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(54) SOLID CORE STRUCTURE PARABOLIC TROUGH SOLAR ENERGY COLLECTION SYSTEM

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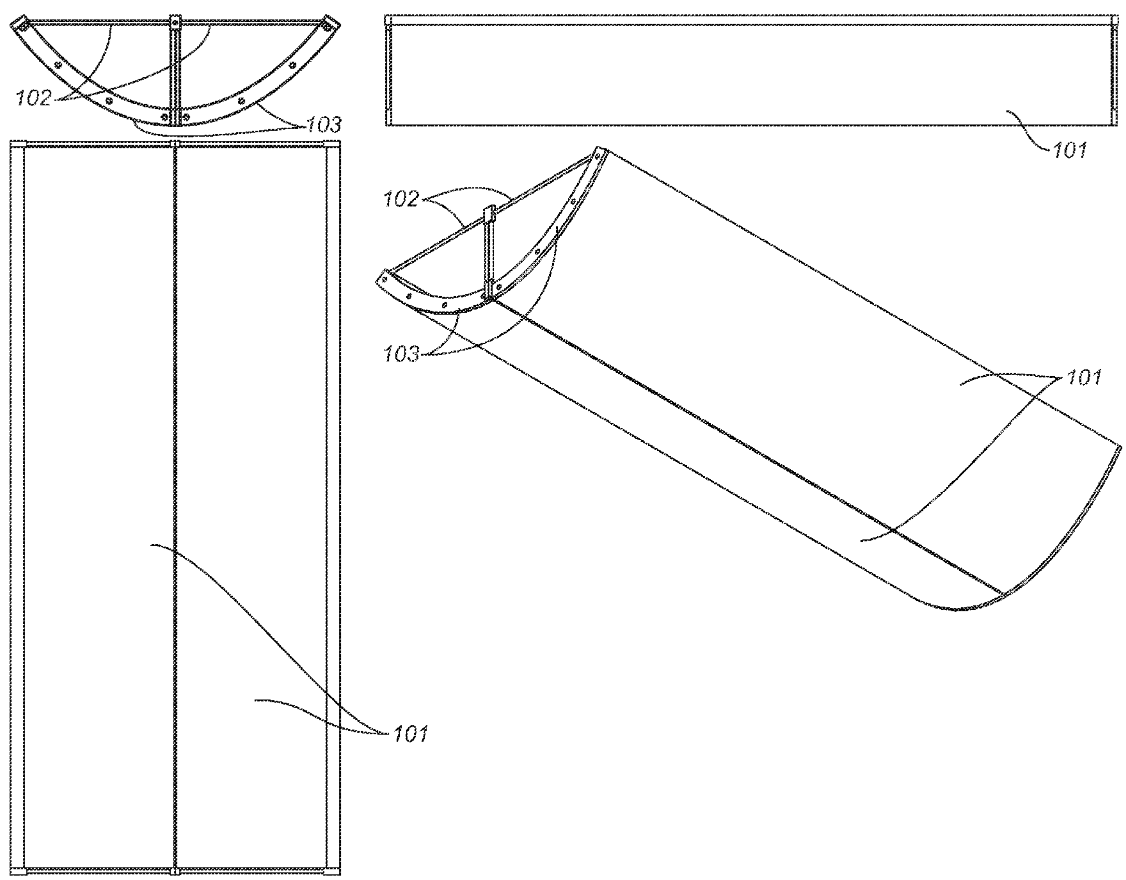
(52) **U.S. Cl.** **126/694**

(57) **ABSTRACT**

Foam backed solid support structure and trough solar energy collector. A support structure has foam or other polymeric material, a plurality of end arms, and a plurality of end caps secured to the formed foam material. The foam material is cut into a parabolic or semi-parabolic shape, and a reflective element may be placed onto the formed foam material and secured mechanically, with adhesion, and/or integrated with the surface. A solar energy collector formed using a polymeric core may have longitudinally-extending cowling, end caps, and end arms as described.



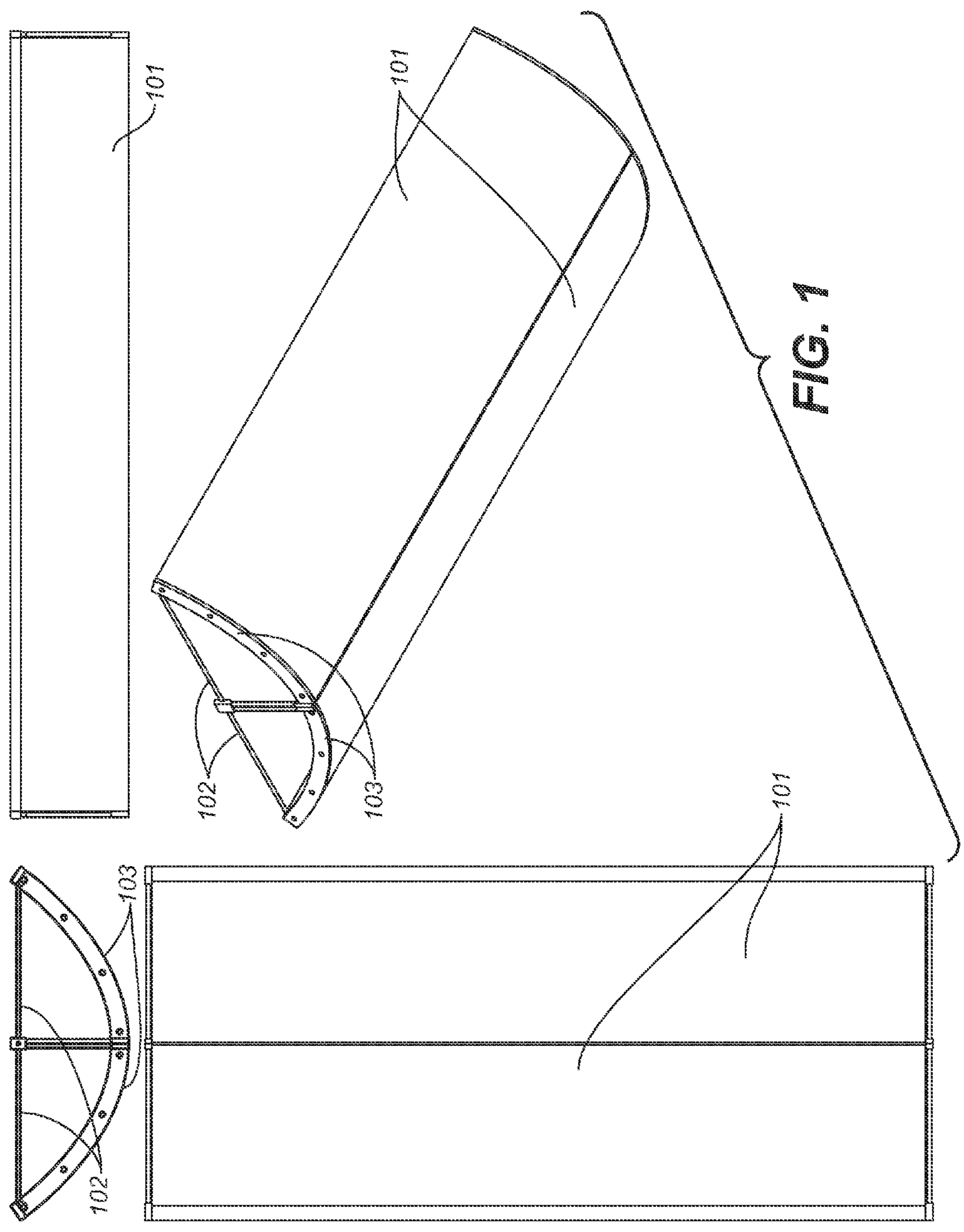


FIG. 1

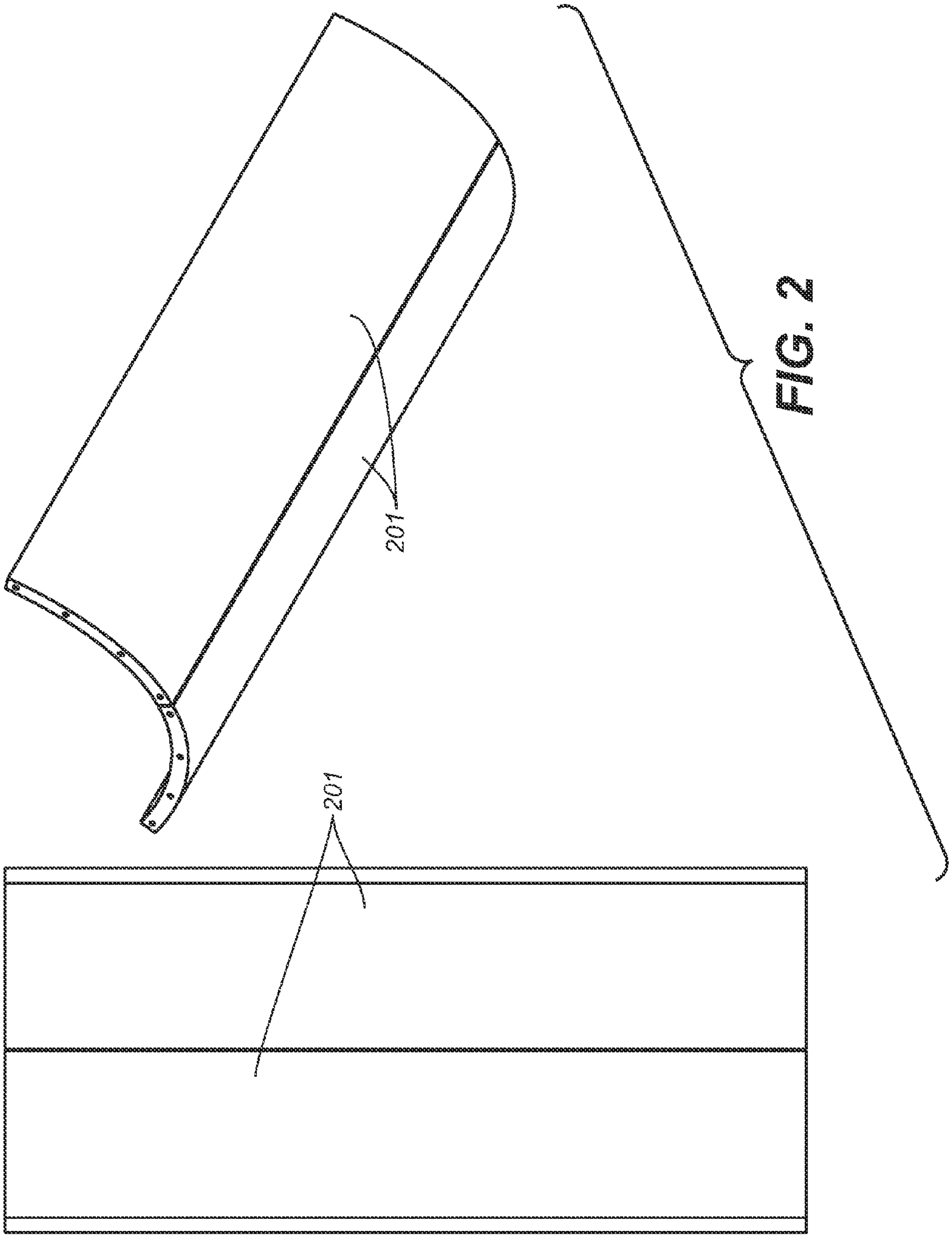
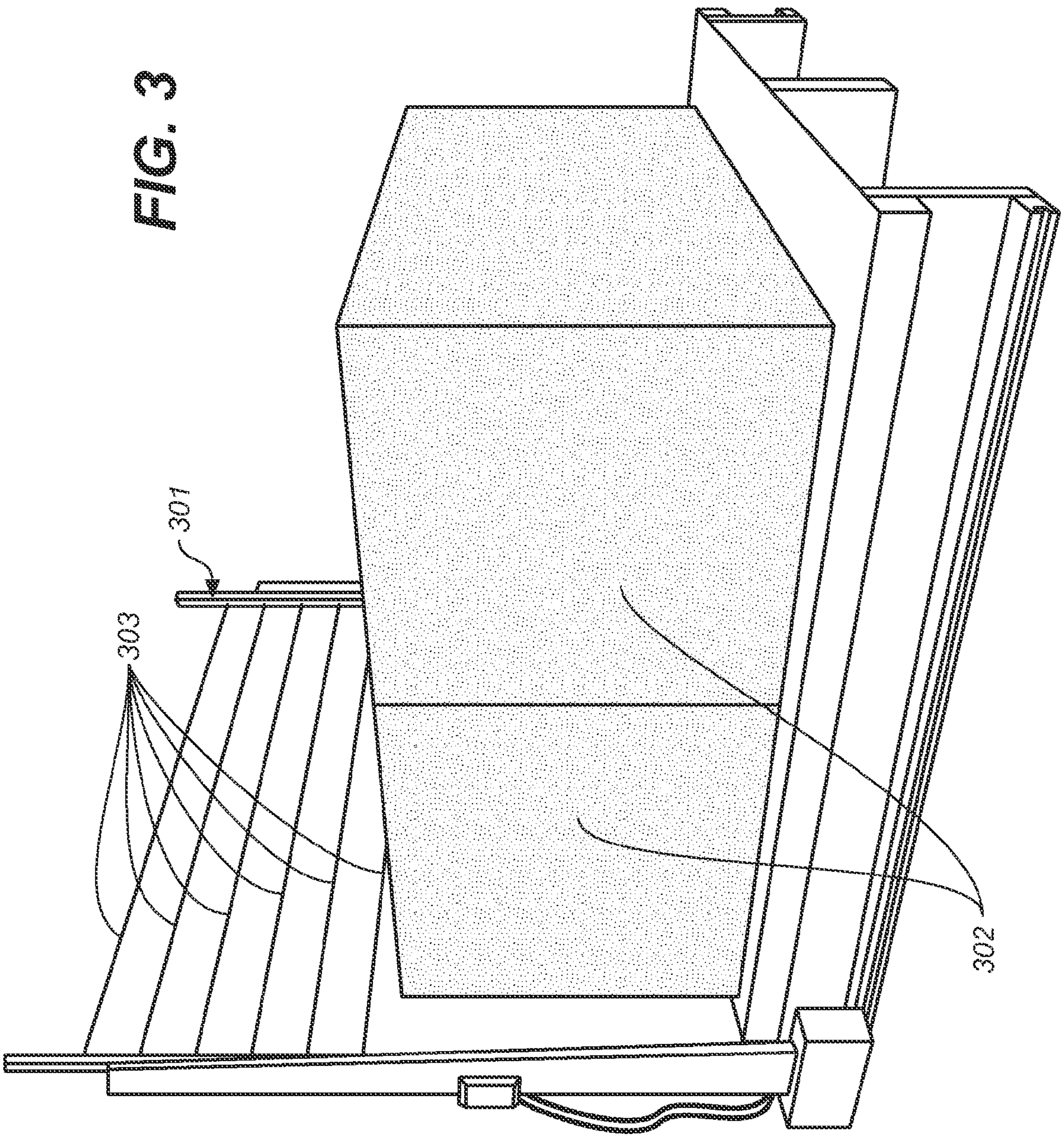


