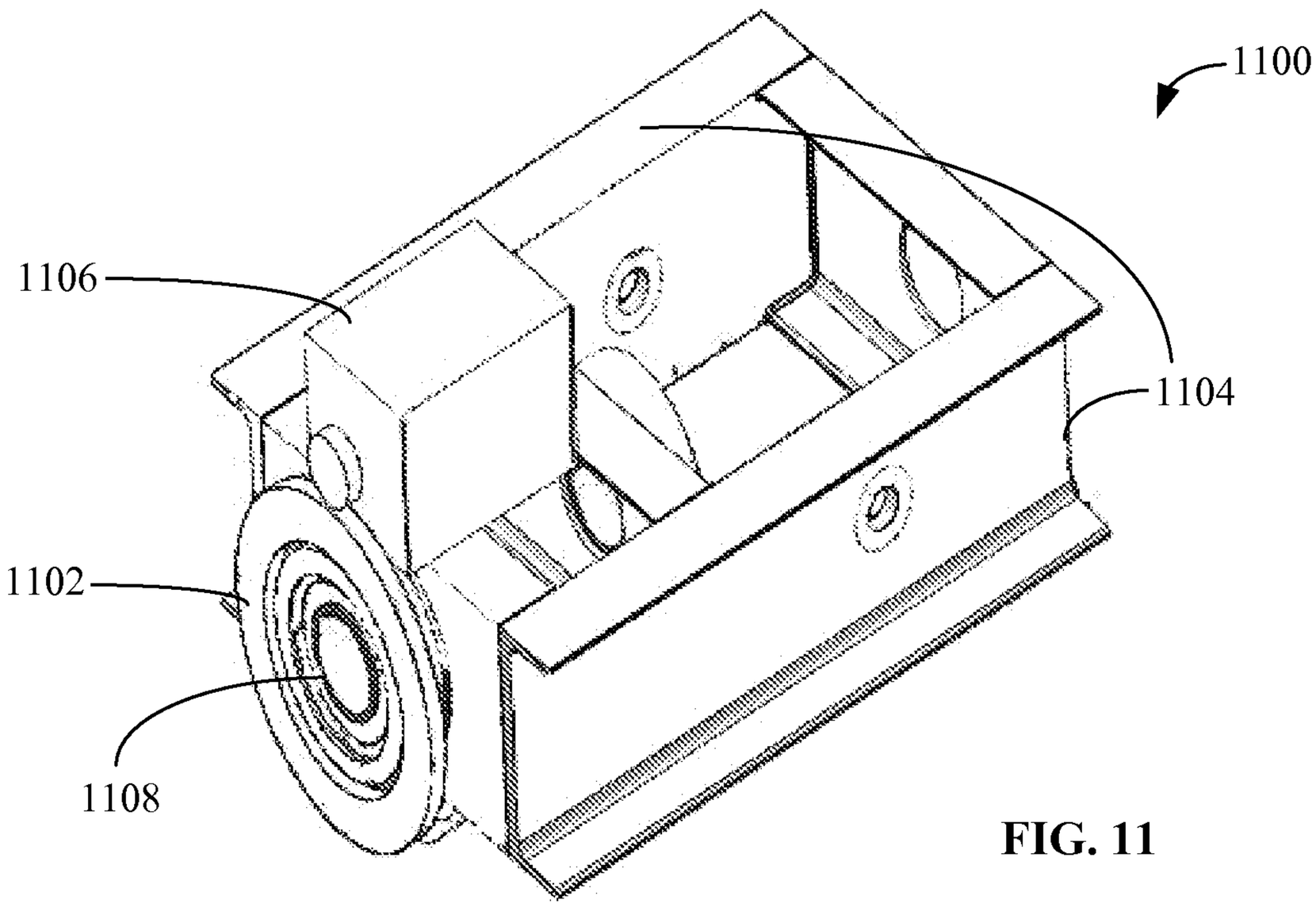


FIG. 11

FIG. 12

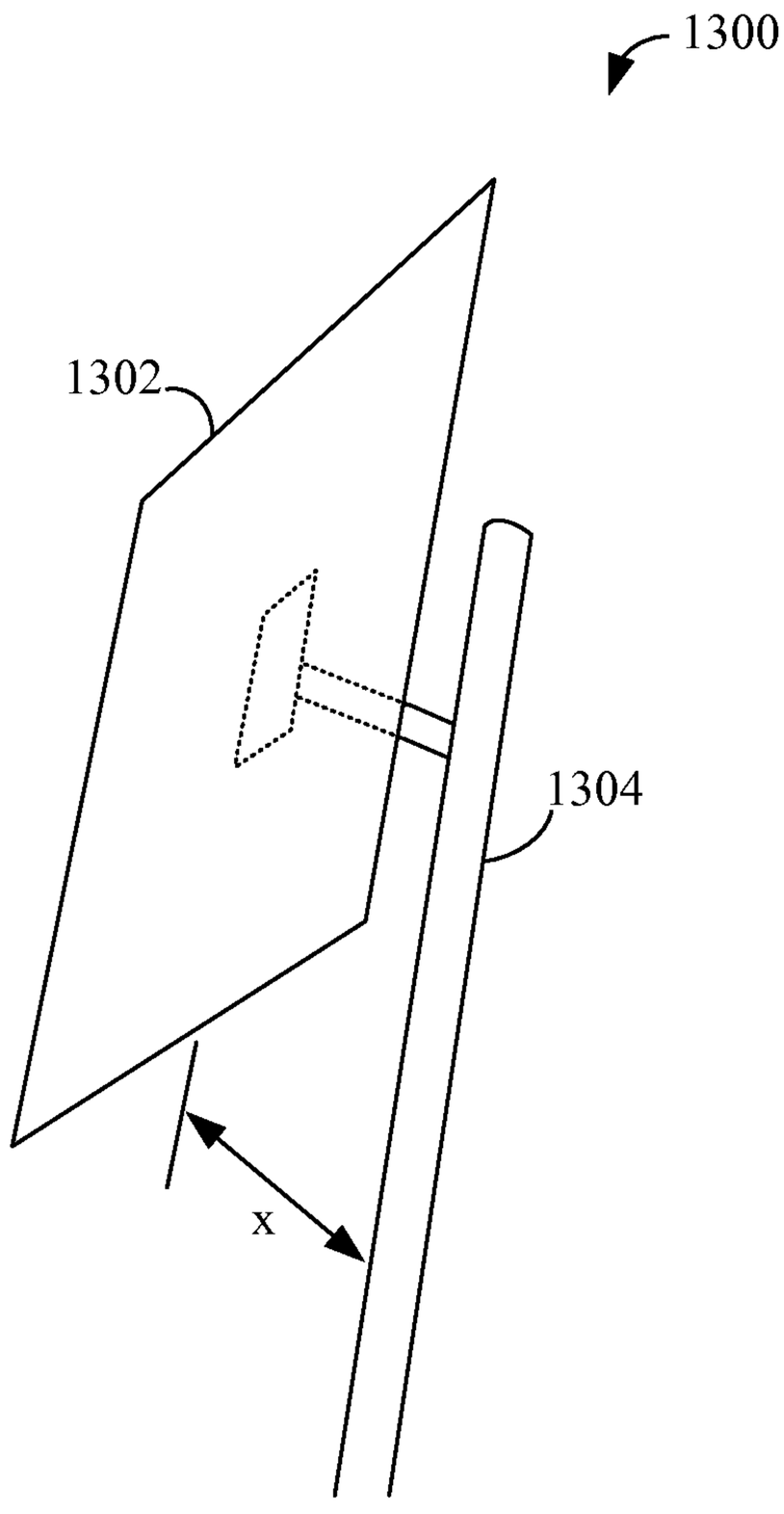


FIG. 13

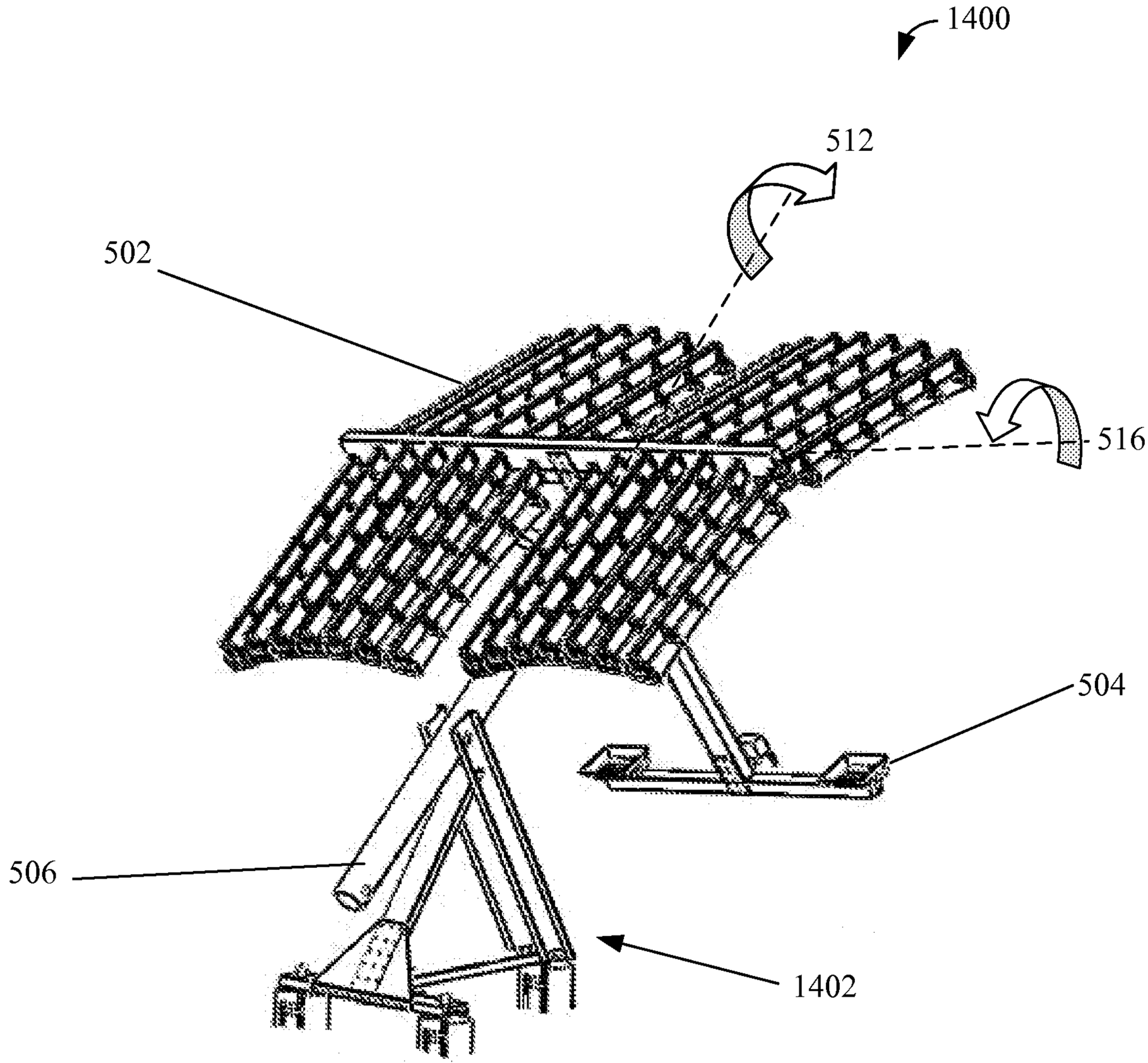


FIG. 14

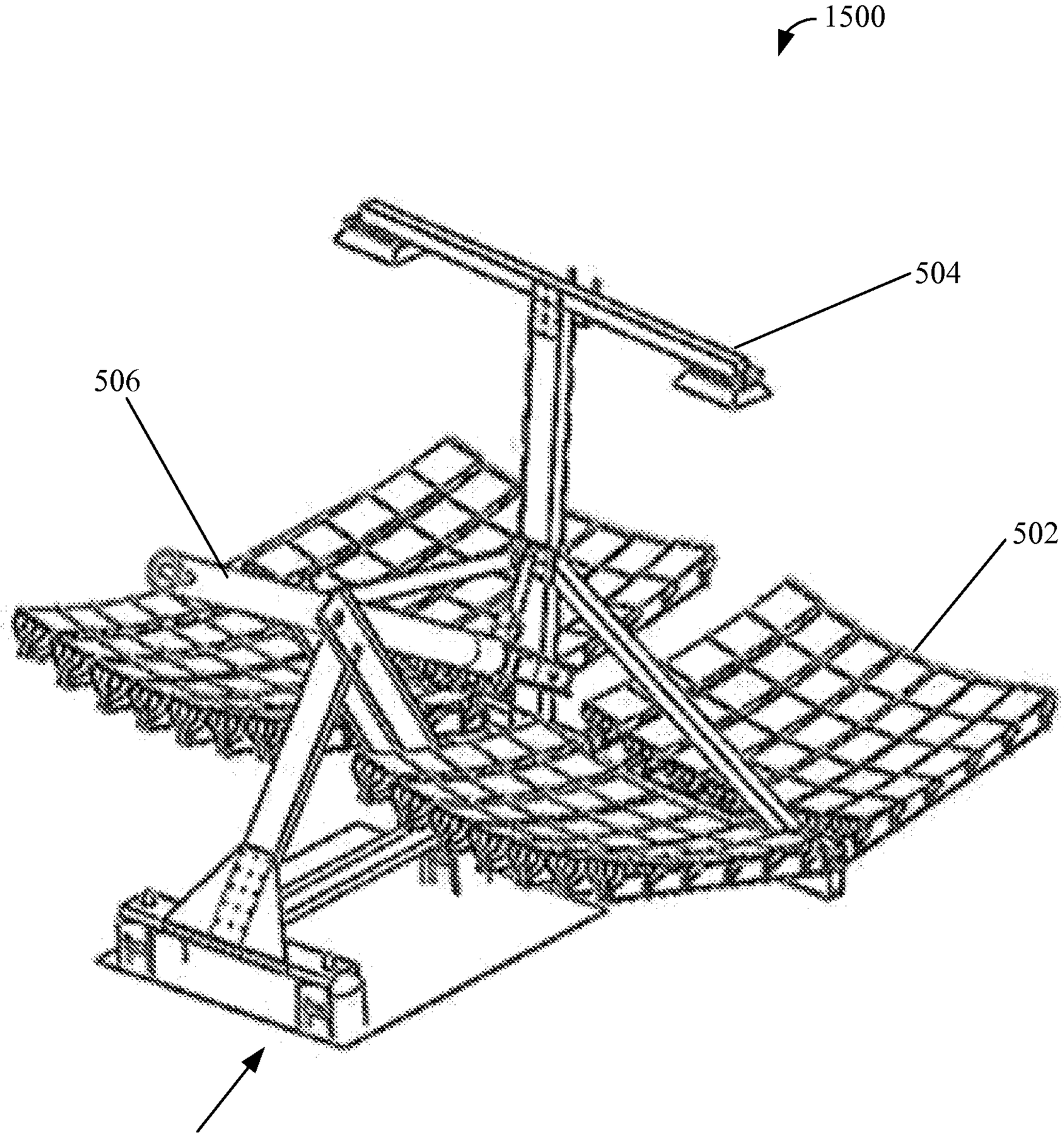


FIG. 15

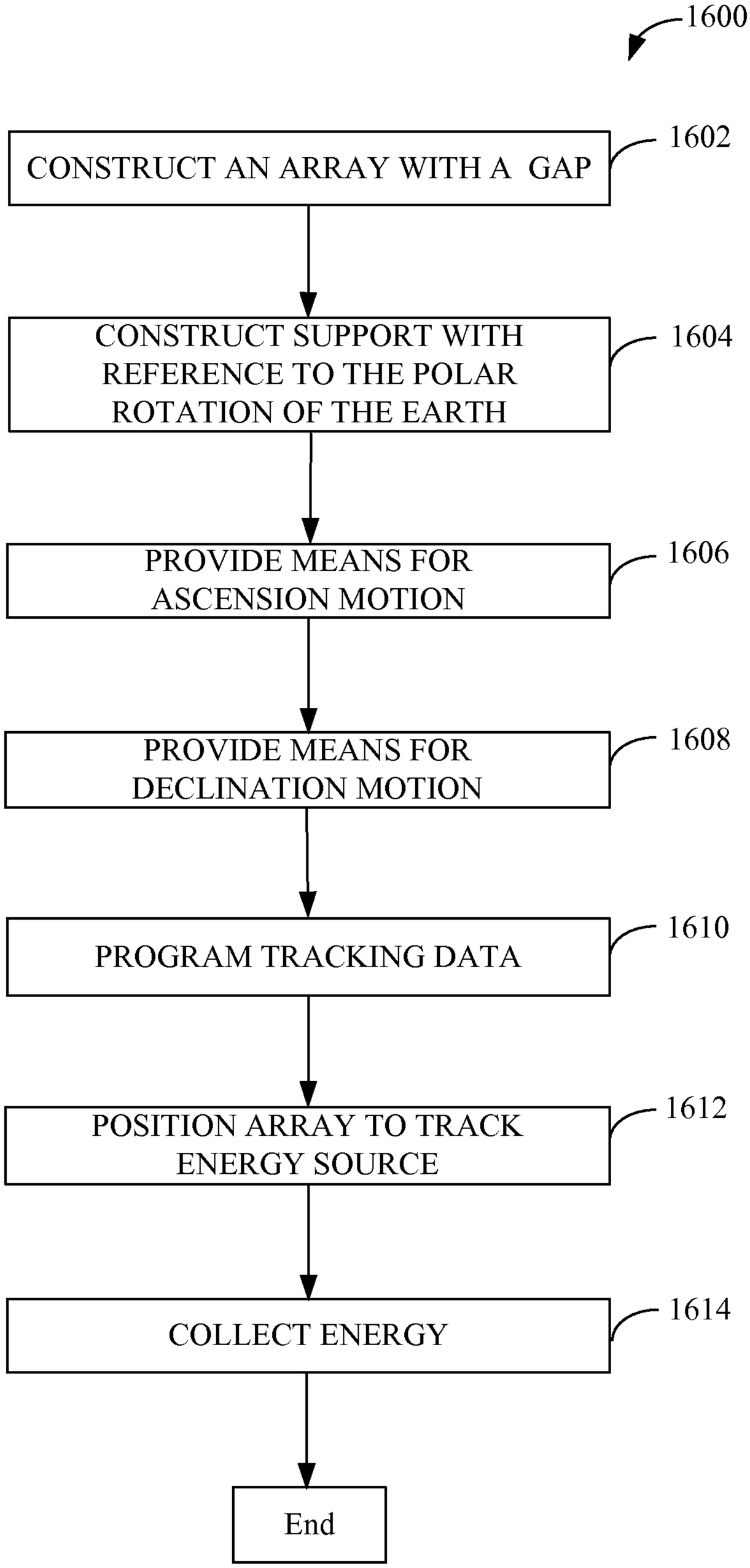

1600
CONSTRUCT AN ARRAY WITH A GAP
1602
CONSTRUCT SUPPORT WITH REFERENCE TO THE POLAR ROTATION OF THE EARTH
1604
PROVIDE MEANS FOR ASCENSION MOTION
1606
PROVIDE MEANS FOR DECLINATION MOTION
1608
PROGRAM TRACKING DATA
1610
POSITION ARRAY TO TRACK ENERGY SOURCE
1612
COLLECT ENERGY
1614
End

FIG. 16

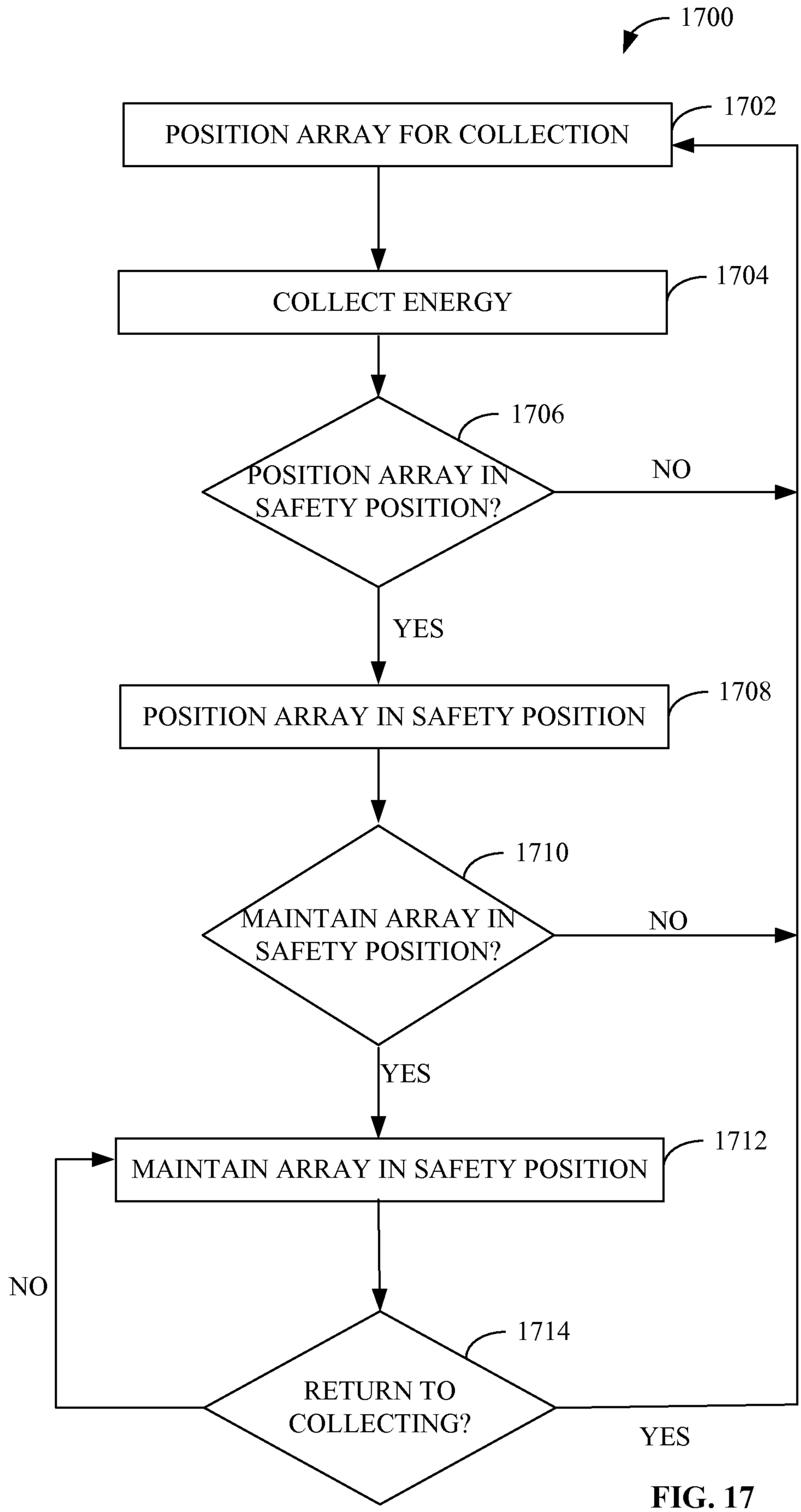

1700
POSITION ARRAY FOR COLLECTION
1702
COLLECT ENERGY
1704
POSITION ARRAY IN SAFETY POSITION?
1706
NO
YES
POSITION ARRAY IN SAFETY POSITION
1708
MAINTAIN ARRAY IN SAFETY POSITION?
1710
NO
YES
MAINTAIN ARRAY IN SAFETY POSITION
1712
NO
RETURN TO COLLECTING?
1714
YES

FIG. 17

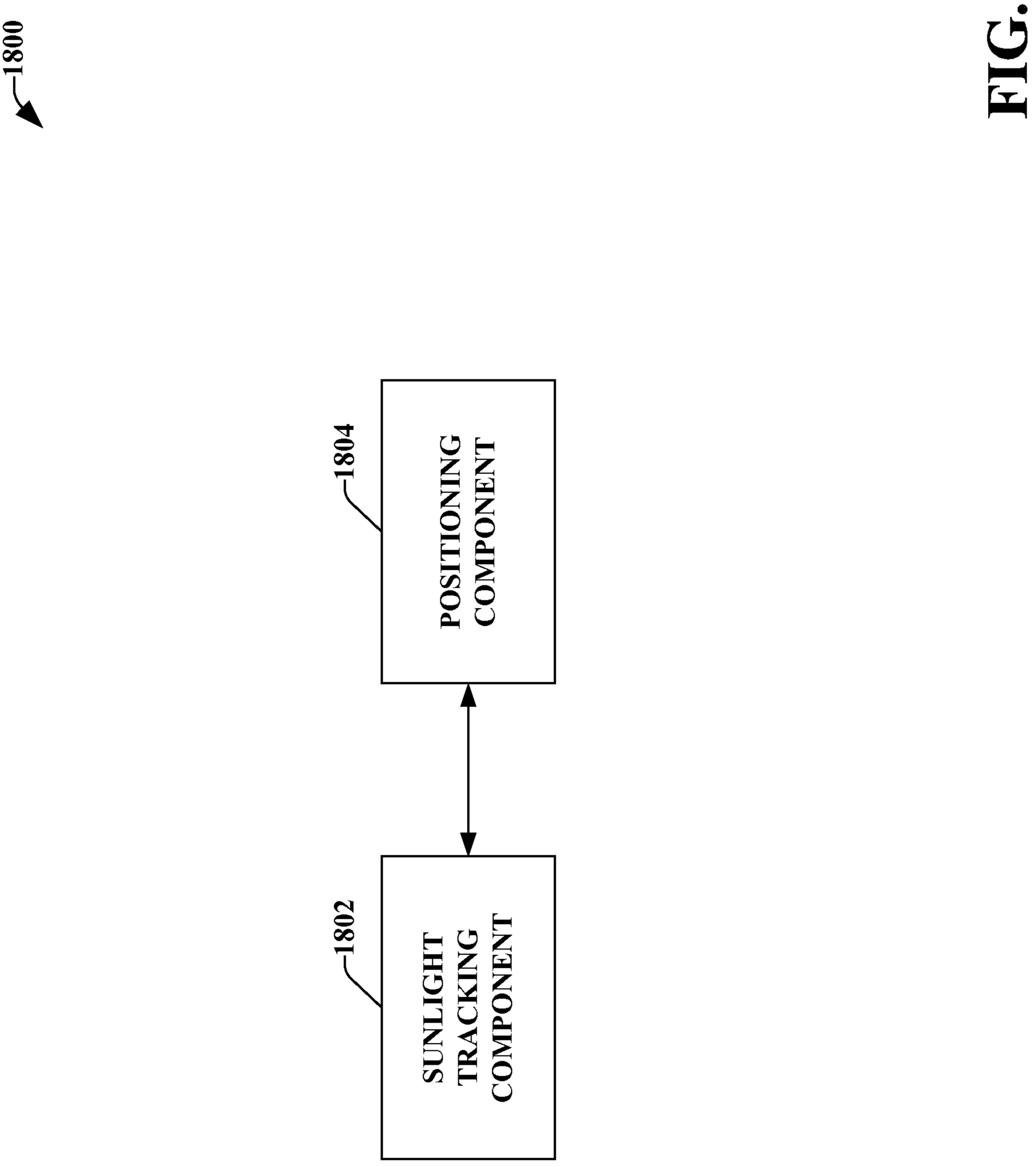
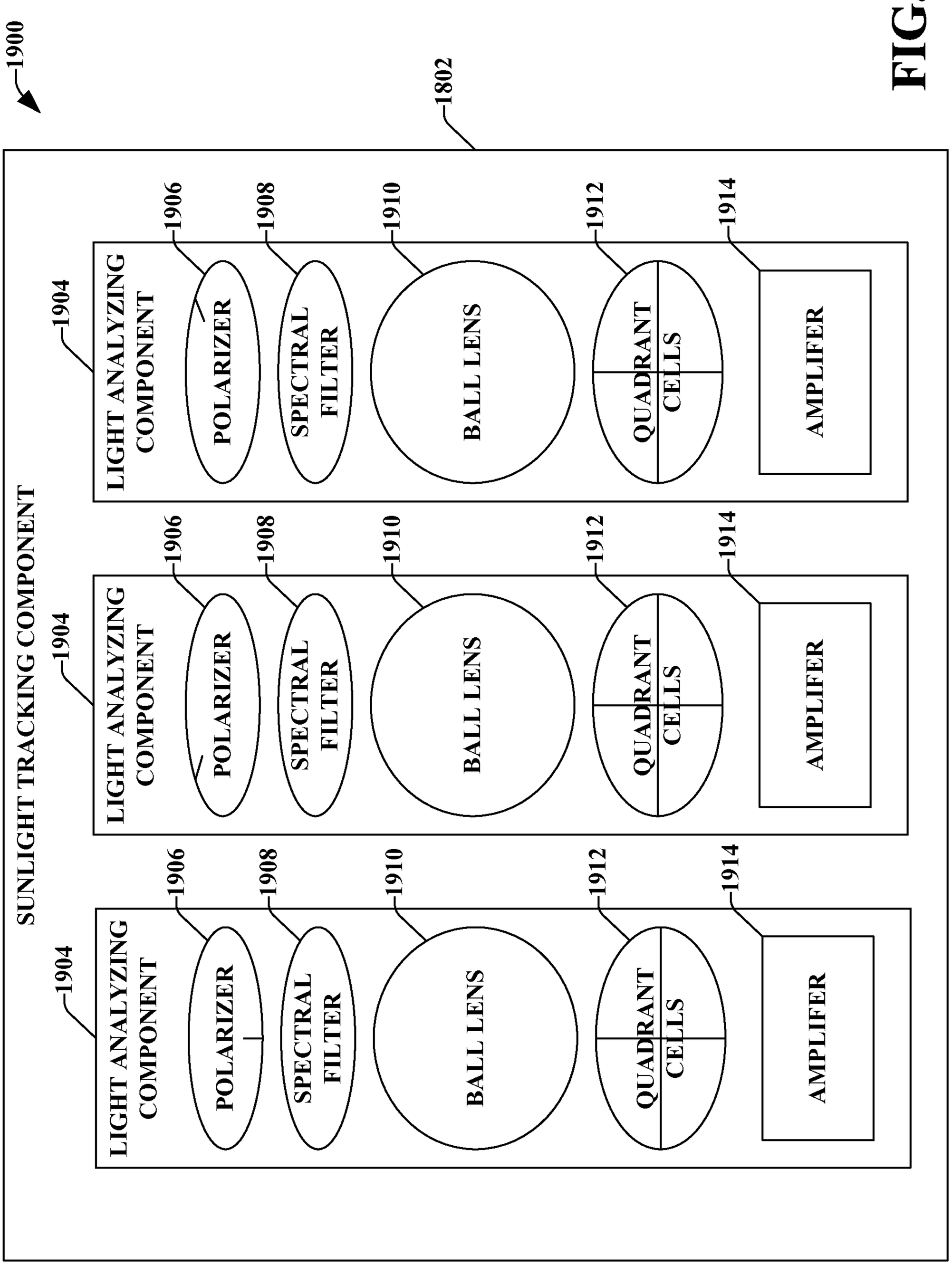

1800
1804
POSITIONING COMPONENT
1802
SUNLIGHT TRACKING COMPONENT

FIG. 18

FIG. 19


1900
1802
SUNLIGHT TRACKING COMPONENT
1904
LIGHT ANALYZING COMPONENT
1906
POLARIZER
1908
SPECTRAL FILTER
1910
BALL LENS
1912
QUADRANT CELLS
1914
AMPLIFER

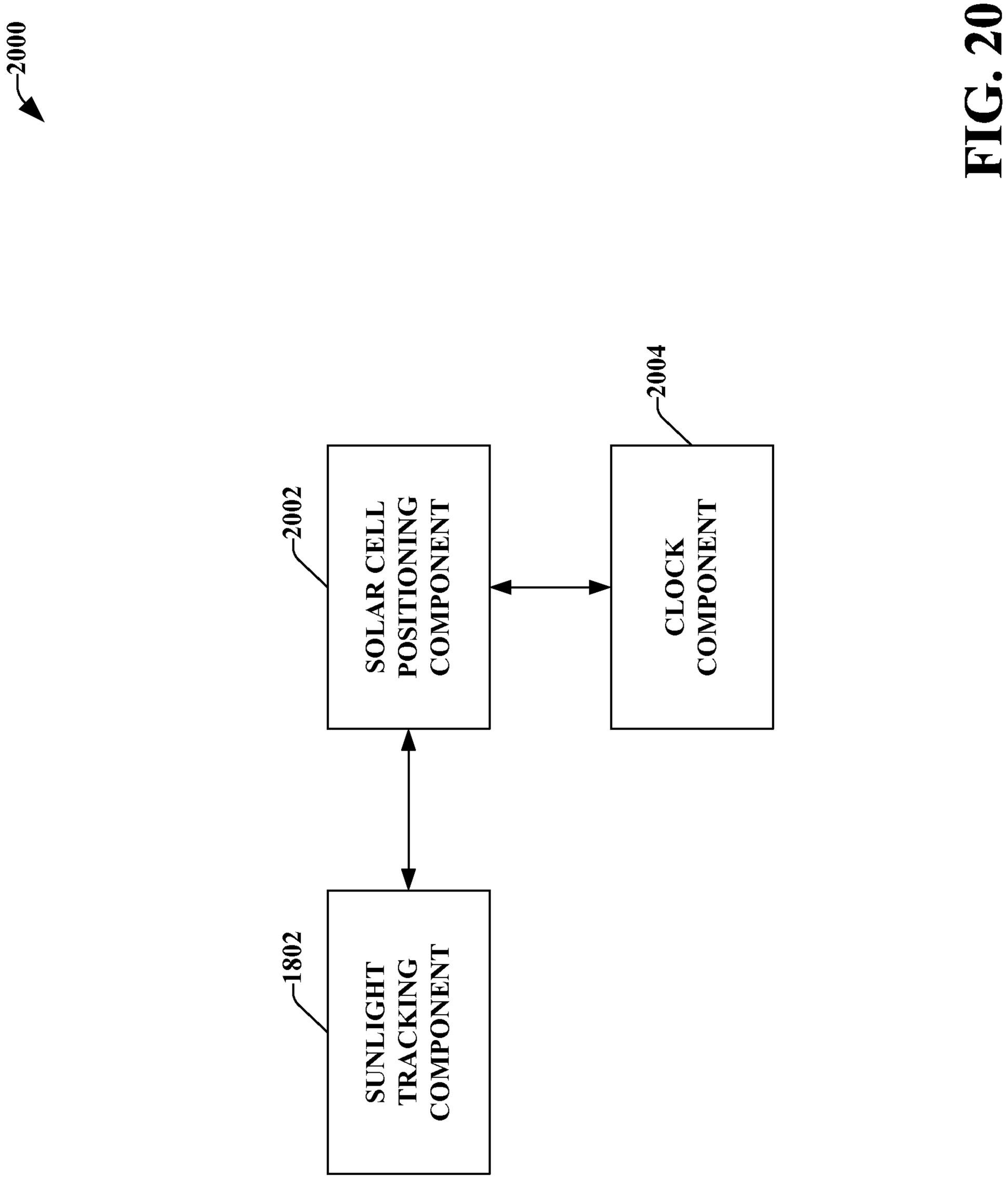

2000
2002
SOLAR CELL POSITIONING COMPONENT
2004
CLOCK COMPONENT
1802
SUNLIGHT TRACKING COMPONENT

FIG. 20

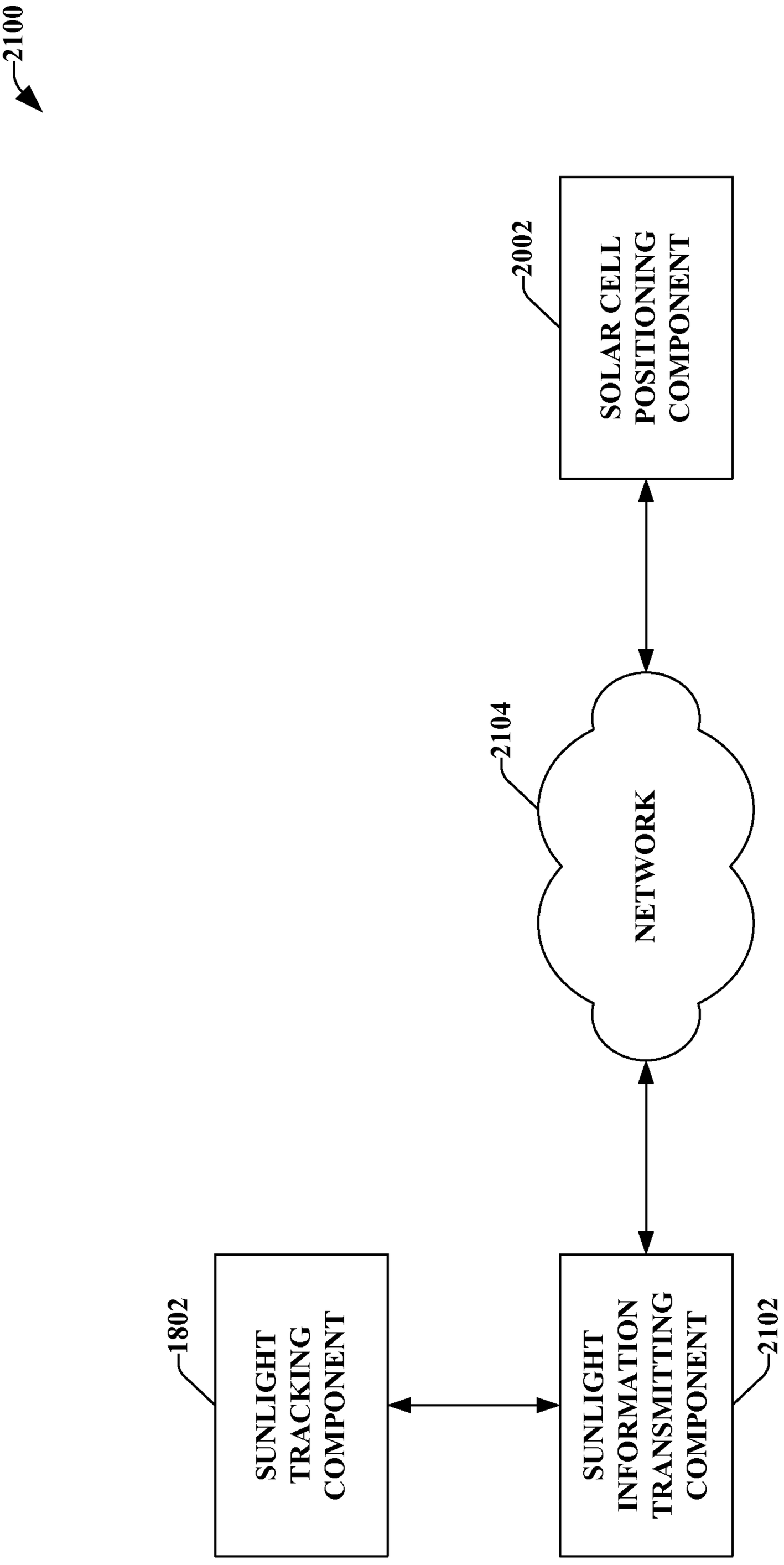

2100
2002
SOLAR CELL POSITIONING COMPONENT
2104
NETWORK
1802
SUNLIGHT TRACKING COMPONENT
SUNLIGHT INFORMATION TRANSMITTING COMPONENT
2102

