US 20050126420A1

(19) **United States**

(12) **Patent Application Publication**

Givens et al.

(10) **Pub. No.: US 2005/0126420 A1**

(43) **Pub. Date: Jun. 16, 2005**

(54) **WALL BREACHING APPARATUS AND METHOD**

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(21) Appl. No.: **10/938,199**

(22) Filed: **Sep. 10, 2004**

Related U.S. Application Data

(60) Provisional application No. 60/501,815, filed on Sep. 10, 2003.

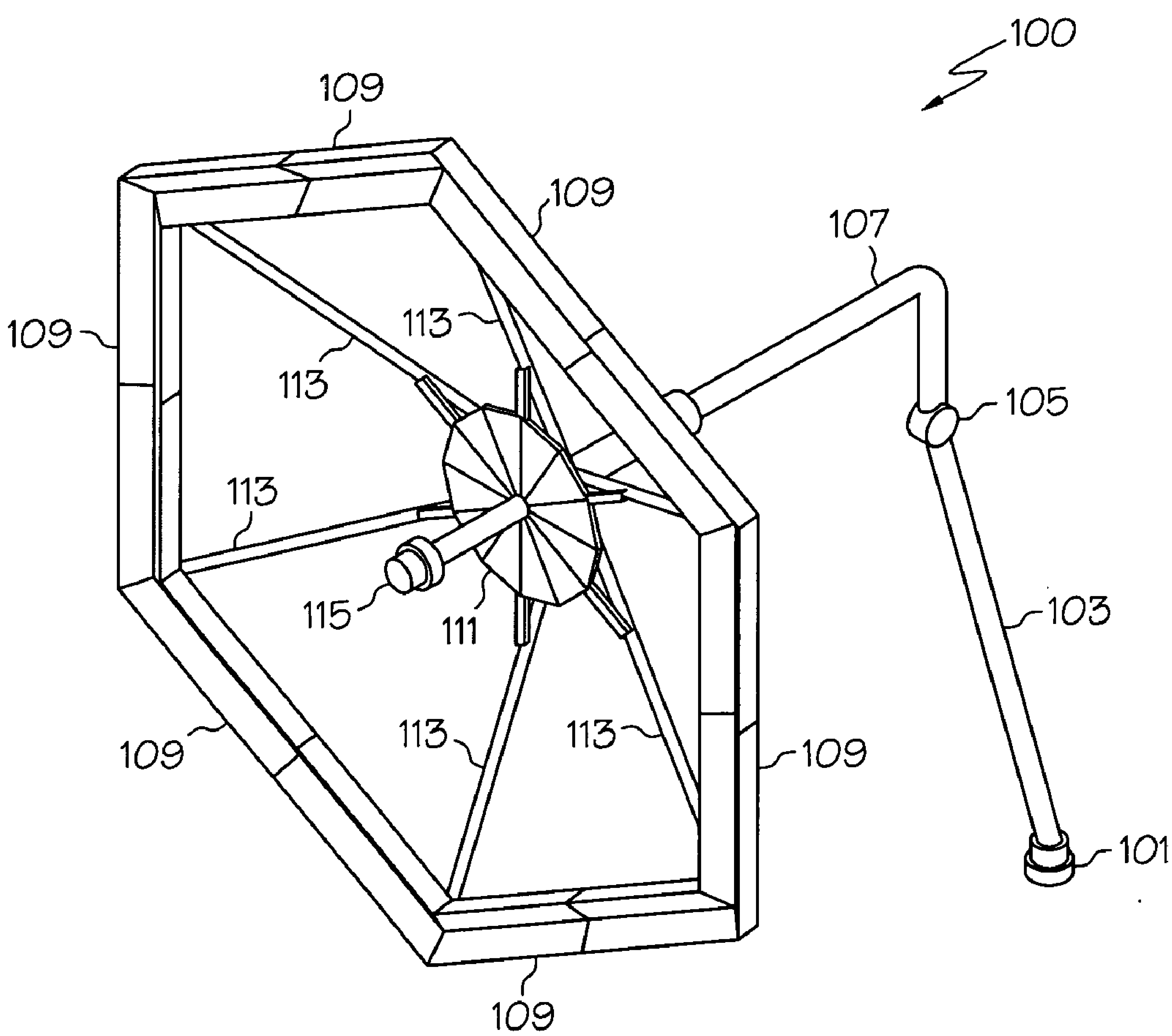
Publication Classification

(51) **Int. Cl.**[7] **F42B 1/00**

(52) **U.S. Cl.** **102/310**

(57) **ABSTRACT**

Wall breaching apparatus and methods utilizing shaped charges for penetration of walls of buildings and other structures for rescue, escape, or military operations.



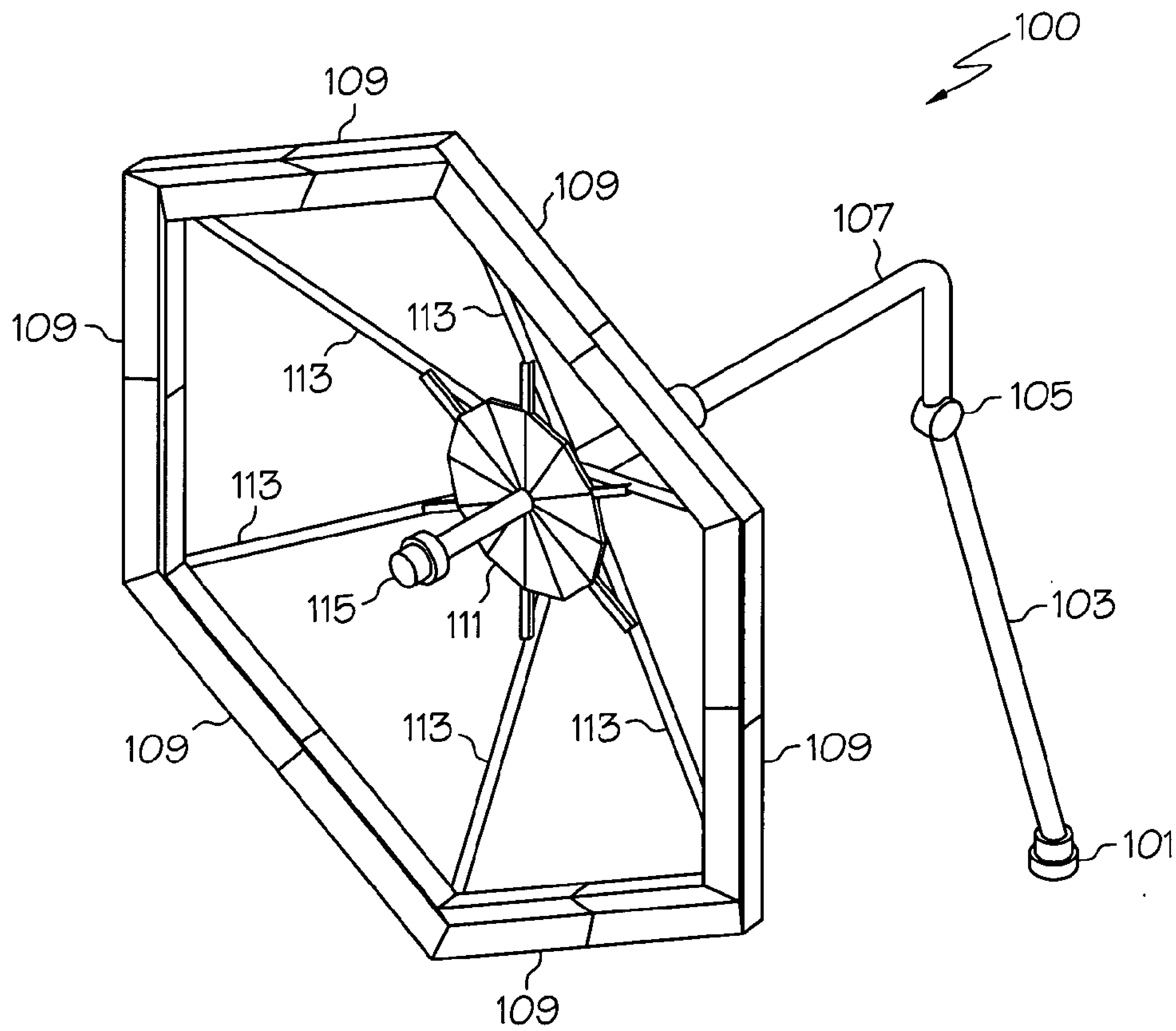

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FIG. 1A

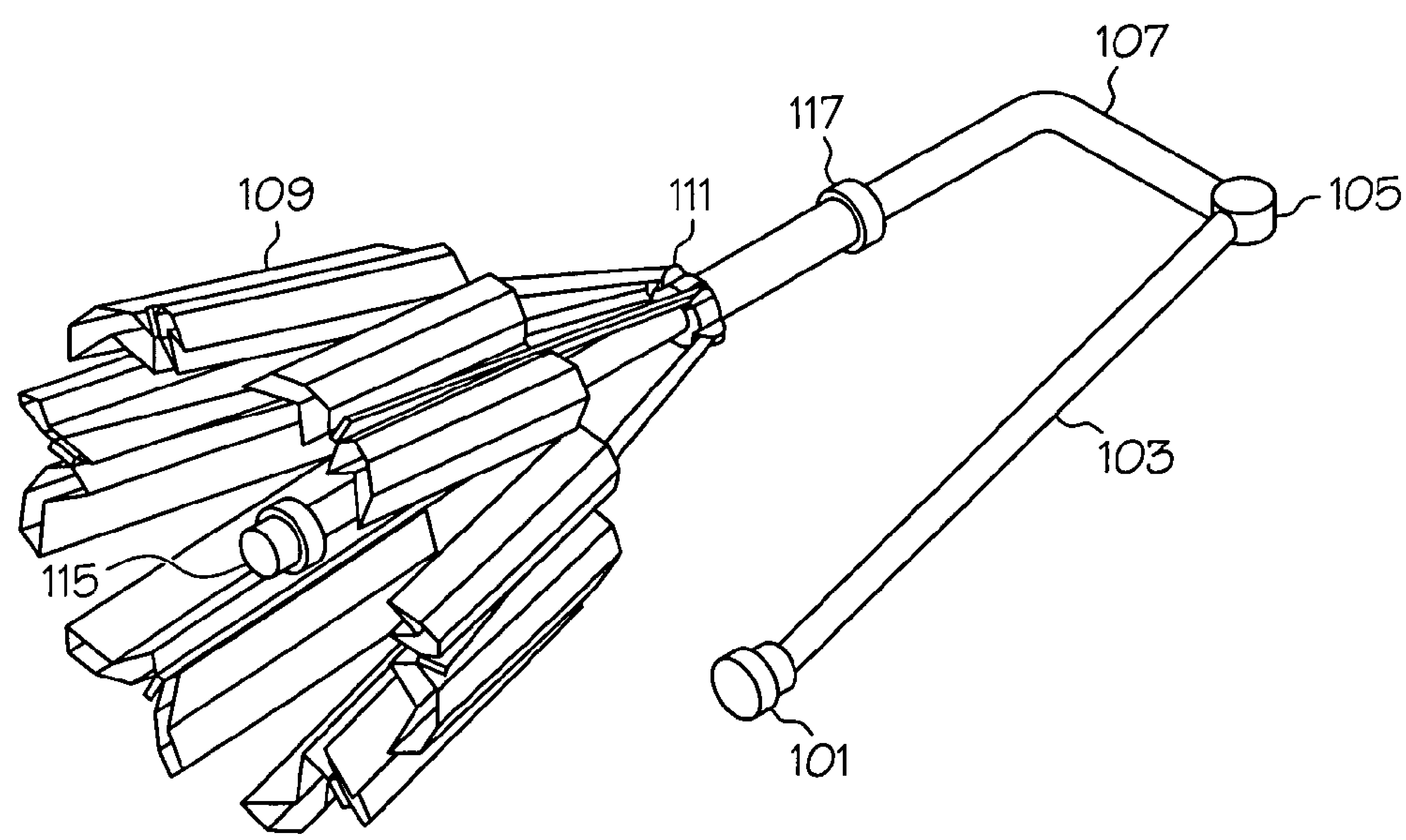
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FIG. 1B

