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(54) **OAR-BUFF: A FULL BODY EXERCISE SYSTEM THAT PRODUCES GREATER BENEFITS THAN WEIGHTS OR GYM MACHINES AND DOESN'T USE DANGEROUS POTENTIAL OR KINETIC ENERGY**

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*A63B 24/00* (2006.01)

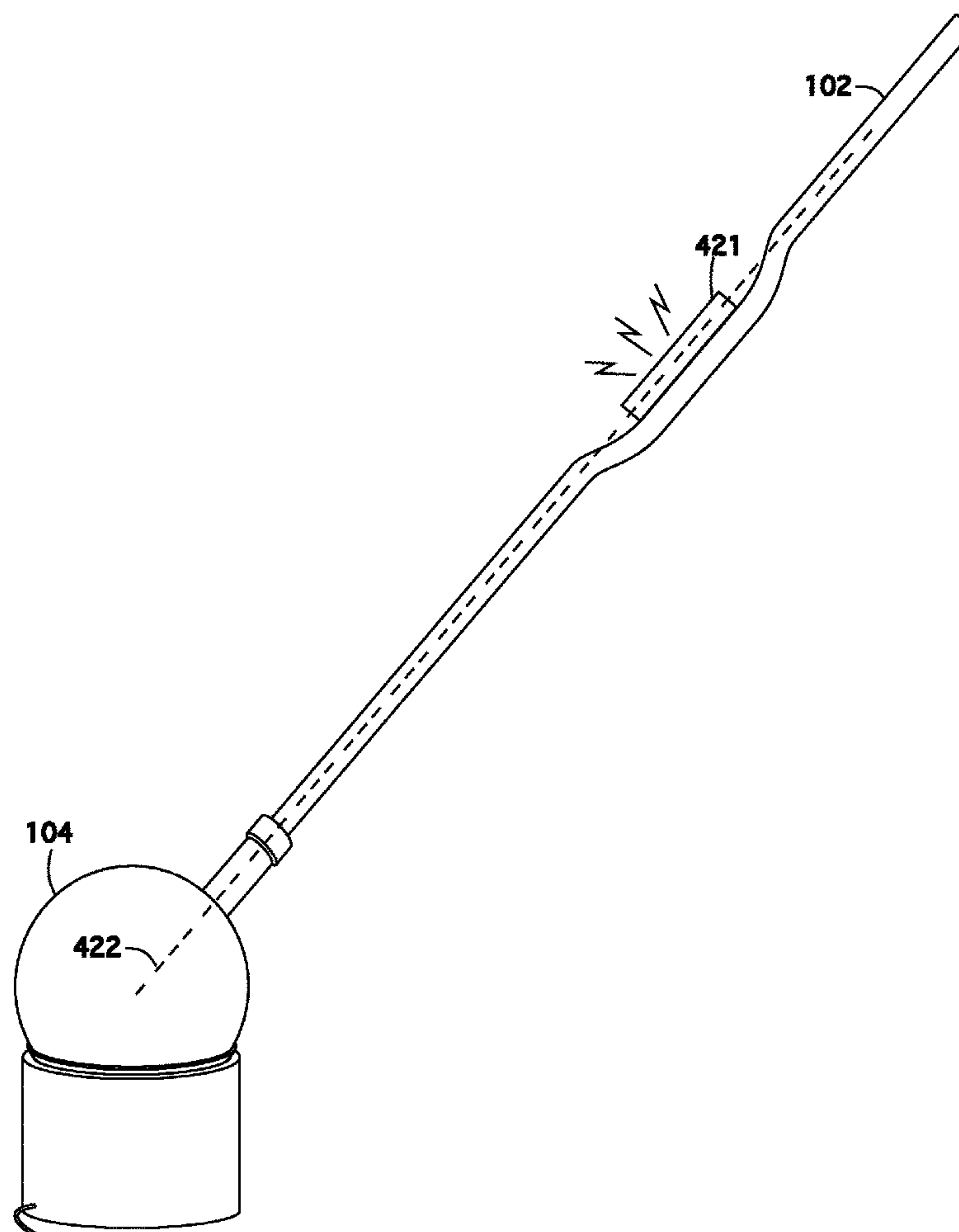
(52) **U.S. Cl.**

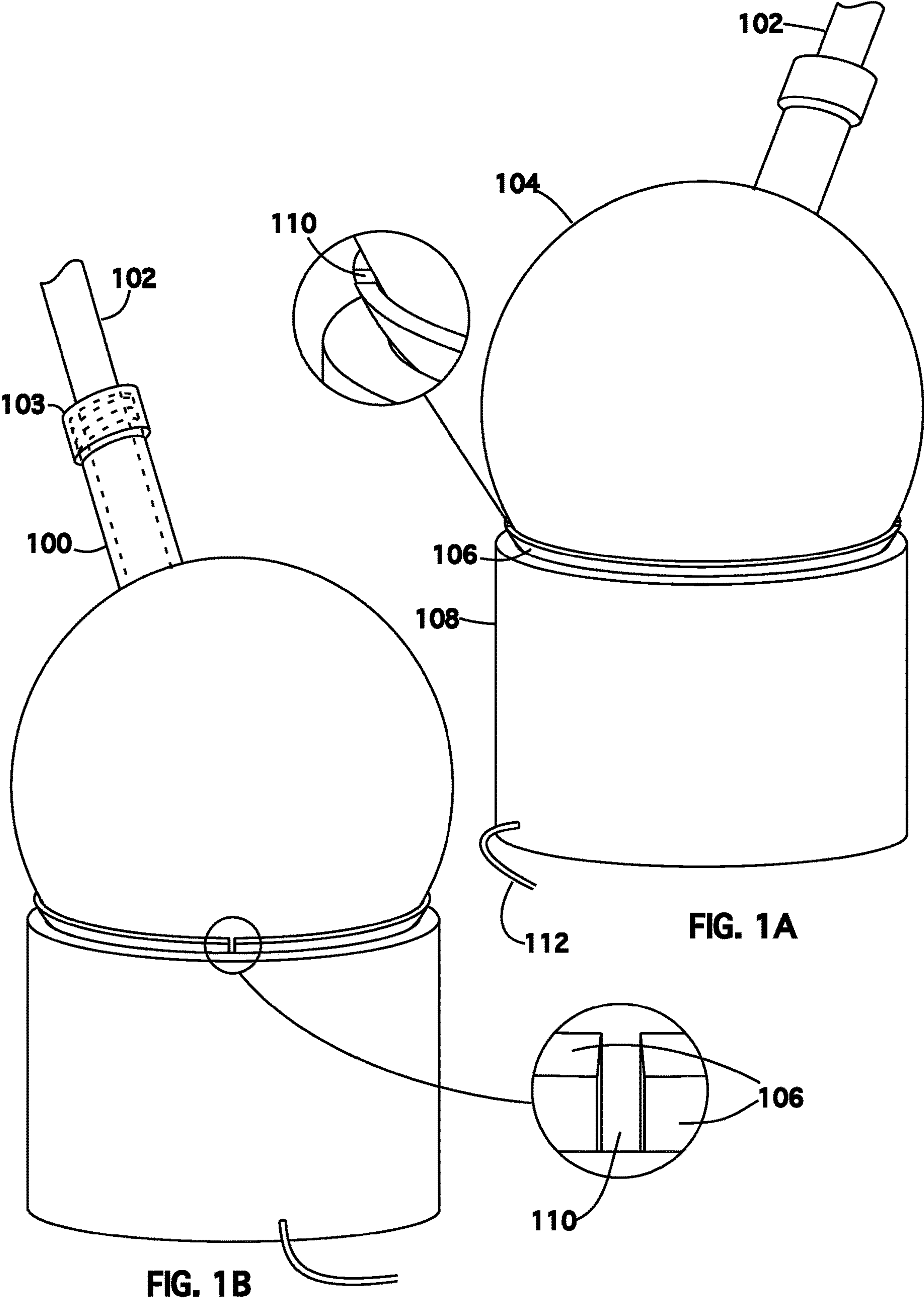
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(57)

**ABSTRACT**

A unique full body exercise experience is provided by embodiments that produce user controlled resistance that can be assigned verbally, remotely by electronic means or manually. The embodiments can sense hand and foot location and then automatically change the resistance according to those locations, or by spoken word or programmed time. Exercise resistance can be offered in the three dimensions of space. Muscle groups can be exercised in complementary fashion with movements that fully stress the muscles. Two-movement exercises can be repeated endlessly or complicated ensembles in 3-space can be strung together, all with unlimited, user-defined changes of resistance. Every movement that is possible to perform with free weights or universal gyms is available to the user. Movements that are impossible with weights are easily performed with great safety. There has never been anything like this.





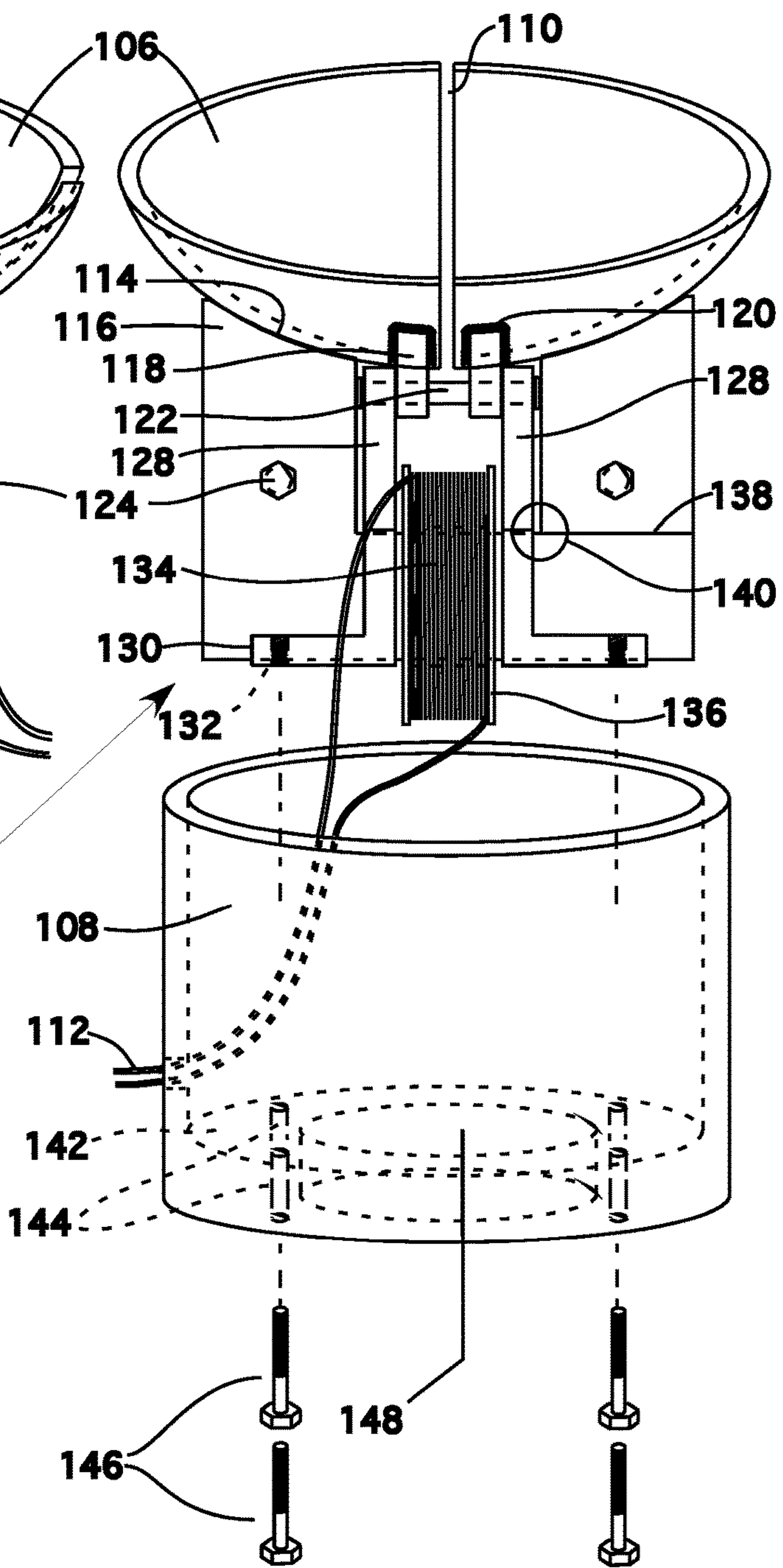
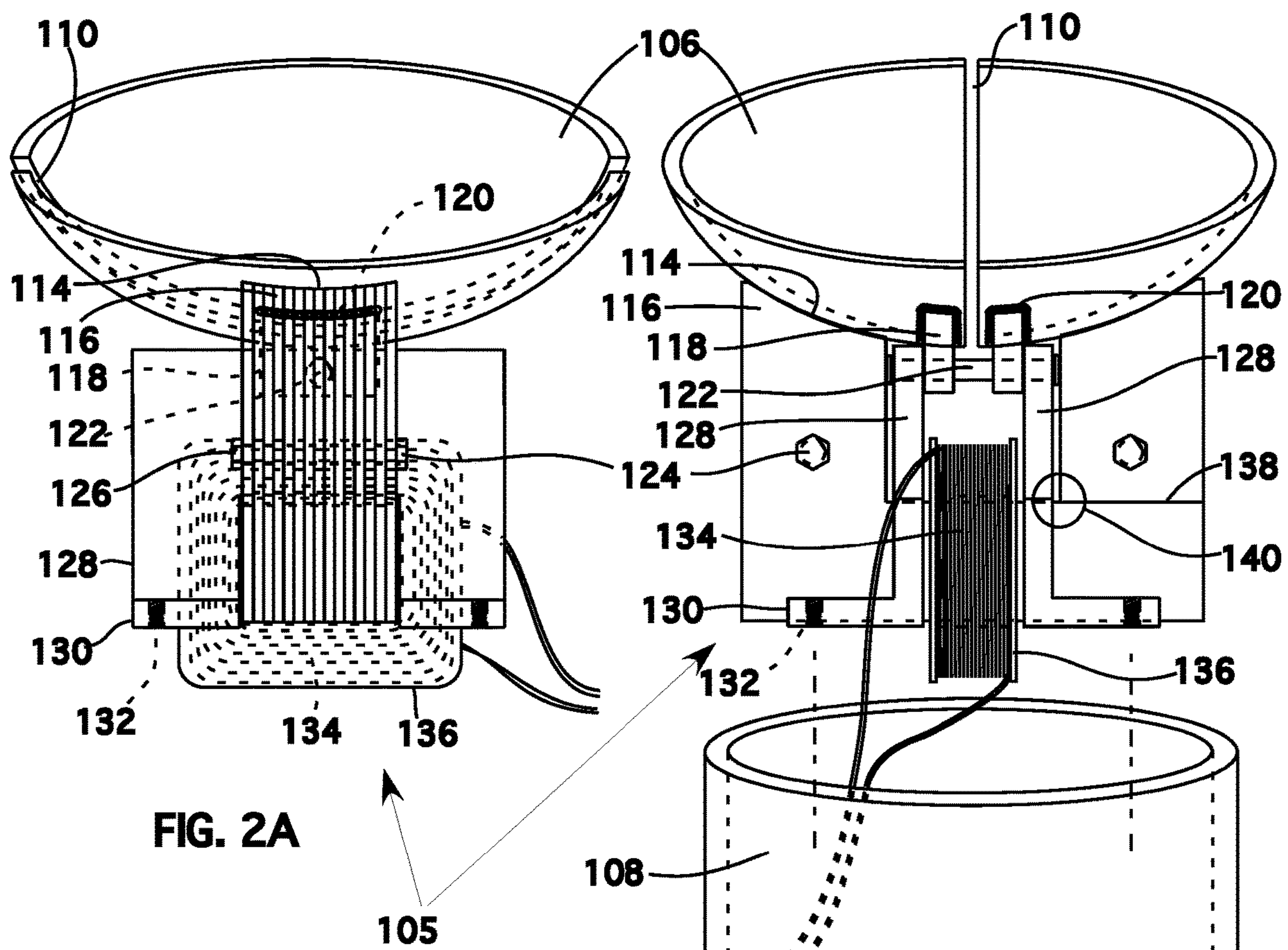