FIG. 21

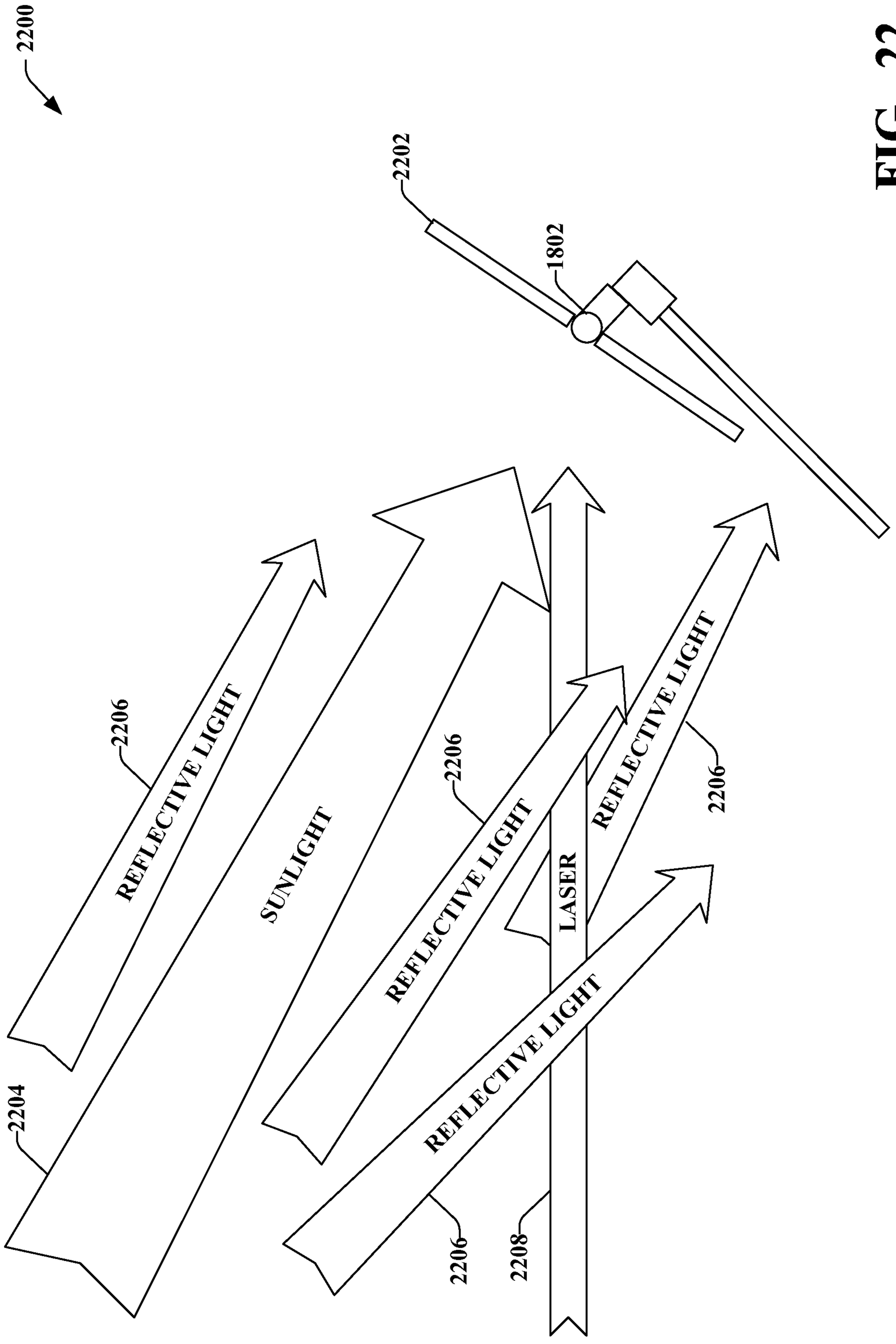

2200
2202
1802
2206
REFLECTIVE LIGHT
SUNLIGHT
2206
REFLECTIVE LIGHT
LASER
REFLECTIVE LIGHT
2206
2204
REFLECTIVE LIGHT
2206
2208

FIG. 22

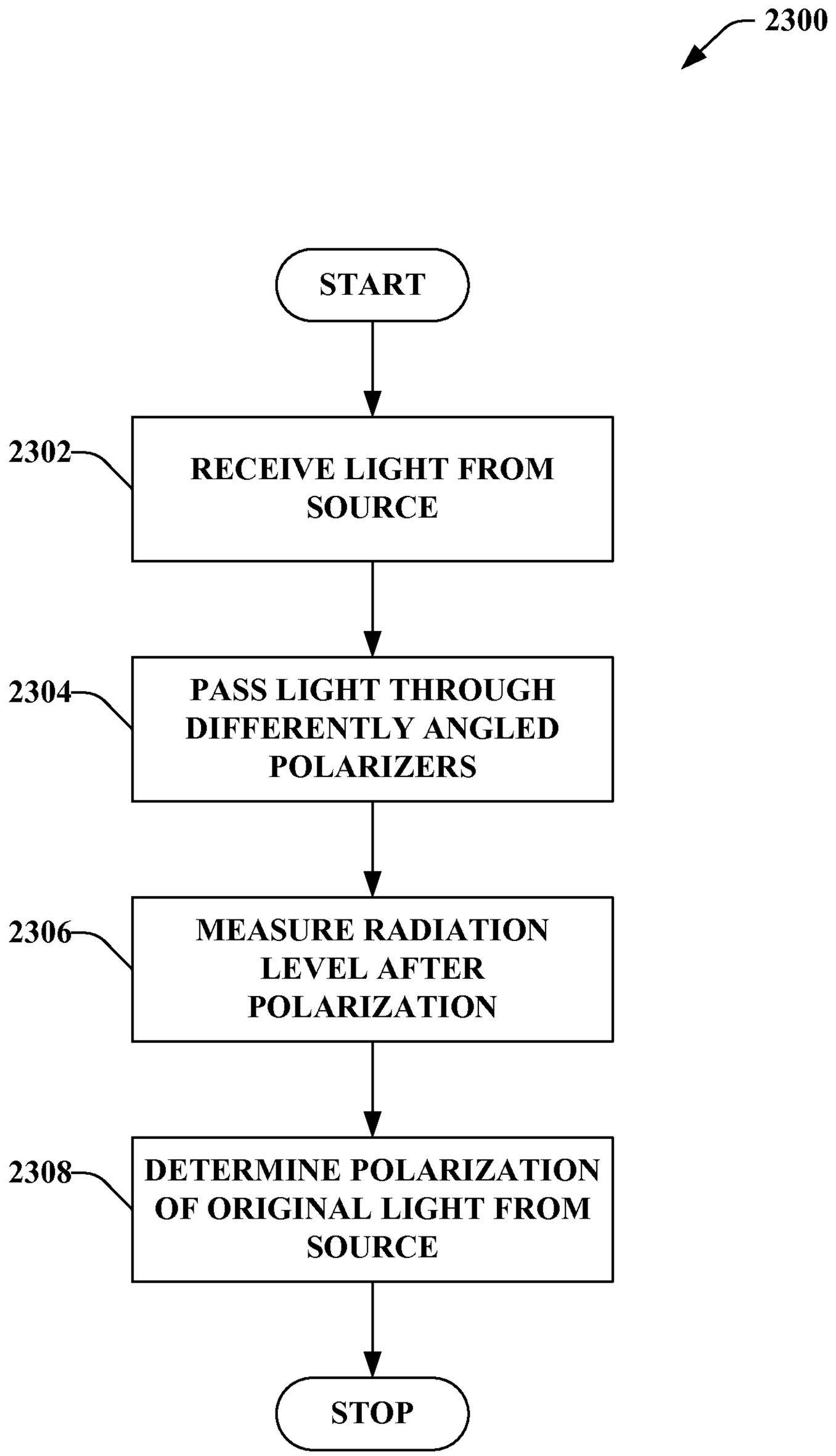

2300
START
2302
RECEIVE LIGHT FROM SOURCE
2304
PASS LIGHT THROUGH DIFFERENTLY ANGLED POLARIZERS
2306
MEASURE RADIATION LEVEL AFTER POLARIZATION
2308
DETERMINE POLARIZATION OF ORIGINAL LIGHT FROM SOURCE
STOP

FIG. 23

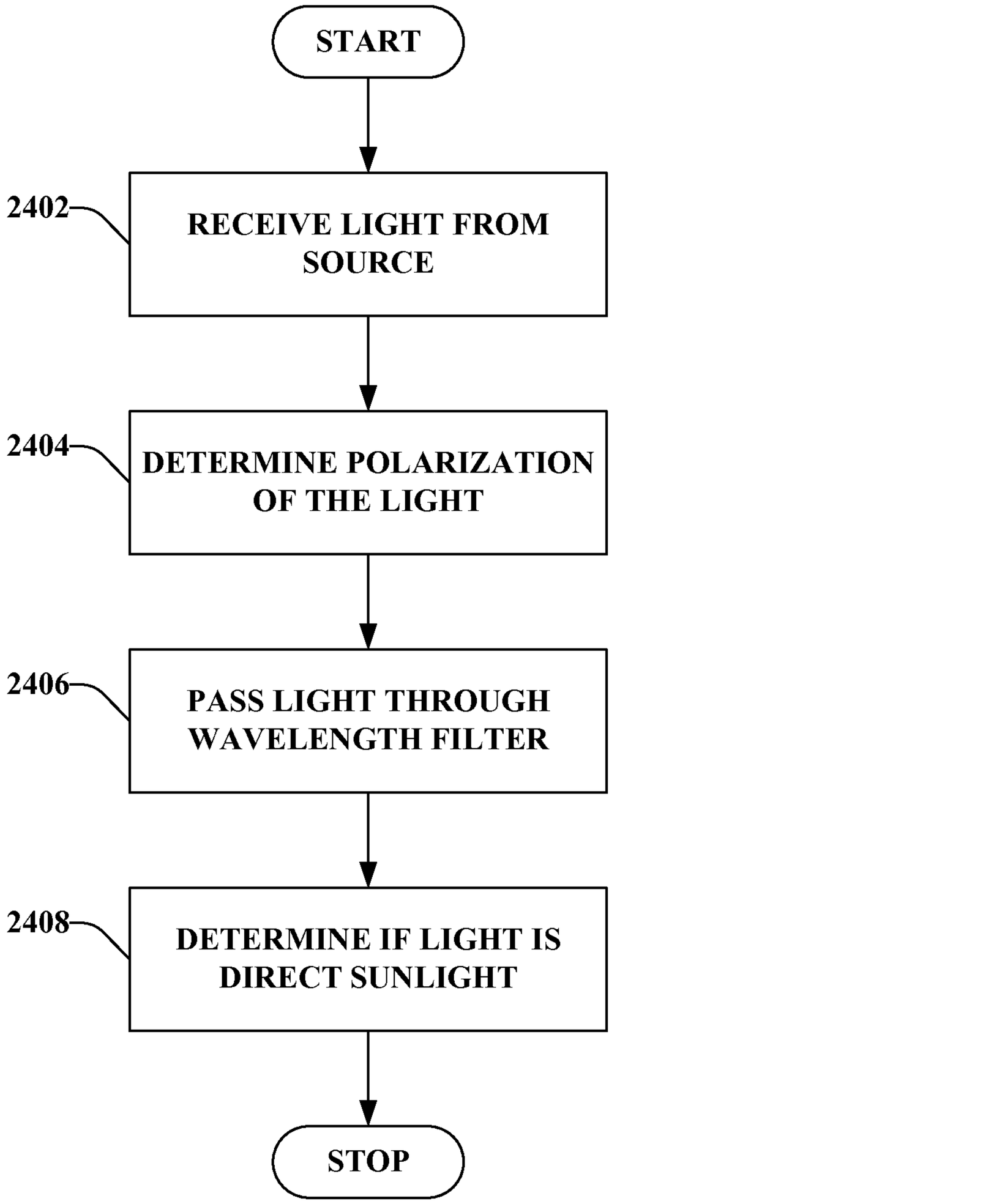

2400
START
2402
RECEIVE LIGHT FROM SOURCE
2404
DETERMINE POLARIZATION OF THE LIGHT
2406
PASS LIGHT THROUGH WAVELENGTH FILTER
2408
DETERMINE IF LIGHT IS DIRECT SUNLIGHT
STOP

FIG. 24

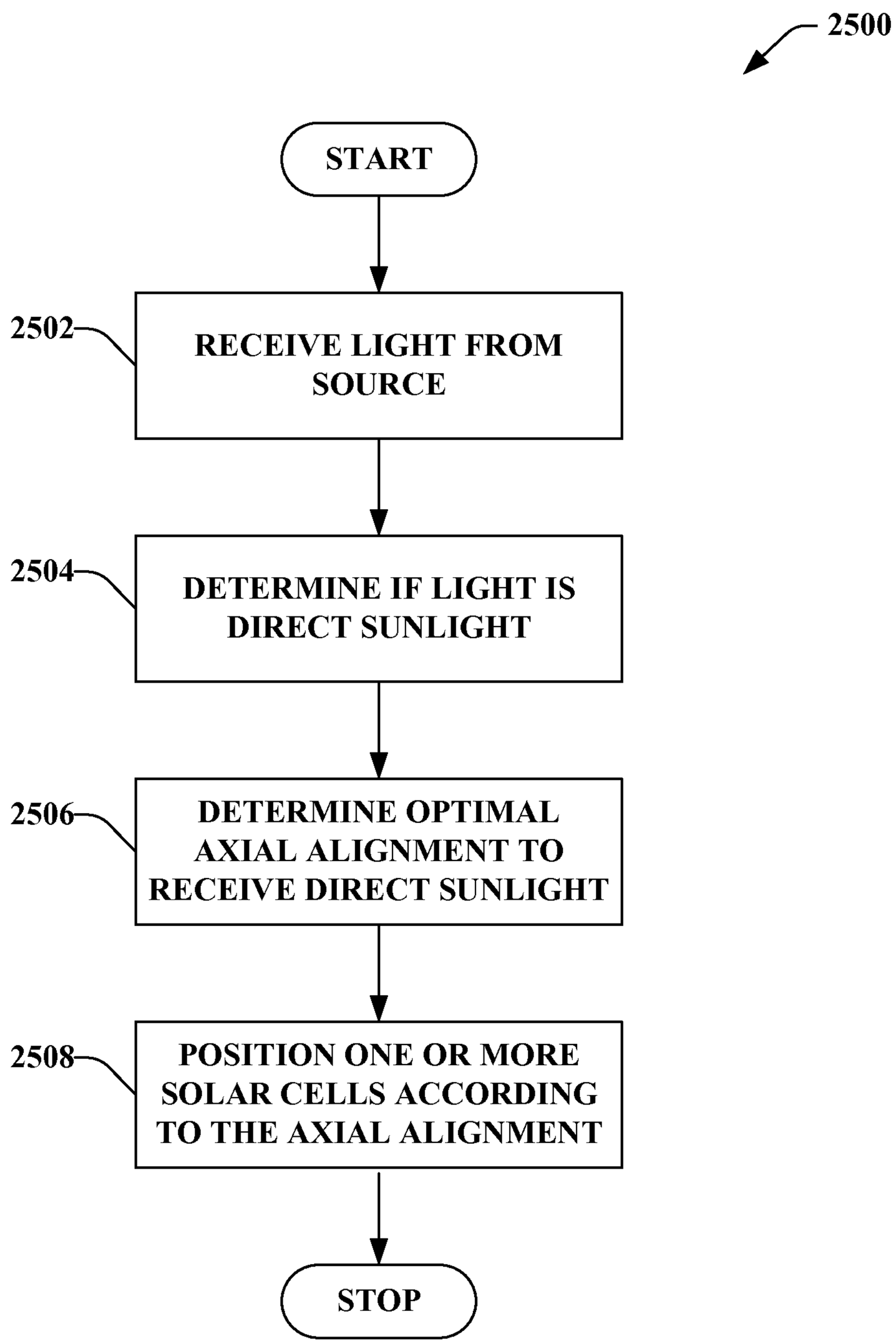
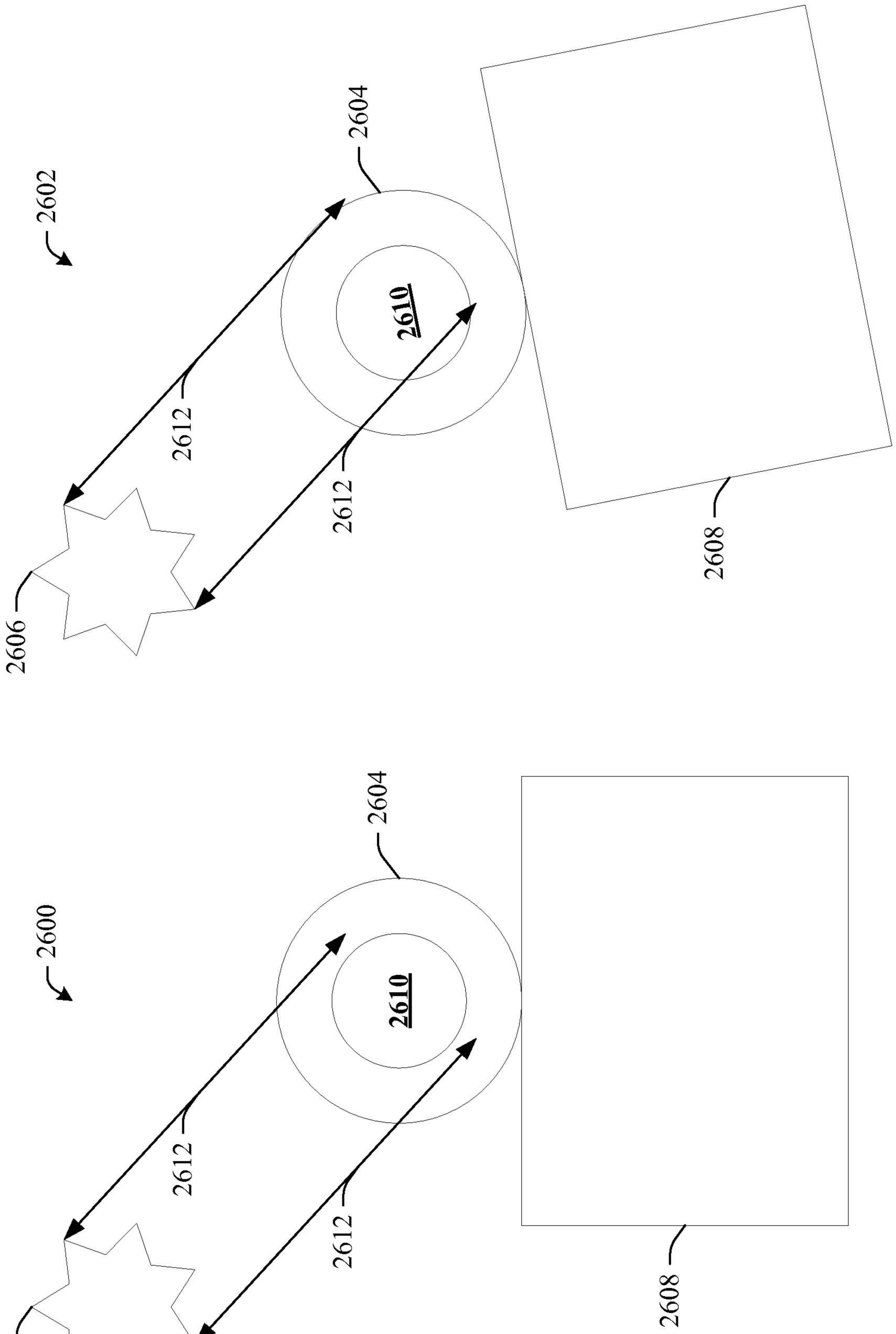

2500
START
2502
RECEIVE LIGHT FROM SOURCE
2504
DETERMINE IF LIGHT IS DIRECT SUNLIGHT
2506
DETERMINE OPTIMAL AXIAL ALIGNMENT TO RECEIVE DIRECT SUNLIGHT
2508
POSITION ONE OR MORE SOLAR CELLS ACCORDING TO THE AXIAL ALIGNMENT
STOP

FIG. 25

FIG. 26



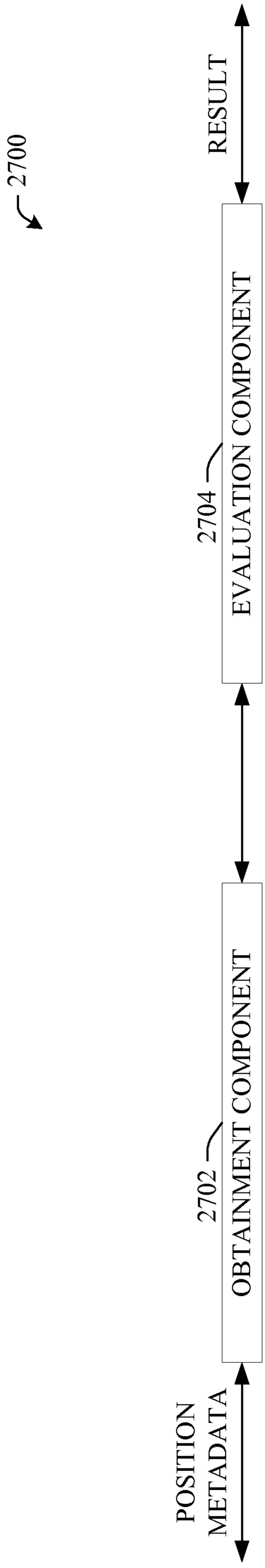

2700
RESULT
EVALUATION COMPONENT
2704
OBTAINMENT COMPONENT
2702
POSITION METADATA

FIG.27

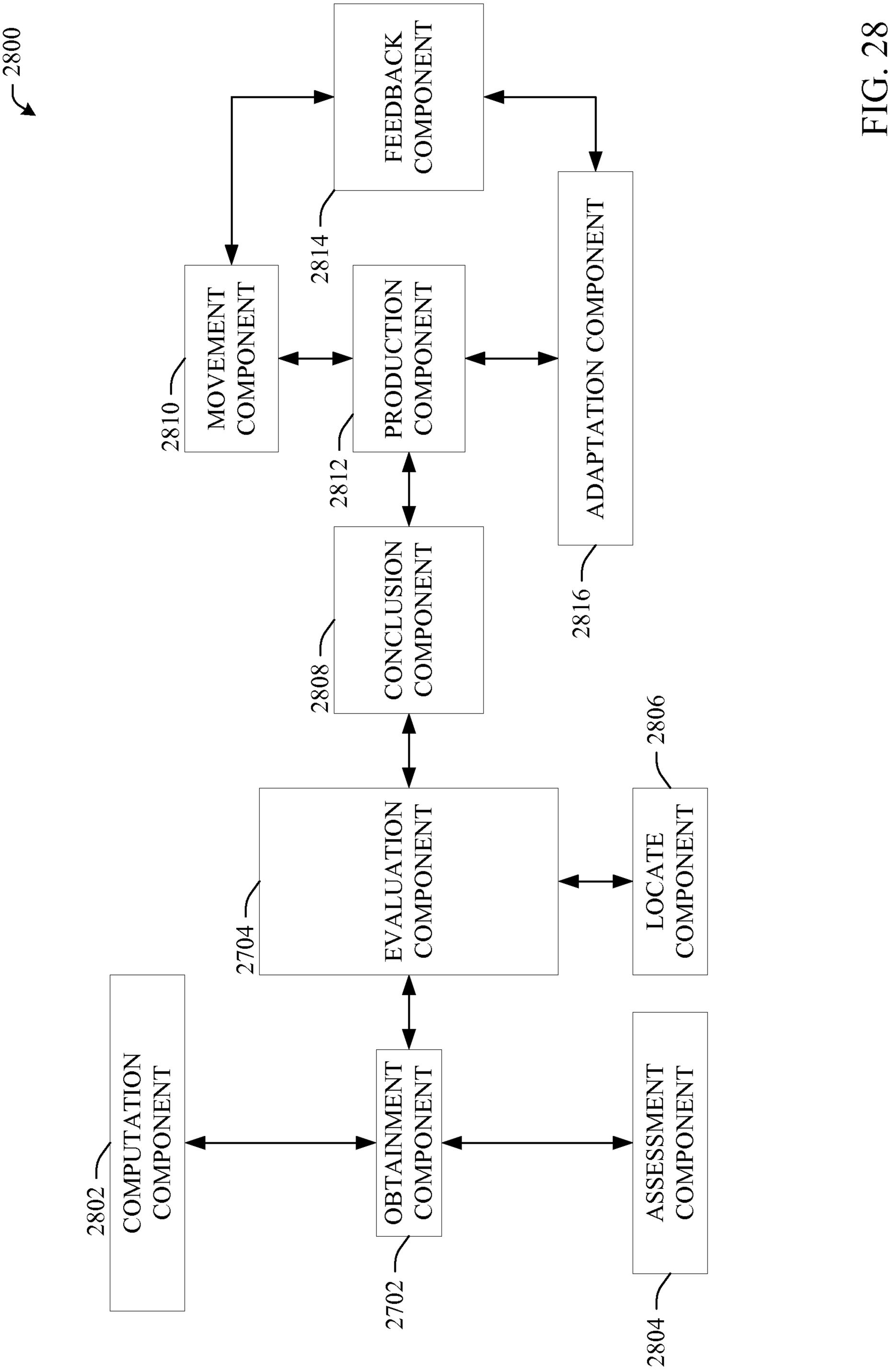

2800
FEEDBACK COMPONENT
2814
MOVEMENT COMPONENT
2810
PRODUCTION COMPONENT
2812
ADAPTATION COMPONENT
2816
CONCLUSION COMPONENT
2808
2806
EVALUATION COMPONENT
2704
LOCATE COMPONENT
COMPUTATION COMPONENT
2802
OBTAINMENT COMPONENT
2702
ASSESSMENT COMPONENT
2804

FIG. 28

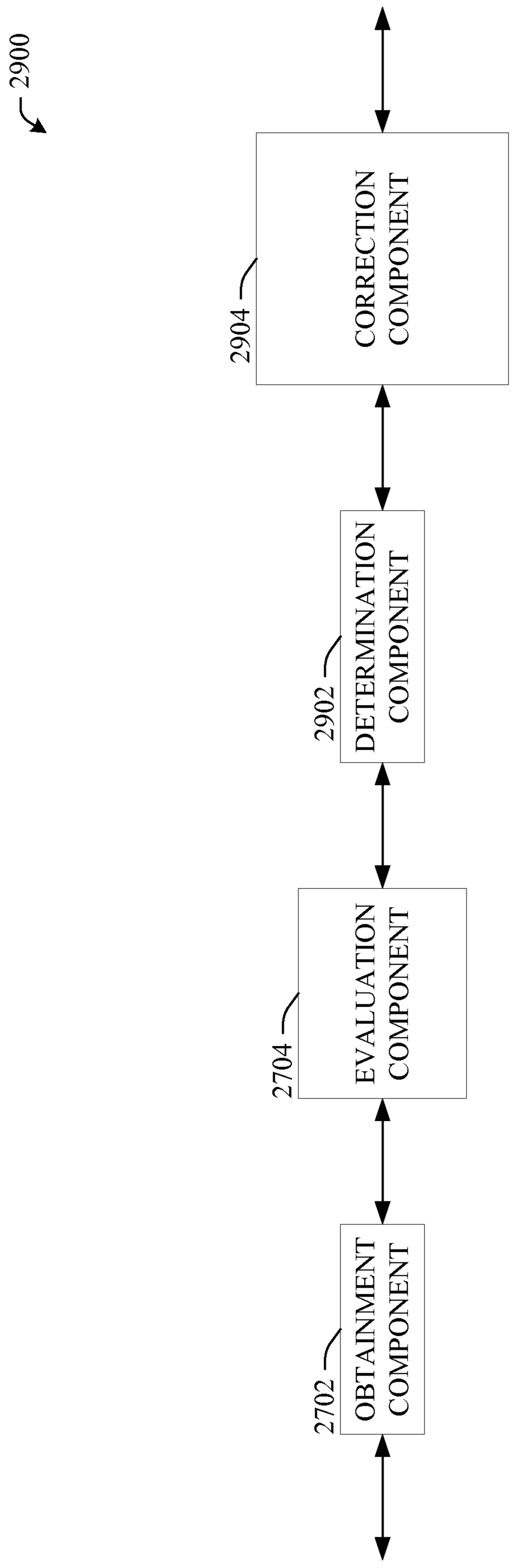

2900
2904
CORRECTION COMPONENT
2902
DETERMINATION COMPONENT
2704
EVALUATION COMPONENT
2702
OBTAINMENT COMPONENT

FIG. 29

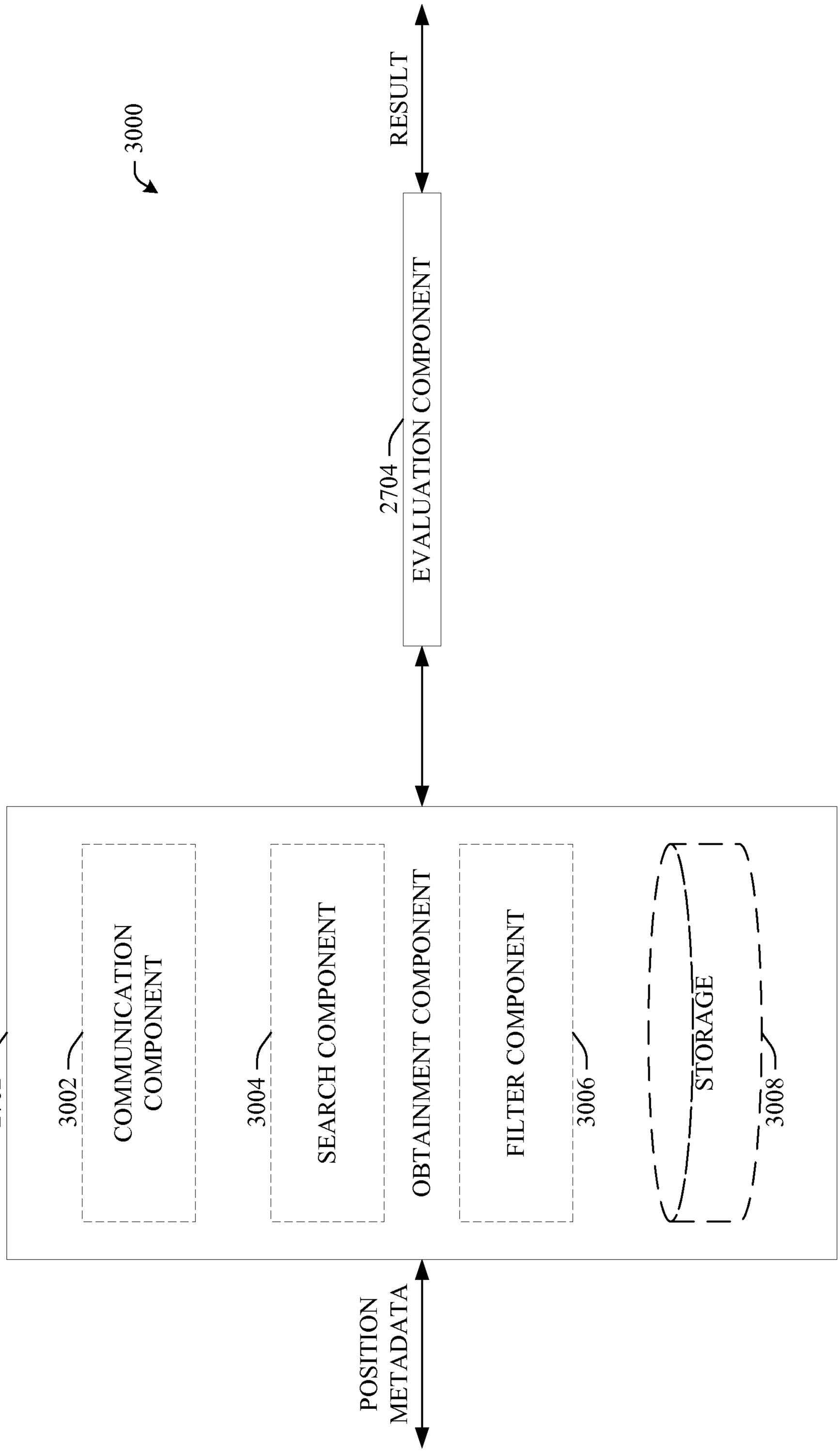

3000
RESULT
2704
EVALUATION COMPONENT
2702
3002
COMMUNICATION COMPONENT
3004
SEARCH COMPONENT
OBTAINMENT COMPONENT
FILTER COMPONENT
3006
STORAGE
3008
POSITION METADATA

FIG. 30

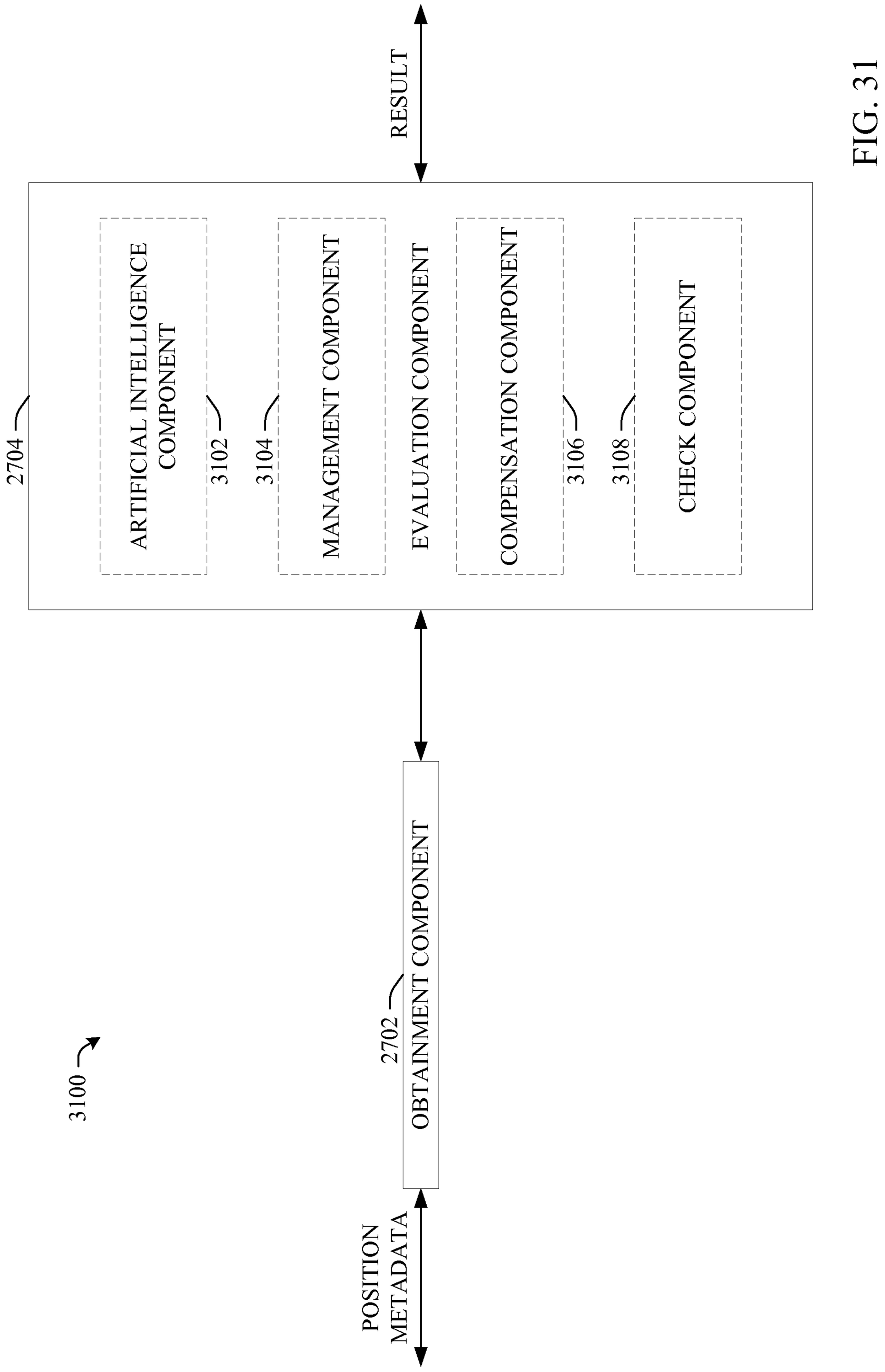

3100
POSITION METADATA
OBTAINMENT COMPONENT
2702
RESULT
2704
ARTIFICIAL INTELLIGENCE COMPONENT
3102
MANAGEMENT COMPONENT
3104
EVALUATION COMPONENT
COMPENSATION COMPONENT
3106
CHECK COMPONENT
3108

FIG. 31

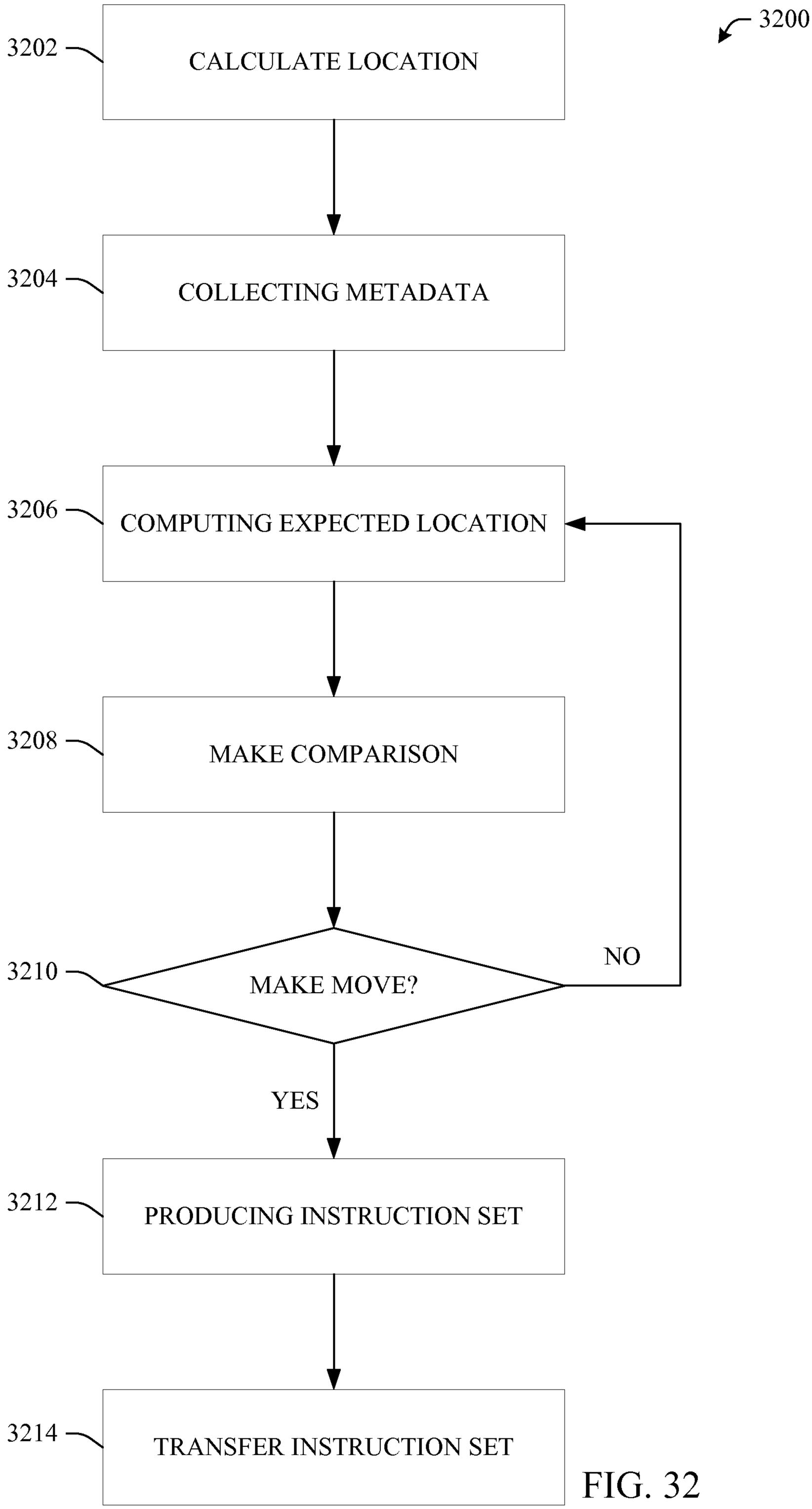

3200
3202
CALCULATE LOCATION
3204
COLLECTING METADATA
3206
COMPUTING EXPECTED LOCATION
3208
MAKE COMPARISON
3210
MAKE MOVE?
NO
YES
3212
PRODUCING INSTRUCTION SET
3214
TRANSFER INSTRUCTION SET

FIG. 32

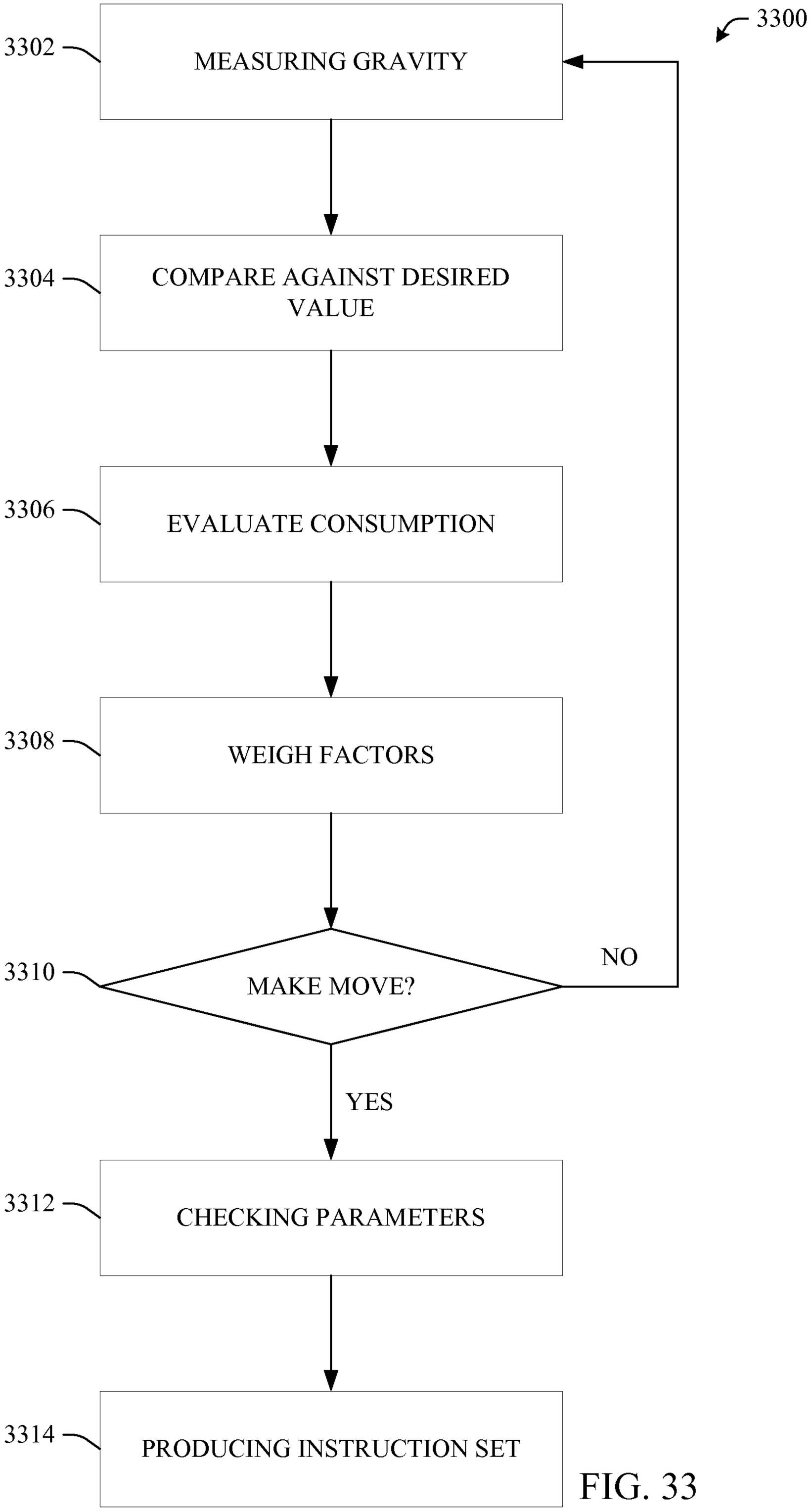

3300
3302
MEASURING GRAVITY
3304
COMPARE AGAINST DESIRED VALUE
3306
EVALUATE CONSUMPTION
3308
WEIGH FACTORS
3310
MAKE MOVE?
NO
YES
3312
CHECKING PARAMETERS
3314
PRODUCING INSTRUCTION SET