FIG. 2

FIG. 3



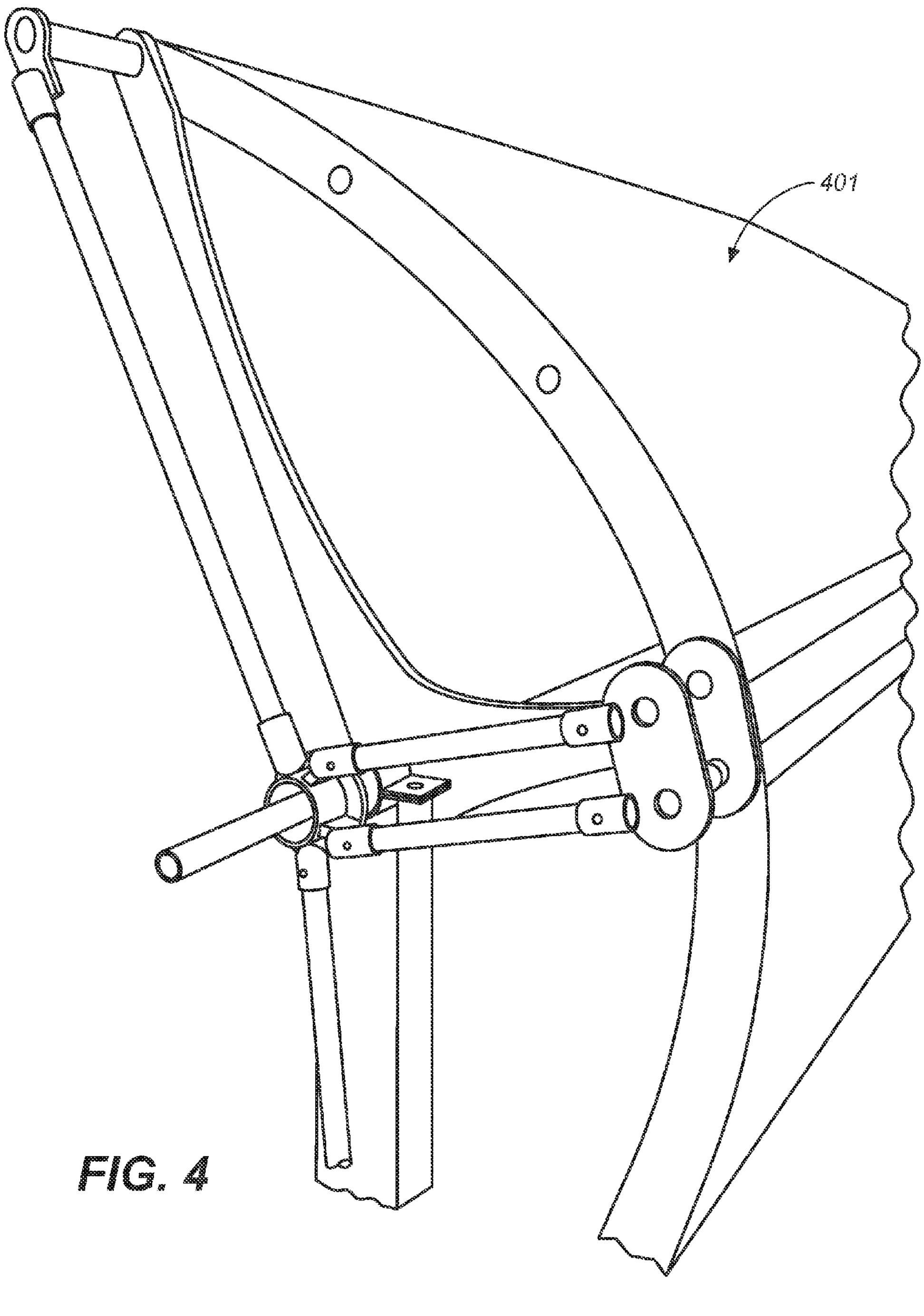


FIG. 4

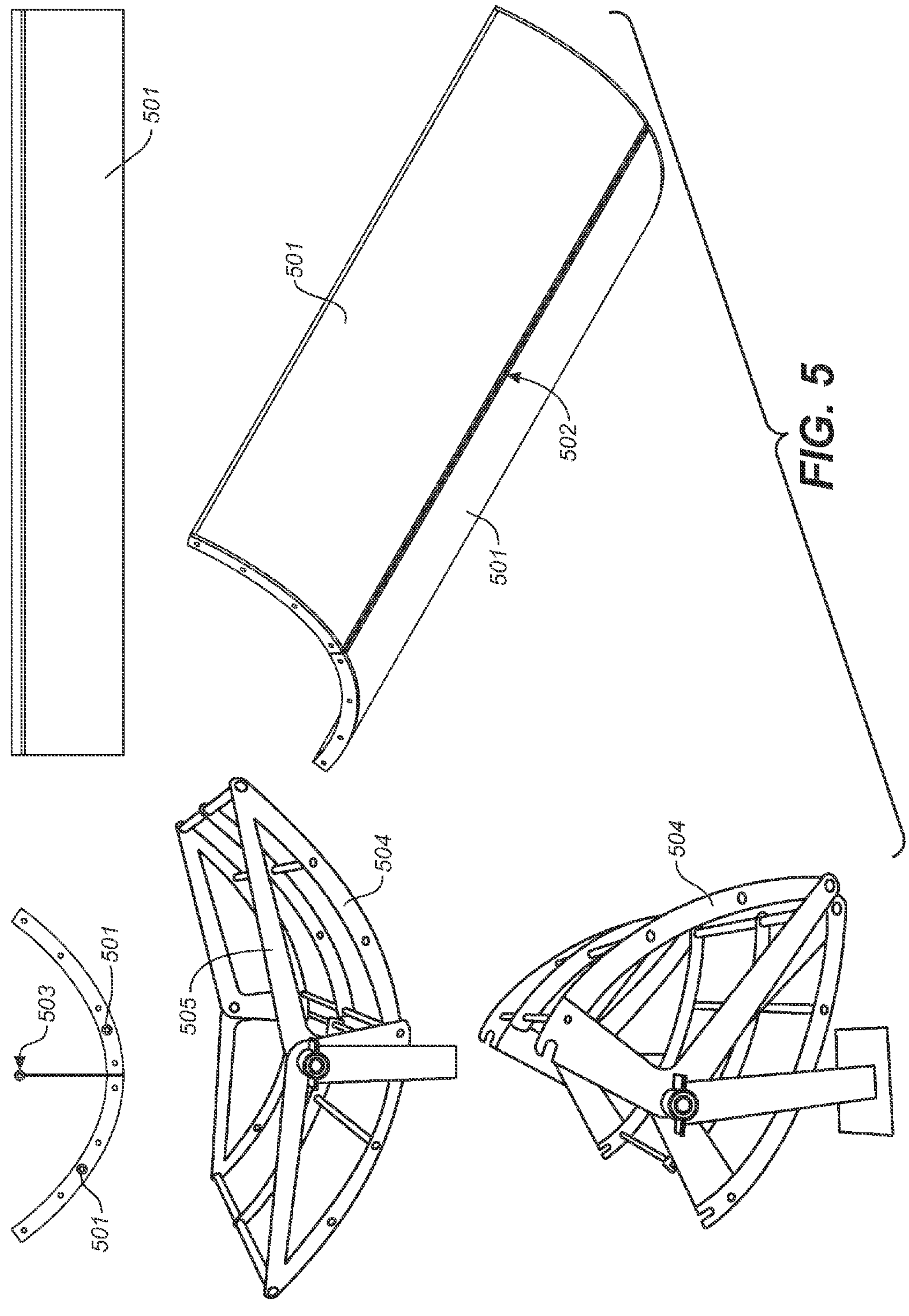


FIG. 5

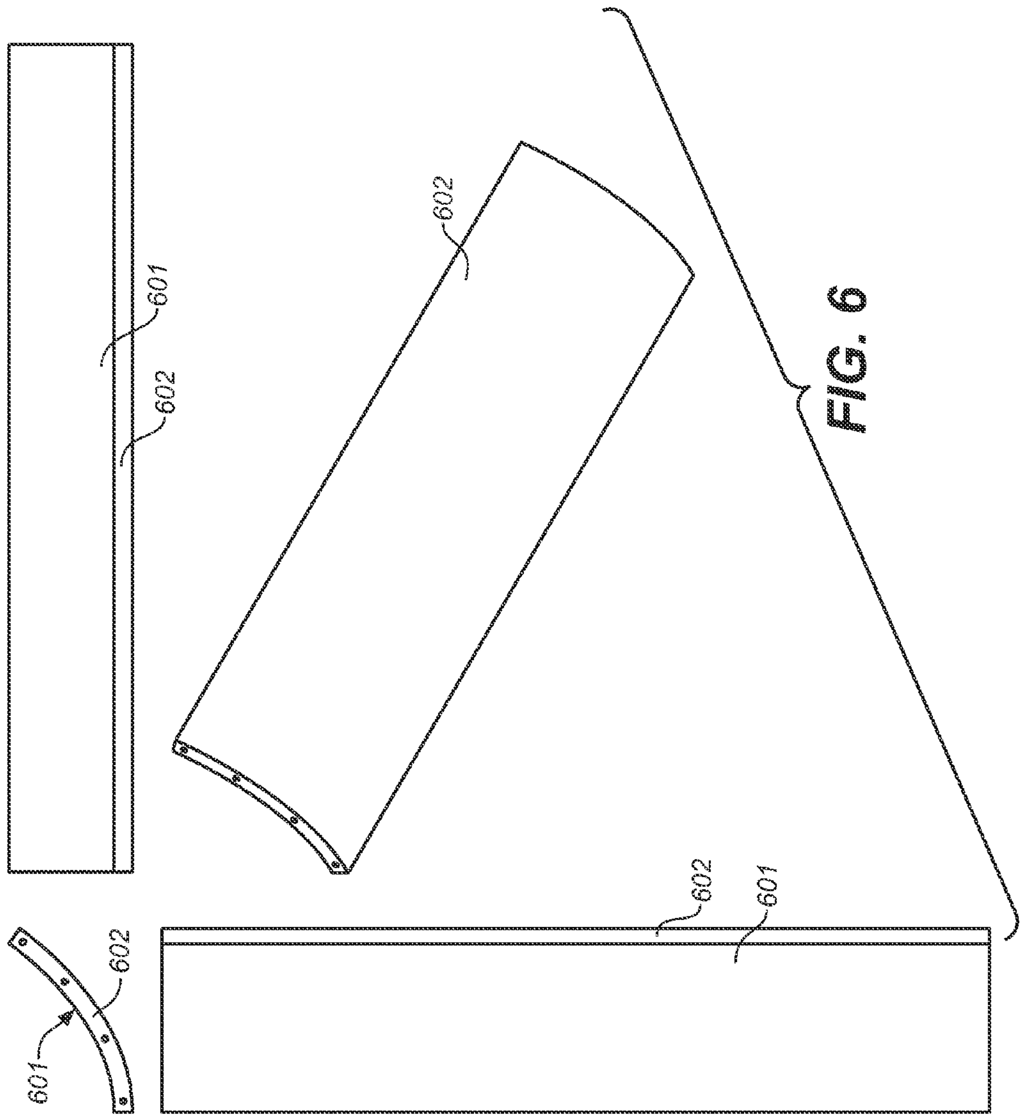


FIG. 6

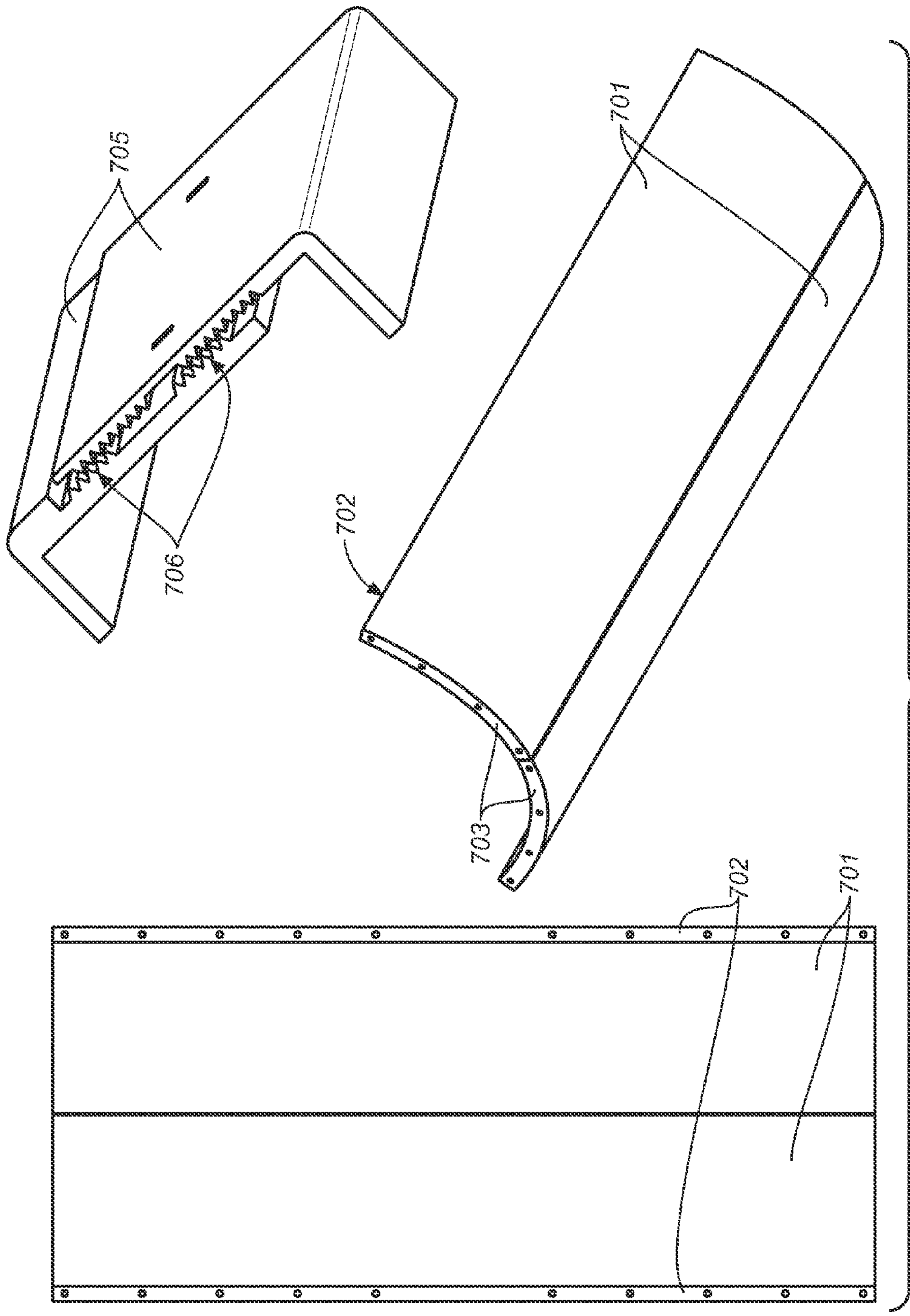


FIG. 7

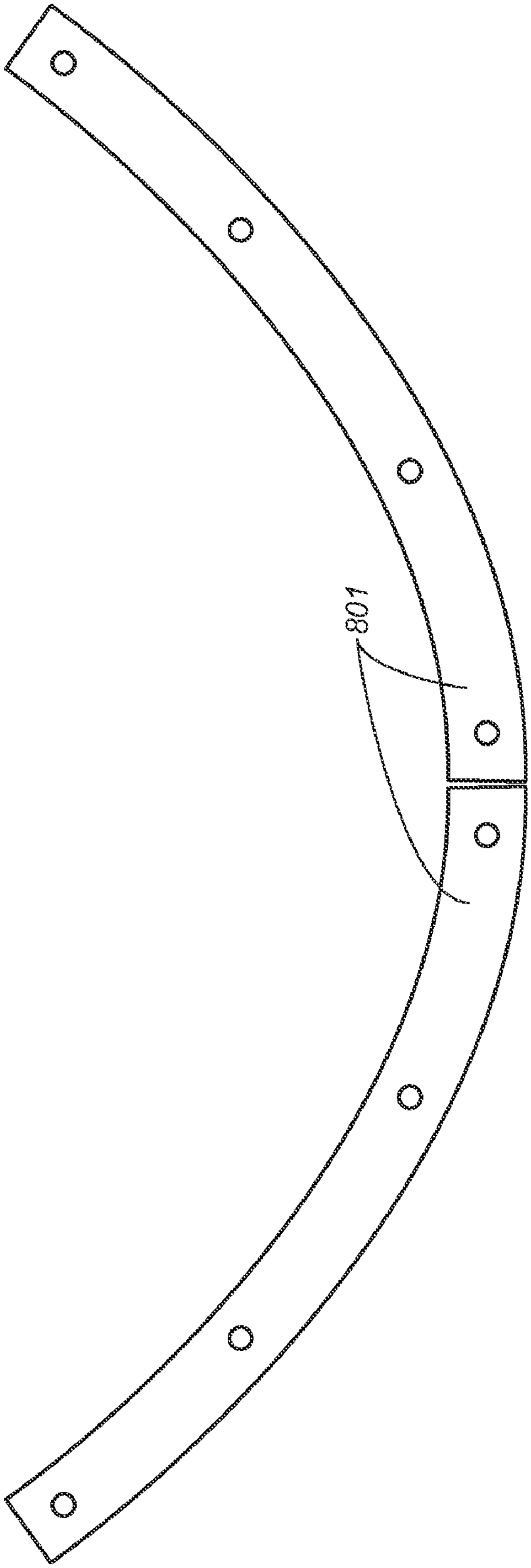
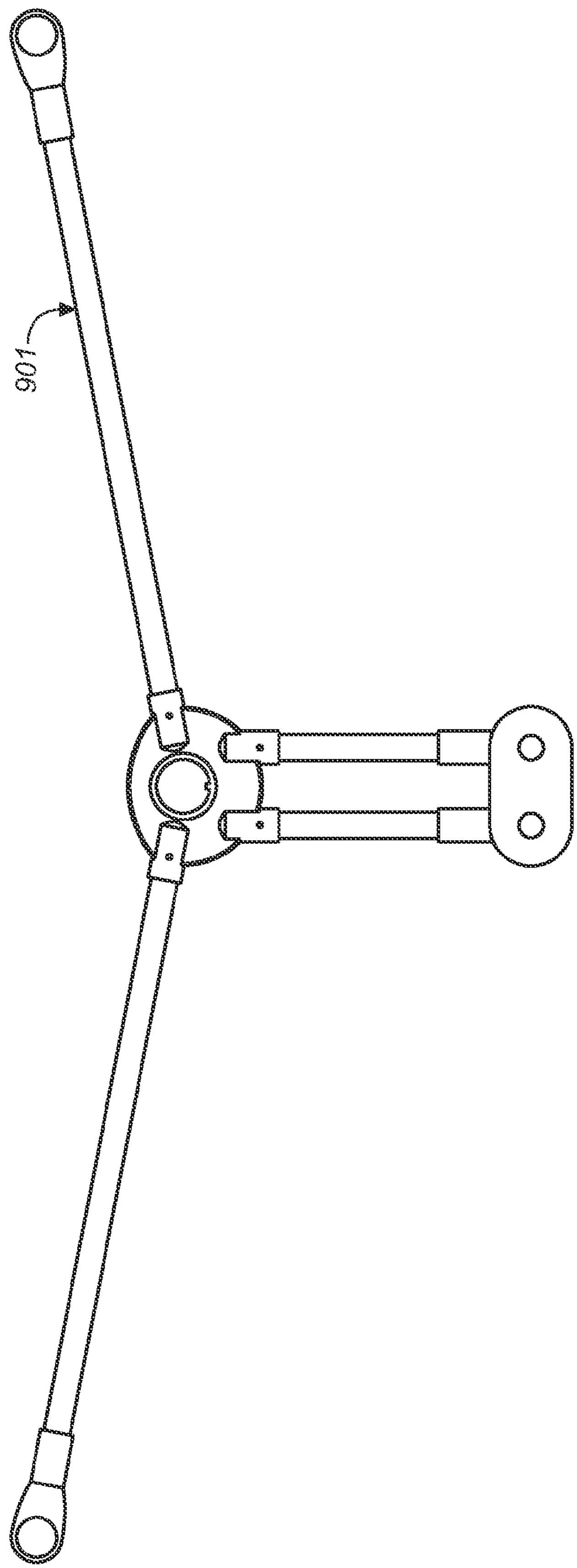


FIG. 8



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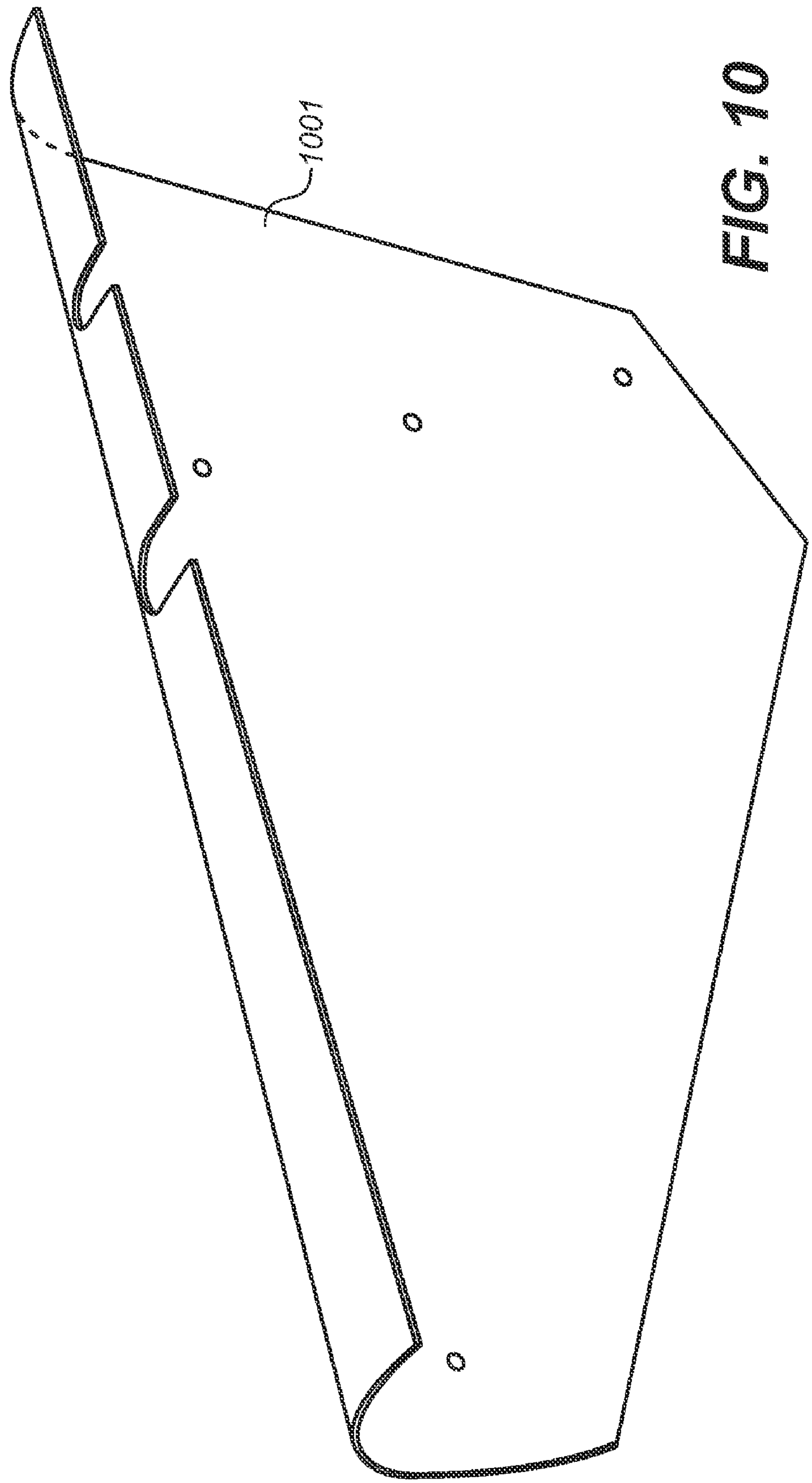

FIG. 10

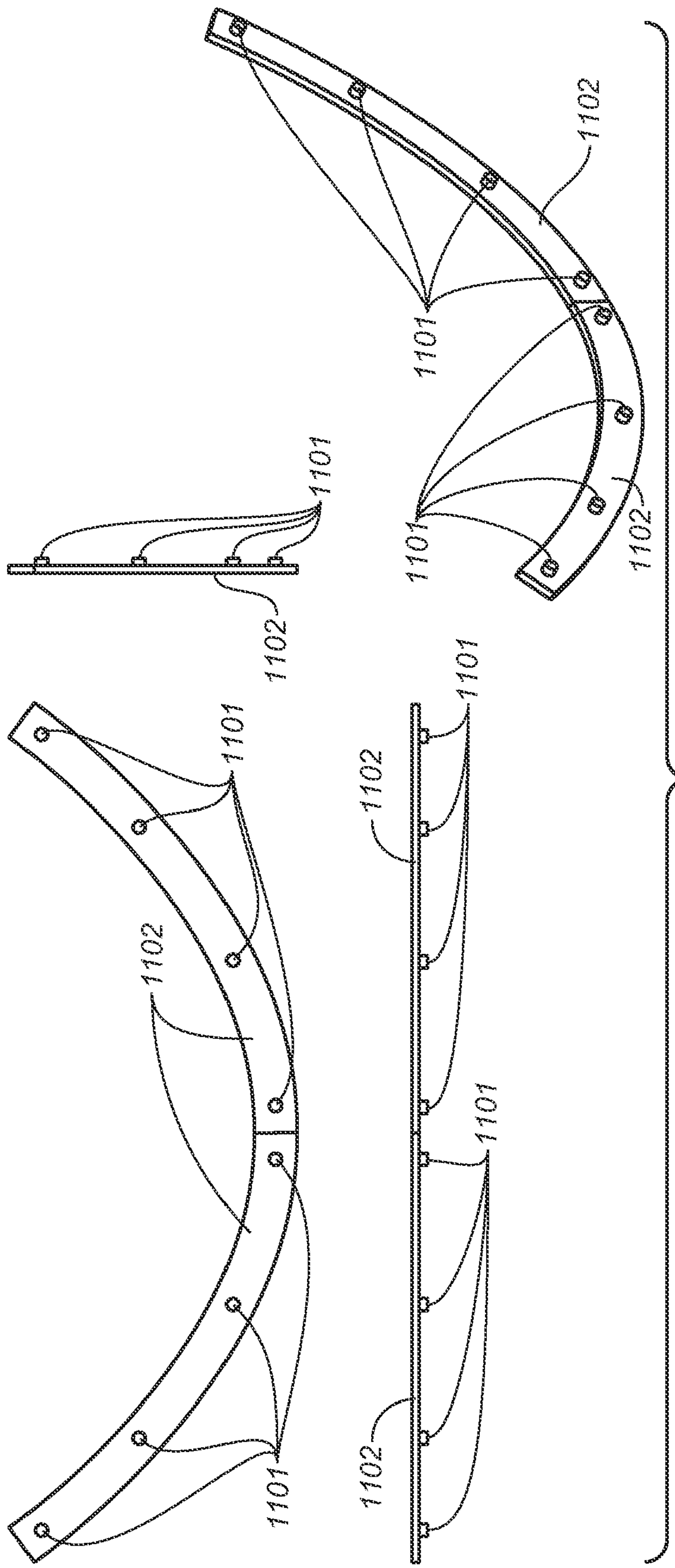
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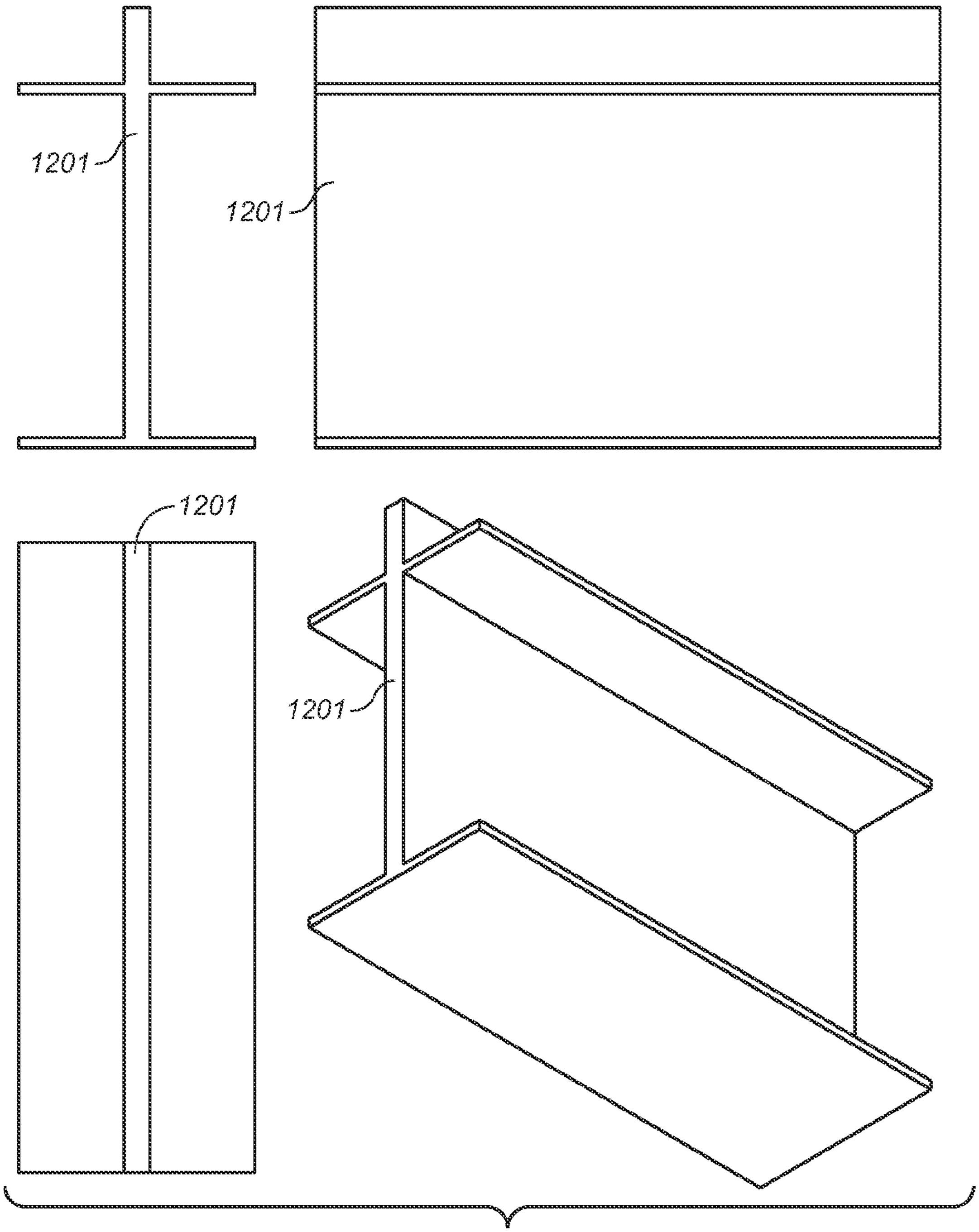
FIG. 11