FIG. 2B

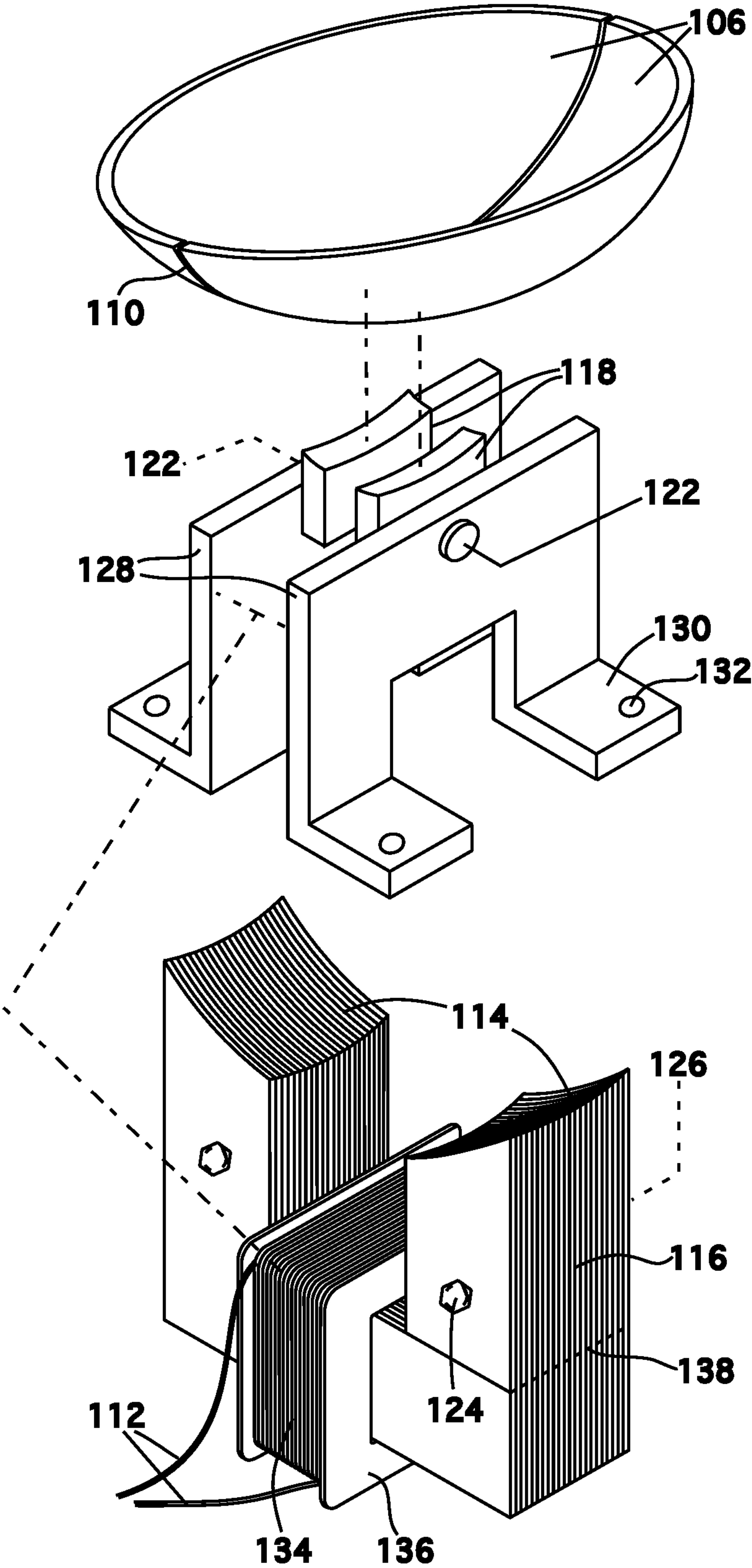


FIG. 3

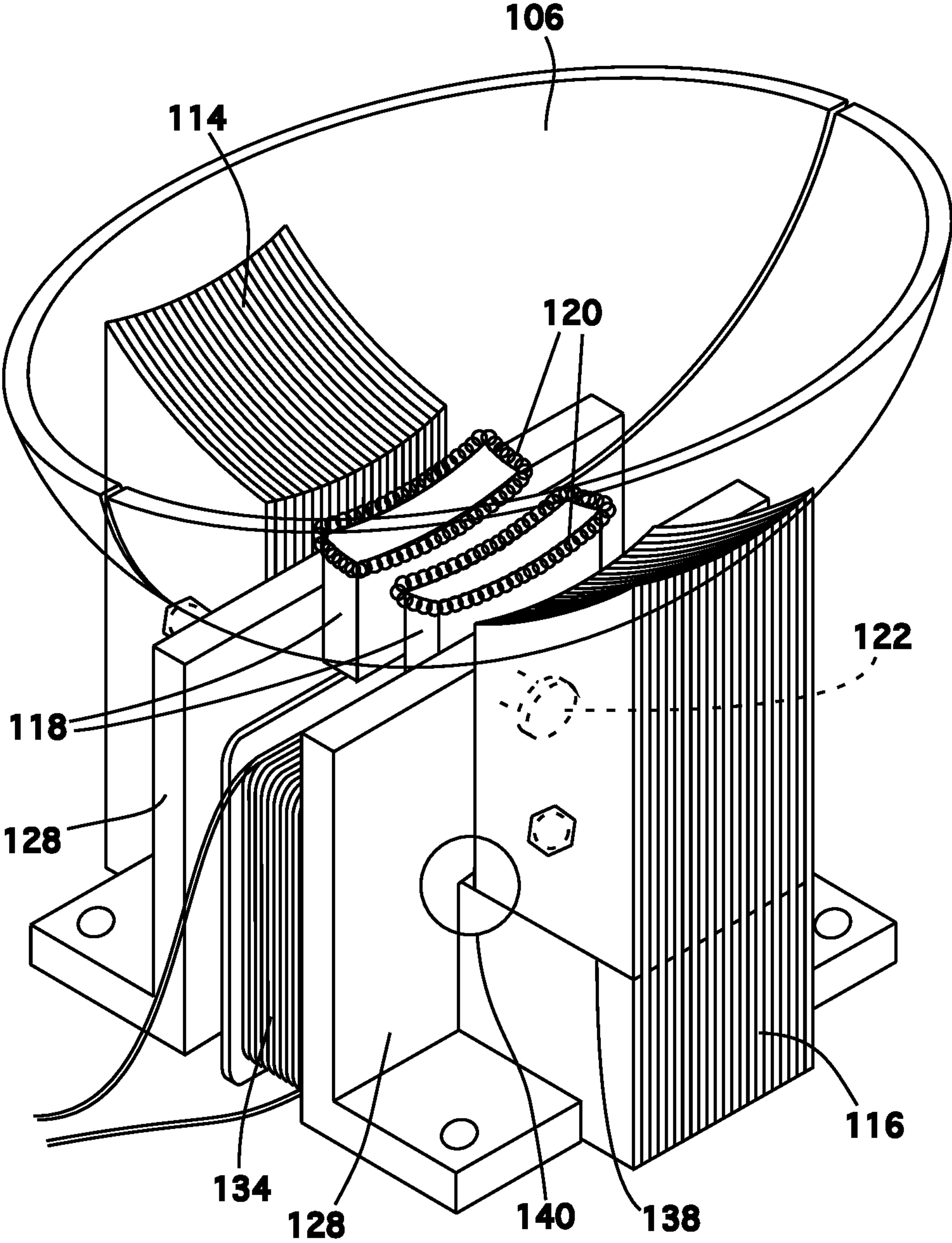


FIG. 4

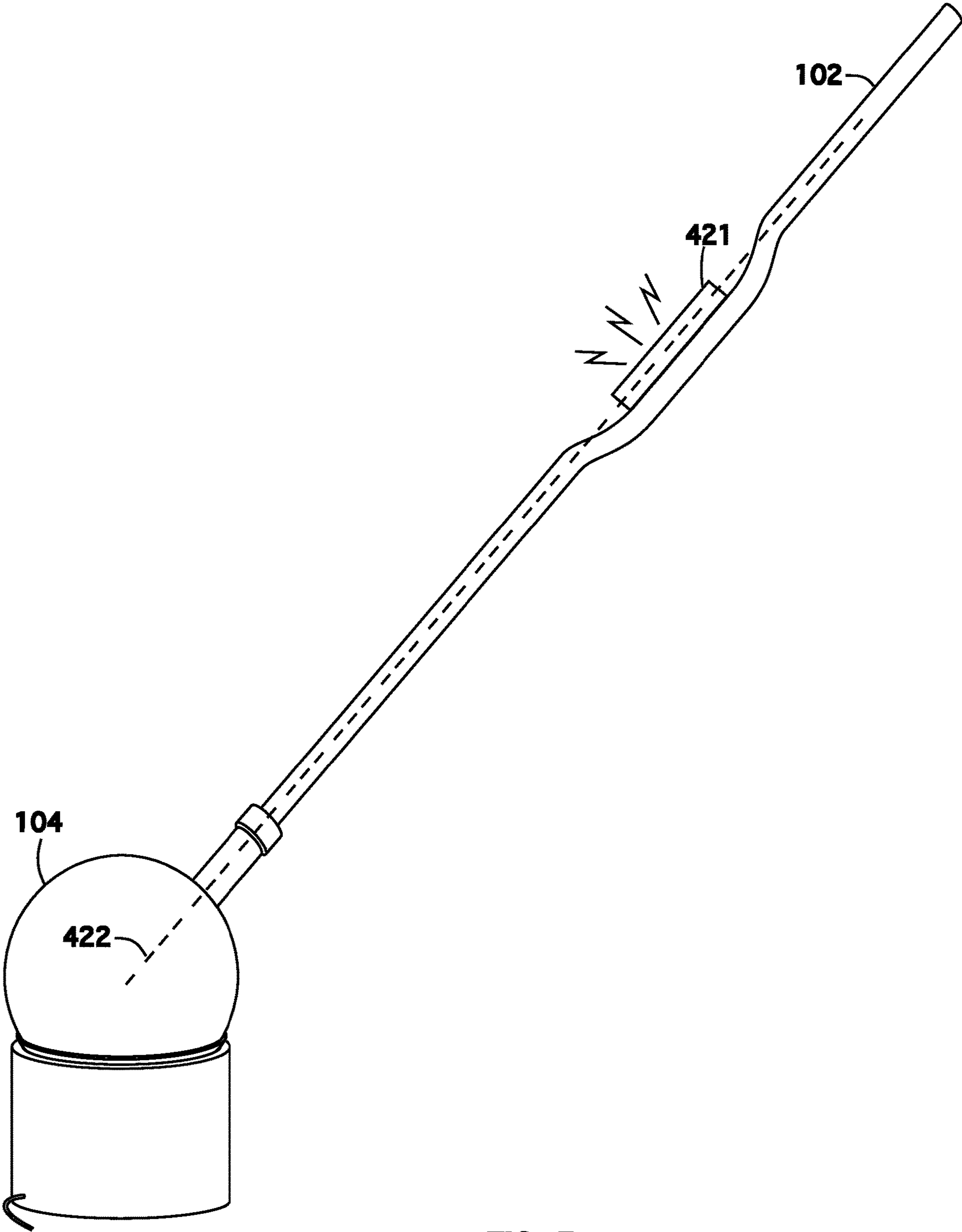
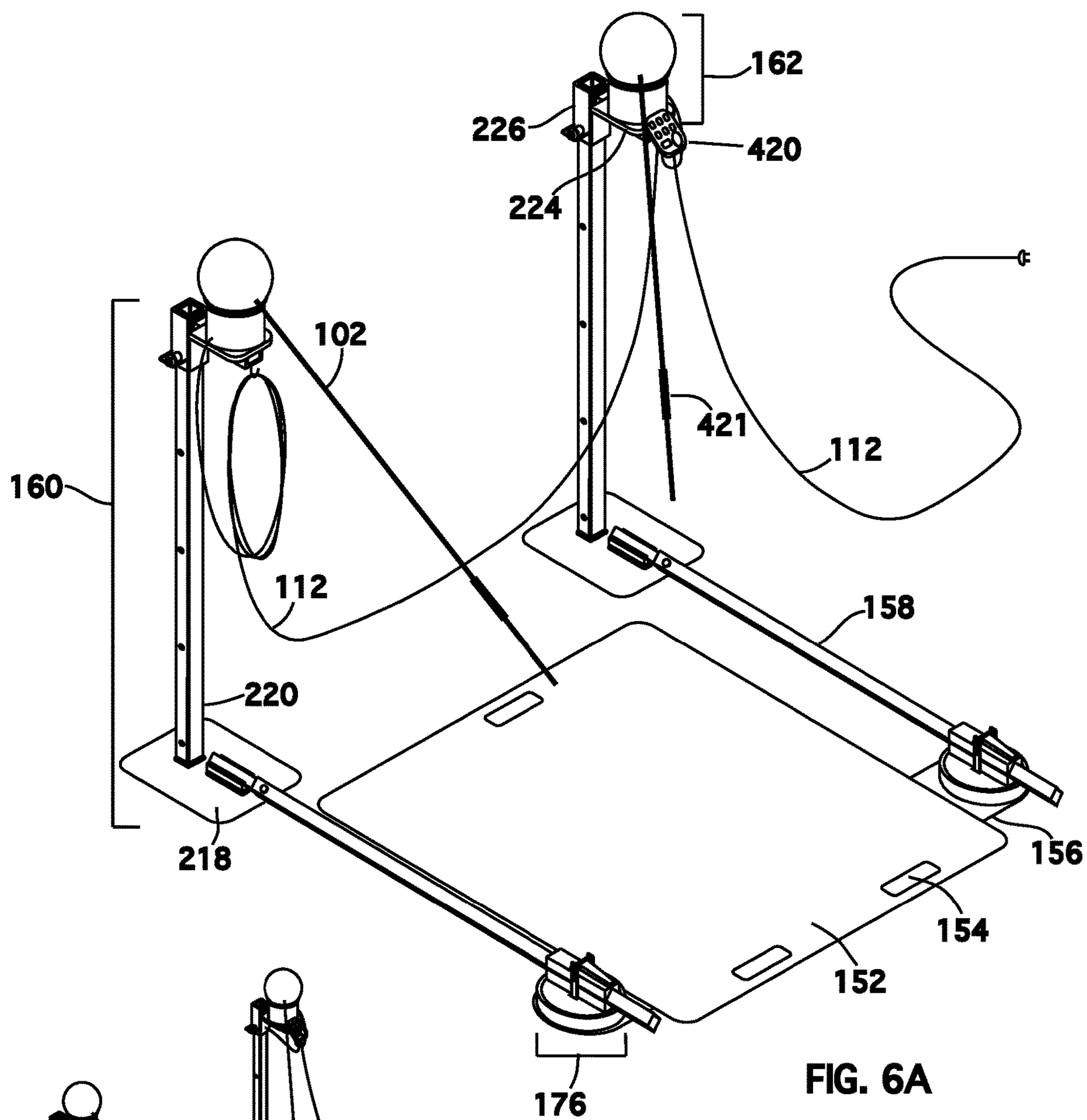
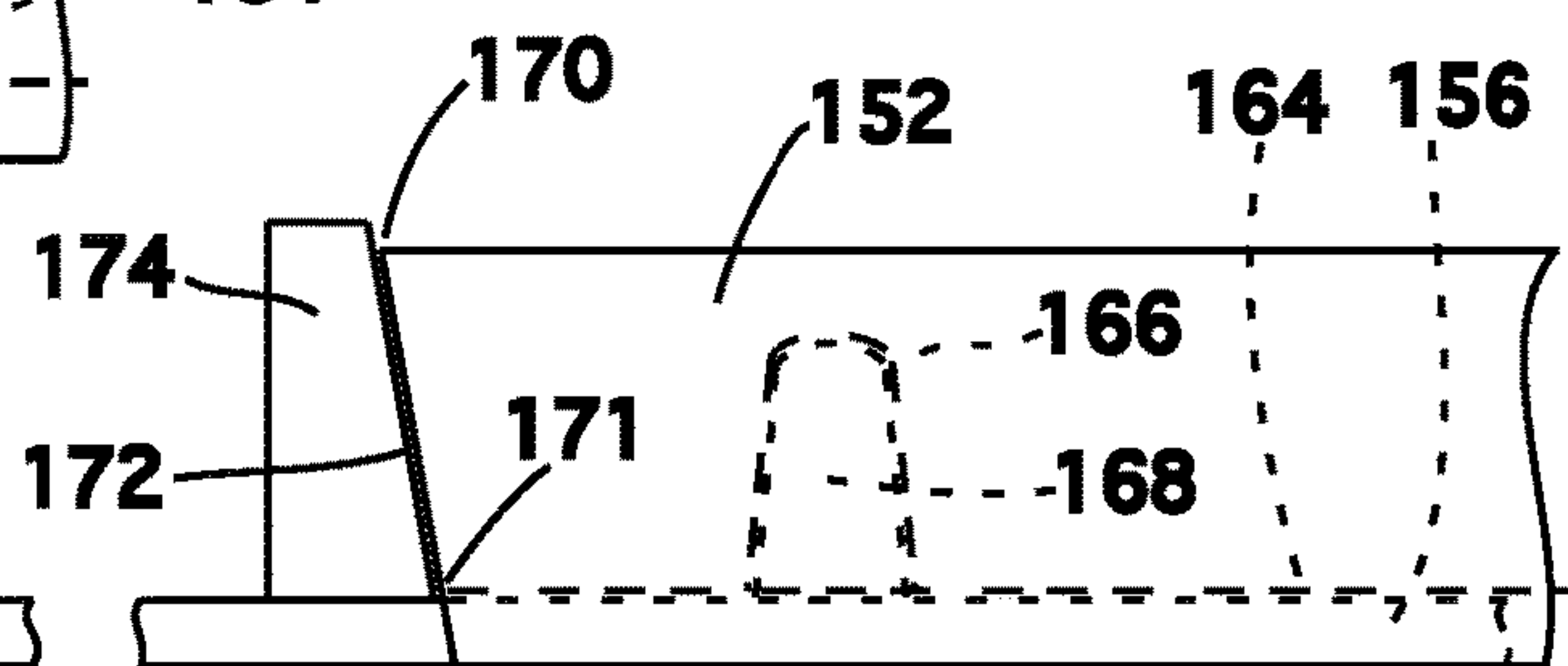
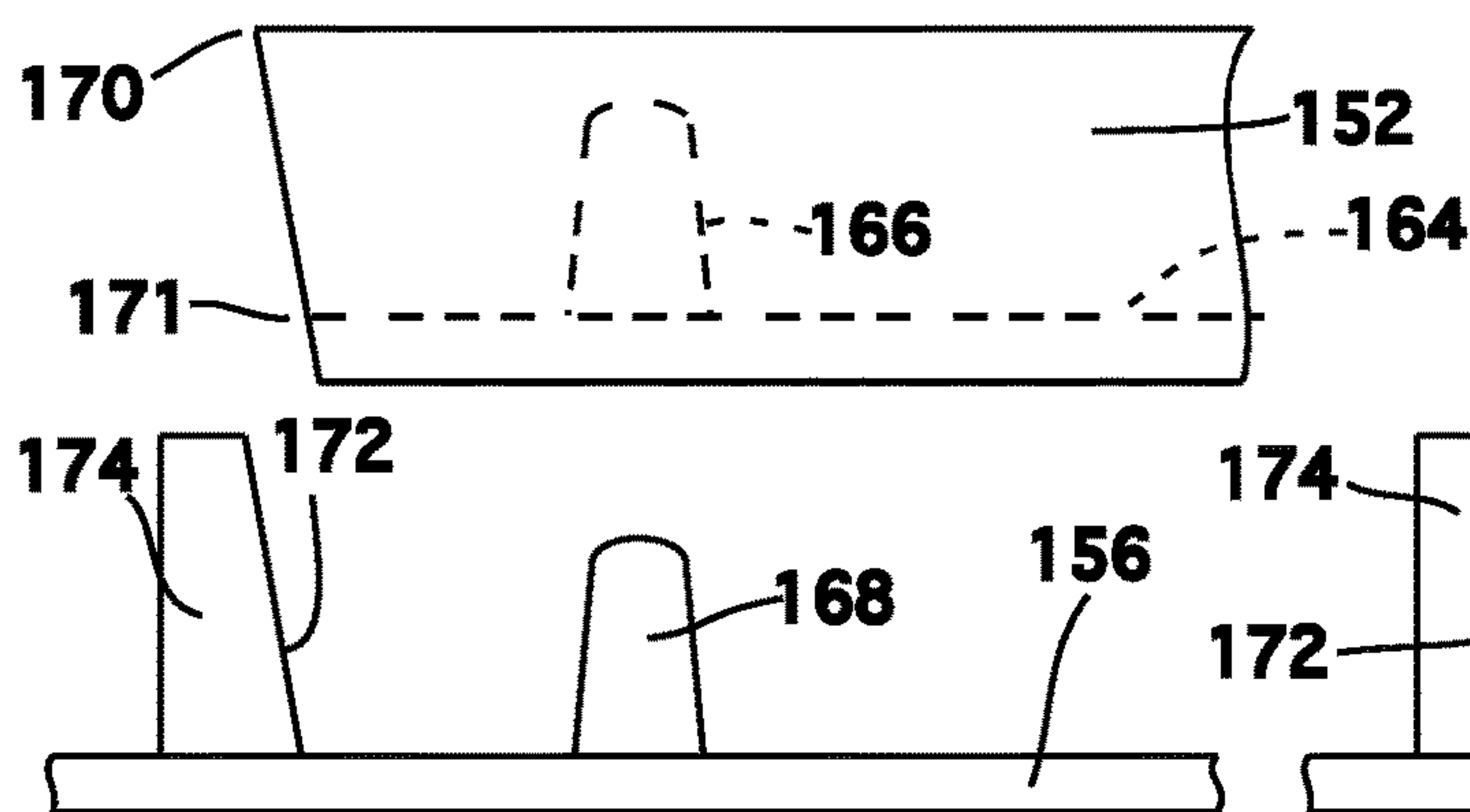
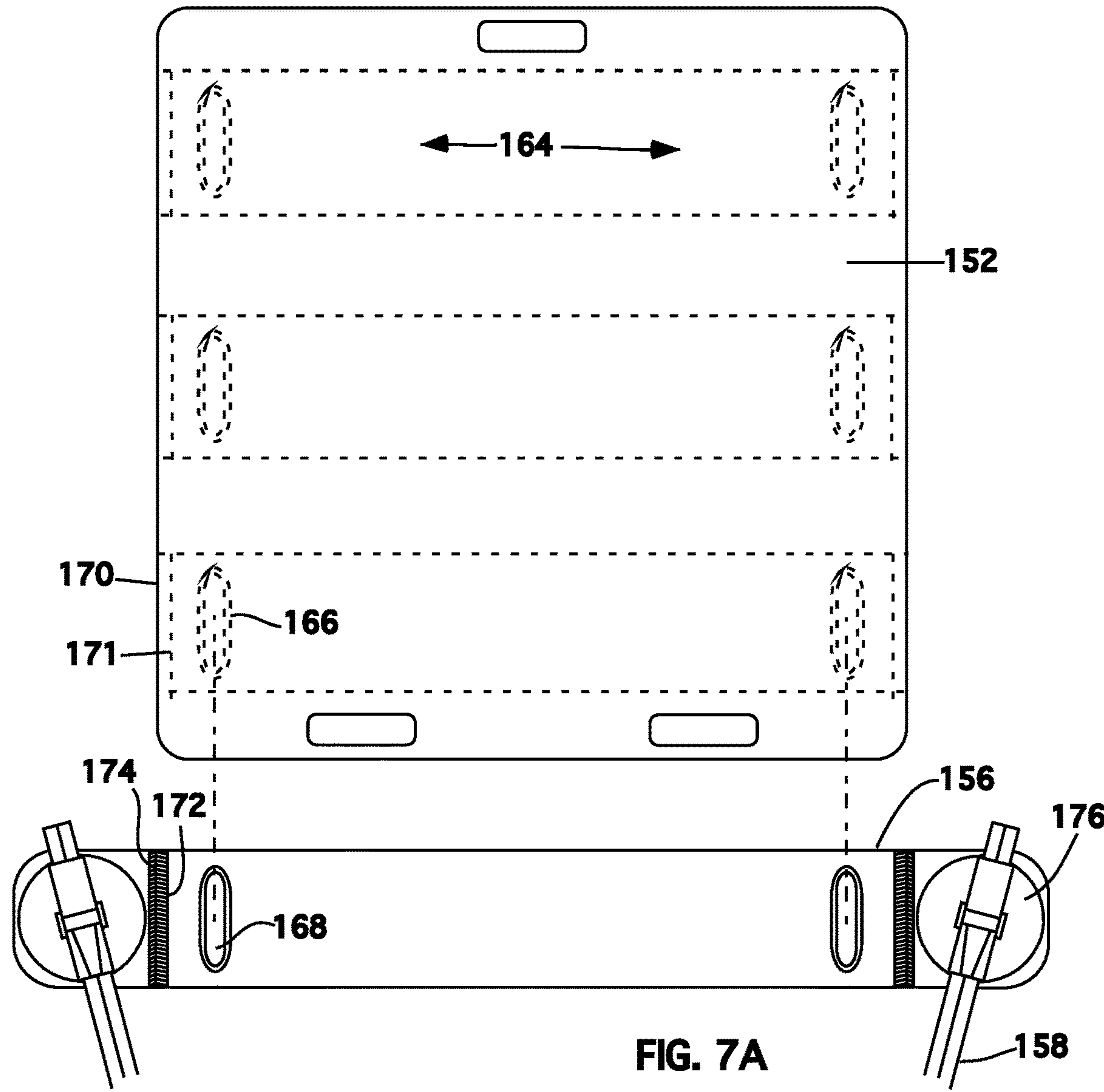


FIG. 5





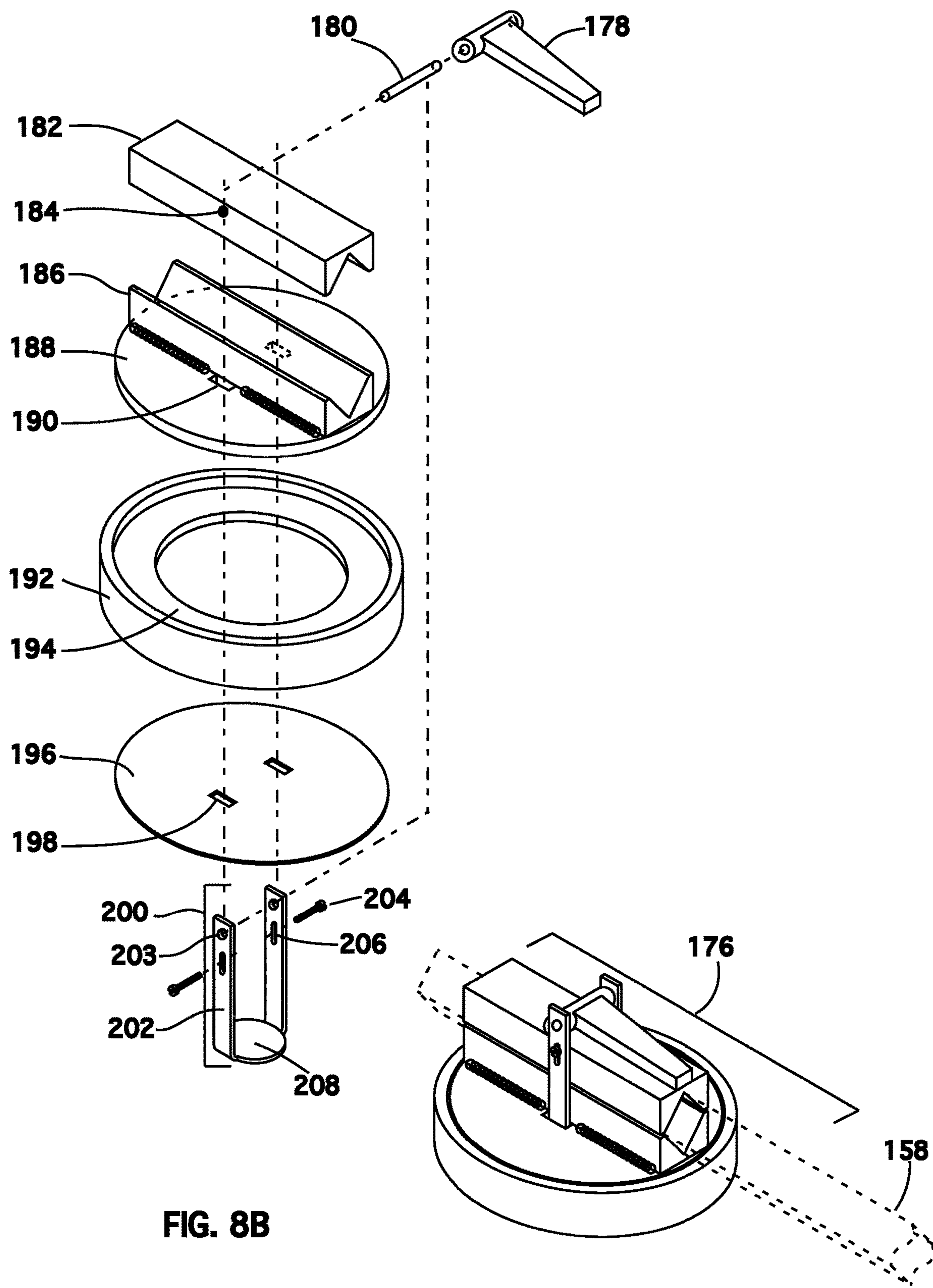


FIG. 8B

FIG. 8A

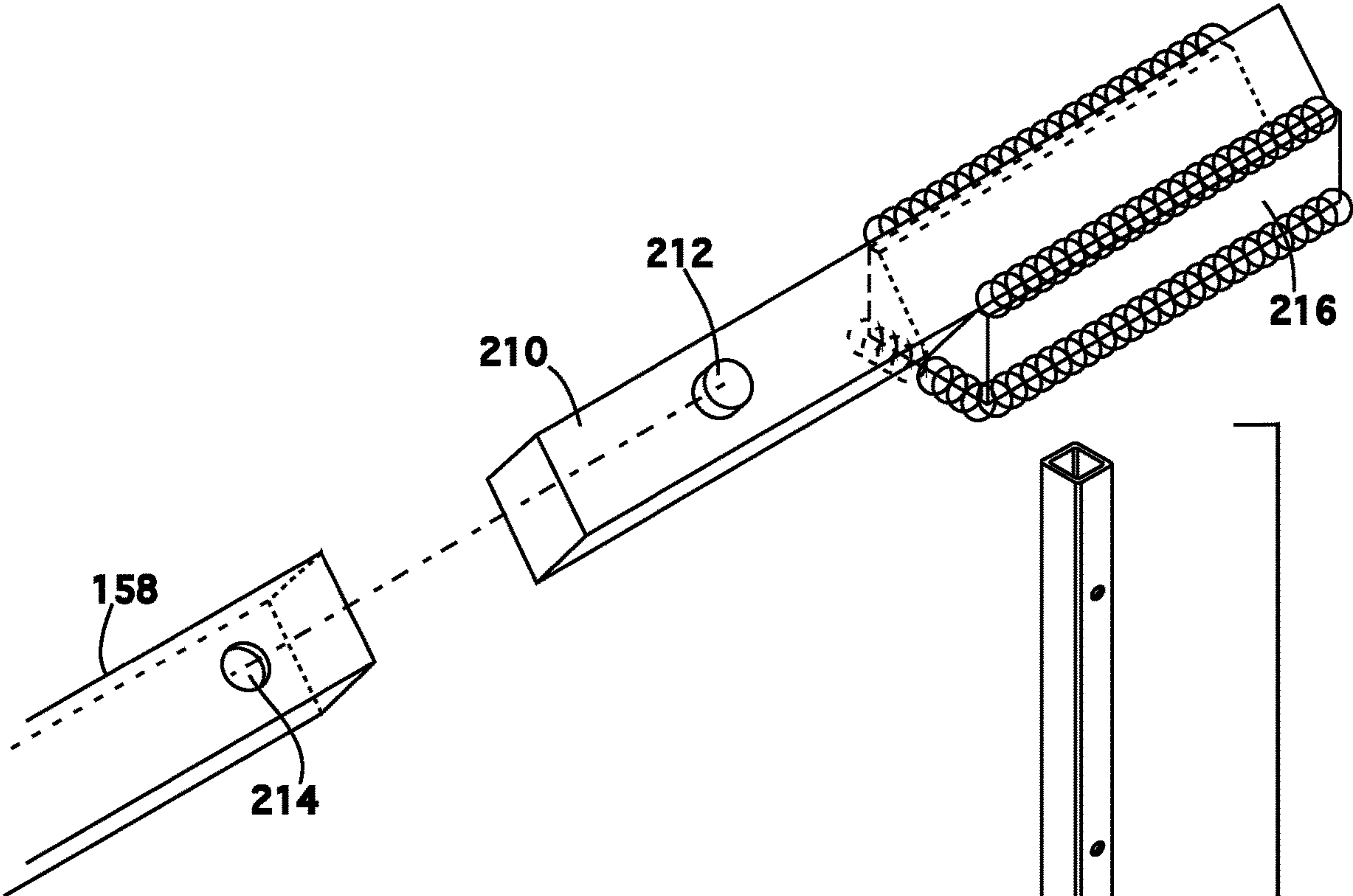


FIG. 9B

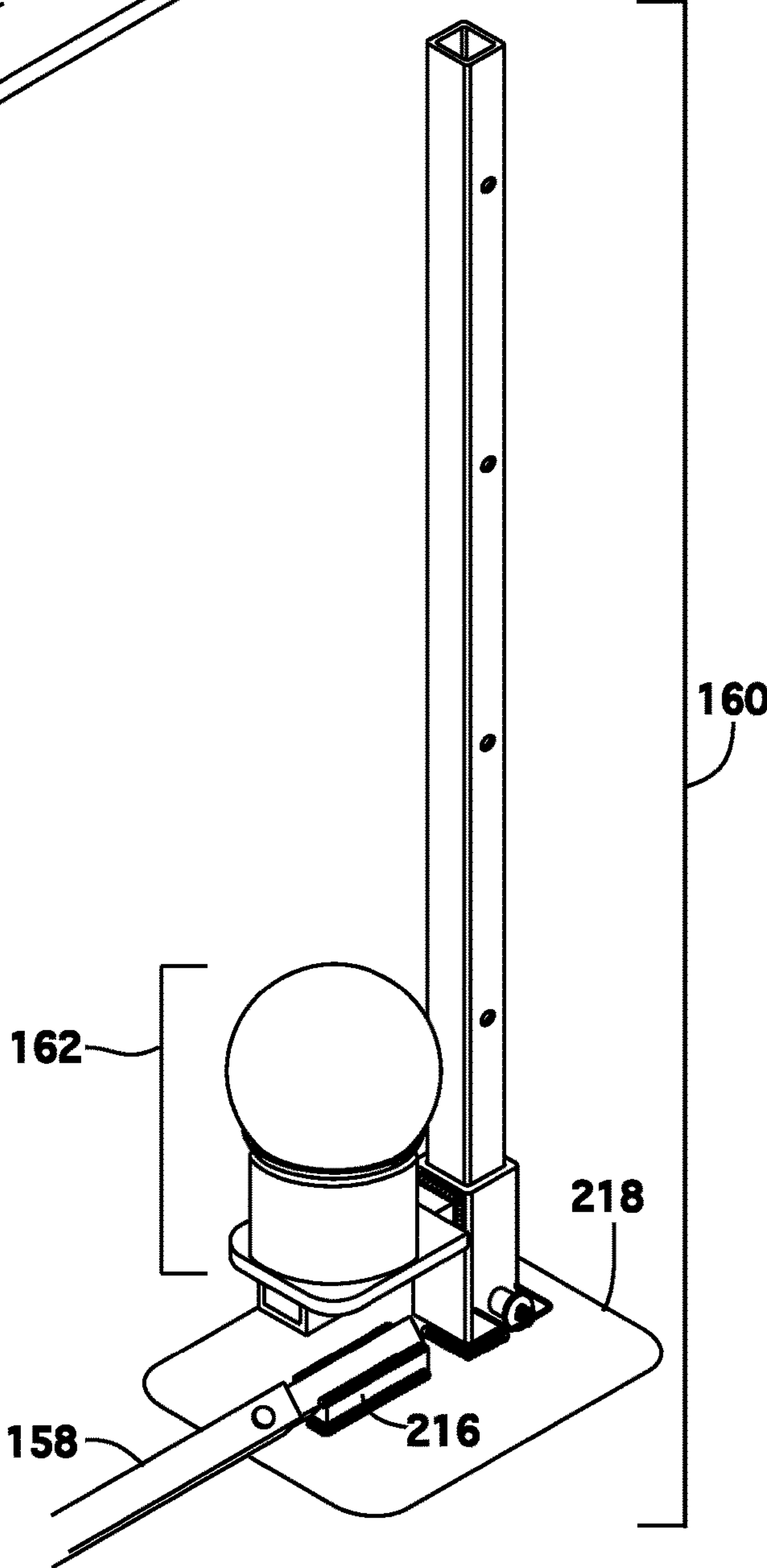
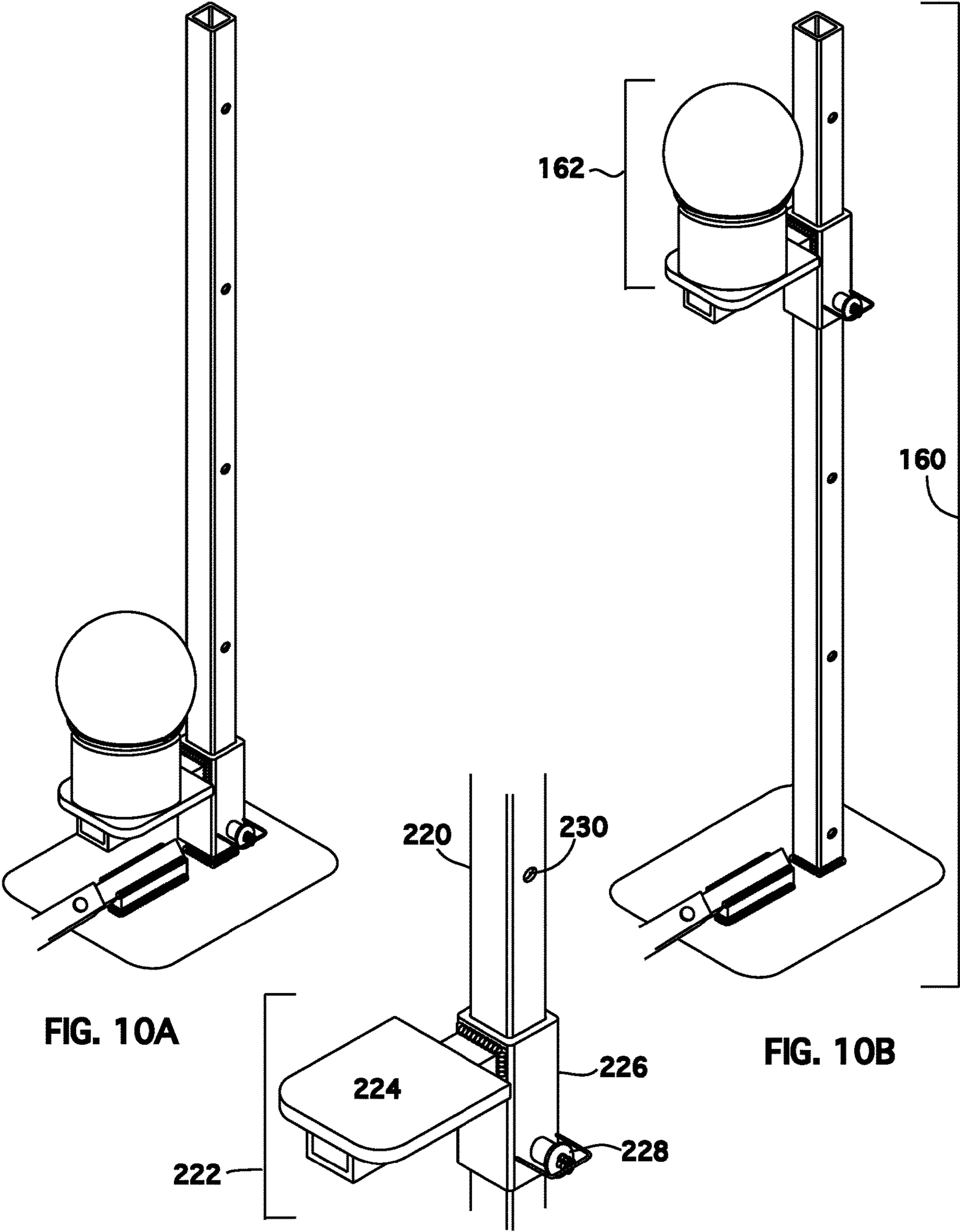