FIG. 33

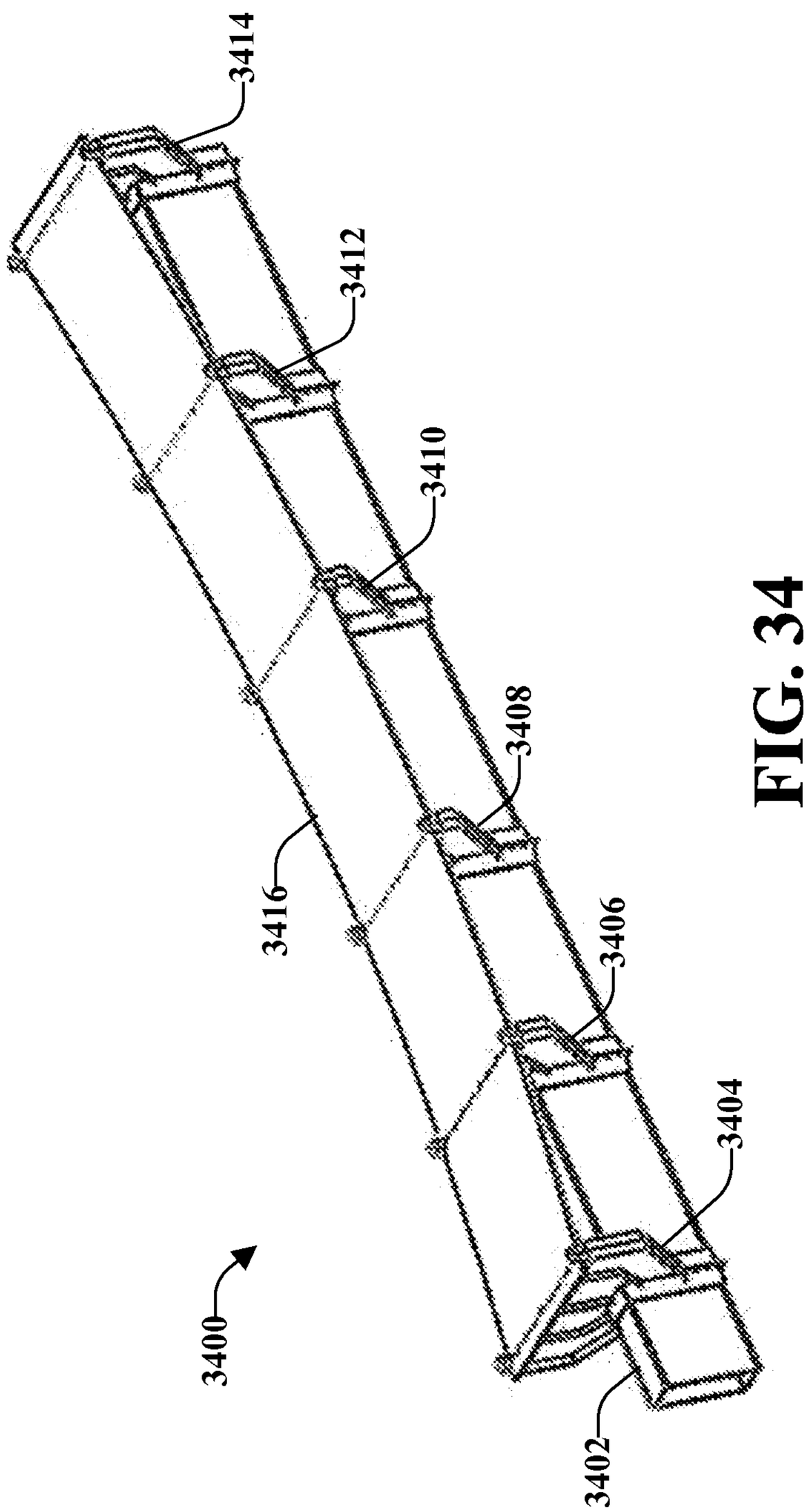


FIG. 34

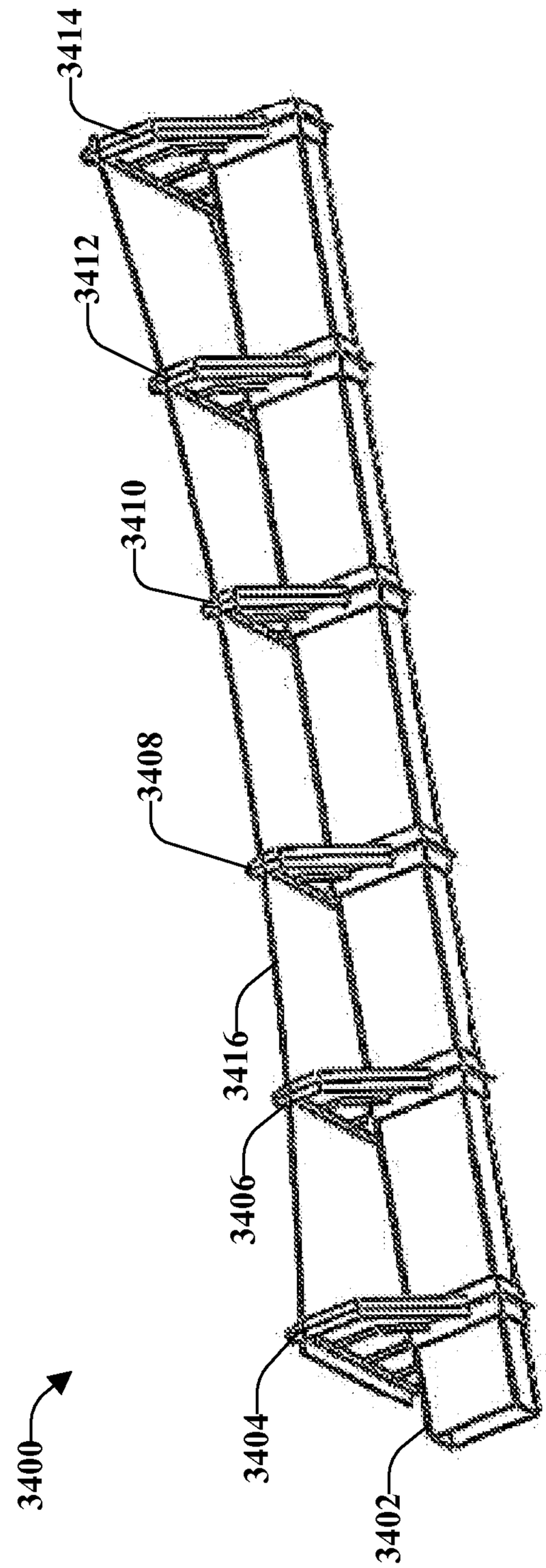


FIG. 35

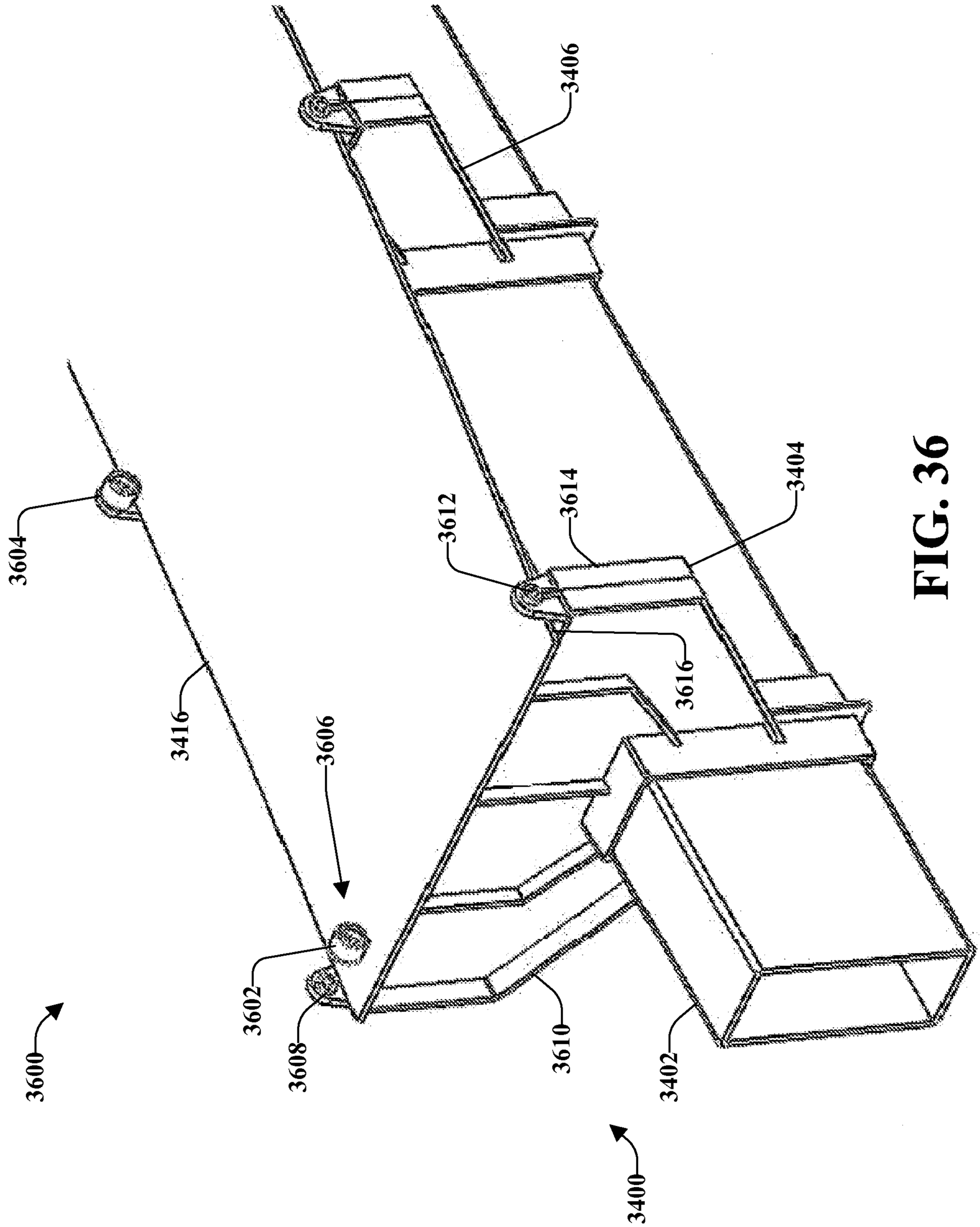

3600
3604
3416
3606
3602
3608
3610
3402
3400
3612
3614
3404
3406
3616

FIG. 36

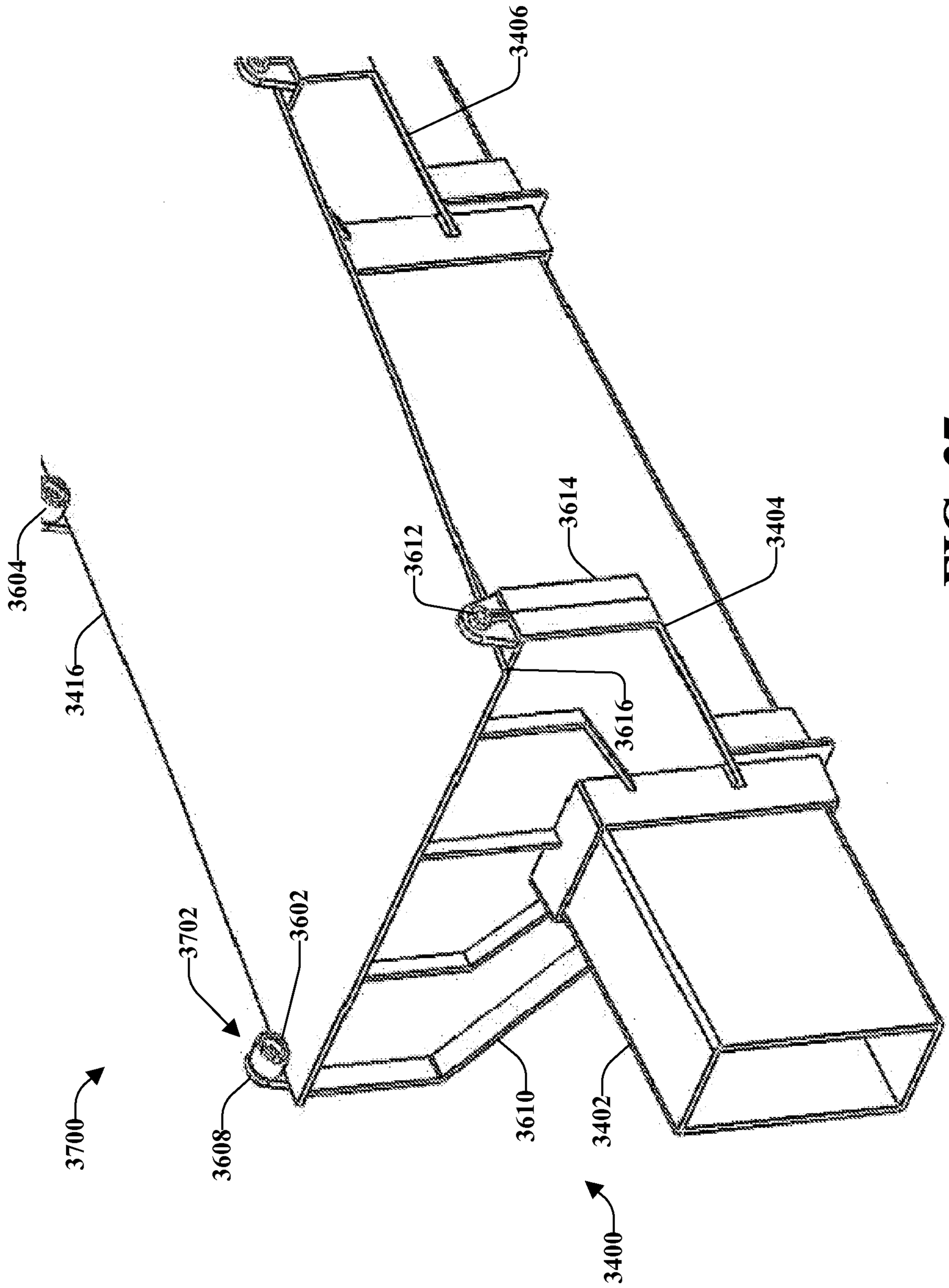

3406
3604
3416
3700
3702
3602
3608
3612
3614
3404
3616
3610
3402
3400

FIG. 37

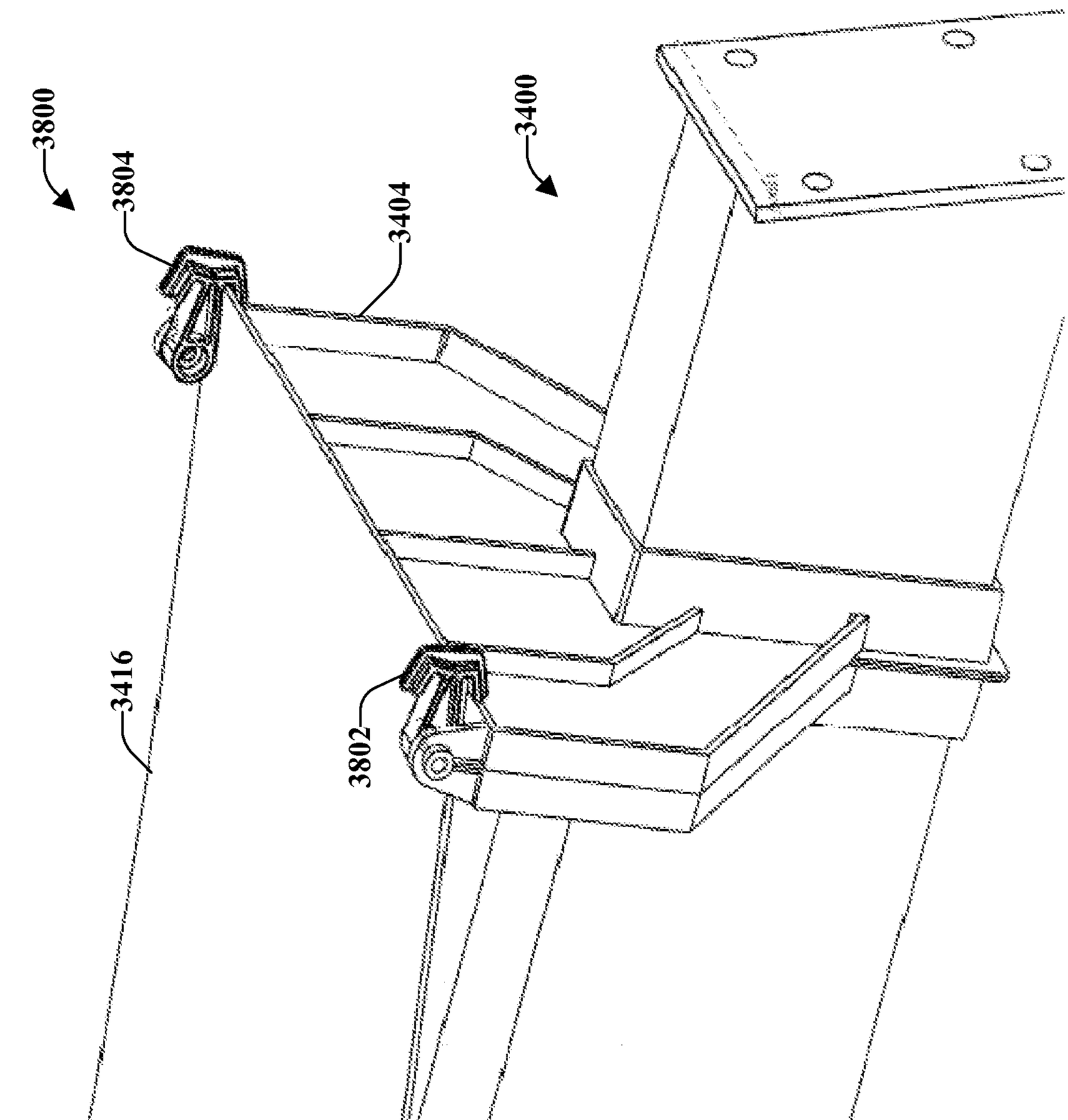


FIG. 38

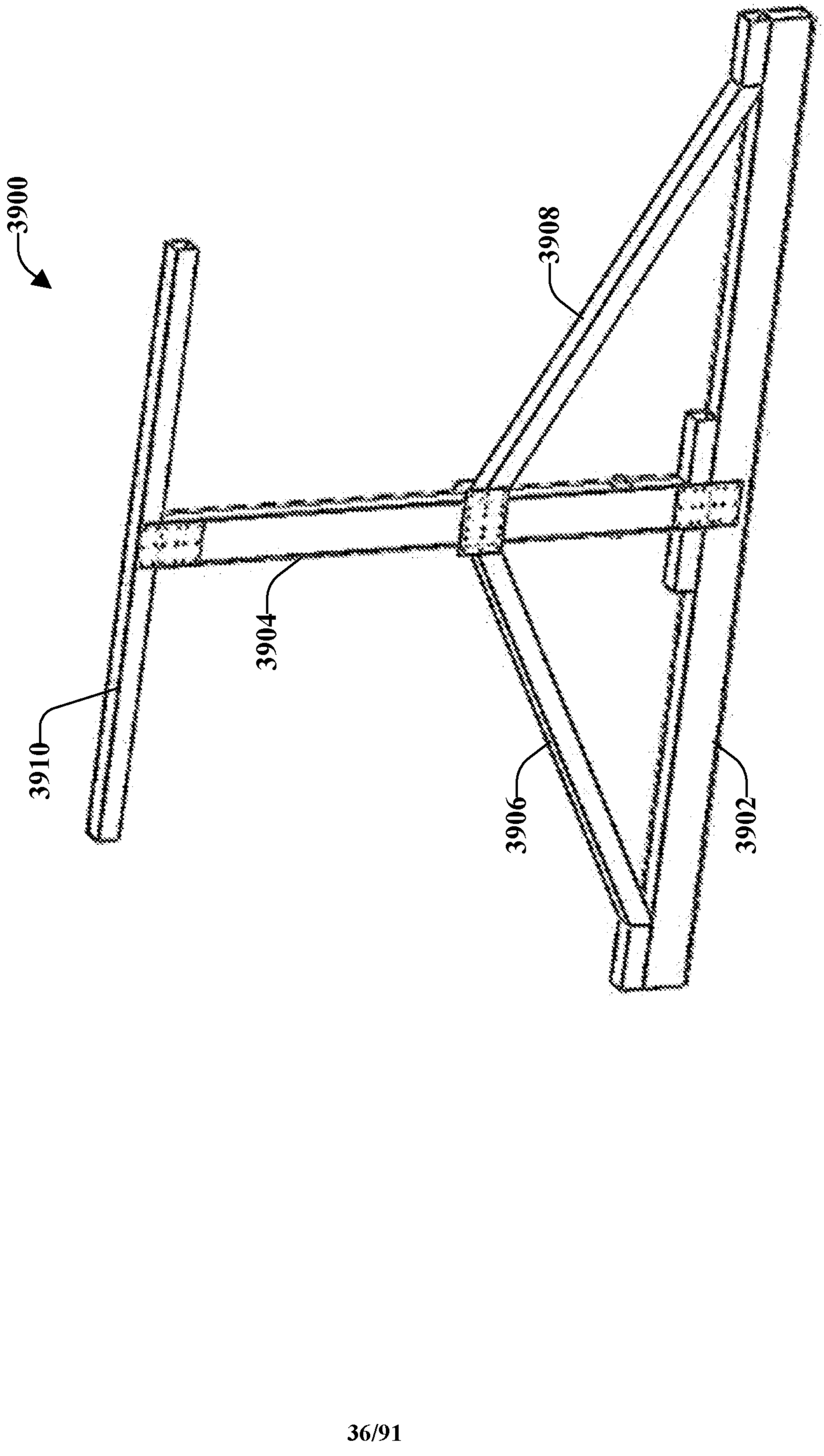


FIG. 39

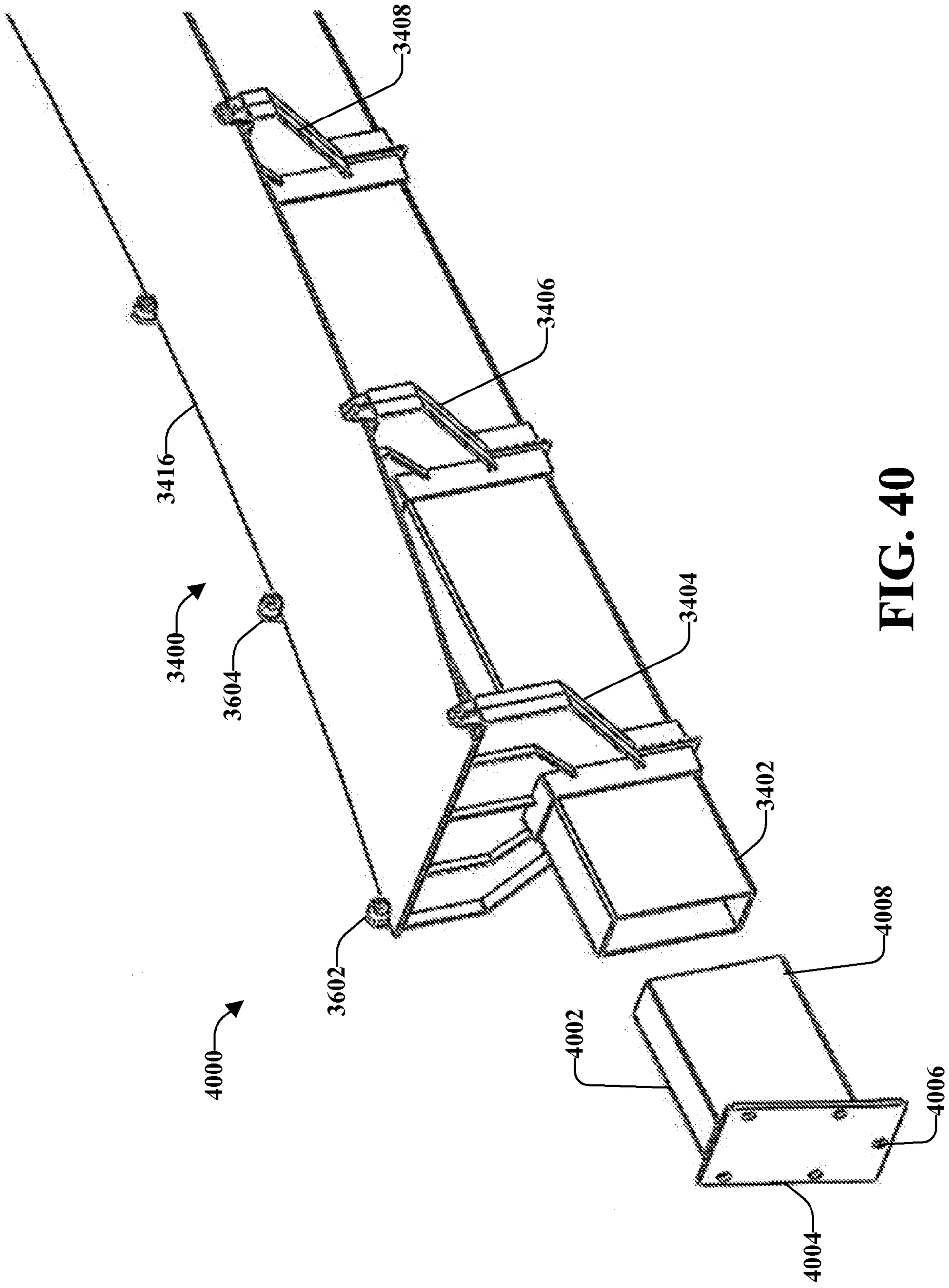

3408
3406
3404
3402
3416
3400
3604
3602
4000
4008
4002
4006
4004

FIG. 40

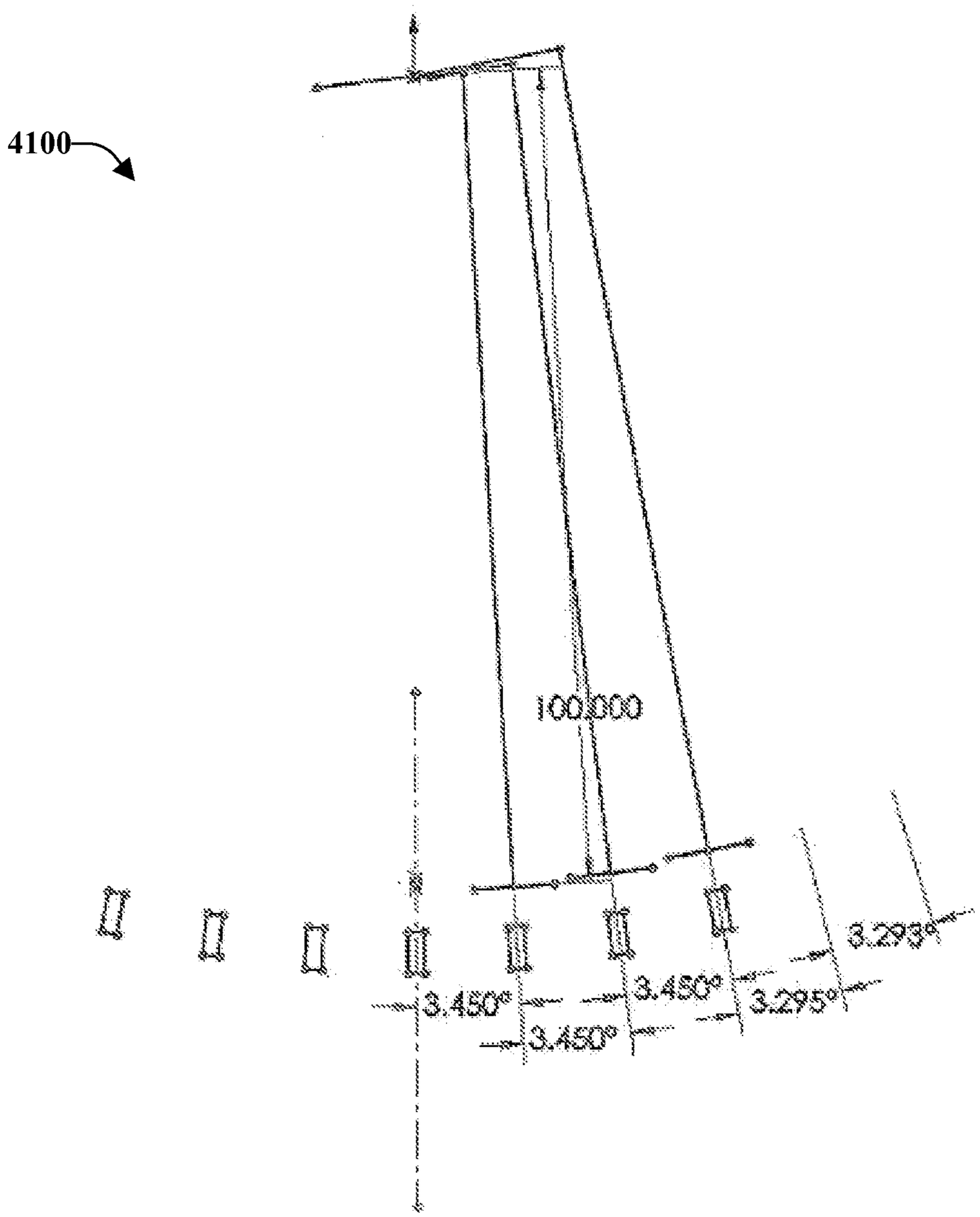


FIG. 41

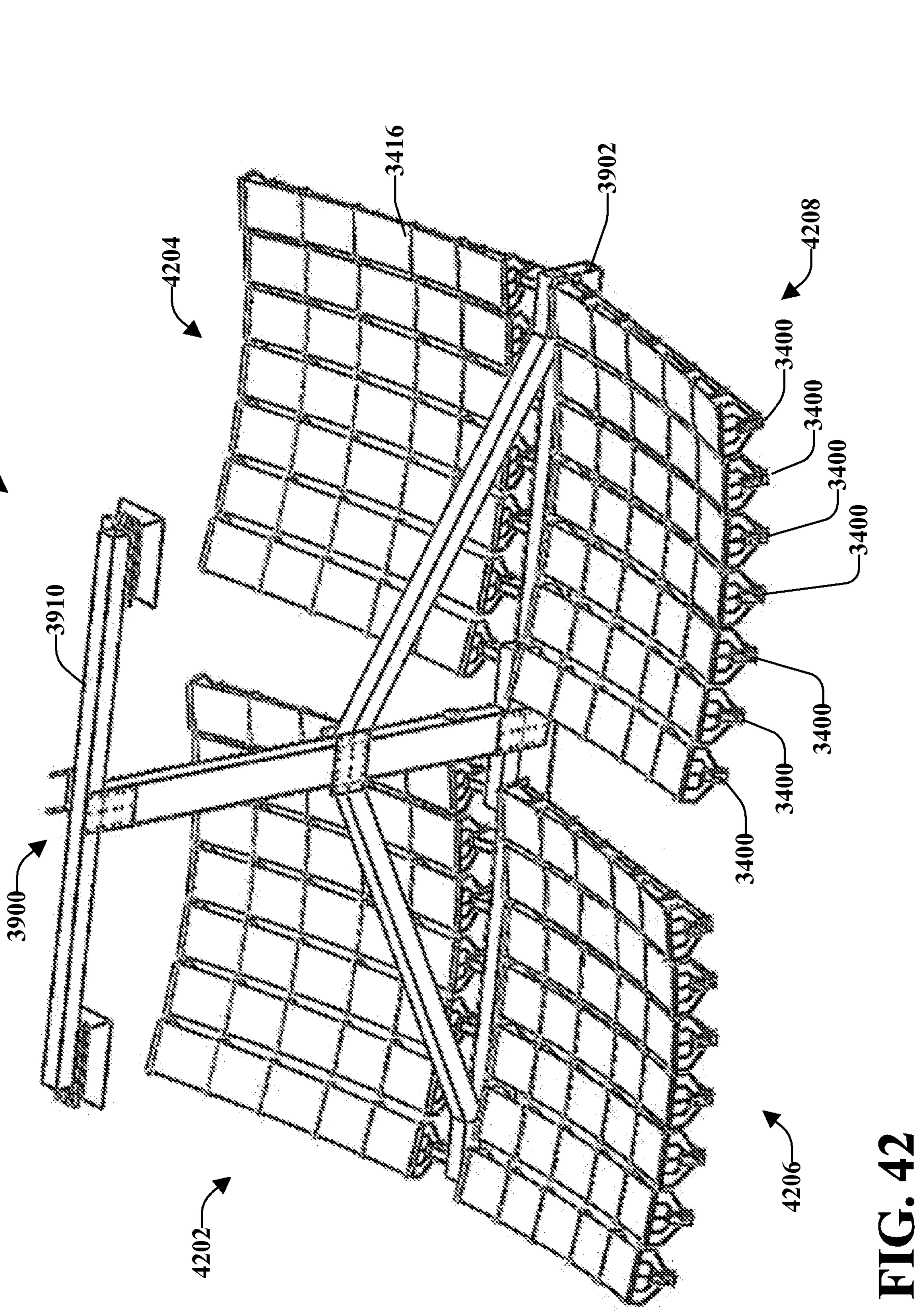

4200
3910
3900
4202
4204
3412
3902
4208
3400
3400
3400
3400
3400
3400
4206

FIG. 42

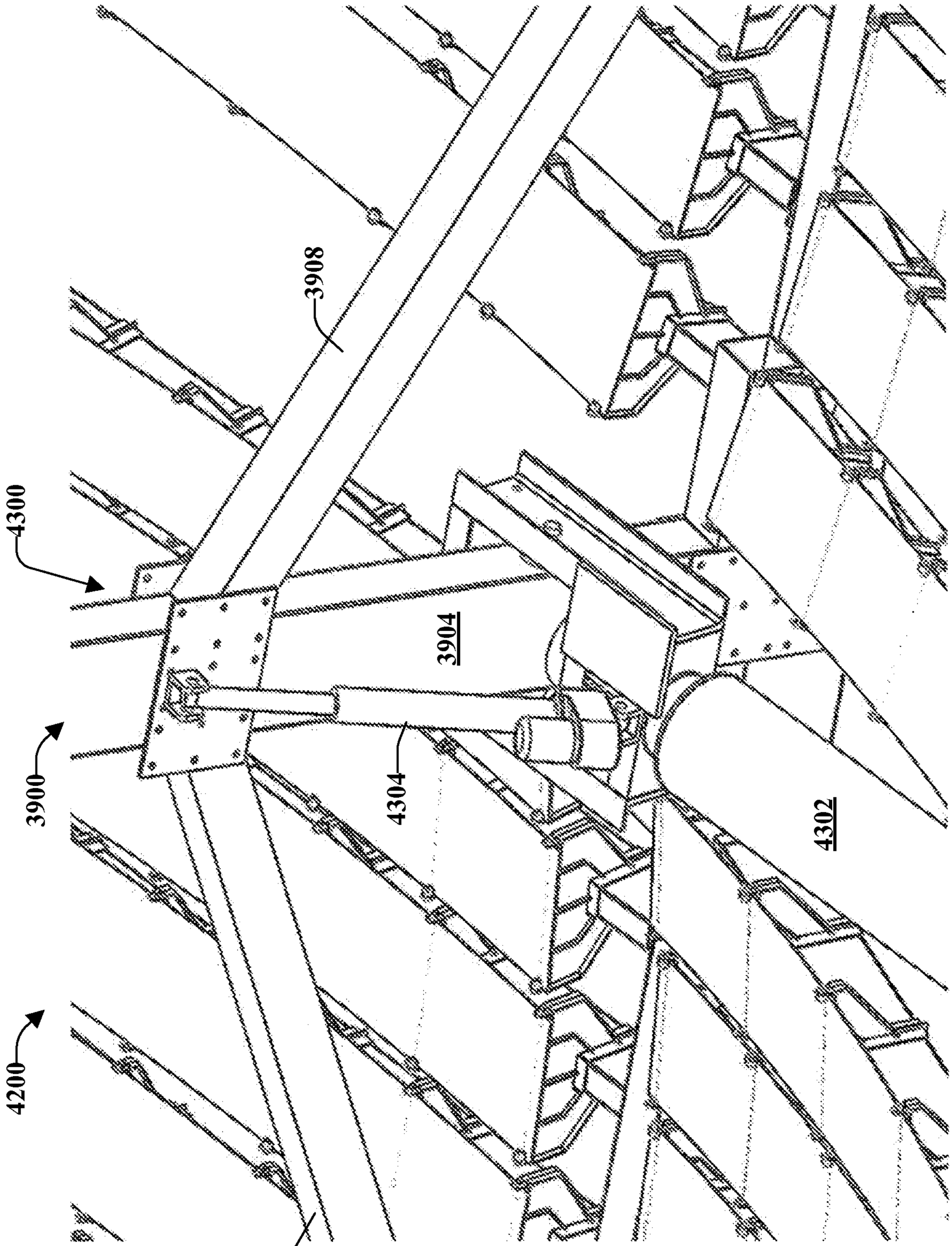


FIG. 43

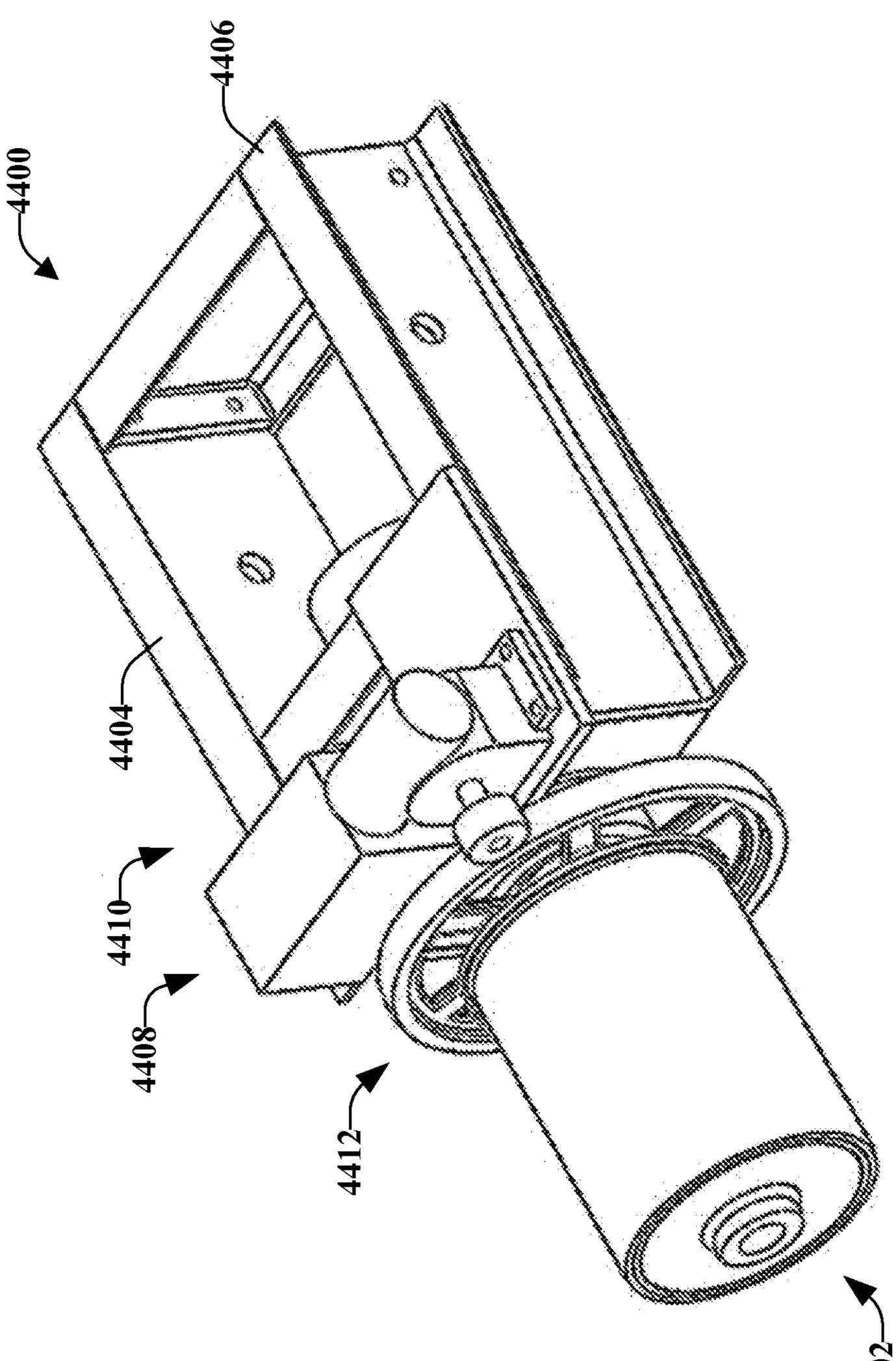


FIG. 44

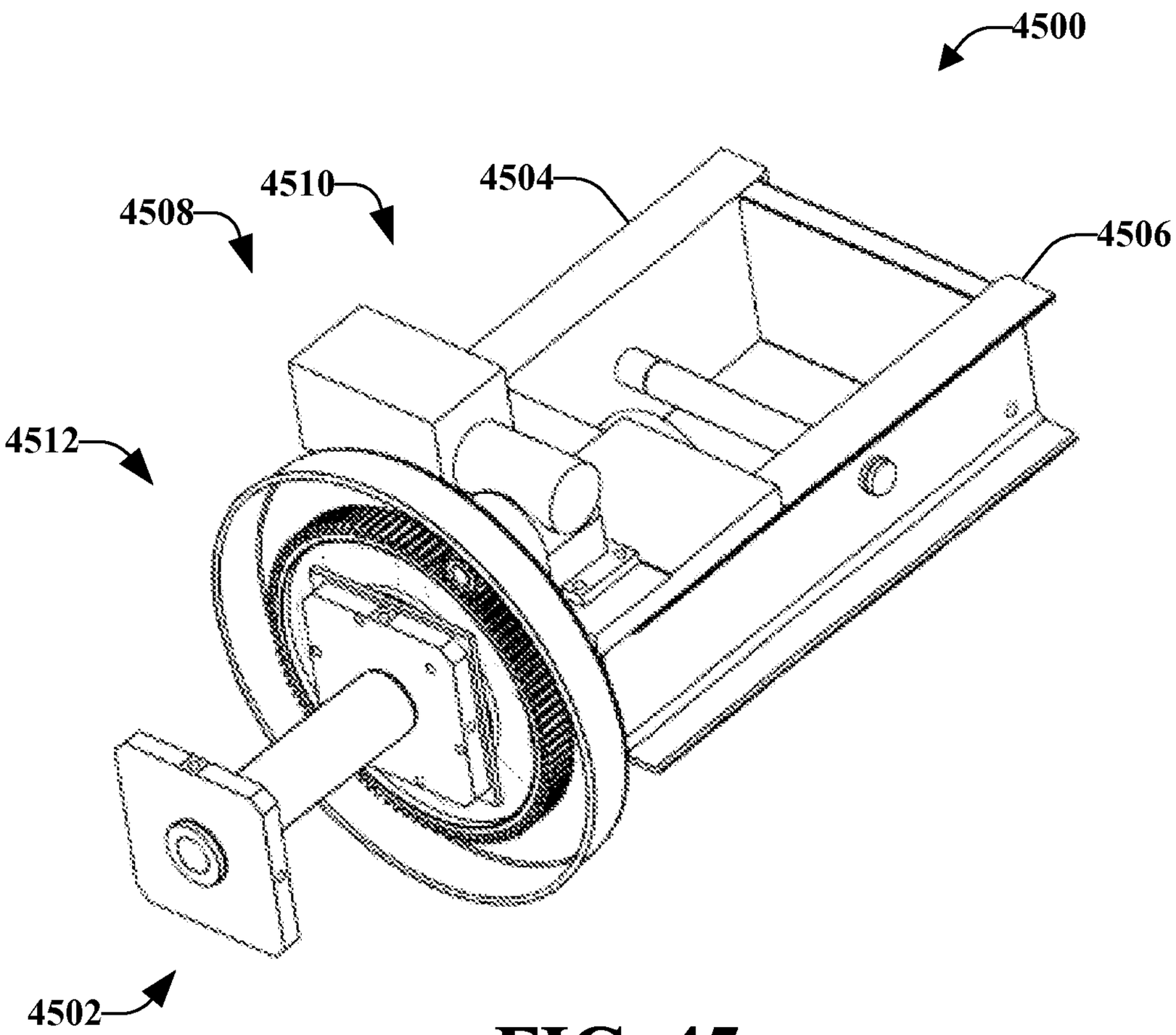


FIG. 45

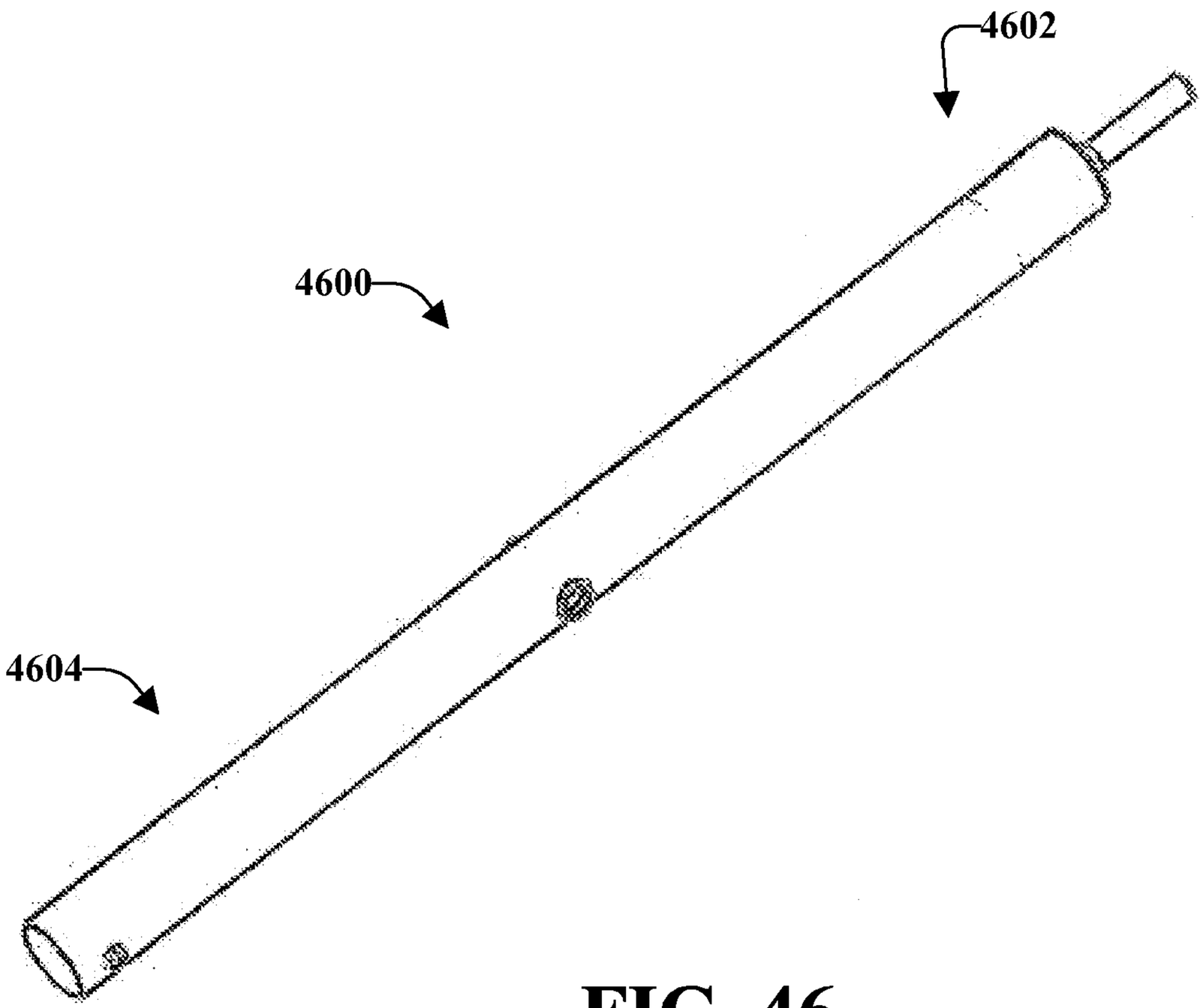


FIG. 46

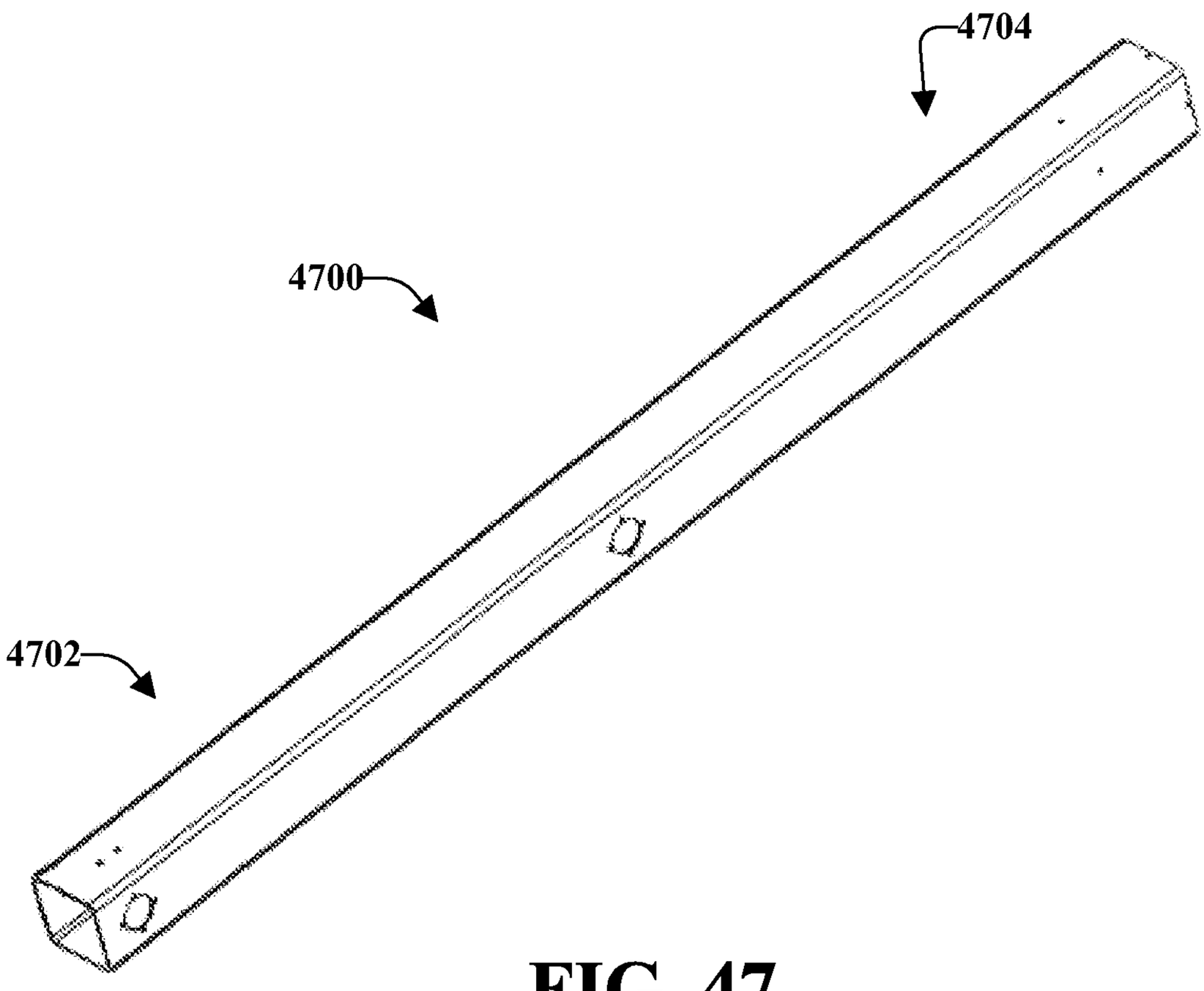


FIG. 47

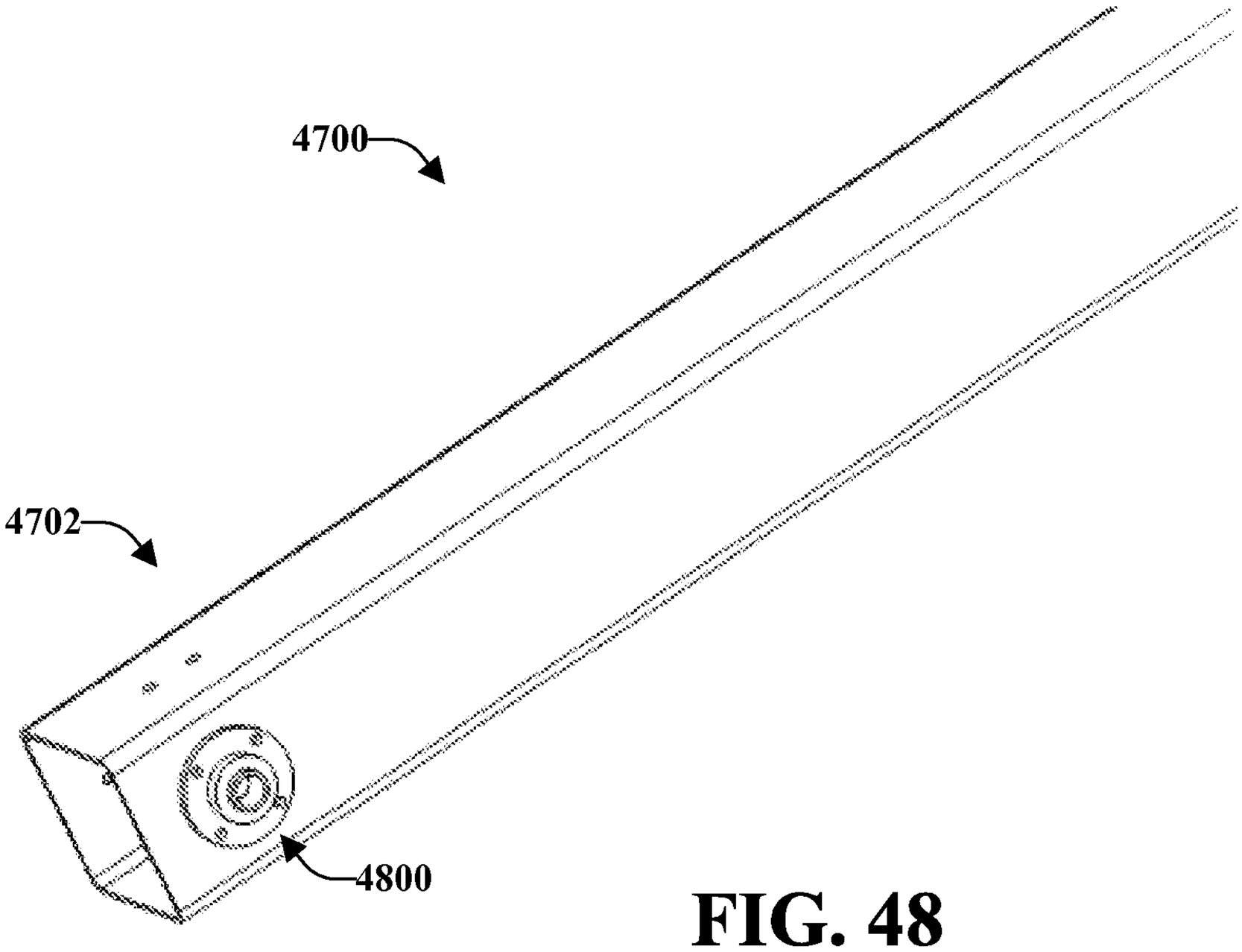


FIG. 48

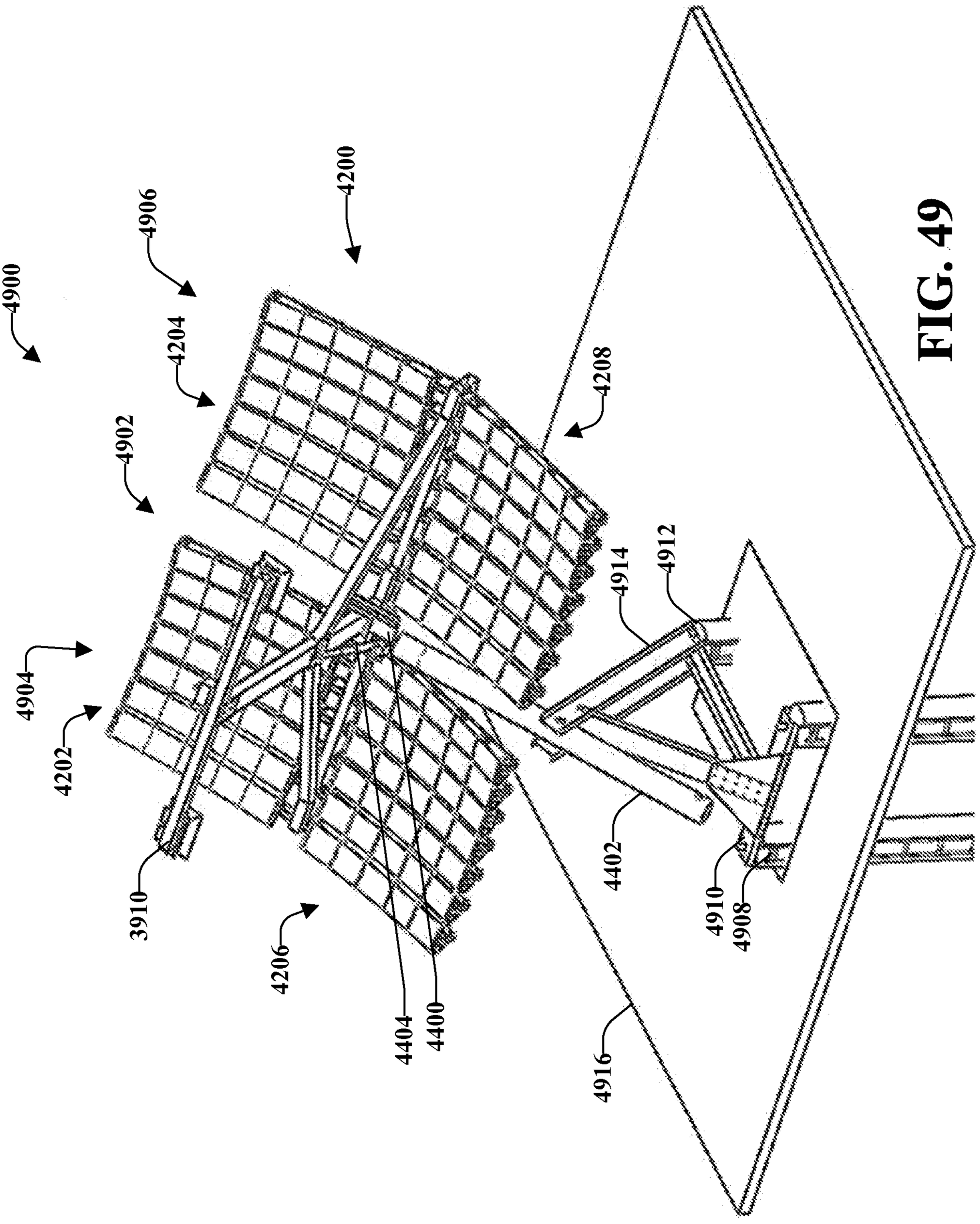

4900
4906
4200
4204
4902
4208
4904
4202
3910
4206
4404
4400
4914
4912
4402
4910
4908
4916