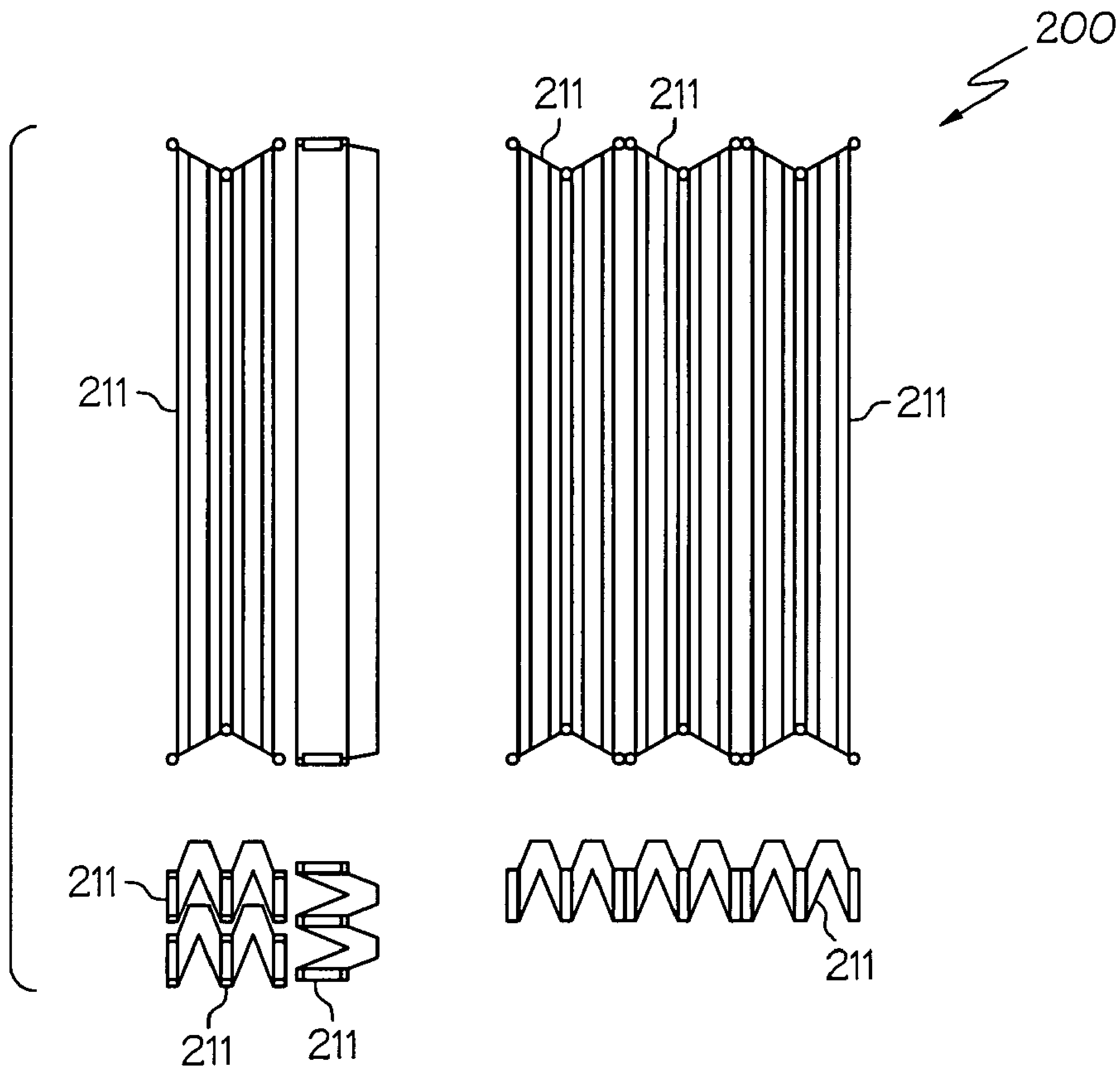

FIG. 2A

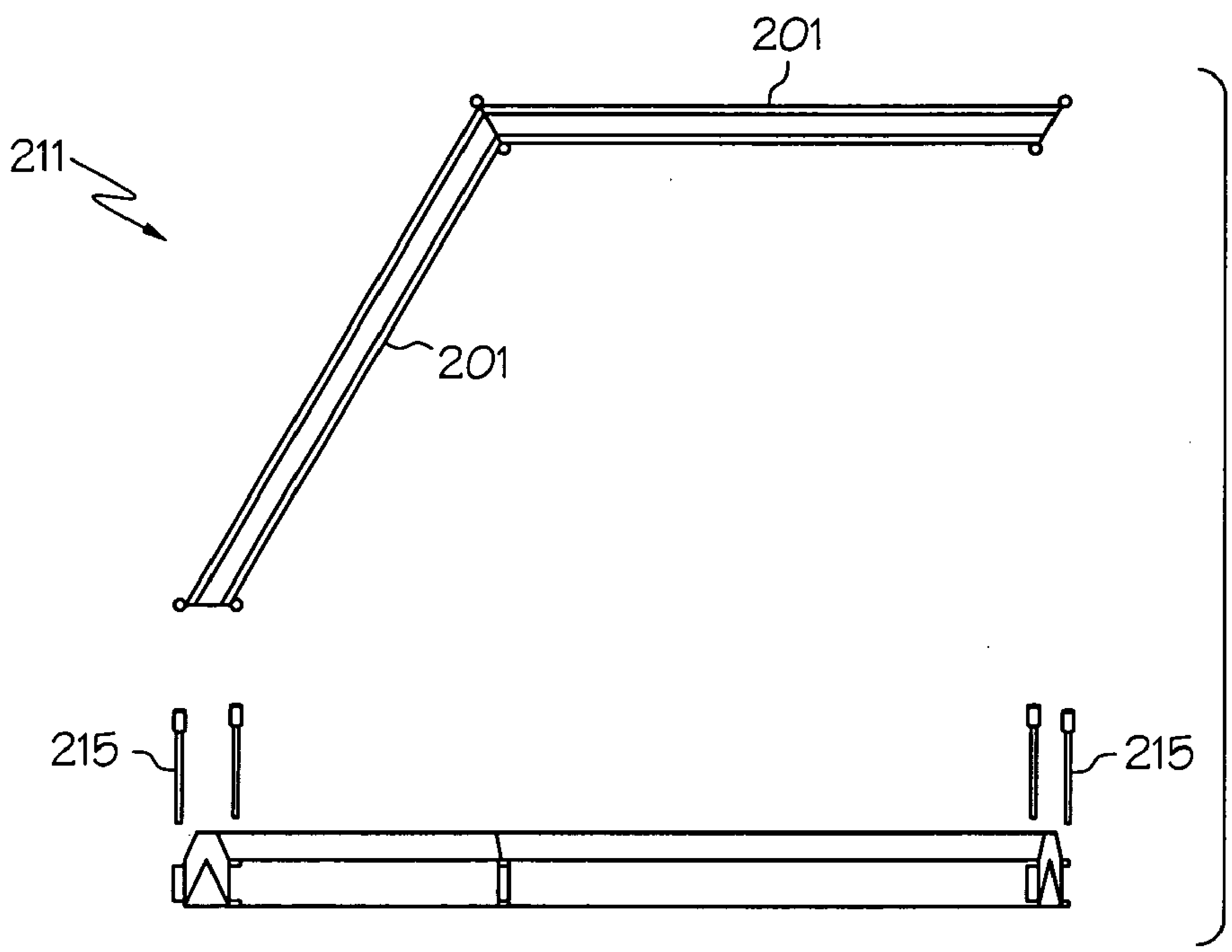

FIG. 2B

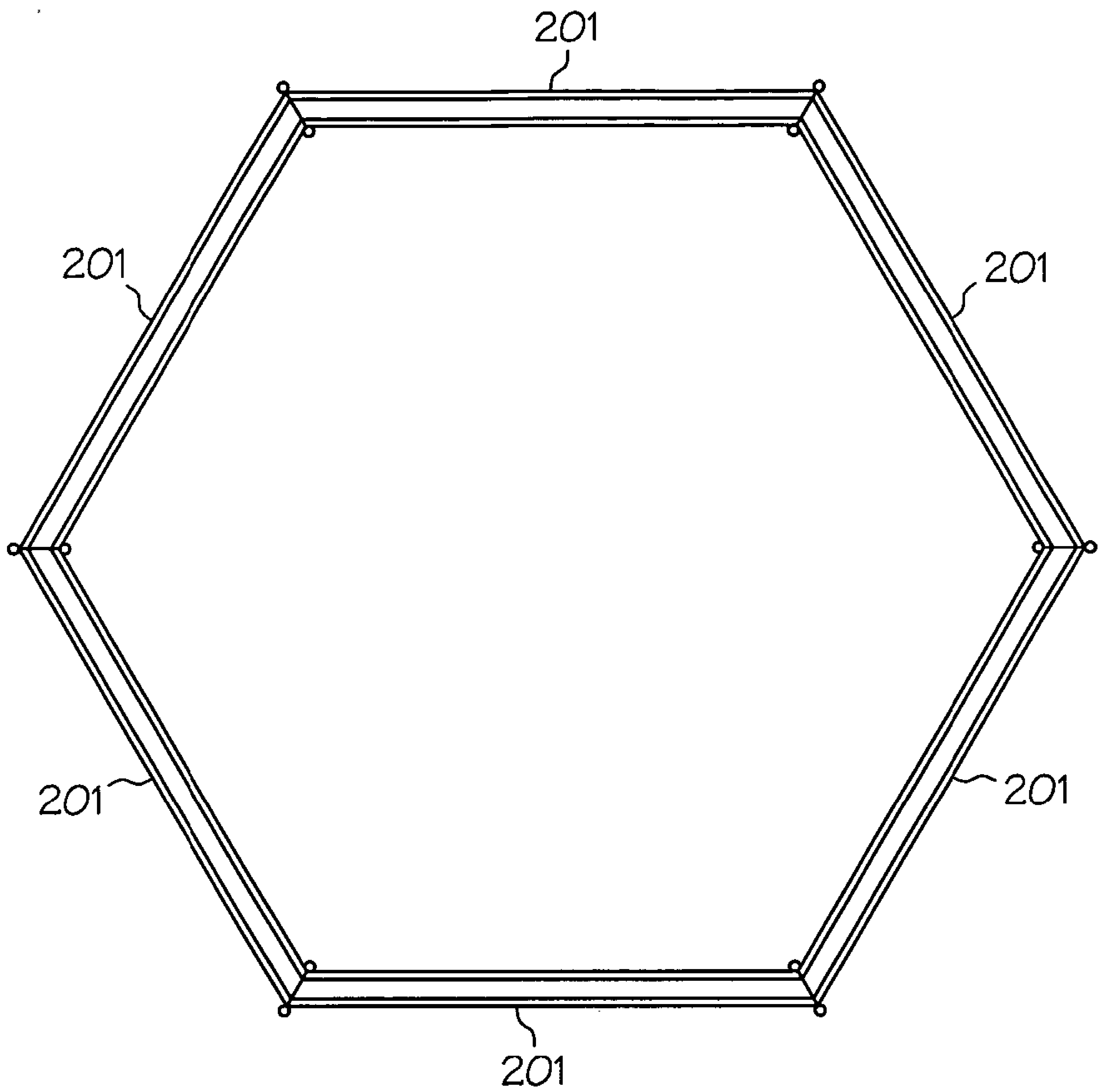
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FIG. 2C

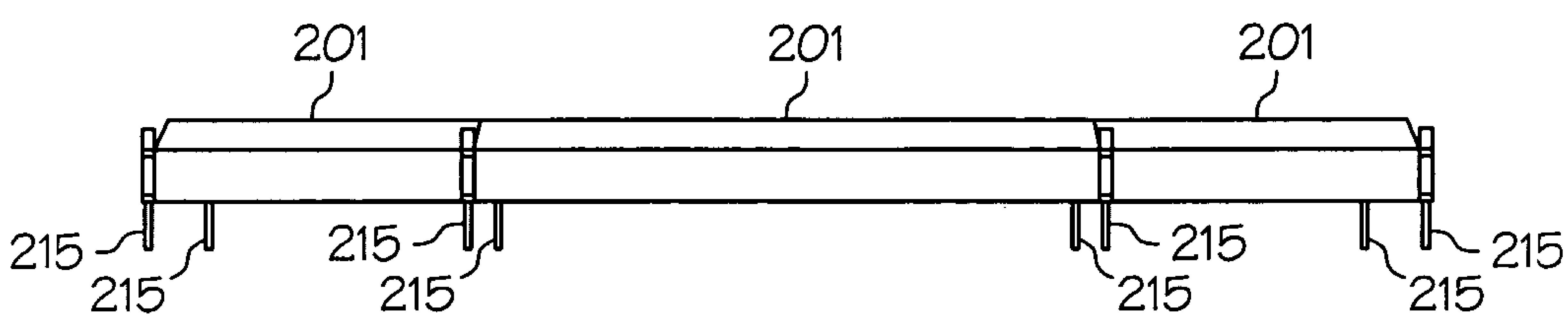
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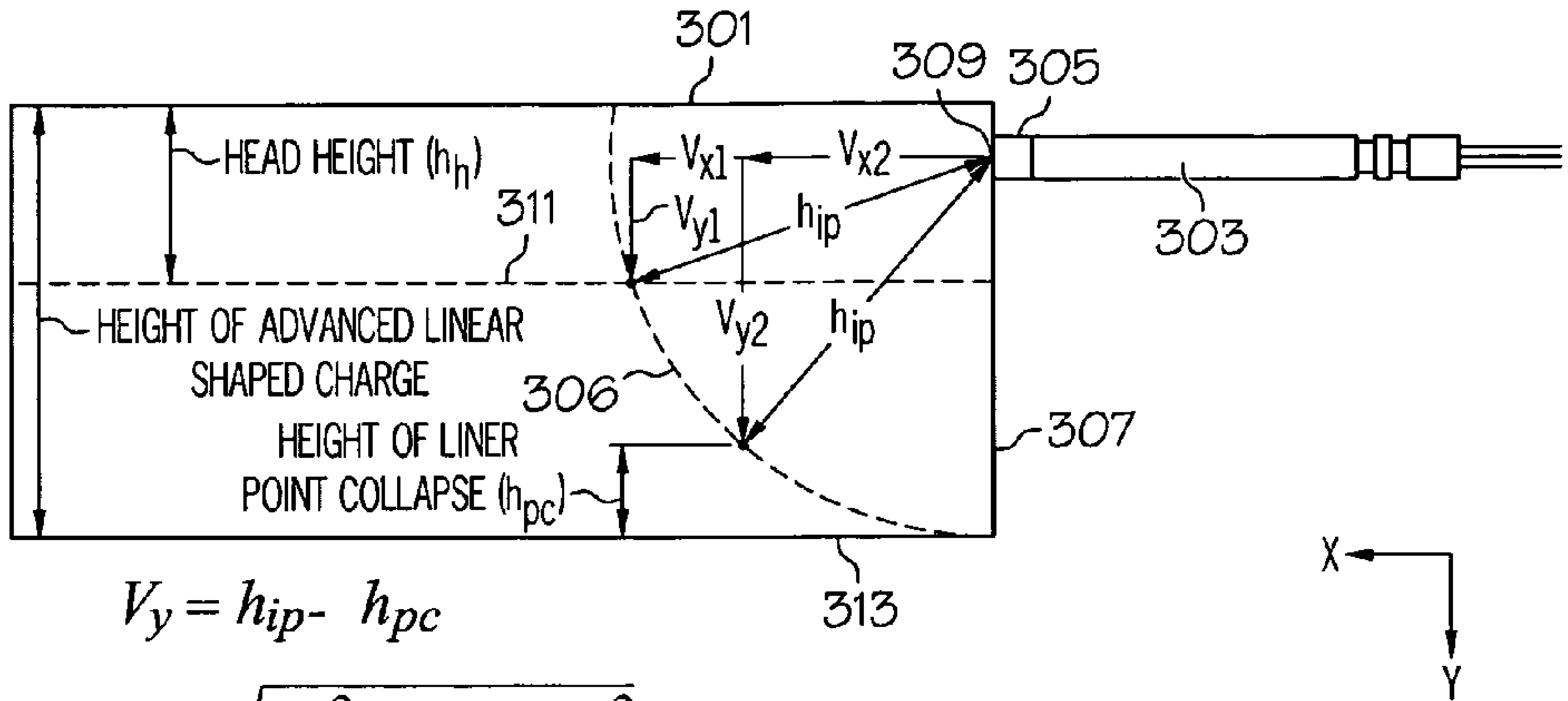
FIG. 2D