FIG. 9A



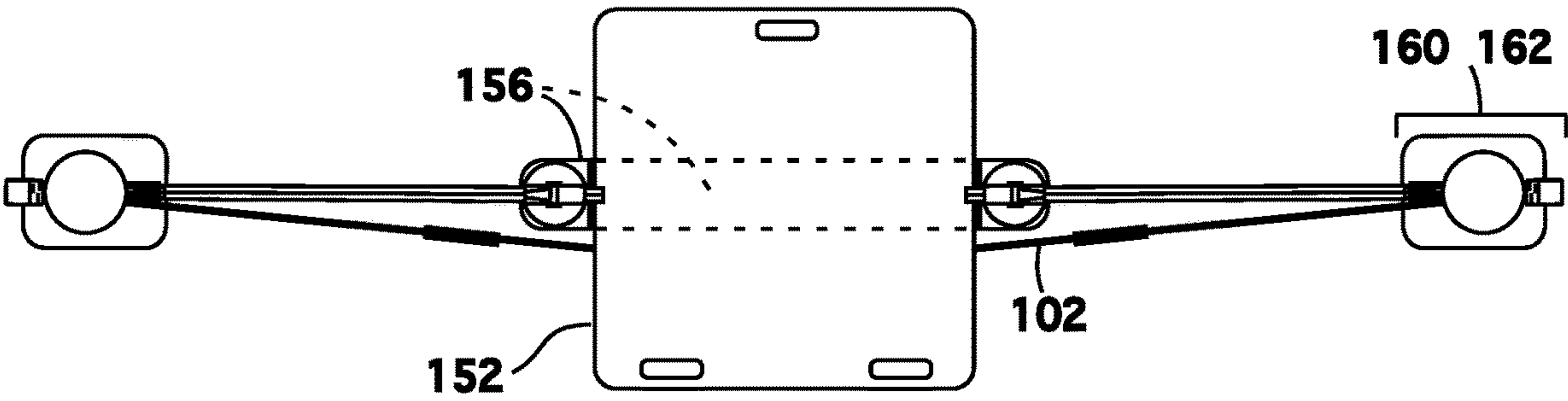


FIG. 11C

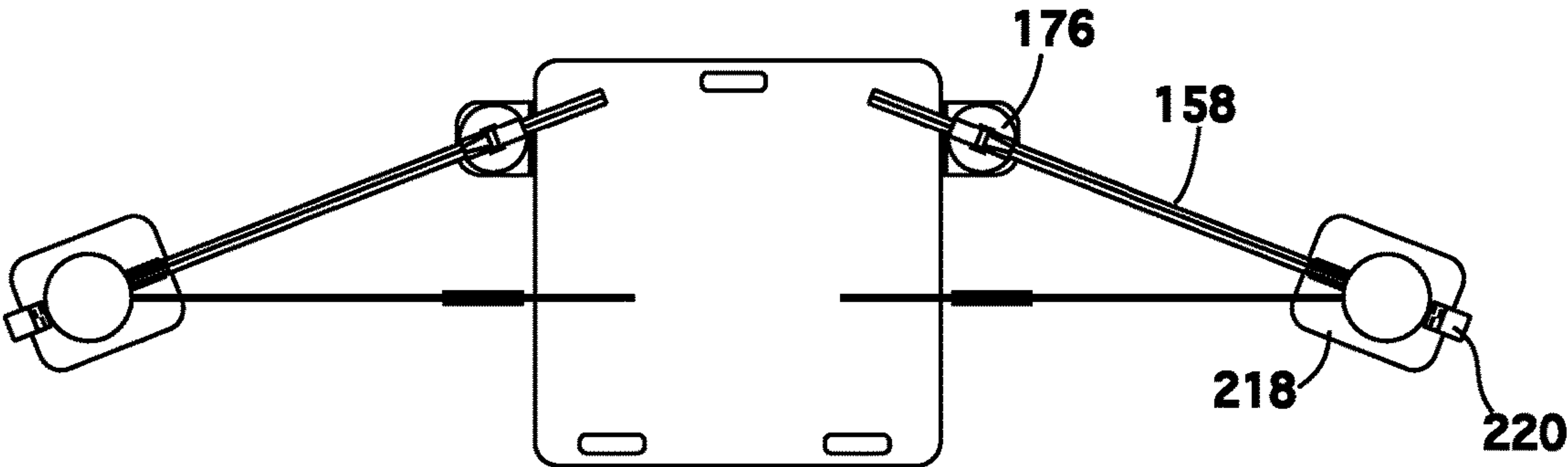


FIG. 11B

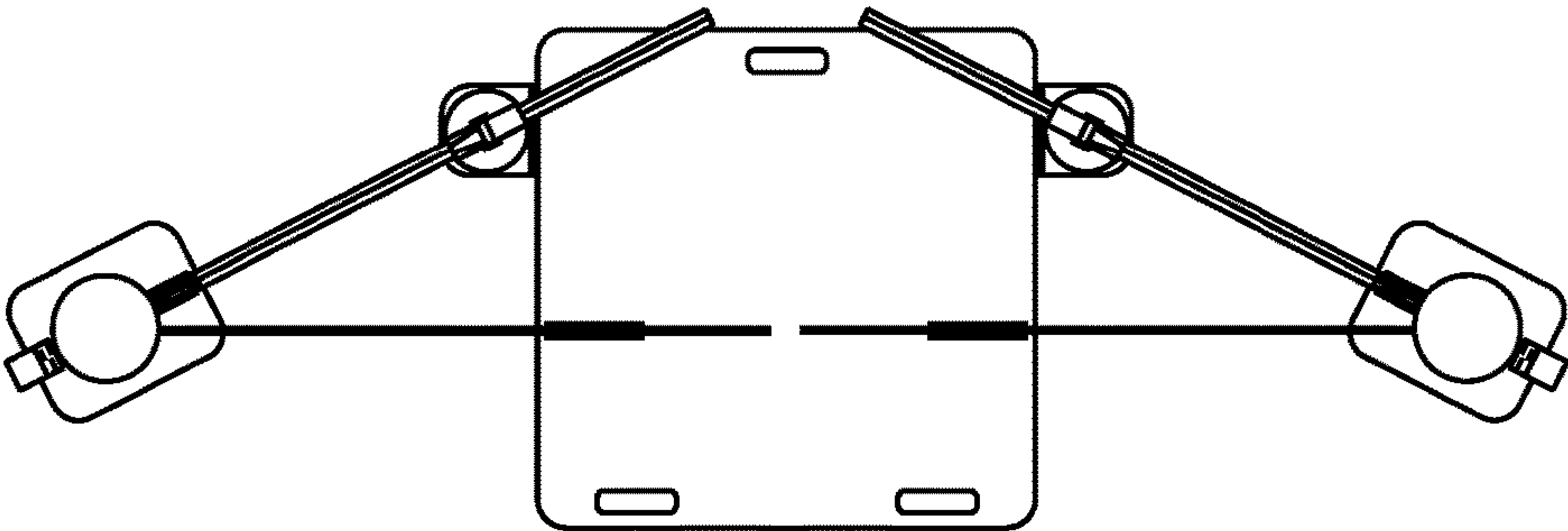


FIG. 11A

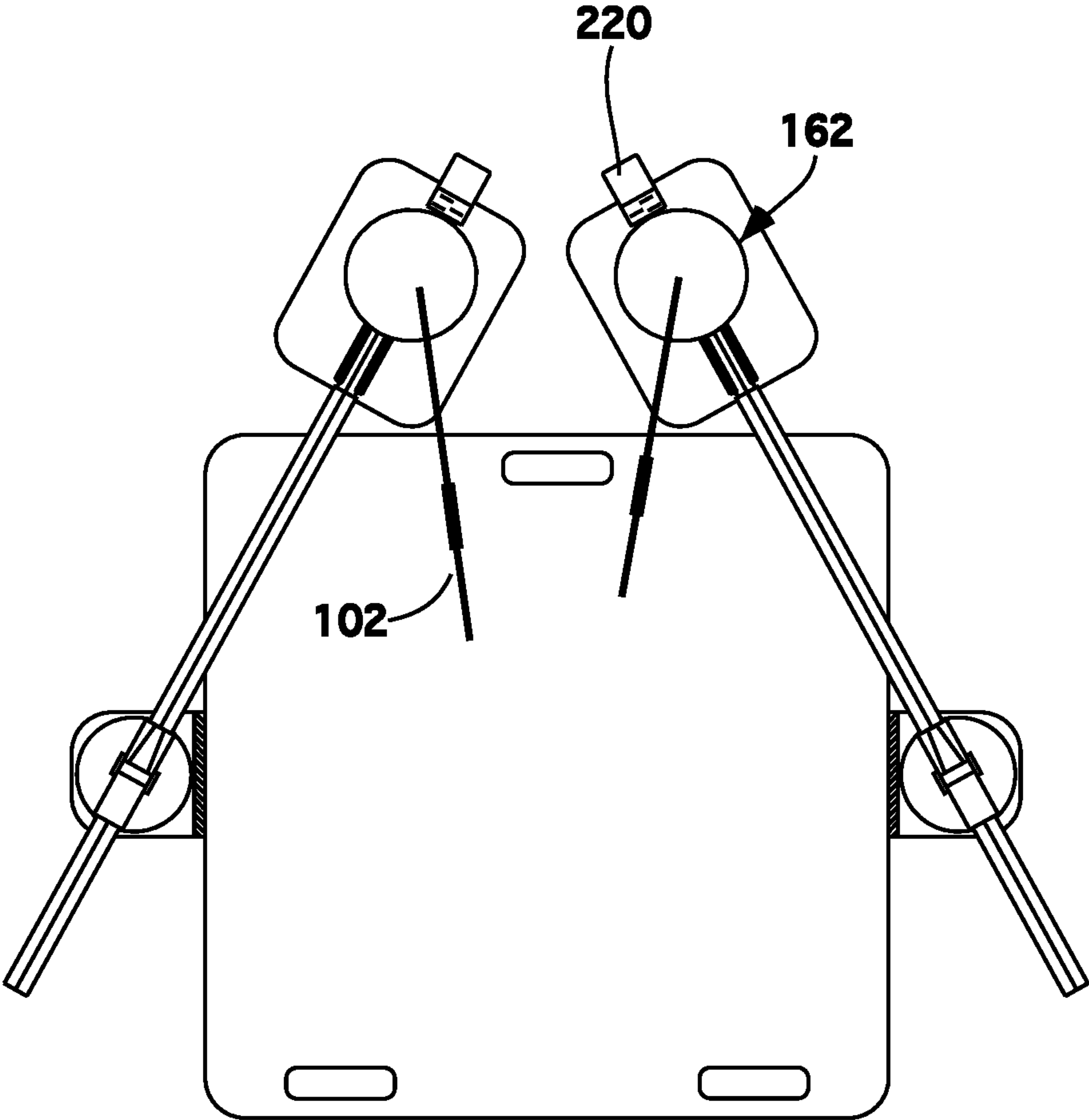


FIG. 12

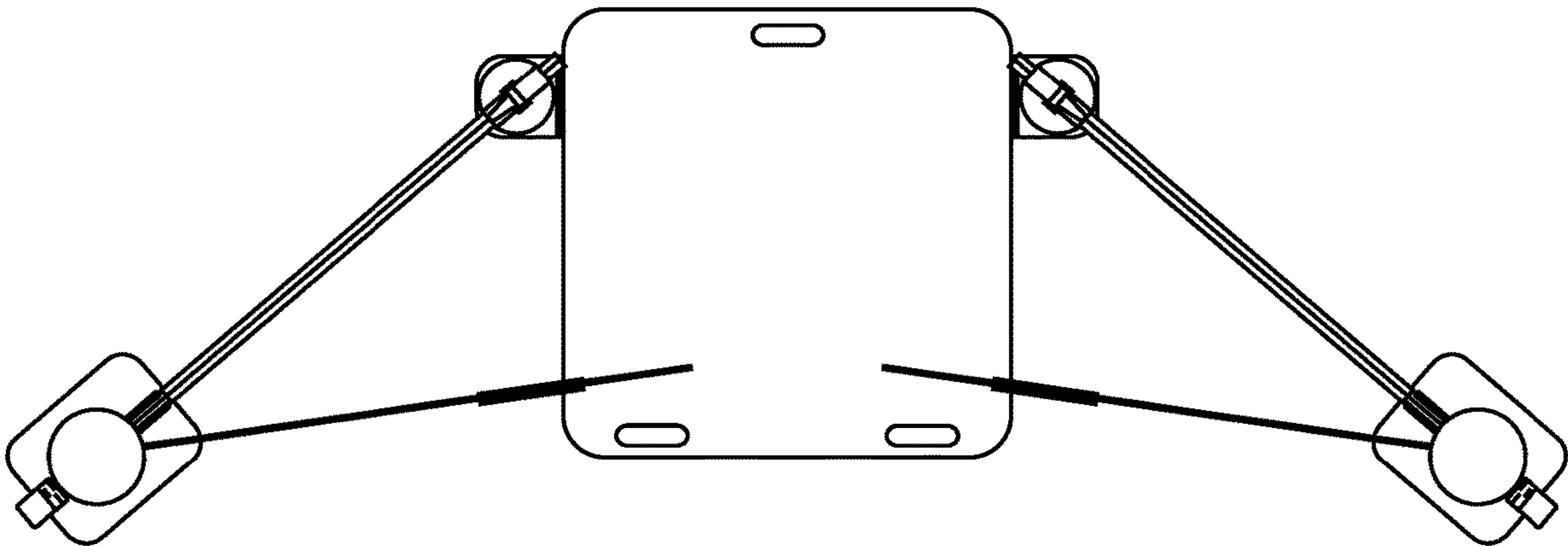


**FIG. 13B**

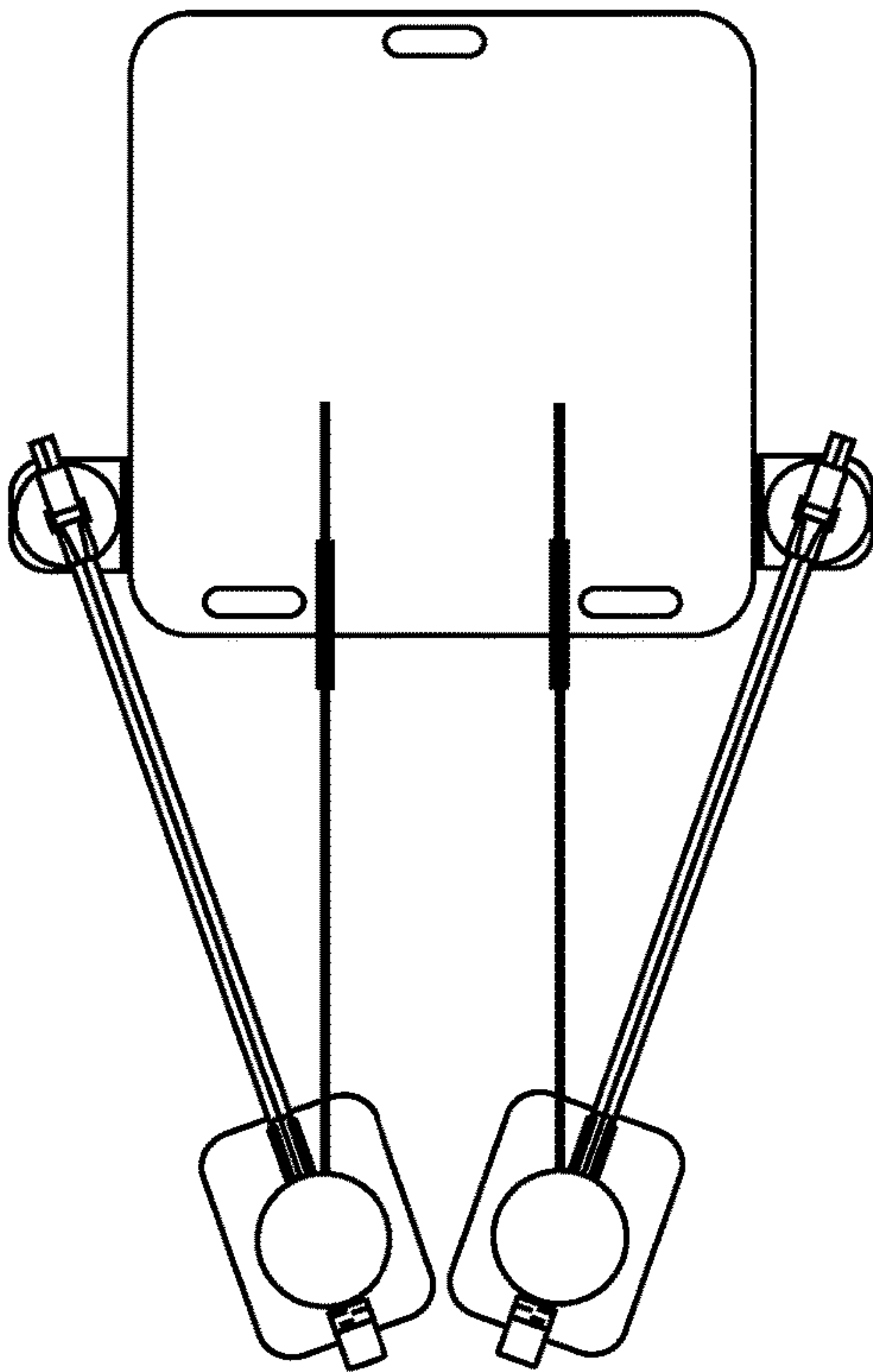


**FIG. 13A**

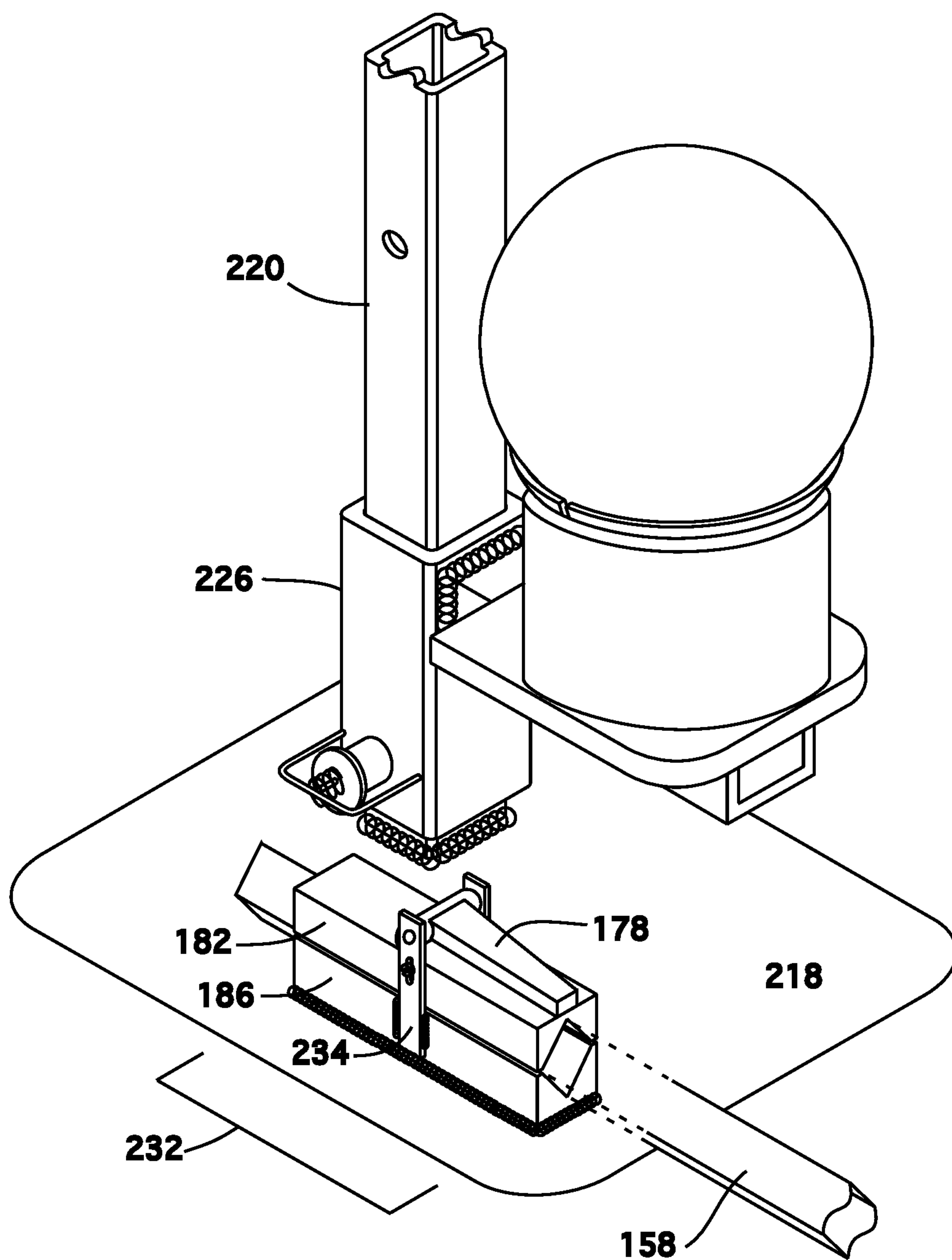


FIG. 14

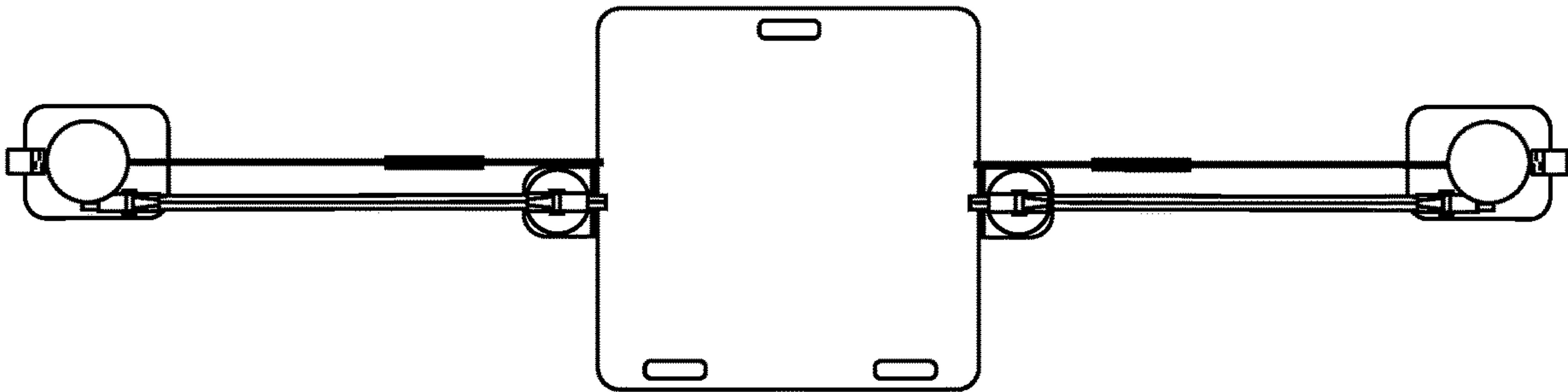


FIG. 15C

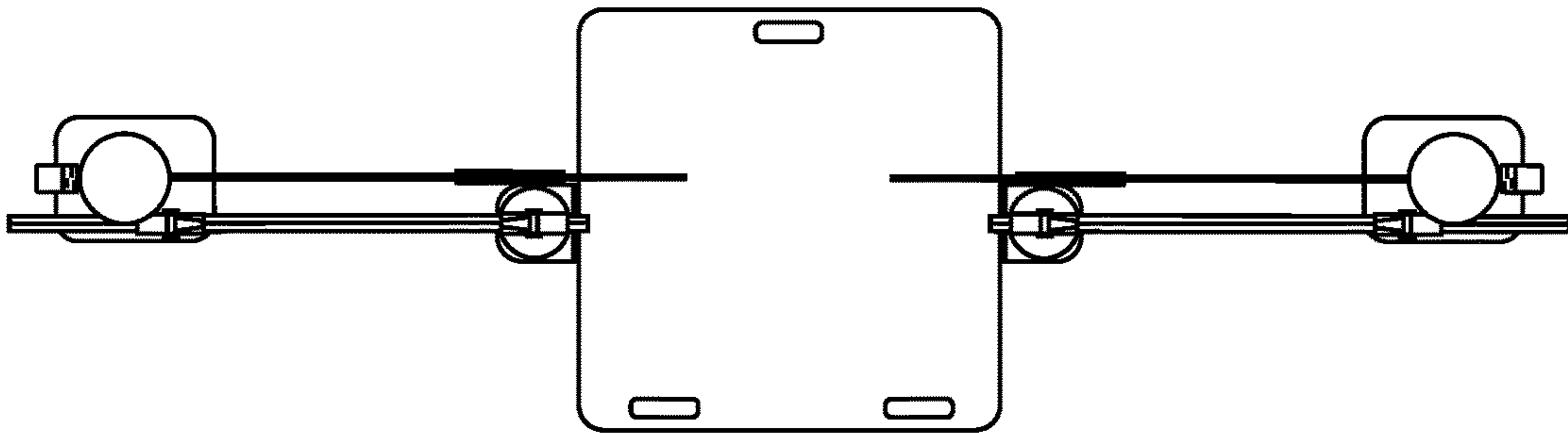


FIG. 15B

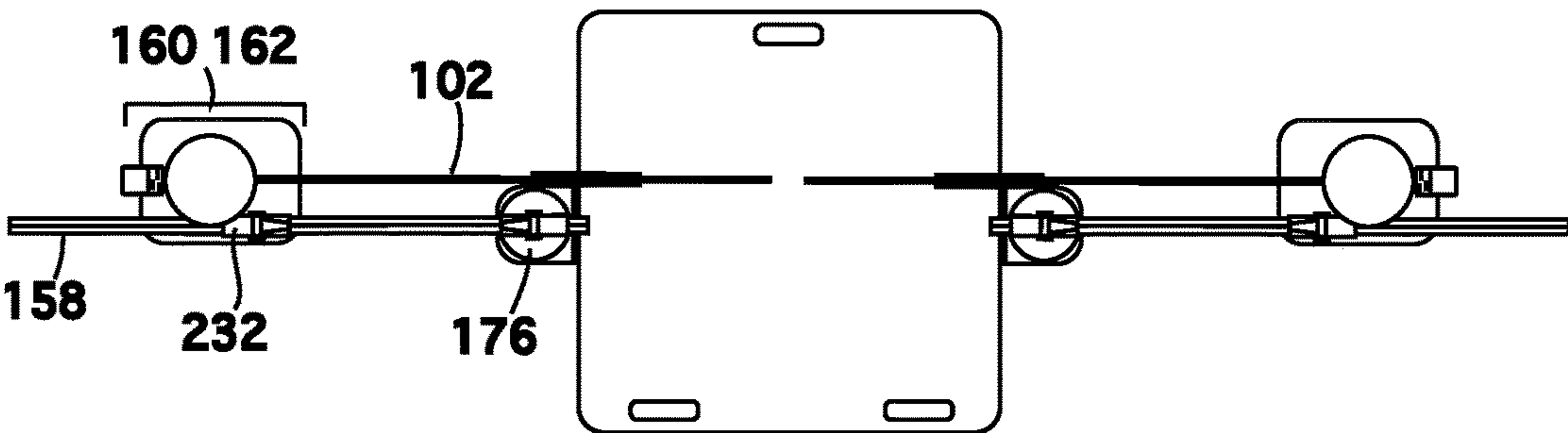


FIG. 15A

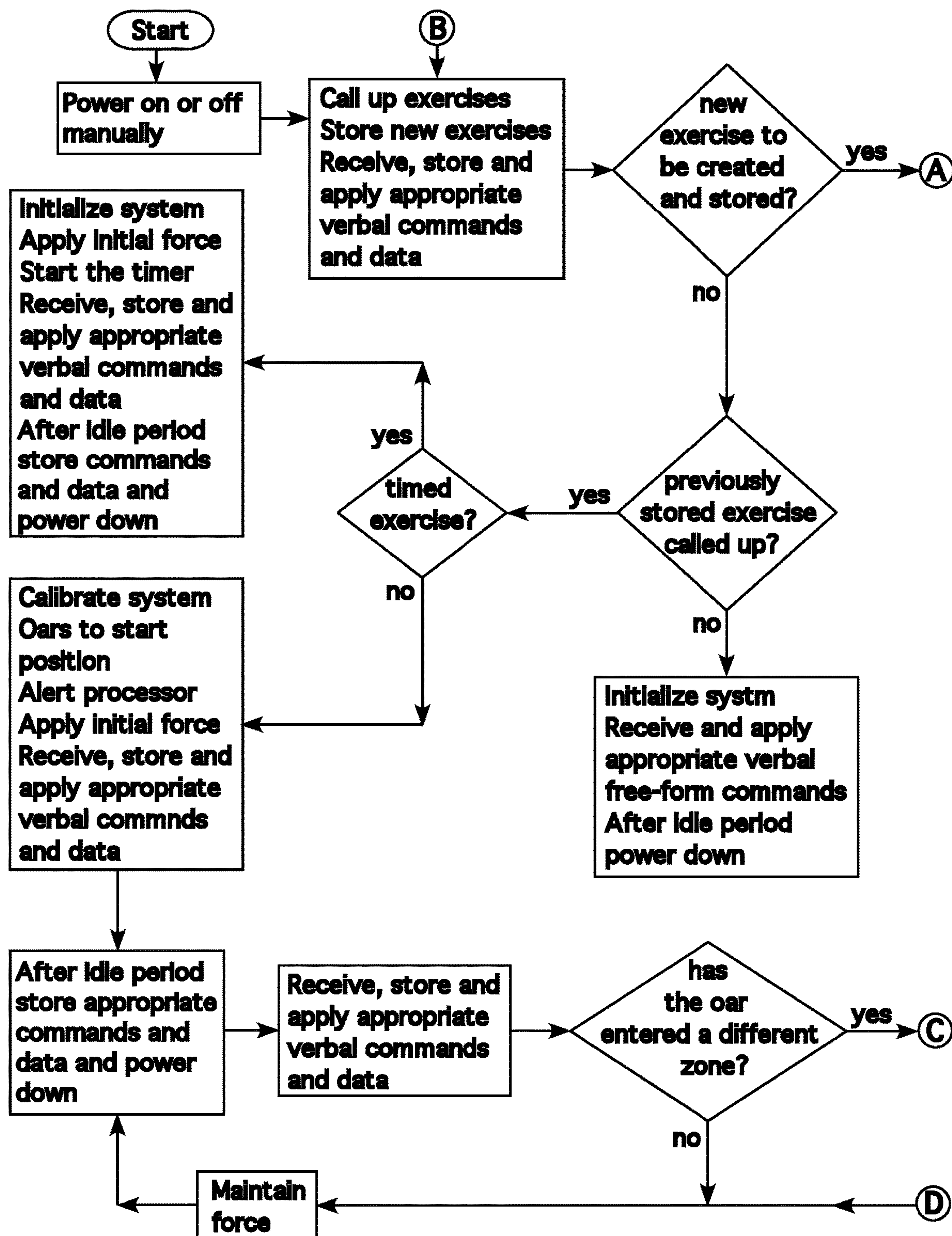


FIG. 16

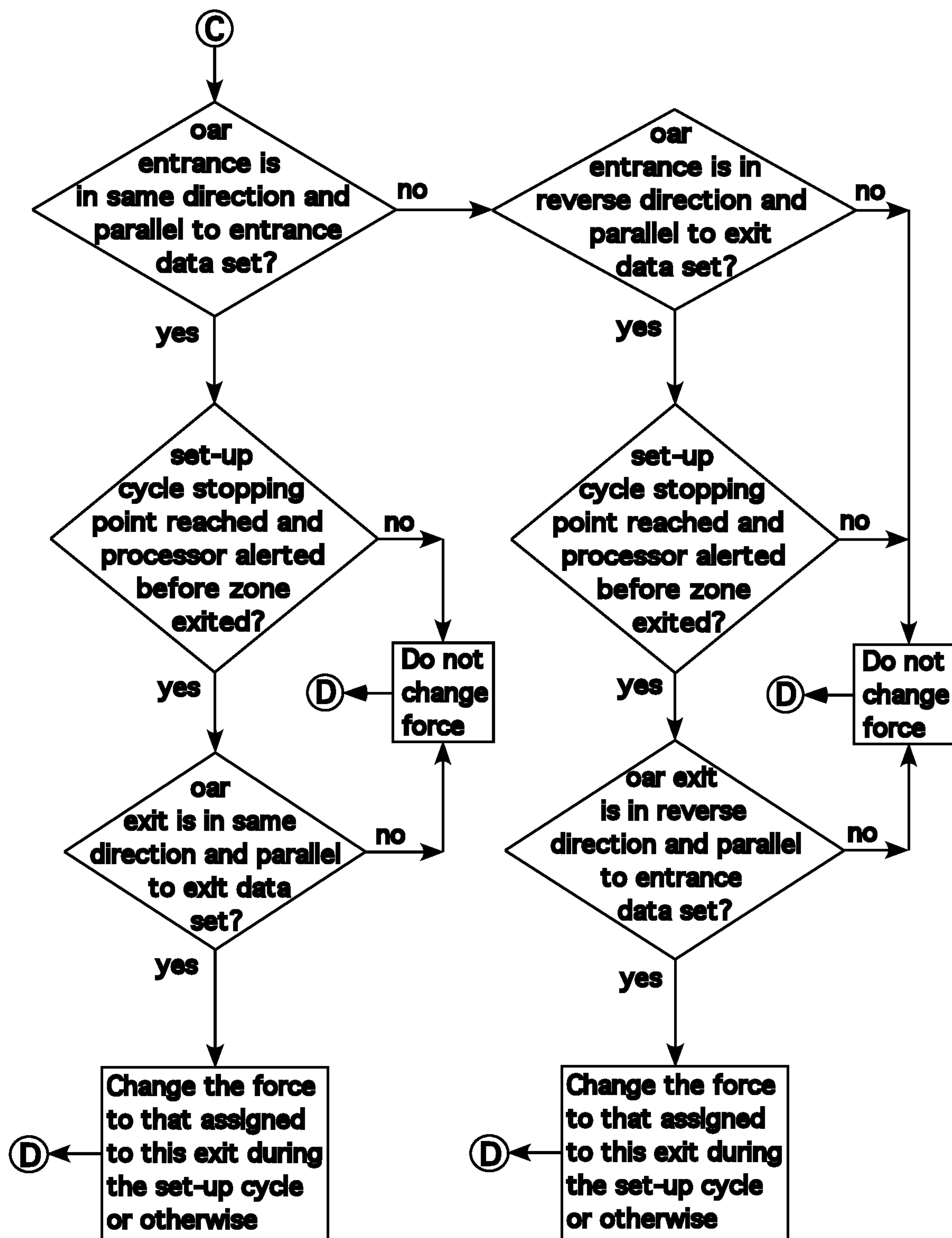


FIG. 17

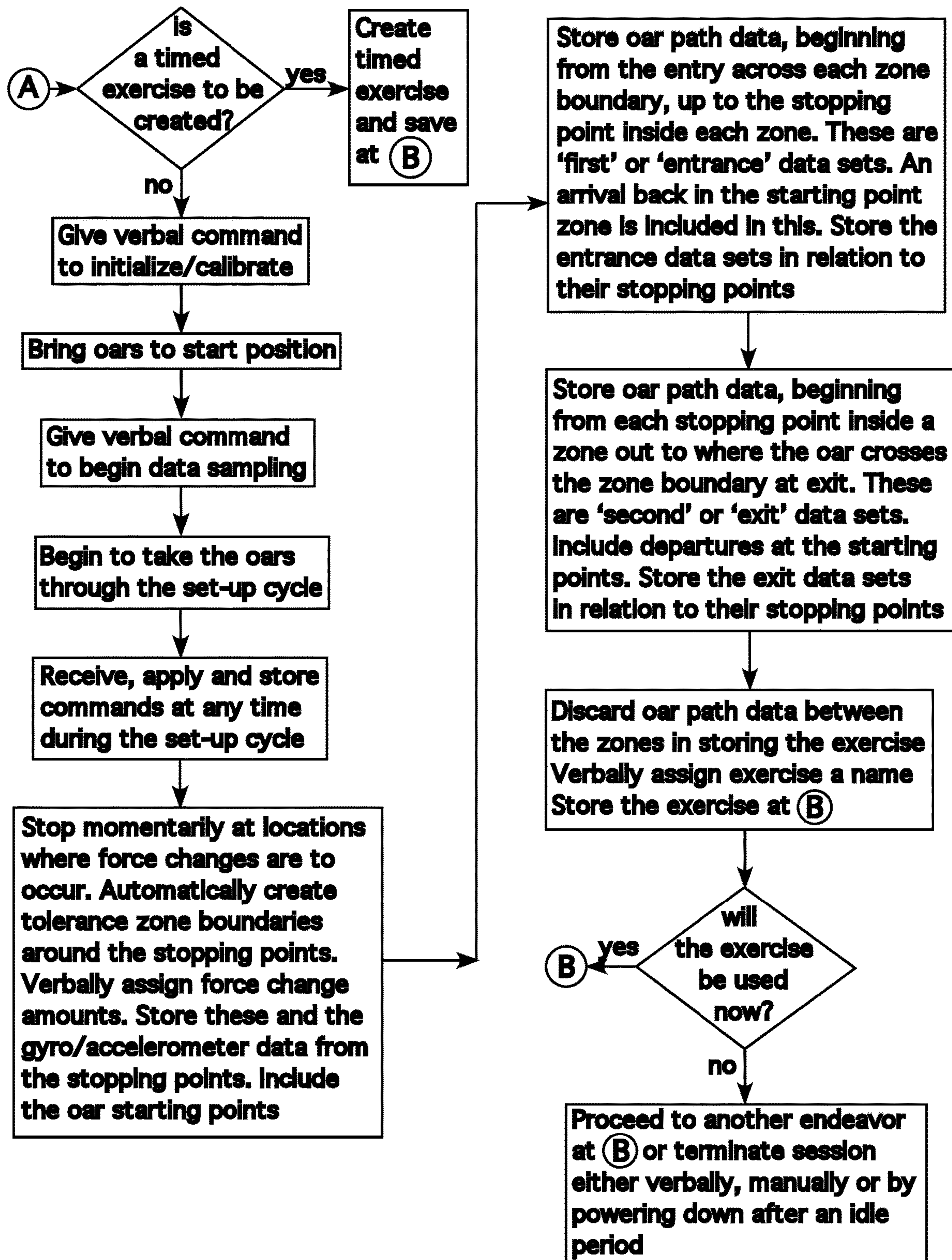
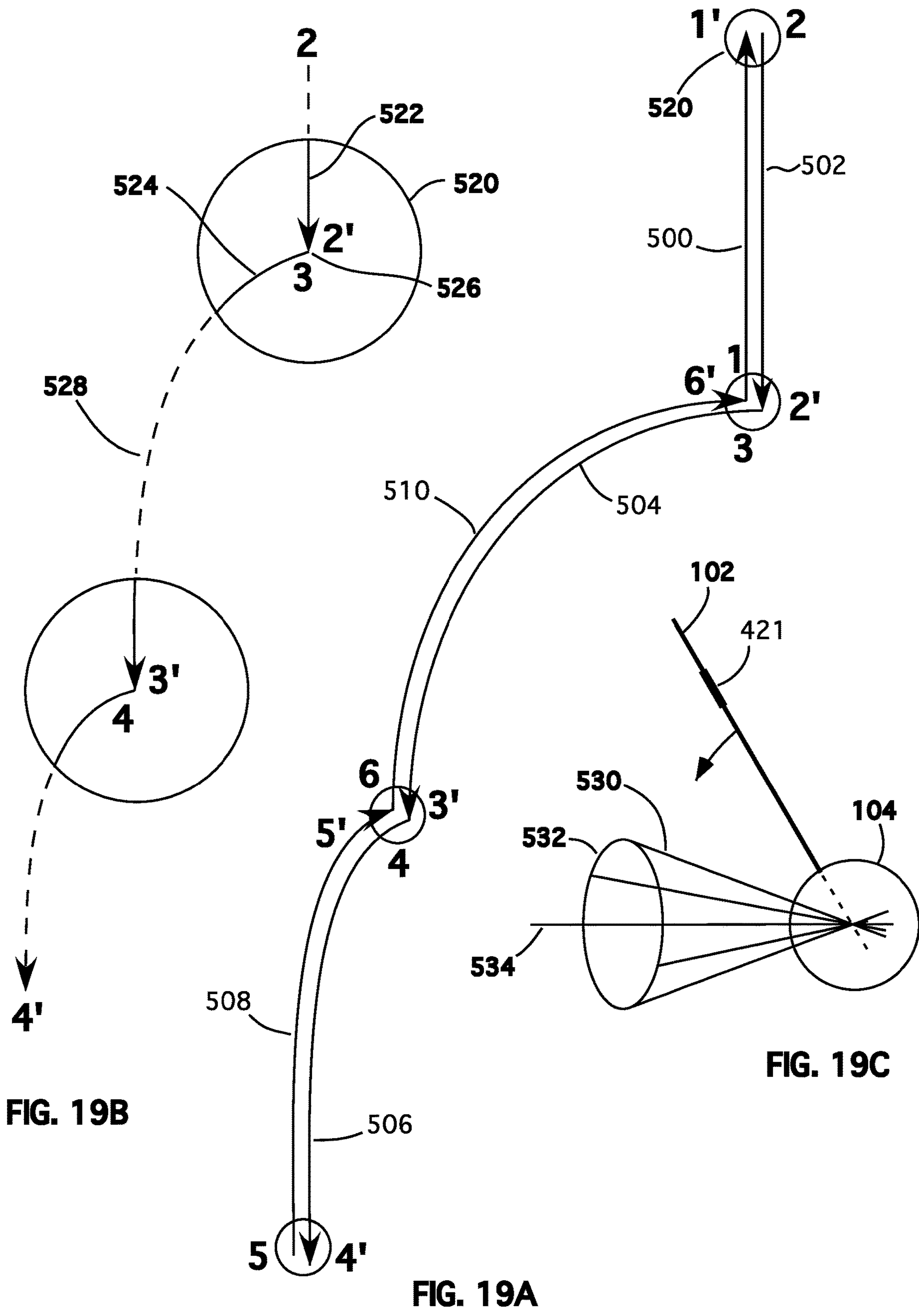