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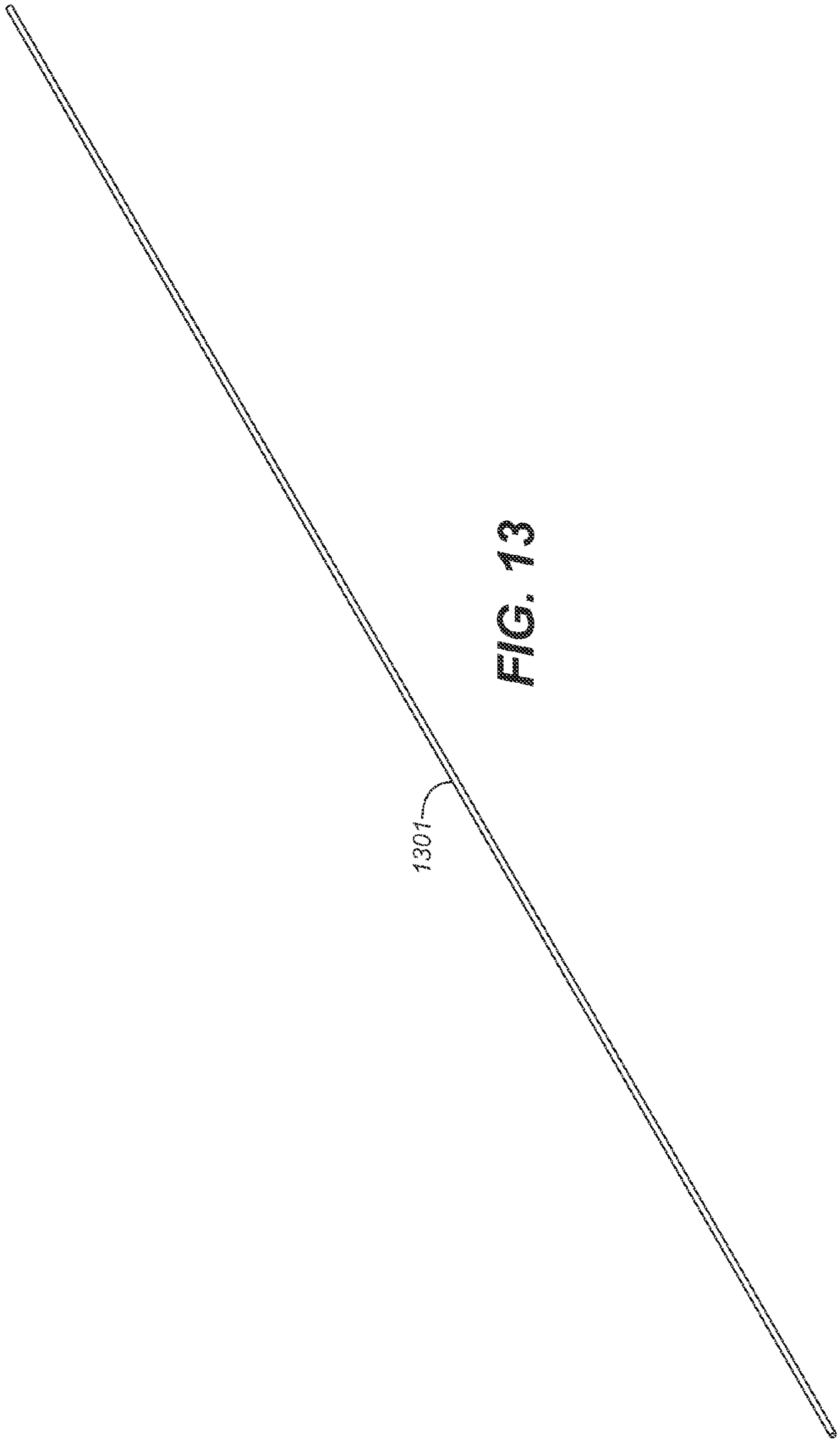


FIG. 13

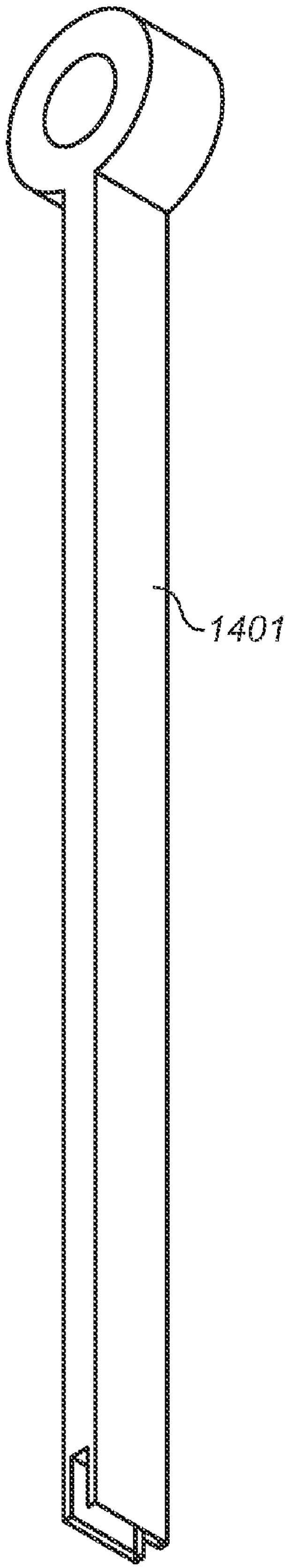
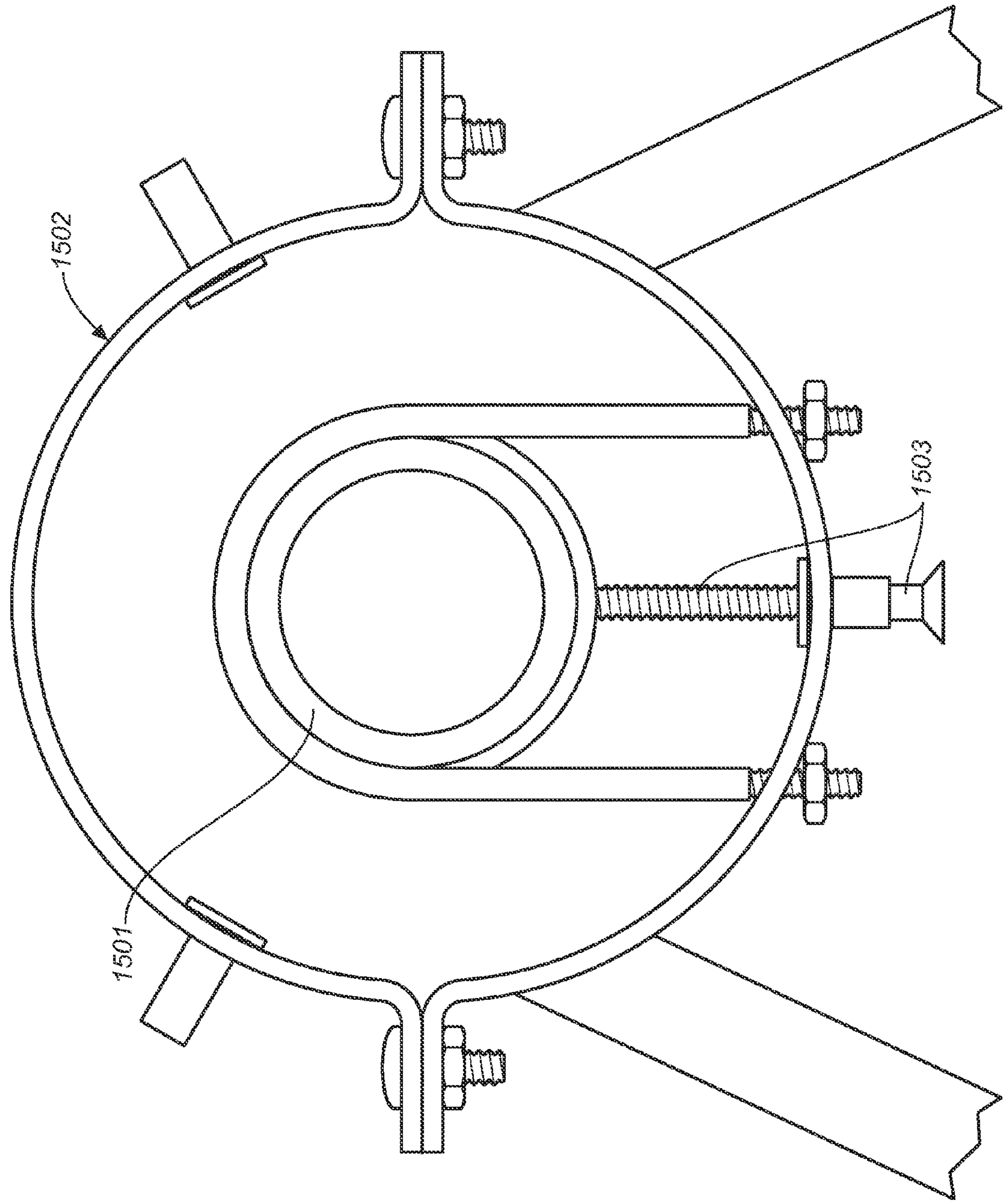


FIG. 14



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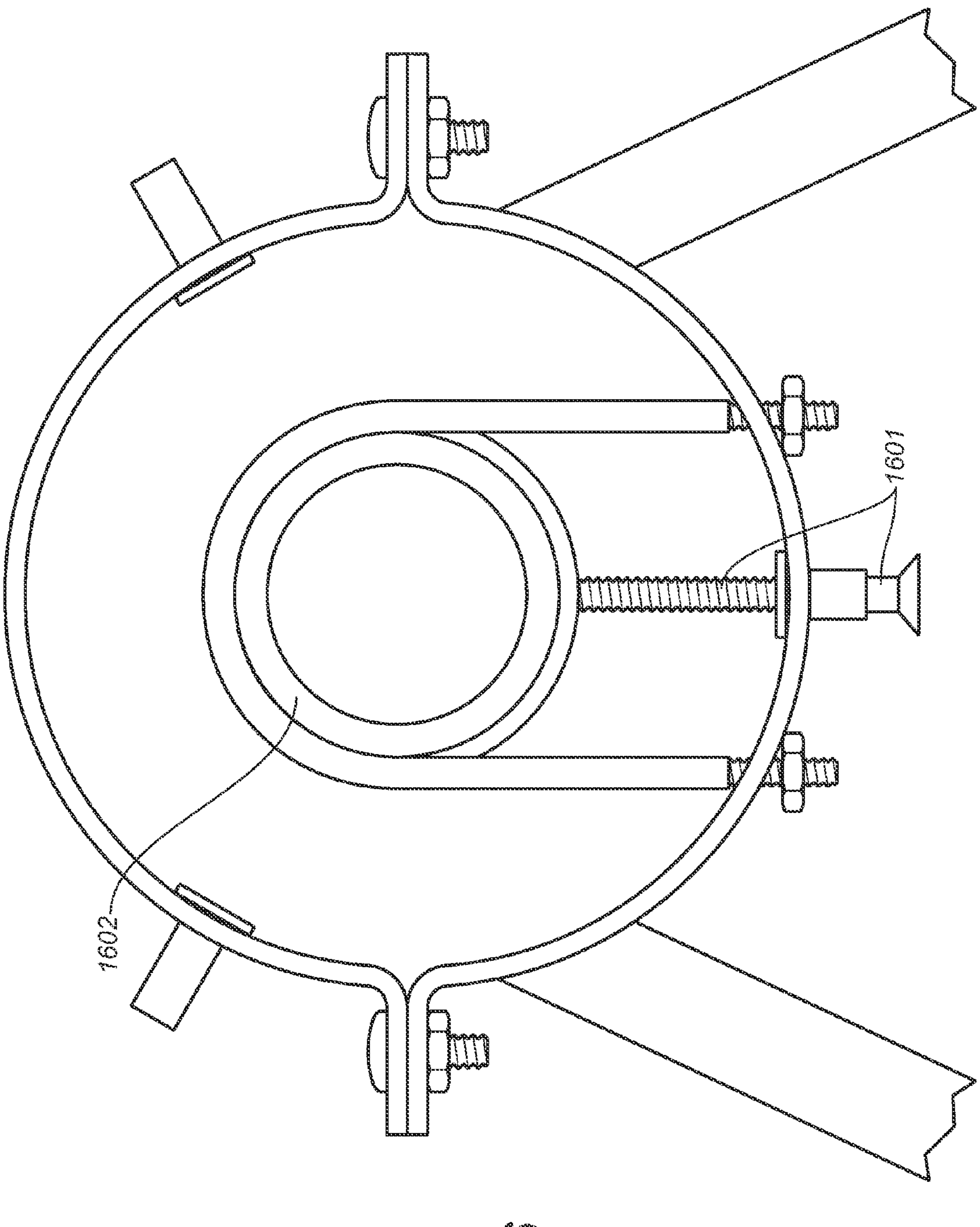

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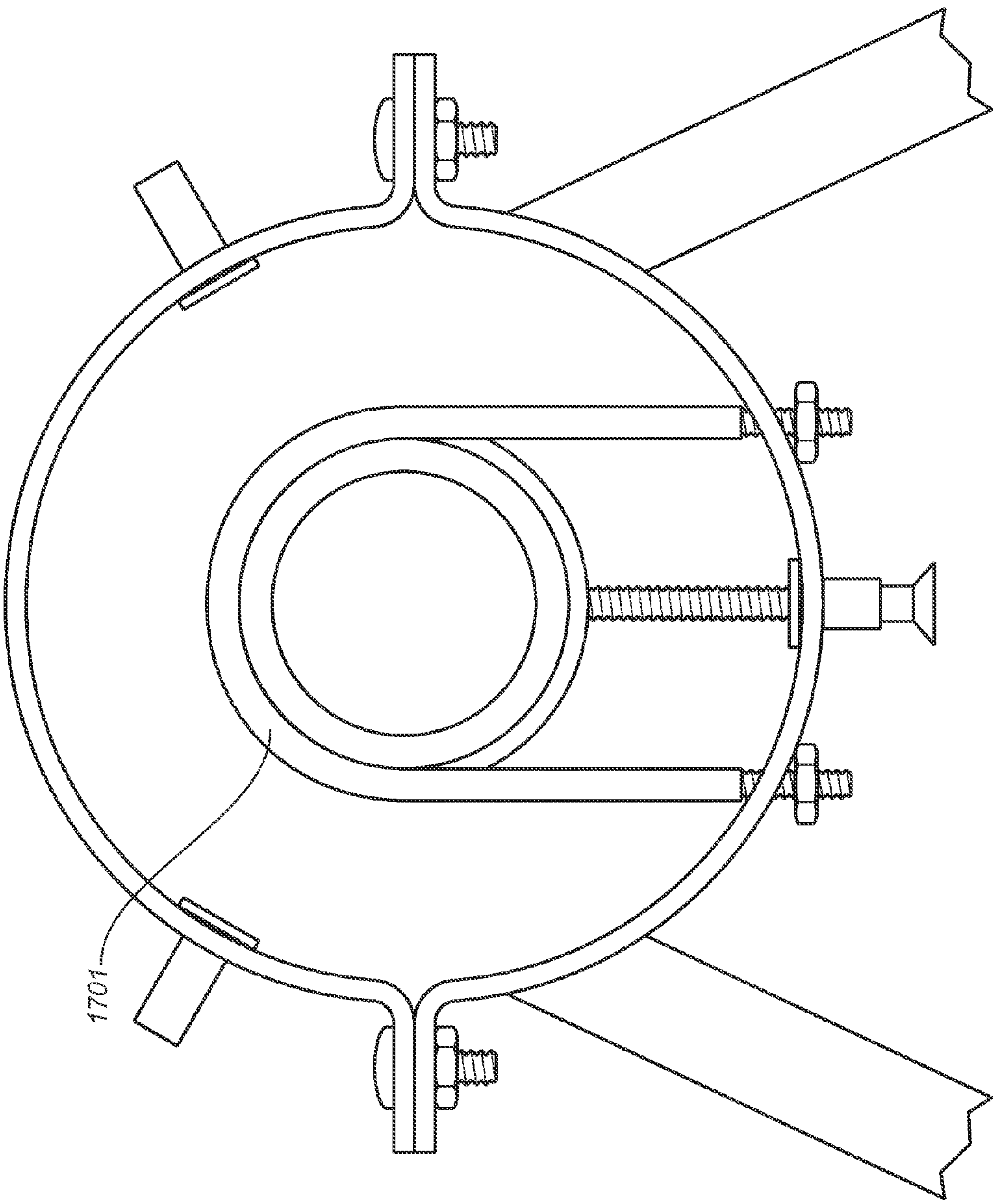

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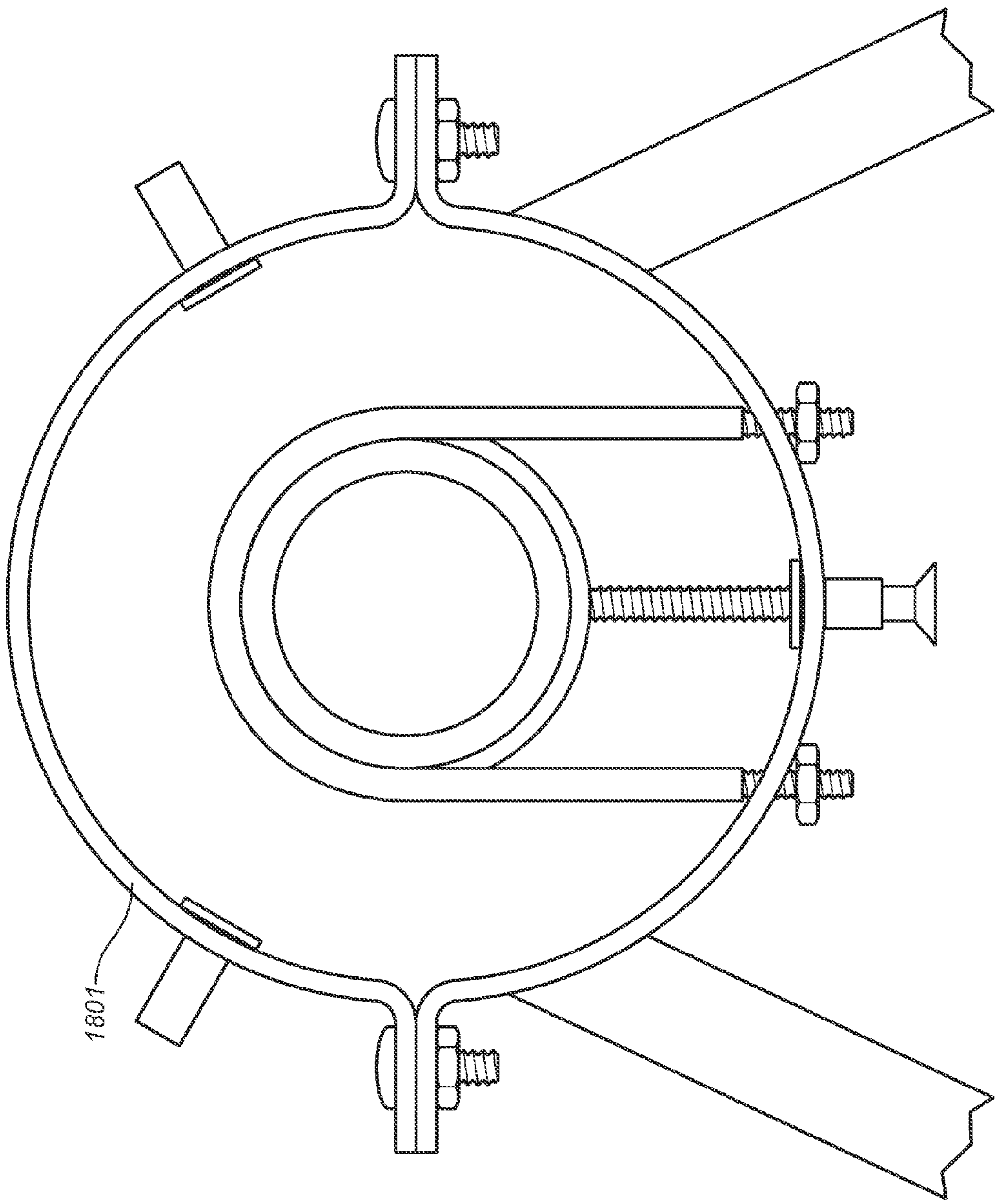