FIG. 49

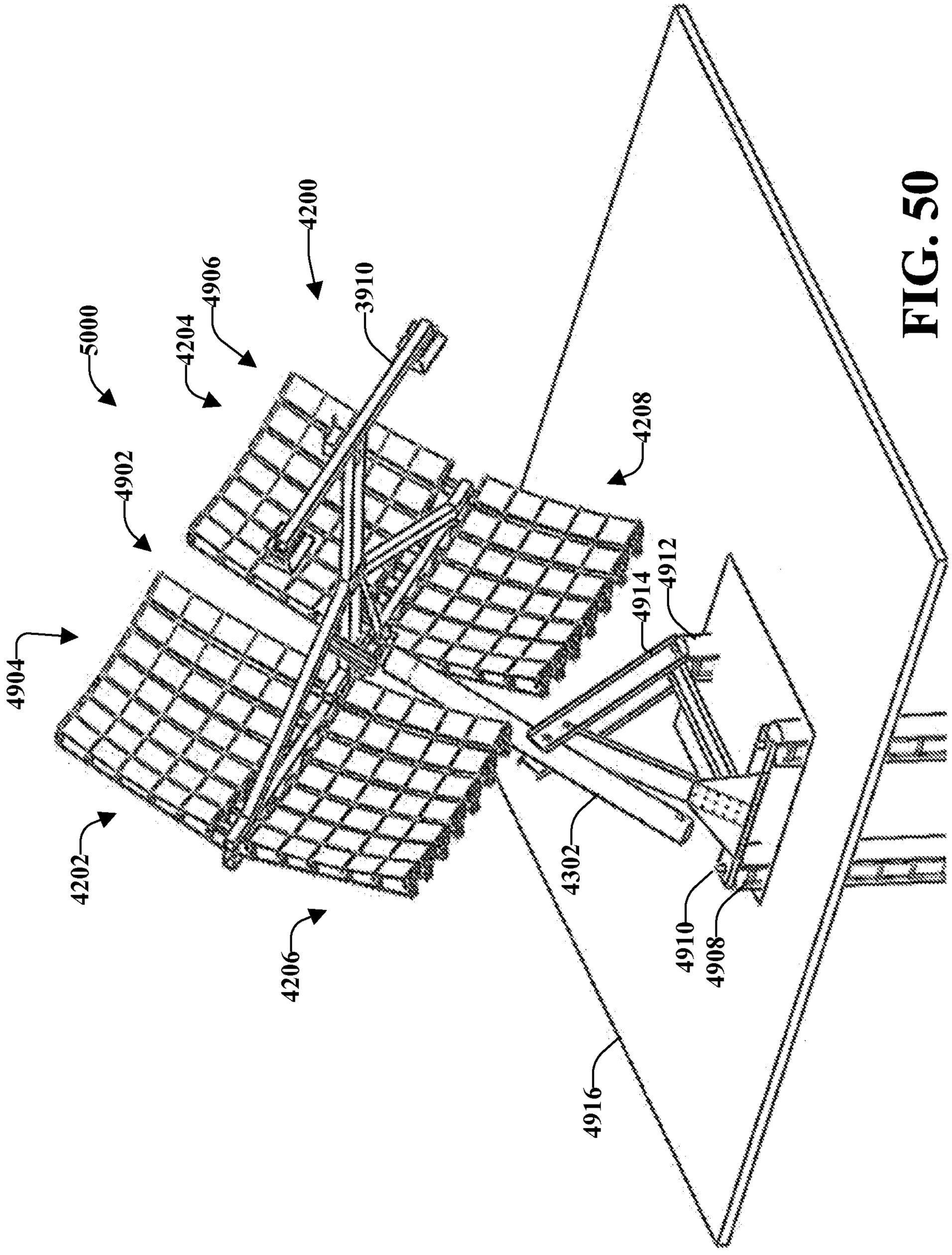

5000
4902
4904
4202
4206
4204
4906
4200
3910
4208
4914
4912
4302
4910
4908
4916

FIG. 50

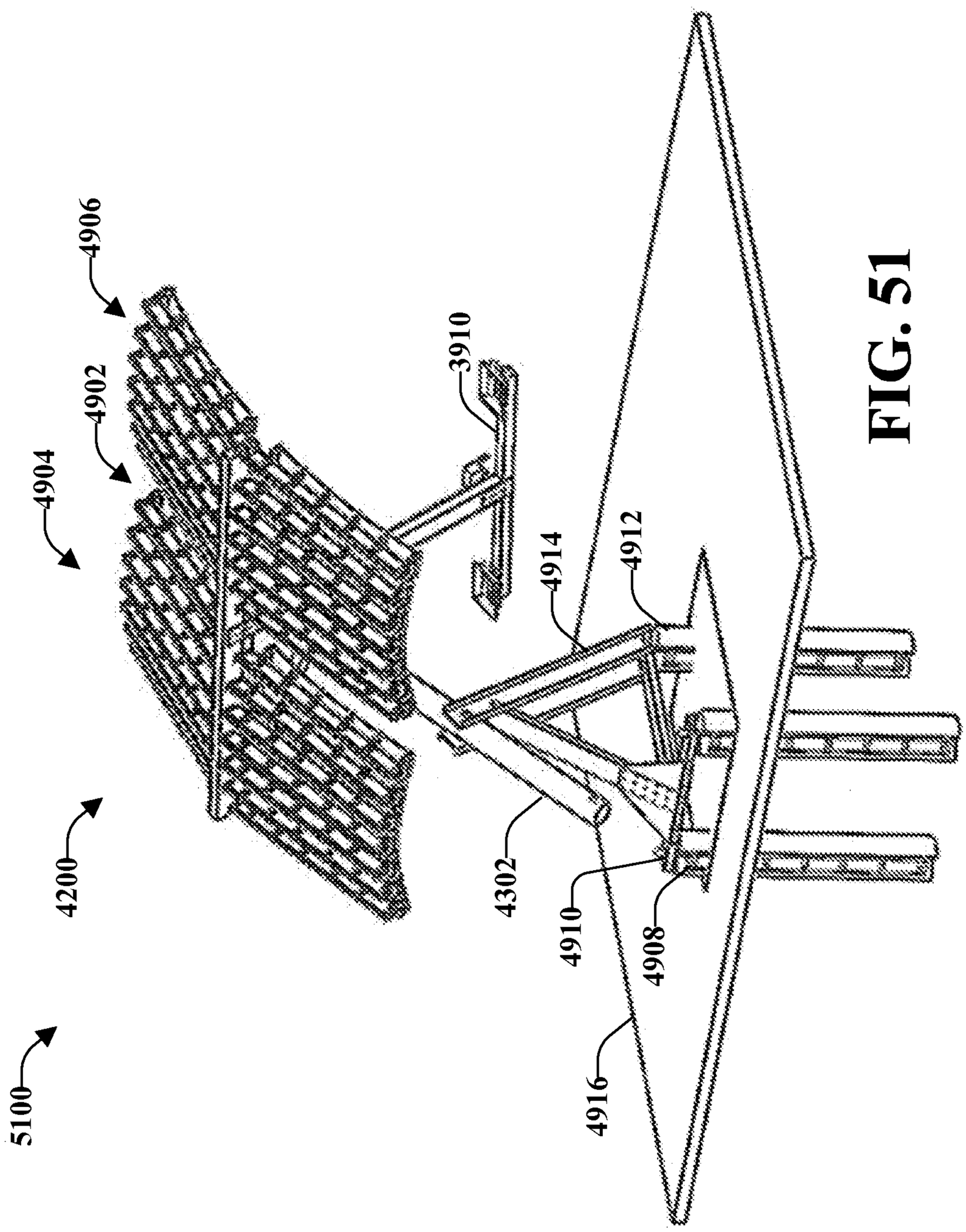


FIG. 51

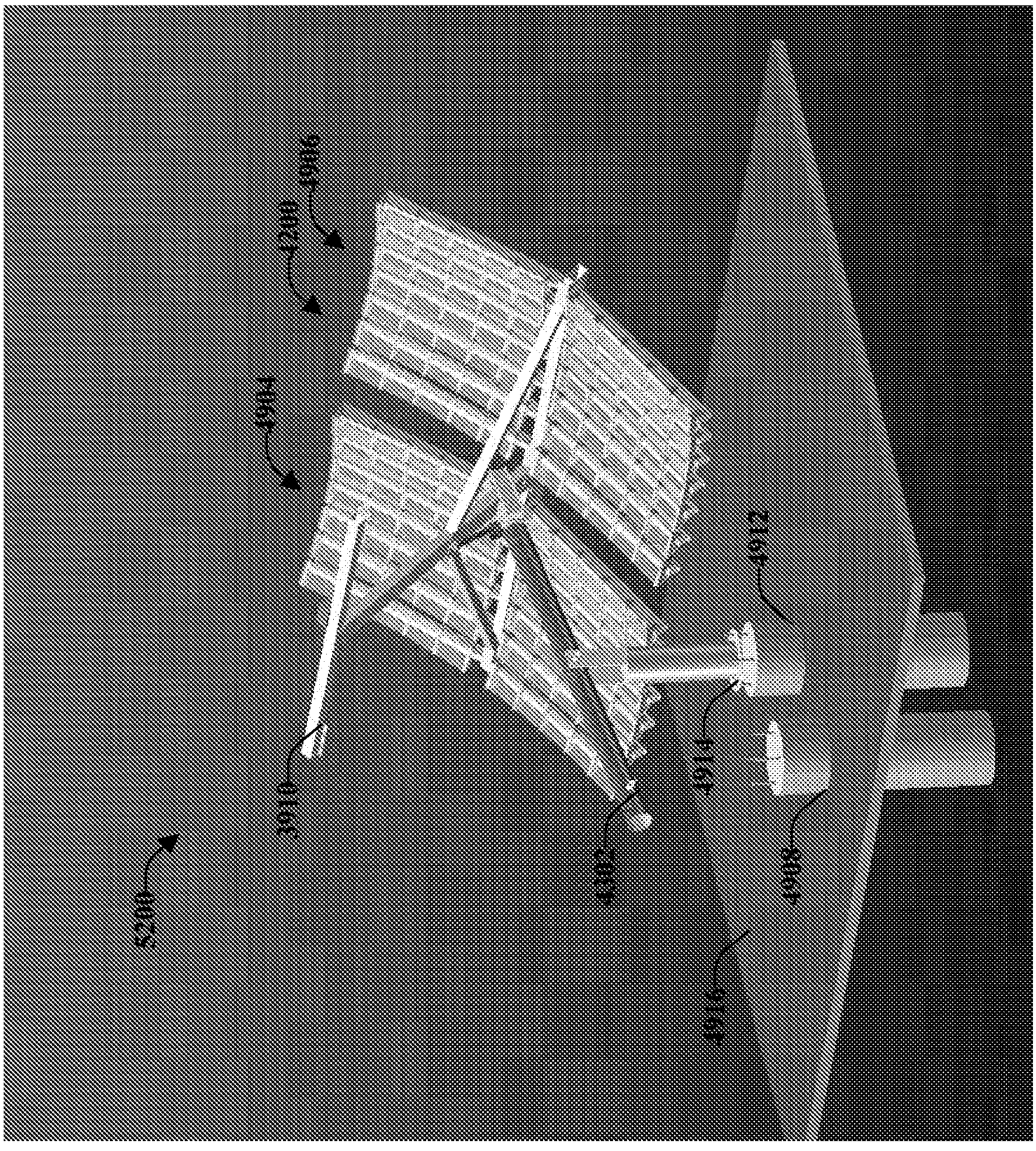


FIG. 52

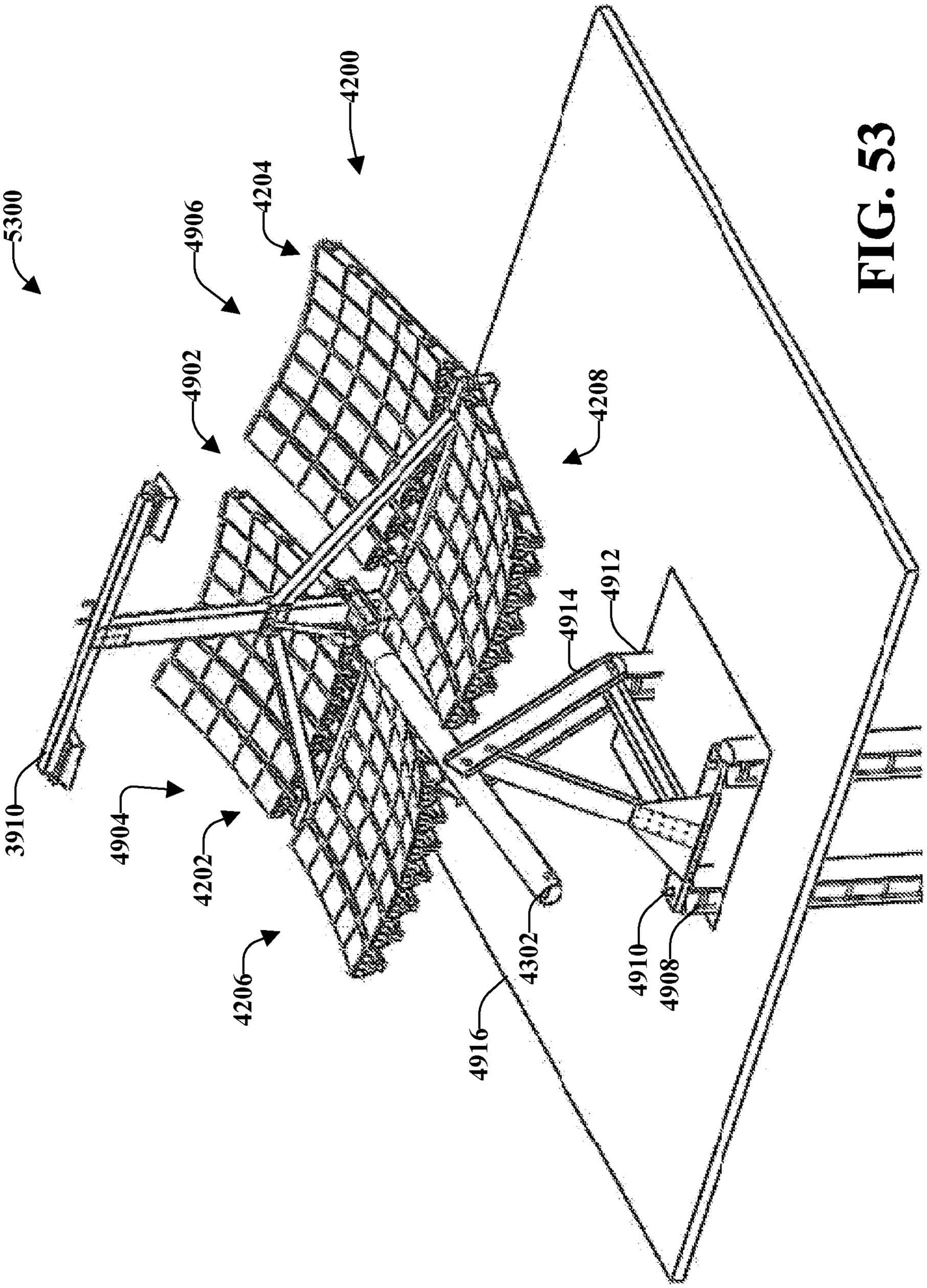

5300
4200
4204
4906
4902
4208
4912
4914
3910
4904
4202
4206
4302
4916
4910
4908

FIG. 53

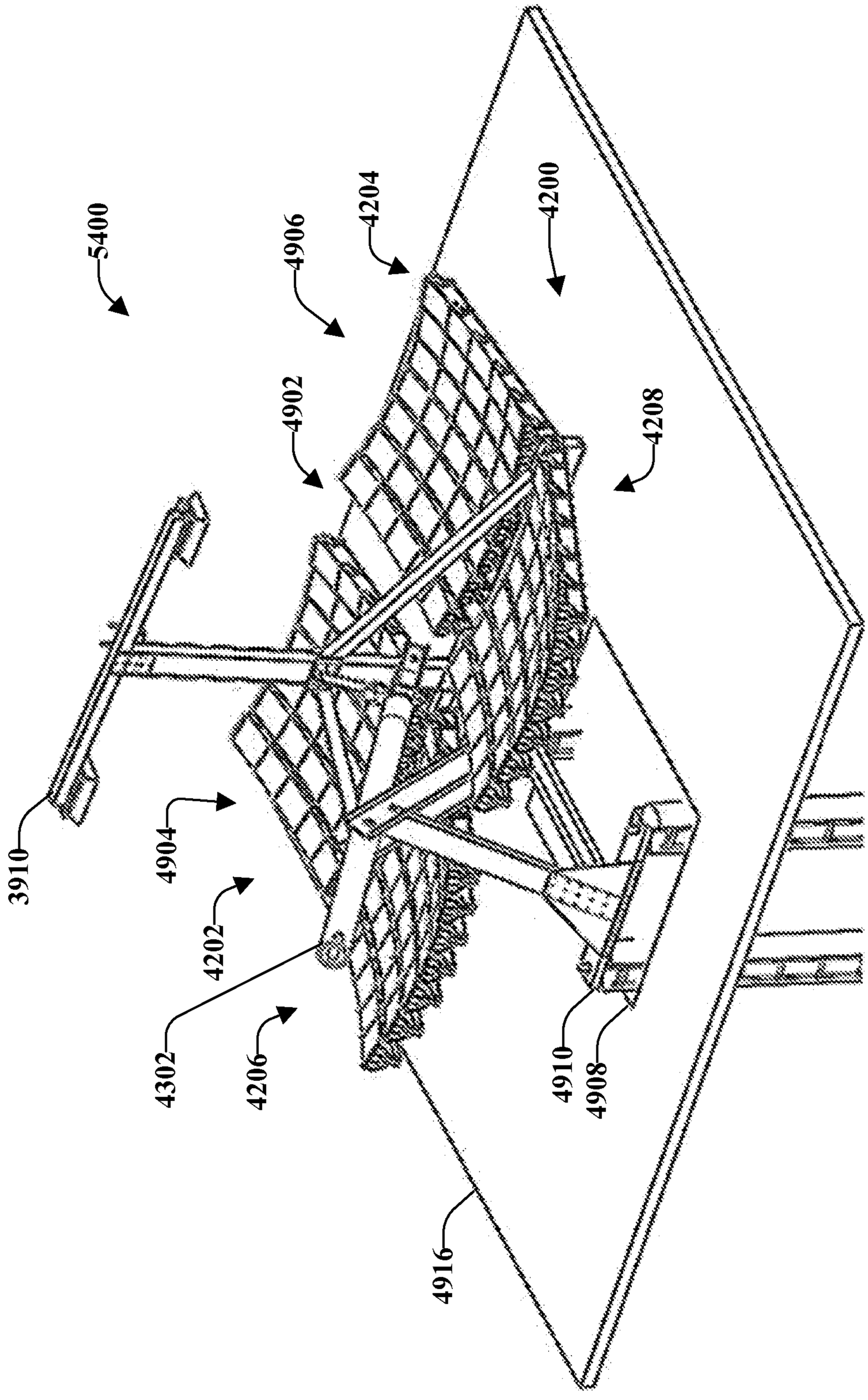

5400
4906
4204
4200
4902
4208
3910
4904
4202
4302
4206
4910
4908
4916

FIG. 54

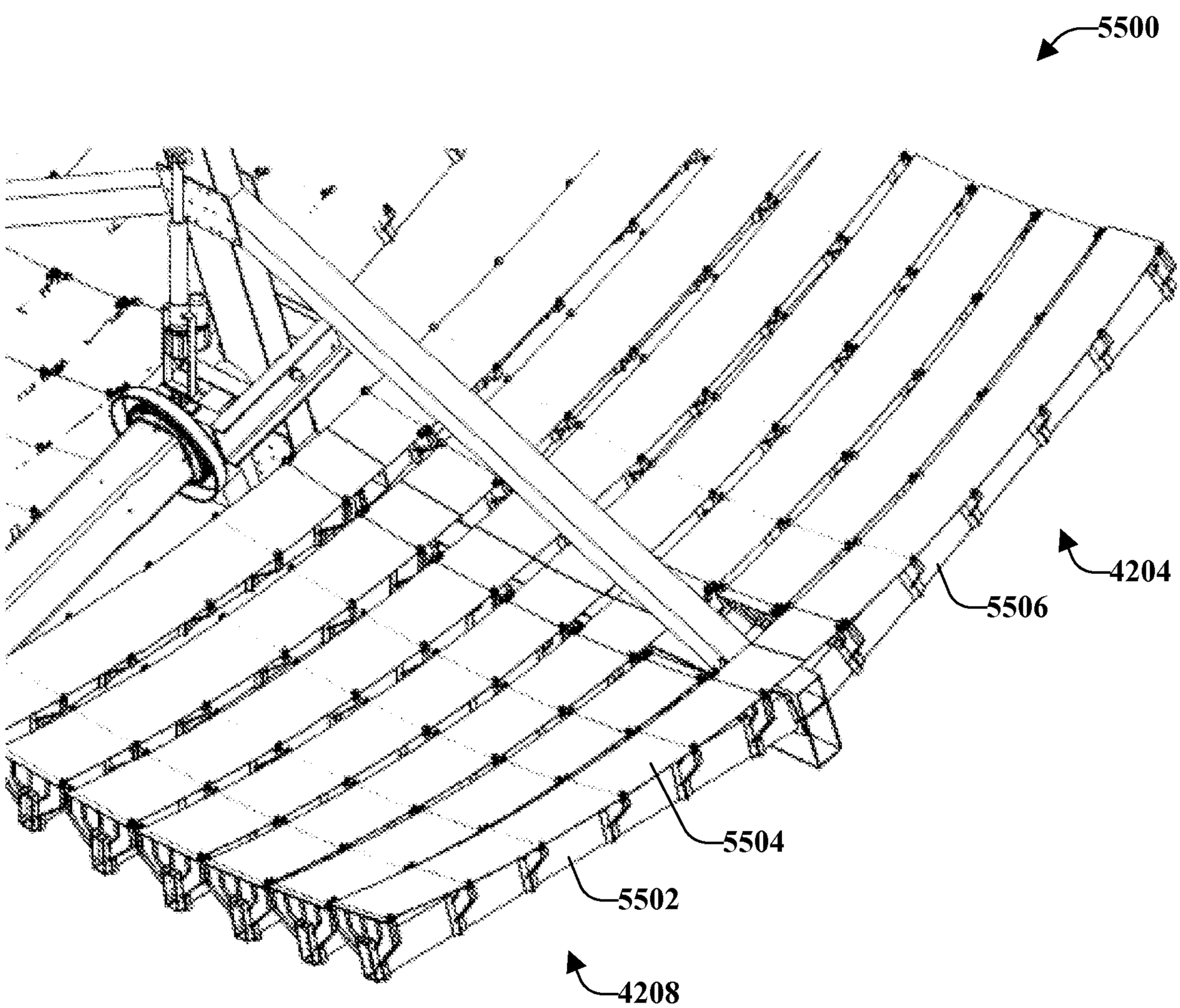


FIG. 55

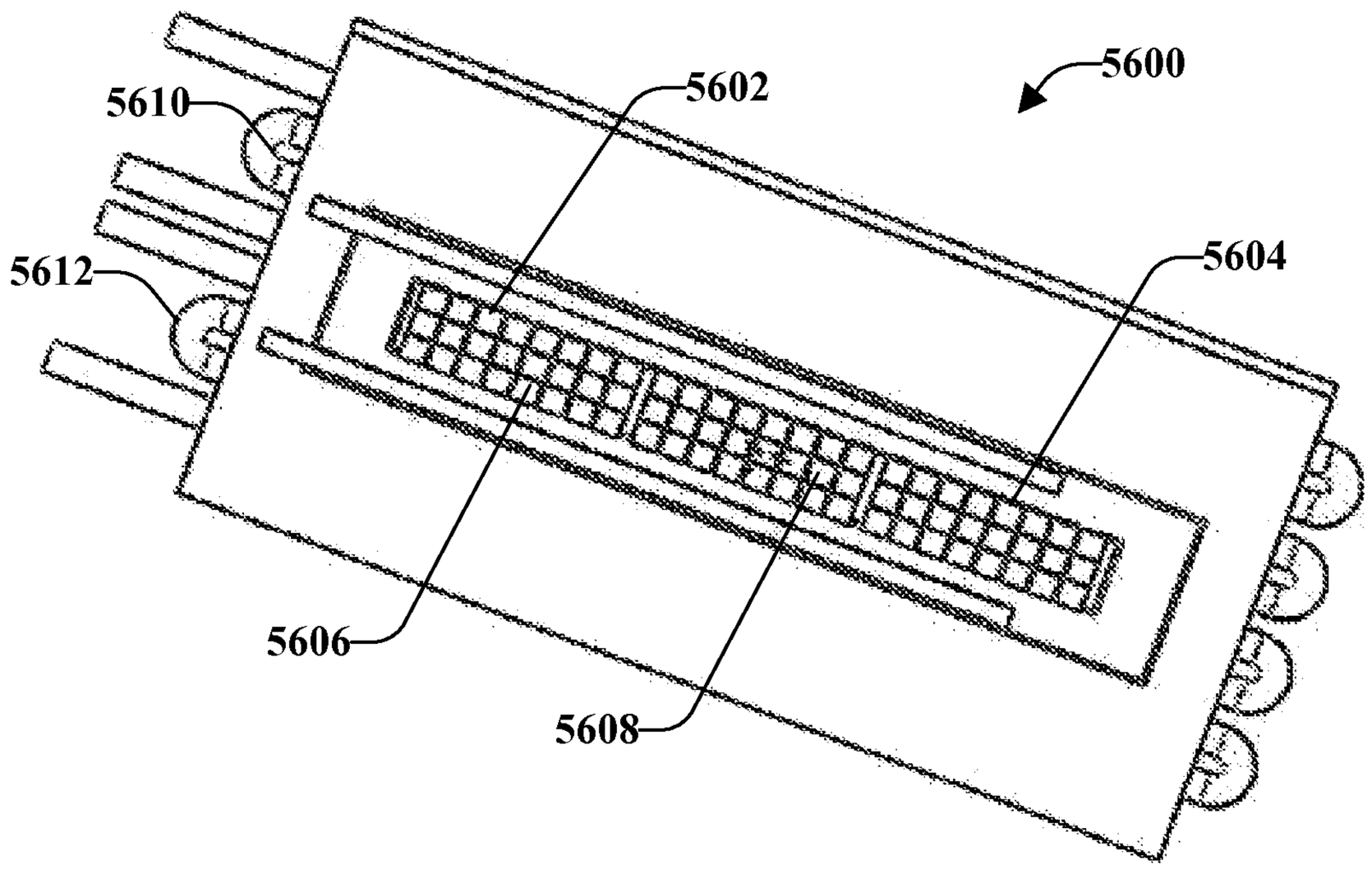


FIG. 56

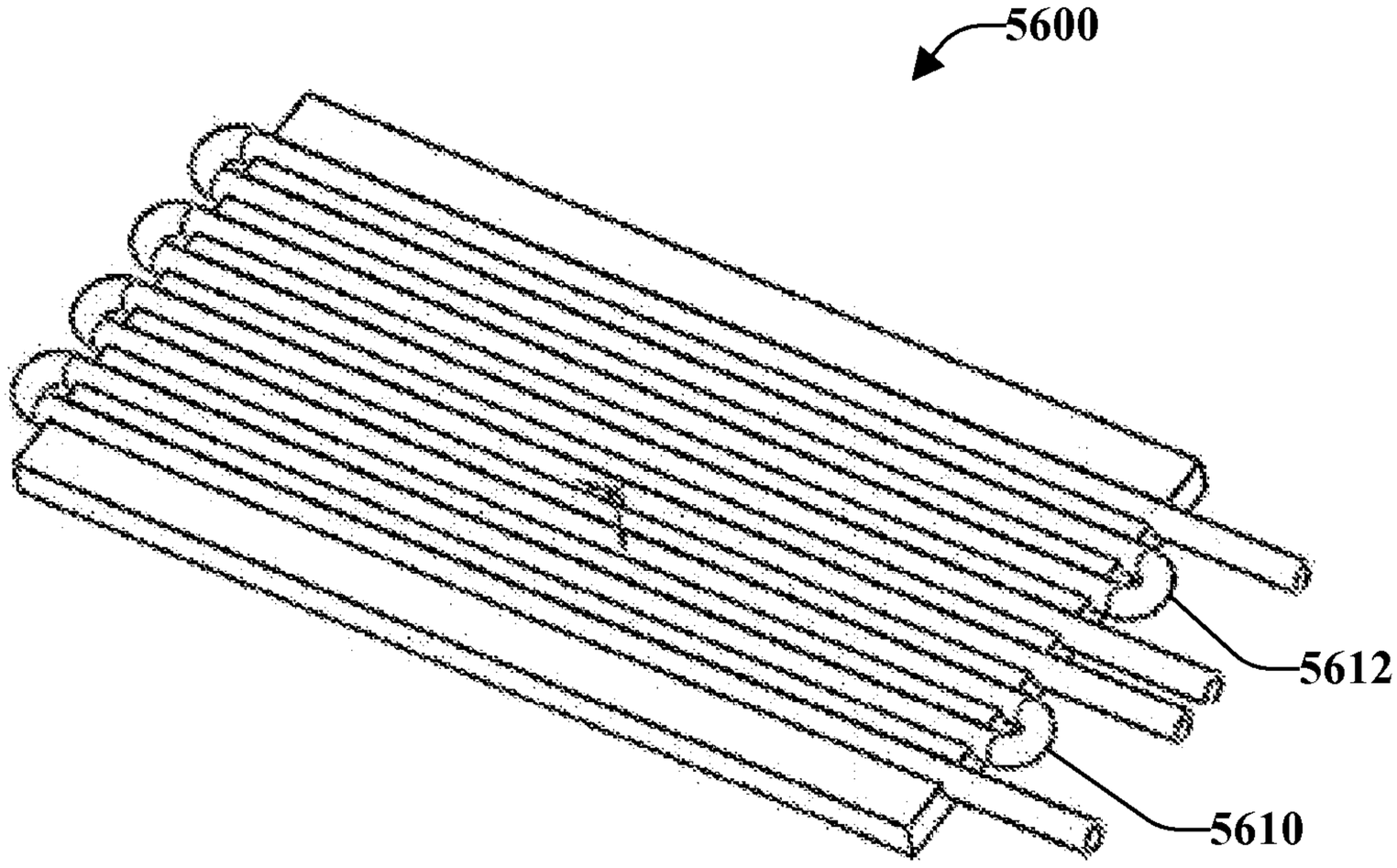


FIG. 57

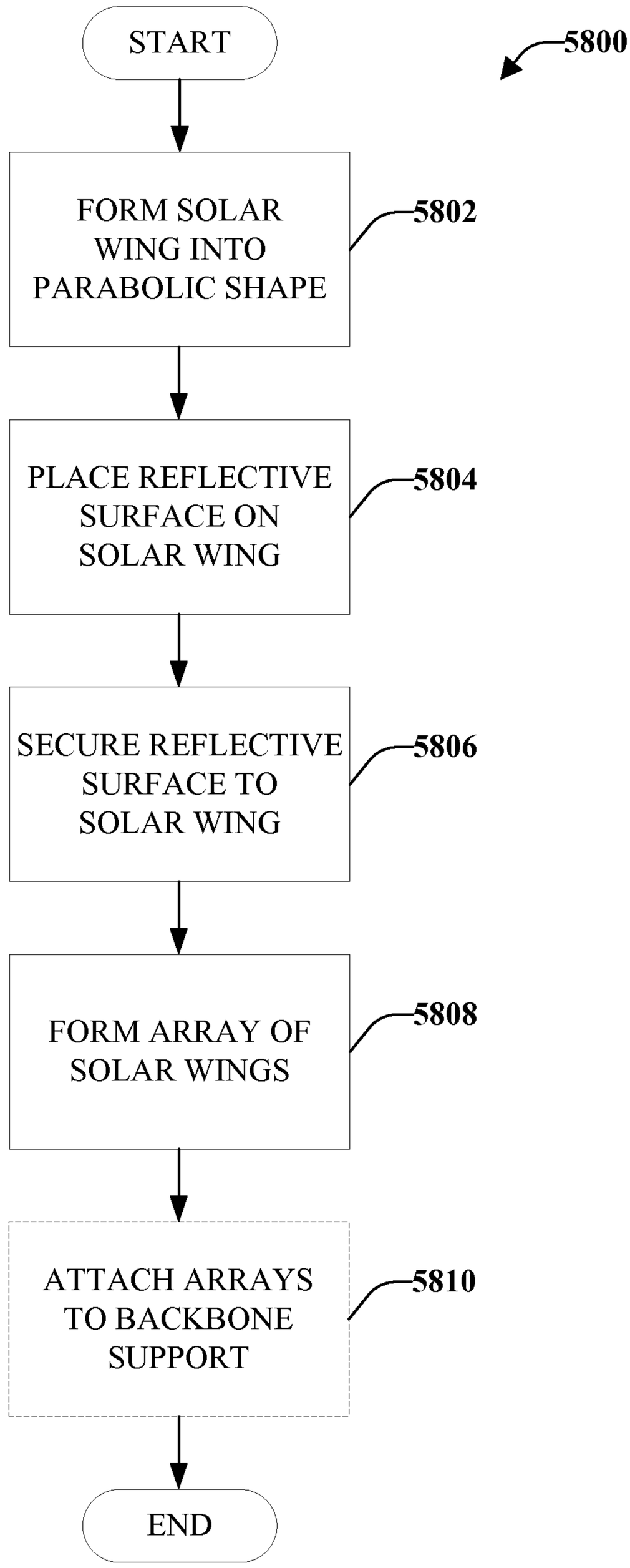

START
5800
FORM SOLAR WING INTO PARABOLIC SHAPE
5802
PLACE REFLECTIVE SURFACE ON SOLAR WING
5804
SECURE REFLECTIVE SURFACE TO SOLAR WING
5806
FORM ARRAY OF SOLAR WINGS
5808
ATTACH ARRAYS TO BACKBONE SUPPORT
5810
END

FIG. 58

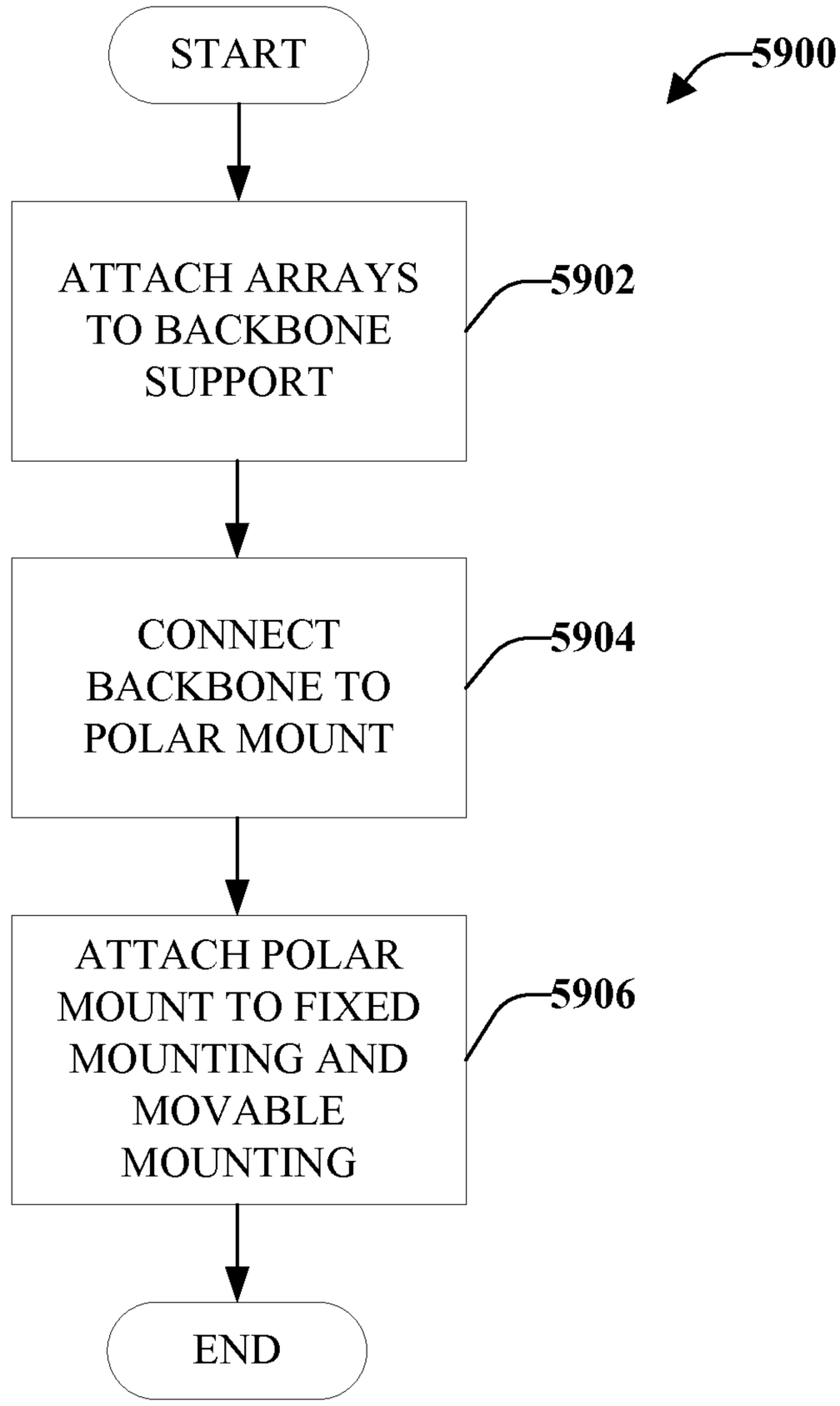

START
5900
ATTACH ARRAYS TO BACKBONE SUPPORT
5902
CONNECT BACKBONE TO POLAR MOUNT
5904
ATTACH POLAR MOUNT TO FIXED MOUNTING AND MOVABLE MOUNTING
5906
END

FIG. 59

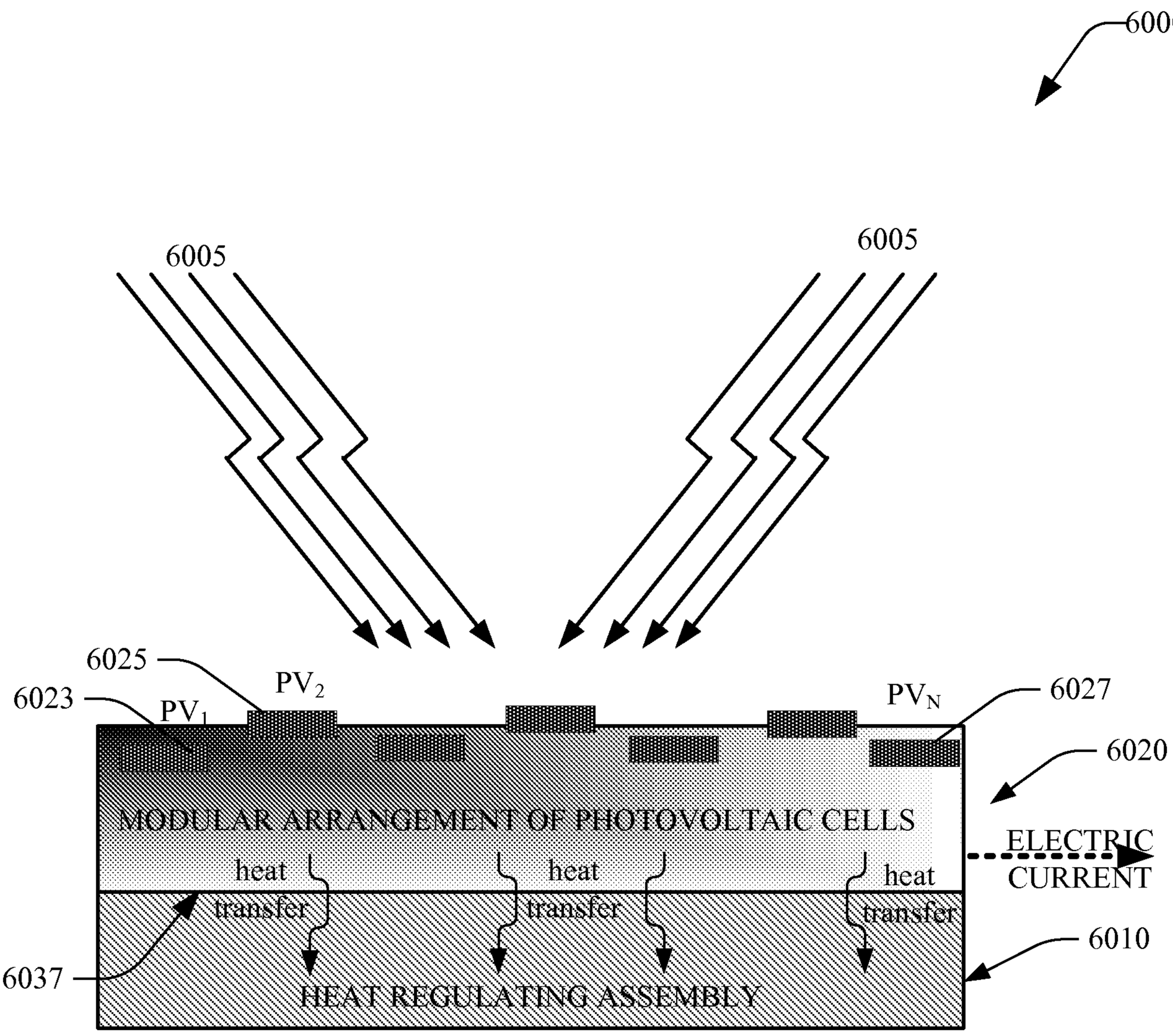

6000
6005
6005
6025
6023
PV1
PV2
PVN
6027
6020
MODULAR ARRANGEMENT OF PHOTOVOLTAIC CELLS
ELECTRIC CURRENT
heat transfer
heat transfer
heat transfer
6010
6037
HEAT REGULATING ASSEMBLY

FIG. 60

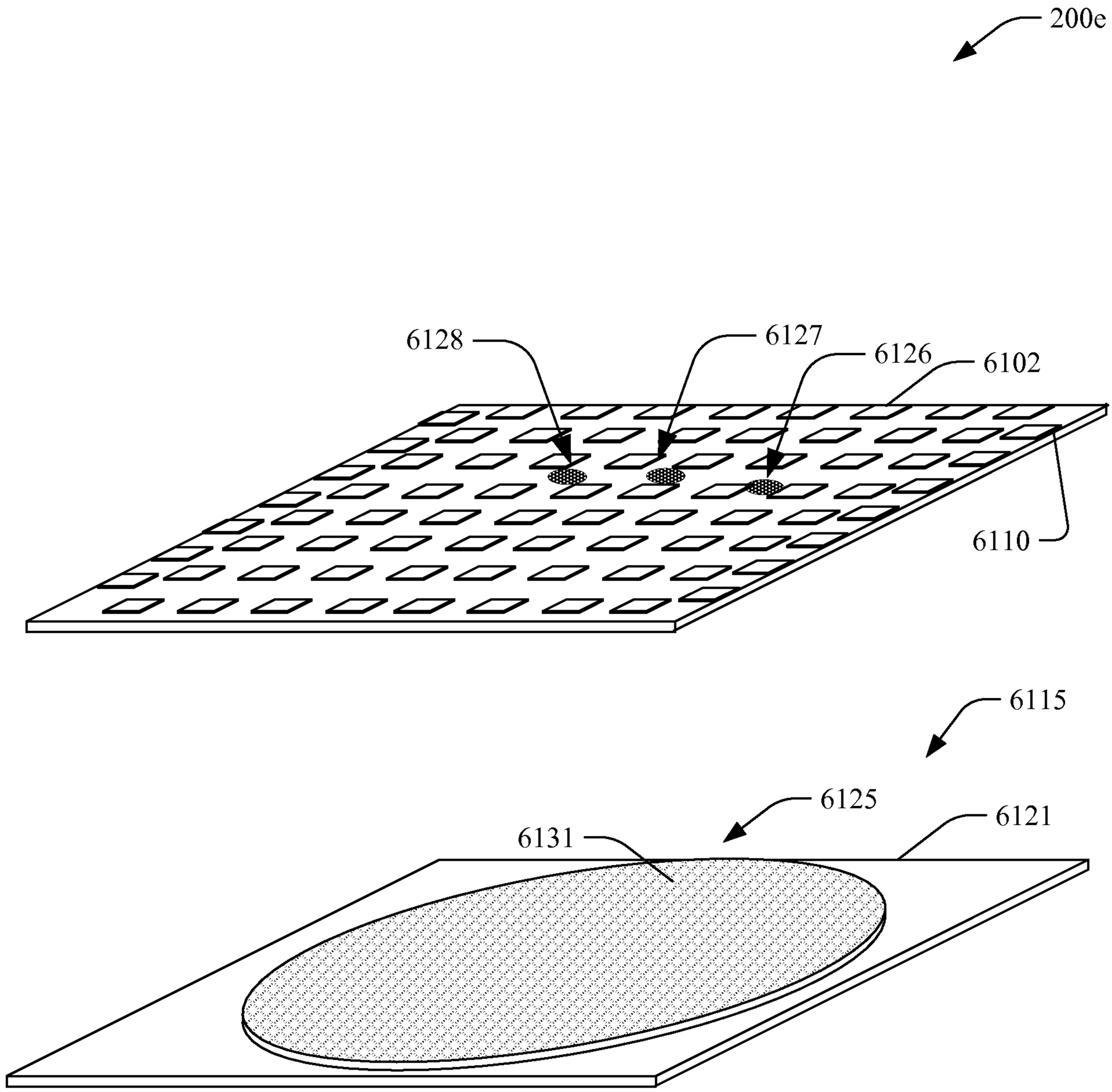


FIG. 61

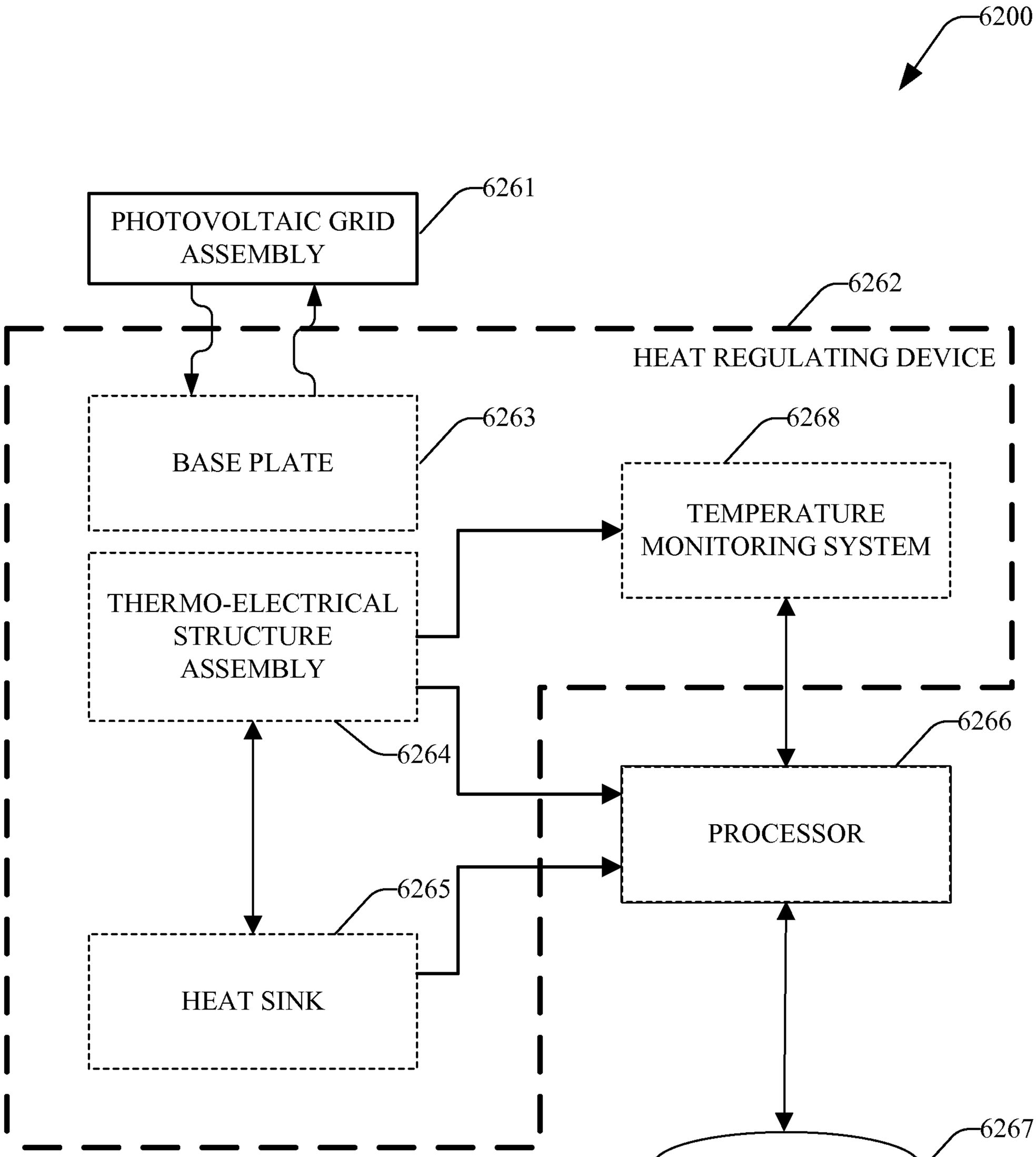

6200