FIG. 18



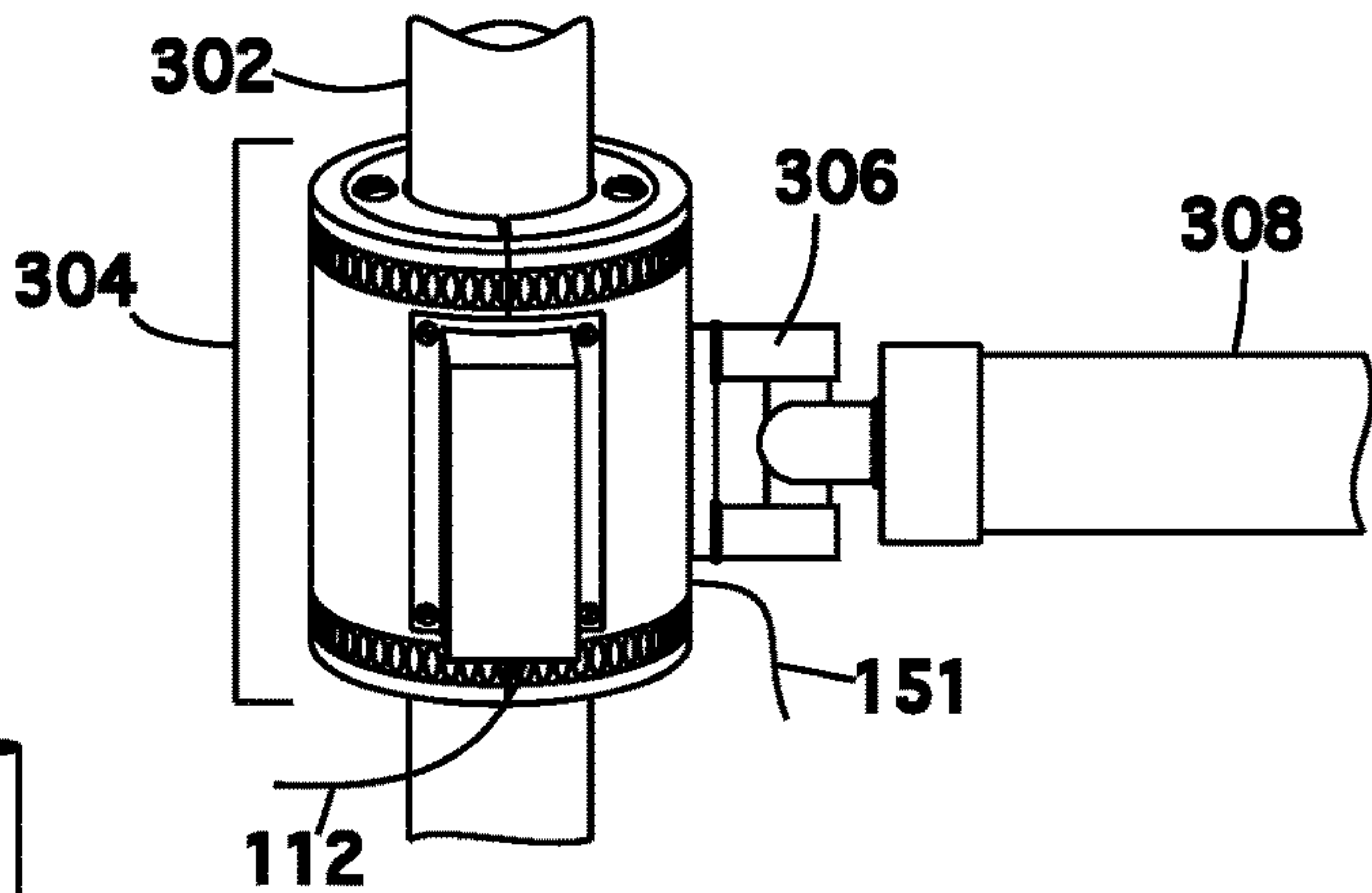


FIG. 20B

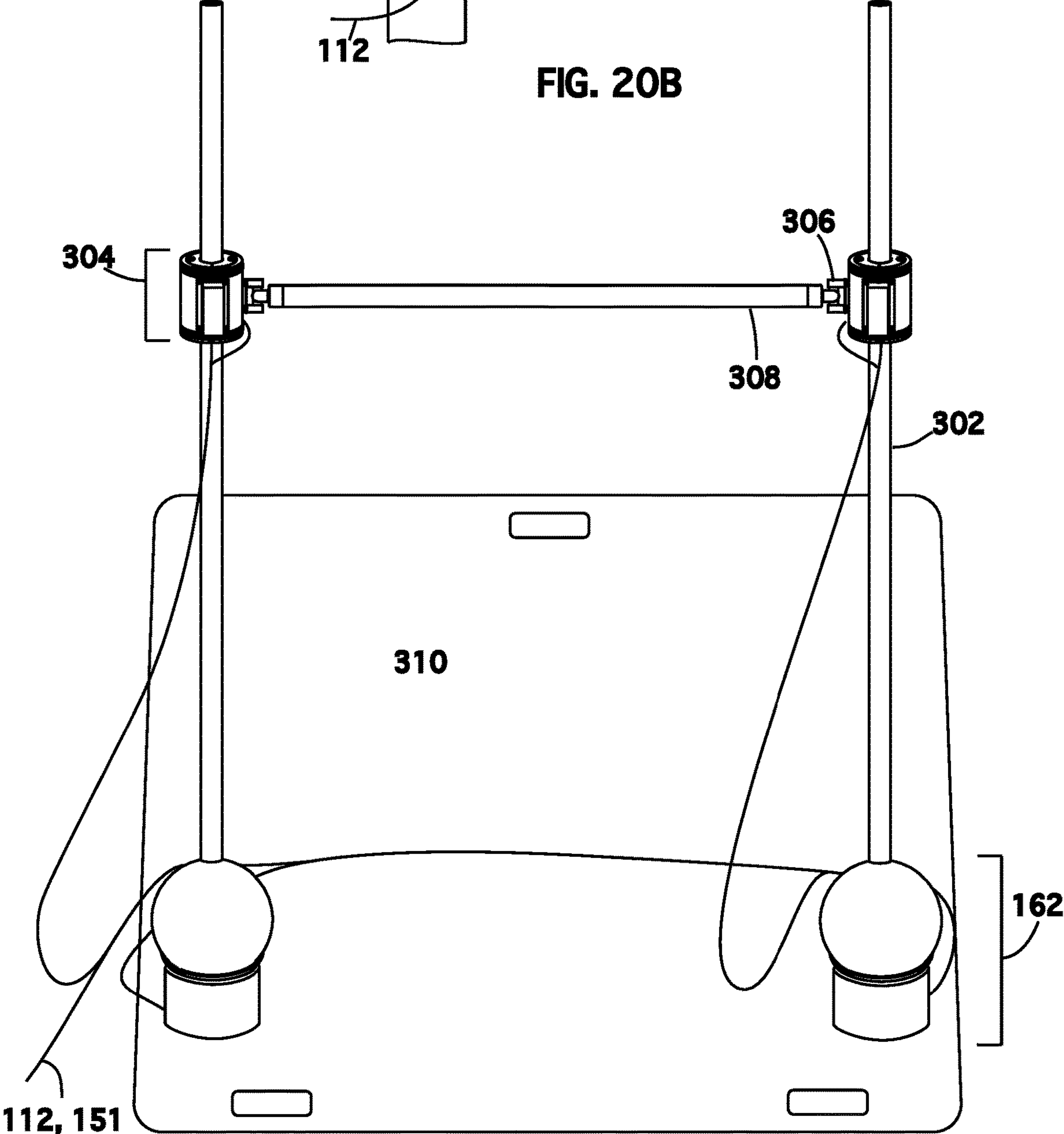


FIG. 20A

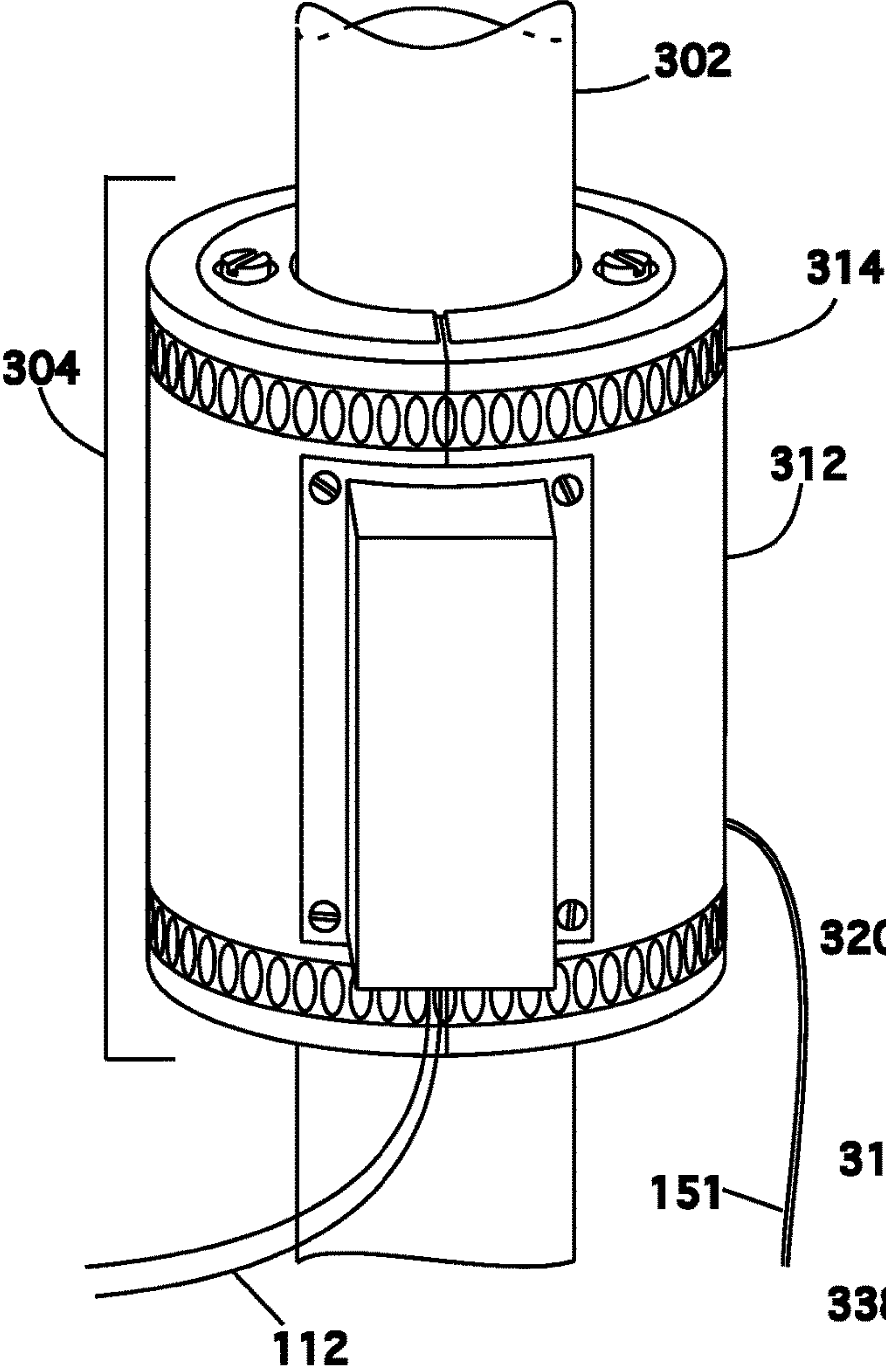


**FIG. 21A**

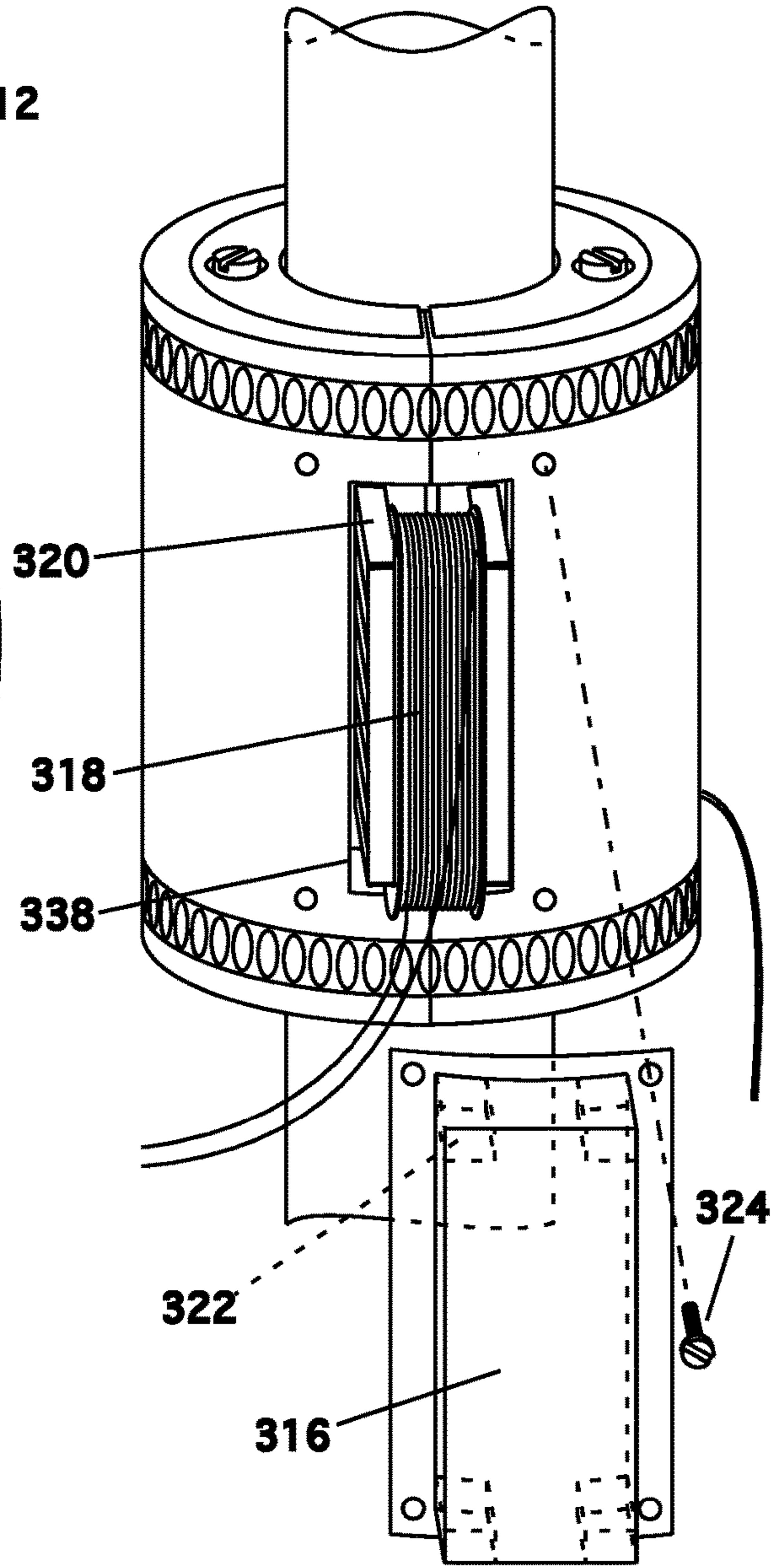


**FIG. 21B**



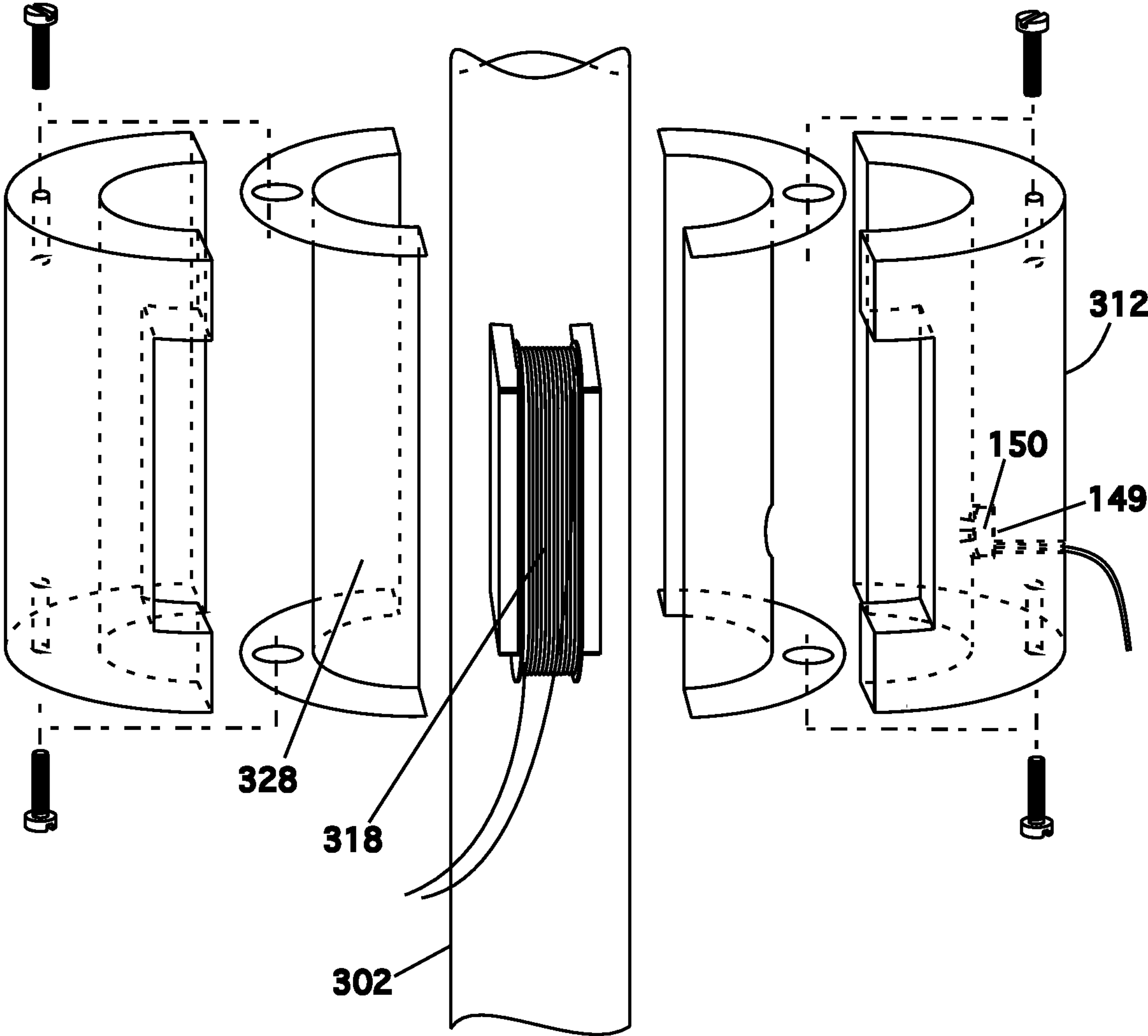


**FIG. 23**

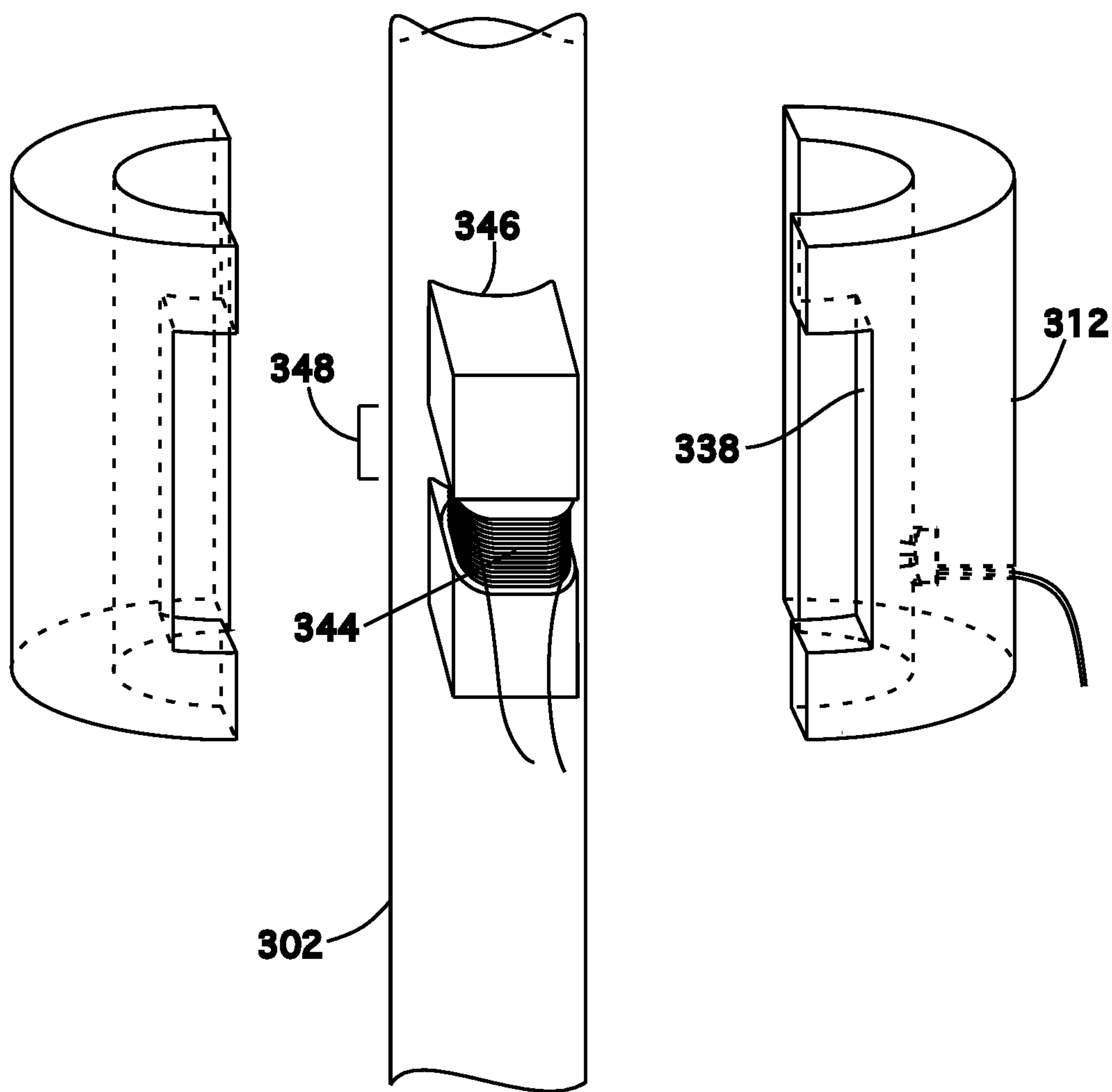


FIG. 24

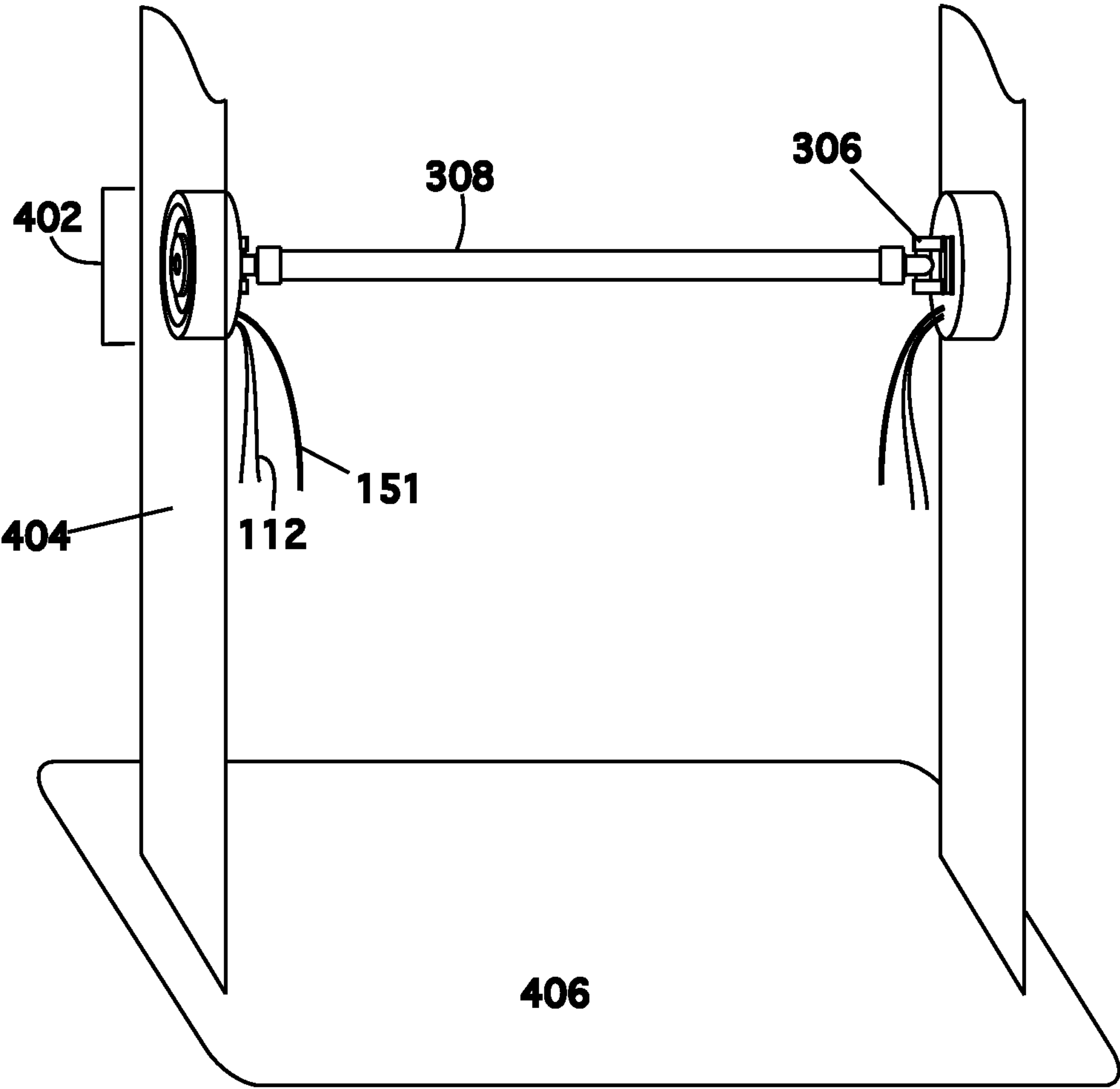


**FIG. 25**

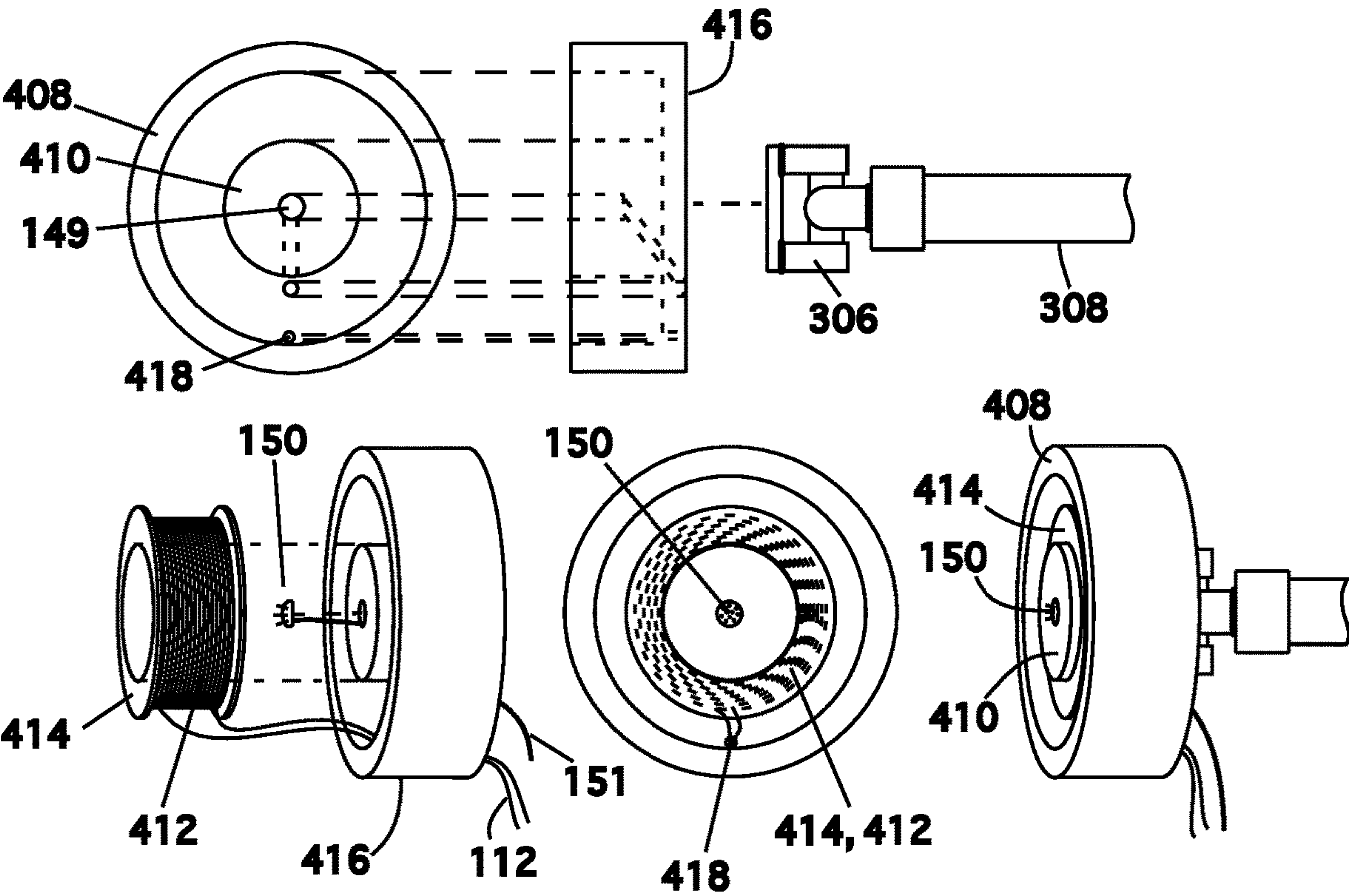


FIG. 26B

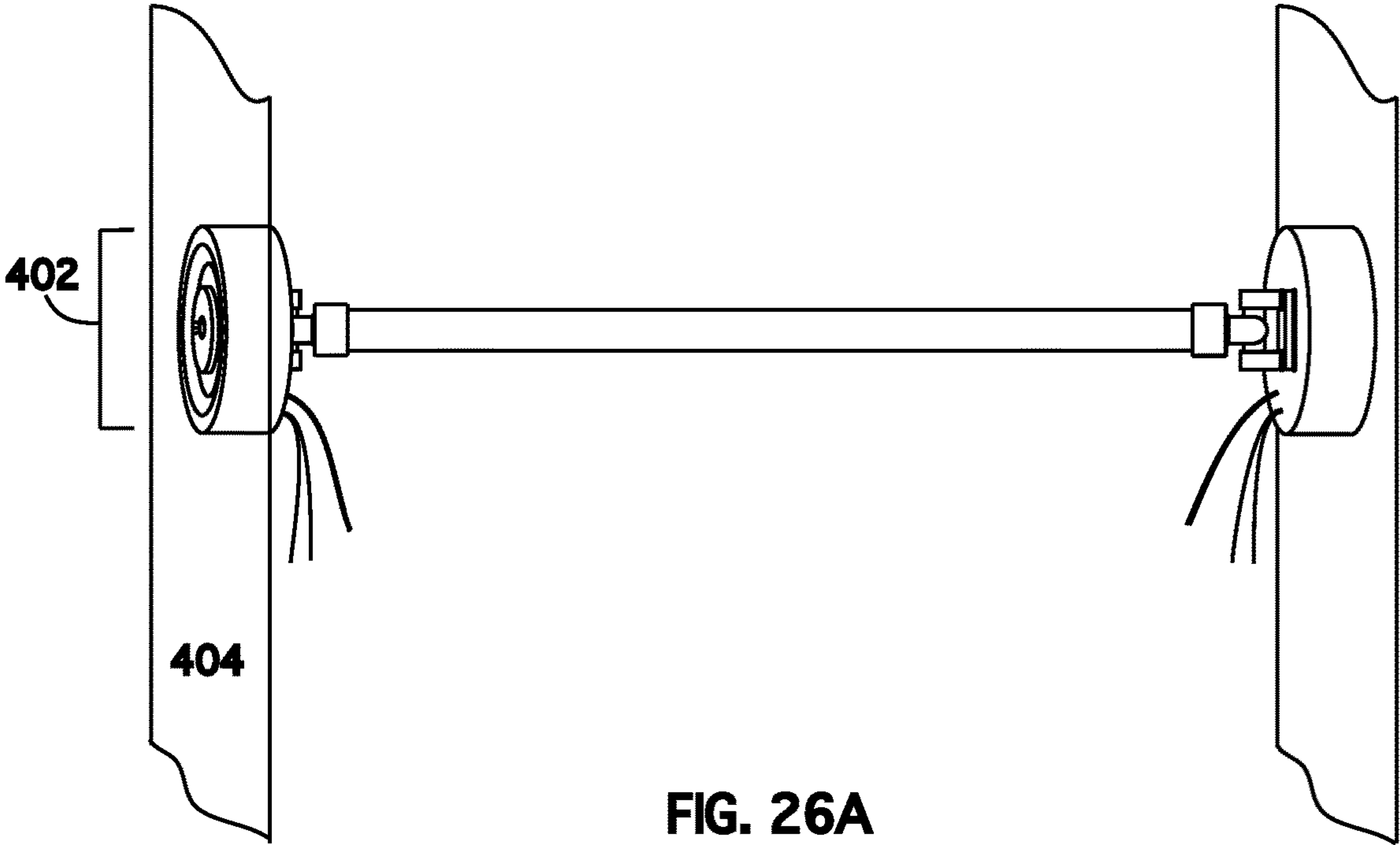


FIG. 26A

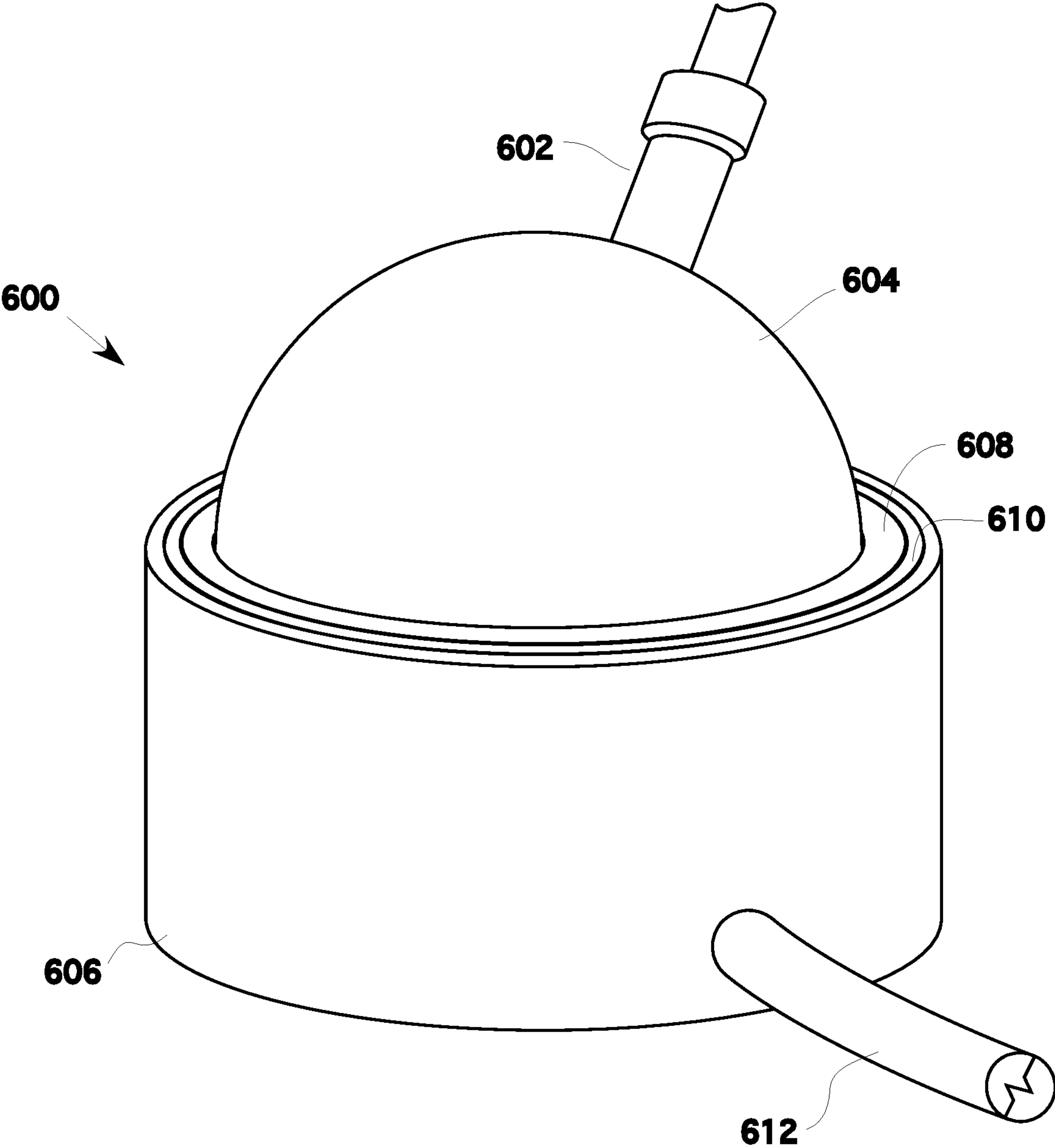


FIG. 27

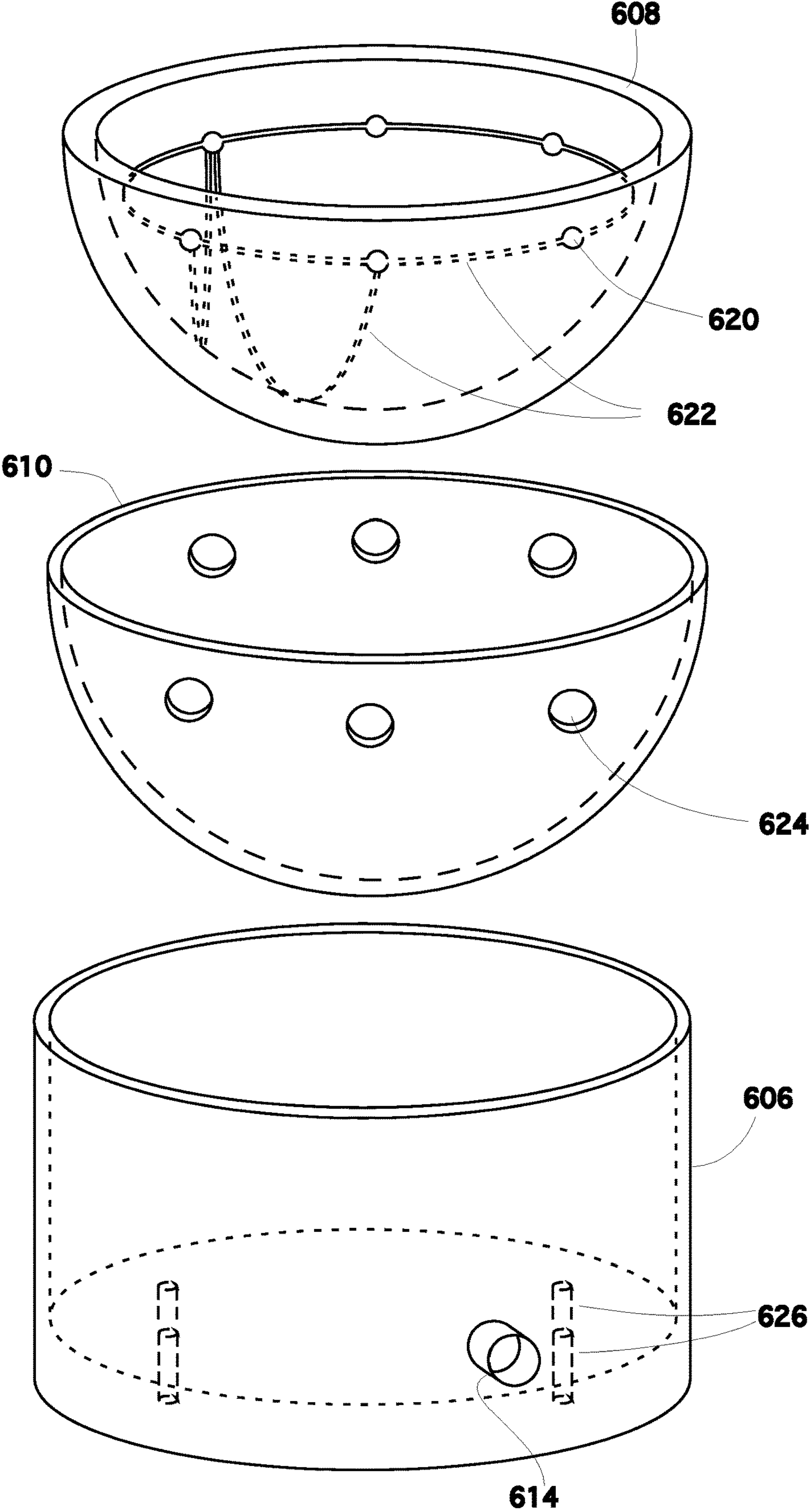


FIG. 28

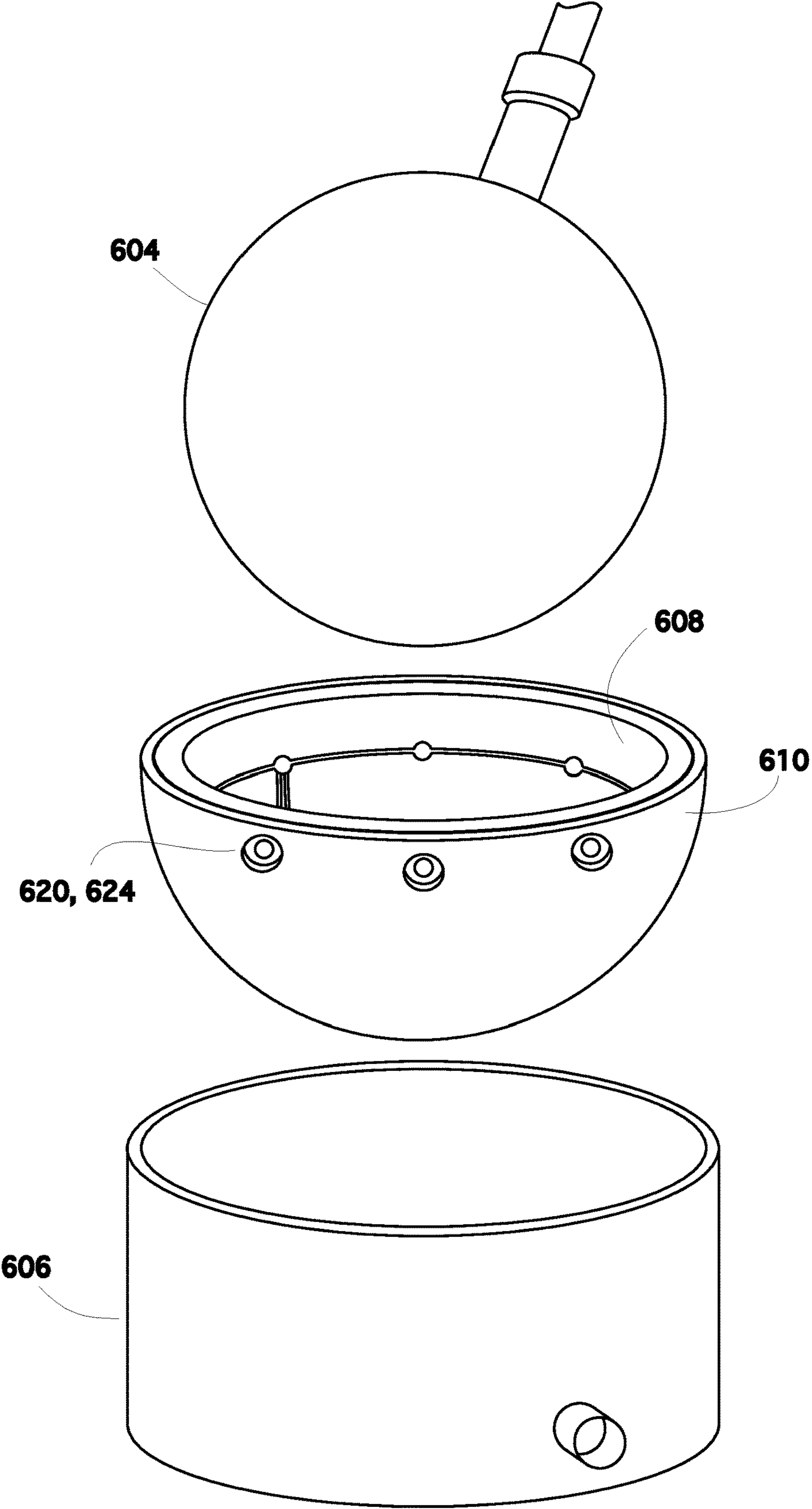


FIG. 29

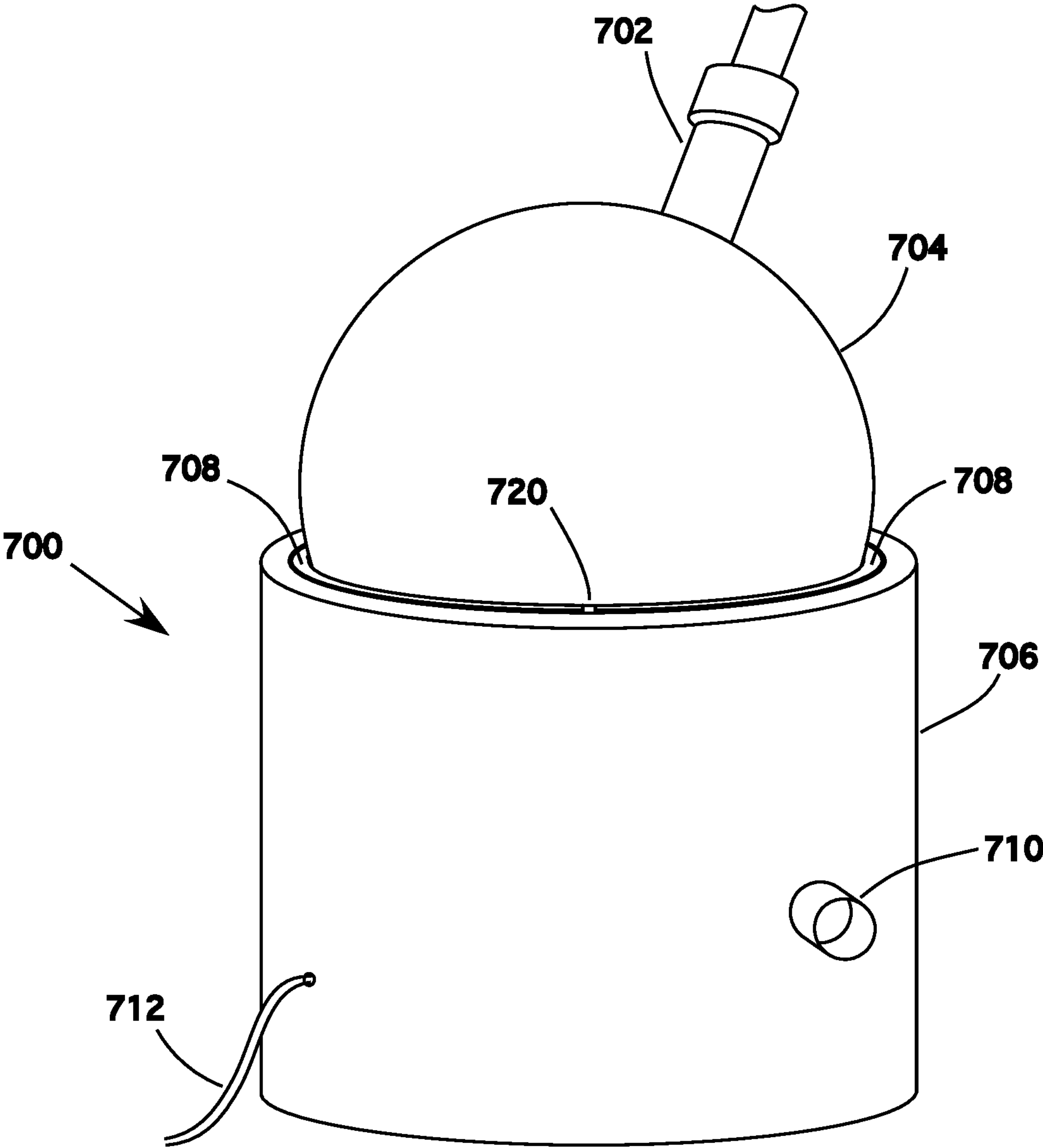


FIG. 30

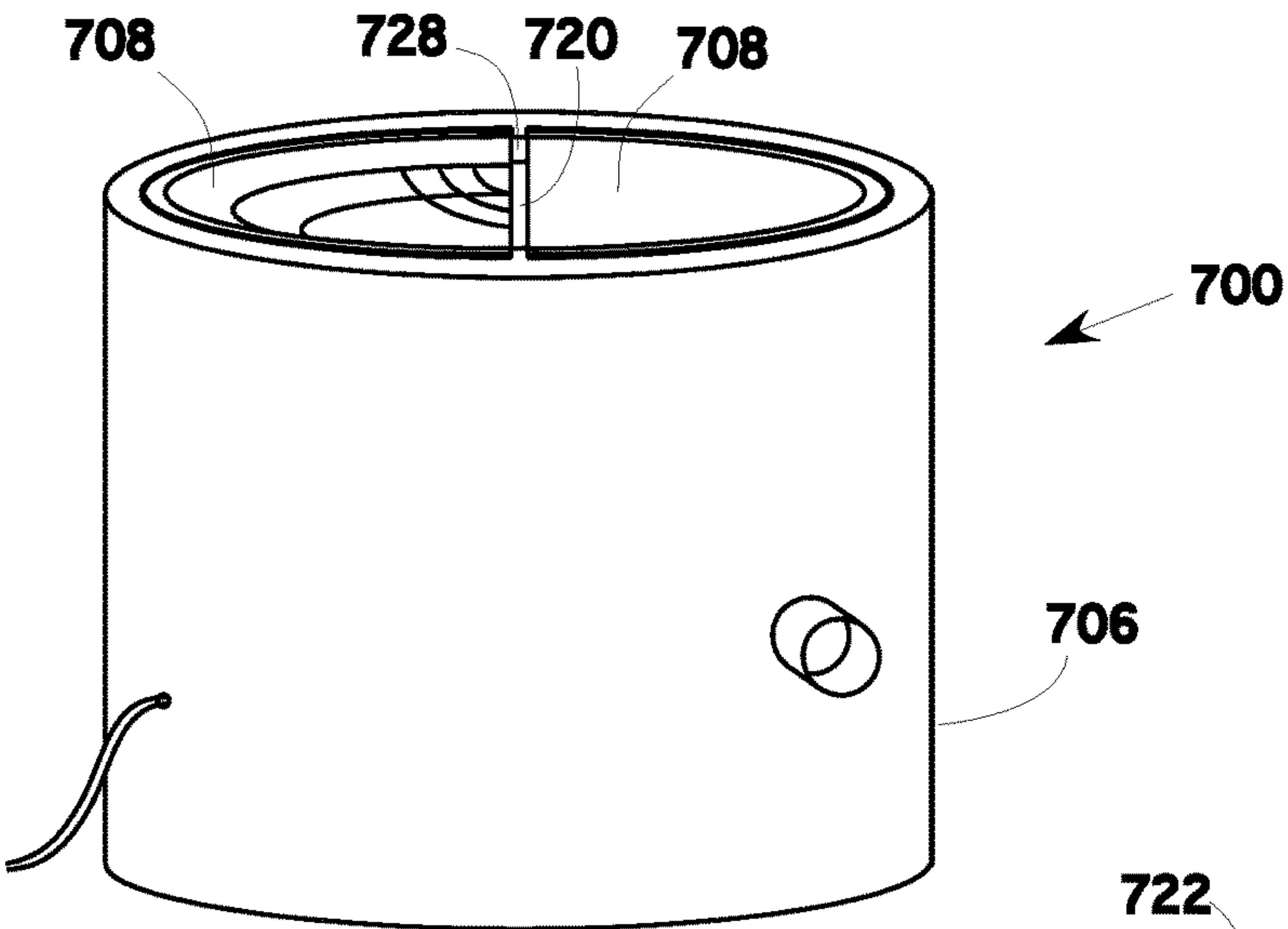


FIG. 31B

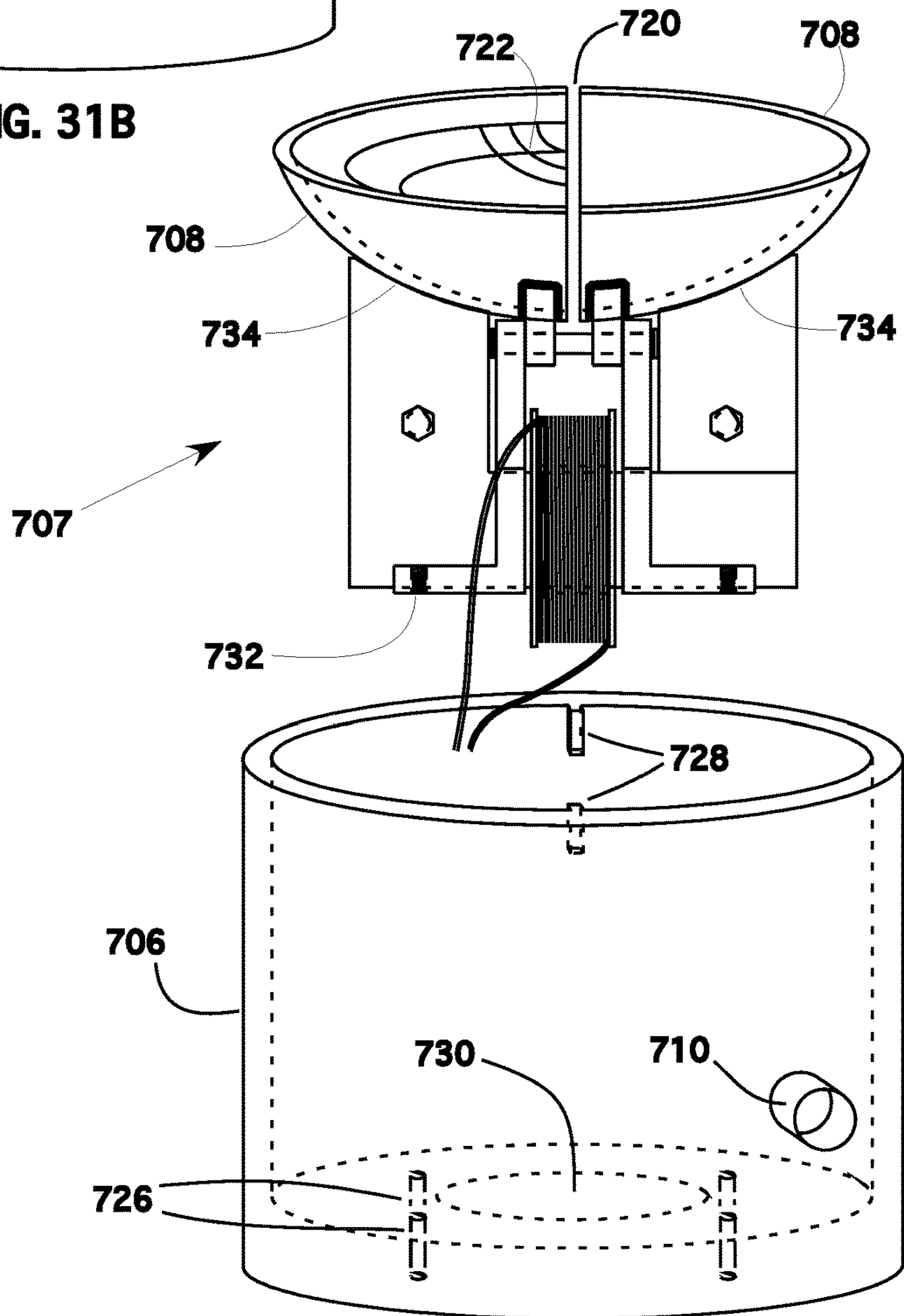


FIG. 31A

**OAR-BUFF: A FULL BODY EXERCISE  
SYSTEM THAT PRODUCES GREATER  
BENEFITS THAN WEIGHTS OR GYM  
MACHINES AND DOESN'T USE  
DANGEROUS POTENTIAL OR KINETIC  
ENERGY**

**BACKGROUND OF THE INVENTION—PRIOR  
ART**

[0001] It has always been that strength training brought advantages to physical competition, both in strength and stamina. It is known that exercising in complementary fashion, stressing opposing muscle groups in succession, yields great benefit.

[0002] Within a person's home there may be various kinds of equipment to accomplish desired ends. Within a gymnasium there certainly are.

[0003] To perform exercise there are heavy ropes that are waved, elastic bands and sets of springs with hand grips, free weights such as barbells and dumbbells and kettle bells. There are treadmills and bikes and exercise machines that utilize elliptical foot movement. Some store rotational kinetic energy in a flywheel and some have handles to be moved in planar fashion for upper body exercise. There are stair steppers, body weight incline machines, and also large systems that use multiple weights and pulleys or flexure elements such as springy bows, and more. All of these strengthen, tone and provide greater stamina. And all have drawbacks.

[0004] (a) Serious injuries can occur. Free weights can slip out of grasp and be dropped on the feet or legs—or more seriously—on the head or across the throat. An attempted movement, such as a bench press, may not be able to be completed because of tiredness, and the weight bar may come down without sufficient control, causing great harm. Similarly, a barbell may come down uncontrollably during a standing press because of simple loss of balance, tiredness, even vertigo, causing severe injury.

[0005] Strains of muscles or ligaments are a common injury with weights. The rotator cup area of the shoulder is especially prone to strains, as are the knee and back areas. Especially when attempting more weight than can be properly handled, strains to these areas can easily occur.

[0006] Injuries aren't limited to the use of free weights. Treadmills are easy to stumble on and fall from. Their belts can slip, causing a loss of balance or a wrenching of the back. Sadly, it has happened that people have fallen on the tread, brought to the rear and wedged against furniture, and if not able to get up or off, receive a severe friction burn.

[0007] While standing in an exercise machine of the circular or elliptical type it is possible to turn or jam an ankle or knee, even to fall off of the machine while it is in motion. At least one popular exercise system uses a set of elongated springy elements anchored at one end to provide resistance to movement. The spring arrangement stores kinetic energy from the user that could be returned at the user in a direct line very rapidly and possibly with devastating results if grip were to be lost.

[0008] (b) Convenience is an issue. A good set of free weights can amount to several hundred pounds of plates and bars. Changing the plates often during an exercise routine can be laborious and time consuming. And if weight plates and bars are permanently dedicated for individual exercise resistance, several of these set-ups are needed for a complete

workout. The necessary amount of such equipment can be extensive. And all of that weighs a lot, is difficult to relocate, and requires quite a bit of floor space for usage and storage. A further inconvenience with free weights involves the common sense fact that safety dictates that a spotter—another person, or even two—be used when attempting some movements.

[0009] The machines and systems, such as treadmills and circular and elliptical cyclers, are substantially stationary on the floor, often difficult to move because of their large bulk and great weight. And the “universal” systems for exercising the whole body can be very difficult for one person, even two, to relocate within a room. These systems can all have transportation costs involved at purchase, and should they be moved a distance after being installed, additional costs of dismantling and reassembly can occur.

[0010] With most of these systems only one person at a time is able to use them. For instance it is impossible for two people to use an elliptical cycler at one time, and as a practical matter a treadmill. And the required floor space and the portion of room volume taken up by these permanently stationed systems can be significant.

[0011] (c) Cost is an issue. Many exercise systems cost more than a thousand dollars, into the multiple thousands of dollars. The author is aware of one in-home system retailing for fourteen thousand dollars.

[0012] (d) Lack of versatility is an issue. Generally popular machines, such as circular and elliptical cyclers and treadmills, are dedicated to exercising the muscles of specific parts of the lower body. They don't exercise muscle groups outside of their narrowly dedicated purview.

[0013] To improve versatility and help maintain user balance manufacturers have added an upper body device: poles to be gripped by the hands, that move forward and backward while the machine is powered by the lower body. These poles don't help to build much strength, since they are little more than moving resting places for the arms. Most are limited to a planar direction of movement. These systems don't go beyond the benefits of aerobics.

[0014] Free weights and “plate loaded” universal systems offer perhaps the greatest ability to build strength and muscle. But in the main they don't provide overall aerobic development. In their ability to produce muscle they are generally limited to motion in a plane, and many plate loaded machines are devoted to exercising one muscle group only. Of course dumbbells can easily be moved outside of a plane while being used if they are light enough for the user, but they must be used carefully in doing so, even at lighter weights. It isn't difficult to strain or tear something while using dumbbells in an extra-planar movement, or even to hit oneself with them.

[0015] Among other types there are abdomen developing equipment that utilize mid-body lateral twisting, and equipment for doing partial sit-ups, or “crunchier”. These are quite popular and not very expensive. They too are limited to the bounds of their dedication, specifically targeting the torso. Rowing machines develop some of the back, shoulder, arm and chest areas and can be used to partially develop the legs. An inclined sliding apparatus, using body weight as the resistive force, is relatively simple and inexpensive, yet doesn't develop the body as completely as free weights. Equipment types that utilize one or more pneumatic cylinders exist. These are most often limited to offering resistance

along a straight line or even an arc held to within a plane. And typically each exercise machine is dedicated to one type of movement.

**[0016]** (e) A further drawback is experienced with equipment which utilizes cables attached to anchored, cantilevered springs, or to weights. The problem is that in performing extension kinds of movements, such as bench presses or military presses, or even curls, the arms can shake in overcoming the resistance. This is because the connecting cables allow the hand grips to move laterally very easily at right angles to the resistive force, and the muscles naturally try to correct, but in actuality they continuously over-correct in each direction. The shakiness, which can be annoying to the user, can with difficulty be brought under control in order to provide a relatively smooth extension through a movement.

**[0017]** (f) Complementary movements create faster results, both in muscle building, body toning and stamina enhancement. Free weights and plate loaded systems don't work the full body in complementary fashion, and neither does anything else. In general they offer resistance only along a line of action or else along a planar arc, even a circle or ellipse. These don't allow for a complete stressing of the muscles in more than one resistance orientation when doing a series of movements. In order to ideally work muscle groups in complementary fashion a user's energy input to the equipment should alternate between at least two opposed directions in sequence, for instance a push and then a pull.

**[0018]** (g) None of the above systems can work the muscles in rapid circuit fashion with an instantaneous and almost infinite variety of different movements that are user defined and that offer variable, controllable resistance along any chosen path of movement, including true three-dimensional orientations of applied resistance.

#### PRIOR ART

**[0019]** [PA01] The following patents and applications, listed in paragraphs [PA02 through PA23], are given as Prior Art:

**[0020]** [PA02] U.S. Pat. No. 3,802,701 to Good (April 1974) concerns a shaft permanently oriented vertically the way an ice augur is used. It is mechanically held in a base and can be rotated only horizontally, using handles that are at a right angle to the shaft. It is an upper body device only that operates in one horizontal plane at a time and is adjusted for resistance manually.

**[0021]** [PA03] U.S. Pat. No. 8,936,538 to Marcantonio (January 2015): The two arms of the device are restricted by the changeable orientation of their pivots to rotation within two sagittal or else two intersecting vertical planes. Though an additional movement of the handles along the lengthwise axes of the arms, with the handles under bi-directional tension, is also a feature, this motion results in a radial displacement within the two planes mentioned, and does not aid in bringing about movement beyond the restriction of those two planes. The device can therefore be thought of as longitudinal-planar. Resistance is manually adjusted only. The Marcantonio device does not exercise the legs, whereas the present device does.

**[0022]** [PA04] U.S. Pat. No. 8,777,817 to Finestein (July 2014) uses pneumatic cylinders and is restricted to rotation in two predetermined sagittal planes and also provides longitudinal motion within those planes along the major axes of telescoping arms secured to a frame, similar to the

Marcantonio patent above. The device does offer exercise for the legs, restricted to the two sagittal planes.