FIG. 18

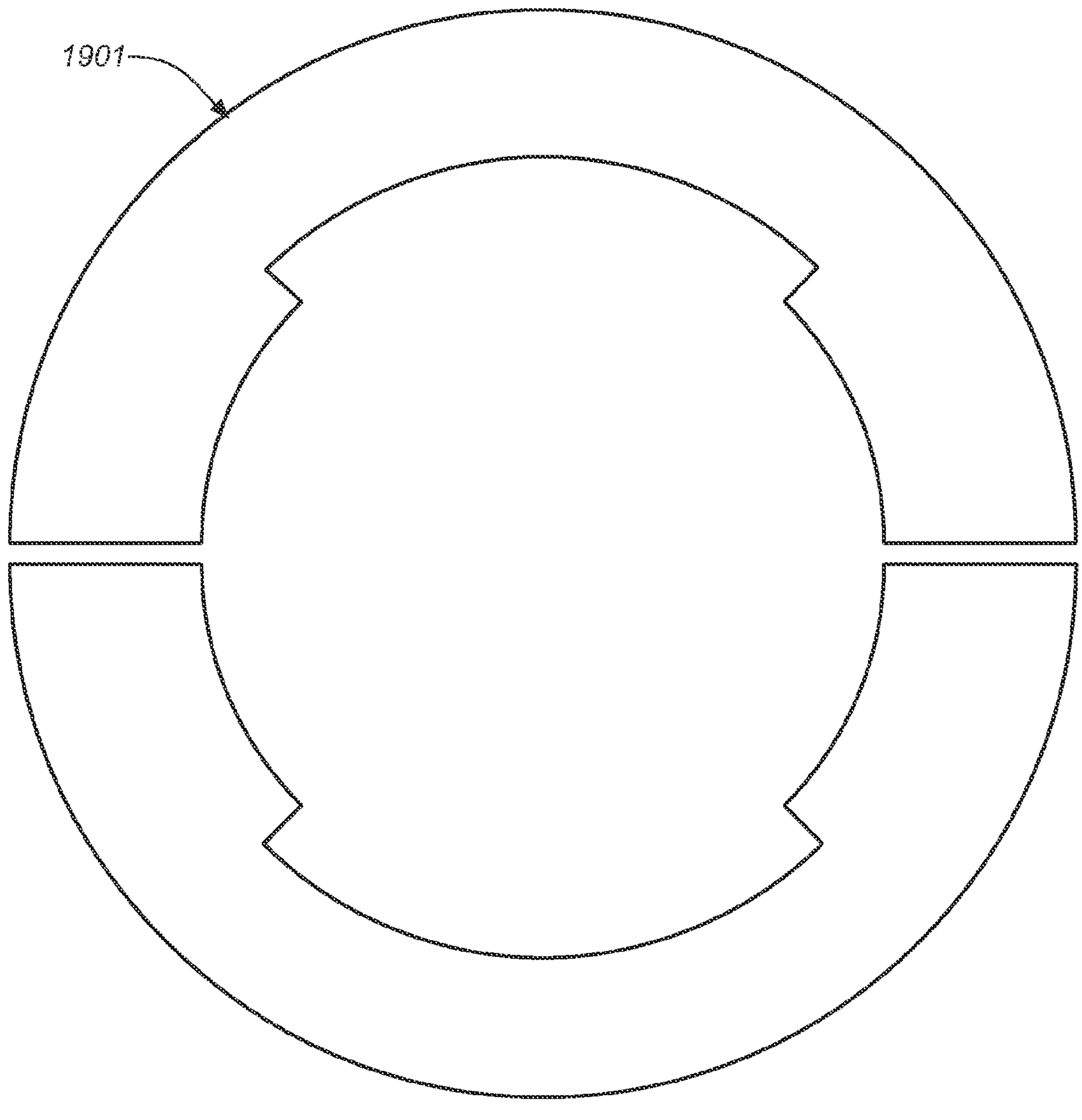


FIG. 19

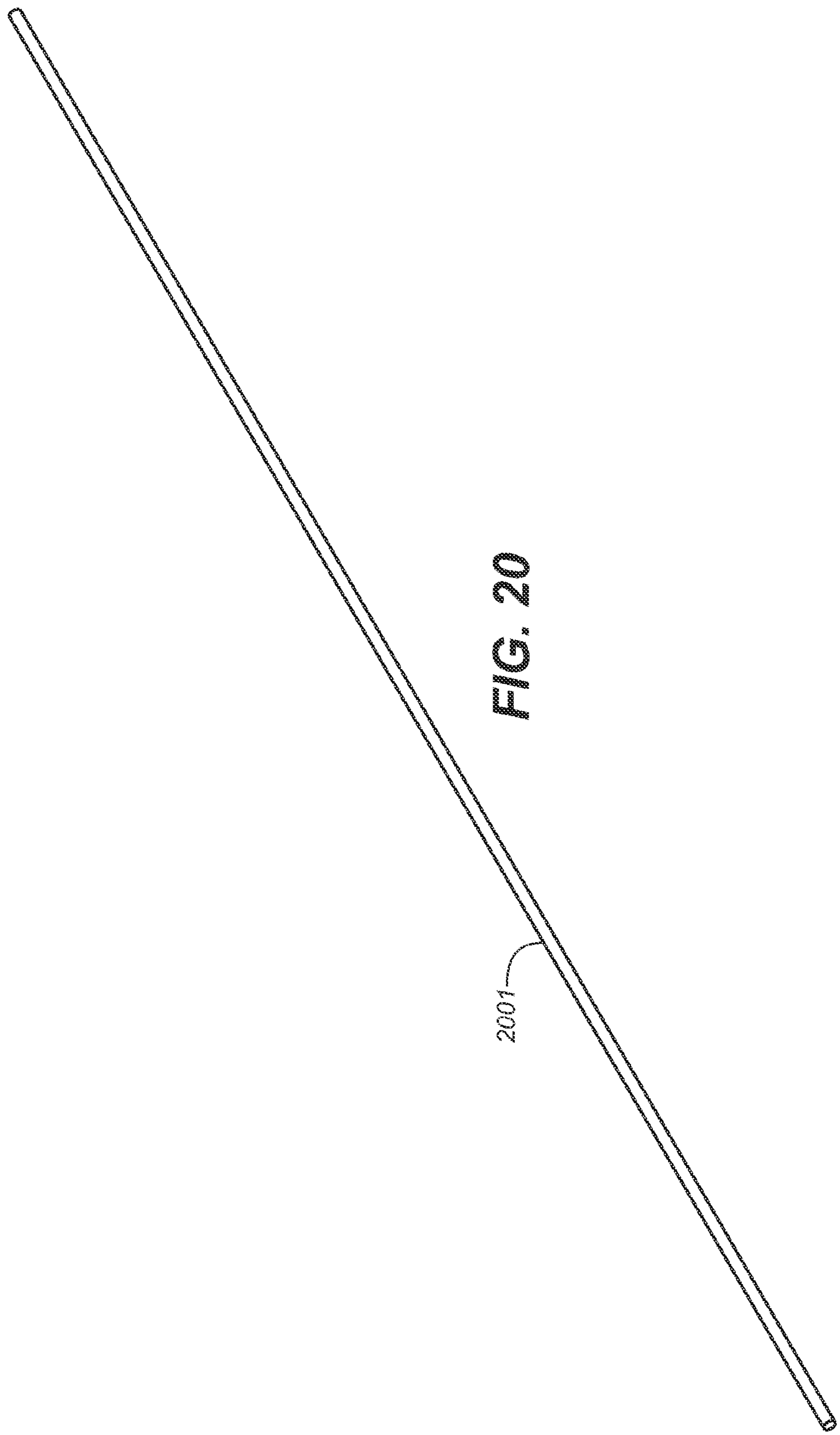


FIG. 20

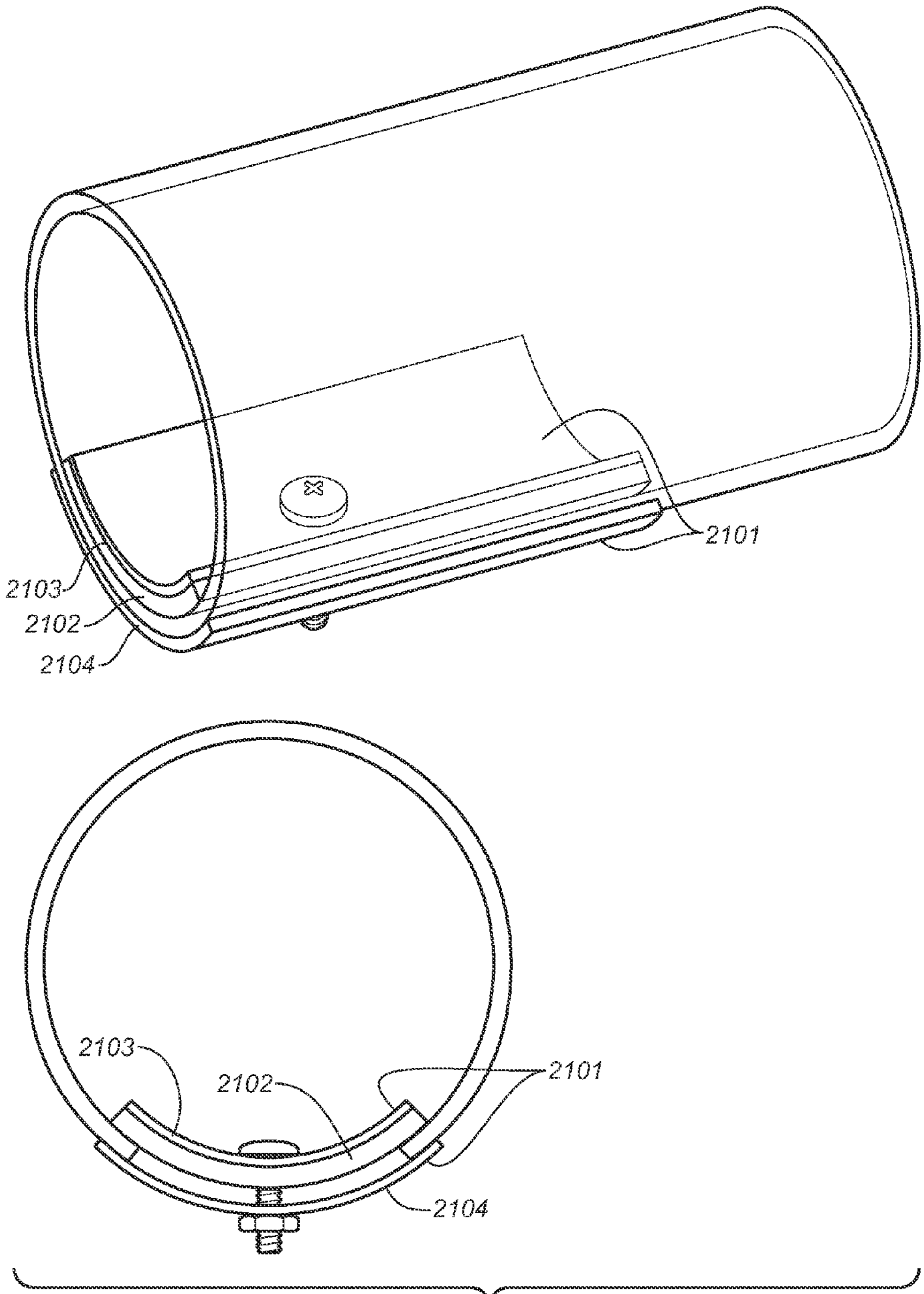
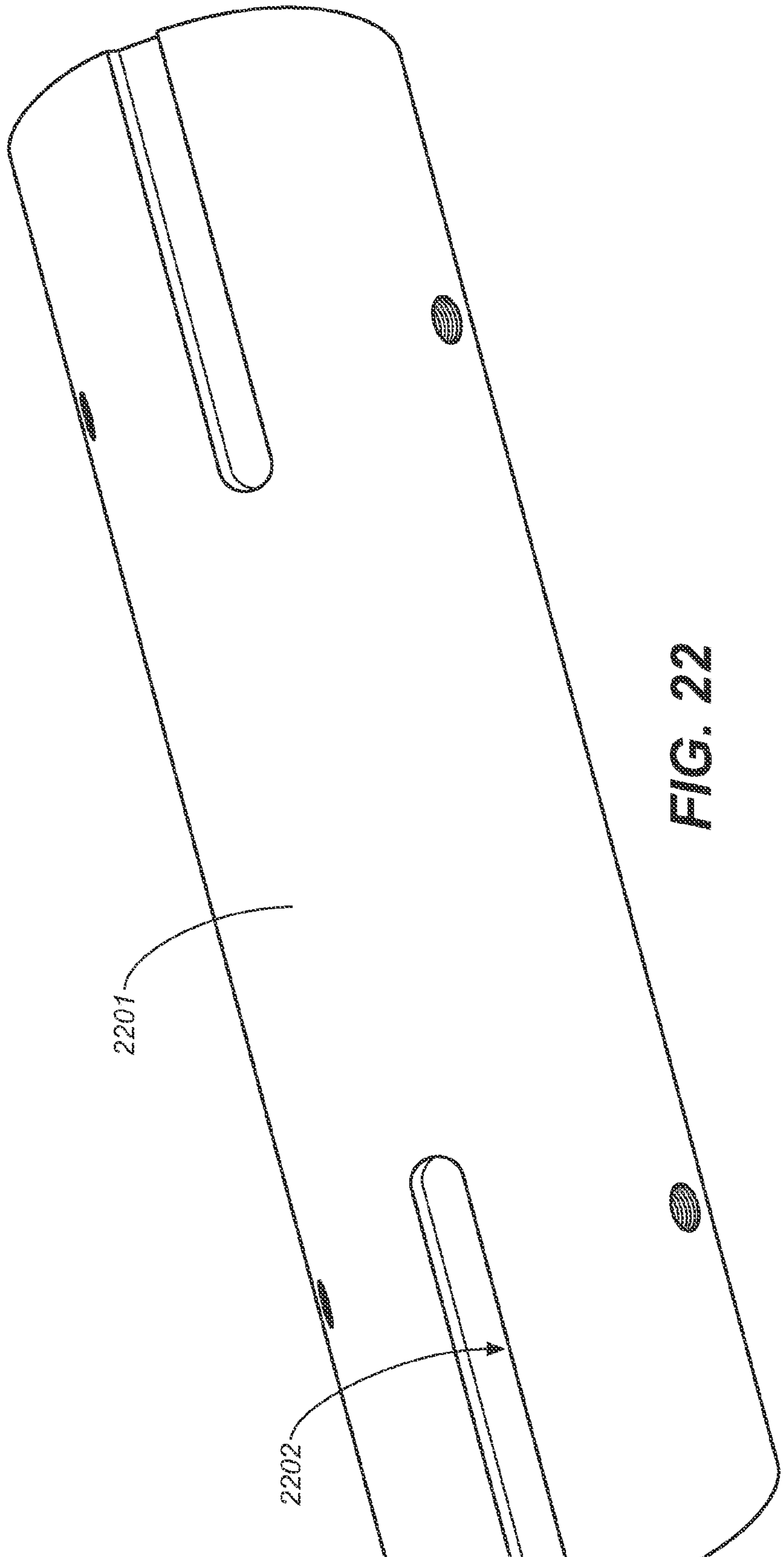


FIG. 21



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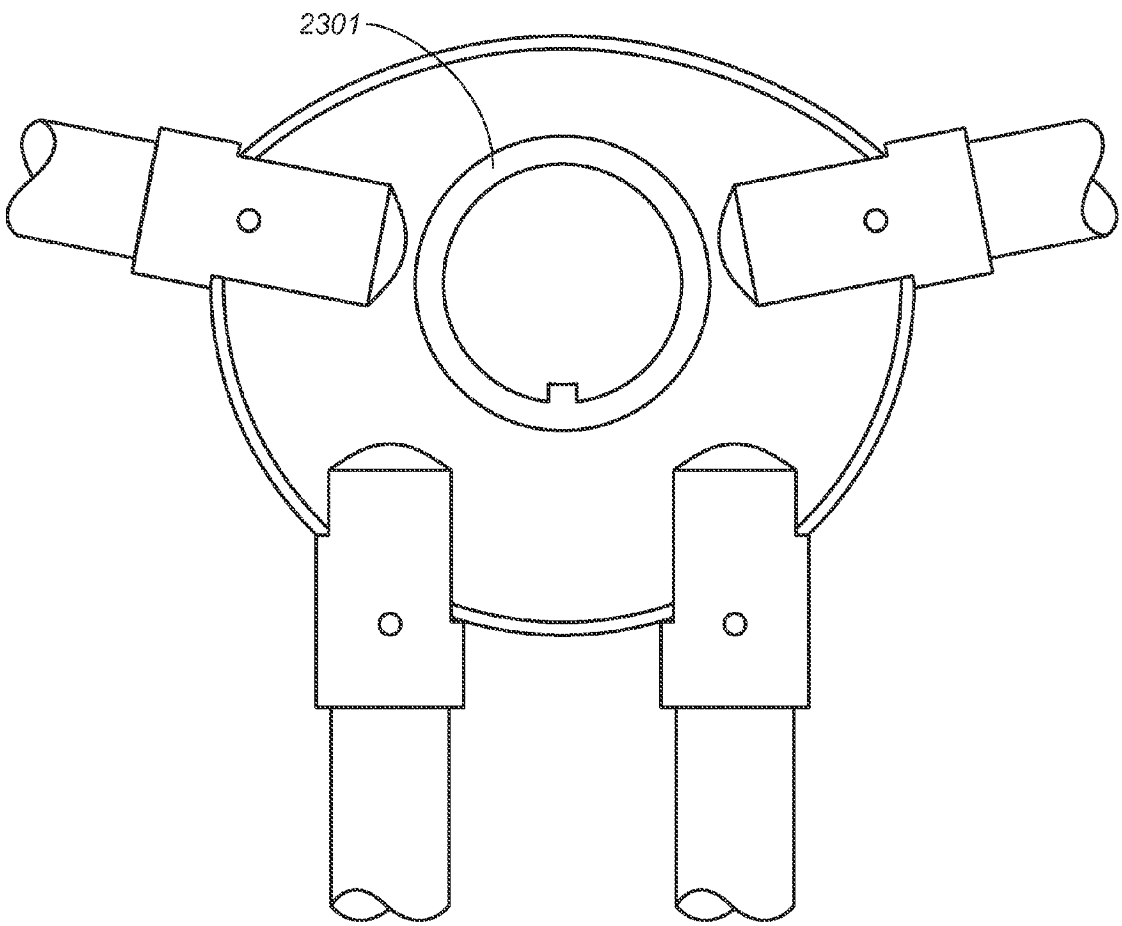


FIG. 23

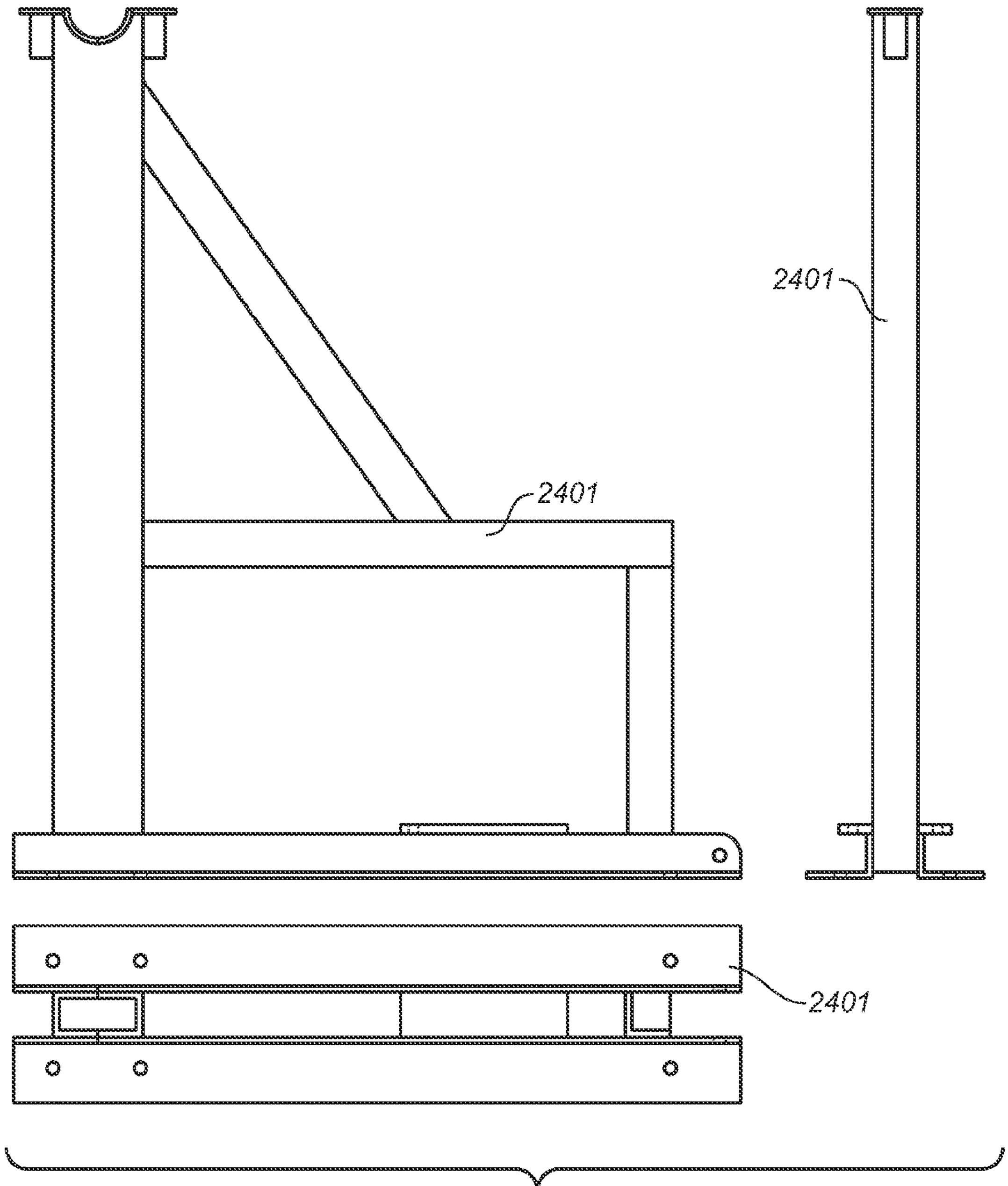


FIG. 24

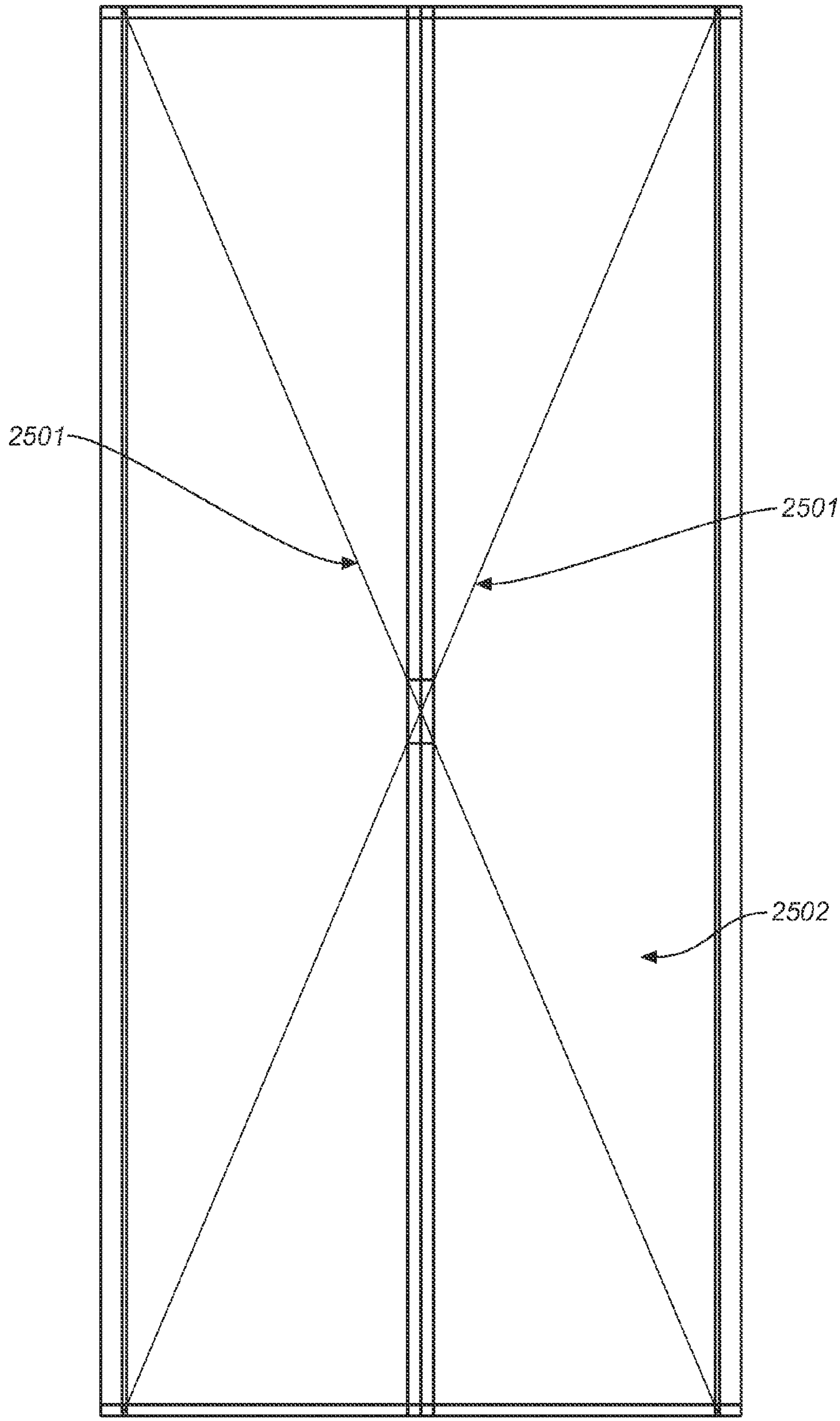
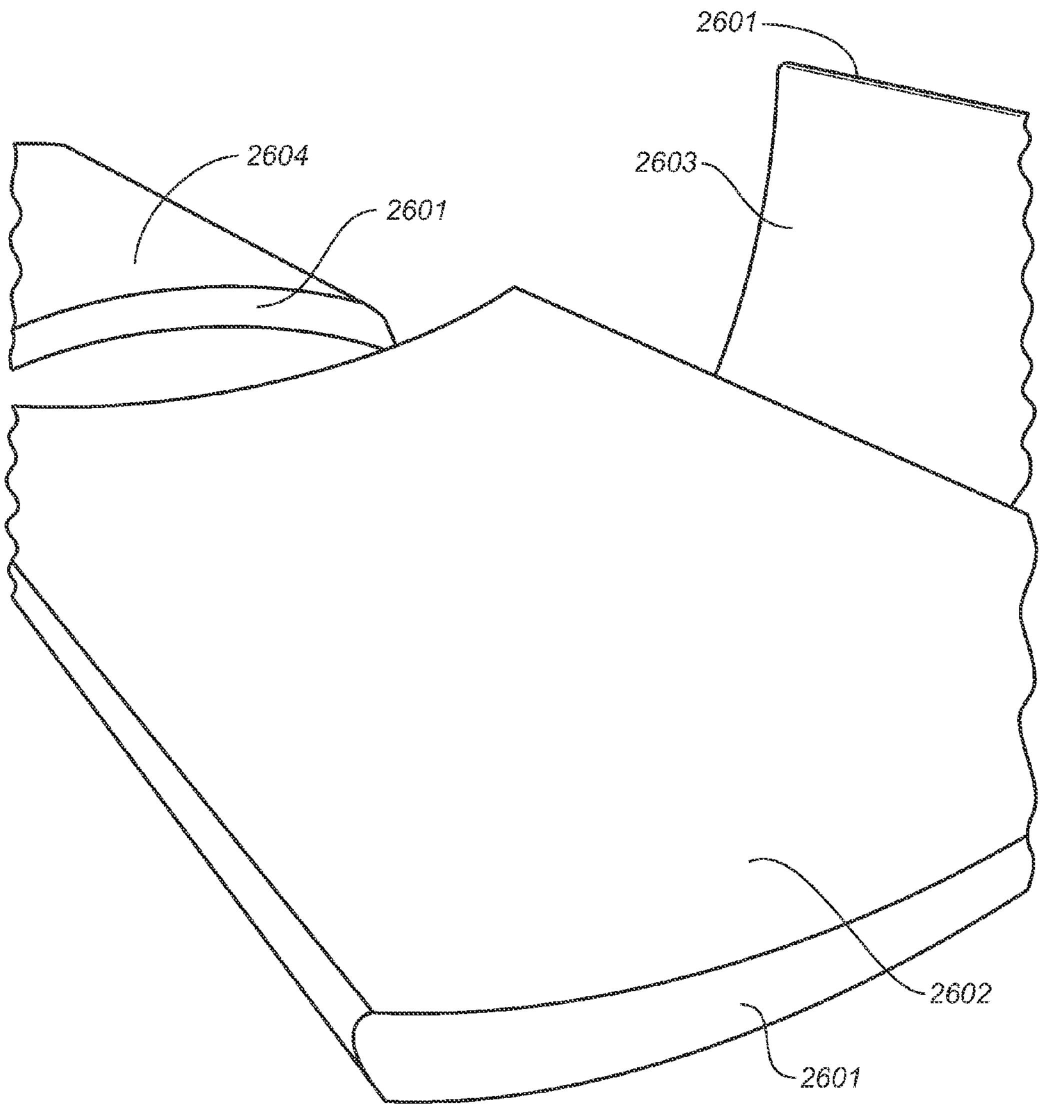