$$V_y = h_{ip} - h_{pc}$$

$$V_y = \sqrt{h_{ip}^2 - (h_{ip} - h_{pc})^2}$$

FIG. 3

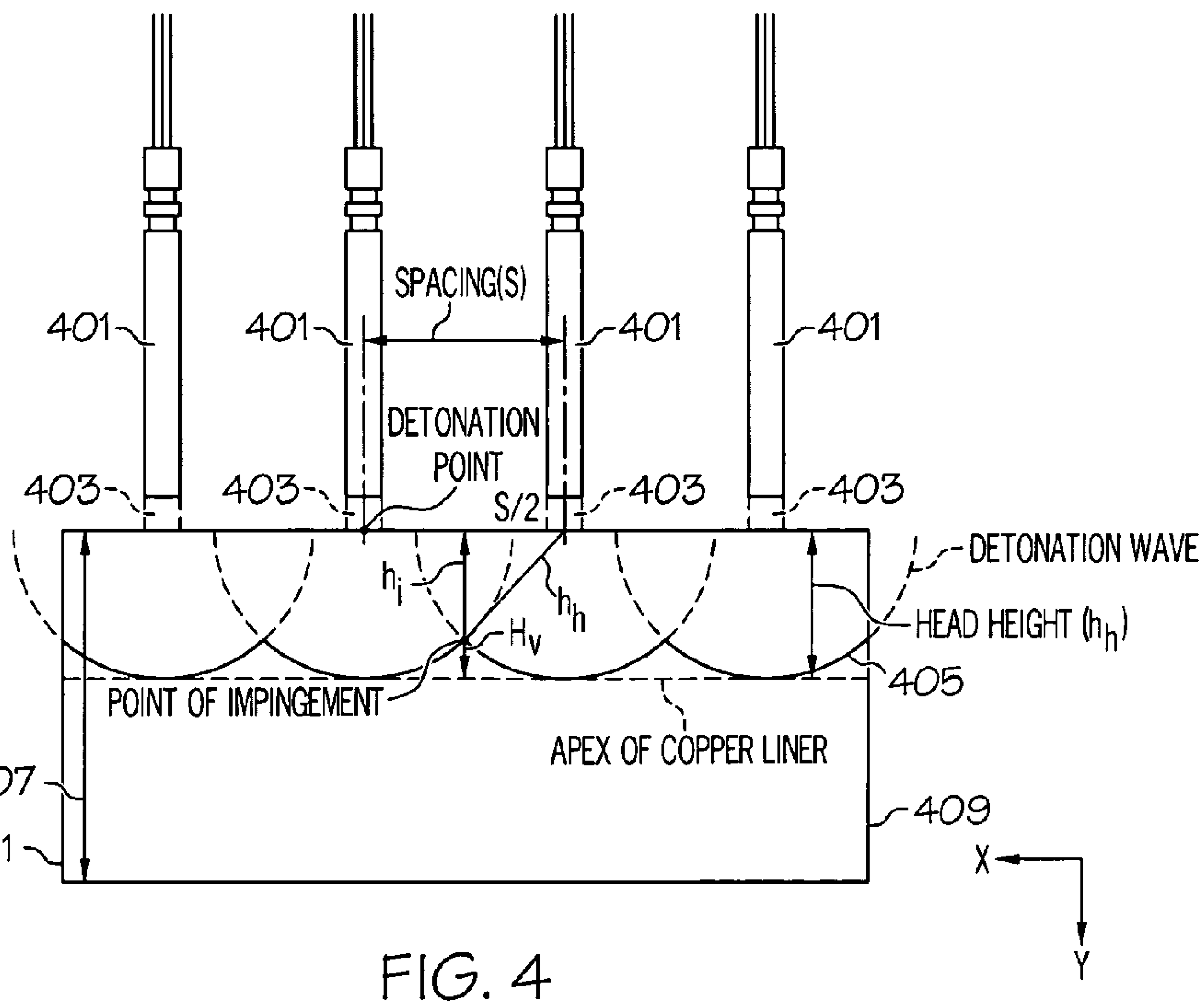


FIG. 4

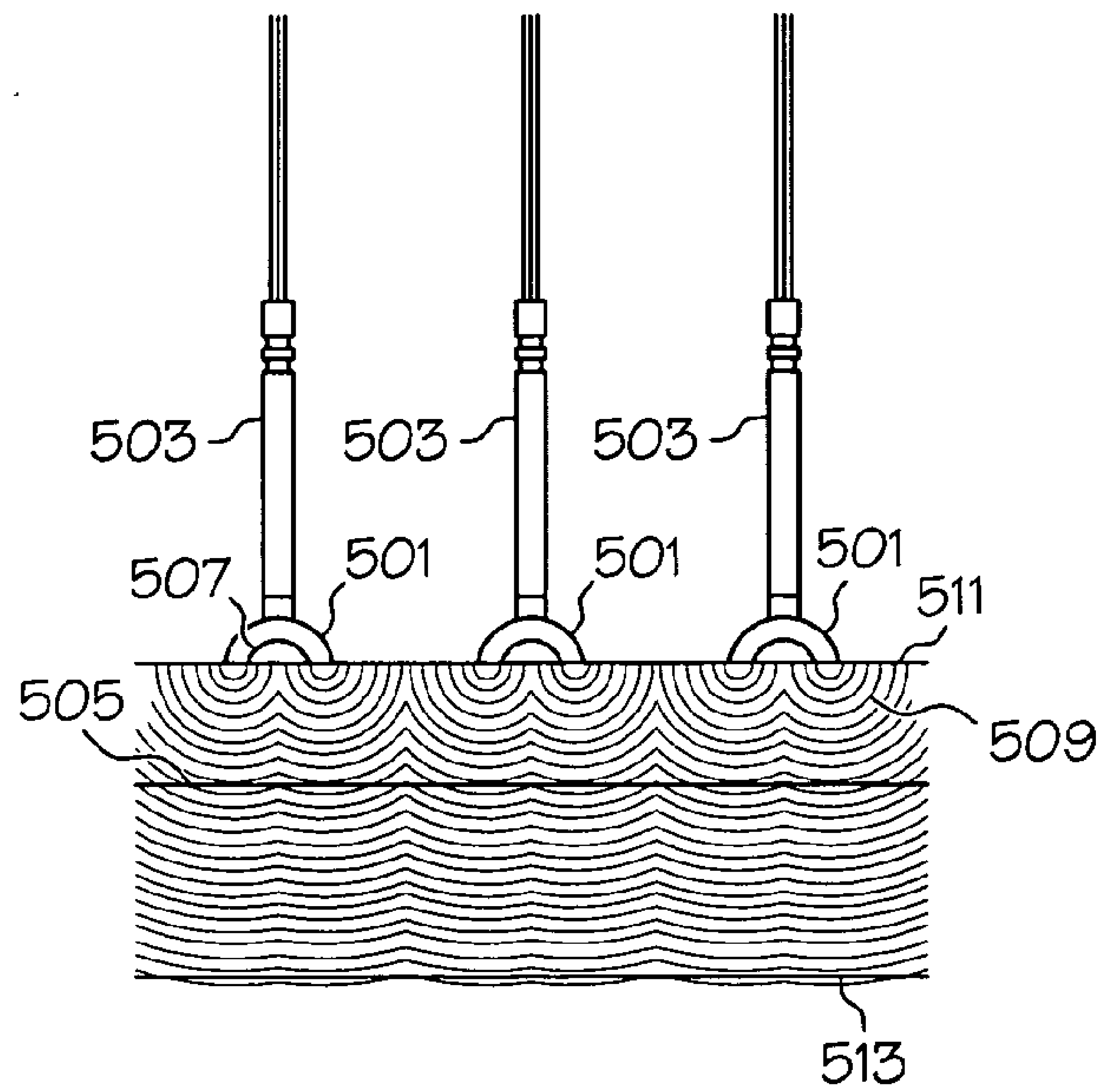


FIG. 5

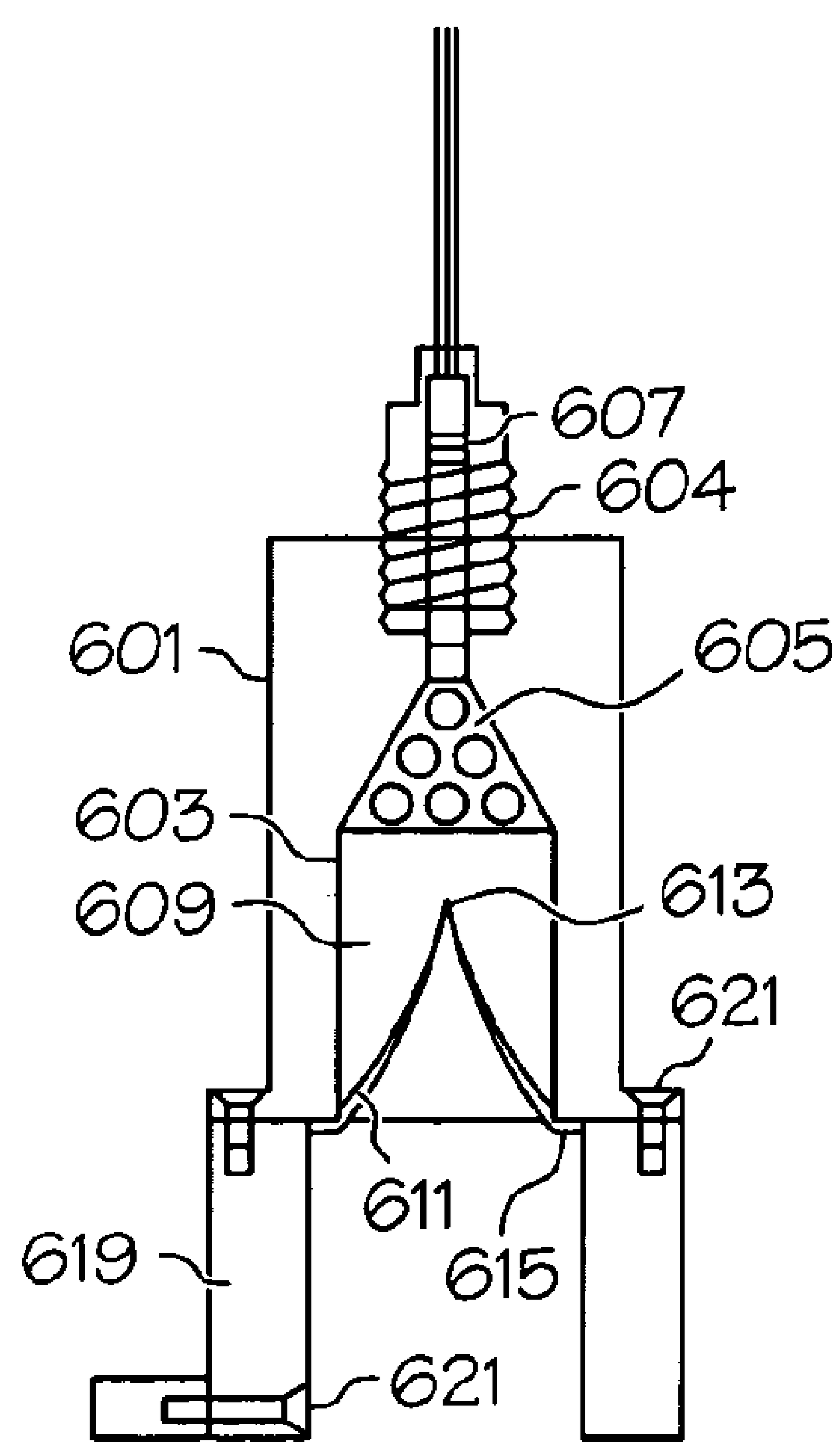


FIG. 6A