**[0023]** [PA05] U.S. Pat. No. 5,803,874 to Wilkinson (September 1998) offers exercise by mounting two arms at the sides of a treadmill. The arms are limited to rotation within two sagittal planes. Their resistances are manually adjusted.

**[0024]** [PA06] U.S. Pat. No. 6,773,378 to Bastyr (August 2004) represents a portable bi-directional device that rotates ostensibly within any single plane, according to how the entire device is oriented in space. It is formed of two arms connected together at a pivot. The pivot restricts rotation to the plane of usage, but the device, if allowed to change spatial orientation under use, will describe movement in more than a plane. Its resistance is manually adjusted.

**[0025]** [PA07] U.S. Pat. No. 7,125,365 to Kreitzman (October 2006): The "Moving Stick" device described in this patent is limited in motion compared to the present device in that The Moving Stick is confined to describing a single planar path, so is not a three-dimensional device. This is because the cylindrical pin, the Stick's rotation pivot which passes through the Stick's lower region, is permanently attached to a stationary wall(s). And too, the resistances claimed are those of either a flux from a permanent magnet brake, pneumatic cylinders or of friction originating through mechanical means. They are neither a friction caused by surface-to-surface contact through magnetic or vacuum attraction, as with the present device, nor are the resistances either instantly or automatically adjustable as with the present device.

**[0026]** [PA08] Application 20070184941 of Krietzman (August 2007) claims a "weighted sphere" or a "volumetric element" able to be slid along a vertically oriented "stick", producing resistance. The stick is terminated at its lower end in a "rockable support" (such as a ball-like structure) that is laid into a "rocking guide" (a socket). The slidable weighted sphere or a volumetric element provide adjustable inertial resistance to movement of the stick which can describe an inverted cone as it is being moved. The present embodiments do not utilize an inertial element along a stick-like structure to produce resistance.

**[0027]** [PA09] U.S. Pat. No. 9,011,301 to Balandis (April 2015) allows for the utilization of various central shaft rotation devices in generating resistive force to a user: pneumatic disk being the primary, but particle brake, electric clutch, etc. are mentioned. These devices all produce a force contrary to the user's attempted rotational movement, so that the Balandis device's two parallel arms running from the central shaft mentioned above to a bar that is the user's physical interface, describe parallel circular planar segments when rotated. Therefore as far as concern the user's hands, this is a planar device.

**[0028]** [PA10] Voice control is discussed but not claimed in the Balandis patent. Voice control is specifically claimed and described in detail in the present device's patent application, in addition to gyroscopes and accelerometers.

**[0029]** [PA11] U.S. Pat. No. 8,066,621 to Carlson (November 2011) is a large device that uses sliding elements that follow arcuate tracks. The tracks resemble semi-hoops that are pivoted at their two ends at a base so that they could be oriented from the straight up vertical plane to the laid down horizontal. The user pushes or pulls the sliding element along the track typically in a two dimensional motion, but ostensibly, if the arcuate track were light enough and would be allowed to rotate freely, the user could describe a three

dimensional path in moving the slider. The freedom of movement in three-dimensional space however, doesn't equal that of the present device, so that some exercises comparable to the use of free weights are impossible with the Carlson device, yet those exercises are highly duplicable with the device of the present invention.

**[0030]** [PA12] U.S. Pat. No. 4,249,727 to Dehan (February 1981) involves a ball at the bottom end of a shaft mechanically held in place in a base by being friction-clamped around its horizontal equator. The mechanical clamping arrangement, necessarily gripping from both above and below the ball's horizontal equator, limits the amount of shaft rotation to approximately 120 degrees in any vertical plane when an assumed shaft thickness is factored in. Contrastingly, the sphere of the present invention, being pulled by magnetism (or vacuum) toward its mated curvature base, only needs to be in contact with its base from one direction, that is, only from below the equator for instance. The present device's moderate amount of magnet-to-sphere contact, all below the horizontal equator, allows the oar (shaft) to be rotated at least 240 degrees through any user-arbitrary vertical plane, in combination with a full 360 degree horizontal sweep, so that it is truly 3-dimensional. Resistance with Dehan's device is manually adjusted.

**[0031]** [PA13] U.S. Pat. No. 5,330,407 to Skinner (July 1994) describes several embodiments that use elastomeric spheres as though ball bearings. In one a larger hard sphere is resting on smaller spheres in a base, with the larger sphere clamped on both sides of its horizontal equator by structures, at least one of which has smaller elastomeric spheres installed to be in contact with the larger sphere. A bar attached to the larger sphere transmits the user's urging to that clamped larger sphere. Clamping pressure is manually adjusted to vary the resistance.

**[0032]** [PA14] U.S. Pat. No. 7,559,881 to Roraff (July 2009): This device, with its installed springs, is not easily adjustable as to resistance. Its springs automatically cause the return of the shaft to the vertical and do not allow for the user to apply a positive force to restore the shaft to its vertical rest position. Therefore muscles are not exercised in complementary fashion as with the present device. And the springs could, if powerful enough, cause injury by returning kinetic energy should the shaft not be kept under control by the user. The Roraff device shares a lack of travel with the Dehan device (U.S. Pat. No. 4,249,727) because of the need to grip the rotatable friction-producing ball on both sides of a horizontal equator.

**[0033]** [PA15] U.S. Pat. No. 9,011,291 to Birrell (April 2015) is an assemblage of belts, pulleys, shafts, rotating disks, arms, linkages and a resistance provider, enabling a user to move the device's interfaces in three-dimensional mode in order to graphically follow the outline of or "fill in" one or more visual tracings, ostensibly provided on a monitor screen.

**[0034]** [PA16] In U.S. Pat. No. 10,039,682 (Aug. 7, 2018); U.S. Pat. No. 8,915,871 (Dec. 23, 2014) U.S. Pat. No. 8,753,296 (Jun. 17, 2014) and U.S. Pat. No. 8,545,420 (Oct. 1, 2013) issued to Einav et al, a braking force applied to a ball can be provided in several ways: By a ring, either solid or inflatable, that encircles the ball near its equator, with the ring being brought into contact with the ball at selectable distances from the ball's equator to cause a corresponding clamping friction; By the ring being made of 'shape memory

alloys' that undergo heating or cooling, thus clamping expansion or de-clamping contraction; An orthogonally oriented braking substance that is 'pressed onto the surface' of the ball.

**[0035]** These patents involve expensive medical devices, composed of pluralities of motors, drive wheels, gears, belts, brakes, sensors and various other components. In the main the devices are robots, "capable of applying a motive force" to a patient. They are also able to be controlled predeterminedly or by real time input from remote personnel, so caution is to be used that a device doesn't force a patient into movement that the patient dangerously resists or isn't medically ready to enter.

**[0036]** The present author's embodiments, being passive, cannot apply a motive force against a user to move a body part as can the Einav devices. Since the present embodiments don't have the potential of being pro-active, they will not urge a user to enter or remain in a movement that the user does not intend, therefore cannot of themselves bring on that type of injury.

**[0037]** [PA17] Application 20180272185 by Barber, published on Sep. 27, 2018, concerns a hand—wrist—forearm therapeutic device that resembles a motorcycle's handlebar system. Two sockets are oppositely oriented and co-linear at the center of the system. The sockets each receive a ball that will rotate under the user's urging. Rotatable lever and cable assemblies, attached to springs, and resembling motorcycle handbrakes, are attached to handles that each have an attached ball that mates to one of the two receiving sockets. Use of the levers will temporarily bring the clamping pressure against the balls inside the sockets toward zero. Mechanical adjustment by hand is provided to vary the continuous clamping pressure within each socket upon its inserted ball. Either each manual adjustment mechanism encroaches upon its respective ball, or causes its socket to deform, thus varying the continuous resistance felt by the user.

**[0038]** [PA18] Application 20180214740 of Aug. 2, 2018, by Horen, is of a therapeutic device that utilizes adjustable mechanical means to impart friction to ball and socket arrangements by way of causing the sockets to compress about the balls.

**[0039]** [PA19] Application 20110287907 of May 17, 2010, and its corresponding U.S. Pat. No. 8,636,630, issued to Morris, use mechanical means to provide clamping pressure about the equator of a ball.

**[0040]** [PA20] Application 20110251032 of Oct. 13, 2011 and its resultant U.S. Pat. No. 8,986,175 issued to Batiste et al use a manually adjusted friction pad to produce friction upon the inner wall of a spherical socket that holds a ball.

**[0041]** [PA21] Published application 20110028286 of Feb. 3, 2011 and the resultant U.S. Pat. No. 8,079,941 issued to Nortje, depict a purely mechanical device, a ball held between two annular rings in parallel, one on either side of the ball's equator. The rings are adjustable as to their separation, allowing a stronger or looser grip upon the ball as desired.

**[0042]** [PA22] Application 20170128765 by Garretson et al, published on May 11, 2017, concerns a barbell system that uses a gyroscope/accelerometer, together with other sensing elements, in interface with a computer, for logging the barbell's motion.

**[0043]** [PA23] Other patents, starting from 1925, utilize mechanically clamped spherical or cylindrical member(s)

caused to rotate when an attached elongate member is urged by the user in exercise. These are as follows:

**[0044]** U.S. Pat. No. 1,535,391 to Anderson, April 1925: “Exerciser”, uses a clamped sphere

**[0045]** U.S. Pat. No. 2,126,443 to Begley, August 1938: “Exercise Device”, a clamped sphere

**[0046]** U.S. Pat. No. 2,817,524 to Sadler, December 1957: “Orthopaedic Exercising Device”, is a clamped sphere

**[0047]** U.S. Pat. No. 3,428,311 to Mitchell, February 1969: “Resistance Exerciser For Wrists, Arms and Upper Body”, is a clamped sphere

**[0048]** U.S. Pat. No. 3,782,721 to Passera, January 1974: “Physical Training Device”, uses clamped spheres

**[0049]** U.S. Pat. No. 4,208,047 to Olsen, June 1980: “Exerciser and tension relieving device”, uses clamped circular planes

**[0050]** U.S. Pat. No. 4,344,615 to Carlson, August 1982: “Controlled friction exercising device”, is a clamped cylinder

#### BACKGROUND OF THE INVENTION—OBJECTS AND ADVANTAGES

**[0051]** Accordingly, the embodiments herein claimed and described overcome the above objections, surpassing the prior art.

**[0052]** (a) The present embodiments provide a safe exercise experience. Since a user’s energy input is very minimally stored as potential energy, and zero kinetic energy, the embodiments can’t return dangerous energy back into the user’s environment. Injury from energy being accidentally released back to the user, such as can happen with weights or springs, is prevented from occurring.

**[0053]** Additionally, the use of the present embodiments can actually cause a user’s balance to be maintained while exercising. Injuries from loss of balance, especially while standing, can therefore be prevented. And falling from or stumbling upon the present embodiments while in use is virtually eliminated.

**[0054]** (b) The present embodiments provide convenience of usage. The embodiments don’t require a spotter or partner to be used, at even maximum resistance levels. It is even possible for two people to use the first of the present embodiments simultaneously and receive complete workouts that exercise all of the muscle groups in complementary fashion.

**[0055]** (c) The present embodiments provide convenience of transport. The present embodiments, involving only a few components, of rather light weight, are easy to move around a house or workout area. Further, several of the present embodiments can be loaded into and unloaded from a car and brought into a home by one person. This makes those embodiments ideal to be demonstrated in the homes of others, thus allowing a party plan or multi-level type of marketing.

**[0056]** (d) The present embodiments provide convenience of set-up and storage. The system’s lightness and modularity give aid to its being put together quickly and easily, likewise its teardown. Its ease of storage upon teardown is enhanced by the compactness of design of its individual components. This in turn allows a temporary exercise area of the home or office to be easily returned to its normal use, that of a living or office space, by either tearing the system down and storing it out of sight, or by simply moving it to a less prominent location upon use.

**[0057]** (e) The present embodiments provide a non-complex, non-massive structure, affording a purchaser a lower cost than that provided by the other types of systems that are considered full-body, complete workout systems.

**[0058]** (f) The present embodiments provide a greater number and variety of exercise movements than any other system, including dumb bells. Almost every muscle group of the human body that is exercisable can easily be caused to benefit with the present embodiments. All movement is highly controllable as to resistance offered at every point throughout each repetition’s user-defined pathway. Resistances are both speed controllable and time controllable. And all movements can be undertaken in complementary fashion, enabling the continuous exercising of opposing muscle groups. Individual exercise movements can be strung together to form a workout in all three dimensions, bringing great development advantage compared to much more costly and complicated full-body exercise systems. As a package of features this is not possible with any other system.

**[0059]** (g) The present embodiments provide a comfortable exercise experience, free of the shakiness inherent with certain kinds of cable systems. Since it doesn’t exist, there is no need for the user to attempt to control such shakiness.

**[0060]** (h) The present embodiments provide a very complete full-body workout quickly. Exercises can be strung together in very great variety and type, to be performed in rapid circuit fashion, including “micro-bursting”. This ability allows an extensive aerobic experience, with heavy resistances if desired.

**[0061]** (i) The present embodiments provide the opportunity to form the basis of a revolution within the exercise equipment manufacturing and marketing industry, and further, within the fitness club industry. These embodiments are of such radical departure and improvement over prior art that fitness, both in-home or through a club system, will be greatly facilitated. Many people will be added to the numbers of fitness buffs as a result of the implementation of these embodiments.

#### SUMMARY

**[0062]** Each of the several embodiments has at least one element involved in the production of and at least one element acted upon by a mutually attractive force that is either ferromagnetism, vacuum or static electricity. Hybrid combinations of these forces and the elements necessary to undergo mutual attraction are also contemplated. The at least two elements are held in tight contact by at least one of the forces mentioned in order to cause friction between the contact surfaces of the elements when an attempt is made to slide those surfaces in relation to each other. Static electric attraction between elements in contact is considered for the purposes of this specification to be synonymous with the attraction caused by ferromagnetism and vacuum.

**[0063]** The user physically transmits force to at least one of the elements in frictional contact to cause a sliding displacement to occur, thus introducing resistance to movement that the user overcomes. Three sets of contact surface portions are presented in the Detailed Description and are claimed: Convex spherical—to—Concave spherical; Convex cylindrical—to—Concave cylindrical; Planar—to—planar. Other cross-sectional contours of contact surface

portions, not presented in the Detailed Description, are also claimed and are given in the Conclusion, Ramifications and Scope.

#### Advantages

[0064] Thus several advantages of one or more aspects of the embodiments are greater safety, greater convenience of use, less size and weight, car-to-home transportability, less cost in manufacture and purchase, greater versatility, no inducing of unsteadiness during exercise, and the ability to continuously engage muscle groups in complementary fashion. These and other advantages of one or more aspects will become apparent from a consideration of the ensuing description and accompanying drawings.

#### DRAWINGS—FIGURES

[0065] In the drawings closely related figures have the same number, but different alphabetic suffixes.

[0066] FIGS. 1A and 1B are external views of one of the embodiment's pair of electromagnet/sphere/oar combinations for producing frictional resistance.

[0067] FIGS. 2A and 2B are of electromagnet components that generate and transmit the magnetic field necessary to cause friction, and the components' container.

[0068] FIG. 3 is an isometric exploded view of the electromagnet, frame and shell halves of FIG. 2.

[0069] FIG. 4 is an isometric assembled view of the components shown in FIGS. 2 and 3.

[0070] FIG. 5 shows an oar with its gyro/accelerometer, attached to a sphere, with the gyro/accelerometer being along a line passing through the sphere's center of radius.

[0071] FIG. 6A is a view of the assembled first embodiment comprised of modular components: platform, locking swivel base, swing arms, tower assemblies, spherical electromagnet canister assemblies, oars with gyro/accelerometers and power control module w/cabling.

[0072] FIG. 6B shows FIG. 6A, but with the interconnecting cable between towers eliminated and an internal track system (not shown) used to distribute power to both canister assemblies.

[0073] FIGS. 7A, 7B and 7C show the platform and the locking swivel base which fits underneath it, with partial views of them before and after they are in contact.

[0074] FIGS. 8A and 8B show an assembled and also an exploded view of the locking swivel assembly.

[0075] FIGS. 9A and 9B depict a tower assembly connection to a swing arm.

[0076] FIGS. 10A, 10B and 10C are of a spherical canister assembly at two different heights on a tower assembly, and also the canister assembly's mounting and locking components.

[0077] FIGS. 11A, 11B, 11C, 12, 13A and 13B show some possible floor locations of the tower assemblies and their related swing arm positions and oar proximities and orientations.

[0078] FIG. 14 depicts a swing arm vice system affixed to a floor plate, with the vice system offset from the floor plate's longitudinal centerline.

[0079] FIGS. 15A, 15B and 15C show some usage of the offset vice system of FIG. 14 and the related oar proximities and efficiencies of floor space use.

[0080] FIG. 16 is a programing flowchart depicting sequences to take place within the power control module,

not including force change decisions at the tolerance zones, nor the creation of exercises to be stored.