FIG. 25



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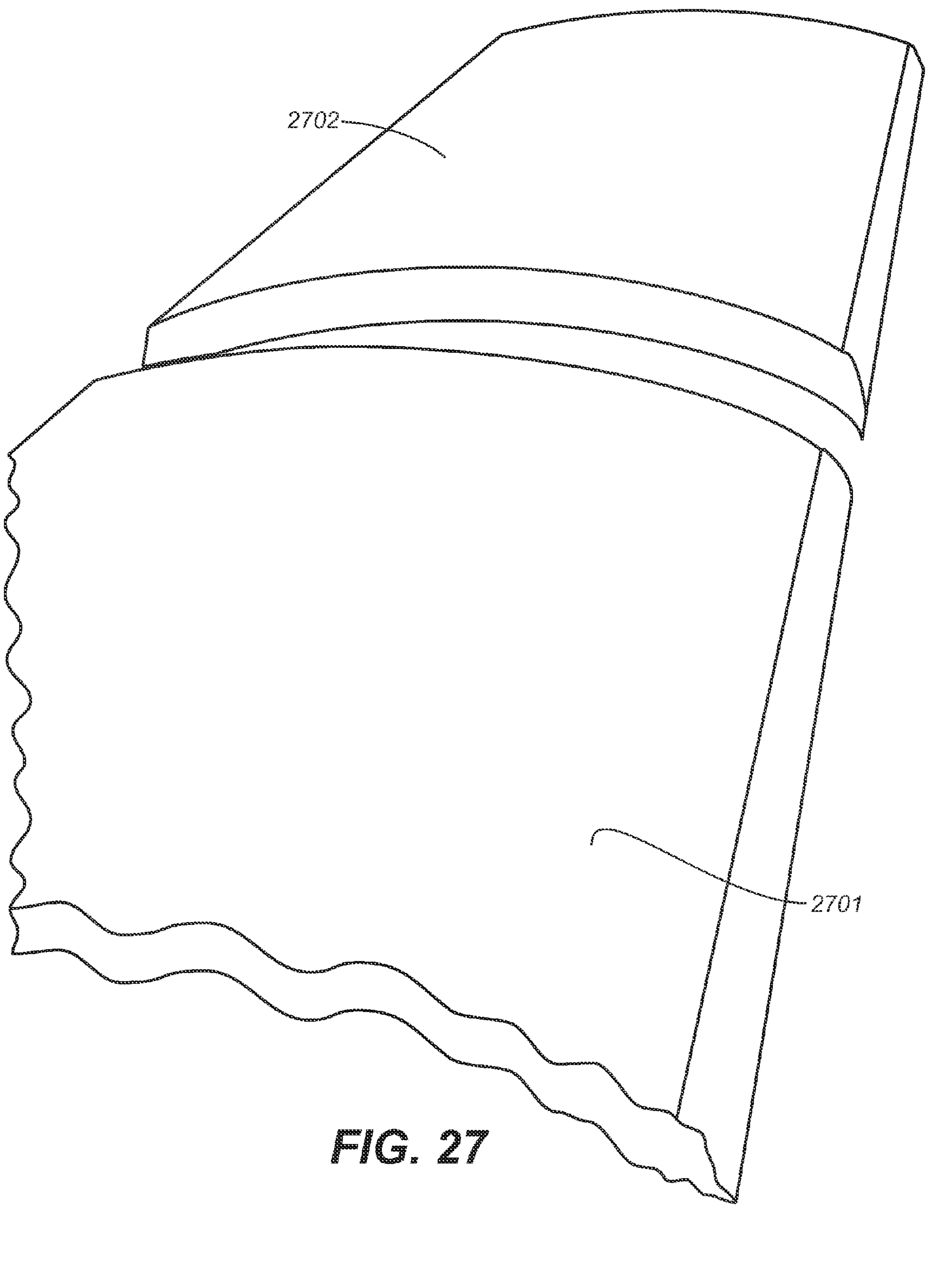

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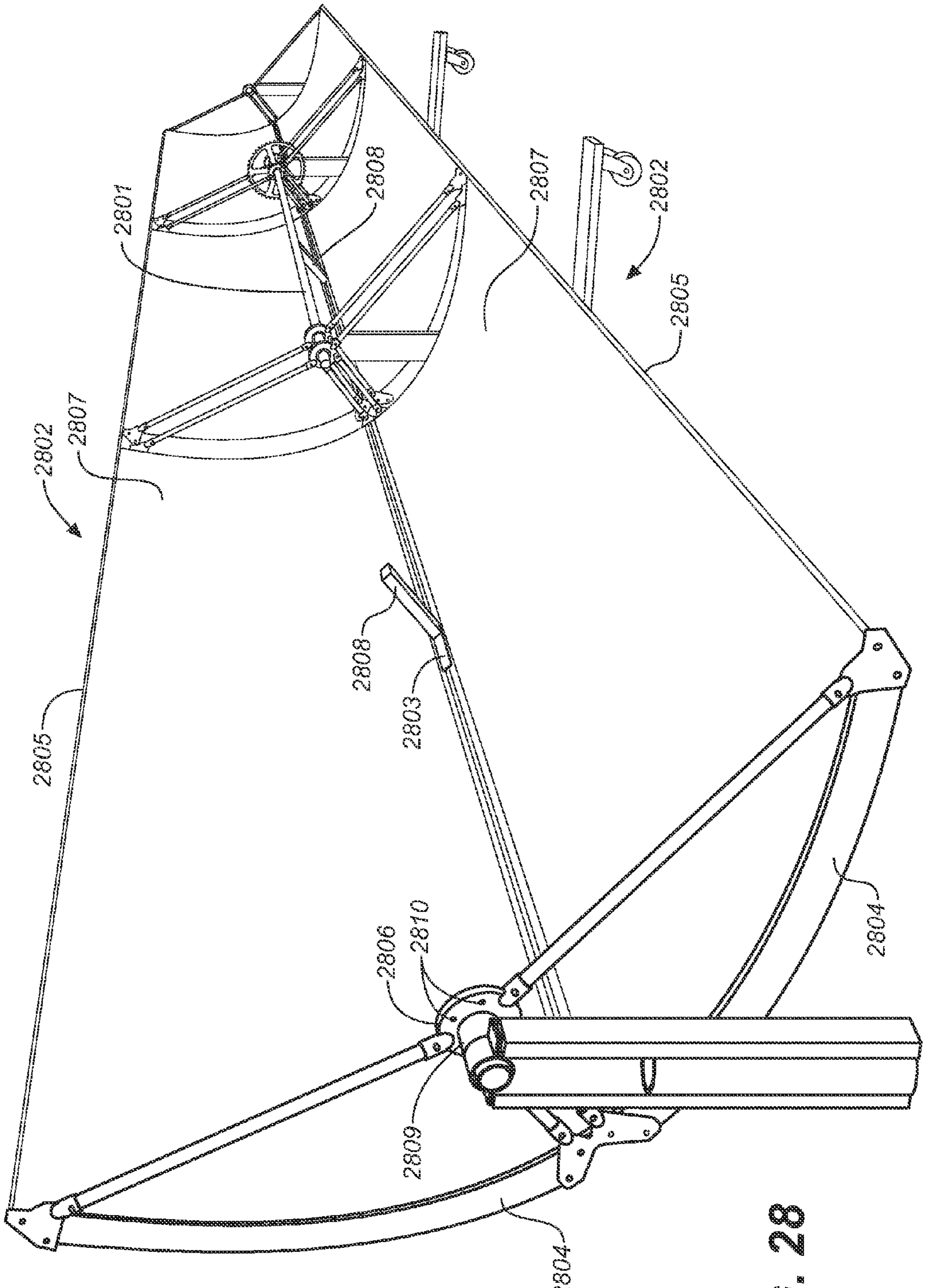
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FIG. 28

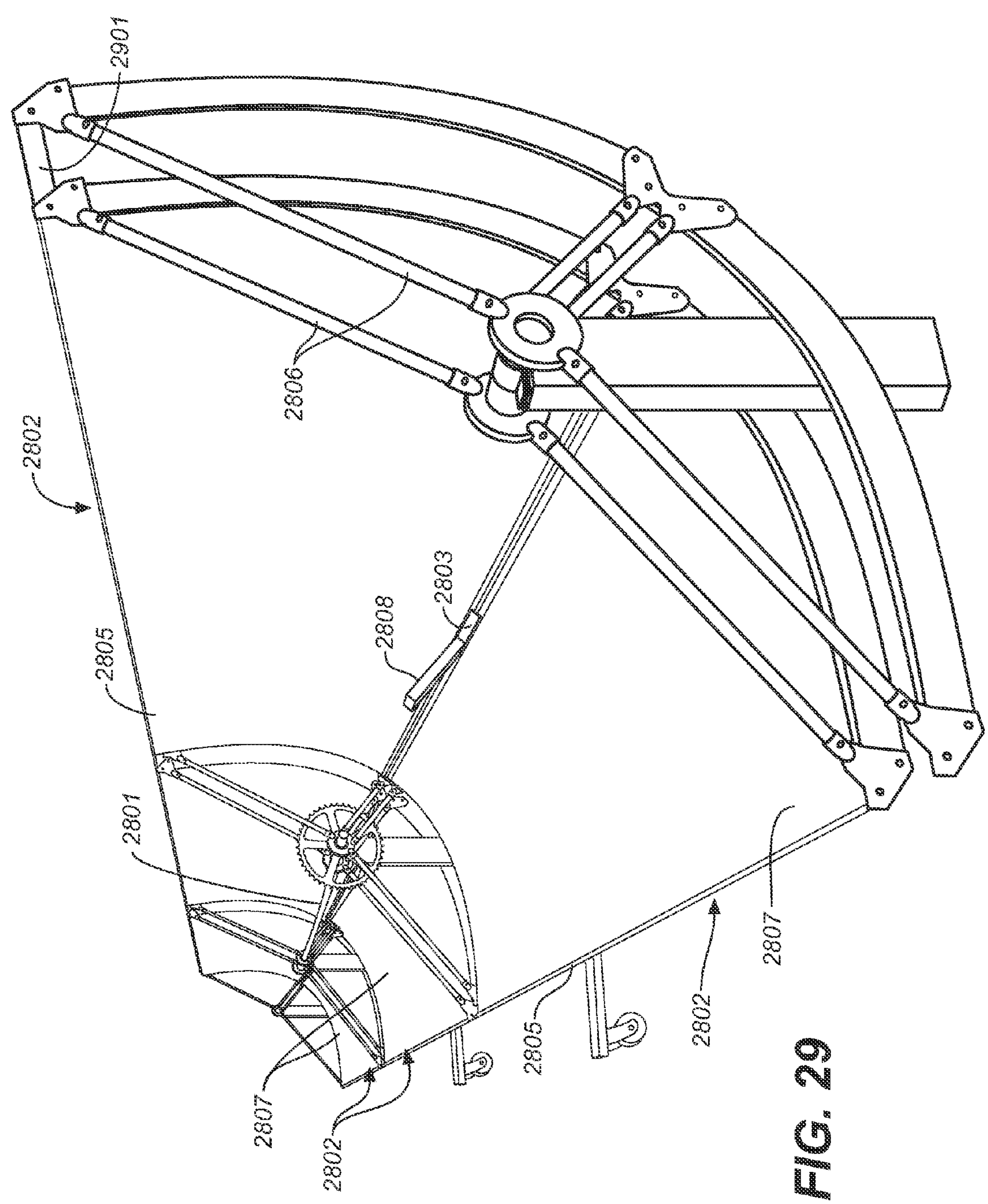
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FIG. 29