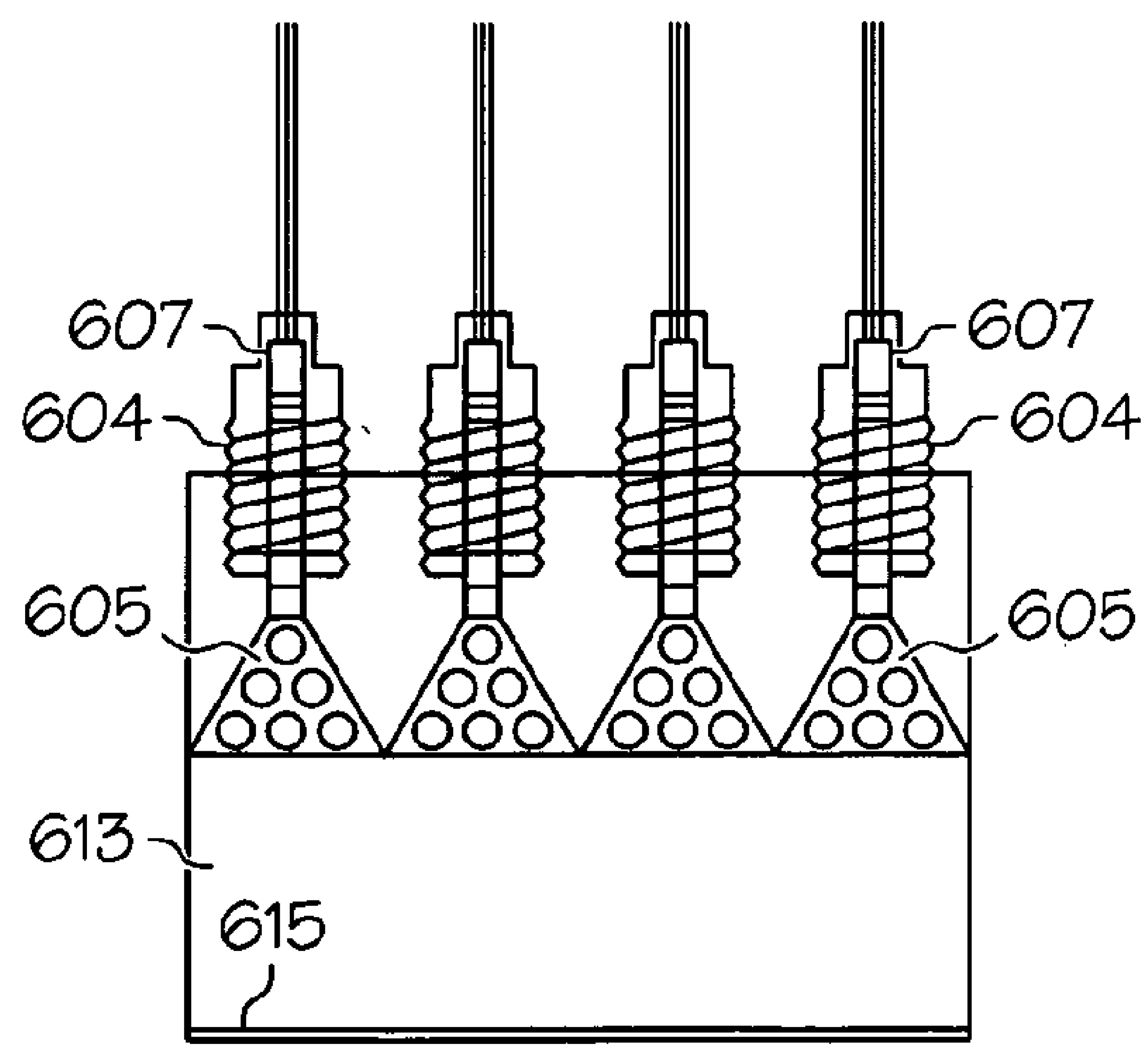


FIG. 6B

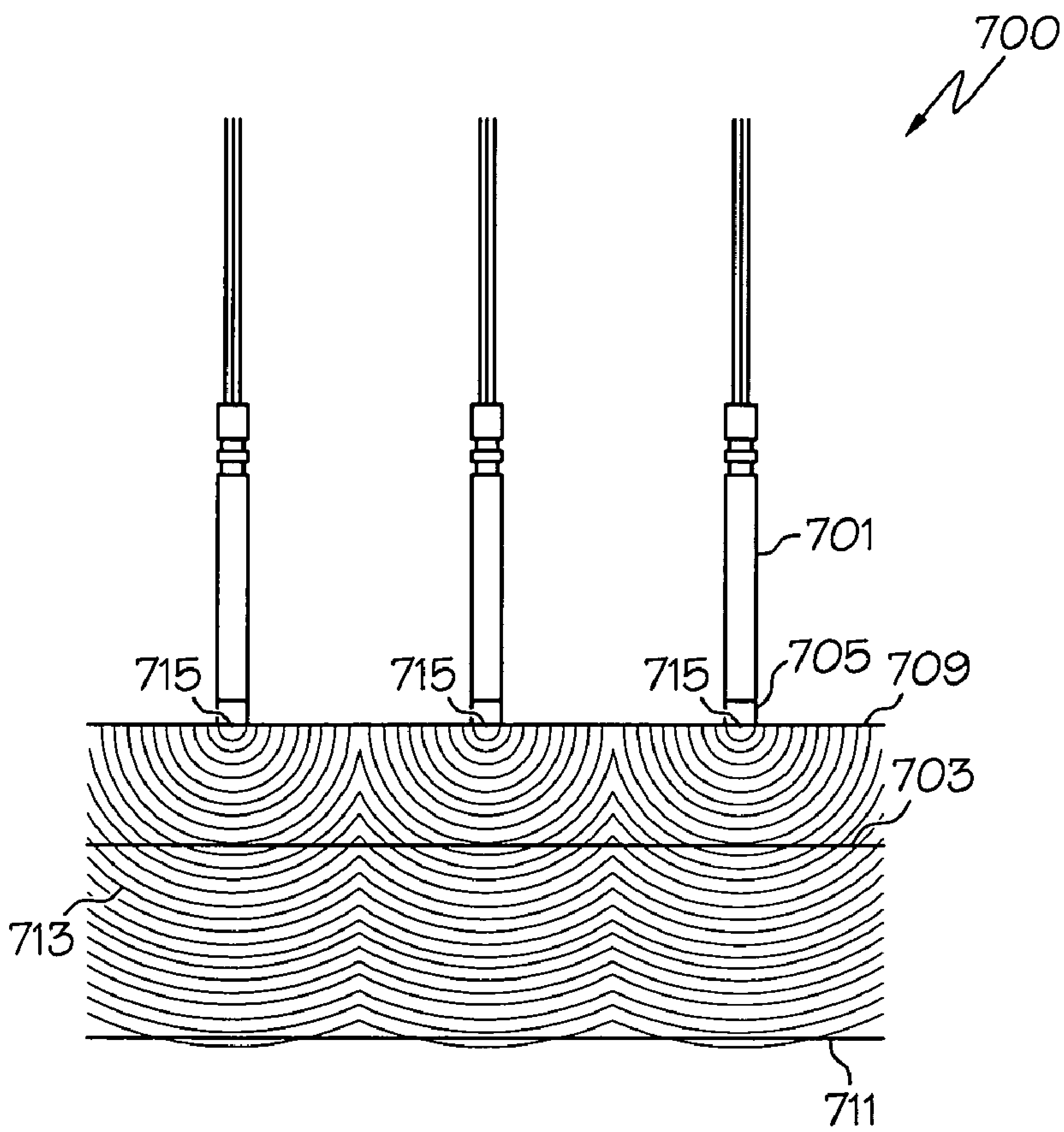


FIG. 7

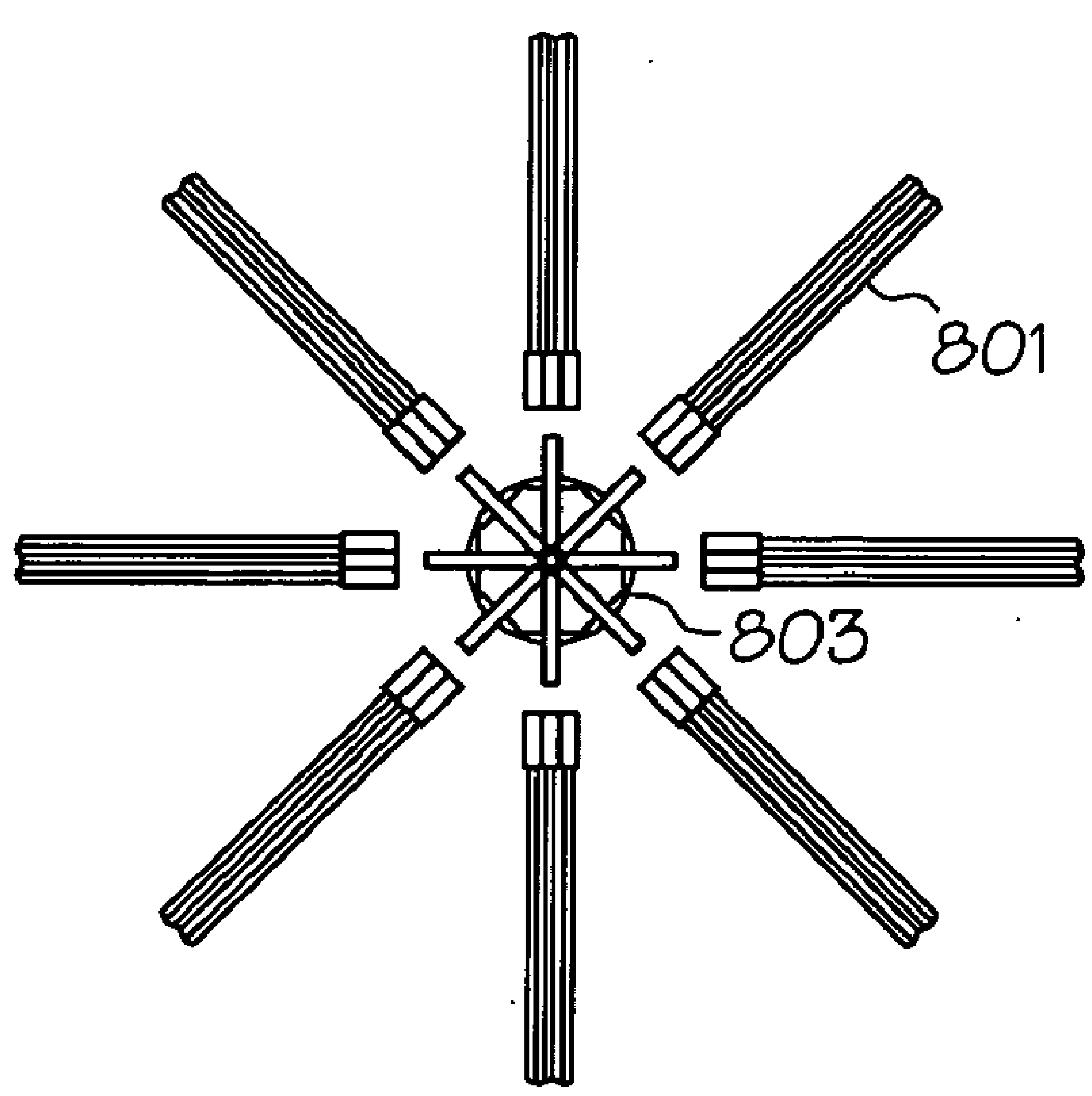


FIG. 8

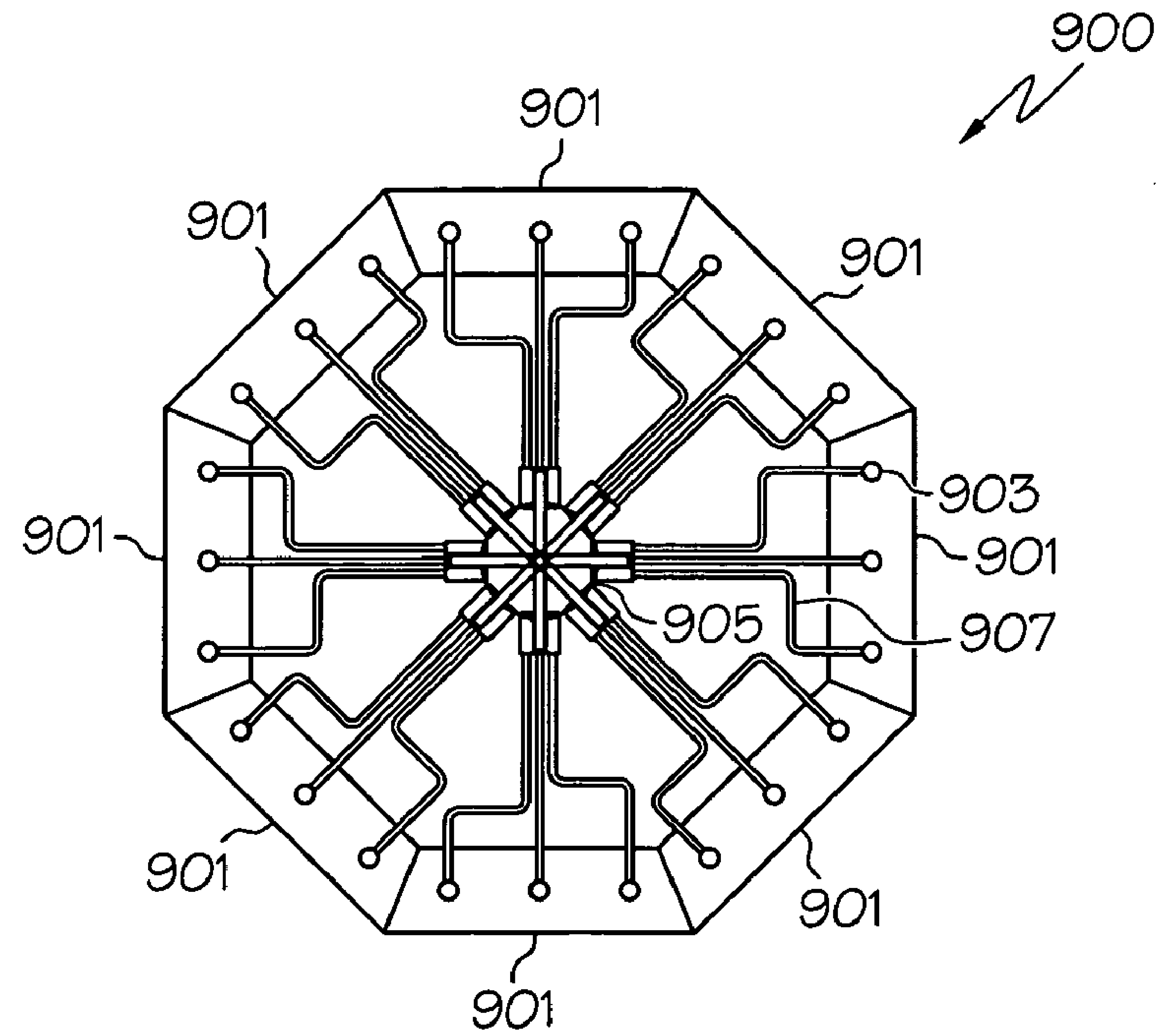
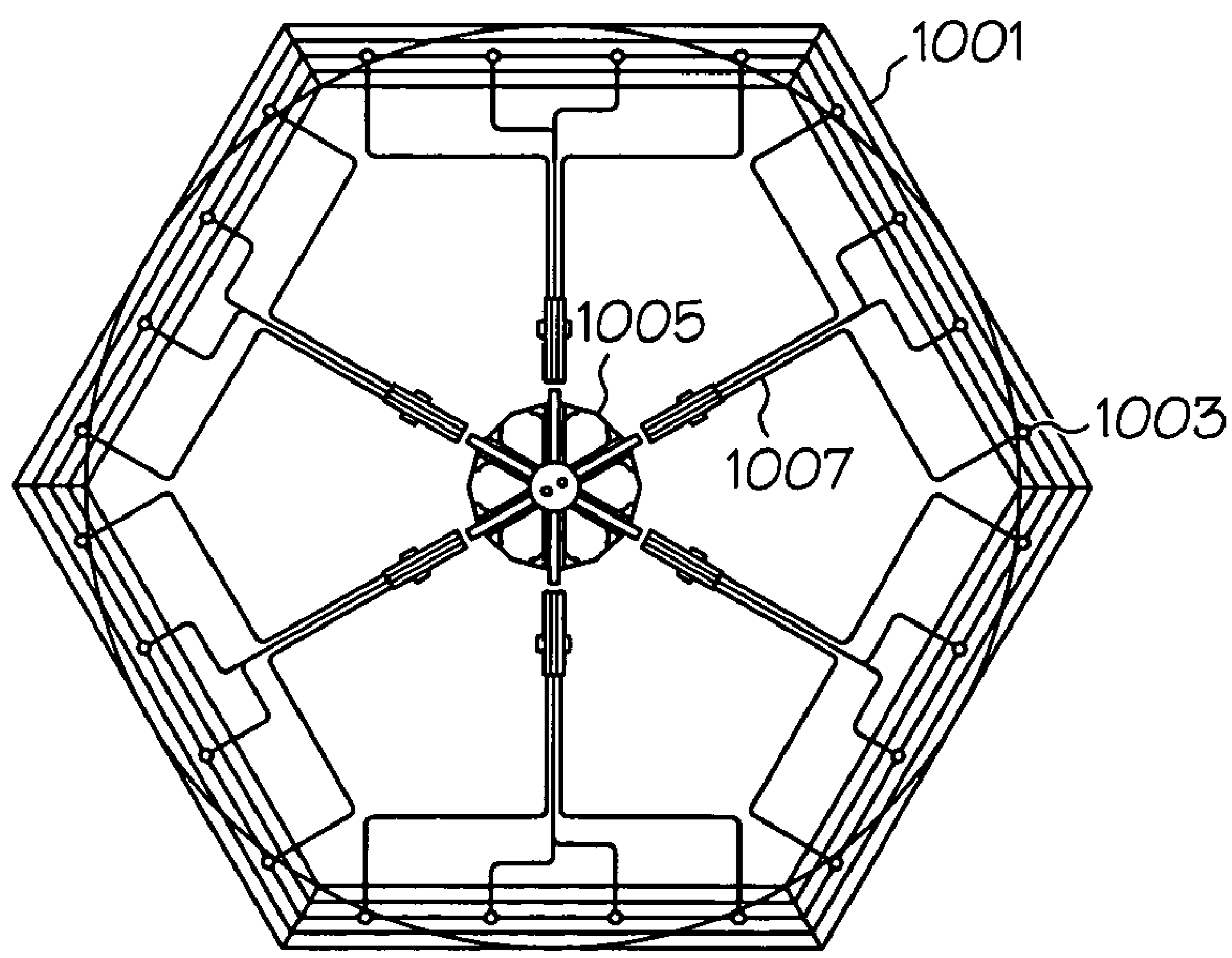