PHOTOVOLTAIC GRID ASSEMBLY
6261
6262
HEAT REGULATING DEVICE
BASE PLATE
6263
6268
TEMPERATURE MONITORING SYSTEM
THERMO-ELECTRICAL STRUCTURE ASSEMBLY
6264
6266
PROCESSOR
6265
HEAT SINK
6267
MEMORY

FIG. 62

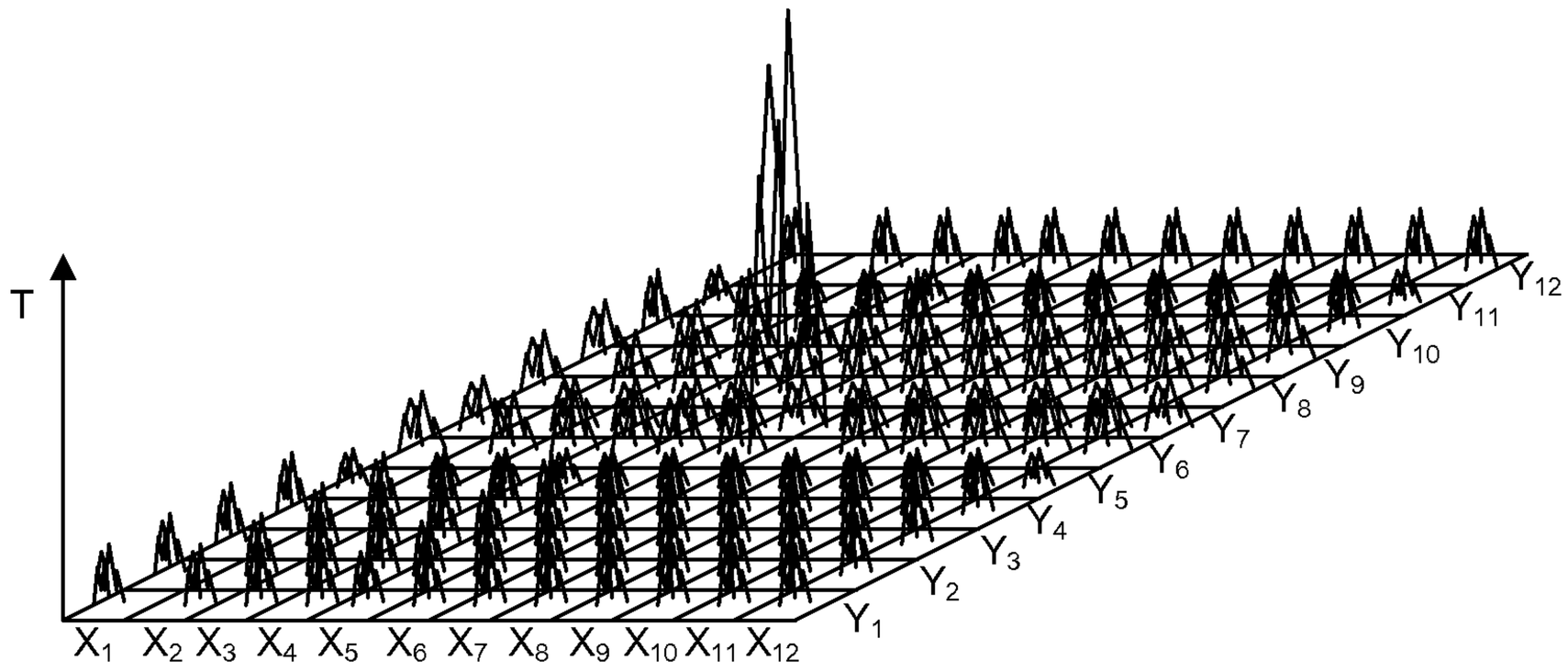


FIG. 63

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y_1	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_2	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_3	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_4	T_A	T_A	T_A	T_A	T_A	T_A	T_U	T_A	T_A	T_A	T_A	T_A
Y_5	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_6	T_A	T_A	T_A	T_A	T_A	T_A	T_U	T_A	T_A	T_A	T_A	T_A
Y_7	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_8	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_9	T_A	T_A	T_U	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_{10}	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_{11}	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A
Y_{12}	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A	T_A

FIG. 64

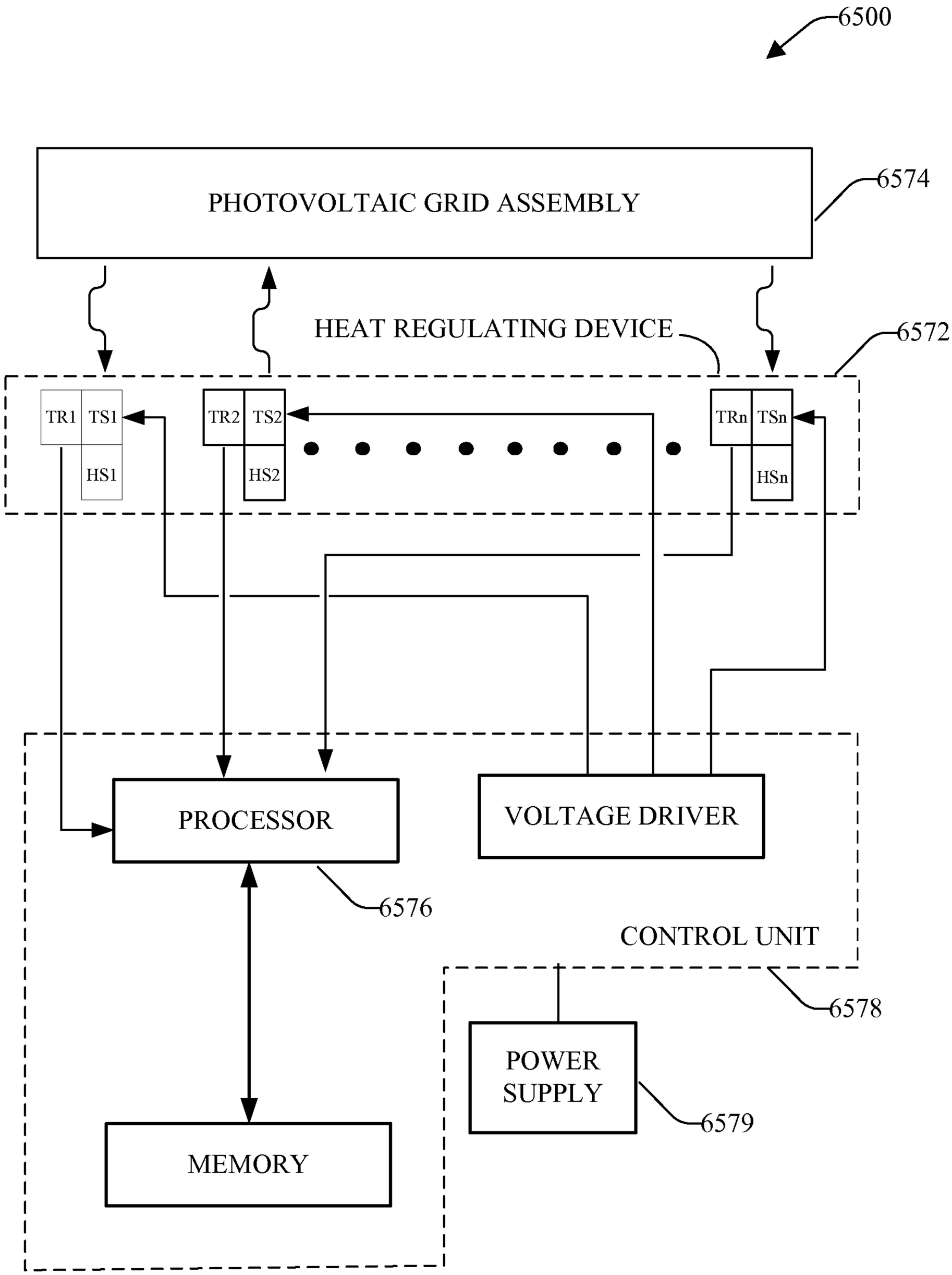

6500
PHOTOVOLTAIC GRID ASSEMBLY
6574
HEAT REGULATING DEVICE
6572
TR1
TS1
HS1
TR2
TS2
HS2
TRn
TSn
HSn
PROCESSOR
6576
VOLTAGE DRIVER
MEMORY
CONTROL UNIT
6578
POWER SUPPLY
6579

FIG. 65

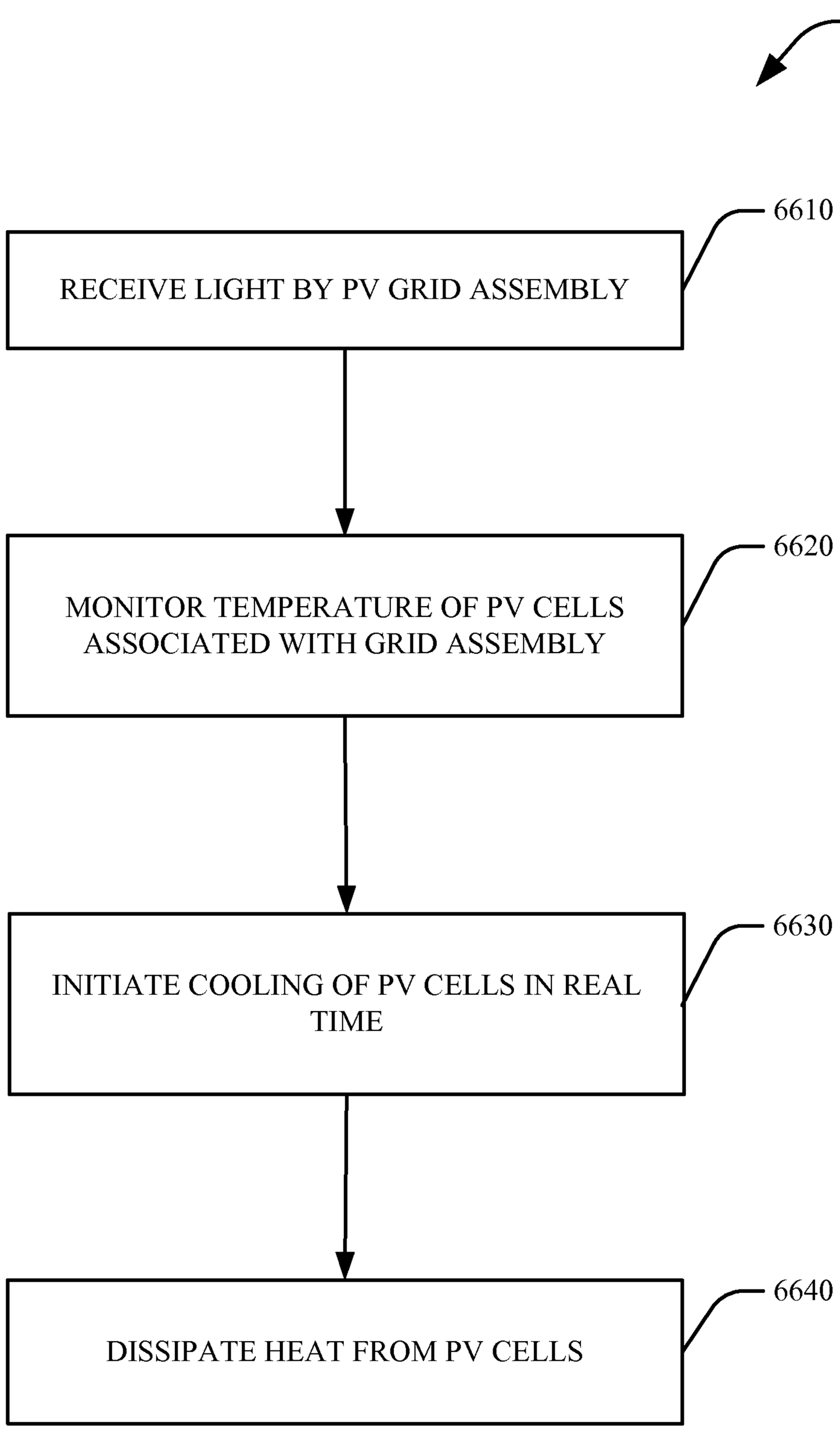

6600
RECEIVE LIGHT BY PV GRID ASSEMBLY
6610
MONITOR TEMPERATURE OF PV CELLS ASSOCIATED WITH GRID ASSEMBLY
6620
INITIATE COOLING OF PV CELLS IN REAL TIME
6630
DISSIPATE HEAT FROM PV CELLS
6640