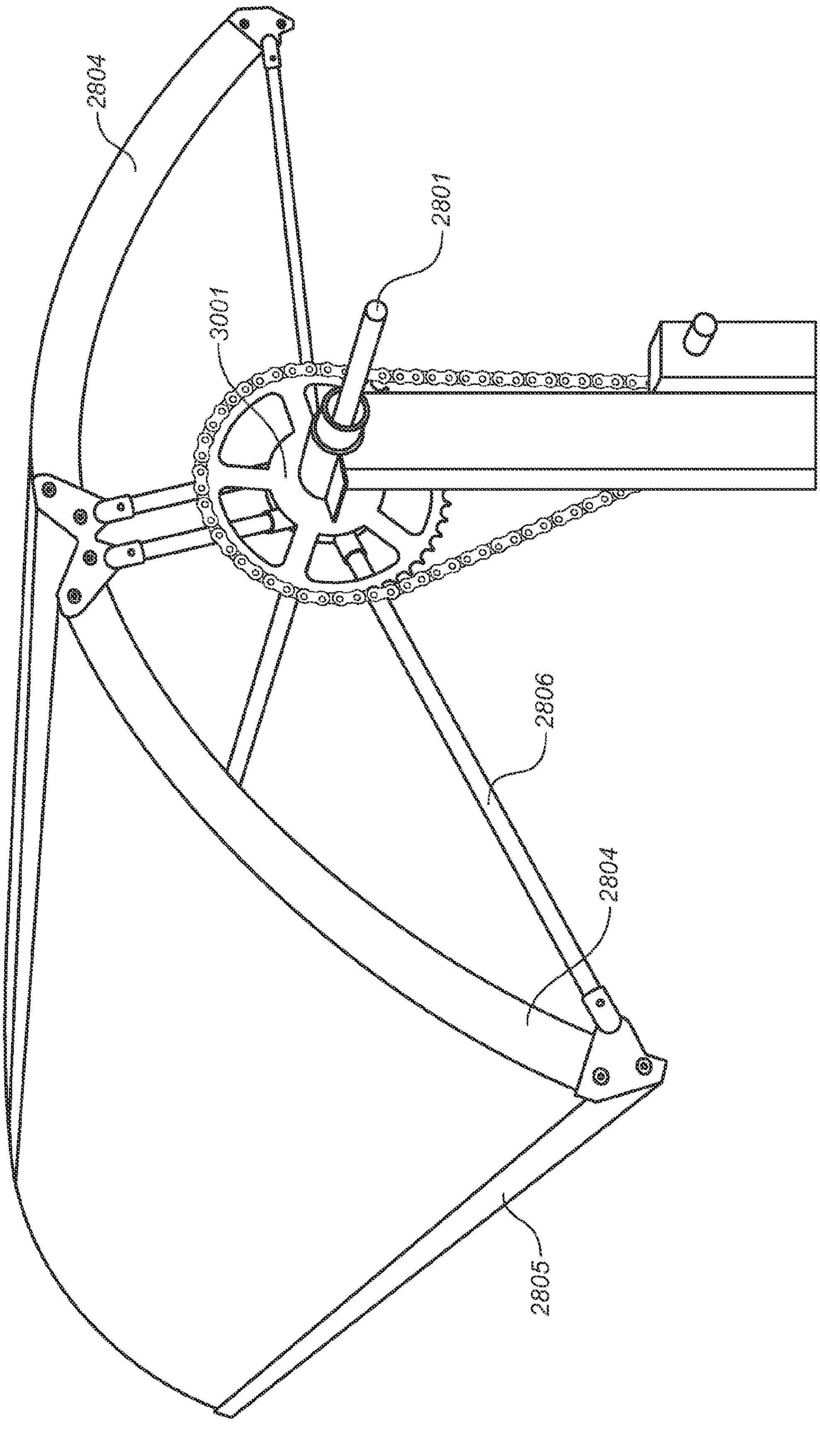

FIG. 30

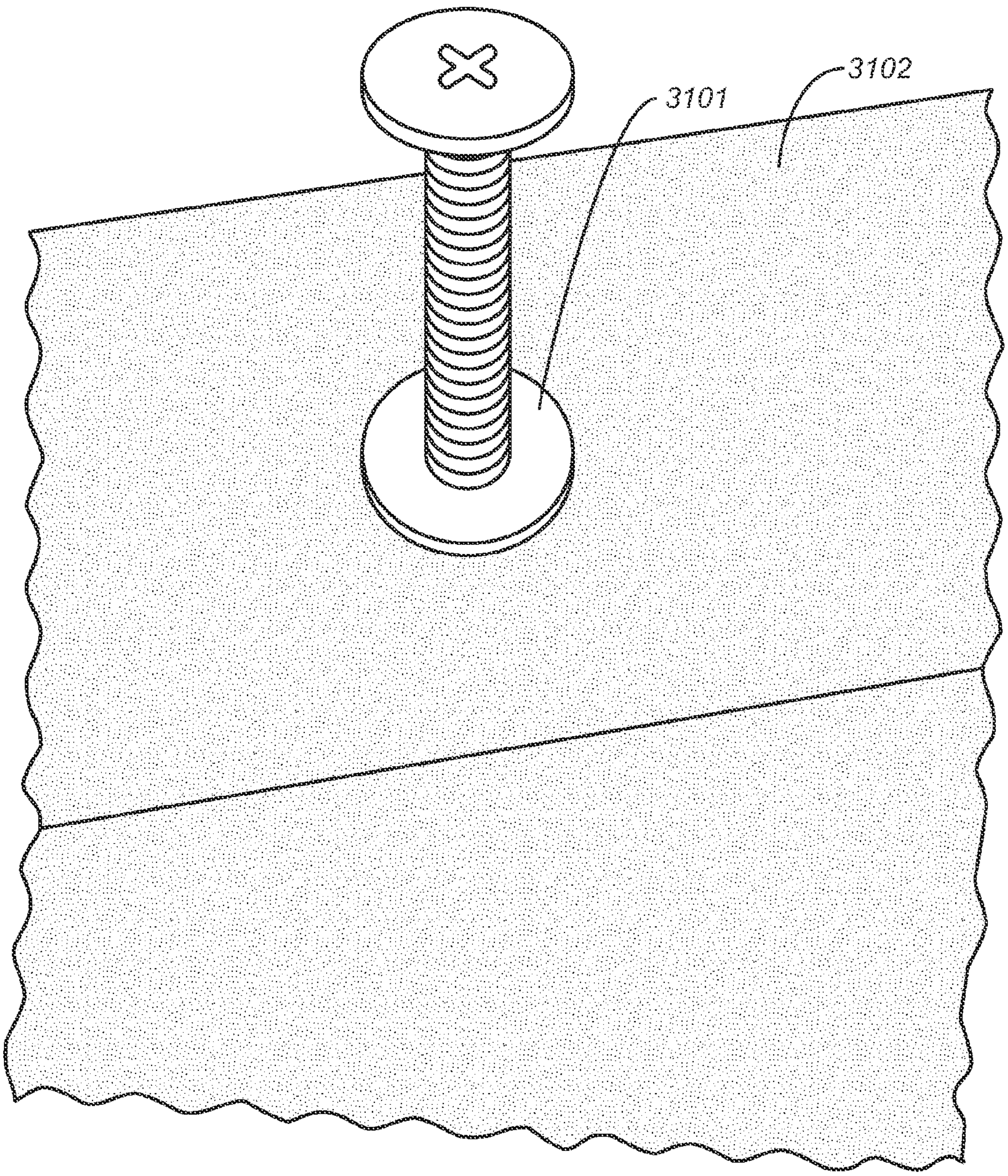

FIG. 31

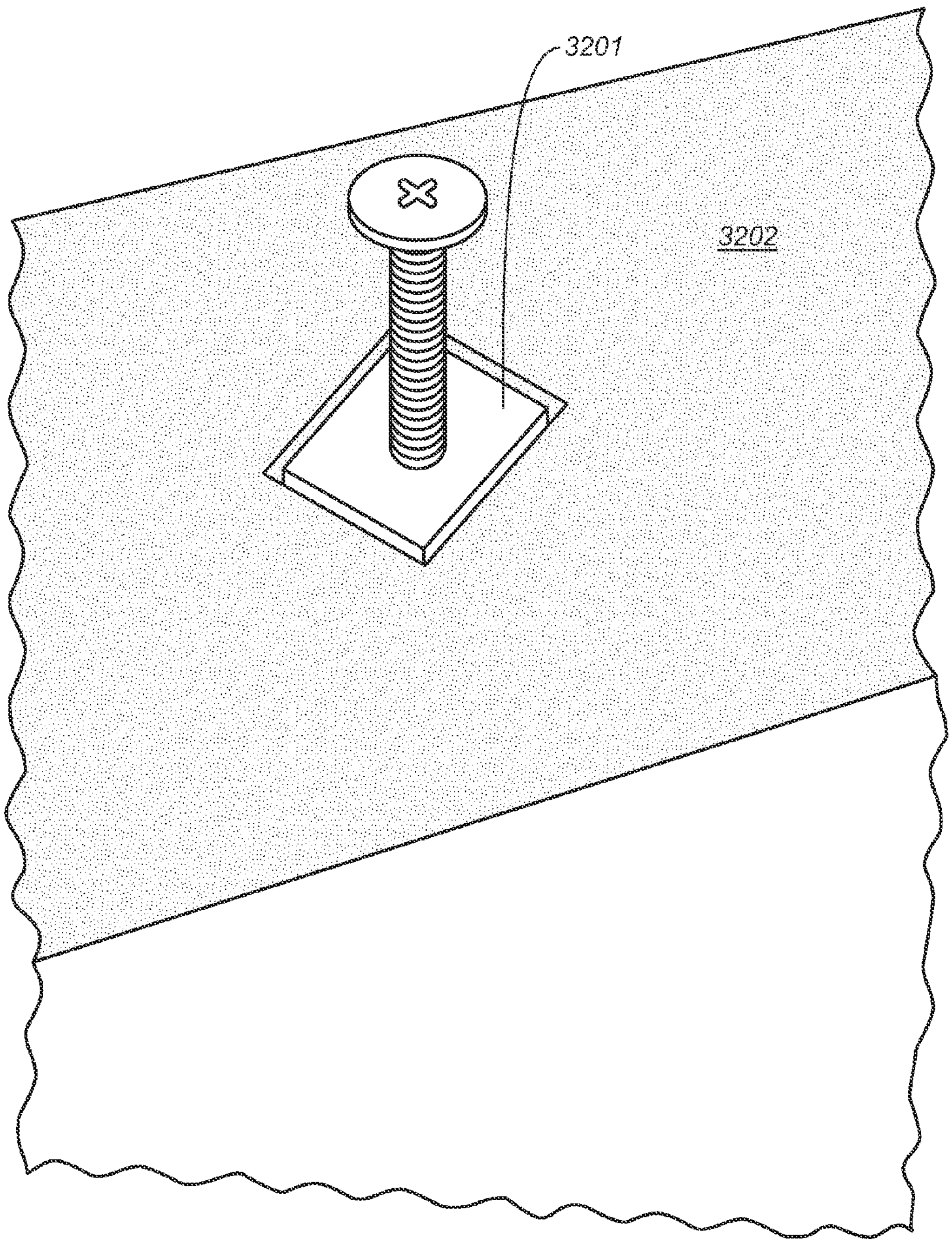

FIG. 32

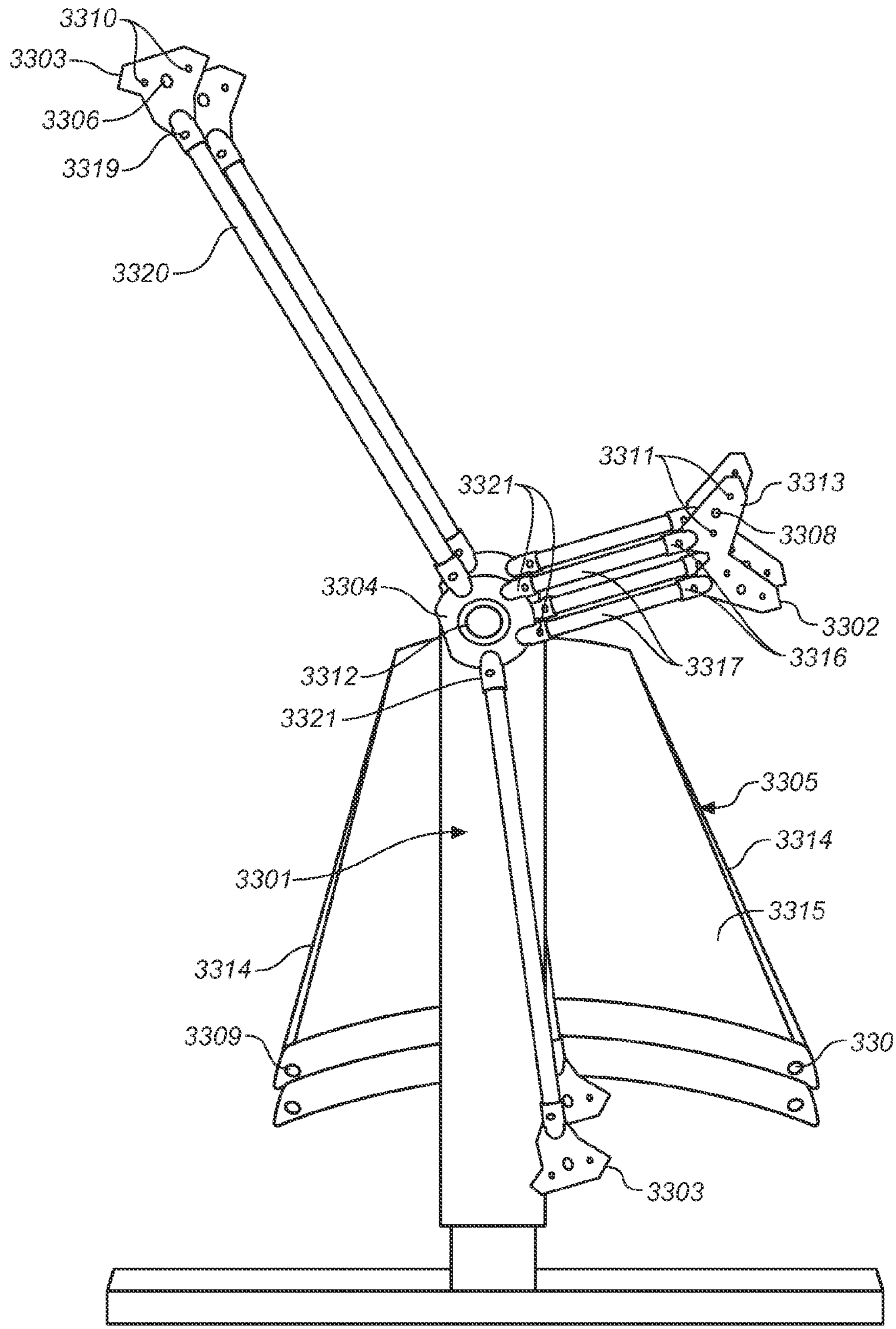
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FIG. 33

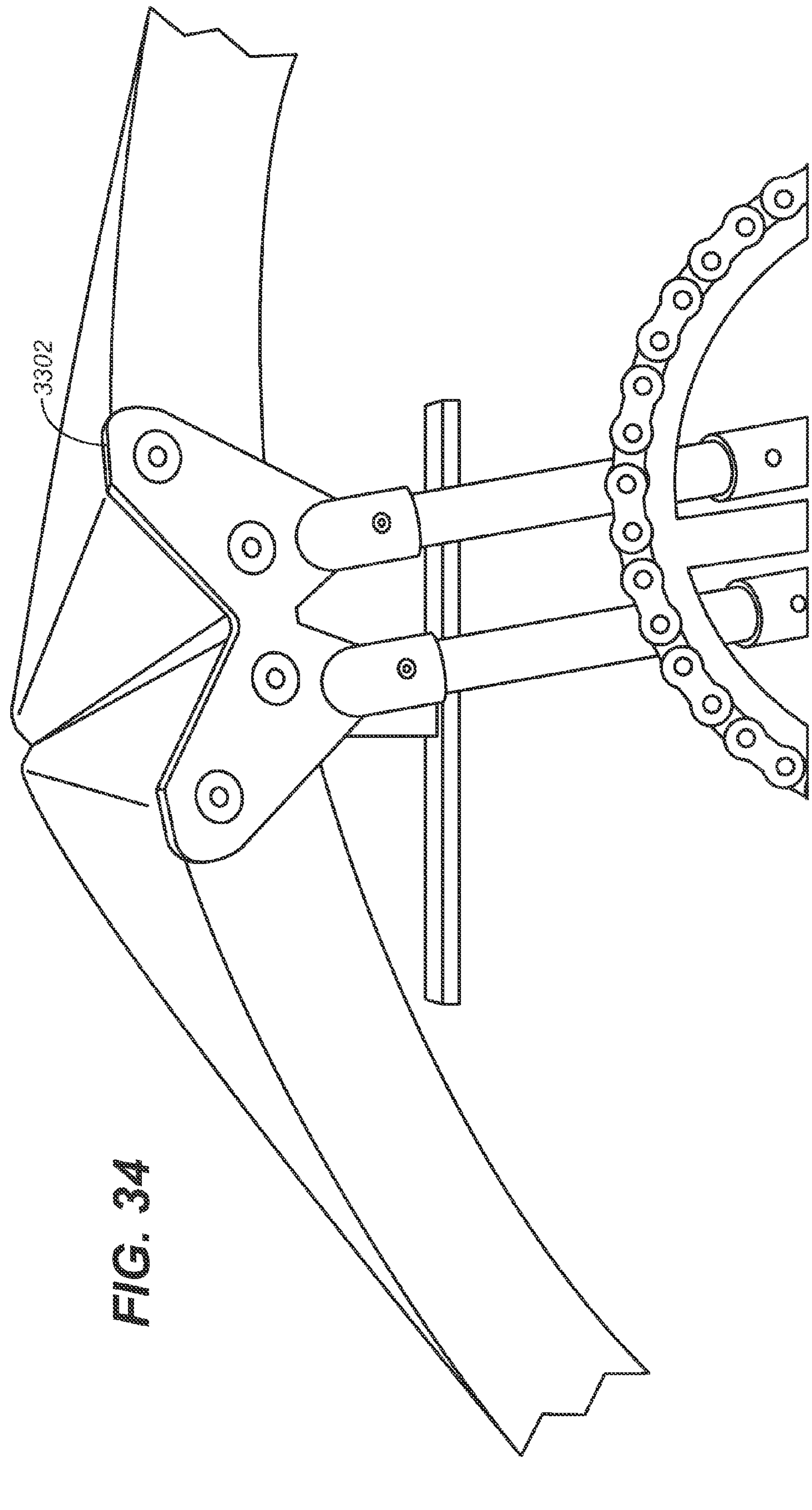

FIG. 34

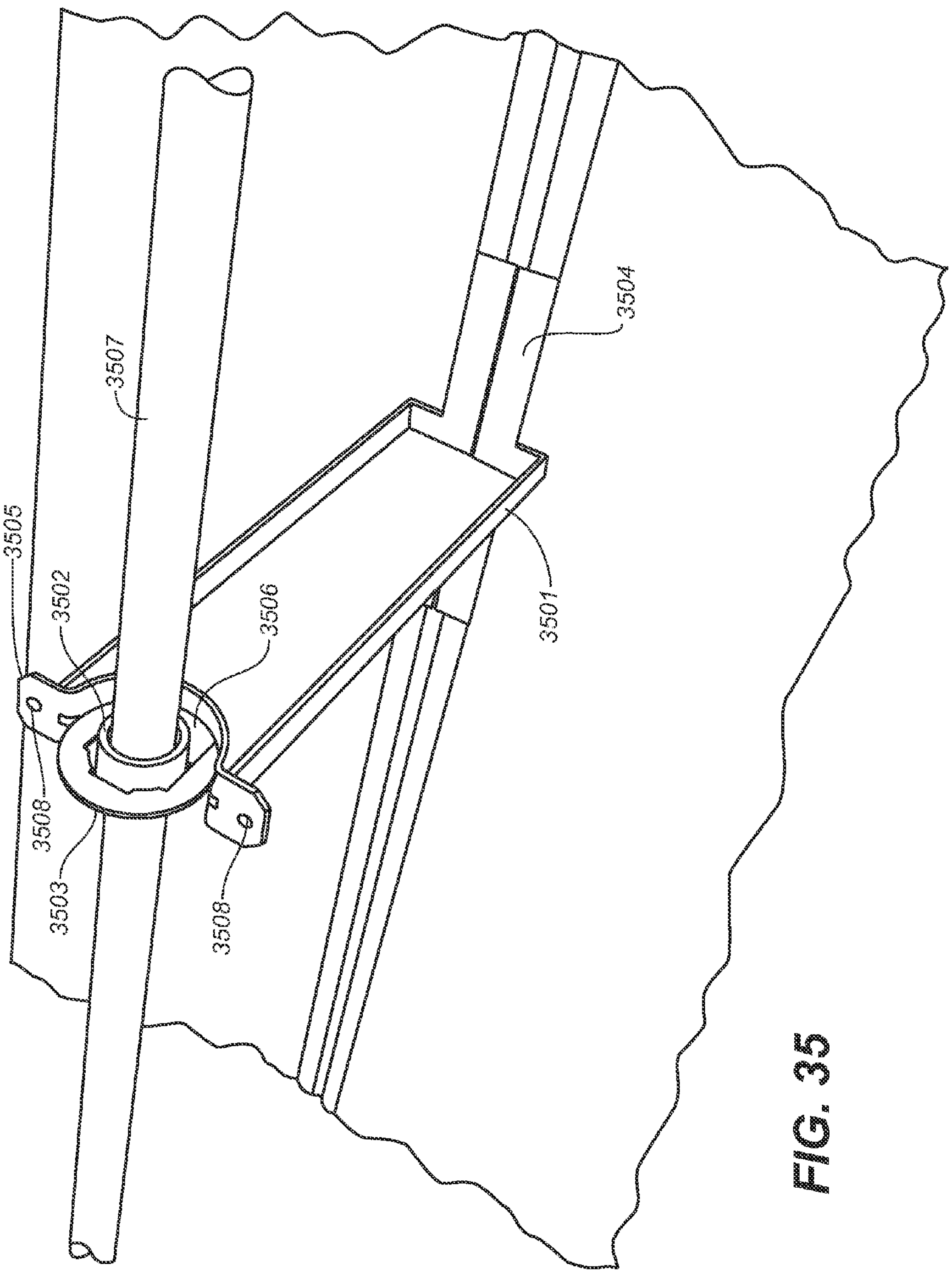

FIG. 35

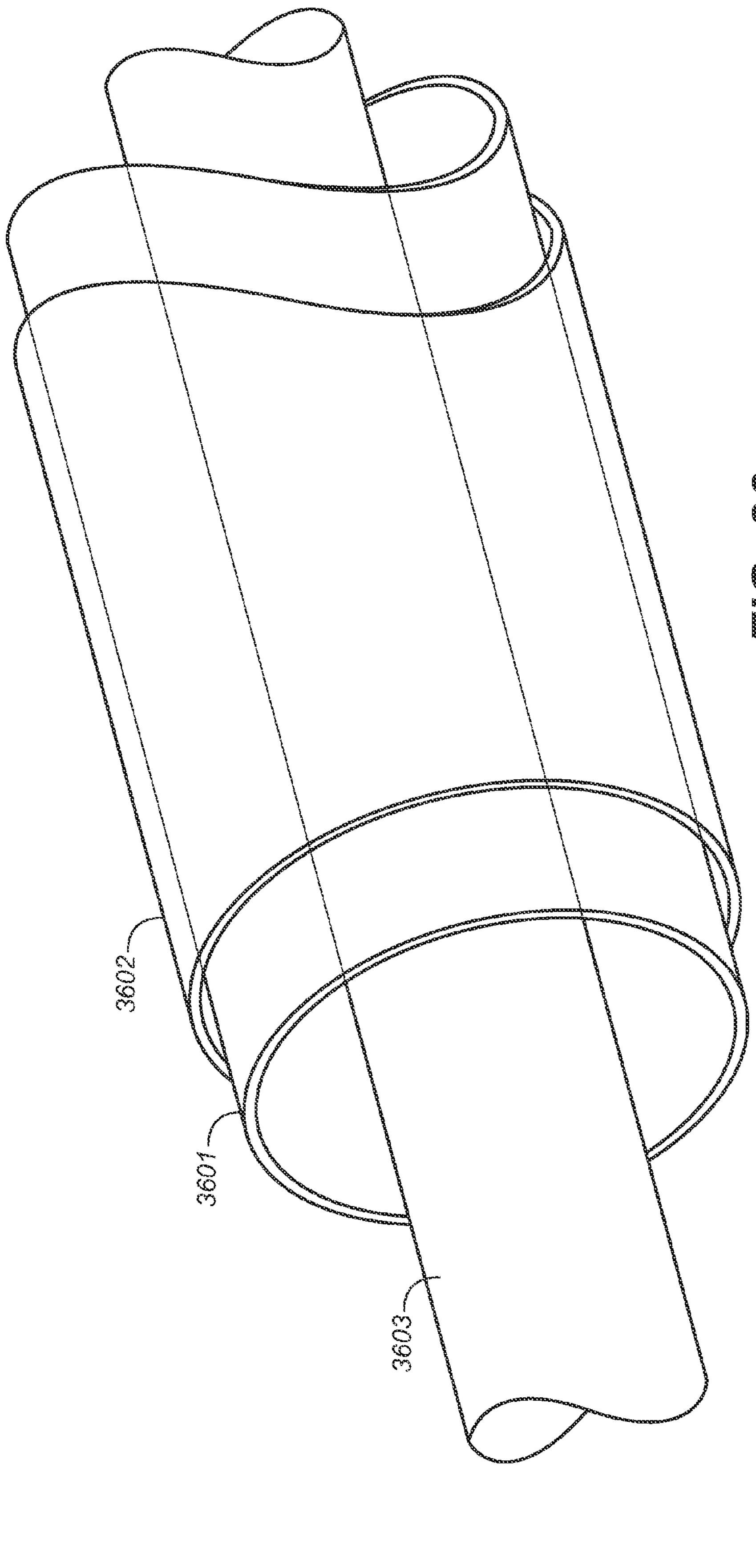

FIG. 36

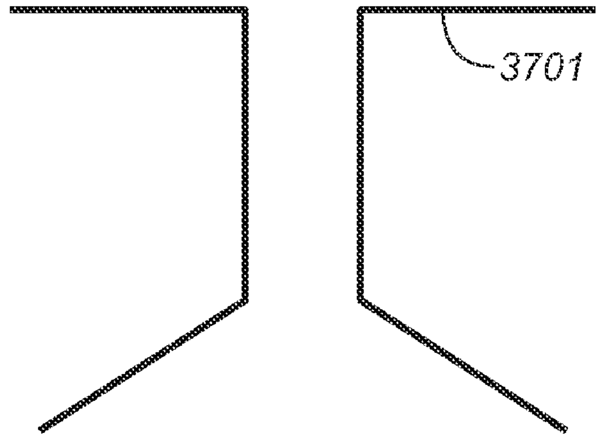

FIG. 37A

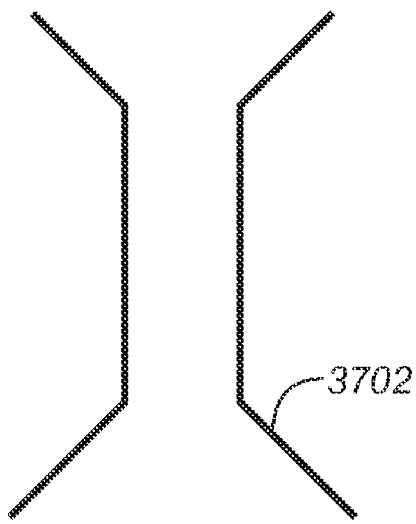

FIG. 37B

SOLID CORE STRUCTURE PARABOLIC TROUGH SOLAR ENERGY COLLECTION SYSTEM

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. App. Ser. No. 61/274,046 filed Aug. 11, 2009 and entitled "Solid Core Structure Parabolic Trough Solar Energy Collection System," inventors Kip H. Dopp and Darren T. Kimura, which application is incorporated by reference in its entirety.

[0002] This application also incorporates by reference the following patent applications, some of which are referred to elsewhere in the text, in their entirety as if put forth in full below: U.S. application Ser. No. 11/811,329 (filed Jun. 8, 2007) "Mirror Assemblies for Concentrating Solar Energy"; U.S. application Ser. No. 11/811,109 (filed Jun. 8, 2007) "Use of Brackets and Rails in Concentrating Solar Energy Collectors"; U.S. application Ser. No. 11/811,027 (filed Jun. 8, 2007) "Protecting Solar Energy Collectors from Inclement Weather"; U.S. application Ser. No. 11/811,073 (filed Jun. 8, 2007) "Use of Identical Components in Solar Energy Collectors"; U.S. application Ser. No. 11/811,153 (filed Jun. 8, 2007) "Support of Heat Collectors in Solar Energy Collectors"; PCT App. No. PCT/US2007/013618 (filed Jun. 8, 2007) "Apparatus and Methods for Concentrating Solar Power"; PCT App. No. PCT/US2009/041171 (filed Apr. 20, 2009) "Parabolic Trough Solar Energy Collection System"; PCT App. No. PCT/US2008/007115 (filed Jun. 6, 2008) "Parking Solar Energy Collectors"; and the PCT Application filed concurrently with this application on Aug. 11, 2010 and entitled "Solid Core Structure Parabolic Trough Solar Energy Collection System," inventors Kip H. Dopp and Darren T. Kimura.

[0003] The present invention relates to the structural improvement of a concentrating parabolic trough collector through the use of non-conventional core materials that enable the reduction in metal frame structures, weight, and fasteners and that may increase the collector's durability and integrity.

BACKGROUND AND SUMMARY OF THE INVENTION

[0004] Solar energy is an environmentally friendly source of renewable and sustainable energy that does not necessarily rely on the use of fossil fuels and reduces the release of green house gases that are attributed to global warming and related environmental problems. In many cases, solar energy can be captured and used locally, thereby reducing requirements for transportation or importation of fuels such as petroleum. Concentrating solar power (CSP) systems are one of several technologies that may be used to harness solar energy form the sun.

[0005] Solar heaters, such as concentrating troughs, focus sunlight from mirrors and/or lenses onto a central receiver which can be a tube through which a heat transfer fluid flows. The trough collector may be positioned to track the sun so the reflected solar energy is concentrated onto the tube. The heated tube warms the fluid, and high quality heat from the heated fluid can be used to generate electricity, create air conditioning, drinking water from sea water or as steam. Trough solar energy collectors have been designed and manufactured to numerous specifications. The Micro Concentrated Solar Power (MicroCSP™) collectors, for instance, may provide a modular and scalable approach to solar technology suitable for electricity generation, process heat or other energy use.

[0006] Various MicroCSP™ collectors have been described in the prior patent applications referenced above. Provided herein is a frame assembly that may be used to construct solar energy collection and conversion systems using a suitable rigid material such as expanded polystyrene or extruded polystyrene, polyurethane, fiberglass, or recyclable materials for example, to support the reflective surface. Preferably, a foam material such as expanded polystyrene or extruded polystyrene may be used as the support surface in lieu of ribs or complex metal frames previously described in patent applications incorporated by reference above, may provide increased solar energy collection efficiency, reduced manufacturing costs, lighter in weight, provides for easy assembly, prolonged life, improved durability, larger or smaller collector apertures, and a modular structure suitable for ground, rooftop or trellis application.