FIG. 9



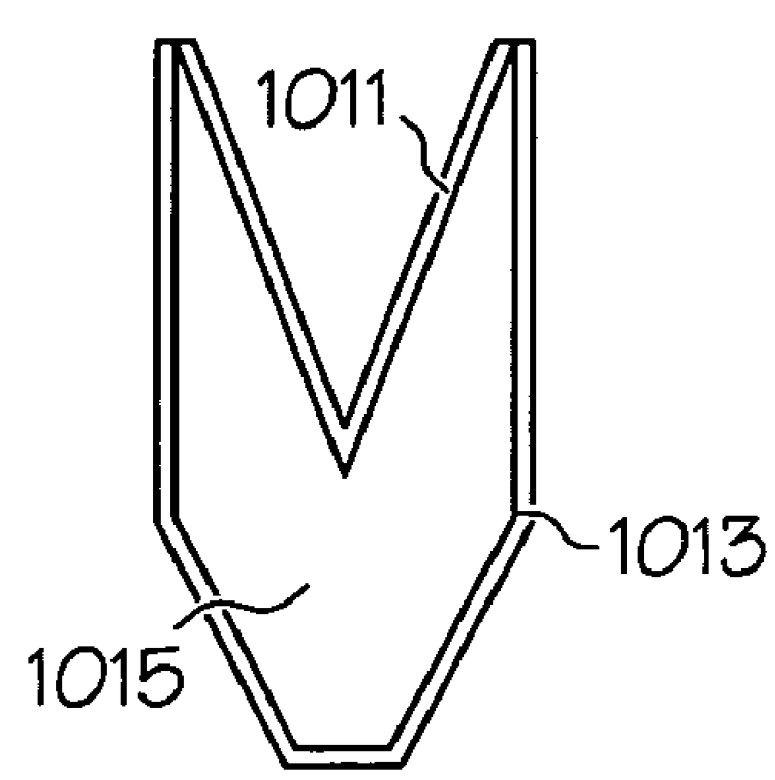


FIG. 10B

FIG. 10A

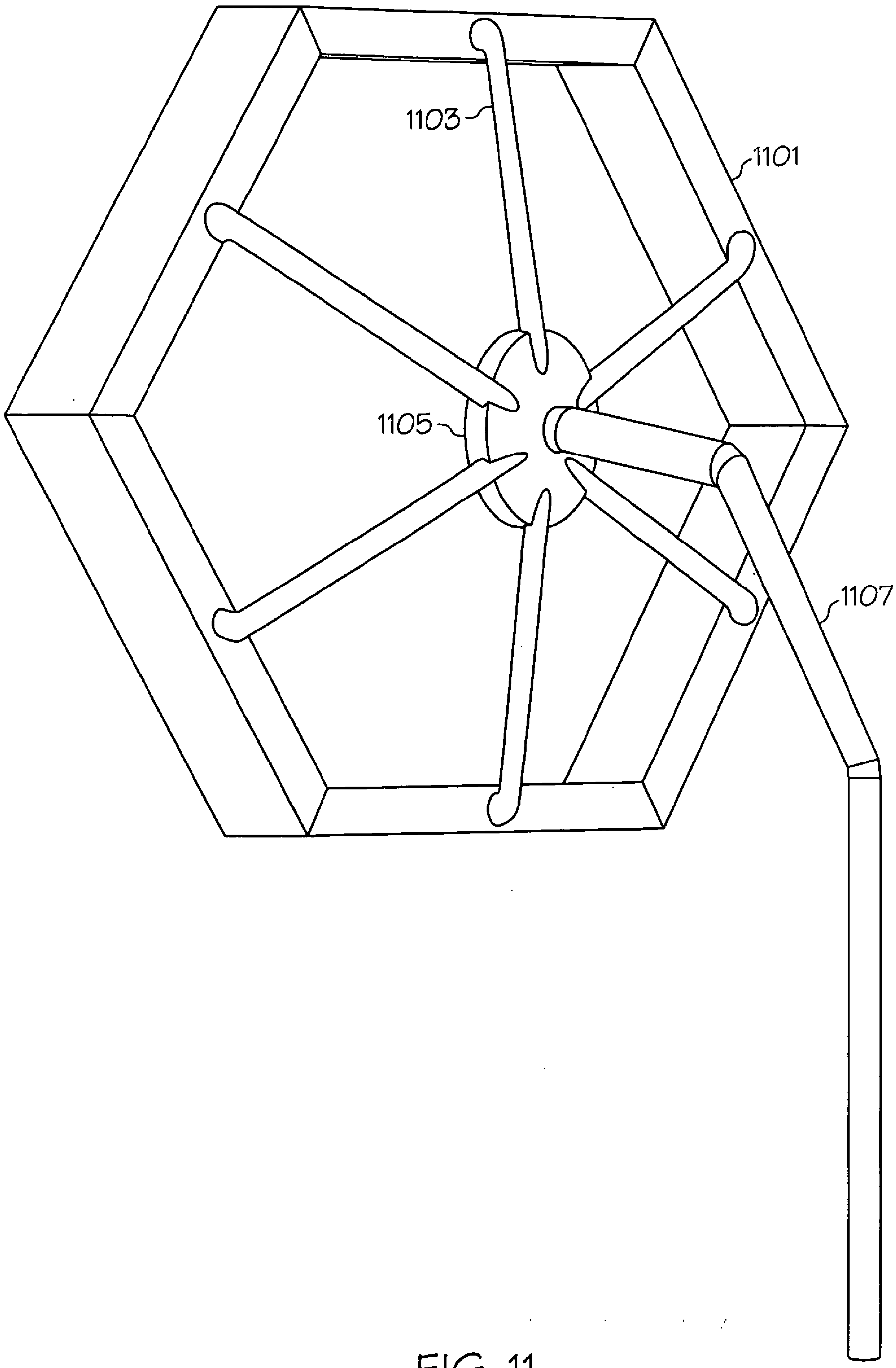


FIG. 11

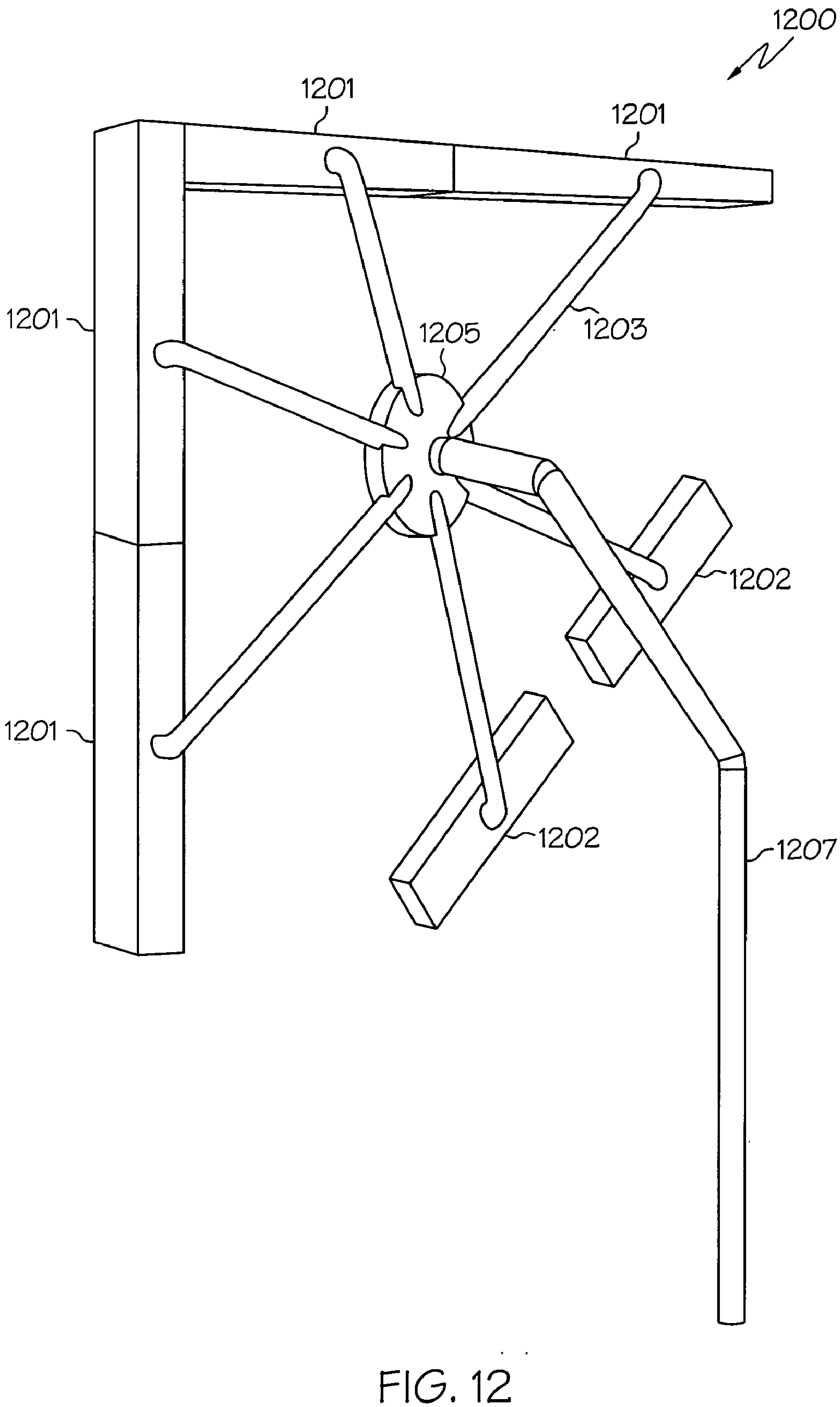


FIG. 12

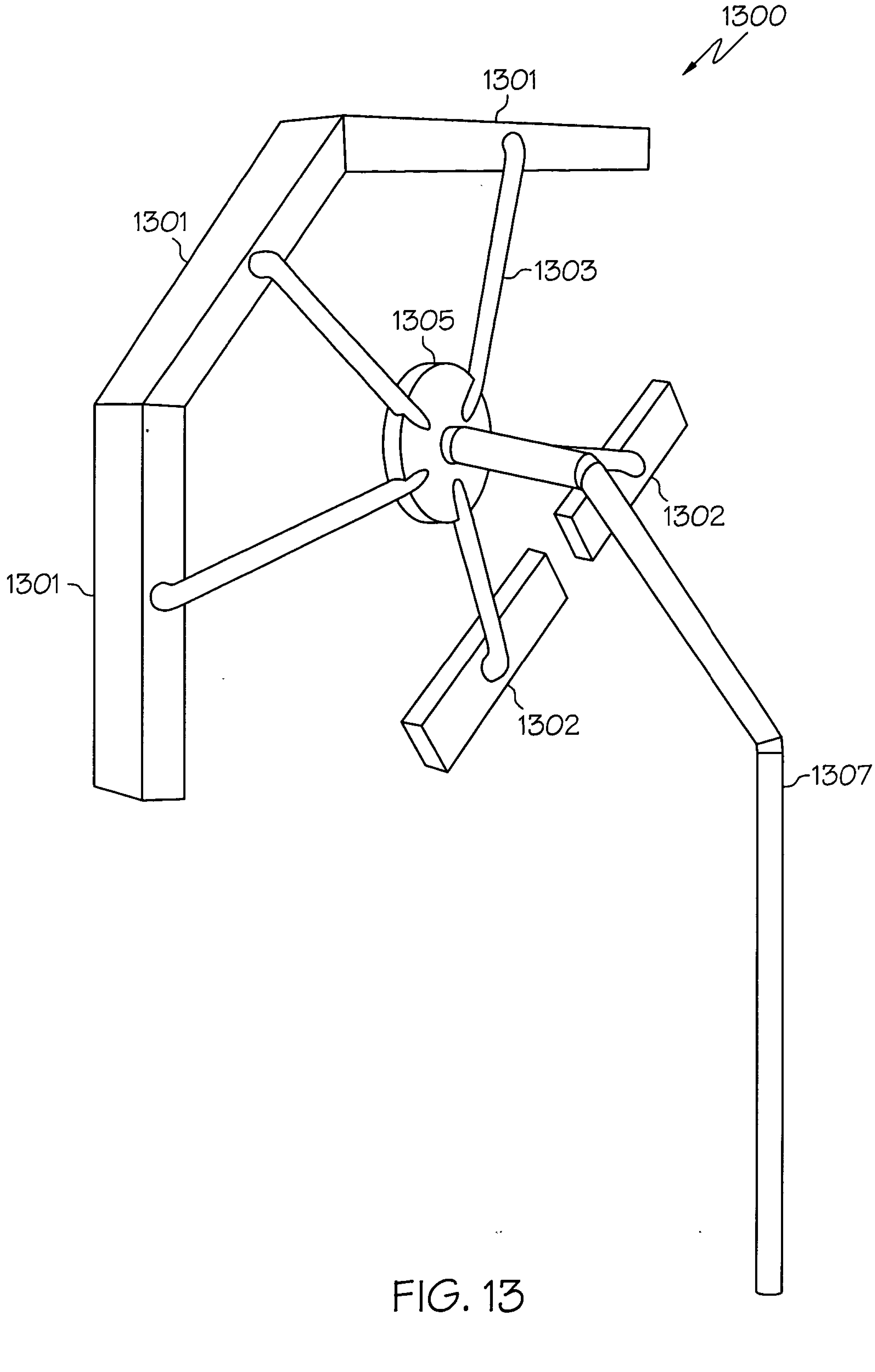


FIG. 13

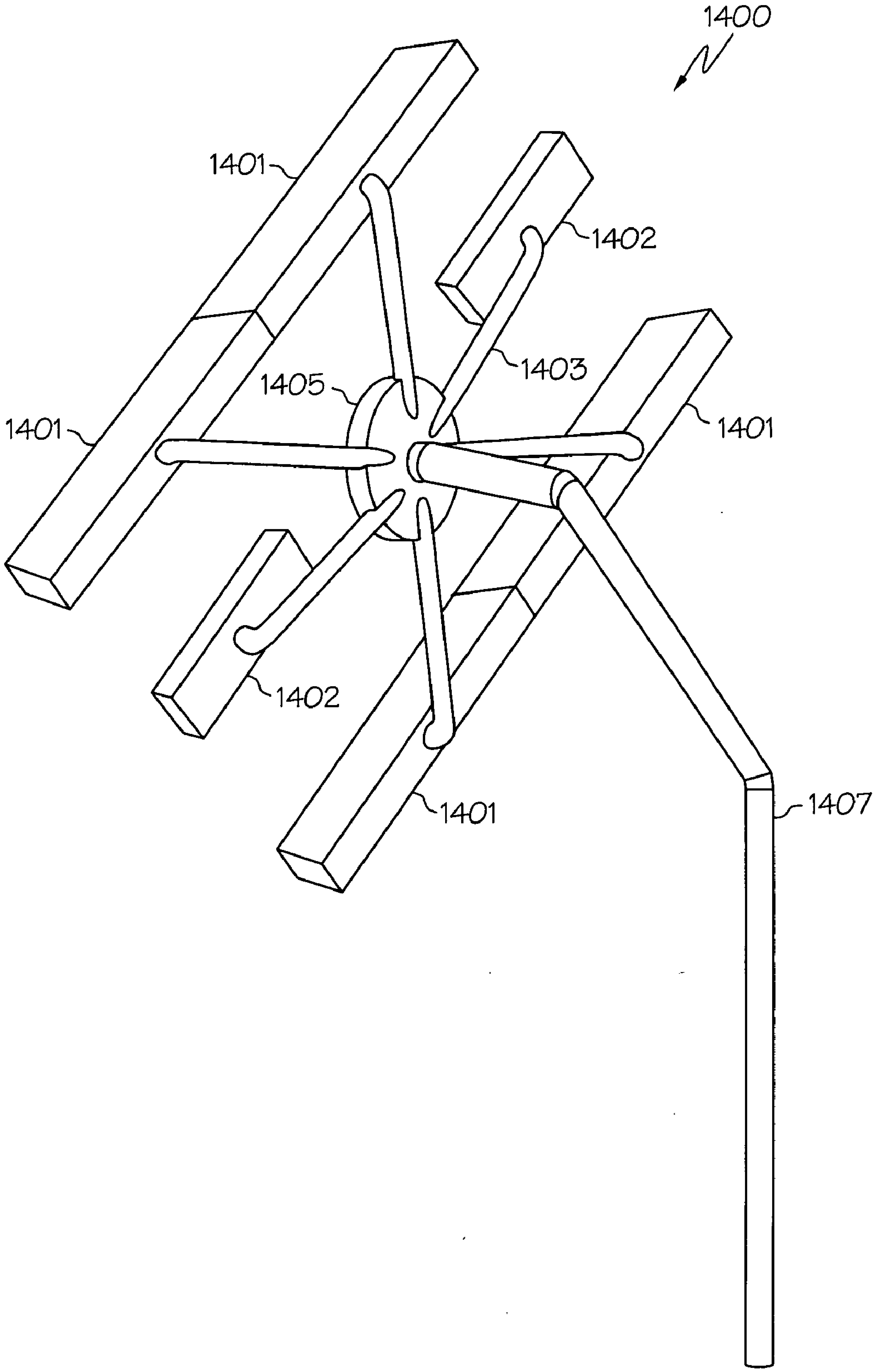


FIG. 14

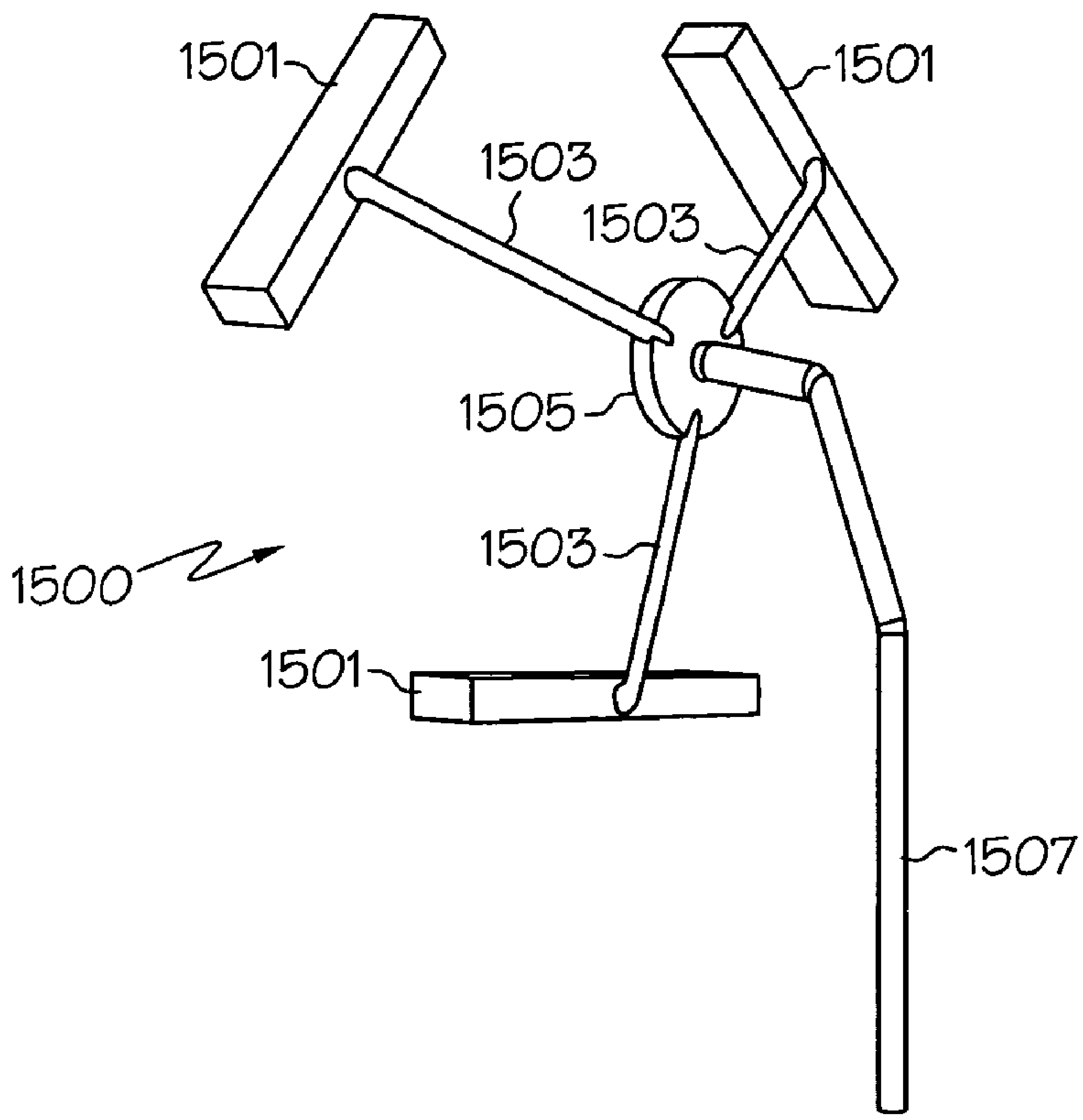


FIG. 15A

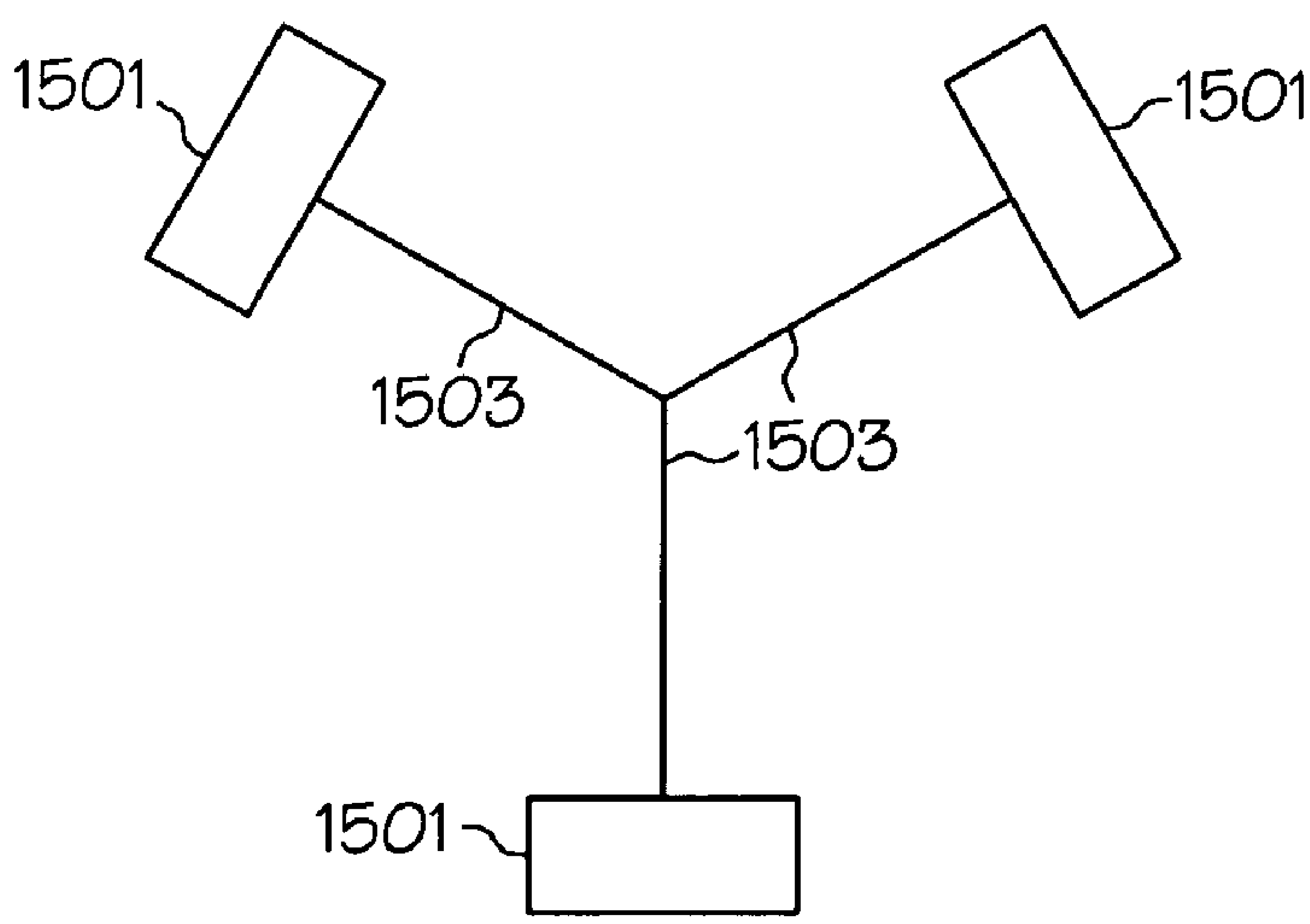


FIG. 15B

WALL BREACHING APPARATUS AND METHOD

[0001] This application claims the benefit of U.S. Provisional Application No. 60/501,815, filed Sep. 10, 2003.

[0002] The full disclosure of the parent provisional application is incorporated herein by reference.

FIELD OF THE INVENTION

[0003] This invention provides a portable easily deployable apparatus for wall breaching in both civilian and military environments. The apparatus has particular use in rescue operations where persons may be trapped inside buildings or in providing escape from an enclosed environment. Other uses include forced entry into buildings or other structures.

BACKGROUND OF THE INVENTION

[0004] Conventional shaped charges can be used to defeat targets such as reinforced concrete and typical structural materials such as brick, stone, wood and the like. However, conventional apparatus for breaching targets lack the ability to attack widely variable targets, are typically heavy and cumbersome to carry. Typical prior art devices are exemplified by U.S. Pat. No. 3,838,643 to Austin et al.; U.S. Pat. No. 4,430,939 to Harrold; U.S. Pat. No. 4,905,601 to Gabriel et al.; U.S. Pat. No. 5,036,771 to Alford; and U.S. Pat. No. 5,524,546 to Rozner et al.

BRIEF DESCRIPTION OF THE INVENTION

[0005] The present invention includes several broad embodiments. A first broad embodiment includes a kit that can be used for constructing a wall breaching structure. The kit is made up of a plurality of linear shaped charges; a plurality of block explosive charges; and a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; typically the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure.

[0006] A second broad embodiment includes an apparatus produced from the kit that includes, a plurality of linear shaped charges; a plurality of block explosive charges; and a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; typically the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure.

[0007] A third broad embodiment includes a method for breaching a structure such as a wall and the like with a reduced weight charge. The method provides for simultaneous cutting of rebar and blast of an opening using a light shaped charge typically less than about 60 pounds. Typically the method includes the steps of providing a metal lined linear shaped charge having a weight of less than about 60 pounds; placing the linear