FIG. 66

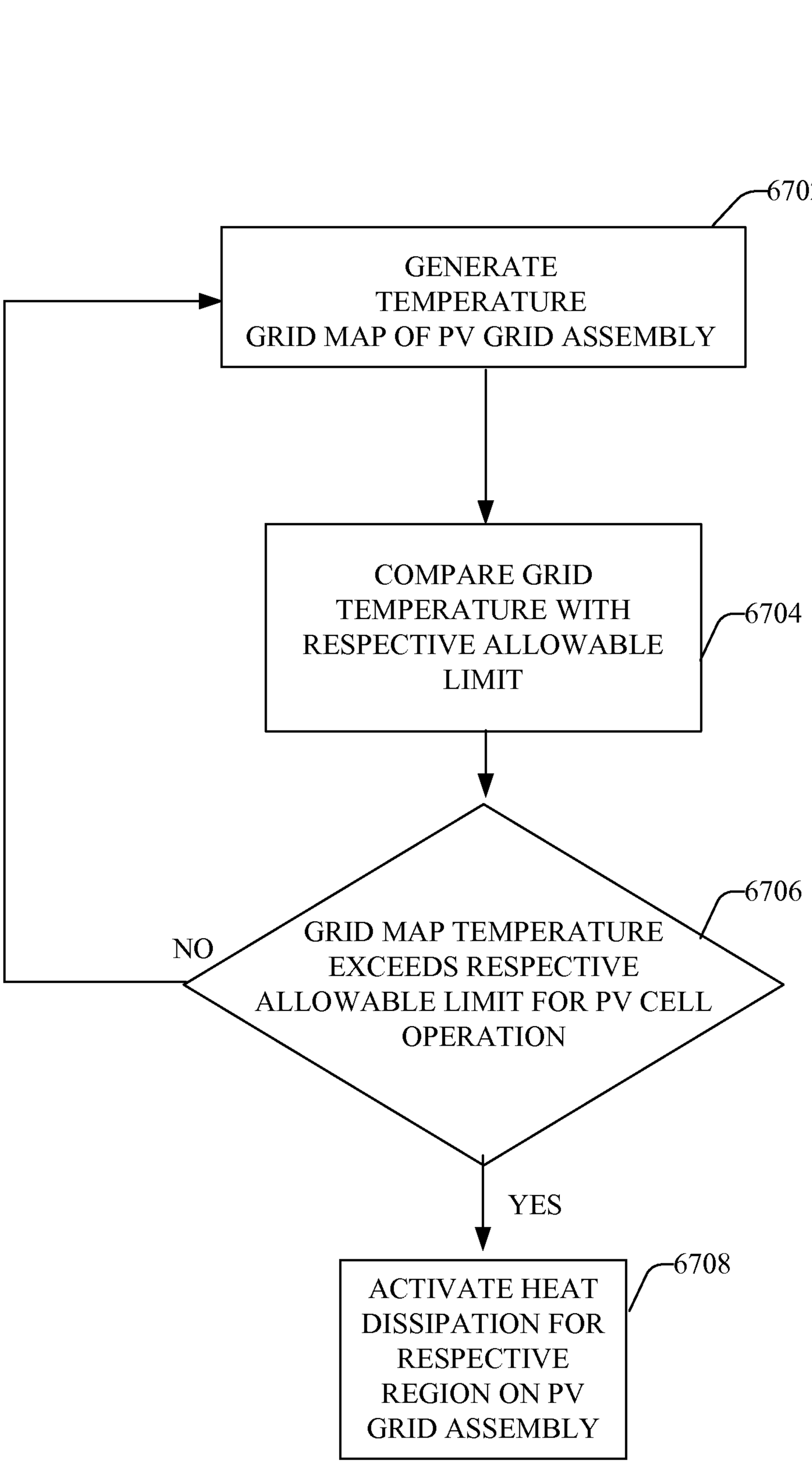

6700
6702
GENERATE TEMPERATURE GRID MAP OF PV GRID ASSEMBLY
COMPARE GRID TEMPERATURE WITH RESPECTIVE ALLOWABLE LIMIT
6704
GRID MAP TEMPERATURE EXCEEDS RESPECTIVE ALLOWABLE LIMIT FOR PV CELL OPERATION
6706
NO
YES
ACTIVATE HEAT DISSIPATION FOR RESPECTIVE REGION ON PV GRID ASSEMBLY
6708

FIG. 67

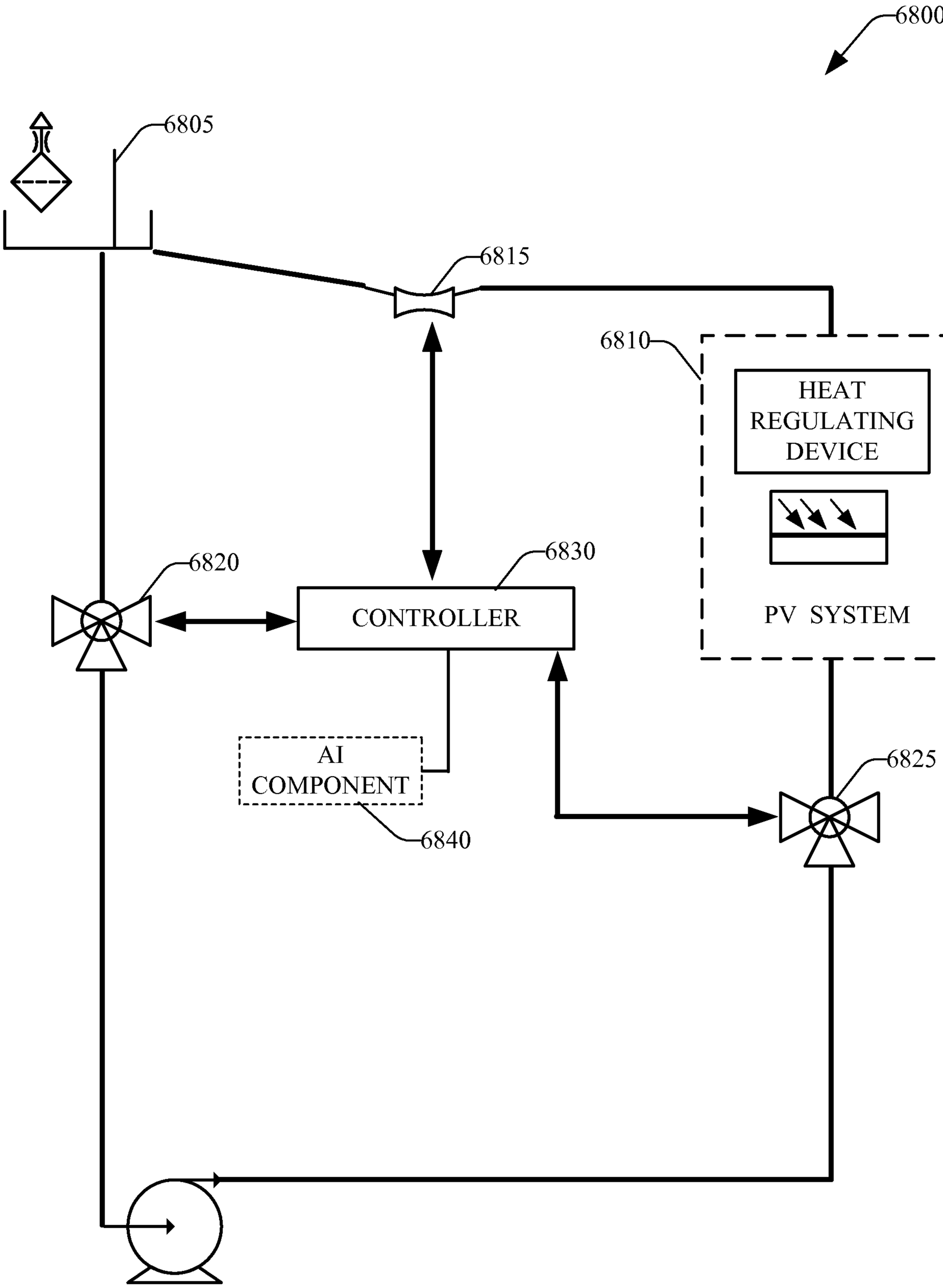

6800
6805
6815
6810
HEAT REGULATING DEVICE
PV SYSTEM
6820
6830
CONTROLLER
AI COMPONENT
6840
6825

FIG. 68

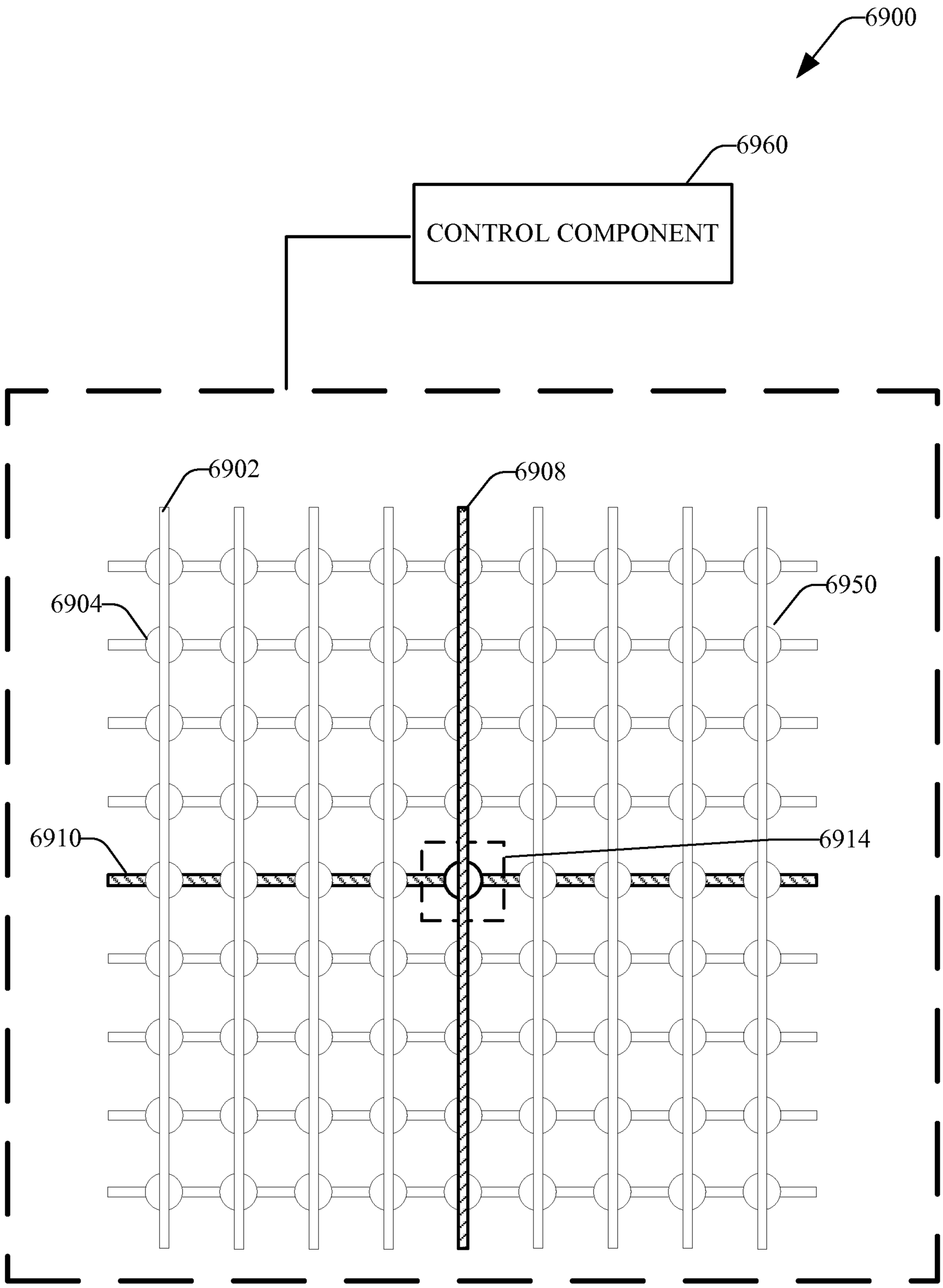


FIG. 69

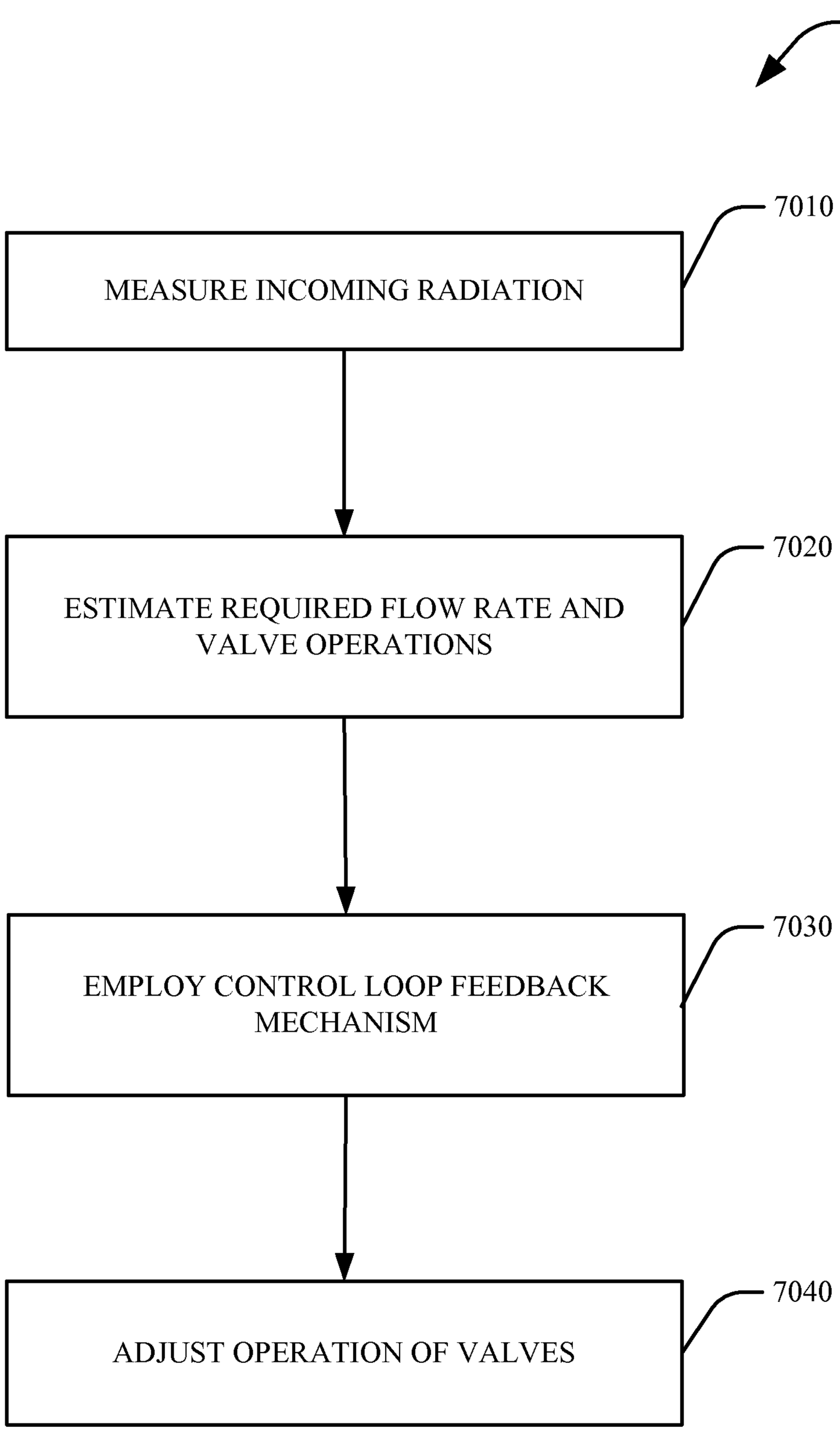

7000
7010
MEASURE INCOMING RADIATION
7020
ESTIMATE REQUIRED FLOW RATE AND VALVE OPERATIONS
7030
EMPLOY CONTROL LOOP FEEDBACK MECHANISM
7040
ADJUST OPERATION OF VALVES

FIG. 70

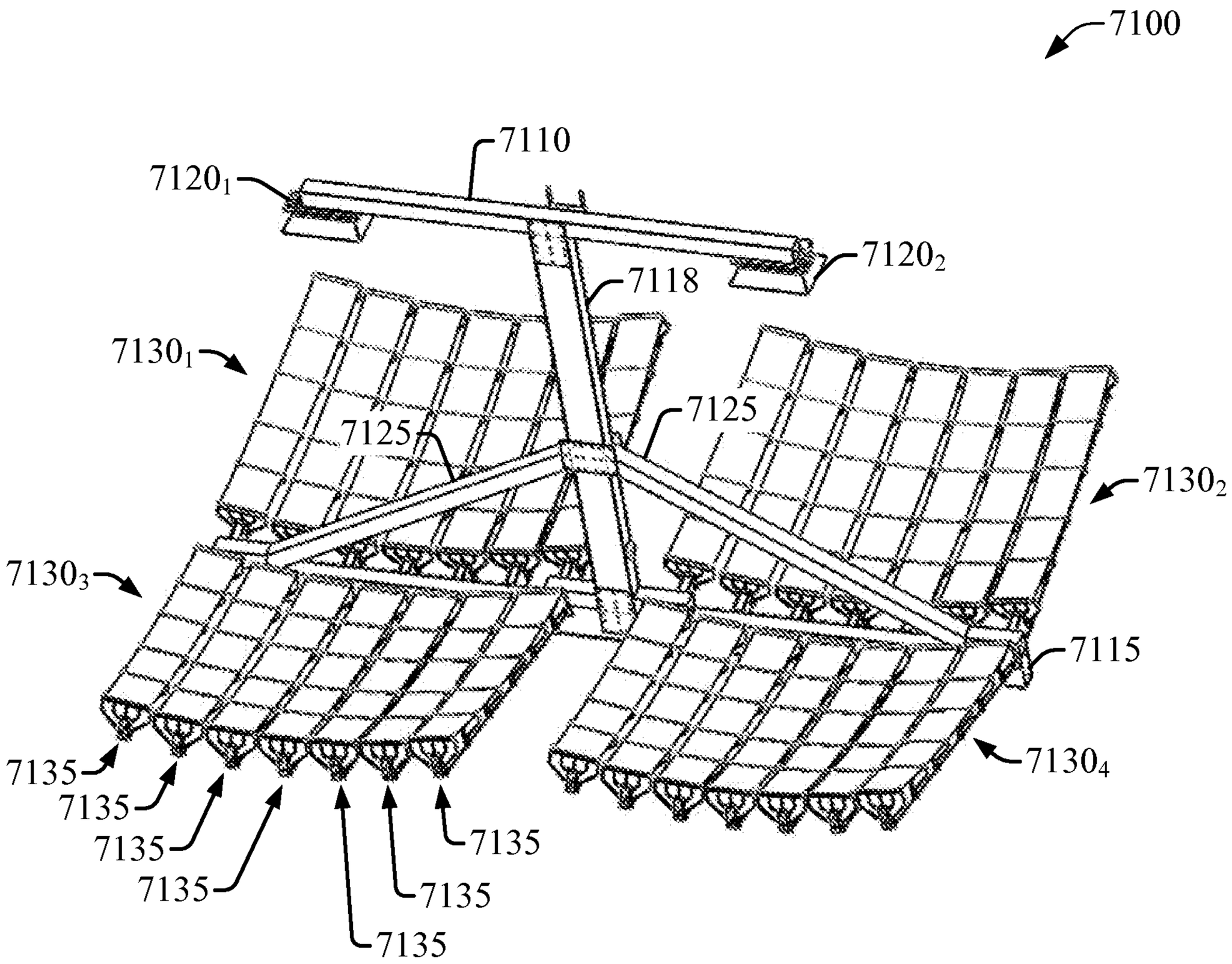

7100
7110
7120$_1$
7120$_2$
7118
7130$_1$
7125
7125
7130$_2$
7130$_3$
7115
7130$_4$
7135
7135
7135
7135
7135
7135
7135

FIG. 71A

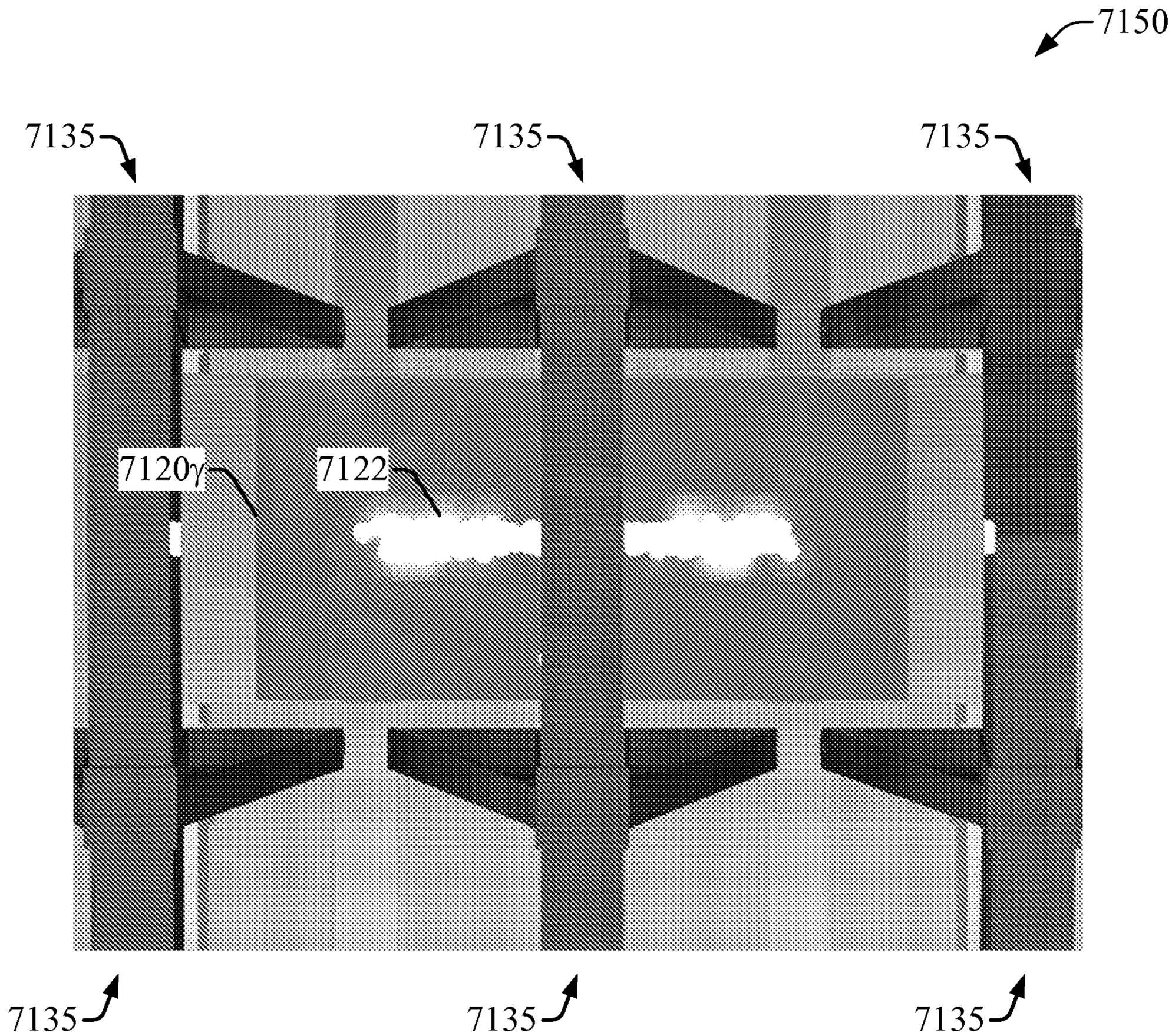


FIG. 71B

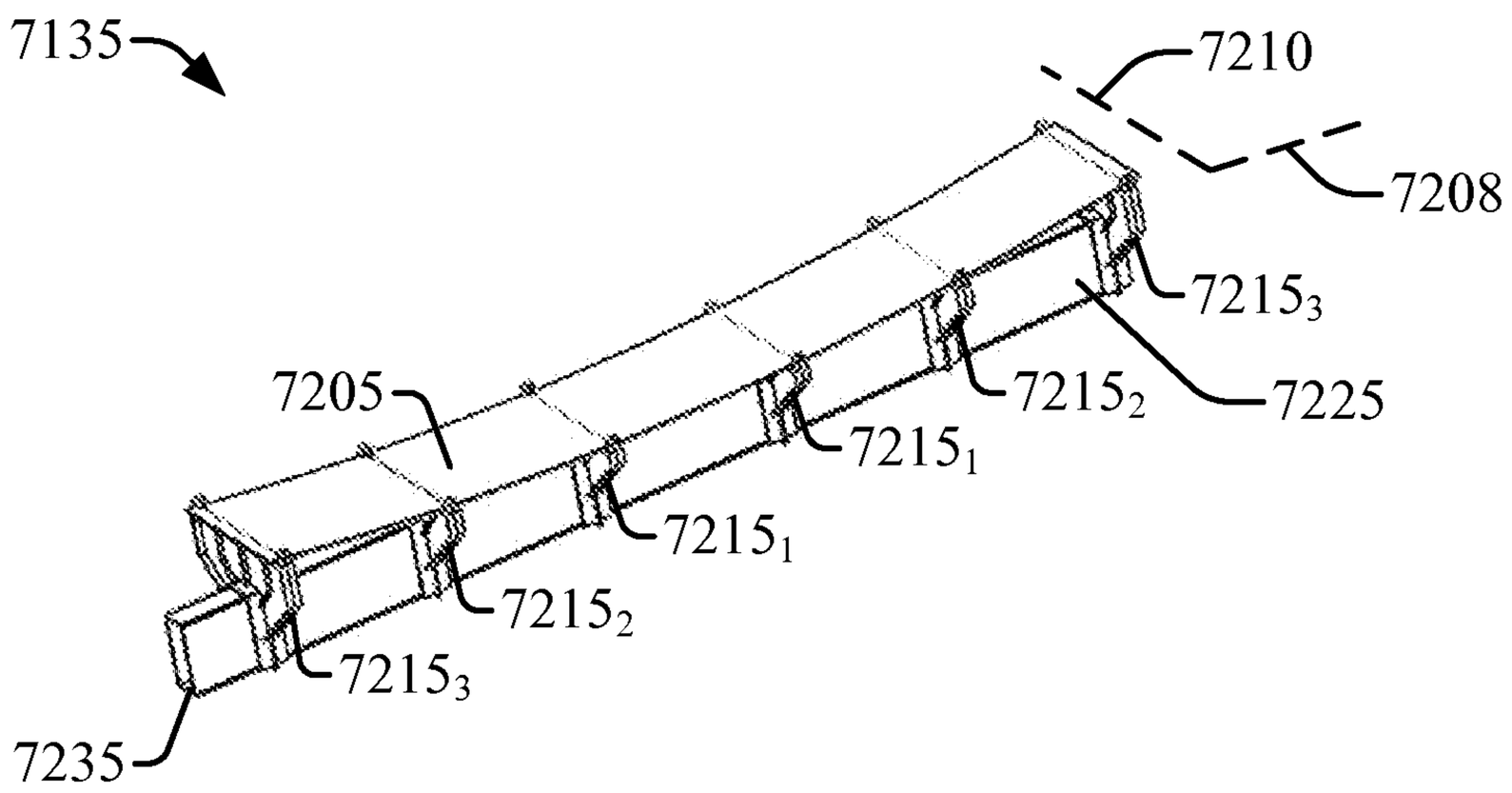

7135
7210
7208
7215$_3$
7205
7225
7215$_2$
7215$_1$
7215$_1$
7215$_2$
7215$_3$
7235