[0081] FIG. 17 is a flowchart of the force change decision process occurring at the tolerance zones.

[0082] FIG. 18 is a flowchart of the process to create and store a particular exercise.

[0083] FIGS. 19A and 19B depict a hypothetical exercise series using tolerance zones. FIG. 19B illustrates two of the zones of FIG. 19A and oar movement in the forward direction through those zones.

[0084] FIG. 19C is a wireframe view of a typical zone showing the relationship between a zone's stationary wall vectors, set-up cycle stopping point and an oar's sweeping orientation vector approaching the zone.

[0085] FIGS. 20A and 20B are an overall view of the second embodiment and also an external view of one of its cylindrical magnetic canister assemblies and its proximal components, exclusive a control module.

[0086] FIGS. 21A and 21B are views of a cylindrical canister assembly mounted on a portion of an oar with a ferromagnetic surface, and also a view with the electromagnet's cover removed.

[0087] FIG. 22 is a partially exploded view of a cylindrical canister assembly, its gripper halves, and electromagnet positioned as though in use at a portion of the oar.

[0088] FIG. 23 is an exploded view of FIG. 22 that shows the gripper halves separated from the ferromagnetic oar, and with the electromagnet positioned as though in use.

[0089] FIG. 24 is an exploded view of a modification of the second embodiment, one that uses cylindrically contoured electromagnet pole faces, and not gripper halves.

[0090] FIGS. 25, 26A and 26B are of a third embodiment, one with planar ferromagnetic surfaces.

[0091] FIG. 25 is an overall external view of the planar electromagnet system, exclusive a power control module.

[0092] FIGS. 26A and 26B depict the planar electromagnet assemblies in contact with ferromagnetic planar substrates, and also exploded views of the planar electromagnet assembly.

[0093] FIGS. 27, 28 and 29 are of a fourth embodiment, one that uses vacuum and spherical surfaces.

[0094] FIG. 27 is an overall view of a vacuum canister assembly and its sphere.

[0095] FIG. 28 is an exploded view of the vacuum canister's components.

[0096] FIG. 29 shows the vacuum assembly partially assembled and the sphere.

[0097] FIGS. 30 and 31 are of a fifth embodiment, a hybrid that uses vacuum and magnetic force, and spherical surfaces.

[0098] FIG. 30 is an overall view of a hybrid vacuum and electromagnetic canister assembly and sphere.

[0099] FIG. 31A is an exploded view of the hybrid canister's components.

[0100] FIG. 31B shows the hybrid canister assembly put together and ready to be vacuum sealed.

#### DRAWINGS—REFERENCE NUMERALS

[0101] 100—oar tube

[0102] 102—oar

[0103] 103—lock ring

[0104] 104—sphere

[0105] 105—spherical electromagnet assembly

[0106] 106—spherical shell halves

[0107] 108—spherical canister body

|        |                                                   |        |                                                      |
|--------|---------------------------------------------------|--------|------------------------------------------------------|
| [0108] | 110—shell half spacing gap                        | [0171] | 228—sliding collar lock                              |
| [0109] | 112—power cable                                   | [0172] | 230—locking hole                                     |
| [0110] | 114—spherically contoured electromagnet pole face | [0173] | 232—offset vice system                               |
| [0111] | 116—electromagnet laminations                     | [0174] | 234—offset vice system shank                         |
| [0112] | 118—hinge tangs                                   | [0175] | 302—ferromagnetic oar                                |
| [0113] | 120—weldments                                     | [0176] | 304—cylindrical electromagnet canister assembly      |
| [0114] | 122—hinge pin                                     | [0177] | 306—u-joint                                          |
| [0115] | 124—through-bolt                                  | [0178] | 308—connecting bar                                   |
| [0116] | 126—through-bolt nut                              | [0179] | 310—platform                                         |
| [0117] | 128—support frame halves                          | [0180] | 312—cylindrical canister body                        |
| [0118] | 130—support frame foot                            | [0181] | 314—bands                                            |
| [0119] | 132—mounting holes                                | [0182] | 316—electromagnet cover                              |
| [0120] | 134—magnet windings                               | [0183] | 318—gripper electromagnet                            |
| [0121] | 136—magnet windings form                          | [0184] | 320—flat horizontal surface                          |
| [0122] | 138—small lamination edge                         | [0185] | 322—cover blocks                                     |
| [0123] | 140—lamination-to-frame spacing                   | [0186] | 324—cover screws                                     |
| [0124] | 142—internal canister shelf                       | [0187] | 326—cylindrically contoured electromagnet pole faces |
| [0125] | 144—bolt holes                                    | [0188] | 328—sliding gripper halves                           |
| [0126] | 146—bolt                                          | [0189] | 329—sensor port                                      |
| [0127] | 148—access hole                                   | [0190] | 330—sliding gripper spacing gap                      |
| [0128] | 149—movement sensor cavity                        | [0191] | 332—sliding gripper flange                           |
| [0129] | 150—optical movement sensor                       | [0192] | 334—sliding gripper flange slot                      |
| [0130] | 151—sensor cable                                  | [0193] | 336—canister body end                                |
| [0131] | 152—platform                                      | [0194] | 338—canister body window                             |
| [0132] | 154—carry grips                                   | [0195] | 340—gripper flange screws                            |
| [0133] | 156—locking swivel base                           | [0196] | 342—screw holes                                      |
| [0134] | 158—swing arm                                     | [0197] | 344—oar electromagnet                                |
| [0135] | 160—tower assembly                                | [0198] | 346—oar electromagnet pole face                      |
| [0136] | 162—spherical electromagnet canister assembly     | [0199] | 348—oar electromagnet pole gap                       |
| [0137] | 164—platform positioning trough                   | [0200] | 402—planar electromagnet assembly                    |
| [0138] | 166—trough recess                                 | [0201] | 404—ferromagnetic planar surface                     |
| [0139] | 168—swivel base protrusion                        | [0202] | 406—platform                                         |
| [0140] | 170—upper bevel portion                           | [0203] | 408—outer planar electromagnet pole face             |
| [0141] | 171—lower bevel portion                           | [0204] | 410—inner planar electromagnet pole face             |
| [0142] | 172—berm bevel                                    | [0205] | 412—magnet windings                                  |
| [0143] | 174—swivel base berm                              | [0206] | 414—windings form                                    |
| [0144] | 176—locking swivel assembly                       | [0207] | 416—planar electromagnet housing                     |
| [0145] | 178—levered cam                                   | [0208] | 418—wire lead-out hole                               |
| [0146] | 180—cam pin                                       | [0209] | 420—power control module                             |
| [0147] | 182—upper vice jaw                                | [0210] | 421—gyro/accelerometer/wireless transmitter          |
| [0148] | 184—upper vice jaw screw hole                     | [0211] | 422—oar centerline                                   |
| [0149] | 186—lower vice jaw                                | [0212] | 500—military press                                   |
| [0150] | 188—vice platen                                   | [0213] | 502—lat pull down                                    |
| [0151] | 190—vice platen slot                              | [0214] | 504—downward triceps extension                       |
| [0152] | 192—swivel ring                                   | [0215] | 506—standing abdominal crunchie                      |
| [0153] | 194—swivel ring shelf                             | [0216] | 508—dead lift                                        |
| [0154] | 196—spring disk                                   | [0217] | 510—reverse curl                                     |
| [0155] | 198—spring disk slot                              | [0218] | 520—tolerance zone end view                          |
| [0156] | 200—stirrup                                       | [0219] | 522—saved first data set                             |
| [0157] | 202—stirrup shank                                 | [0220] | 524—saved second data set                            |
| [0158] | 203—stirrup shank hole                            | [0221] | 526—oar stopping point                               |
| [0159] | 204—stirrup screw                                 | [0222] | 528—oar path data to be discarded                    |
| [0160] | 206—stirrup shank slot                            | [0223] | 530—tolerance zone wall vectors                      |
| [0161] | 208—stirrup foot                                  | [0224] | 532—imaginary cone base                              |
| [0162] | 210—swing arm stud                                | [0225] | 534—oar stopping point vector                        |
| [0163] | 212—spring button                                 | [0226] | 600—vacuum canister assembly                         |
| [0164] | 214—button locking hole                           | [0227] | 602—vacuum oar                                       |
| [0165] | 216—v-block                                       | [0228] | 604—vacuum sphere                                    |
| [0166] | 218—floor plate                                   | [0229] | 606—vacuum canister                                  |
| [0167] | 220—tower                                         | [0230] | 608—vacuum cup                                       |
| [0168] | 222—canister mounting assembly                    | [0231] | 610—vacuum cup housing                               |
| [0169] | 224—canister mounting deck                        | [0232] | 612—vacuum line                                      |
| [0170] | 226—sliding collar                                | [0233] | 614—canister vacuum port                             |

- [0234] 620—channel port
- [0235] 622—channel
- [0236] 624—vacuum cup housing port
- [0237] 626—mounting holes
- [0238] 700—hybrid canister assembly
- [0239] 702—hybrid oar
- [0240] 704—hybrid sphere
- [0241] 706—hybrid canister
- [0242] 707—hybrid spherical electromagnet assembly
- [0243] 708—hybrid spherical cup halves
- [0244] 710—hybrid canister vacuum port
- [0245] 712—electromagnet power cord
- [0246] 720—evacuation gap
- [0247] 722—vacuum channel network
- [0248] 726—mounting holes
- [0249] 728—evacuation gap plug
- [0250] 730—canister well
- [0251] 732—threaded mounting holes
- [0252] 734—spherical magnet pole face

#### DETAILED DESCRIPTION

[0253] Three ferromagnetic embodiments are discussed, followed by a vacuum operated embodiment, and then a hybrid vacuum/electromagnetic embodiment.

[0254] FIGS. 1A and 1B are external views of the magnetic components of a first ferromagnetic embodiment, together with an oar 102 for the user to transmit force to the embodiment.

[0255] FIG. 1A shows a convex surface portion of substantially spherical curvature, sphere 104, in mated contact with and resting upon two concave surface portions of substantially spherical curvature, spherical shell halves 106.

[0256] The sphere 104, is constructed of a ferromagnetic material such as an iron-containing metal and is magnetically attractable to the shell halves 106, which are constructed of a magnetically permeable (conductive) material, such as ferromagnetic, iron-containing metal. Whenever a magnetic field exists between the contact surfaces of the sphere 104, and shell halves 106 a resultant attraction occurs and a slide-resisting friction is produced.

[0257] The two concave shell halves 106, are separated from each other by a shell half spacing gap 110. The shell halves 106 are housed in a non-magnetic spherical canister body 108 such as of carbon fiber or plastic. The sphere has a removable oar 102 affixed to it by way of the oar being inserted to an oar tube 100 permanently affixed to the sphere. The oar is removably locked in place by a threaded lock ring 103 at the oar tube 100.

[0258] During use the oar 102 transmits a user's mechanical effort to overcome the friction that exists between the sphere 104 and the spherical shell halves 106 caused by a magnetic field pulling them together at their contact surface portions. A power cable 112 connects an electromagnet within the spherical canister 108 to a power control module 420, see FIGS. 6A and 6B. FIG. 6B uses an electrical power distribution system (not shown) inside the components to run electrical power between the two spherical electromagnet assemblies 162.

[0259] FIG. 1B depicts the device of FIG. 1A rotated about the vertical axis by 90 degrees counterclockwise in order to better view the shell half spacing gap 110 between the two portions of spherical shell halves 106.

[0260] FIGS. 2A and 2B depict the spherical electromagnet assembly 105. The components of the spherical electro-

magnet assembly 105 are held in the spherical canister body 108. These figures are a combination of face and perspective views, with FIG. 2B rotated 90 degrees about the vertical axis from FIG. 2A. See FIGS. 3 and 4 for additional depiction.

[0261] Each of the two spherical shell halves 106 is in self-adjustable magnetic contact at a portion of its convex side (its bottom surface) with one of two substantially spherically contoured electromagnet pole faces 114 that are concave. See FIG. 3 for further illustration of the pole faces.

[0262] These spherical pole faces 114 transmit a magnetic field to the shell halves 106. The magnetic field is created by an electromagnet made of electromagnet laminations 116 and magnet windings 134. The windings are wound on a magnet windings form 136 that has the electromagnet laminations 116 passing through it. The laminations are secured together at two places by through-bolts 124 and through-bolt nuts 126. The magnet windings 134 terminate in power cable 112 and lead out through the spherical canister body 108 to the power control module 420 of FIGS. 6A and 6B.

[0263] Each of the two spherical shell portions 106 is affixed on its convex side to a hinge tang 118 made of non-magnetic, austenitic, high nickel stainless steel, such as 316 stainless, by a non-magnetic, ferrite-free weldment 120. A non-magnetic hinge pin 122, perhaps of austenitic 316 stainless, or carbon fiber, or some other non-magnetic material, runs through a hole in each hinge tang 118. The hinge tangs can each rotate partially about, and also slide slightly along, the hinge pin 122. See FIG. 2B. Their rotation and sliding is limited by the proximity of the shell halves 106 to the electromagnet pole faces 114. The freedom to move slightly allows self-adjustment between the spherical shell halves 106 and the spherical pole faces 114 when the device is in use.

[0264] Two support frame halves 128 (see also FIGS. 3 and 4) are drilled for insertion of the hinge pin 122 and hold it in place. These holes through the frame halves 128 are of slightly smaller diameter than the holes through the hinge tangs 118. The ends of the hinge pin 122 are pressed to widen them upon assembly and therefore form a tight fit between the hinge pin 122 and the frame halves 128, yet not widened so much as to disallow freedom of movement of the hinge tangs 118 upon the hinge pin 122.

[0265] The support frame halves 128 are placed outboard of the hinge tangs 118. The hinge pin 122, support frame halves 128 and hinge tangs 118 are located in the space between the two pole faces 114 of the electromagnet. There is sufficient clearance between the ends of the hinge pin 122 and the magnet laminations 116 to prevent shorting of the magnetic circuit, which would then not allow full magnetic field strength to complete the circuit through the spherical shell halves 106 and the sphere 104, thus lessening the production of frictional force. Insulation could be added between the ends of the hinge pin 122 and the laminations 116 if necessary.

[0266] There is a lamination-to-frame spacing 140 between the two support frame halves 128 and the magnet laminations 116. The clearance is also sufficient in all directions to prevent shorting of the magnetic circuit. And insulation between the electromagnet laminations 116 and the ends of the hinge pin 122 could be utilized if necessary. The lamination-to-frame spacing 140 allows a certain freedom of movement that enhances self-adjustment between the two lamination pole faces 114 and the spherical shell

halves **106**. The windings form **136** is narrower than the distance between the two support frame halves **128**, as shown in FIG. 2B, so that the form, which is of tight fit to the laminations **116**, cannot interfere with the self-adjustment between support frame halves **128**, magnet laminations **116** and shell halves **106**.

[0267] The electromagnet is thus both vertically and horizontally free-floating within the system, albeit in limited amount, being able to move within the frame halves **128** along the three orthogonal axes X, Y, Z. This additional self-adjustment feature further allows for maximum magnetic flux to be continuously transmitted in circuit from one of the pole faces **114**, through its spherical shell half **106**, through a portion of the sphere **104**, through the other shell half **106** and into the second pole face **114**. The self-adjusting lamination-to-frame spacing **140** is further depicted in FIG. 4.

[0268] There is an integral support frame foot **130** that extends at a right angle from the bottom of each support frame half **128**. Each support frame foot **130** is drilled and tapped with mounting holes **132**. The support frame halves **128** are mounted to the canister's internal shelf **142** at bolt holes **144**, by bolts **146**. These bolts can be used to mount the spherical canister **108** to the canister mounting deck **224** of FIGS. 6 and 10C. There is an access hole **148** in the bottom of the canister.

[0269] As is standard in the manufacture of electric transformers, the full body of laminations **116** (called a stack) is of both small straight pieces of lamination and large L-shaped pieces. The area above a small lamination edge **138** in FIG. 2B (see also FIG. 3) illustrates a small straight piece of lamination. Below that line of a lamination edge **138** and continuing all the way to the left and up, is a large L-shaped piece. These different pieces are necessary to assemble a complete U-shaped lamination stack **116** that has each individual 2-piece U-shaped lamination layer residing in its own individual plane.

[0270] Each individual lamination layer of the stack **116** is built up by inserting one of the L-shaped lamination pieces through the pre-wound windings form **136**, and then adding a short piece to the stack adjacent the inserted end of the large L-shaped piece. The short piece is stood atop the leading end of the inserted L-shaped piece as in FIG. 2B. This operation is repeated, with the direction of insertion of the L-shaped piece of each new layer alternating from side-to-side, until the entire lamination stack **116** is built up.

[0271] FIG. 3 is an exploded view of the electromagnet, with its laminations **116** and windings **134**, the support frame halves **128**, hinge pin **122** and the hinge tangs **118**. The spherically contoured shell halves **106** are also depicted.

[0272] The spherical shell halves **106** are shown positioned above the hinge tang **118** that each shell half respectively is to be permanently affixed to by weldment **120** of FIG. 2B. The electromagnet, comprised of lamination stack **116** and windings **134**, inserts loosely within the support frame halves **128**.

[0273] FIG. 4 depicts the assembled view of the exploded view of FIG. 3. The shell halves **106** are depicted as though transparent. The weldments **120** that secure the shell halves **106** to their respective hinge tangs **118** are also shown. A hidden view of the near end of the hinge pin **122** is shown in relation to its protruding through the near support frame half **128** and not touching the interior surface of the near laminations **116**.

[0274] Note the lamination-to-frame spacing **140**, which together with the clearance between the windings form **136** (FIG. 3) and the insides of the frame halves **128** (FIG. 2B), allows the electromagnet to be free floating within the confines of the support frame halves **128**.

[0275] The near end of the hinge pin **122** is shown in hidden view and as seen, protrudes through the near support frame half **128**, stopping short of the inside of the laminations **116**. Enough spacing is allowed between both ends of the hinge pin **122** and the lamination group **116** to help facilitate the ongoing self-adjusting movement necessary for the lamination's curved pole faces **114** to come into good magnetic contact with the two spherical shell halves **106** in order to provide efficient magnetic flux transmission.

[0276] FIG. 5 is a view of an oar **102** with its centerline **422** extending through the center of the sphere **104**. A gyro/accelerometer/wireless transmitter **421** shares the oar's centerline. This allows the gyro/accelerometer **421** to accurately track the oar's movement during use without regard for the roll that could occur were the gyro **421** attached to the oar **102** with an off-set mounting. This is further explained in the following two paragraphs.

[0277] The relationship of a sphere's center to the two shell halves **106** is always substantially the same no matter the sphere's **104** movement. This does not imply that something attached to an oar **102** is in a constant relationship with the center of a sphere **104** even if the oar's centerline is. If the gyro/accelerometer **421** is offset-mounted from the oar's centerline **422**, so that the oar's centerline **422** doesn't pass through the detection component within the gyro/accelerometer **421**, and if the gyro **421** does not have roll detection ability, the possibility exists that the gyro/accelerometer **421** would undergo roll during use after calibration that would not be compensated for. Roll is defined here as the gyro's **421** rotation about the centerline **422** of the oar **102**, caused by the gyro **421** being mounted at a radial distance from the centerline **422**. Together with the oar's **102** regular movement this would amount to a compound movement in space that could provide false data as to exact oar **102** position.

[0278] The gyro/accelerometer **421** being on the oar's centerline **422** obviates the need for roll detection. The oar **102** can spin on its longitudinal axis (centerline **422**) and it won't matter. The gyro **421** will be rotating about its own centerline with only the oar's **102** regular movement needing to be detected. And too, being constantly oriented along the oar's centerline **421** through the sphere's center, the gyro/accelerometer **421** wouldn't require calibration as to its angular relationship with the sphere.

[0279] The gyro/accelerometer **421** is a wireless transmitter type, and could be such as are used in Nintendo®, Sony® or other home entertainment products. InvenSense® is a manufacturer of gyro/accelerometer components. Their products can be used to design and build a gyro/accelerometer for the embodiment should complete units by game device manufacturers or others not be used. The embodiment's gyro/accelerometer **421** units should be able to be installed and removed by the user to facilitate safe storage and transport.

[0280] FIG. 6A is a view of the assembled first embodiment, made up of seven modular component categories: a platform **152**; a locking swivel base **156** with a locking swivel assembly **176** at each end of the swivel base **156**; two swing arms **158**; two tower assemblies **160**; two spherical

electromagnet canister assemblies **162**; two oars **102** along with two gyro/accelerometer/wireless transmitters **421**, shown attached; and a removable power control module **420** and cabling **112**.

[0281] The power control module **420** is composed of speech recognition, memory, computational and possibly audible feedback subsystems for the control of an internal power supply. Carry grips **154** are holes within the platform. The part of the power cable **112** that runs between the two spherical electromagnet canister assemblies **162** can be eliminated, as in FIG. 6B, by designing the system so as to use electrically conductive wires or tracks (none of which are shown) within the system's framework parts.

[0282] The platform **152** sits upon the locking swivel base **156**, holding it in place. The swivel base extends underneath the width of the platform **152** and beyond. The swivel base **156** and its two swivel assemblies **176** allow the two swing arms **158** to be adjusted for effective length and angular displacement, providing versatility in the floor positions of the two tower assemblies **160** and therefore their attached electromagnet canister assemblies **162**. A tower assembly **160** is composed of a floor plate **218** attached to the bottom of a tower **220** that supports a vertically sliding collar **226** that has a canister mounting deck **224** attached to the sliding collar **226**. Further choice of tower assembly **160** floor position is brought about by locating the swivel base **156** in one of three platform positioning troughs **164** at the underside of the platform **152**, as depicted in FIG. 7.

[0283] FIG. 7A is a top view of the platform **152** and the locking swivel base **156** which fits within any of the three platform positioning troughs **164** underneath the platform **152**. The figure shows hidden views of the troughs **164** integral to the underside of the platform **152**. Each trough is able to be fit down over the swivel base **156**, holding it in place. FIGS. 7B and 7C are side views of the alignment between the platform **152** and the swivel base **156**, both before they are brought into contact (FIG. 7B), and afterward (FIG. 7C).

[0284] Aiding stability between the platform **152** and the locking swivel base **156**, are the two trough recesses **166** near the ends of each of the three platform positioning troughs **164**, which mate with the two swivel base protrusions **168** in the swivel base. The trough recesses **166** and swivel base protrusions **168** correspond in size and spacing to each other. The protrusions **166** insert to the recesses **168** when the platform is lowered upon the locking swivel base **156** and help keep the swivel base steady within its positioning trough **164**. The recesses **166** and the protrusions **168** also aid the user in placing the platform **152** down upon the swivel base **156** correctly.

[0285] The outboard areas (ends) of the platform positioning troughs **164** are beveled from the upper surface of the platform **152**, which is here the upper bevel portion **170**, downward to at least near the bottom surface of the platform **152**, which is here the lower bevel portion **171**. This is illustrated in FIGS. 7B and 7C. When the platform **152** is placed upon the locking swivel base **156**, the beveled areas **170**, **171** at each outboard edge of the three platform positioning troughs **164** in the platform **152** rest against a mating surface on a berm bevel **172**, located at the inboard sides of two swivel base berms **174** protruding upward from the locking swivel base **156**.

[0286] Proper fit between the swivel base's two berm bevels **172** and the platform positioning trough's two end

surfaces **170**, **171** within each positioning trough **164**, grants stability during use between the platform **152** and locking swivel base **156**. The locking swivel base berm **174**, being outside of the footprint of the platform **152**, also serves as a locator and guide in the placement of the platform upon the locking swivel base.

[0287] FIG. 7B shows the platform **152** positioned above the swivel base **156**. Note that the platform positioning trough **164** and the trough recess **166** are hidden features. The swivel base **156** and its features, which mate to the platform **152**, are not hidden in this view. FIG. 7C shows platform **152** and locking swivel base **156** mated together as during use.

[0288] FIG. 8A depicts the locking swivel assembly **176** and a portion of a swing arm **158** locked in place.

[0289] FIG. 8B is an exploded view depicting the parts of the locking swivel assembly **176**, comprised of levered cam **178**; cam pin **180**; upper vice jaw **182**; upper vice jaw screw holes **184**; lower vice jaw **186**; vice platen **188**; vice platen slots **190**; swivel ring **192**; swivel ring shelf **194**; spring disk **196**; spring disk slots **198**; stirrup **200**; stirrup shanks **202**; stirrup shank holes **203**; stirrup screws **204**; stirrup shank slots **206** and stirrup foot **208**.

[0290] The locking swivel assembly **176** serves three functions. One is to allow a swing arm **158** to have its effective length adjusted at the upper and lower vice jaws **182**, **186**, which aids in placing each tower assembly **160** with its spherical electromagnet canister assembly **162** of FIG. 6A on the workout floor.

[0291] A second function is that it allows a swing arm **158** to be rotated either clockwise or counter-clockwise parallel to the floor, about the vertical axis through the center of the swivel ring **192**. This further aids in the placement of a tower assembly **160** on the floor.

[0292] A third function is to lock a swing **158** arm securely in place within the upper and lower vice jaws **182**, **186** of the swivel assembly **176**, enabling the desired position of a tower assembly **160** to be solidly maintained during use.

[0293] The cylindrical swivel ring **192** is stationary, being permanently affixed to the locking swivel base **156** (see FIG. 6). There is a swivel ring shelf **194**, which is a flat circular plate with a large hole at the center, permanently affixed to the inner circumference of the swivel ring **192**.

[0294] Placed into the swivel ring **192** and on top of the swivel ring shelf **194** is the vice platen **188**, which is a flat circular plate of appropriately strong material, slightly smaller in diameter than the inner diameter of the swivel ring **192**. The vice platen **188** is able to be rotated within the swivel ring **194**. The vice platen has a lower vice jaw **186** permanently affixed to its upper side. The vice platen **188** contains two vice platen slots **190** which are immediately outboard from the long sides of the affixed lower vice jaw **186**. These slots allow passage through the platen **188** of the two stirrup shanks **202** of the stirrup **200**.

[0295] At the underside of the swivel ring shelf **194**, and inside the circumference of the swivel ring **192**, is a flat spring disk **196**, of diameter slightly smaller than the inside diameter of the swivel ring **192**. The spring disk **196** has two slots **198** in it to allow passage through the spring disk of the two shanks **202** of the stirrup **200**. The stirrup shanks insert from below through the two spring disk slots **198**, then through the large hole at the center of the swivel ring shelf **194** and then up through the two vice platen slots **190**, to be

fastened off at the cam pin 180, above the upper vice jaw 182. See FIG. 8A for the assembled view.

[0296] The cam pin 180 runs through the levered cam 178 and through the two stirrup shank holes 203. The ends of the cam pin are expanded to hold it in the stirrup shank holes 203. The levered cam 178 is a cylinder with a hole drilled through it parallel to the major axis of the cylinder, and offset from the center. A handle is permanently affixed to the cylinder. Stirrup screws 204 are inserted through the two stirrup shank slots 206 and into the upper vice jaw 182 at holes 184 to guide the stirrup shanks 202 in vertical travel and to help keep the stirrup shanks close to the sides of the upper vice jaw 182.

[0297] As the levered cam 178 begins to be rotated downward (clockwise in FIGS. 8A and 8B), toward the upper vice jaw 182 from a relaxed vertical position, the stirrup shanks 202 and their stirrup foot 208 begin to be pulled vertically upward. As the cam 178 is rotated sufficiently, its camming action against the upper vice jaw 182 increases. To complete the locking action the cam 178 will be rotated through its maximum applied force so that the lever of the cam is then held against the top of the upper vice jaw 182 by the downward recovery force of the spring disk 196, which is in opposition to the spring disk 196 being deflected upward as the stirrup 200 was being raised by the levered cam 178.

[0298] The vice jaws 182, 186 are thus locked, clamping an inserted swing arm 158 tightly until the levered cam 178 is rotated back the other way causing the camming action to pass back through its maximum toward the relaxed condition of the spring disk 196. Relaxation of spring disk 196 force will allow the swing arm 158 that is inserted to the vice jaws to be slid lengthwise for adjustment or removal.

[0299] The spring disk 196, when not upwardly flexed, is positioned to be in negligible contact with the underside of the swivel ring shelf 194, allowing the spring disk to be slid against the shelf in rotation. This allows a swing arm 158 to be easily rotated parallel to the floor.

[0300] The spring disk is sufficiently thin to allow a flexure (displacement) in the vertical direction at its center and beyond, out toward its periphery, whenever an upward force is applied by the levered cam 178 acting on the stirrup 200. The cam 178 pulls the stirrup shanks 202 upward. This brings the stirrup foot 208 upward toward the spring disk 196. As the stirrup foot 208 begins to make harder contact with the underside of the spring disk 196, the disk is forced upward against the underside of the swivel ring shelf 194.

[0301] As the spring disk 196 begins to become distorted from its normally planar condition, flexing upwardly toward the hole in the swivel ring shelf 194, the spring disk 196 makes very hard contact with the underside of the swivel ring shelf 194. Sufficient upward displacement of the spring disk 196 causes the swivel ring shelf 194 to be forcefully sandwiched between the ascended spring disk 196 underneath the swivel ring shelf 194, and the vice platen 188 riding on top of the swivel ring shelf 194. This combined action grips the stationary swivel ring shelf 194 strongly.

[0302] As part of this, the upper vice jaw 182 is forced downward by the levered cam 178, gripping the inserted swing arm 158 between the two vice jaws 182, 186. The vice platen 188, the upper and lower vice jaws (182, 186) and the swing arm 158 inserted in the vice jaws, are thus held tightly. And with the swivel ring 192 being permanently affixed to

the locking swivel base 156, the swing arm 158 and its tower assembly 160 are thus held in position on the floor.

[0303] FIG. 9A is a view of a tower assembly 160, its spherical electromagnet canister assembly 162 and a portion of a connected swing arm 158. The electromagnet canister assembly 162 is shown placed at its minimum height on the tower assembly 160.

[0304] FIG. 9B shows the swing arm 158 of FIG. 9A ready to be joined to a swing arm stud 210, which is permanently affixed through a v-block 216 to the floor plate 218 of a tower assembly 160. The end of the swing arm 158 is inserted to the swing arm stud 210 with sufficiently close tolerance to form a good fit. A spring button 212 in the swing arm stud 210 is thumb-depressible, allowing the end of the swing arm 158 to pass over the button 212 when the button is depressed. The spring button 212 then snaps back to its extended position within the button locking hole 214 near the end of the swing arm 158. This locks the swing arm to the tower assembly 160. Conversely, depressing the spring button 212 allows the swing arm 158 to be slid back off of the swing arm stud 210.