shaped charge against the non-homogeneous reinforced aggregate structure, the structure having a reinforcement member; and exploding the linear shaped charge to generate a metal jet and a blast wave, wherein the metal jet cuts the reinforcement member at at least one location and the blast wave creates an opening in the aggregate material, and wherein the cutting of the reinforcement member and the creation of the opening occur substantially simultaneously.

[0008] A fourth broad embodiment includes provides for using non-continuous polygon shaped wall breaching apparatus. The method includes the steps of placing an explosive charge configured to define a portion of a perimeter of an opening to be formed against the non-homogeneous reinforced aggregate structure, the structure having a reinforcement member; and exploding the explosive charge, wherein a blast created by the explosive charge creates an opening in the aggregate material, cuts the reinforcement member in one location, and bends the reinforcement member substantially at the portion of the perimeter of the opening in a direction of the blast, such that a person can travel through the opening thereby created.

[0009] A fifth broad embodiment includes an initiation mechanism for firing a linear shaped charge. The mechanism typically includes a linear shaped charge having a metal liner; a plurality of detonators attached to the linear shaped charge; and a mechanism for simultaneously igniting the plurality of detonators; wherein the simultaneous ignition of the plurality detonators creates a substantially planar detonation wave. A yet further embodiment of the invention includes a method for making a substantially planar detonation wave. One method includes creating a substantially planar detonation wave, by the steps of providing a linear shaped charge having a metal liner; attaching a plurality of detonators to the linear shaped charge; and igniting the plurality of detonators with a mechanism for simultaneously igniting the plurality of detonators; and wherein the simultaneous ignition of the plurality detonators thereby creates a substantially planar detonation wave. Another method for igniting a linear shaped charge includes the steps of providing a linear shaped charge having a metal liner; a first detonator attached to the linear shaped charge; a second detonator attached to the linear shaped charge; an intermediate detonator attached to the linear shaped charge and disposed between the first detonator and the second detonator; and a mechanism for simultaneously igniting the first, second, and intermediate detonators, and wherein the simultaneous ignition of the plurality first, second, and intermediate detonators thereby creates a substantially planar detonation wave.