[0007] Also provided herein is a method of achieving the desired panel shape by hot wire cutting the foam material with a CNC machine, a laser cutting machine or other device, or by molding or extruding the foam like material into the parabolic form. The collectors are formed into partial parabolic shapes whereby two or more pieces are used to form a complete parabolic trough collector. This design allows for efficient nesting of the pieces thereby minimizing shipping costs and reducing manufacturing costs. Once the panel is cut or molded to shape, a reflective element may then be applied. The reflective elements may also be applied to the foam material prior or during the creation of the parabolic form.

[0008] Further, provided herein are various methods of applying the reflective element to the panel, which may include attachment, adhesion or integration with the surface. Once applied to the formed foam material, the reflective element may be reinforced with cowlings or other fastening devices on each side of the parabola piece(s) in order to provide rigidity, reflective stability and to hold the reflector in place. End caps or other fastening components may also be applied at each end of the panel to further lock the reflective element in place, to provide additional structural strength to the panel design, and to provide a point of attachment for the arm, tracking system or for cosmetic treatment.

[0009] In addition to the foam material being formed into an appropriate shape giving the collector its parabolic functional characteristics, a method of maintaining the reflector's parabolic shape with the formed foam material may include the use of embedded inserts to secure the end caps and cowlings. An interconnect piece may be used to tie the parabolic shapes together and provide a support for a stanchion to hold the receiver tube and glass envelope in position. A method of connecting multiple panel rows together may comprise using connectors to tie the panels together. The connecting piece may serve to improve multiple collector row strength, may be decorative, and may be used for torsion control.

[0010] Thus, in one instance, disclosed is a trough solar energy collector having a rotational axis comprising

[0011] a collector tube,

[0012] a first reflective panel and a second reflective panel,

[0013] each of said first and second reflective panels comprising

[0014] a polymeric core having an arc-shaped surface

[0015] a reflector on the arc-shaped surface of the polymeric core

[0016] cowling along a longitudinal edge extending along the polymeric core and

[0017] extending parallel to the rotational axis of the solar collector

[0018] the first reflective panel being positioned to illuminate a first side of the collector tube,

[0019] the second reflective panel being positioned to illuminate a second side of the collector tube.

[0020] Also disclosed is an end arm in assembled or disassembled form comprising

[0021] a hub fitting having an opening,

[0022] a plurality of top fittings configured to engage with top portions of respective ones of a first reflective panel and a second reflective panel,

[0023] a bottom fitting configured to engage with bottom portions of each of the first reflective panel and the second reflective panel, and

[0024] a plurality of fitting couplers securing the plurality of top fittings and the bottom fitting to the hub fitting.

[0025] In addition, disclosed is a method comprising

[0026] simultaneously slicing a plurality of arcuate reflector cores from a polymer blank,

[0027] placing reflective surfaces on concave portions of the arcuate reflector cores,

[0028] affixing cowling along edges of the arcuate reflector cores to form arc-shaped reflectors.

[0029] Further, disclosed is a method comprising

[0030] using a first set of sliced polymeric cores to form a first plurality of arc-shaped reflectors;

[0031] using a second set of sliced polymeric cores to form a second plurality of arc-shaped reflectors;

[0032] affixing a first and second reflector selected from said first plurality of arc-shaped reflectors and said second plurality of arc-shaped reflectors along an adjacent edge of each of said first and second arc-shaped reflectors at a mid-point between a larger arc formed by the first and second arc-shaped reflectors and distant from ends of the first and second arc-shaped reflectors.

[0033] These and other aspects of the inventions are discussed further below in the text as well as the claims, which are hereby incorporated by reference into the text herein.

BRIEF DESCRIPTION OF THE FIGURES

[0034] FIGS. **1** and **2** depict a support structure comprised of a foam material, end arms, and end caps.

[0035] FIG. **3** illustrates hot wire cutting with a CNC machine.

[0036] FIG. **4** depicts an outer coating.

[0037] FIG. **5** illustrates two panels forming the wings, which may fit together using an H-clip that also attaches a stanchion.

[0038] FIG. **6** illustrates reflective panels on a foam material.

[0039] FIG. **7** illustrates a foam material with end caps, cowlings and inserts for a support structure.

[0040] FIG. **8** shows decorative end caps for a support structure.

[0041] FIG. **9** depicts an end arm assembly.

[0042] FIG. **10** shows a corner end panel interconnect.

[0043] FIG. **11** illustrates inserts in an end cap.

[0044] FIG. **12** shows an H-clip.

[0045] FIG. **13** illustrates a receiver tube.

[0046] FIG. **14** illustrates a stanchion that is used to hold a receiver tube.

[0047] FIGS. **15-18** depict a U-bolt assembly with a receiver tube bearing, a receiver tube bearing attachment, a receiver tube bearing attachment screw, and a stanchion bracket.

[0048] FIG. **19** shows a silicone foam gasket.

[0049] FIG. **20** depicts a glass envelope.

[0050] FIG. **21** shows inner and outer reflective covers with an insulating material.

[0051] FIG. **22** shows a locator tube.

[0052] FIG. **23** depicts a locator tube collar.

[0053] FIG. **24** illustrates a stand for a support structure.

[0054] FIG. **25** depicts torsion cables to adjust tension on a support structure.

[0055] FIG. **26** illustrates multiple cores, one bare (**2603**), one **2601** with reflector panel **2602**, and one **2601** with a backing panel **2604** applied.

[0056] FIG. **27** likewise shows two cores, one with a backing panel.

[0057] FIG. **28-30** provide various views of partially-assembled collectors ganged together (FIGS. **28** and **29**) and alone.

[0058] FIG. **31-32** illustrate inserts into cores that can be used in conjunction with screws or bolts to secure cowling, end caps, clips, backing, or other components to reflector cores.

[0059] FIG. **33** illustrates two end arms, each attached to a locator tube collar in a bearing assembly in a stand.

[0060] FIG. **34** illustrates some details of a panel-joining fitting.

[0061] FIG. **35** illustrates two arc-shaped reflective panels joined to one another by a clip **3504** as well as a stanchion **3501** supporting the collector tube.

[0062] FIG. **36** illustrates telescoping glass tubes (with one tube withdrawn) concentric with the collector tube.

[0063] FIGS. **37**A and **37**B depict cross sectional views of two clips.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0064] Various aspects of the inventions disclosed herein may be understood better by reference to the following discussion in conjunction with the figures, which form a part of this specification and are incorporated by reference. The discussion of particular examples does not limit the scope of the invention, and the discussion is provided only to aid in understanding various aspects of the inventions disclosed herein. The claims are to be afforded a broad interpretation consistent with the principles, as well as the general and specific description herein.

[0065] By way of introduction to various parts and combinations of parts, FIG. **28-30** illustrate a partially-assembled solar energy trough collector which may include a collector tube **2801**, a plurality of arc-shaped reflectors **2802** connected by at least one fastener **2803** at a midpoint of the larger arc formed by joining the arc-shaped reflectors, and end arms **2806**. An arc-shaped reflector may have a core, a reflective portion **2807**, cowlings **2805**, and optional end caps **2804** as described more fully below. A support structure is a trough collector as discussed above that does not have a reflective portion.

[0066] FIG. **1** illustrates how one particular collector may be formed using a core such as a foam material **201**, a plurality of end arms **102**, and a plurality of end caps **103**. Each of these pieces is discussed below in further detail.

[0067] 1. Core

[0068] A core may be a polymer, a polymeric foam material, or a honeycomb material such as a composite honeycomb sheet (e.g. aluminum honeycomb core with rigid sheets sandwiching the honeycomb and/or rigid polymer filling the interstices). A core is preferably rigid, so that a concave arcuate surface on the core may have a reflective surface applied that conforms in shape to that of the concave arcuate surface.

[0069] The concave arcuate surface may be parabolic, cylindrical, or other concave arc on one side of the core. The opposite side of the core may be of convex curvature that is a mirror image of the curvature of a second core, as explained later. The opposite side may therefore be of convex curvature or may have no curvature.

[0070] A core that is flexible may be used if it retains accurate concave curvature when other pieces such as cowling, end caps, reflective element, backing, and/or end arms are applied.

[0071] (i) Polymeric Core

[0072] A core may be a polymer such as a rigid or semi-rigid polymer. The core may be solid or a foam that has cells (either open or closed). Preferably, a closed cell foam material is used because of its moisture resistant characteristics. The polymer may have sufficient rigidity and surface strength such that the curved surface deforms little when a reflective material is applied to the surface. The core's curved surface therefore accurately imparts its curvature to an applied material.

[0073] As shown in FIGS. **1**, **2**, and **26**, a core formed from a foam material **201**, **2601** such as expanded polystyrene (EPS), extruded polystyrene (XPS), or expanded extruded polystyrene (XEPS) may be used to form the arc-shaped reflectors **101** of the collector. Other suitable materials like polyurethane, fiberglass or epoxy may alternatively be used to form the panels. XPS, for instance, has good moisture resistant characteristics. Different densities of foam may be used, and density may be around two or three pounds per cubic foot, for instance.

[0074] Foam is inexpensive to manufacture and may be locally produced, shaped, and modified. Using foam may reduce the number of parts required because tooling is not required to achieve the collector shape. The foam allows for single piece manufacturing (e.g. a core may be formed as a single piece in a mold or cut from a block of foam) and is easy to handle, thereby reducing assembly time and easing field assembly. The foam material **201**, **2601** is also lightweight while maintaining sufficient strength to bear wind loads, significant advantages for roof-mount applications. The formed foam material may easily be shaped and sized to various apertures. For instance, a wider aperture increases the amount of reflective surface per panel, thereby allowing higher temperatures to be reached and therefore providing greater power conversion efficiencies.

[0075] In addition, the foam core **201**, **2601** may provide a better substrate for the reflective element **601** (FIG. **6**) and **2602** (FIG. **26**) because, when adhered to a reflective element such as polished metal, the composite is a significantly stronger and a more accurately formed structure. One reason for this is that the reflective element **601**, **2602** is supported by a solid substance, the foam material **201**, **2601** rather than spanning a set of ribs, as described in prior patent applications incorporated by reference above. The formed foam material **201**, **2601** may provide structural integrity and resistance to forces that may flex or twist the support structure. Thus, the foam core **201**, **2601** provides better support as well as a protective backing to the arcuate reflective surface.

[0076] Any core may have other materials applied to it or incorporated into it, such as moisture barrier layer or layers, adhesive, UV blocker or absorbent, and strengthening layer or layers. Thus, various protective layers of material may be applied to any or all surfaces of the core (e.g. convex and/or concave arcuate surfaces), or anchors may be incorporated into a core, for instance.

[0077] (i) Honeycomb Core

[0078] As mentioned, a honeycomb core may be e.g. an aluminum honeycomb sheet. The sheet may be made rigid by applying rigid or semi-rigid layers to one or more surfaces of the core or by solidifying a material such as a polymer in the interstices of the honeycomb. These layers may include any of the rigid or semi-rigid polymers such as polycarbonate, polyurethane, and polystyrene.

[0079] Any core will have a concave arcuate surface on which a reflective layer is placed and optionally a convex arcuate surface as well on which a backing material or materials may be placed.

[0080] 2. Method to Achieve the Desired Collector Panel Shape

[0081] As shown in FIG. **3**, the foam material **201** (FIG. **2**), **2601** (FIG. **26**) may be shaped into its desired panel shape by hot wire cutting one or more foam blanks **302** such as one or more blocks of foam using a CNC machine **301**, or by using a laser cutting machine or other device. In the system depicted in FIG. **3**, a plurality of cores are formed simultaneously by using hot wires **303** to cut one or a plurality of foam blanks. Multiple cores are therefore formed simultaneously from polymer blanks. The foam blank may be molded and cut into one or more cores **201** close to the location of any given project site thereby reducing shipping costs.

[0082] Use of a CNC hot wire **301** cutting machine to cut the foam material **201** may reduce overall tooling costs as compared to the tooling costs of stamping out ribs, described in prior patent applications incorporated by reference above. The collectors may be shaped to form parabolically shaped wings **501** (FIG. **5**) whereby two pieces are positioned together along their longitudinal ends to form a complete parabolic trough collector **501** having a larger arc-length than either of the pieces. This design allows for efficient nesting of the pieces during fabrication and shipment to reduce material drop when cutting and also minimizes shipping costs. The foam sections **201**, **2601** may be cut with areas of greater or lesser thicknesses to provide features like reflector stops that stand above the overall surface and help hold a reflector panel in place, height adjustment to accommodate parts that interface with the core, and areas of increased strength where needed (e.g. in the vicinity of fasteners and/or cowling).

[0083] A bottom or convex face of a core may be identical in curvature to a top or concave face of another core if desired, especially if the cores are both sliced simultaneously from the same polymer blank.

[0084] It is thought that a polymeric core may be uniform in tension and compression throughout the polymer of the core, especially where the core or multiple cores are formed by slicing a foam blank (such as a block) into the desired shape without further heating and bending of the bulk foam material. While a core may also be made by extruding the foam or by molding it, it is theorized that heating and bending foam that has already polymerized introduces compression and tension into the foam (especially into closed-cell foam), as may polymerizing a polymer in an arcuately-shaped mold.

[0085] Further, slicing a foam blank provides cores than are "skinless" as compared to a core that is formed in a mold. A core cut from a polymeric blank has little to no skin. Any skin formed by slicing a foam blank using hot wires or laser cutting is typically quite thin and/or discontinuous and is believed to be thinner overall than skin formed during polymerization in a mold. A core formed in a mold typically has a skin with physical properties much different from the bulk foam beneath the skin. When a core is sliced from a foam blank, the surface of the core is very much like the bulk foam beneath the surface. The core sliced from a blank is therefore expected to be more uniform than a core formed in a mold. Methods of slicing a core from a blank therefore provide a skinless core as distinguished from a polymeric core formed in a mold.

[0086] Further, a foam core sliced from a blank may have already been formed at a higher temperature than foam formed in a mold. Foam typically has low thermal conductivity, and it is anticipated that a large blank of foam during polymerization experiences a higher temperature within much of the foam because of the large size of the blank and/or a high temperature for a much greater period of time than does a core formed in a mold. The much smaller quantity of foam in a mold for a core can cool more quickly, providing a lower temperature at which polymerization occurs in most or all of the foam and/or a much faster cool-down time. It is therefore believed that a foam core sliced from a blank will have already been subjected to a higher temperature and/or a higher temperature for a longer period of time than a molded core experiences, a sort of "pretreatment" of the foam that may lead to longer service life for a core formed from a polymer blank.

[0087] 3. Outer Coating

[0088] As shown in FIG. **4** and FIG. **27**, the outer surface **2701** of the formed foam material **201** may be coated with a suitable outer coating **401**, **2702** such as an epoxy, paint, vinyl or other UV inhibitor to (1) protect the foam from UV rays, (2) seal the foam from moisture, and/or (3) provide additional structural support. The coating **401**, **2702** may be a material such as plastic or other polymer such as polyvinylchloride, metal such as aluminum, fiberglass, canvas or other material that is fused, or otherwise externally affixed to the formed foam material **201**, **2601**, or that may be fabric layered, thereby providing impact resistance to harsh weather. The coating may be applied by spraying, troweling, dipping, fusing or pouring the desired material onto the foam or alternatively, the plastic material may be modified to allow for the appropriate protective outer coating to be included in, or combined with, the foam material itself.

[0089] 4. Arc-Shaped Reflector (Wing)

[0090] As shown in FIG. **5** and FIG. **28-30**, there may be two or more symmetrical arc-shaped reflectors or wings **501**, **2802**. These wings **501**, **2802** may be attached at the bottom of the parabolic arc with a fastener such as a clip, e.g. an H- or other shaped-clip **502**, **2803** and **3701** and **3702** of FIGS. **37**A and **37**B described in further detail below. The clip **502**, **2803**, **3701**, **3702** may optionally have a provision for attaching a stanchion **503**, **2808** described in further detail below, which supports the receiver tube **1301**, **2801** also described in further detail below.

[0091] The wings **501**, **2802** may also be independently rotated so they may close in upon each other in a clamshell like configuration **504** which allows for the protection or storage of the collector. Specifically, the wings may be attached pivotably to allow each wing to pivot and rotate on top of the other **504**. This protects the inside of the panel and reduces the wind load profile. The wing is driven by a sprocket assembly that when reaching a certain point, engages the second half of the panel and drives it synchronously. The wings, also or instead may be decorative.

[0092] 5. Reflective Panels

[0093] As shown in FIG. **6** and FIG. **26**, the core supports reflective element panels or panel segments **601**, **2602** that are placed onto the formed foam surface **602**, **2603**. One or more reflective panels **601**, **2602** may form the reflective surface upon the support structure. The reflective element may be a flexible material such as polished aluminum, aluminum laminated with reflective Mylar, or other suitable material such as epoxy sputtered with silver or a glass mirror. Preferably, a flexible aluminum panel polished to a mirror finish is used as the reflective element. The reflective element may be flexible so that a flat sheet of the reflective element can be bent into the desired shape at room temperature and pressure, or the reflective element may be rigid at room temperature and pressure but capable of being deformed into the desired shape using heat and optionally pressure or vacuum.

[0094] One or more flat but flexible reflective panels **601**, **2602** may be retained onto the formed foam surface **602**, **2603** mechanically through the use of cowlings **702** (FIG. **7**) and **2805** (FIG. **28-30**) and end caps **703**, **2804** discussed in further detail below, or through the use of adhesion using an adhesive such as 3M adhesive, or both. The formed foam material **602**, **2601** beneath the reflective element provides the desired panel shape (such as parabolic shape, flat, or partially parabolic shape that a wing may take).

[0095] 6. Top and Bottom Longitudinal Cowlings

[0096] As shown in FIGS. **7** and **28-30**, the formed foam material **701** and the reflective element **2807** may be mechanically held together using reinforcing cowlings **702**, **2805** on each longitudinal edge of the parabola pieces. The cowlings **702**, **2805** mechanically hold the reflective element in place and provide rigidity. The end caps **703**, **2804** discussed in further detail below, may also serve to mechanically hold down the reflective element to the core **701**.

[0097] The top and bottom cowlings **702**, **2805** may be made of aluminum (polished or unpolished) or other metal such as stainless steel that has high rigidity or a plastic. The cowlings **702**, **2805** may be applied by positioning inserts **704** or **3101** or **3201** of FIGS. **31** and **32**, discussed in further detail below, to allow fasteners to be placed into the core foam material **701**, **3102**, **3202**. An alternative may include using glue to bond the cowlings **702**, **2805** to the foam material **701**, **3102**, **3202** or using a band or cable to join the upper and lower cowlings **702**, **2805** to prevent deflection under load.

[0098] The top and bottom cowlings **702**, **2805** may also accommodate a variety of thicknesses of the combination of core, reflective element, and/or backing through the use of laterally opposed interlocking notches **706** to provide a cowling with variable opening size. This assembly **705** allows for the adjustability of the opening of the cowling assembly to accommodate varying thicknesses of the combination of the formed foam material, outer coating, and the reflective element. The adjustability of the opening may also accommodate the need to add, change, or remove the reflective material. This cowling assembly **705** also serves to lock the adjusted width in place because the cowlings legs rotate in towards the center as the width is adjusted, thereby providing increased holding pressure on the combination of the formed foam material, outer coating, and the reflective element. This may provide a significantly stronger and more secure attachment of the reflective material. Lastly, the top and bottom cowlings **702** are secured longitudinally with inserts **704** through the center to engage the edge of the panels and force the reflective material to form and maintain a parabolic shape.

[0099] The cowlings may be made of flat sheet stock that is bent into a shape to conform with the longitudinal edges of the core, or the cowlings may be rigid channels or conformal material that, alone or together with the core material, provide rigidity to the arc-shaped reflector formed from the core, reflector material, longitudinal cowlings, and optional end caps. The cowlings may themselves be polymeric (e.g. polycarbonate, solid rigid polystyrene), metallic (e.g. aluminum, stainless steel, or other material), ceramic, or other material that aids in protecting the core as well as providing additional rigidity.

[0100] 7. Transverse End Caps

[0101] As shown in FIG. **8** and FIG. **28-30**, a support structure may also have transverse end caps **801**, **2804** which provide further rigidity to the assembly and resistance to flexure and/or torsion. The end caps **801**, **2804** located at either end of the collector are identical and may be attached to an end arm **901** (FIG. **9**), **2806** (FIG. **28-30**) described below. The end caps **801**, **2804** may be made of any suitable rigid material, preferably aluminum (polished or unpolished) or another metal, such as stainless steel, that has high rigidity. The end caps **801**, **2804** may be used at both ends of the panels to further lock the reflective element in place, transfer load, retain the parabolic shape and provide additional structural strength to the panel design.

[0102] The end caps **801**, **2804** may be a single piece of metal stamped, or otherwise cut, from a sheet and having a surface that has a shape which is generally parabolic or substantially arc-shaped to fit the profile of the formed foam material and provide a structural frame. The end caps **801**, **2804** preferably may have a tab such as an outer perimeter tab to encase the edge of the formed foam material and to allow for points of attachment. The tab may therefore be configured to overlap the reflector and/or cowling, and the tab may be configured to allow the core to insert within the tabbed portion of the end cap so that the assembled pieces may be secured. The tab may protect the edge of the panel, hold the reflective element in place, add a dimension to the end cap **801**, **2804** for rigidity, and provide a finished look to the support structure.

[0103] One or more ribs may be used in place of or in addition to end caps. Ribs attach directly to the end arms and form arc-shaped members that make the end-arm a more rigid structure independently of whether reflector panels or wings are attached to the core and end-arms. A rib is therefore separate from a reflector panel or wing and end cap as discussed above.

[0104] 8. End Arms

[0105] End arms help to support Mirrored panels and transmit movement induced by a motor to the panels to track the sun's apparent movement. An end arm may be configured in a number of ways.

[0106] As shown in FIG. **9** and FIG. **33**, the end arms **901**, **3301** may be similar to the end arms described in prior patent applications incorporated by reference herein. The support structure may have transverse end arms **901**, **3301** which provide further rigidity to the support structure and resistance to flexure and/or torsion. The end arms **901**, **3301** located at either end of the collector, are identical and may be attached to a stand. Additionally, the end arm **901**, **3301** may rotate as one unit about the longitudinal axis.

[0107] An end arm **505** as illustrated in FIG. **5** may be formed by stamping or otherwise cutting the end arm from sheet-metal. An end arm can be a single piece of material such as metal stamped from sheet-stock, so that the end arm depicted in FIG. **5** has a generally "T"- or "Y"-shaped structure. Alternatively, an end arm may be formed using two pieces as shown in FIG. **5** that each have a generally "L"-shaped structure. In this instance, the two stampings may be identical and positioned together during assembly to provide a generally "T- or "Y"-shaped structure when the support structure is viewed from the side. An end arm **505** may also be formed by superimposing two or more end pieces having a "T," "Y," or "L" shape and attaching them to one another directly or with or without a cowling. An end arm need not be "T"- or "Y" shaped. It may be solid or perforated to which parts are attached, for instance.