FIG. 72

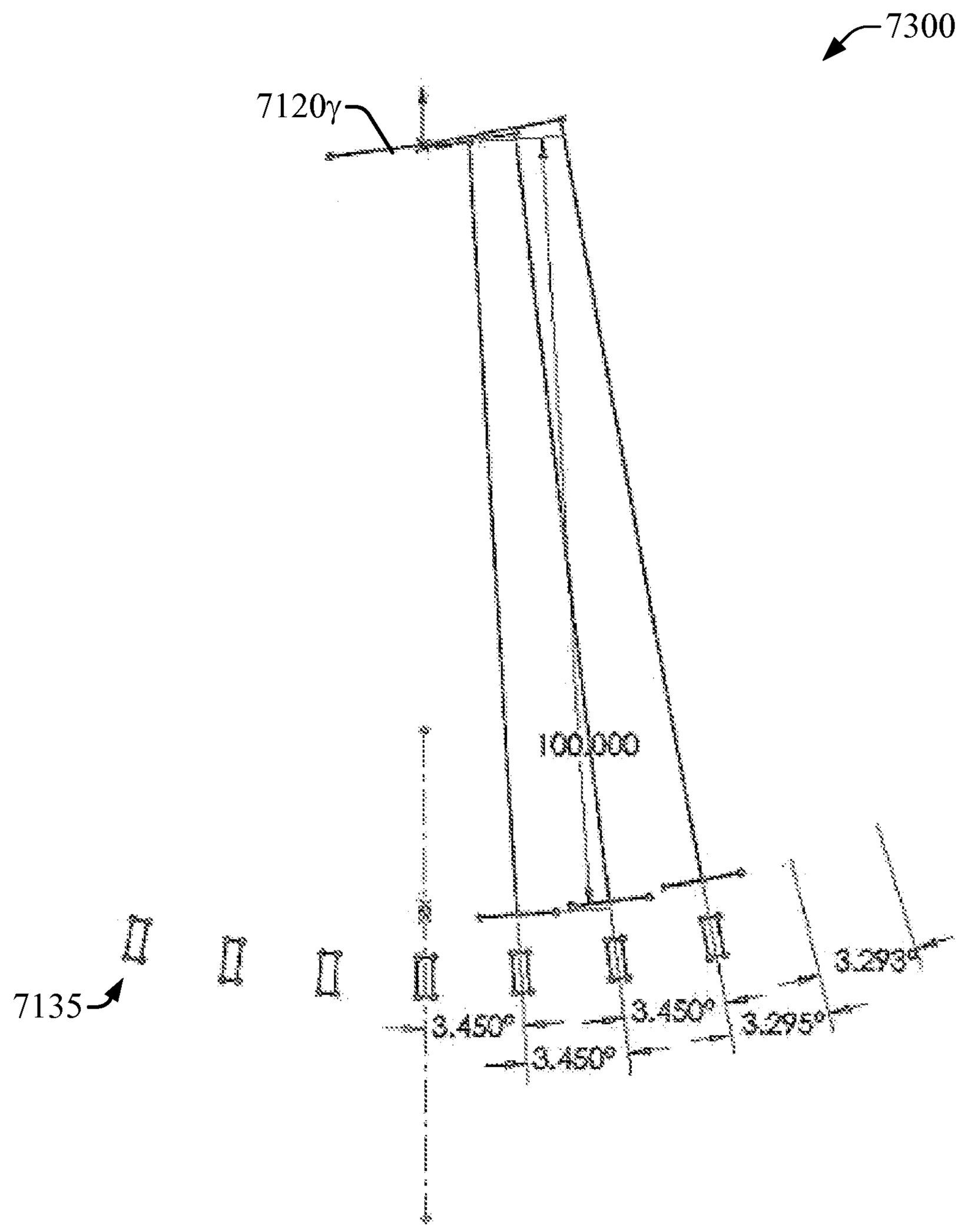


FIG. 73A

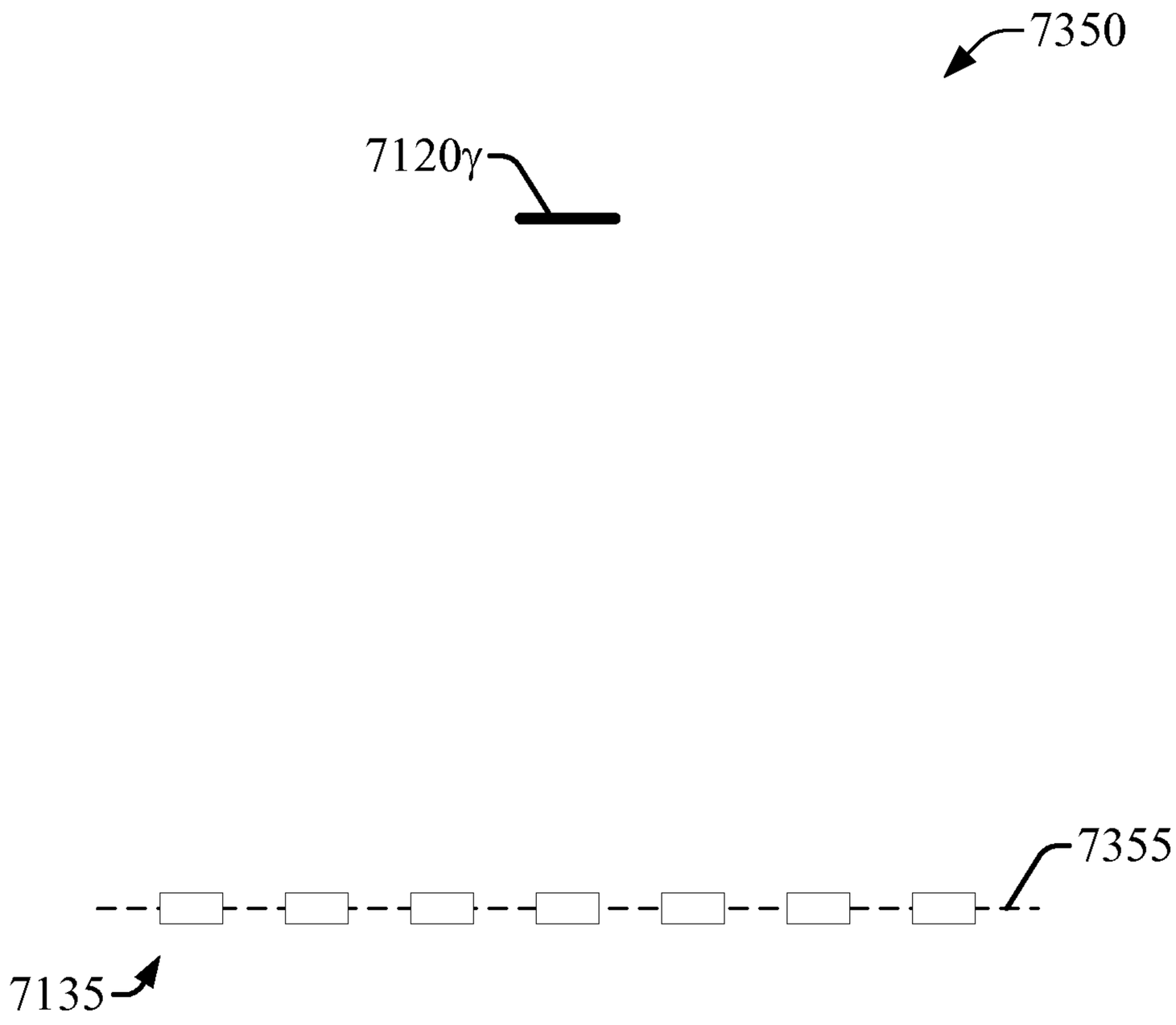


FIG. 73B

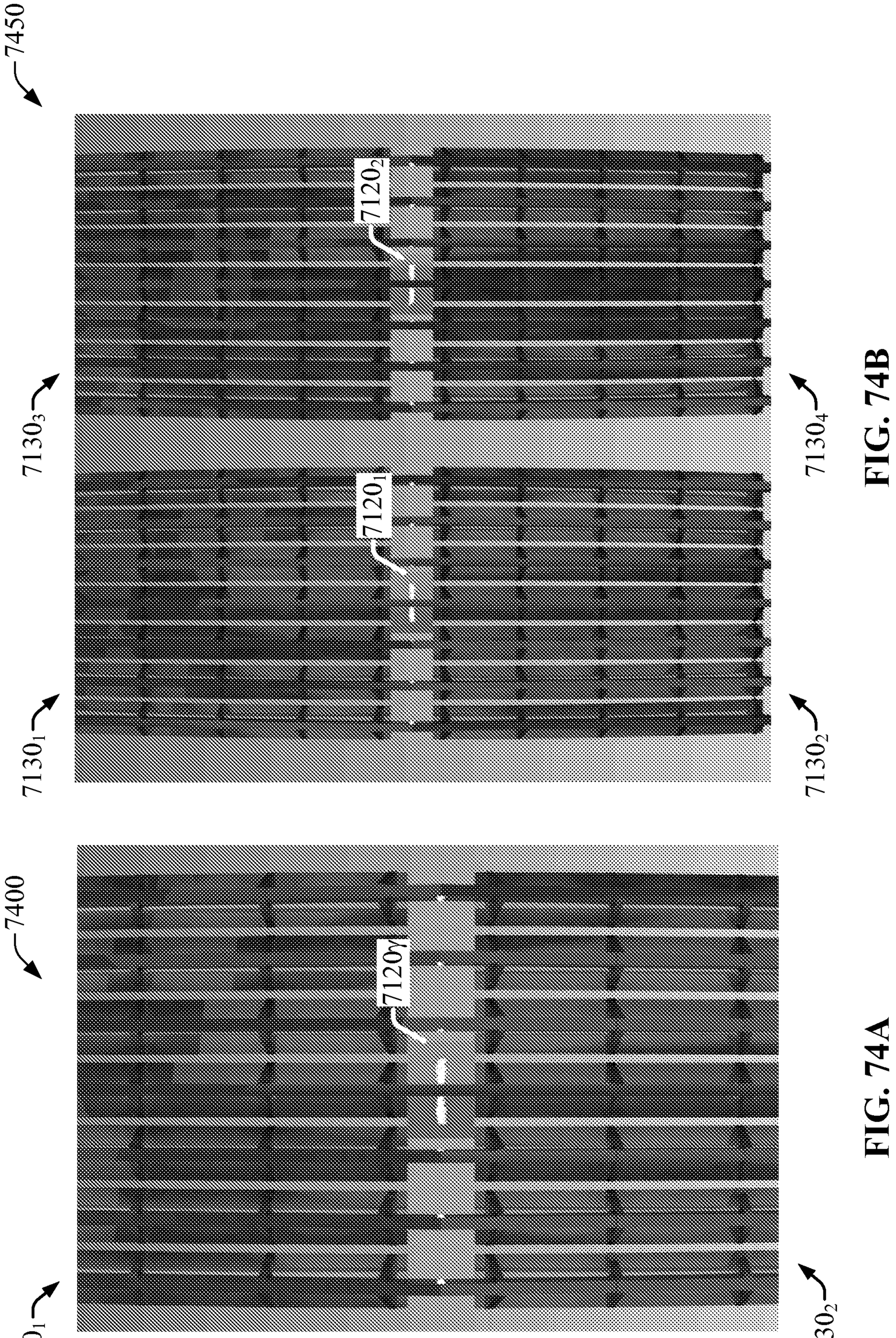


FIG. 74B

FIG. 74A

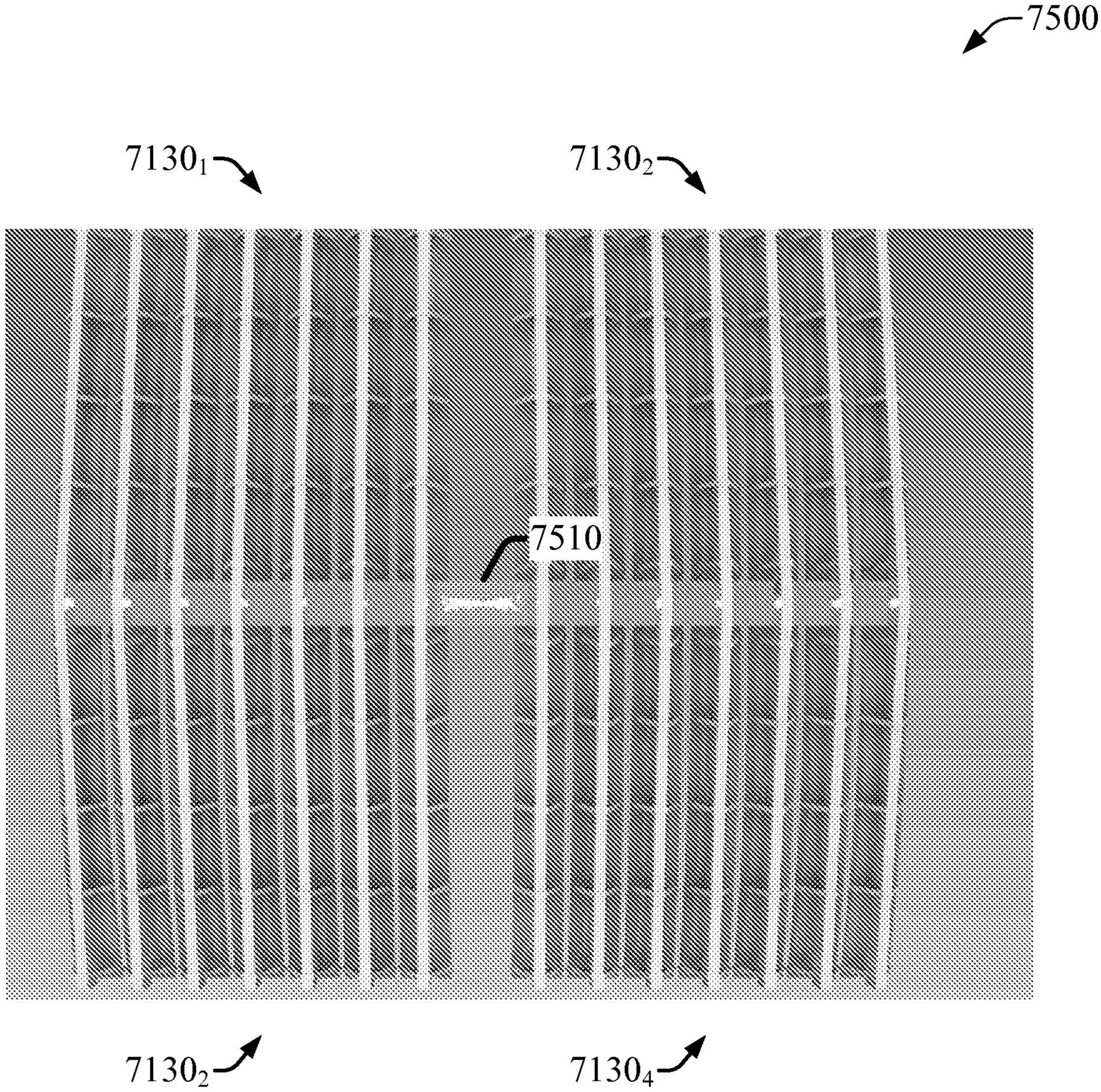


FIG. 75

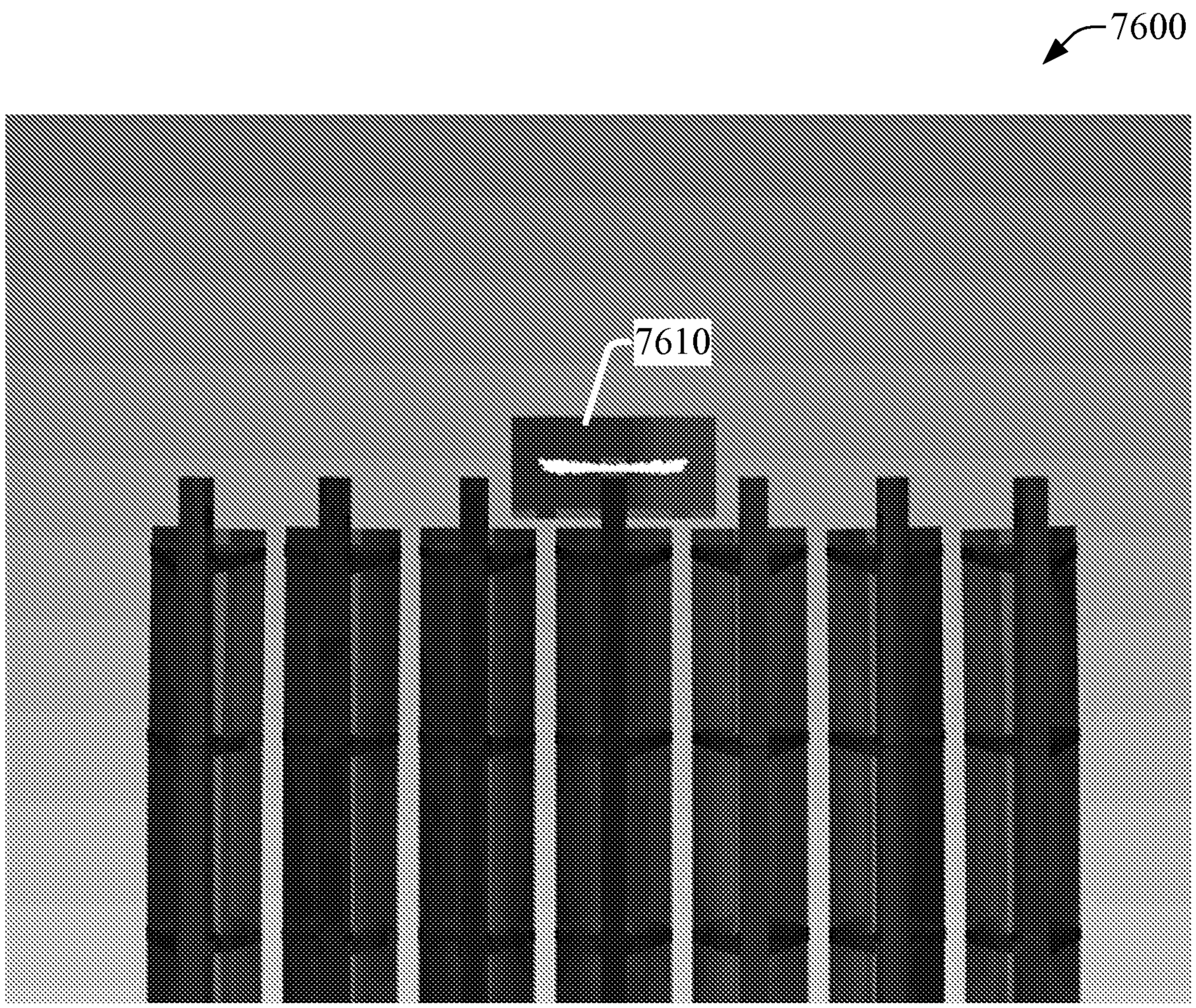


FIG. 76

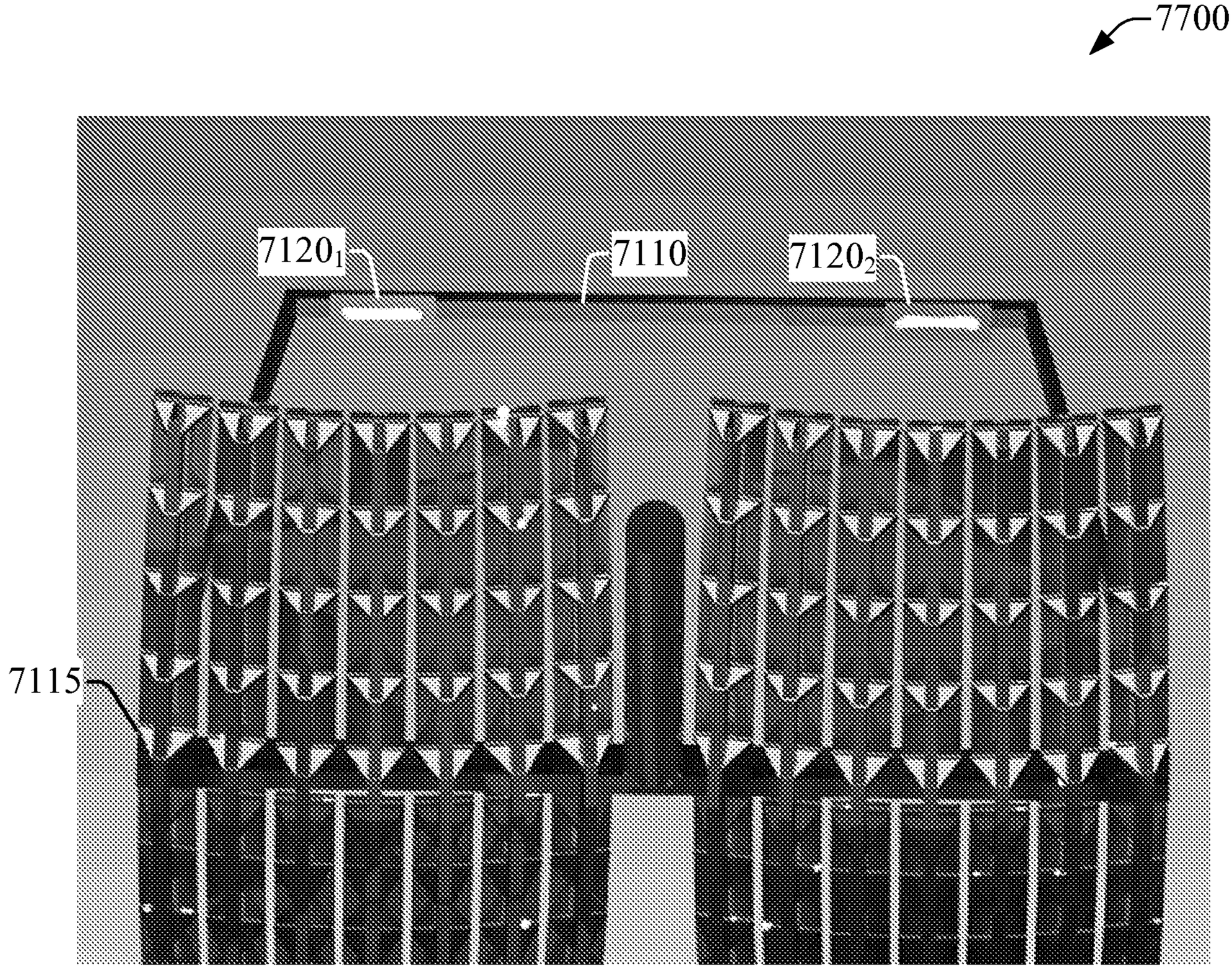


FIG. 77

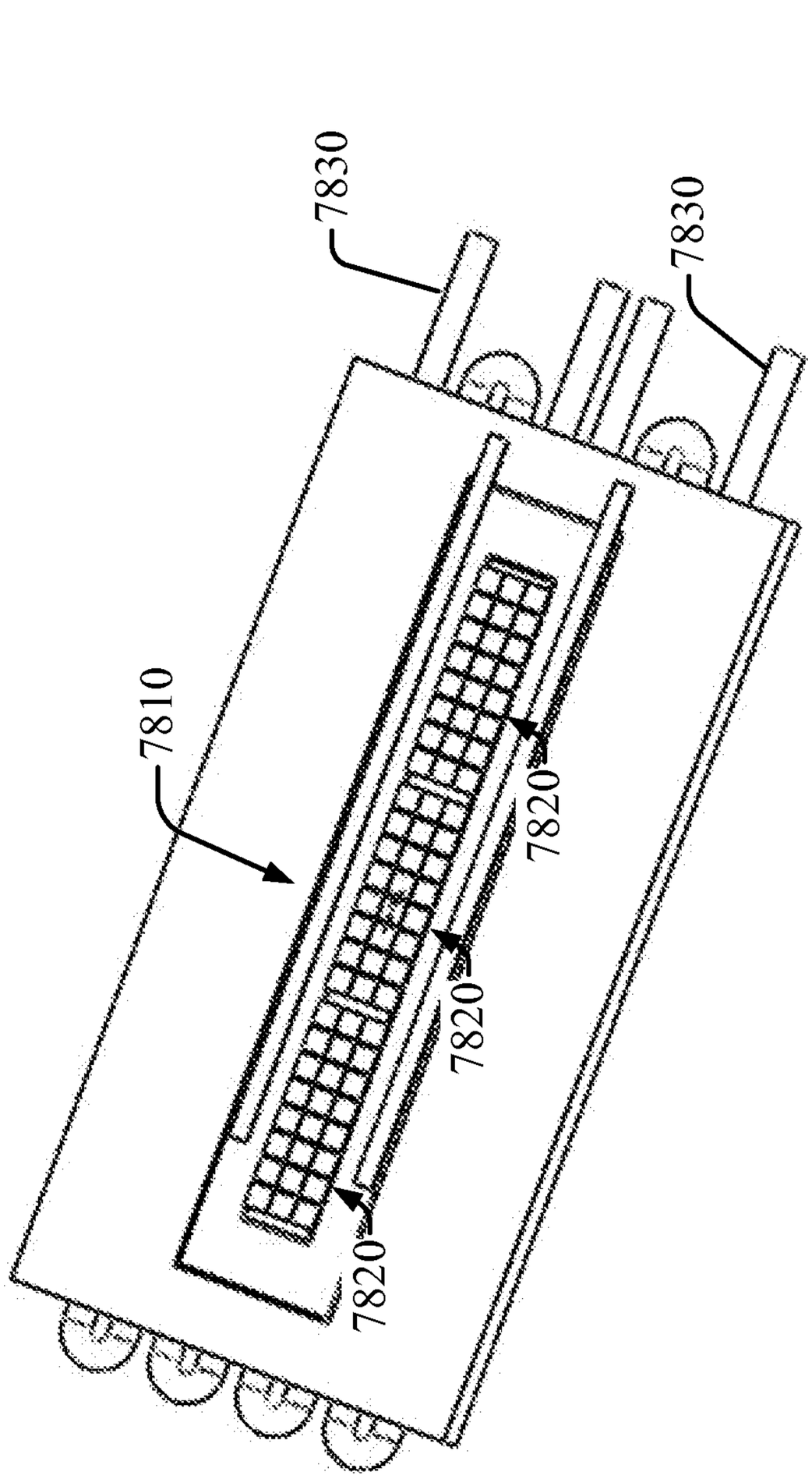


FIG. 78

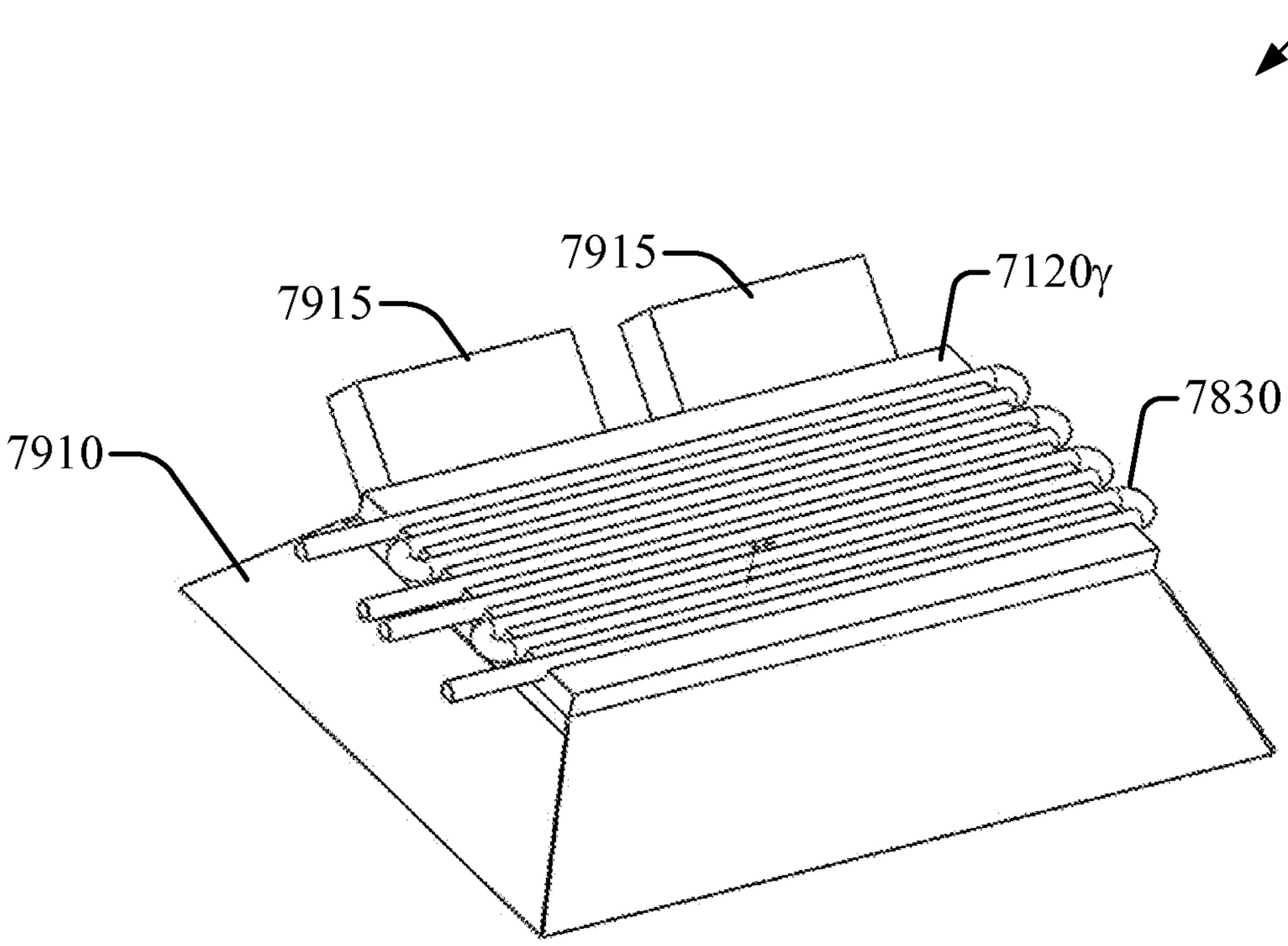


FIG. 79A

FIG. 79B

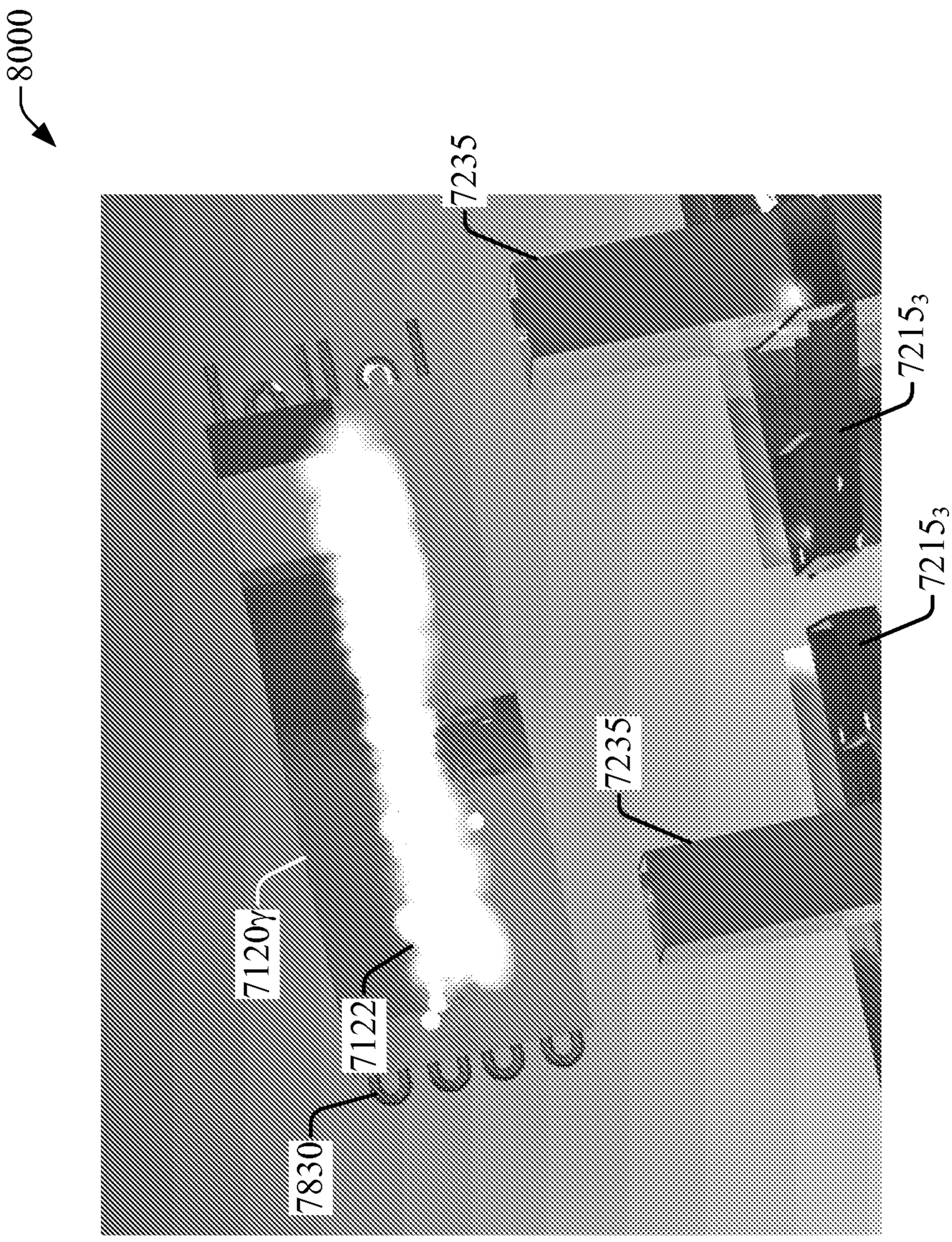


FIG. 80

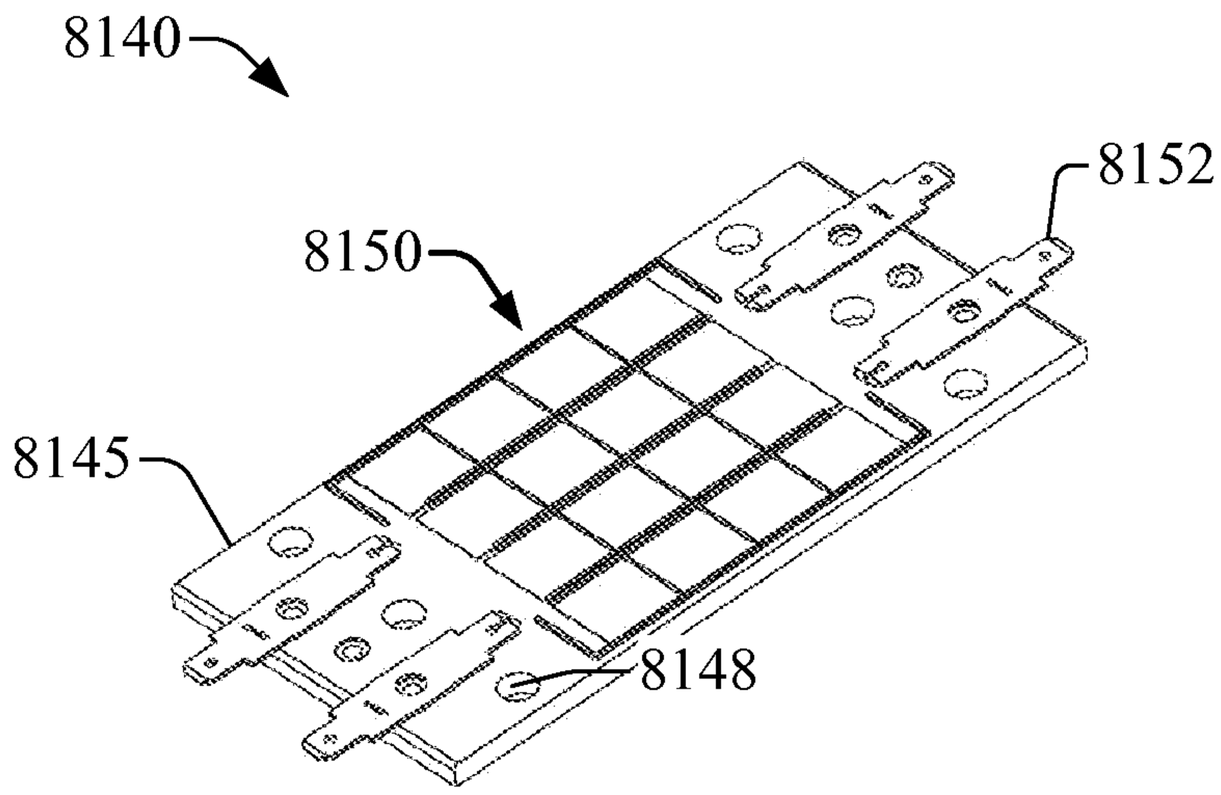


FIG. 81A

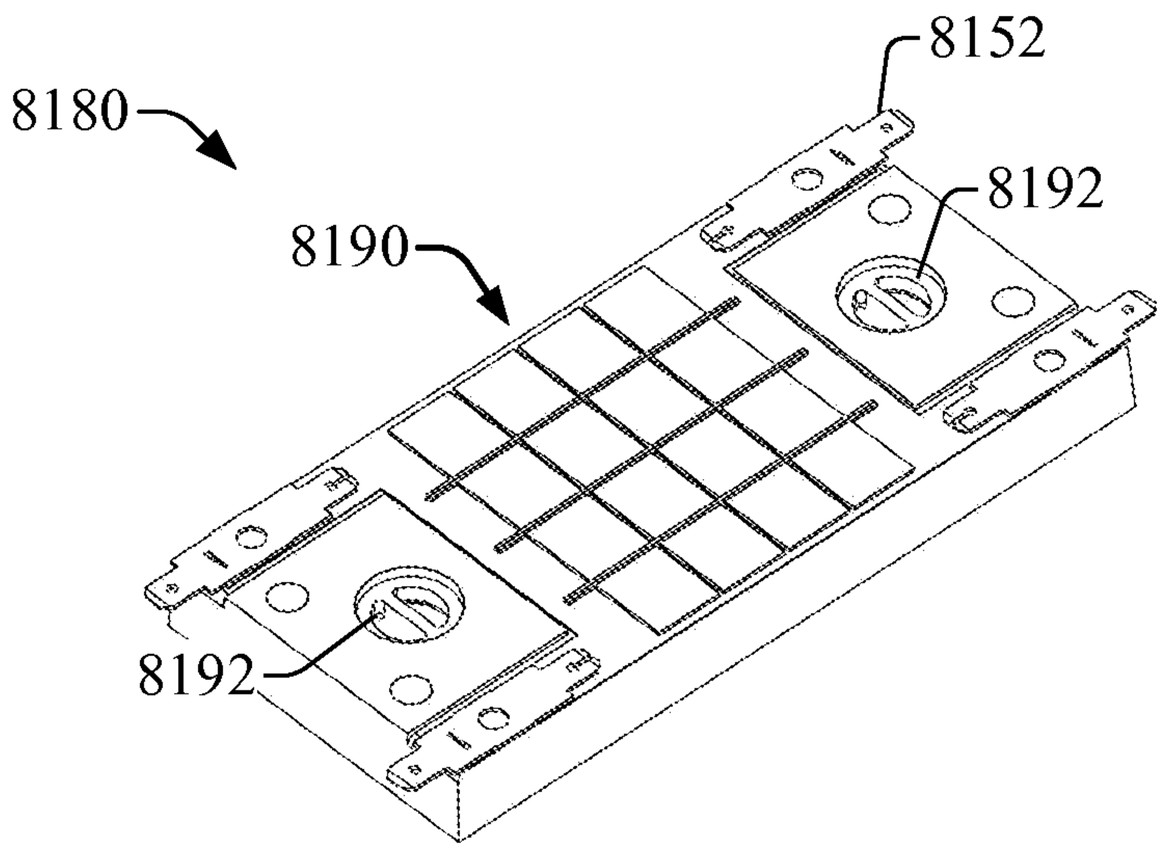


FIG. 81B

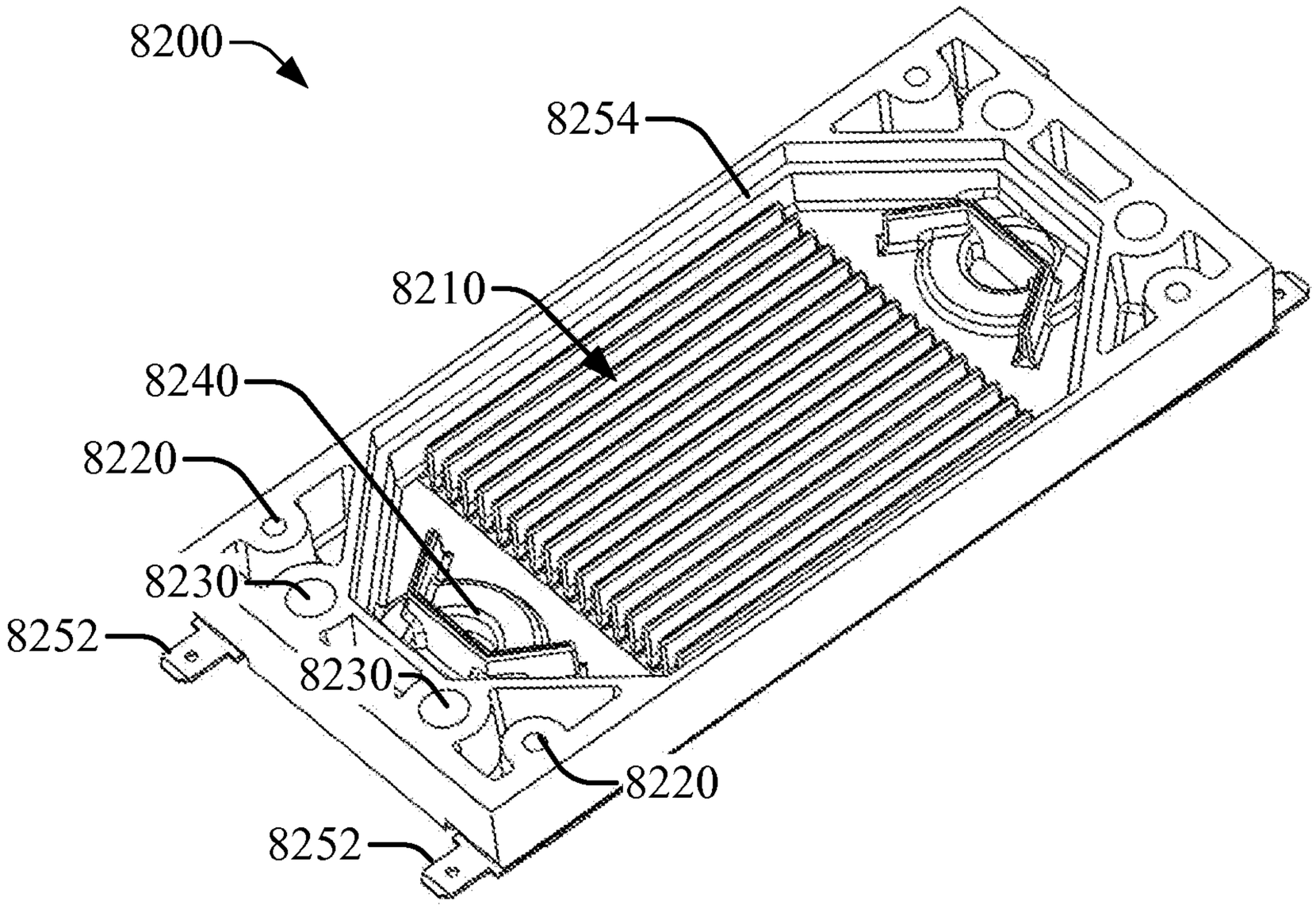


FIG. 82

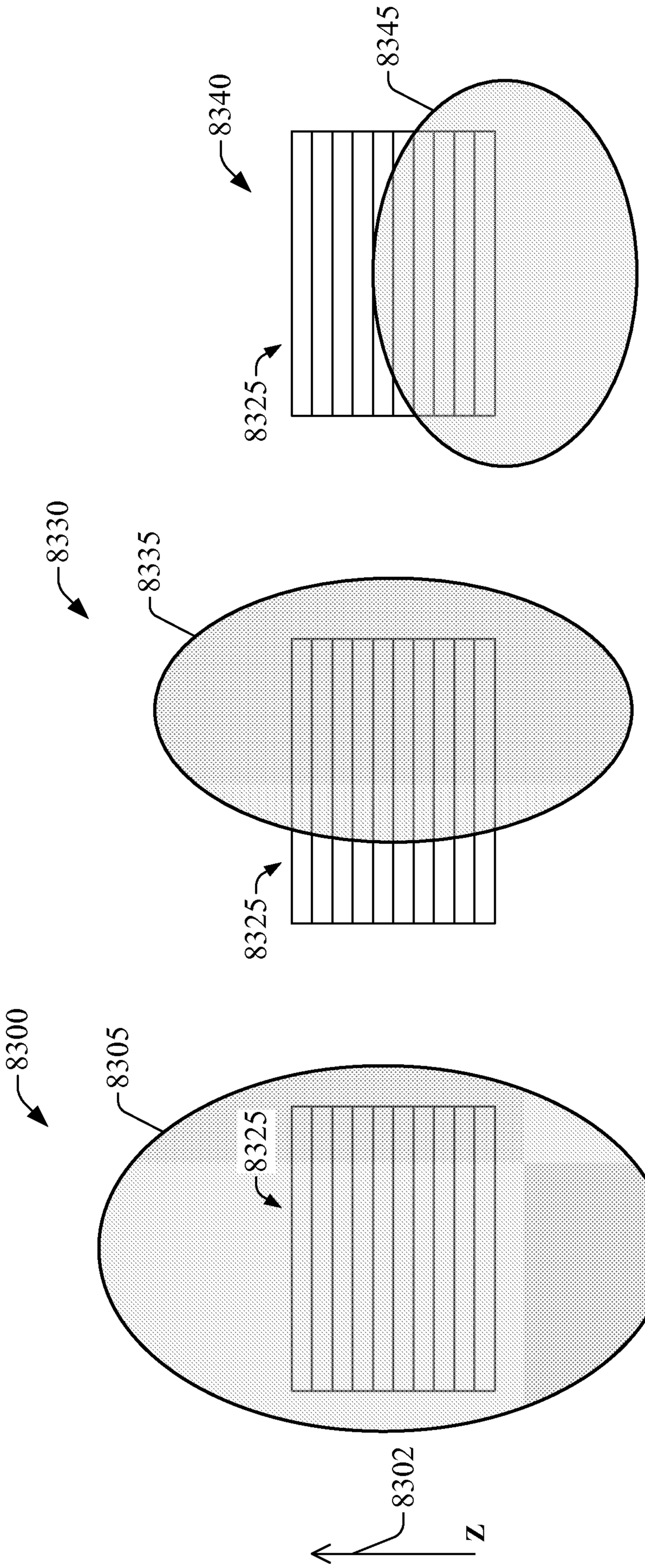


FIG. 83C

FIG. 83B

FIG. 83A

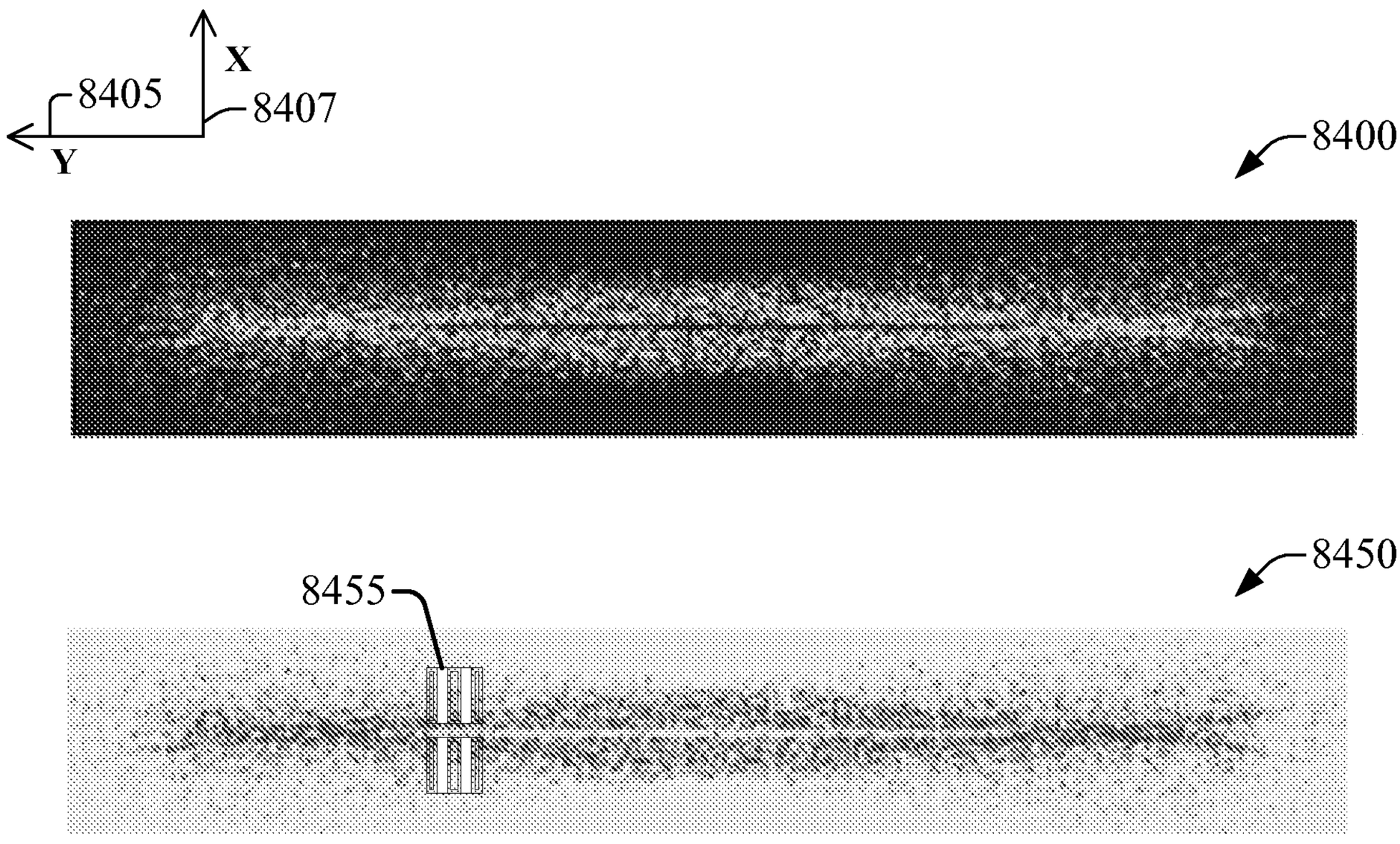


FIG. 84

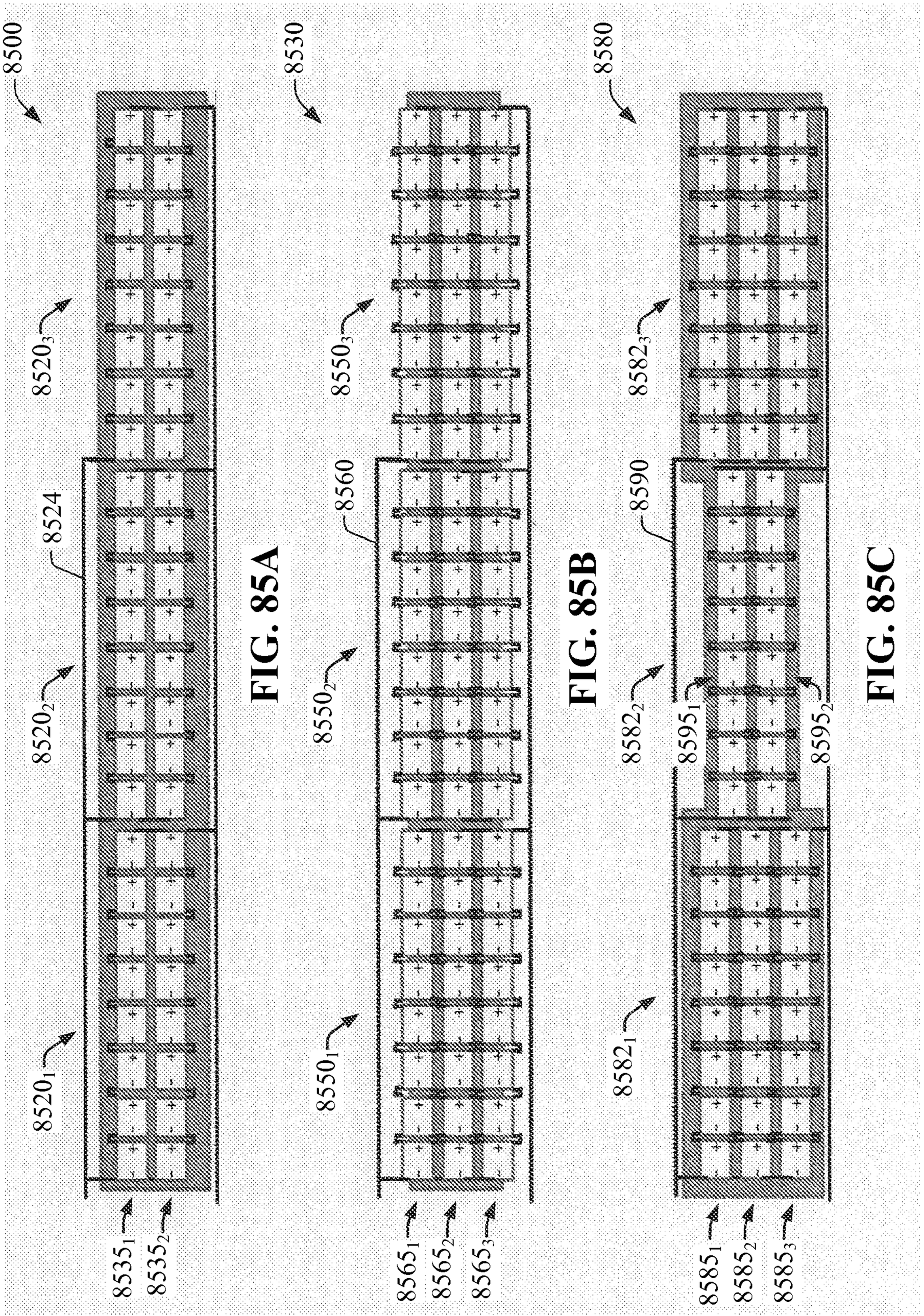


FIG. 85A

FIG. 85B

FIG. 85C

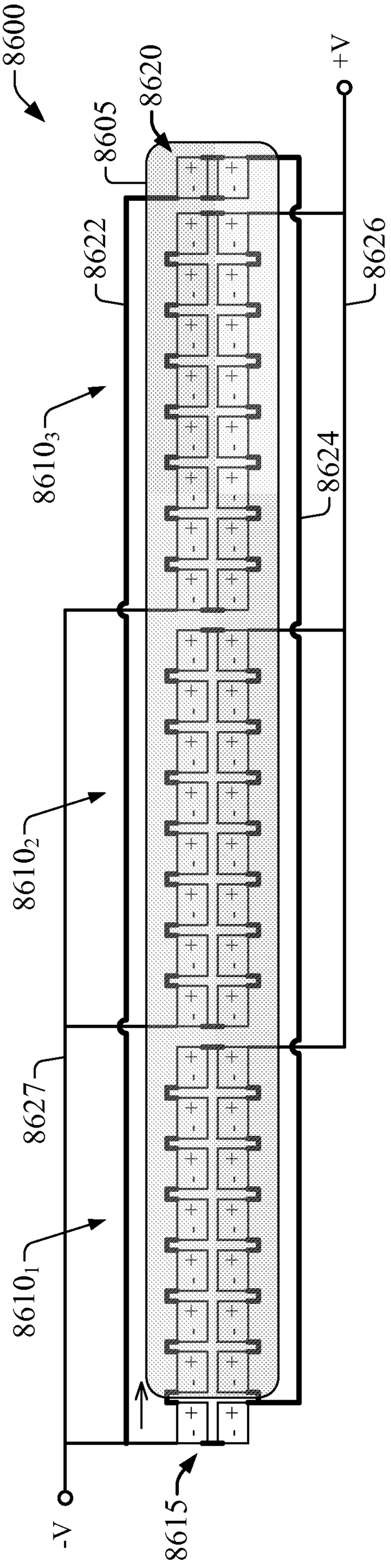


FIG. 86A

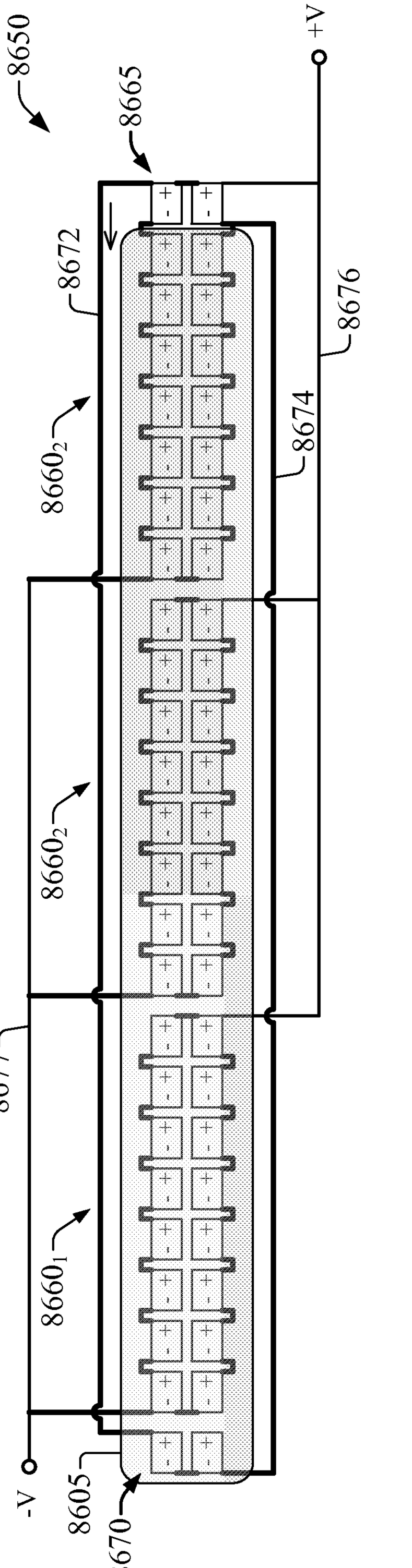


FIG. 86B

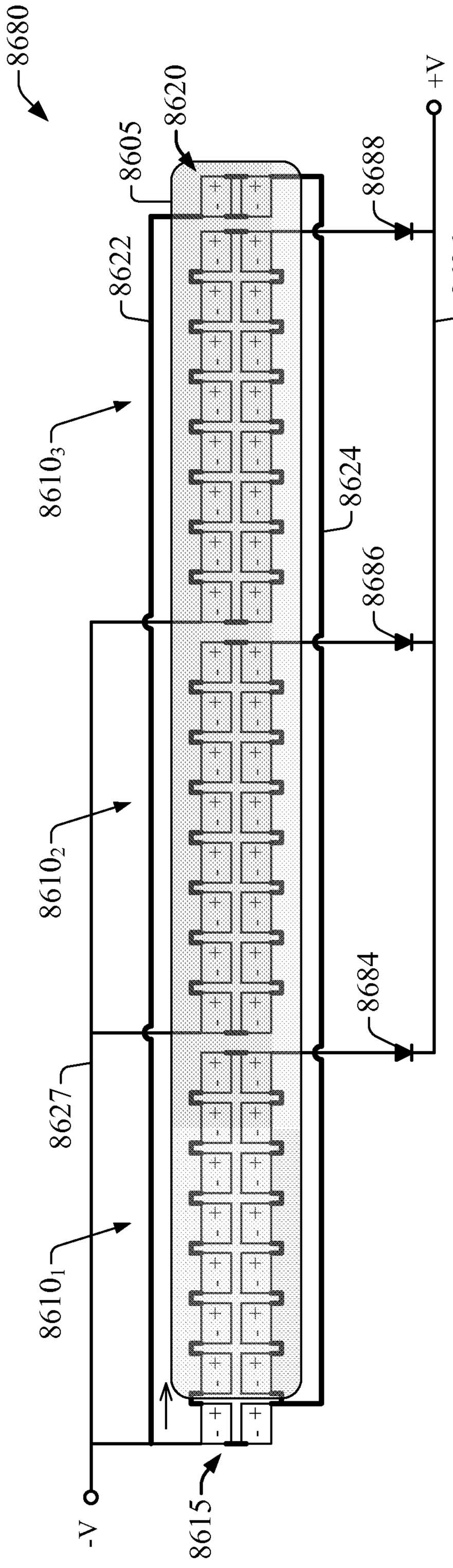

8680
8620
8605
8622
8610_3
8610_2
8610_1
8627
-V
8615
+V
8688
8626
8624
8686
8684

FIG. 86C

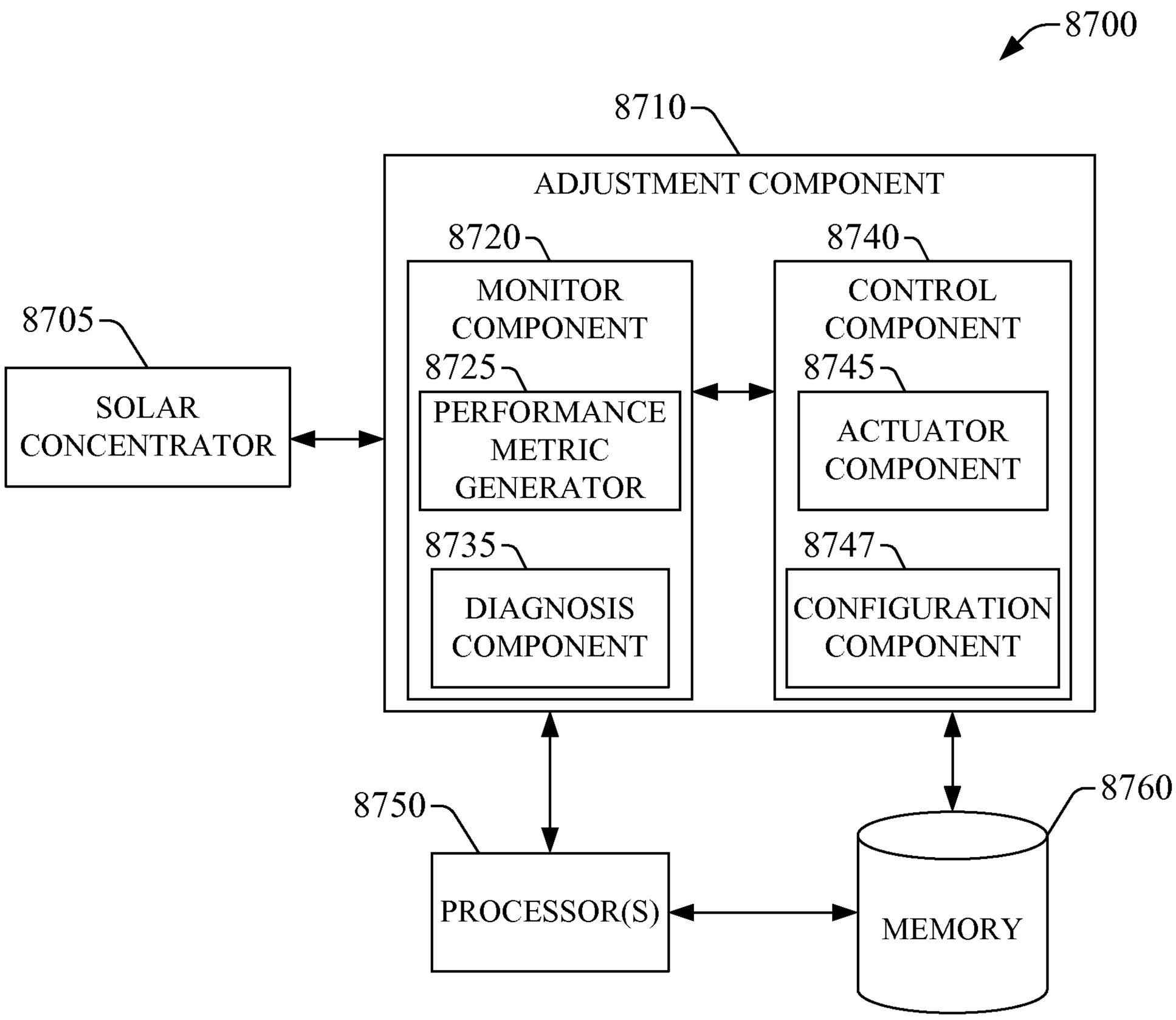

8700
8710
ADJUSTMENT COMPONENT
8720
MONITOR COMPONENT
8725
PERFORMANCE METRIC GENERATOR
8735
DIAGNOSIS COMPONENT
8740
CONTROL COMPONENT
8745
ACTUATOR COMPONENT
8747
CONFIGURATION COMPONENT