[0010] Typically the methods according to the invention provide that the metal jet and/or explosive charge cuts at least about 10% to 75% of the cut reinforcement members at one location and the remainder at two locations. In some embodiments the where double rebar is used the metal jet and/or explosive charge cuts at least two of the cut reinforcement members at one location and the remainder at two locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is set of two diagrams depicting extended (**FIG. 1A**, top diagram) and partially folded (**FIG. 1B**, bottom diagram) of an apparatus according to the invention.

[0012] **FIG. 2** is set of schematic diagrams depicting a frontal view (top diagram) and a side view (bottom diagram) of the linear charge arrangement according to the invention.

[0013] **FIG. 3** illustrates the effect of standard linear shaped charge initiation on liner collapse factors as in the prior art.

[0014] FIG. 4 illustrates the effect of multiple initiation points on wave shaping for the apparatus according to the invention.

[0015] FIG. 5 illustrates is a frontal view of wave fronts for simultaneous initiation using hemispherical wave shaper initiations.

[0016] FIG. 6 illustrates side (left diagram) and frontal views (right diagram) for pyramidal wave shaper initiation.

[0017] FIG. 7 illustrates a four point initiation configuration.

[0018] FIG. 8 illustrates detonating cord down-line connectors and how they would mate.

[0019] FIG. 9 illustrates a complete initiation system with hemispherical wave shapers, three point initiation, down-line connectors and central hub

[0020] FIG. 10 illustrates a top view of a typical wall breaching apparatus according to the invention and a side view of a linear shaped charge.

[0021] FIG. 11 illustrates a schematic for a typical "basic" configuration as discussed herein.

[0022] FIG. 12 illustrates a schematic for a "concept L" configuration as discussed herein.

[0023] FIG. 13 illustrates a schematic for a "concept C" configuration as discussed herein.

[0024] FIG. 14 illustrates a schematic for a "concept parallel" configuration as discussed herein.

[0025] FIG. 15 illustrates a schematic for a "concept Y" configuration as discussed herein.

DETAILED DESCRIPTION OF THE INVENTION AND BEST MODE

[0026] The wall breaching apparatus typically includes a quickly deployed, fully contained, modular explosive charge. The wall breaching apparatus typically includes a folding template, linear shaped charges, integral initiation system, and attachment system. The attachment system typically is a mini-stun gun attachment or a (support) prop pole to hold the system in place. Other methods for attachment known in the art may be used. There are two different embodiments for the folding template that will trade-off deployment time and cost/weight.

[0027] The wall breaching apparatus is modular so that it can be used against differing target wall designs. One embodiment of a typical wall breaching apparatus (typically six segments forming a hexagon, approximately 23 pounds net explosive weight) will breach the concrete and both layers of rebar contained in an 8 inch thick double layer reinforced poured concrete wall producing at least a 36 inch diameter hole. A typical three segment system (three segments separated by 120 degrees, approximately 12 pounds net explosive weight) will breach a triple layer brick wall. A typical two segment system (two segments separated by 180 degrees, approximately 8 pounds net explosive weight) will breach CMU and brick-on-block walls.

[0028] Detailed below are typical deployment embodiments and methods, designs for the templates, initiation systems, and explosive charges.

[0029] The invention provides for a kit that can be used for constructing a wall breaching structure. The kit is made up of a plurality of linear shaped charges; a plurality of block explosive charges; and a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; typically the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure.

[0030] The shaped charges contained in the kit are linear shaped charges. The standard cross sectional design of a typical linear shaped charge has straight sides extending from a single included angle. This conventional linear shaped charge design is economical to produce but is not the best based on weight and performance. The design of the shaped charges for this wall breaching system follow convention for high performance design of conical shaped charges typically used for armor defeat in military applications, instead of the convention for linear charges. Because of this the choice available for cross section designs is much more varied. The cross sections in this case can include the following patterns: straight-sided, "trumpet" shaped, "tulip" shaped, and "bi-conic" shaped. Using these additional shapes it is possible to obtain better performance than the standard straight-sided approach.

[0031] The materials used to construct the shaped charge liners useful in this wall breaching kit can include: copper, tantalum, silver, gold, aluminum, composites of metals, alloys of these metals, composites of these metals with fluorocarbon polymers, other malleable metals, glass and mixtures thereof.

[0032] The block explosives used in the kit can typically be high velocity explosives such as the standard M112 demolition block which consists of 1.25 pounds of plastic explosive. Other block or bulk explosive charges could be used, including: one pound TNT demolition blocks, cartridges of either military or commercial dynamite, cast pentolite boosters, flexible sheet explosive or detonating cord charges.

[0033] The connecting members and other supporting or enclosing parts of the kit or apparatus according to the invention are typically constructed of lightweight and strong materials with the desire being to minimize the amount of fragmentation created during the detonation of the wall breaching charges. These construction materials may include: wound carbon fiber, carbon fiber composite, an aluminum/polymer composite, fiberglass or other polymer composite. The connecting members will be able to deploy the explosive charges from a folded, compact arrangement into an extended position in the final moments before breaching the wall target. The connecting members will perform this deployment by either unfolding or extending by applied gas pressure or mechanical force.

[0034] Another aspect of the invention is an apparatus produced from the kit that includes, a plurality of linear shaped charges; a plurality of block explosive charges; and a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; typically the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure. The constituents of the apparatus are typically those described earlier for the kit.

[0035] Deployment Method

[0036] A preferred embodiment such as an umbrella template is designed for quick deployment and the reduction of time-on-target. **FIG. 1** shows the umbrella template with attached explosive charges. The following steps are used to deploy the umbrella template version of the modular breaching system:

[0037] 1. Pull contents out of a carrying bag (not shown)

[0038] 2. Approach wall;

[0039] 3. Place front end of device on wall while making sure that the (support) leg is firmly planted. In poor weather conditions stakes may be used;

[0040] 4. Deploy umbrella template by pushing sleeve towards wall;

[0041] 5. While holding deployed device against wall, anchor charge to the wall by firing two stud guns (not shown) through attachment pads (not shown) if necessary;

[0042] 6. Prime central hub **111** with either one or two standard detonator systems (e.g. time delay firing unit, shock-tube, etc); and

[0043] 7. Retreat to safe area and fire breaching charge.

[0044] Another embodiment of the invention provides for a Compact Template **200** that consists of three (3) jointed sections shown either as **211** or **213** in Diagram 2A. Diagram 2B shows the jointed sections **211** or **213** partially assembled. Individual shaped charges **201** are shown as part of the set. See diagrams **2A**, **2B**, **2C** and **2D** in **FIG. 2**. The three sections can be joined by pins **215** to create a hexagon (diagram 2C) that can be used to make a thirty-six inch hole in a rebar reinforced concrete wall, lesser sections can be used in configurations described herein, or a single section can be deployed against smaller targets, such as lesser walls. Diagram **2D** is a side view of the assembly. The following steps are used to deploy the compact template version of the modular breaching system:

[0045] 1. Pull contents out of carrying bag (not shown);

[0046] 2. Assemble the hexagon or other figure;

[0047] 3. The six sides are folded in the middle via hinge, unfold the hinge and slide lock pin in place;

[0048] 4. Connect the six sides together to form a hexagon, hook inside and slide pin on outside (note hook is integral and slide pins are permanently attached);

[0049] 5. Attach the two mini-stud guns,

[0050] 6. Connect the detonation cords from the distributor into the legs of the hexagon;

[0051] 7. Carry assembled hexagon to the wall;

[0052] 8. While holding device against wall, anchor hexagon to wall by firing two or more stud gun studs (not shown) through attachment pads (not shown);

[0053] 9. Prime central hub **111** with either one or two standard detonator systems (e.g. time delay firing unit, shock-tube, etc);

[0054] 10. Retreat to safe area and fire breaching charge.

[0055] Referring again to **FIGS. 1A and 1B**, the umbrella type system **100** includes a leg support made up of a leg base **101**, a straight leg portion **103**, connector **105**, and angled leg **107**. These provide support to hub **111** which in turn provides support to linear shaped charges **109** with connection members **113** that are connected to both the charges **109** and the hub **111**. End stop **115** and stop connector **117** complete the assembly.

[0056] Initiation System for the Wall Breaching Apparatus

[0057] The initiation mechanism of the wall breaching apparatus is a key contributor to its enhanced performance over standard linear shaped charges. A simultaneous line initiation along the entire back of the charge allows for the classical collapse sequence of the angled liner. With this method, the detonation wave planes from a circular pattern at the point source into a horizontal line. This planar detonation wave sweeps across the angled liner from the apex to the base of the liner's triangular shape. This collapse profile allows for the plastically deformed metal from both sides of the liner to impact at the stagnation point and jet efficiently towards the target. The cross-sectional view of this reaction in the wall breaching apparatus is very similar to that of a classical conical shaped charge.

[0058] This contrasts with the detonation methodology of a standard linear shaped charge. This device is normally initiated from the ends of each charge as shown in **FIG. 3**. The detonation front for such an initiation travels perpendicular to the angled liner. This detonation method does not permit the Chapman-Jouguet (CJ) front to collapse the liner in the desired manner, from the apex to the base. This side on method would initiate collapse at the front edge of the CJ front. This collapse point may not be the apex of the liner. The side on wave would also induce an X and Y component into its jet's velocity vector. The X component, jet momentum parallel to the target surface, would represent lost penetrating ability.

[0059] The initiation method of the wall breaching apparatus strives to achieve an apex to base collapse of the liner in a direction that is tangent to the target as shown in **FIG. 4**. This collapse progression of the wall breaching apparatus liner is like that of a conical shaped charge. This maximizes the penetrating ability of the charge. In order to achieve a planar detonation wave shape, simultaneous multipoint initiation is used. The detonation front from the multiple initiation sites collide midway between the points. This integrated wave approaches a planar form much faster than a detonation wave produced from a single initiation point. This technique has a similar effect to wave shaping in conical charges. **FIG. 4** shows four detonators **401** and boosters **403** that are used to fire a linear shaped charge **407**. The detonators **401** produce four wave fronts **405** that combine to produce a linear wave front perpendicular to the target. The wave fronts **405** move much more linearly from the apex **409** of the linear shaped charge **405** to the bottom **411** in the Y direction than the prior art.

[0060] The initiation method used for wall breaching apparatus assumes a simultaneous line initiation directly above the apex of the liner along the entire length of each segment of the system. This line initiation method is crucial to the charge performance. An instantaneous detonation wave that collapses the liner from apex to base results in a jet that is oriented directly at the target. This line initiation forms a detonation wave that begins as a small circle expanding outward through the explosive towards the liner. As this circle expands with time, the circumference of the front expands radially from the initiation point. From the reference location of the liner, the expanding shape of the wave begins to flatten and become somewhat planar. This flattened wave sweeps the liner from apex to base. The time related contours of this wave can be seen below in **FIGS. 4, 5**, and **7**. As the detonation front sweeps the liner, it transfers momentum into the liner material. The liner material is then accelerated as a jet inward towards a linear axis progressing from the apex to the base. The jets collide at a point along this axis called the stagnation point. At the stagnation point, the momentum is again redirected towards the base along the axis. This redirected jet is oriented perpendicular to the target for achieving maximum penetration.

[0061] Achieving an instantaneous line initiation along the back of the charge is not easily accomplished. Referring now to **FIGS. 6A and 6B**, these setups use sections of Primasheet® explosive cut in the form of equilateral triangles. These triangles contain a sequential series of holes cut in them at regular intervals. The spacing between each of these holes also forms a progression of equilateral triangles. These holes force a circular shaped detonation front to curve around them. The equidistance around each equilateral triangle force the detonation front to assume a planar shape as it moves down the sheet.

[0062] A planar wave shape can also be achieved with simultaneous multi-point initiation. Collisions of multiple circular shaped detonation fronts congeal into an integrated wave front that has a flattened appearance as it moves through the remaining un-reacted explosive. The spacing between multiple initiation points determines the degree of planarity that is achieved in the newly formed wave. This can be observed in the drawing below. This assumes that the detonation velocity is constant throughout the explosive, as is most often the case.

[0063] Referring again to **FIG. 3**, a standard linear shaped charge **301** that is end initiated by detonator **303** and booster **305** results in a detonation wave **306** that engulfs the liner **307** (see liner apex **311** and liner base **313**) in an enlarging circular expansion focused from the point source **309** and expanding along the longitudinal axis of each charge. This wave geometry results in jets that move in an angular direction to the target. This angular direction contains vector components that are both parallel and at right angles to the intended target. For future discussions, the parallel to target directions will be defined as the "X" direction and the perpendicular to target direction will be defined as the "Y" direction. The shape of this detonation front results in a unique jet shape. The jet vector from the top portion of the liner is moving primarily in the "X" direction. Accordingly, the jet vector from the base of the liner is moving mainly in the "Y" direction. The focusing jet from the liner collapse is moving in a gradient from the apex to the base. It would appear as an inverted angle traveling at an incidental angle to the liner. The jet's gradated, angular formation helps to explain the comparatively short length jets that result from end initiating a standard linear shaped charge.

[0064] This phenomenon was observed in a test performed in a small mockup of hexagonal breaching charge using standard 2,000 grains/foot linear shaped charge, loaded with 70/30 Octol. This test device was shot at a ½ inch thick steel target. The six segments of the charge were sized to fit inside a 4 inch inscribed circle. Each segment was simultaneously initiated at its midpoint. This initiation technique resulted in collision of 12 separate and inverted angular jets at the corners of the hexagon. Because of the inverted angular shape of the colliding jets, expanded penetration of the target was achieved. The initial collisions occurred along the "Y" axis of the angular liner. After the bottom of the center point of the jets collided along the liner axis, the collisions began to occur outward and away from the liner's centerline. These collisions resulted in expanded penetration in the target opposing the connecting corners of the assembled hexagon.

[0065] The present invention uses multiple firing points that enhance the planarity of the detonation wave and maximize the "Y" component of the jet.

[0066] Referring now to **FIG. 5**, hemispherical shaped boosters **501** between the detonators **503** and planar shaped charge **505** are one embodiment that can expand the distributed detonation front area from multi-point initiation along the charges back. These hemispheres **501** would contain a phenolic material or similar acting material inside its interior to prevent the shock wave from passing straight through the booster in a spherical shape. The explosive would comprise a shell configuration **507** around the half circle's perimeter. At the charge contact point, the detonation from would be in the shape of a ring. As the front **509** expands inward and outward from the ring, the colliding waves result in a greatly flattened shape. The wave which started at the top **511** of the linear shaped charge is much flatter in appearance when it reaches the bottom **513** than single point initiation in the same three locations.