[0108] An end arm **901** may be formed from individual fittings such as welded, die cast, or molded fittings that are formed to accept tubing, rods, or other fitting couplers and attach to the wings. As depicted in FIGS. **33** and **34**, the fittings may comprise a bottom fitting **3302** that engages with bottom cowling of adjacent arc-shaped reflectors, an end fitting **3303** that engages with an arc-shaped reflector **3305** (two of which are shown stacked awaiting assembly to the end arms), and a hub fitting **3304**.

[0109] A bottom fitting **3302** may have a collar or shape **3308** that engages another depression or opening **3309** of the same or an adjacent panel. A bottom fitting may be formed in one piece as shown so that the piece engages both of the reflective panels of adjacent panels to form a larger arc from the two panels. A bottom fitting may instead be formed in two or more pieces that are secured to one another. A bottom fitting may have one or more collar portions **3313** that overlie an edge of the reflective layer or element and/or the cowling **3314** as well as the core. The collar portion **3313** may also or instead overlap a backing material **3315** applied to the core. The bottom fitting may also have holes that allow e.g. a bolt or screw to engage with a fastener or anchor in the core. A bottom fitting may also have one or a plurality of holes **3316** that receive fitting couplers **3317** that engage with the hub fitting.

[0110] An end fitting **3303** may have a collar or shape **3306** that engages a recess or opening **3307** in the arcuate reflector panel **3305**. Screws or bolts may be inserted through holes **3310**, **3311** in the end and bottom fittings to secure an arc-shaped reflector to fittings in the core by screwing into anchors in the foam or honeycomb beneath the optional end-caps. An end fitting may have one or more collar portions **3318** that overlie an edge of the reflective layer and/or the cowling as well as the core. The collar portion may also or instead overlap a backing material applied to the core. An end fitting may also have one or a plurality of holes **3319** that receive fitting couplers **3320** that engage with the hub fitting. An end fitting may also optionally have a flat rectangularly-shaped surface **3322** along an edge of the end-fitting so that e.g. a flat bar **2901** (FIG. **29**) can be attached upon the edge of adjacent collectors to gang the collectors together and therefore move multiple collectors simultaneously using a single motor and drive sprocket.

[0111] A hub fitting **3304** may have the locator tube collar mentioned previously, an end of which is depicted as **3312** in FIG. **33** and the collar end of which is seen as **2809** in FIG. **28**. As shown in these figures and in FIG. **23**, a locator tube collar **2301**, **2809** of the hub fitting **3304** may be used to connect the end arms **901** perpendicular to the locator tube **2201**. The hub fitting may have means for mounting a drive sprocket **3001** as seen in FIG. **30**. Such means include holes **2810** (FIG. **28**) such as threaded holes for bolts, a keyway and corresponding key (either as a separate piece or formed integrally with the hub fitting), screws, rivets, welding, adhesive, and any other known fastening arrangement for securing one piece to another. A hub fitting **3304** also may have holes **3321** extending radially from the hub and into which couplers **3317**, **3320** insert to couple a plurality of end fittings and one or a plurality of bottom fittings. The locator tube **2201** (FIG. **22**) inserts through the locator tube collar **2301**, **2809** of the hub fitting and engages with a bearing. The bearings may be roller, ball, plastic, or graphite bearings that are retained in the stand by screws in the stand and from a cap that mates with the stand. The hub fitting, made of any suitable rigid material, preferably aluminum (polished or unpolished) or another metal such as stainless steel that has high rigidity, slides onto the locator tube **2201** and may be secured with bolts and/or a keyway **2202**. The keyway may allow for accurate positioning of the locator tube collar **2301**, **2809** on the locator tube **2201**. The collar **2301** may consist of one or more elements that allow each end arm **901**, **3301** to rotate independently of the other so the wings may rotate together in a clamshell configuration as mentioned earlier.

[0112] Couplers **3317** and **3320** may run radially from the hub fitting **3304** on a locator tube collar and to the end **3303** and bottom **3302** fittings, thereby forming generally two "L" shapes or a "Y" shape. Various lengths of couplers may be used to adjust the shape and length of the end arm **901**, **3301** to allow forming collectors of varying aperture widths mentioned earlier. The fittings may be rods such as solid or tubular metal rods (e.g. aluminum), and the rods may be e.g. cylindrical, square, rectangular, regular, or irregular in cross-section.

[0113] The fittings and/or couplers may be formed of polymer (such as a rigid non-foamed polymer as discussed herein), metal such as aluminum, ceramic, or other suitable material.

[0114] 9. Corner End Panel Interconnect

[0115] As shown in FIG. **10**, there may be a corner end panel interconnect **1001** that serves to tie the end caps **1102** to the cowlings **702** structurally, providing for extra strength and support. The corner end panel interconnect **1001** may be made of any suitable rigid material, preferably aluminum (polished or unpolished) or a metal such as stainless steel that has high rigidity. It is either die cast or metal stamped into its desired shape.

[0116] The corner element **1001** may bridge one panel to another to maintain alignment and transfer torque to the next row of collectors. Potentially, multiple corner end panel interconnect **1001** pieces may be used to tie the bottom cowlings together to form an I-beam type structural member. This member may also be a one piece extruded shape.

[0117] An interconnect may also be a section of flat bar **2901** (FIG. **29**), for instance. And end fitting may have a flat rectangularly-shaped surface **3322** along an edge of the end-fitting so that e.g. flat bar **2901** can be attached to the edge of adjacent collectors to gang the collectors together and therefore move multiple collectors simultaneously using a single motor and drive sprocket.

[0118] 10. Inserts/Anchors

[0119] As shown in FIGS. **11**, **31**, and **32**, inserts **1101**, **3101** or embedded anchors **3201** may be used to attach the cowlings (e.g. FIG. **7 702**, FIG. **28-30 2805**) to the formed foam material **701**, **3102**, **3202**. One insert or anchor **1101**, **3101**, **3201** may be used every few feet. The inserts or embedded anchors may also be used to secure the end caps **1102** that maintain the parabolic shape and engage with the end arms **901**, **2806** as a means of support.

[0120] An insert may be glued into foam or other polymer of a core, as shown in FIG. **31**. The foam may be melted, and an insert may be anchored into the foam by heating and embedding it and allowing the polymer to resolidify around the anchor. As shown in FIG. **32**, a small hole may be formed in a surface of the foam by melting the surface, and the insert, may be glued into the hole.

[0121] 11. Fastener (e.g. Clip)

[0122] As shown in the figures, a clip (**502** (FIG. **5**), **1201** (FIG. **12**), **2803** (FIG. **28-30**)) such as an H-clip may be used to attach two arc-shaped reflectors **501**, **2802** together at the bottom of a parabola by connecting the cowling of one arc-shaped reflector to the cowling of the opposite reflector. A clip such as an H-clip may therefore have two sets of arms, one set that engages one arc-shaped reflector and one set that engages the other arc-shaped reflector.

[0123] A clip **502**, **1201**,**2803** may also optionally have a provision for attaching a stanchion **1401**, **2808** to support the receiver tube **1301** and glass envelope **2001**. The stanchion **1401**, **2808** may be positioned on top of the H-clip **1201** in the center of collector. This allows the stanchion **1401** to remain stationary and ensures the receiver tube **1301** is always centered at the focal point of the collector.

[0124] A clip as used in the collector depicted in FIG. **28-30** may not have the exact shape of an "H" as the H-clip of FIG. **12** has. A clip **3701**, **3702** in this instance may have a cross-section similar to that depicted in FIG. **37**A or **37**B and be generally H-shaped.

[0125] The fastener need not be a clip. For instance, the fastener may be a screw that joins flat tabs from adjoining cowling together or a latch and receiving portion on adjacent panels, for instance.

[0126] A clip may span some or all of the distance from one end cap to the other end cap. Since a clip need only provide an attachment point to improve rigidity of the assembly, a clip may be relatively short, being less than about 1/10 of the length of the cowling with which it engages. If further rigidity is desired, the clip can be made longer. The clip may be positioned at a midpoint along the longitudinally extending cowling for instance, or multiple clips may be positioned approximately equidistantly along the longitudinally extending cowling.

[0127] 12. Longitudinal Collector Tube

[0128] As shown in FIG. **13** and FIG. **28-29**, a longitudinal collector tube **1301**, **2801** similar to that described in prior patent applications incorporated by reference above, may be positioned with the parabola to receive light and solar thermal energy reflected by a parabolically-shaped reflective panel of a solar energy collector.

[0129] The collector or receiver tube **1301**, **2801** may have a working fluid, preferably an oil, Freon or water, working through the interior of the pipe. The receiver tube **1301** may connect to a joint or pass through a locator tube collar **2301** (FIG. **23**) (**3312** of hub **3304** in FIG. **33**) and locator tube **2201** (FIG. **22**) joined to a stand **2401** (FIG. **24**) that supports the support structure. Each support structure may have its own receiver tube **1301**, **2801** that joins to adjacent receiver tubes through joints, hoses, or other types of connectors typically used in joining tubes that will undergo thermal expansion and contraction. Alternatively, a single receiver tube **1301**, **2801** may be used for ganged support structures or for two or three adjacent support structures. A support structure may have one or more stanchions **1401**, **2808** to support the receiver tube, as explained in further detail below. The receiver tube may be painted with black paint or coated with a coating that absorbs solar energy and transmits the resultant heat to the tube wall. If the trough solar energy collector has an axis of rotation coaxial with the collector tube, the collector tube may be configured to rotate with the trough solar energy collector, or the collector tube may be fixed in position so that the trough collector rotates about the stationary collector tube. If the axis of the collector tube does not coincide with the rotational axis of the trough solar energy collector, the collector tube may revolve about the axis of rotation of the trough solar energy collector.

[0130] 13. Stanchion

[0131] As shown in FIG. **14** and FIG. **35**, one or more stanchions **1401**,**3501** similar to those described in prior patent applications incorporated by reference above, may be used to support a longitudinal receiver tube **1301** by means of a bearing (FIG. **15 1501**, FIG. **35 3502**) and bearing attachment (FIG. **17 1702**, FIG. **35 3503**) as explained in further detail below, as well as to support the glass envelope **2001** described below. One or more two-leg stanchions and/or single-leg stanchions **1401** are positioned between transverse end arms **901** and may attach to the arc-shaped reflector panel. The stanchion **1401**, **3501** may be positioned on top of or formed as part of a clip **1201**, **3504** in the center of the collector to keep it stationary and ensure the receiver tube **1301** is always centered at the focal point. A stanchion **1401**, **3501** may be made of any suitable rigid material. preferably aluminum, stainless steel, or the like, may have adjustment screws **1503** or bolts or plastic screws, explained below, which can be adjusted to provide better reflective focus across the collector.

[0132] Collector tube height can be adjusted by moving the plate **3506** on which the bearing rests up or down and then tightening the bearing attachment **3503** to secure the collector tube **3507** and bearing **3502** in place. An additional cap (not shown for sake of clarity) engages with bolt-holes **3508** onto the stanchion to retain an insulating glass envelope (discussed below).

[0133] 14. U-Bolt Assembly

[0134] As shown in FIGS. **15-18**, a U-bolt assembly may be used to fasten the receiver tube bearing **1501**, described below, to the stanchion **1401**. thereby allowing for adjustability of the receiver tube **1301**. The U-bolt assembly shown in FIGS. **15-1 8**, which is secured by nuts, extends in a "U" shape through the bottom of the stanchion **1401**, around the receiver tube bearing **1501**, and back through the other side of the stanchion. Additionally, there may be a bolt extending through the bottom of a bracket where the "U" bolt is attached. This allows for height adjustments of the receiver tube bearing **1501** centering the receiver tube **1301**.

[0135] 15. Receiver Bearing Adjustment Screw

[0136] As shown in FIGS. **15** and **16**, stanchions may have adjustment screws **1503** and **1601** or bolts or plastic screws that can be adjusted to provide better reflective focus across the collector. Adjustment screws **1503** and **1601** may adjust the height of the receiver tube bearing **1602** to provide optimal reflective focus across the length of the collector, thereby increasing collector efficiency.

[0137] 16. Receiver Tube Bearing Attachment

[0138] As shown in FIG. **17**, a receiver tube bearing attachment **1701** may be used to accommodate the thermal expansion and contraction of the receiver tube **1301**. The bearing attachment **1701** permits the panels to rotate around the receiver tube **1301** and position the receiver tube **1301** to ensure maximum reflective focus and collector efficiency. This allows the receiver tube **1301** to slide longitudinally as the receiver tube **1301** expands and contracts.

[0139] 17. Stanchion Bracket

[0140] As shown in FIGS. **18** and **33**, stanchion brackets **1801**, **3303**, **3305** may be used to support the glass envelope **2001**, described below. The brackets **1801**, **3303**, **3305** may be made of any suitable rigid material, preferably aluminum, stainless steel, or otherwise, clamp together to compress against the glass and provide support across the length of the glass envelope **2001**. An additional cap (not shown for sake of clarity) engages with bolt-holes **3508** on the stanchion bracket **3505** to retain an insulating glass envelope.

[0141] 18. Gaskets

[0142] As shown in FIG. **19**, silicone **1901**, preferably, or another resilient polymer, organic or inorganic gel, ceramic or metals able to withstand high temperatures as described in prior patent applications incorporated by reference above, may be used to support the glass envelope **2001** and serve as an end seal. The silicone foam gaskets **1901** are placed at the ends of the glass envelope **2001** between the receiver tube **1301** and the glass and are clamped down by a bracket secured with bolts.

[0143] The seal created contains the ambient atmosphere within the chamber of the glass envelope **2001** when a cover, described below, is placed on or in the opening of the glass envelope **2001** housing. The silicone end seals **1901** may be pliable and movable to allow thermal expansion without undue stress being created on the ends of the glass envelope **2001** or the receiver tube **1301**.

[0144] 19. Glass Envelope

[0145] As shown in FIG. **20**, the glass envelope **2001**, a transparent tubular housing similar to those described in prior patent applications incorporated by reference above, may be used to enclose the receiver tube **1301** to provide an insulating layer and reduce heat loss. The glass envelope **2001** may vary in thickness, preferably around 2 millimeters thick and may have a chamber that is sufficiently large to contain the receiver tube **1301** positioned within the glass chamber. The glass envelope **2001** may be transparent to UV, visible, and/or infrared light. Preferably, the glass envelope **2001** is transparent to at least the sun's visible and infrared radiation. The envelope **2001** may be formed from borosilicate glass such as Pyrex. Alternatively, the envelope **2001** may be formed of an acrylic polymer such as polymethacrylate, a butyrate, a polycarbonate, or other polymer that admits at least 70% of the sunlight **14** incident upon it. The glass envelope **2001** may contain air, other gases, or be evacuated or partially evacuated in some variations.

[0146] Additionally, the glass envelope **2001** may be sliced to shape leaving at least one opening to allow easy access to the chamber, so the envelope **2001** may be placed over the receiver tube **1301** without having to slide it on and risk breakage. This opening allows for convenient and easy installation, assembly, replacement, and cleaning. The one or more openings may run the entire length of the glass envelope **2001** and may be as wide as or wider than the receiver tube **1301** that is to reside within the chamber of the envelope **2001**. Once placed over the receiver tube **1301**, the glass envelope **2001** opening may be filled with an inner and outer reflective cover **2101** described below, and an insulating material **2102**, all of which are sealed by the silicone foam gaskets **1901**.

[0147] A glass envelope may be a telescoping envelope as illustrated in FIG. **36**. One glass tube **3601** nests within a second glass tube **3602** around a collector tube **3603**. During collector assembly, the nested tubes are placed over the collector tube, and subsequently the outer glass tube is slid along the inner glass tube so that one of the tubes can be secured to a side of the stanchion and the other of the glass tubes can be secured to or in the vicinity of the locator tube collar **3312** of the hub **3304** of FIG. **33**.

[0148] 20. Inner and Outer Reflective Cover

[0149] As shown in FIG. **21**, a cover assembly, similar to that described in prior patent applications incorporated by reference above, may be placed on or in the glass envelope **2001** opening, and may or may not be retractable. The cover assembly may consist of an inner and outer cover **2101**, as well as insulating material **2102**. The cover assembly may be attached in a manner to allow the cover be retractable for venting and cleaning of the glass envelope **2001**.

[0150] The inner and outer covers **2101** are often movable and may fit within or upon the one or more openings of the glass envelope **2001**. The inner and outer covers **2101** may be made of any suitable rigid material, preferably aluminum (polished or unpolished), may be formed of a metal such as stainless steel that has high rigidity, or may be silvered to make a reflective surface. The outer cover **2104** may provide a protective backing for the glass envelope **2001**. The inner cover **2103** acts as a lens to better direct solar radiation onto the receiver tube **1301**. The inner cover **2103** focuses solar energy upon the receiver tube **1301** when it is seated in the glass envelope **2001** and reflects any solar radiation that is not reflected directly onto the receiver tube **1301**. The inner cover's **2103** surface may reflect at least 50% of the radiation incident upon it, and preferably the surface reflects greater than 80% or 90% of the radiation incident upon it. Inserted in between the inner and outer cover **2101** is a thermally insulating material **2102** able to withstand high temperatures, preferably a rigid polymer like polycarbonate, polyamide, or polyimide that may have a mirrored coating to reflect light. The insulating material **2102** and the inner and outer covers **2101** may be clamped together by a bolt, screw, rivet, or any other suitable fastener.

[0151] 21. Locator Tube

[0152] As shown in FIG. **22**, a locator tube **2201**, similar to that described in prior patent applications incorporated by reference above, may be used to support a solar collector, as well as to join two solar collectors together. The tube **2201**, which extends through an end arm **901**, may be made of any suitable rigid material, preferably aluminum (polished or unpolished) or a metal such as stainless steel that has high rigidity. In addition, the locator tube **2201** rests on a stand **2401**, described below, allowing it to rotate around the receiver tube **1301**. The locator tube **2201** may also contain a keyway or a key which allows it to drive the locator tube collar **2301** described below.

[0153] The locator tube **2201** and locator tube collar **2301** may each have holes through which bolts or adjusting screws, for example, extend. The bolts or screws secure the locator tube collar **2301** and locator tube **2201** so that they rotate in unison. Additionally, the bolts or screws may extend through the holes to support the receiver tube **1301** and the locator tube may be used as a race for the bearing to allow the receiver tube **1301** to pass through.

[0154] 22. Stand

[0155] As shown in FIG. **24**, a support structure is typically secured to stands **2401** containing bearings, similar to those described in prior patent applications incorporated by reference above, to allow the support structure to pivot along an axis defined by the bearings. The stand **2401** may be made of aluminum (polished or unpolished) or a metal such as stainless steel that has high rigidity. The stand **2401** may have a locator tube **2201** extending through the bearing at either or both ends of the bearing and extending into a locator tube collar **2301** of the support structure, thereby providing a more rigid structure.

[0156] 23. Torsion Cables

[0157] As shown in FIG. **25**, the support structure **2502** may have optional torsion cables **2501**, similar to those described in prior patent applications incorporated by reference above, that may extend diagonally from one end arm to the opposite end arm of the support structure **2502**. The torsion cables **2501** may therefore cross in an "X"-shaped configuration, for instance. The torsion cables **2501** help provide a rigid structure that resists torsion without adding significant weight to the support structure or shading to the solar panels or reflective element.

What is claimed is:

1. A trough solar energy collector having a rotational axis comprising

(a) a collector tube,

(b) a first reflective panel and a second reflective panel,

(i) each of said first and second reflective panels comprising

(1) a honeycomb or polymeric core having an arc-shaped surface

(2) a reflector on the arc-shaped surface of the polymeric core

(3) cowling along a longitudinal edge extending along the polymeric core and extending parallel to the rotational axis of the solar collector

(ii) the first reflective panel being positioned to illuminate a first side of the collector tube,

(iii) the second reflective panel being positioned to illuminate a second side of the collector tube.

2. A collector according to claim **1** wherein the core is polymeric and comprises expanded polystyrene, extruded polystyrene, or expanded extruded polystyrene.

3. A collector according to claim **2** wherein the polymeric core is skinless.

4. A collector according to claim **2** wherein the polymeric core is uniform in compression and tension.

5. A collector according to claim **1** wherein the core is polymeric and an outer surface of the polymeric core is coated with a UV inhibitor or an externally affixed material such as metal, plastic, fiberglass, or canvas which provides impact resistance and/or durability against harsh weather.

6. A collector according to claim **1** wherein the collector tube is coincident with the rotational axis of the solar collector.

7. A collector according to claim **1** wherein a portion of the cowling overlies an edge of the reflector to aid in securing the reflector to the core.

8. A collector according to claim **1** and further comprising a fastener, said fastener being positioned between the first reflective panel and the second reflective panel such that the fastener engages an edge of the cowling of the first reflective panel and an edge of the cowling of the second reflective panel.

9. A collector according to claim **8** wherein said fastener is a clip having first and second sets of arms and positioned between the first reflective panel and the second reflective panel such that the first set of arms engages an edge of the cowling of the first reflective panel and the second set of arms engages an edge of the cowling of the second reflective panel.

10. A collector according to claim **9** wherein the clip further comprises a stanchion that supports the collector tube.

11. A collector according to claim **1** and further comprising an end arm comprising

(a) a hub fitting having an opening through which the collector tube passes,

(b) a plurality of top fittings configured to engage with top portions of respective ones of the first reflective panel and the second reflective panel,

(c) a bottom fitting configured to engage with bottom portions of each of the first reflective panel and the second reflective panel, and

(d) a plurality of fitting couplers securing the plurality of top fittings and the bottom fitting to the hub fitting.

12. A collector according to claim **11** wherein the hub fitting has a collar at said opening to engage with a locator tube of the collector.

13. A collector according to claim **12** wherein at least one of the locator tube and the hub fitting has a keyway for engagement of the locator tube and the hub fitting.

14. A collector according to claim **11** wherein the hub fitting further comprises a drive sprocket.

15. A collector according to claim **11** wherein the hub fitting has holes extending radially from the hub fitting to engage ends of the fitting couplers.

16. A collector according to claim **11** wherein the top fittings have collar portions into which edges of the first and second reflective panels insert.

17. A collector according to claim **11** wherein the top fittings or the reflective panels have openings and the other of the top fittings or the reflective panels have shapes that insert into the openings to engage the top fittings with the reflective panels.

18. A collector according to claim **11** wherein the bottom fitting or the reflective panels have openings and the other of the bottom fitting or the reflective panels have shapes that insert into the openings to engage the bottom fitting with the reflective panels.

19. A collector according to claim **11** wherein the bottom fitting has a collar portion into which edges of the first and second reflective panels insert.

20. A collector according to claim **11** wherein the fitting couplers are rods that insert into the holes of the hub fitting and additionally holes of the top and bottom fittings to form the end arm.

21. A collector according to claim **11** wherein a plurality of the fitting couplers interconnect the hub fitting with the bottom fitting.

22. A collector according to claim **1** wherein the polymeric core has a convex arcuate profile in addition to a concave arcuate profile.

23. A collector according to claim **1** wherein the first and second reflective panels further comprise end caps.

24. A collector according to claim **23** wherein the end caps have perimeter encasing tabs that engage the reflectors and the polymeric cores.

25. A collector according to claim **24** wherein the encasing tabs overlie the reflectors, the polymeric cores, and the longitudinally-extending cowling.

26. A collector according to claim **1** wherein the collector tube does not rotate or revolve about the rotational axis of the collector.

27. A collector according to claim **1** wherein the reflective panels are flexible at room temperature.

28. A collector according to claim **27** wherein the reflective panels comprise polished aluminum panels.

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