8705
SOLAR CONCENTRATOR
8750
PROCESSOR(S)
8760
MEMORY

FIG. 87

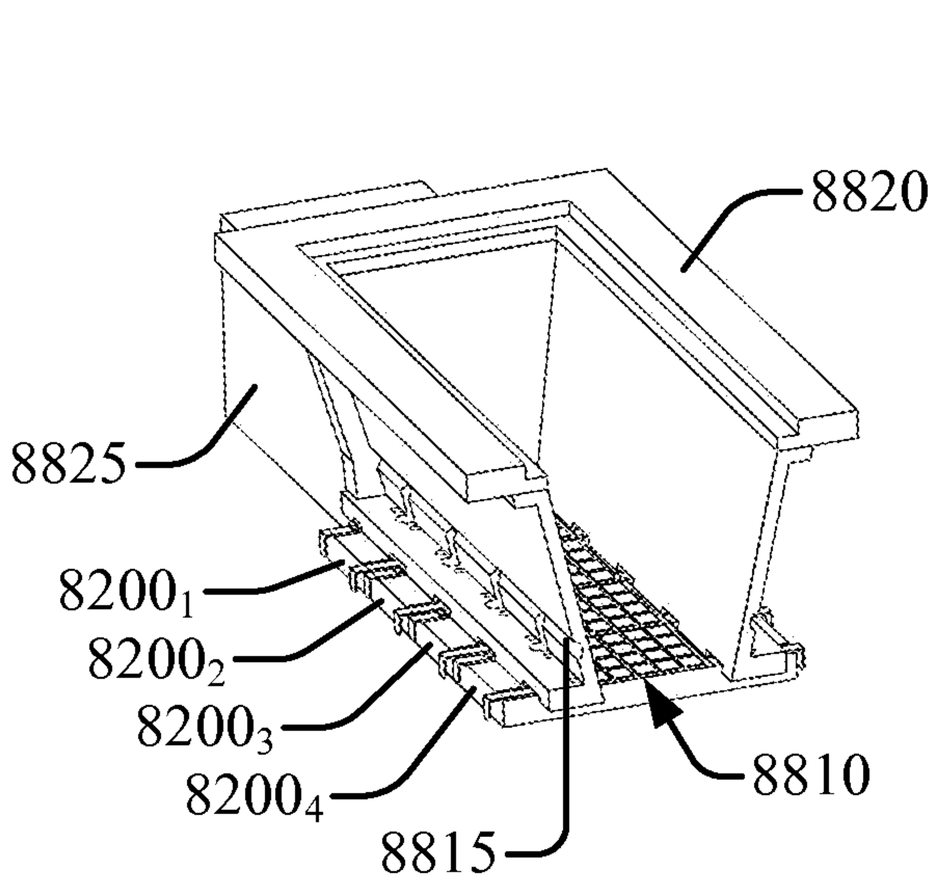


FIG. 88A

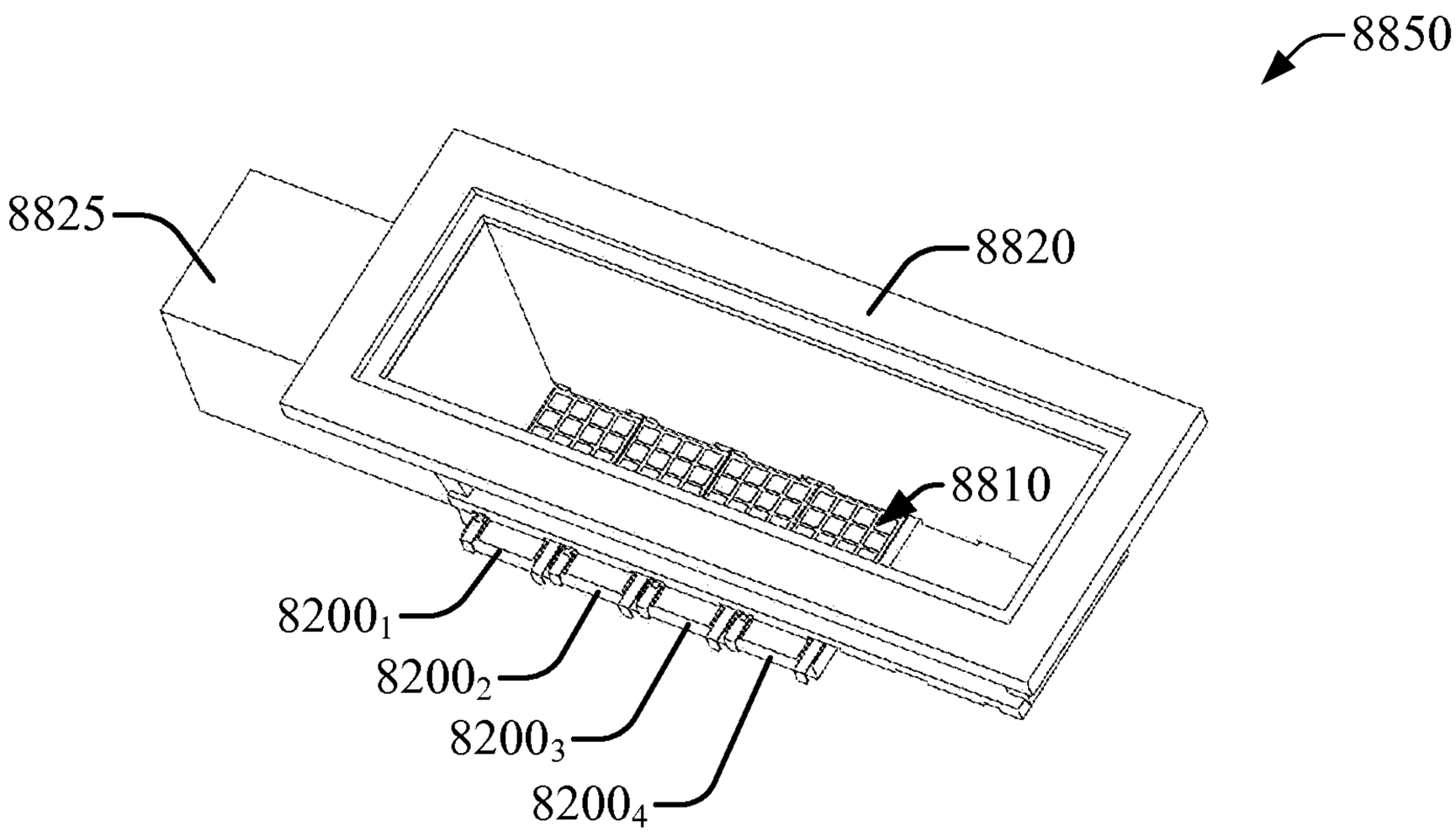


FIG. 88B

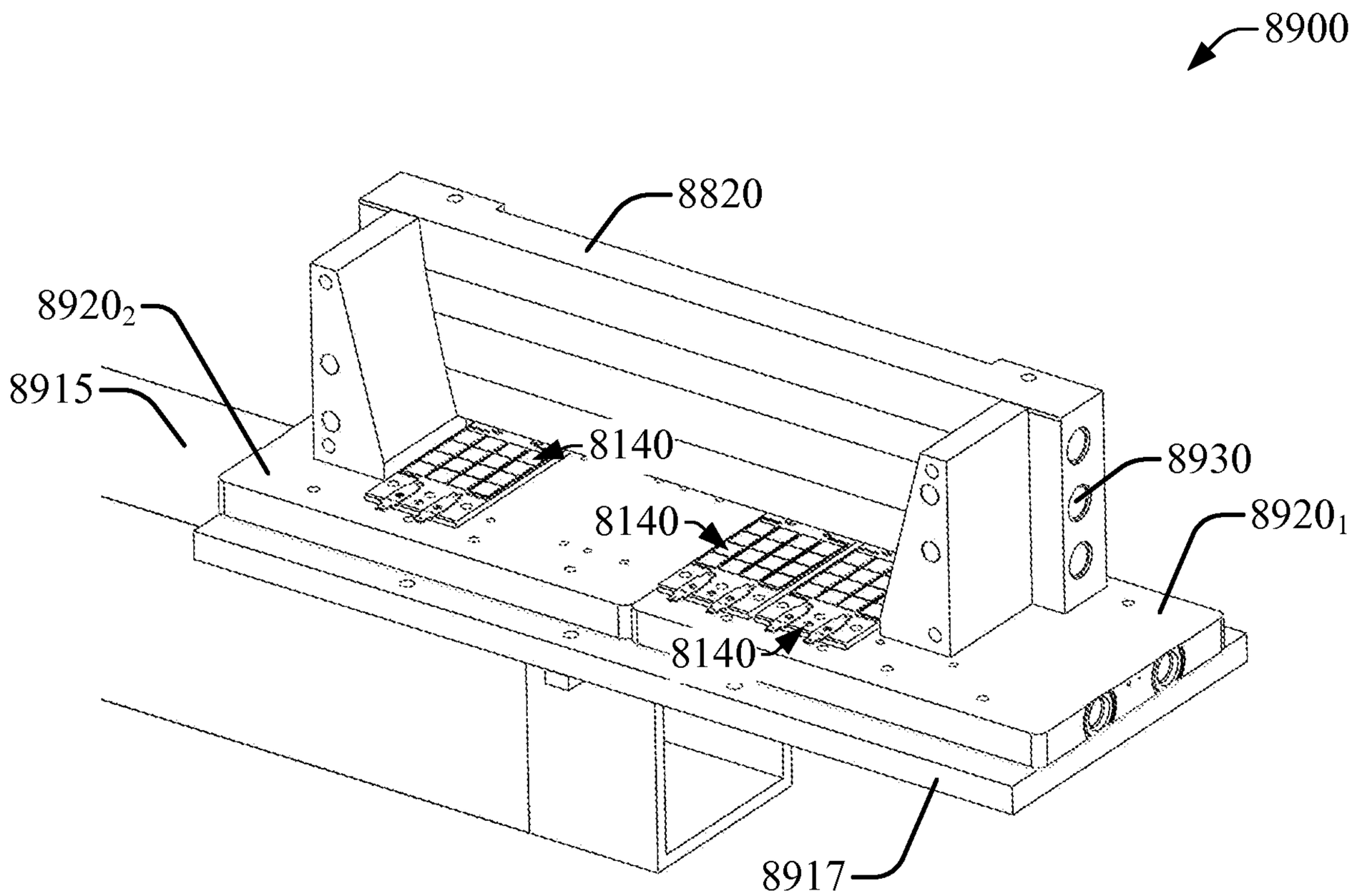


FIG. 89

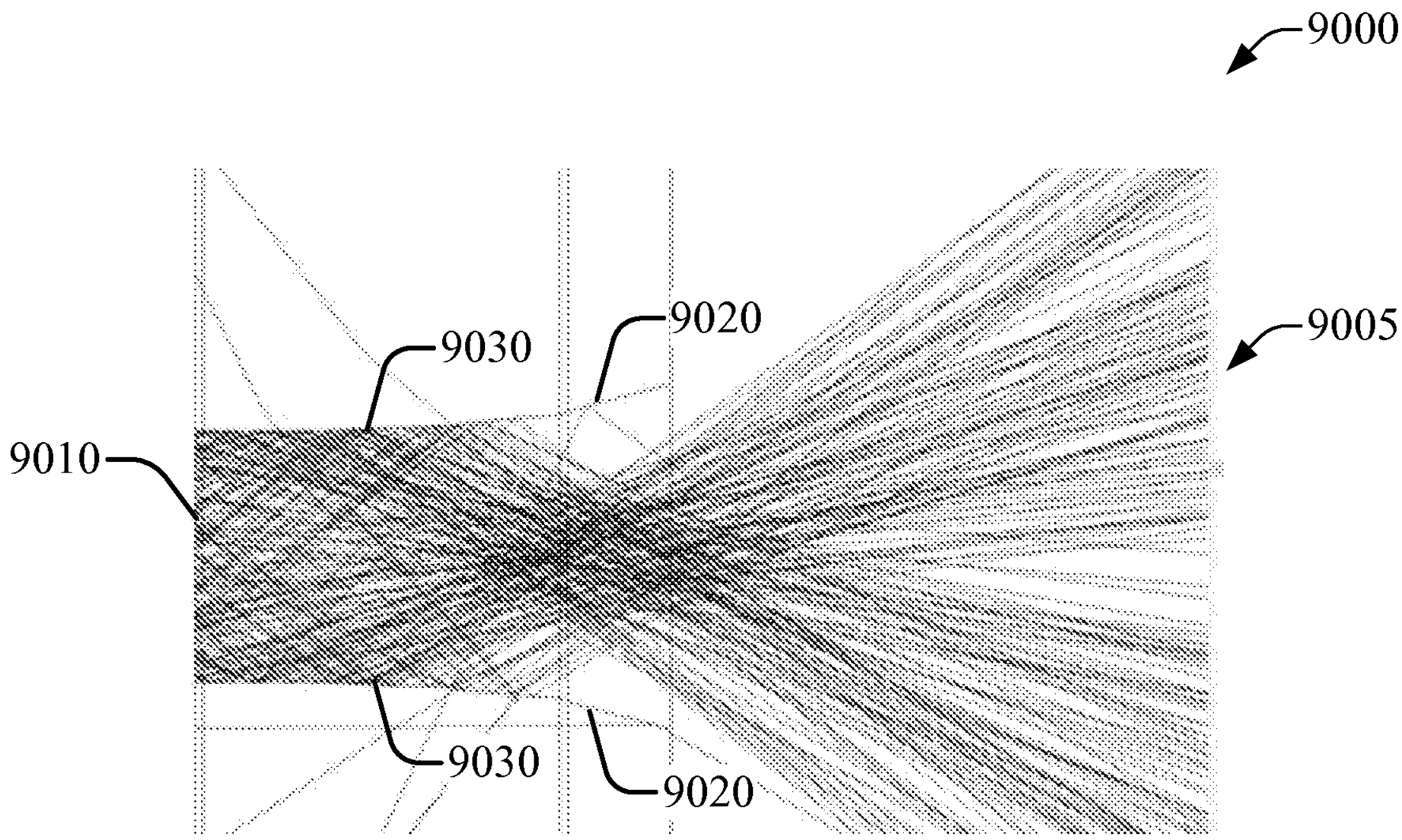


FIG. 90

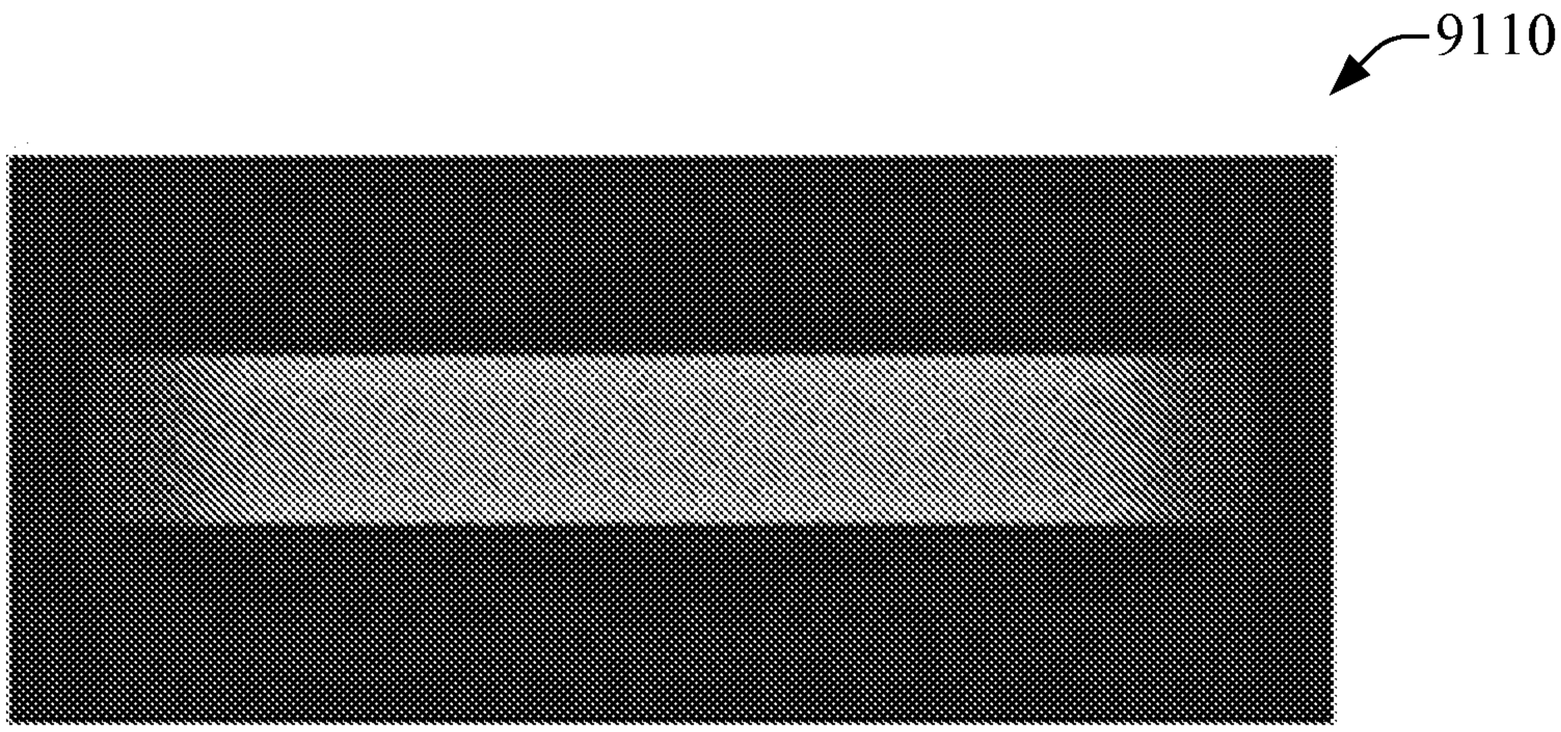


FIG. 91

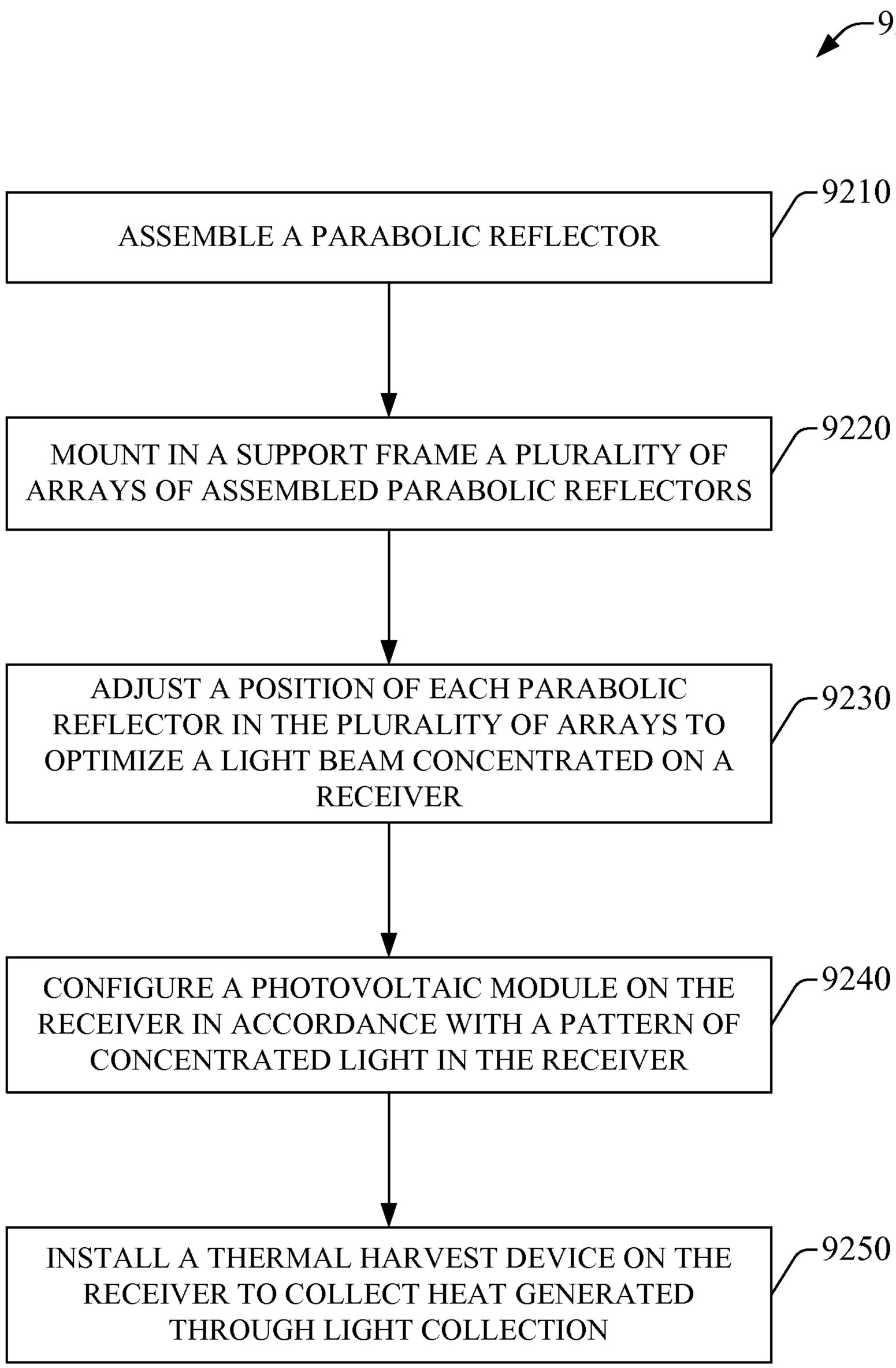

9200
ASSEMBLE A PARABOLIC REFLECTOR
9210
MOUNT IN A SUPPORT FRAME A PLURALITY OF ARRAYS OF ASSEMBLED PARABOLIC REFLECTORS
9220
ADJUST A POSITION OF EACH PARABOLIC REFLECTOR IN THE PLURALITY OF ARRAYS TO OPTIMIZE A LIGHT BEAM CONCENTRATED ON A RECEIVER
9230
CONFIGURE A PHOTOVOLTAIC MODULE ON THE RECEIVER IN ACCORDANCE WITH A PATTERN OF CONCENTRATED LIGHT IN THE RECEIVER
9240
INSTALL A THERMAL HARVEST DEVICE ON THE RECEIVER TO COLLECT HEAT GENERATED THROUGH LIGHT COLLECTION
9250

FIG. 92

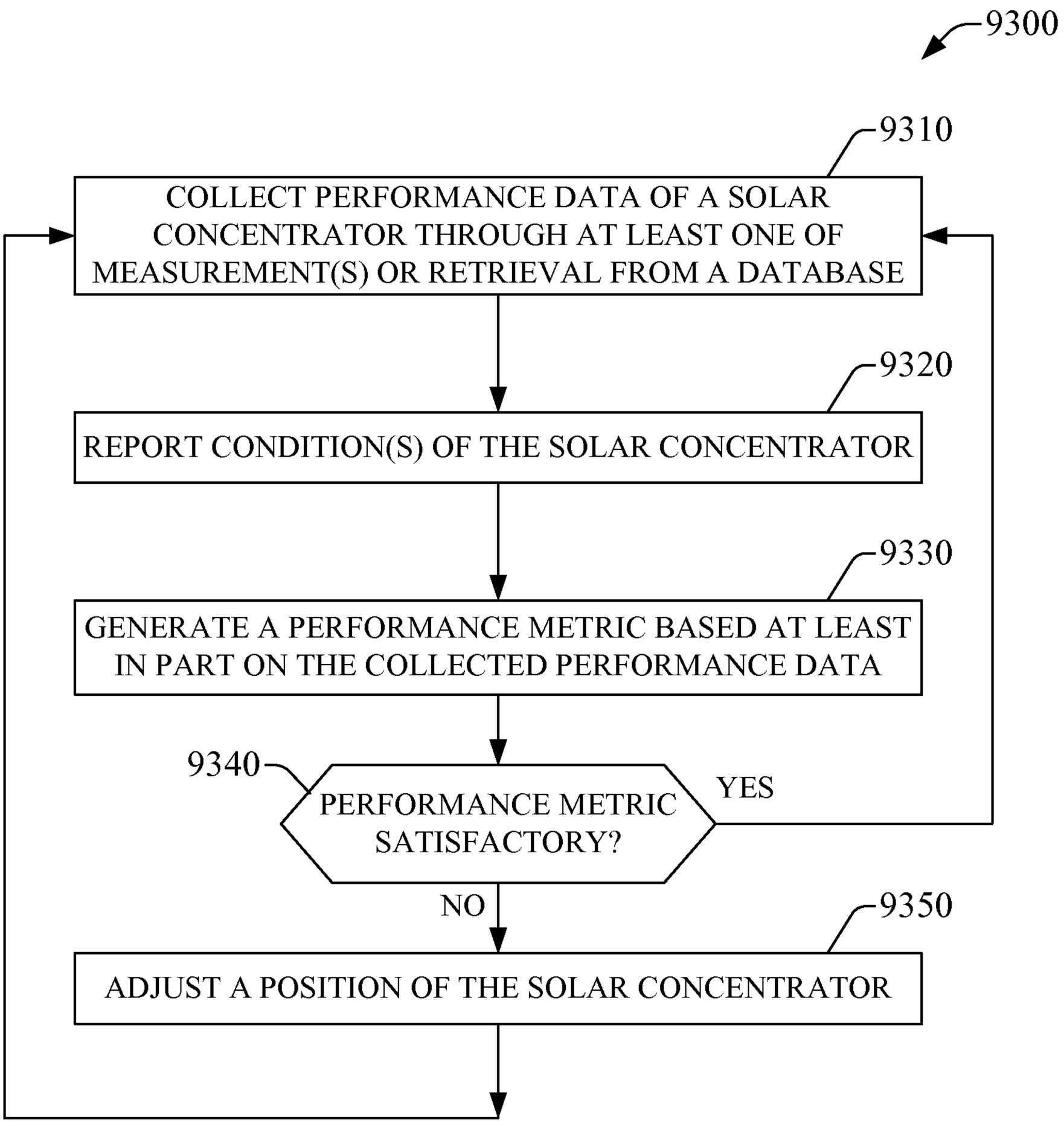

9300
9310
COLLECT PERFORMANCE DATA OF A SOLAR CONCENTRATOR THROUGH AT LEAST ONE OF MEASUREMENT(S) OR RETRIEVAL FROM A DATABASE
9320
REPORT CONDITION(S) OF THE SOLAR CONCENTRATOR
9330
GENERATE A PERFORMANCE METRIC BASED AT LEAST IN PART ON THE COLLECTED PERFORMANCE DATA
9340
PERFORMANCE METRIC SATISFACTORY?
YES
NO
9350
ADJUST A POSITION OF THE SOLAR CONCENTRATOR

FIG. 93

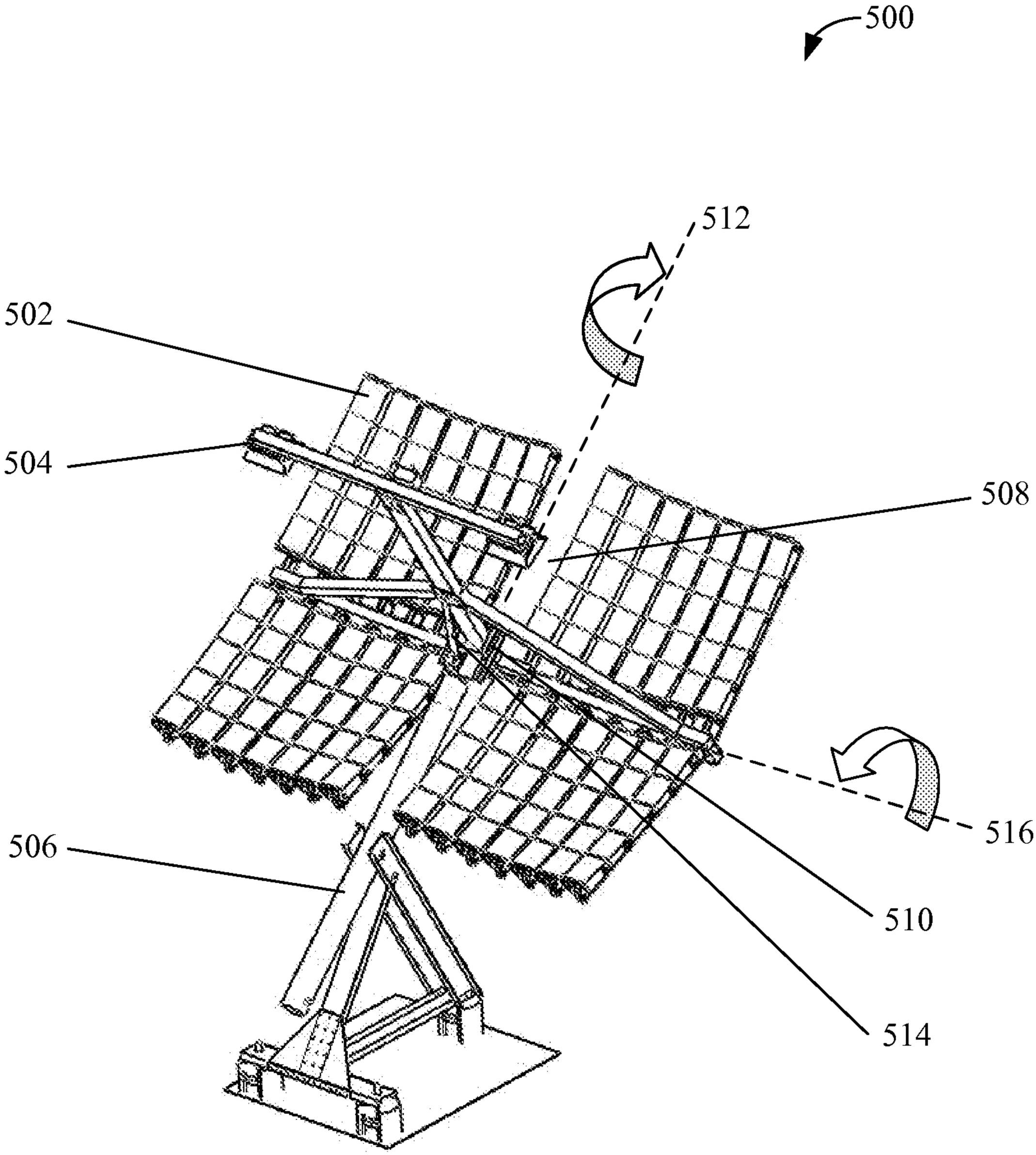


FIG. 5