[0067] Another shape with a unique advantage in wave shaping is a pyramid shape whose bottom side is at the width of the top of the charge has symmetrical advantages along both the charges cross-section and length. See **FIG. 6A** (cross sectional view) and **6B** (side view). In the configuration shown **600** a plastic fixture holds the linear shaped charge **603** and detonator holders **604**. The linear shaped charge is fired with pyramidal wave shapers **605** between the detonators **607** and the high explosive **609** of the linear shaped charge **603**. Typically a copper liner **611** is used with the shaped charge as shown. Liner apex **613** and liner base **615** are typical as shown. Optionally legs **619** may be used to offset the linear shaped charge **603**. Attachment points **621** are those typically used in the art.

[0068] Another configuration for producing satisfactory wave shaping is to use multiple point initiation as seen in **FIG. 7**. In this case four detonators **701** are used per wall breaching apparatus section **700**. For six sections this results in 24 total detonators crimped to detonating cord leads. Each section of four cords is typically connected to a single cord lead using custom down-line connectors. These connectors ensure an explosive train from the single **150** grain cord to the four **50** grain cords. The six **150** grain cords are embedded into the central hub and are initiated by a Primasheet® booster and the firing device detonator. This embodiment uses boosters **705** between detonators **701** and linear shaped charge **703**. The top of the charge is at **709** and the bottom at **711**. The combined wave shape **713** is much more planar and results from the combination of waves from the multiple detonation points **715**.

[0069] **FIG. 8** is a schematic showing cord line connectors **801** and how they would mate from the central hub **803** for three detonation points per linear shaped charge.

[0070] **FIG. 9** illustrates an eight sided polygon configuration **900** with eight linear shaped charges **901**, three hemispherical wave shapers **903** and associated detonators, central hub, and down line connectors **907**.

[0071] Referring now to **FIGS. 10A** and B, these illustrate a four point polygon configuration **1000** with eight linear shaped charges **1001**, four detonators **1003**, central hub **1005**, and down line connectors **1007**. A blown up view of the linear shaped charge **1001** is shown in **FIG. 10B** having a liner **1011**, enclosure **1013**, and explosive **1015**.

[0072] One embodiment for the wall breaching apparatus **1100** is a set of six linear shaped charges **1101** arranged in a hexagonal shape. This embodiment is the basic embodiment. See **FIG. 11**. The charge will be initiated at multiple points on each linear charge in an effort to maintain a planar shock wave during the liner collapse event. Connection members **1103**, central hub **1105** and leg **1105** provide support.

[0073] A preferred material for the shaped charge liner is copper, however other materials such as those listed above may be used. A preferred high explosive for the wall breaching apparatus is PBX-9501. This explosive was selected for its favorable combination of high detonation velocity, good manufacturability, and good sensitivity characteristics. Other explosives useful with the invention include Octol, Composition A, composition B, LX-14, PAX compositions and the like. Preferably a light weight material such as a plastic material (e.g. polymethyl methacrylate) is used to encase the high explosive of the wall breaching apparatus. Other polymeric materials useful for encasing the high explosives include polyethylene, polypropylene, fiberglass, carbon fiber composites, and mixtures thereof.

[0074] Typical high strength materials that can be penetrated by the invention include 7000 psi unconfined compressive strength concrete and 50 Ksi yield strength reinforcing steel.

[0075] The modular breaching system according to the invention is able to defeat concrete, concrete with single rebar, or concrete with double rebar in a single shot. Further this system can be tailored easily in the field to suit the specific target. This reduces its weight and increases the speed of deployment. The modular breaching system is based on the penetrating capabilities of linear shaped explosive charges. This is the basic unit of explosive power that is used to breach the target, but this new particular breaching charge now opens up the ability to change the fundamental approach to wall breaching, particularly hard targets like reinforced concrete, to greatly reduce weight of the breaching system.

[0076] The current approach to wall breaching of reinforced concrete targets is to cut a roughly circular hole with a penetrating explosive charge, usually sections of linear shaped charge. This is shown below in what is termed the "Basic" configuration (See **FIG. 11**). While this charge is highly effective against the reinforced concrete wall targets (assuming the explosive charge of the linear shaped charges clear the opening) the overall charge is very heavy due to the high weight necessary in penetrating charges. This current design to produce a 36" diameter hole uses approximately 108 to 113" of linear shaped charge. Concept basic can weight up to about 60 lbs.

[0077] This embodiment is based on the assumption that it is required to cut both ends of the rebar in the wall in order to effectively breach the target. But this is simply not the case. If the penetrating charge can be counted on to reliably cut the rebar in the wall then it is really only necessary to cut one end of the rebar. The remaining long pieces of rebar will be bent out of the way by the blast effect of the high explosive in the linear shaped charge or in additional bulk explosives. Typically the bulk explosives are of much lower weight per unit than the linear shaped charges. This means that by using the present invention in different geometric shapes that are designed to cut only one end of the rebar the remaining wall section can be fractured and cleared using bulk explosive charges (such as composition C-4 plastic explosive) that are fired substantially simultaneously with linear shaped charges. Discussed below are several different embodiments of the modular breaching system that utilize this methodology and their associated characteristics such as the expected reduction in weight. All of these designs utilize the rapid deployment mechanism and hub described elsewhere in this disclosure as shown in the figures herein.

[0078] A further embodiment of the invention provides for using non-continuous polygon shaped wall breaching apparatus. The method includes the steps of placing an explosive charge configured to define a portion of a perimeter of an opening to be formed against the non-homogeneous reinforced aggregate structure, the structure having a reinforcement member; and exploding the explosive charge, wherein a blast created by the explosive charge creates an opening in the aggregate material, cuts the reinforcement member in one location, and bends the reinforcement member substantially at the portion of the perimeter of the opening in a direction of the blast, such that a person can travel through the opening thereby created. Typical non-continuous polygon shaped apparatus is illustrated in **FIGS. 12-15**.

[0079] First is "Concept L"**1200** shown in **FIG. 12**. This embodiment **1200** uses four (typically 18') linear shaped charge **1201** sections arranged in an "L" shape associated with two blocks of C-4 plastic explosive **1202** to clear the remainder of the hole and push the rubble and rebar out of the way. Support is provided by connection members **1203**, hub **1205**, and leg **1207**. The designed arrangement and simultaneous detonation of the explosive charges will cause colliding shock waves to produce fractures in the concrete between the charges and break up the concrete enough such that the bulk C-4 charges can clear the hole out. This principle of colliding shock waves is repeat in each of the embodiments described. This embodiment produces an approximately 36" square hole and utilizes 72" of linear shaped charge explosive charge. This reduces the weight to approximately 80% of a fully circular "Basic" configuration.

[0080] "Concept C"**1300**, shown in **FIG. 13**, utilizes three 18" linear shaped charges **1301**, two bulk explosive charges

1302, connection members **1303**, hub **1305**, and leg **1307** as shown. This embodiment produces a more circular hole that is approximately 31" in diameter and uses the colliding shock wave phenomena described above. This embodiment uses a total of 54" of linear shaped charge and therefore will weigh approximately 60% of the Basic configuration.

[**0081**] Referring now to **FIG. 14**, "Concept Parallel"**1400** typically utilizes four about 13-14" linear shaped charges **1401**, two bulk explosive charges **1402**, connecting member **1403**, hub **1405**, and leg support **1407** as shown. This embodiment produces a roughly circular hole that is about 30 to 36" in diameter and uses the colliding shock wave phenomena described above. This embodiment uses about a 52 to 56" of linear shaped charge and therefore will weigh approximately 65% of the Basic configuration. The hole diameter is about 113". A typical reinforced rebar spacing is about 8".

[**0082**] The concept parallel typically cuts the reinforcing bars in reinforced concrete in one and/or two places per rebar, however not all of the cut rebars are cut twice as is the case in a circular or polygonal wall breaching system. In this system two parallel linear shaped charges provide double cutting to only some rebars. The system is typically placed against a wall to be breached so that the parallel linear charges are at about a 45° angle from the vertical and the explosive charge initiated. The angle of application may range from about 35° to 55° degrees. Although some of the bars are only cut once the wall is still penetrated either by the linear charges alone or with the aid of one or more additional lightweight explosive charges that blow out the wall. This system is typically of lower weight than a circular or polygonal wall breaching system.

[**0083**] Referring now to **FIGS. 15A and 15B**, "Concept Y"**1500** utilizes three linear shaped charges **1501**, connecting members **1503**, hub **1505**, and leg support **1507** as shown. This embodiment is not designed for breach reinforced concrete but rather is for triple course brick or brick-on-block target walls. This embodiment produces a roughly circular hole that is approximately 30" in diameter. The vertical imprint is shown in **FIG. 15B**. Colliding shock wave phenomena is much less important in these types of targets. This embodiment will weigh approximately 50% of the Basic configuration.

[**0084**] Another embodiment of the invention includes a method for breaching a structure such as a wall and the like with a reduced weight charge. The method provides for simultaneous cutting of rebar and blast of an opening using a light shaped charge typically less than about 60 pounds. Typically the method includes the steps of providing a metal lined linear shaped charge having a weight of less than about 60 pounds; placing the linear shaped charge against the non-homogeneous reinforced aggregate structure, the structure having a reinforcement member; and exploding the linear shaped charge to generate a metal jet and a blast wave, wherein the metal jet cuts the reinforcement member at at least one location and the blast wave creates an opening in the aggregate material, and wherein the cutting of the reinforcement member and the creation of the opening occur substantially simultaneously.

[**0085**] A further embodiment includes an initiation mechanism for firing a linear shaped charge. The mechanism typically includes a linear shaped charge having a metal liner; a plurality of detonators attached to the linear shaped charge; and a mechanism for simultaneously igniting the plurality of detonators; wherein the simultaneous ignition of the plurality detonators creates a substantially planar detonation wave. The mechanism for simultaneously igniting the linear shaped charges typically includes a capacitive discharge pulse power unit, an explosively driven power supply that provides an electrical pulse, and other electrical pulse generators known in the art the associated wiring.

[**0086**] A yet further embodiment of the invention includes a method for making a substantially planar detonation wave. One method includes creating a substantially planar detonation wave, by the steps of providing a linear shaped charge having a metal liner; attaching a plurality of detonators to the linear shaped charge; and igniting the plurality of detonators with a mechanism for simultaneously igniting the plurality of detonators; and wherein the simultaneous ignition of the plurality detonators thereby creates a substantially planar detonation wave.

[**0087**] Another method for igniting a linear shaped charge includes the steps of providing a linear shaped charge having a metal liner; a first detonator attached to the linear shaped charge; a second detonator attached to the linear shaped charge; an intermediate detonator attached to the linear shaped charge and disposed between the first detonator and the second detonator; and a mechanism for simultaneously igniting the first, second, and intermediate detonators, and wherein the simultaneous ignition of the plurality first, second, and intermediate detonators thereby creates a substantially planar detonation wave. More than three detonators than those outlined above may be used.

[**0088**] While the forms of the invention herein disclosed constitute presently preferred embodiments, many others are possible. It is not intended herein to mention all of the possible equivalent forms or ramifications of the invention. It is to be understood that the terms used herein are merely descriptive, rather than limiting, and that various changes may be made without departing from the spirit of the scope of the invention.

We claim:

1. A kit for constructing a wall breaching structure, the kit comprising:

a. a plurality of linear shaped charges;

b. a plurality of block explosive charges; and

c. a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; and

wherein the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure.

2. A wall breaching apparatus comprising:

a. a plurality of linear shaped charges;

b. a plurality of block explosive charges; and

c. a plurality of connecting members for connecting any of the shaped charges and the block explosive charges to others of the shaped charges and the block explosive charges; and wherein the shaped charges and the block explosives can be configured into a multiplicity of different arrangements and connected together to form a wall breaching structure.

3. A method of breaching a non-homogeneous reinforced aggregate structure, the method comprising:

a. placing the linear shaped charge against the non-homogeneous reinforced aggregate structure, the structure having a plurality of reinforcement members; and

b. exploding the linear shaped charge to generate a metal jet and a blast wave, and

wherein the metal jet cuts at least one of the cut reinforcement members at one location and the remainder at two locations and the blast wave creates an opening in the aggregate material, and

wherein the cutting of the reinforcement member and the creation of the opening occur substantially simultaneously.

4. The method according to claim 3, wherein the metal jet cuts at least about 10% to 75% of the cut reinforcement members at one location and the remainder at two locations.

5. The method according to claim 3, wherein when double rebar is used the metal jet cuts at least two of the cut reinforcement members at one location and the remainder at two locations.

6. A method breaching a non-homogeneous reinforced aggregate structure, the method comprising:

a. placing an explosive charge configured to define a portion of a perimeter of an opening to be formed against the non-homogeneous reinforced aggregate structure, the structure having a reinforcement member; and

b. exploding the explosive charge, and

wherein a blast created by the explosive charge creates an opening in the aggregate material, cuts the reinforcement member in one location, and bends the reinforcement member substantially at the portion of the perimeter of the opening in a direction of the blast, such that a person can travel through the opening thereby created.

7. The method according to claim 6, wherein the explosive charge cuts at least about 10% to 75% of the cut reinforcement members at one location and the remainder at two locations.

8. The method according to claim 6, wherein when double rebar is used the explosive charge cuts at least two of the cut reinforcement members at one location and the remainder at two locations.

9. An initiation mechanism for igniting a linear shaped charge comprising:

a. a linear shaped charge having a metal liner;

b. a plurality of detonators attached to the linear shaped charge; and

c. a mechanism for simultaneously igniting the plurality of detonators; and

wherein the simultaneous ignition of the plurality detonators creates a substantially planar detonation wave.

10. A method of creating a substantially planar detonation wave, the method comprising:

a. providing a linear shaped charge having a metal liner;

b. attaching a plurality of detonators to the linear shaped charge; and

c. igniting the plurality of detonators with a mechanism for simultaneously igniting the plurality of detonators; and

d. wherein the simultaneous ignition of the plurality detonators thereby creates a substantially planar detonation wave.

11. An initiation mechanism for igniting a linear shaped charge comprising:

a. a linear shaped charge having a metal liner;

b. a first detonator attached to the linear shaped charge;

c. a second detonator attached to the linear shaped charge;

d. an intermediate detonator attached to the linear shaped charge and disposed between the first detonator and the second detonator; and

e. a mechanism for simultaneously igniting the first, second, and intermediate detonators, and

wherein the simultaneous ignition of the plurality first, second, and intermediate detonators thereby creates a substantially planar detonation wave.

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