[0305] FIGS. 10A and 10B show a tower assembly 160 with its spherical electromagnet canister assembly 162 locked in on a tower 220 (FIG. 10C), at the lowest (FIG. 10A) and also near the highest positions (FIG. 10B).

[0306] FIG. 10C is a view of the parts that hold the spherical canister assembly 162 and allow its height adjustment. A canister mounting assembly 222 is composed of a canister mounting deck 224, permanently affixed to the sliding collar 226, which can be raised or lowered along the tower 220. A sliding collar lock 228 is a coil spring operated bolt that inserts under spring pressure to a locking hole 230 as chosen by the user. Pulling backward along the axis of the collar lock 228 compresses the coil spring and withdraws the bolt from a locking hole 230 to enable the canister mounting assembly 222 and its spherical canister assembly 162 to be positioned along the tower.

[0307] FIGS. 11, 12 and 13 show top views of this first embodiment depicting, in relation to the platform 152, various positions of the locking swivel base 156, swing arms 158, tower assemblies 160 and spherical canister assemblies 162, and oars 102. These views exclude the electrical components.

[0308] The views demonstrate the versatility of placement of the tower assemblies 160 upon the floor, which results in oar 102 spacing and orientation being quite varied. This aids in the accomplishment of a wide variety of exercises.

[0309] In these views the towers 220 are intended to be shown as mounted slightly in the non-vertical, along the axes of the swing arms 158 in a direction away from the swivel bases 176. This inclination facilitates a safety clearance between the oars 102 and the towers 220 when the spherical canister assemblies 162 are in their lowered positions upon the towers 220 and the oars 102 are being used in a near vertical orientation as in FIG. 12. It will therefore be more difficult for the hands to strike the towers 220 when the oars 102 are being used in the near upright position compared to the towers 220 being attached in the strict vertical orientation.

[0310] FIGS. 11A, 11B and 11C assume an arbitrary platform 152 size of approximately 1 meter square for illustration purposes only. FIG. 11A shows the inboard proximity of the oars 102 to each other to be very close. FIGS. 11B and 11C show an inboard proximity of the oars

**102** to be approximately  $\frac{1}{2}$  meter and 1 meter respectively. The spacing can be varied throughout this range by adjusting the lengthwise positions of the swing arms **158** within the locking swivel assemblies **176** and also the angle of rotation along the floor of the swing arms **158** about the locking swivel assemblies **176**.

[0311] Notice that advantage has been taken in choosing the placement of the locking swivel base **156**. In FIGS. **11A** and **11B** the swivel base **156** is in an outboard platform positioning trough **164**, the trough at the top in FIG. **7A**, while in FIG. **11C** the swivel base **156** is in the middle trough **164** depicted in FIG. **7A**. Choosing which platform positioning trough **164** to employ helps the user to stand in the middle of the platform while exercising.

[0312] FIG. **12** shows the oars **102** at an elevated inclination approaching the vertical. The canister assemblies **162** probably would be placed at their lowest positions along the towers **220** to facilitate oar use.

[0313] FIGS. **13A** and **13B** show the swing arms **158** at their longest reach from their swivel assemblies **176** (FIG. **11B**). FIG. **13A** demonstrates orientation of the oars **102** extending away from the user directly to the front or rear. FIG. **13B** has oar **102** orientations roughly similar to those of the FIG. **11** series, that is, oars **102** that extend away in a sideways, lateral direction from a user.

[0314] FIG. **14** shows an offset vice system **232** affixed to a tower's floor plate **218**.

[0315] This system allows the floor plate **218** to be moved along the swing arm **158** without the swing arm **158** contacting the tower **220**. This creates greater versatility in positioning the floor plate **218** on the exercise floor since the swing arm **158** can be left in place at the platform's **152** locking swivel assembly (**176** of FIG. **15A**), and the floor plate **218** simply slid along the swing arm **158** toward or away from the locking swivel assembly **176**, and the user, as desired. This way the swing arm **158** often doesn't need to be swept through an angle of rotation at the locking swivel assembly **176** to attain a comfortable oar **102** separation for the user. Convenience is enhanced and exercise floor space is conserved.

[0316] The offset vice system **232** uses a levered cam **178**, upper vice jaw **182**, lower vice jaw **186** and two offset vice system shanks **234** that are affixed to the lower vice jaw **182**. The lower vice jaw is affixed to the floor plate **218**.

[0317] The levered cam **178** puts pressure on the upper vice jaw **182** when the levered cam **178** is in the clockwise, lowered, position forcing the upper vice jaw **182** to clamp down on the swing arm **158**, holding the swing arm fast. Rotating the levered cam **178** counterclockwise releases the pressure. Spring resistance can be incorporated to the locking system, but isn't depicted here.

[0318] FIGS. **15A**, **15B** and **15C** depict the use and advantage of the offset vice system **232**.

[0319] Note that the tower assemblies **160** and their electromagnet canister assemblies **162** are slid along the swing arms **158**. The swing arms are kept in stationary position at the platform's locking swivel assemblies **176**. Various distances between the oars **102** are thus accomplished without the swing arms **158** being rotated at the locking swivel assemblies **176**, or the swing arms **158** being slid lengthwise through the swivel assemblies **176**, either toward or away from the platform. This forms an advantage in that the swing arms **158** don't encroach upon the user on the platform.

[0320] FIG. **15A** has the tower assemblies **160** and spherical electromagnet canister assemblies **162** slid inboard along the swing arms **158** so that the oars **102** almost touch at their inboard ends. FIG. **15B** has the tower assemblies **160** and electromagnet canister assemblies **162** moved outwardly along the swing arms **158**, providing a wider spacing between oars **102**, while in FIG. **15C** the tower assemblies **160** and electromagnet canister assemblies **162** are moved to substantially a maximum distance from each other, creating wide spacing of the oars **102**.

[0321] FIGS. **16**, **17** and **18** are programming block diagrams/flowcharts, enabling programmers to write the code for the power control system. The flowcharts show only the procedural and logic steps involved in creating, saving and using an exercise program . . . not any hardware.

[0322] The control system hardware includes in part the gyro/accelerometers/transmitters **421**, their battery power sources and any other electronics necessary, mounted as a detachable unit on each oars.

[0323] The control system also includes the power control module **420**, which is comprised of a power control digital processor, speech recognition processor, timer, memories, a wireless receiver for the transmitted gyro/accelerometer data, possibly a speaker system, a power source for the module **420** and any other appropriate electronics and hardware, contained in a detachable unit.

[0324] The system automatically controls the power to the magnets during exercise routines which utilize oar position and tolerance zones, by way of recognizing and acting upon the spatial orientations of the oars. These are orientations in 3-space, the three dimensions we are familiar with. These orientations, once calibration of the system occurs to "zero out" the oars, are in the form of angles of deviation of the oars from their calibration positions.

[0325] The processor can also control the resistances during of timed exercises, whether stored or un-stored, without the locations of the oars playing a part. And by way of real time verbal commands it can also control the forces applied during free-form ad hoc routines. Timed and free-form exercises don't make use of the gyro/accelerometers to notify the power control system where the oars are during an exercise. The control module's timer, or else verbal command, is what controls magnetic force changes during these.

#### An Explanation of the Power Control's Diagrams/Flowcharts

[0326] In the following discussion the decision blocks of FIGS. **16**, **17** and **18** are explained. The word "substantially", meaning here "sufficiently close", should be applied whenever an oar's location in space during actual exercise is needed to be compared with other vectors (see the discussion of vectors further on) and oar orientations, previously generated and saved, in order to cause a force change at a magnet. Close is good enough in this case, since exactness would be almost impossible to achieve as far as orientation vectors exactly coinciding with others during movements of an oar, even though all the vectors have one common point and are rotated about that point, as is brought out further on.

[0327] FIG. **16** shows the control steps taken by the present embodiment upon manual power-up. These steps include; storing new exercises; handling the user's verbal commands; decisions about the type of exercise format; follow-on instructions for each type of exercise; routing to and from FIGS. **17** and **18**.

**[0328]** The upper two-thirds of FIG. 16 concerns starting up and the procedures the system goes through for actuating various exercise scenarios. These include a new exercise to be created; calling up a stored exercise for use; whether or not the exercise is timed or free-form; the decisions involved for routing into these scenarios.

**[0329]** The lower third of FIG. 16, beginning with a statement block at the left, following the timed exercise decision, involves the flow of control for stored exercises having automatic force changes. Timed exercises are not included in this, since it is felt at this time that they won't utilize tolerance zones, therefore won't involve decisions about using oar position to determine automatic changes of force.

**[0330]** When a particular automatic force change exercise is called up, control advances through to the statement block in the lower third along the left side. It causes the system to time out and power down after an idle period. In powering down this way, new verbal commands are first stored, along with any pertinent new data.

**[0331]** Moving to the right a previous instruction set is encountered again, namely "Receive, store and apply appropriate verbal commands and data".

**[0332]** Control won't be transferred to the upper two-thirds of FIG. 16 again until after this exercise is terminated. It is necessary to include the above instruction set again here, since once control enters the lower third of FIG. 16 it stays there or else transfers to FIG. 17 for a period, entering decision blocks that are necessary to cause the system to perform changes of force. Then control transfers back to FIG. 16, not to move higher than the lower third, until the exercise times out from idleness or is terminated by command.

**[0333]** Next on the right in the lower third is a decision block as to whether an oar has entered a different zone. What is meant by an oar entering a tolerance zone is discussed in detail in the further section, "TOLERANCE ZONES: THEIR CONSTRUCTION AND EXPLANATION".

**[0334]** It is not necessary to differentiate between the start zone and any other here, since should the oar leave the start zone and then re-enter before going into a different zone, the initial force will still be applied. It therefore isn't necessary to inquire whether the oar has re-entered the start zone before entering another, since the force wouldn't have changed from exiting the first time to then re-enter and leave again.

**[0335]** If the "different zone" decision block answer at any time during the performance of the exercise is "No—the oar has not entered a different zone", then control loops back through a "Maintain force" statement block and into the "idle period" power-down block at the left, then to begin the "different zone" decision process again.

**[0336]** If the answer is "Yes—the oar has entered a different zone", then control exits FIG. 16 through point (C) into FIG. 17. Then when the decision processes of FIG. 17 are finalized control loops back to FIG. 16 through point (D).

**[0337]** As mentioned, FIG. 17 is a flowchart depicting the force change decision process that occurs when oars enter tolerance zones. A tolerance zone cannot automatically generate a force change without the decision logic of FIG. 17 triggering the change.

FIG. 17 and a Discussion of Data Sets

**[0338]** A "data set" is a sequence of saved gyro/accelerometer data samples, generated as oar orientations i.e., radius vectors (see the discussion of vectors below). They describe the pathway of an oar within a tolerance zone. Data sets, as do all oar orientation vectors, express an oar's angular deviation from the zeroed orientations in 3-space generated and stored at calibration at the beginning of a session.

**[0339]** There are sequential oar orientation data sets in each tolerance zone. An "entrance set", maps the oar's progress from the point of oar entry across the tolerance zone boundary (see the discussion of tolerance zones below) up to where it reaches as far as the oar's set-up cycle stopping point. A second data set, the "exit set", is the oar's path from the stopping point out to the point where the oar goes across the zone's boundary in leaving the zone. The word "substantially" is to be applied to the closeness of an oar's tracking during exercise compared to the set-up cycle pathways.

Entering the Left Side of FIG. 17

**[0340]** Having entered the first decision block of FIG. 17, the force change process has begun in earnest. The block tests for whether or not the oar has entered the new zone in [substantially] the "same direction" as, "parallel to", [and sufficiently close] to the entrance data set, compared to the oar's movement in that zone during the set-up cycle. If so, the oar is in "compliance" with the entrance data set.

**[0341]** If the answer at this first decision block is "Yes—the oar's movement is compliant with this zone's entrance data set"—then control moves downward from the first block into a second decision set.

**[0342]** The decision here is whether or not the oar has substantially reached the set-up cycle's stopping point in the zone just entered, and whether the processor has then been alerted. If the answer to this is "No", the force that was already in existence is not changed and control then flows back to FIG. 16 through (D) for the oar's position to be tested again for being in some zone.

**[0343]** If the answer at this second decision block is "Yes—the stopping point has been substantially reached", control then proceeds down to the next test block.

**[0344]** This third block decides whether the oar's movement is in compliance with the exit data set from the zone during the set-up cycle. If the answer is "No", control is routed back through (D) to FIG. 16 while maintaining the prior force. The process of the lower third of FIG. 16 will then be repeated.

**[0345]** If the answer in this decision block is "Yes", control then passes downward to the statement block at the bottom left, which tells the processor to change the force at the oar's magnet to the force called for in the zone during the set-up cycle while the oar was moving in the outgoing direction, as in going from 3 to 3' of FIG. 19A. Control then returns to FIG. 16 through (D) to begin the zone entrance process again.

**[0346]** Very often during exercise the oars will be brought through the zones in the reverse direction. This is where the right side of FIG. 17 comes in.

Crossing Over to the Right Side of FIG. 17 from the Left

**[0347]** If the test at entering FIG. 17 at the upper left results in a "No", then control proceeds to the right side of

the figure where a test is made as to whether or not the oar has entered the zone in compliance with the reverse direction (opposite or backward sequential order) of the orientation data from the set-up cycle's exit from that zone.

[0348] This is the converse case of the first test block encountered at the top left. That block on the left tested for compliance with the entrance data set (forward sequential order, or outgoing direction). This block at the upper right tests for the only other compliance possibility, the reverse of the exit data set, which involves the reverse or return direction back through the zone.

[0349] If the answer is "No" with this upper decision block, control passes back to FIG. 16 through (D) without a change in force. There has been no compliance, either with entrance to the zone along the forward direction of the entrance, or with entrance along the reverse direction of the exit.

[0350] If the answer is "Yes" at this block, control passes downward to the middle decision block, the same as with the left hand side. The test is again for whether or not the oar has substantially reached the set-up cycle's stopping point and alerted the processor.

[0351] If "No", the process loops back to FIG. 16 through (D) with the force not being changed from what it was at entering FIG. 17 at (C). If "Yes", control moves down to the last decision block on the right.

[0352] This last test block asks whether the oar has exited the zone in compliance with the reverse of the entrance data set, i.e. has it left the zone by tracking the set-up cycle's entrance backwards? If the answer is "No", control loops back to FIG. 16 through (D) without a change of force.

[0353] If "Yes", then control passes downward to the statement block at the bottom right and the force is changed to that called for that zone during the set-up cycle while the oar was moving in the return direction, as in going from 6 to 6' of FIG. 19A. Control then goes back to FIG. 16 through (D) to begin the testing for entrance to a different zone.

[0354] In this way all of the tolerance zones are tested for compliant oar movement, causing forces at the magnets to be changed automatically to those instituted at the exercise's set-up cycle if the passage of the oars is compliant, and maintaining existing forces when non-compliant.

[0355] The control module can receive verbal commands at any time during an exercise. Verbal commands may be given that cause force changes to be applied at any tolerance zone entered. At the user's discretion verbal commands may be saved to become permanent parts of an exercise.

FIG. 18: Creating an Exercise to be Stored: The Set-Up Cycle

[0356] FIG. 18 is a flowchart of the process for creating an exercise to be stored.

[0357] Entering FIG. 18 at (A) from FIG. 16, a decision is called for as to whether or not the exercise being created is a timed one. If it is to be timed, then control moves to the right, to the statement block for this. A timed exercise does not use tolerance zones. Forces are not automatically changed per oar position in timed exercises.

[0358] During the set-up cycle of a timed exercise forces can be verbally assigned to change at specific elapsed times, but not oar position. Changes of force and their times of occurrence can be altered later during the actual use of this type of exercise.

[0359] After creating a timed exercise control is routed back to FIG. 16 through point (B) for the exercise to be stored. It can be used immediately if desired.

[0360] If the decision is made that a timed exercise is not the type to be created . . . that is, a tolerance-zoned exercise is to be created, then control moves downward through several statement blocks of FIG. 18 that call for initialization/calibration; oars being brought to the starting position; verbally commanding the beginning of data sampling; beginning to move the oars through the set-up cycle of the intended exercise; receiving, applying and storing verbal commands.

[0361] Next on the left side of FIG. 18 at the bottom, is a statement block that calls for the creation of tolerance zones. Temporary oar stopping points are called for at each oar position where automatic force change is desired. These stopping points are oar vector data used as reference points for the system to help create the tolerance zones and help enable automatic force changes during actual exercise.

[0362] Beginning from the upper right of FIG. 18 are two statement blocks that call for the creation and storing of these data sets. The first of these two blocks calls for the establishment of "entrance data sets". The entrance sets are gyro/accelerometer readouts in the form of vectors, just as the stopping points are. But the entrance data sets describe the movement of the oars upon entering the tolerance zones, up to the oar stopping points. They describe motion, not a fixed location as do the stopping points. This movement described in vector form extends from the crossing of the zone's boundary inward to the stopping point. The data is saved in sequential order relative to its respective stopping point.

[0363] The second of the statement blocks on the right of FIG. 18 calls for the establishment of "exit data sets". These are of the same nature as the entrance sets, except that they extend from the oar stopping point within a zone out to the crossing of the zone's boundary at an oar's exiting the zone.

[0364] A statement block is next on the right that calls for discarding the oar orientation data that lies between the tolerance zones . . . whether done individually or en masse. The particular exercise is verbally assigned a name and stored through (B) of FIG. 16.

[0365] Next near the bottom of FIG. 18 is a decision block that seeks to find out if the just-created exercise is to be used right away. If "Yes", then control passes back to FIG. 16 at (B) to enter the process of using a saved exercise. If "No", then control is moved downward to the last statement block. At this point either control passes to (B) of FIG. 16 to begin another activity or the session is terminated by the various means.

FIGS. 19A, 19B and 19C

[0366] FIG. 19A is a diagram illustrating a saved exercise. Tolerance zones are shown created at each force change point, here designated by circles. The circles indicate end views of the tolerance zones. The zones are described in the section on TOLERANCE ZONES as conical. They are right circular cones. The circles here represent cone bases, which are imaginary.

[0367] The figure's six movement exercise is composed of: Military press beginning at 1; lat pull-down beginning at 2; downward triceps extension at 3; standing abdominal crunchie at 4; and coming back up, a dead lift at 5; reverse curl at 6. The series finishes up at 1, the starting point.

[0368] The oar path curves appear spaced apart in FIG. 19A, but this doesn't need to be the case during actual use, because the "return" oar path can be done away with since the return path is substantially the same as the forward (outgoing) path when the sequence of the forward path is "flipped around". So that the forward path could be chosen to be saved and used to test for compliance in the cases of both forward and reverse oar directions. Using only one of the oar paths should simplify the processing system's task and may result in memory and part savings.

[0369] FIG. 19B is an expanded view of FIG. 19A involving the two middle tolerance zones, with the oar moving in the forward (outgoing) direction.

[0370] FIG. 19C is a perspective wireframe view illustrating a typical zone's imaginary base and its oar stopping point vector with some of the cone's wall boundary vectors generated about it. The wall vectors are shown coming to a common point at the center of the oar's magnetic sphere, where they also share that one point with the oar's orientation vector. The zone is illustrated without its entrance or exit data sets.

[0371] The oar and its orientation vector rotate about the center of the sphere, in this case in the direction shown. The oar's orientation vector, by rotating about the sphere's center, can become co-incident to one of the stationary wall vectors while passing into the tolerance zone or in exiting the zone while passing through.

#### A Discussion of Vectors

[0372] As concerns distance we are in a 3-space world. That is, our experience involves the three dimensions of length, width and height. Each of these is in a direction that is at right angles to the other two.

[0373] Commonly in mathematics the three directions are designated X, Y and Z. Movement or position to the left or right of some point of reference, as we face it, is typically considered to be along the X axis. An example of movement along the X axis is the direction of reading along the lines of writing here . . . from left to right, or also in the direction of cursor return to begin a new line . . . from right to left. Movement to the right is considered positive, and that to the left is negative.

[0374] A direction that is straight in to or out from this screen or page is assigned as the Y axis. Out from the page is considered positive and in to the page is negative. The vertical direction is assigned as the Z axis. Up is positive and down is negative.

[0375] Linear vectors (here, "vectors") are straight lines in space. Mathematically a vector is a directed line segment between two points in our familiar 3-space. Each of those points has a mathematical description of the form  $aX + by + cZ$ , where a, b and c are whole numbers such as 4, 0 or -7. An example of two points in space is  $(X - 5Y + 3Z)$  and  $(2X + Y + 4Z)$ , relative to a reference point of (0, 0, 0). If we assume that a line drawn between two points begins at one point with coordinates (1, -5, 3) and extends to a second point (2, 1, 4), then the vector between these two points is the difference between their positions, which would be the terminal point minus the initial point. Using algebra, the coefficients of each axis are grouped together and the first point is subtracted from the second point, yielding:  $(2 - 1)X + (1 - (-5))Y + (4 - 3)Z = (1X + 6Y + 1Z) = (X + 6Y + Z)$ , or a vector in the (1, 6, 1) spatial direction, relative to the (0, 0, 0) origin.

[0376] The vectors used by the present embodiment are described more simply. They are "radius vectors". This is because all of an oar's vectors must have the center of the respective magnetic sphere as a common point. That is, each gyro/accelerometer has its centerline passing through the center of its sphere at the end of the oar, (refer to FIGS. 5 and 19 C). When the oar is moved (rotated about the sphere) all of the vectors that are generated, no matter where the oar is, pass through the sphere's center.

[0377] The sphere's center is fixed in space, since it doesn't translate (move in relation to any of the axes) when in use. It only spins around. This implies all of the vectors have one of their points in common, an immovable point. And not only do all vectors of each oar have one point in common, but that point can be considered to be the point of origin of each oar's vectors. So that using the terminal point in the above example, the radius vector may be described as  $(2X + Y + 4Z) - (OX + OY + OZ) = (2X + Y + 4Z) = (2, 1, 4)$ .

[0378] This vector approach is similar to a searchlight, while stationary at the ground, being rotated to any position. The light beam is the vector in this case and each direction it shines is unique from all other light beam directions.

[0379] That point will be wherever the gyro/accelerometer, attached to its oar, has been moved to by rotation about the sphere's center after calibration. In all the universe as far as that gyro/accelerometer is concerned, after calibration there is only one point (vector) with the designation of  $(2X + Y + 4Z)$ . Being unique, this vector can be discerned from all other vectors, which are all themselves unique.

#### A Further Note about Tolerance Zones

[0380] There is no need to measure a distance from the sphere that a gyro/accelerometer has traversed. An oar's gyro/accelerometer cannot have traversed any distance from its sphere. It is at a fixed distance, being fastened to the oar, which is fastened to the sphere. This simplifies the memory and computational requirements of the power control system.

#### The Tolerance Zones: Their Construction and Explanation . . . The Set-Up Cycle

[0381] Tolerance zone boundaries are vector envelopes in the shape of right circular cones about each oar stopping point. They are created during the set-up cycle at each temporary oar stoppage. A force amount is verbally assigned at each zone where a change is desired. The oar stopping point data, boundary vector data and verbal commands at each zone are saved.

[0382] As each oar's movement is variously stopped during a set-up cycle, the oar's angular orientation, which is its deviation from the zero angles established at calibration, is converted into vector form by its gyro/accelerometer and the process for constructing a zone occurs.

[0383] As an aid to understanding, a zone may be visualized as a slightly opened umbrella (see FIG. 19C). Its individual ribs are being considered here and not the umbrella's skin. The umbrella's central shank and handle are also important to the discussion. In this the umbrella has the far top of its shank stuck through to the center of a Styrofoam ball, which represents the magnetic sphere. And also, the umbrella's in-line handle (a handle that isn't curved) is at the location of the gyro/accelerometer on an oar.

[0384] Externally tolerance zones are sets of straight line vectors in 3-space. The large number of these vectors that form each zone are the walls (boundaries) of hollow right-

circular cones. A zone is here to be seen as a conical wall without a base. Each of these cones of vectors is a mathematical construct. These cone vectors are merely computed entities that surround a central vector that is generated as a piece of angular orientation data by each gyroscope at the points where an oar momentarily stops during the set-up cycle. See FIG. 19C.

**[0385]** An elaboration: An oar stops momentarily. The orientation data of the oar's current location in 3-space is read by the gyro/accelerometer. The processor then generates linear vectors that surround the oar stopping point. These vectors form that zone's wall, the vectors together forming a right-circular cone. These boundary vectors cross each other, forming the vertex of the cone. Each cone's vertex is at the center of its respective oar's magnetic sphere.

**[0386]** A fuller elaboration: These wall vectors, as mathematical constructs, form right-circular cones generated to symmetrically encompass an oar's stopping points during a set-up cycle. All of a zone's wall vectors are computed to pass through a common point which forms each cone's vertex. This vertex is computed to be located at the center of each magnetic sphere.

**[0387]** The gyro/accelerometer, along the centerline of each oar, is in line with the center of its sphere (see FIG. 5). As the oar is moved during exercise the sphere's center remains stationary in space . . . it does not translate, which is to move in relation to the three axes of space. The sphere is held in place by the swing arm/tower/canister mounting assembly **158/220/222** combination being locked during exercise.

**[0388]** But the sphere revolves, therefore the sphere's center revolves. The revolving center Has become a pivot point for the oar and the oar's attached gyroscope. An oar might not actually reach into a sphere as far as the sphere's center, but as the oar is being moved it can be considered as pivoting about that center.

**[0389]** As it is a right-circular cone with vertex at the center of a magnetic sphere, a tolerance zone flairs outwardly along its length as an observer would "see" it if he were looking from the sphere along the oar toward the handle. This borrows from the analogy of the slightly opened umbrella given above.

**[0390]** The cones do not have bases. But an imaginary base can be visualized as a circle, slightly larger in diameter than an oar. This circular base has as its center the gyro/accelerometer's major axis, which is the gyro's center of measurement. A cone's wall vectors are substantially evenly spread out around the circle and touch its perimeter. This implies that the wall vectors are substantially symmetrically disbursed about each oar stopping point orientation vector, which is by analogy here the shank of the umbrella. The wall vectors are analogous to the umbrella's ribs.

#### The Relationship of Orientation Vectors to Conical Tolerance Zones

**[0391]** Assume the partially opened umbrella that represents the conical tolerance zone mentioned above is laid down upon an infinitely thin straight wire on top of a desk and that the wire is in contact with one of the umbrella's ribs, which represents a single wall vector, all along each of their lengths. The straight wire represents an oar's constantly changing orientation vector, which gives the oar's instantane-

ous position in space. In this illustration the vector is contacting the cone's wall, unlike in FIG. 19C where it is at the cone's center.

**[0392]** The large number of a cone's wall vectors all intersect at the cone's vertex, which is the sphere's center. And the orientation vector is in contact, per the assumption just made, with one of the cone's wall vectors all along their lengths. Then by implication the orientation vector also intersects all of the wall vectors at the center of the sphere.

**[0393]** The wire represents a single oar orientation vector. This vector has been generated as a gyro/accelerometer location datum, representing just one instant of an oar's travel. These orientation vectors are constantly being generated, one for each instantaneous unique oar position as the oar rotates about the center of its sphere. There can be an infinite number of these unique oar locations.

**[0394]** Just as a straight wire that runs directly along the length of a partially opened umbrella cannot be in contact with more than one rib at a time, an oar's instantaneous orientation vector can be in contact with only one of a cone's large number of surface vectors at any one time, with the exception of at the vertex.

**[0395]** Keep in mind that during oar movement a gyro/accelerometer's orientation vectors each represent the centerline of the oar at that instant. So since a cone's surface vectors are fixed in space and all of those surface vectors cross at the center of a magnetic sphere, and an oar pivots about the center of that sphere during use, the oar's orientation vectors are able to come into contact with any one of a cone's stationary surface vectors, but only one stationary cone vector at a time (see FIG. 19C).

**[0396]** Unique orientation vectors are constantly being produced with the oar pivoting about the sphere's center, and are constantly being compared to the stored stationary wall vectors that make up a tolerance zone's fixed conical walls. This is important.

**[0397]** A vector is identical to another that has the same component values along the three axes (X, Y, Z).

**[0398]** To illustrate, let a stationary vector ( $3X+5Y-2Z$ ), describing a fixed straight line in space within a zone's mathematical wall, be approached mathematically by a succession of continuously generated, instantaneous, unique vectors produced by the radially moving gyro/accelerometer. If that moving generator of vectors happens to produce a vector that temporarily overlays the fixed, stationary vector, then the instantaneous vector that describes the moving generator's position is mathematically identical to the single stationary vector ( $3X+5Y-2Z$ ). Keep in mind that the moving vector is identical to the stationary vector only for the length of time it overlays it in passing, except if the moving vector comes to rest on the stationary vector.

**[0399]** As long as two straight lines (vectors) . . . one stationary and one able to be pivoted all around . . . always share one point fixed in space (in this case the center of a magnetic sphere), the movable line could be pivoted about that common point and come into contact with the stationary line. This contact is the overlay, the mathematical identity between the two vectors.

**[0400]** In coming into contact with each other, the two will at that instant have become mathematically identical, the same vector. And in the next instant, should the orientation vector move away, even infinitesimally, to another location, the prior identity of vectors will no longer exist. They will have become two distinct vectors again. Vectors substan-

tially coming into contact . . . that is approaching within pre-determined limits . . . is a main modus operandi of tolerance zones in controlling the magnetic force at the spheres.

**[0401]** After oar calibration at the beginning of each exercise session the oar's departure from the zero calibration point (the zero vector) is continuously read. These readings are the orientation vectors that the processor uses to decide where an oar is located in space, that is, in relation to the zero vector. As any one of an oar's constantly generated orientation vectors approaches and substantially coincides with . . . even instantaneously . . . any of the wall vectors of a stationary tolerance zone, this coincidence is detected by the processor and then used.

**[0402]** To sum: When a pivoting oar's constantly changing orientation vector is revolving about a fixed common end point that is shared with a collection of immovable vectors, the pivoting vector can sweep through space, and at some point its constantly morphing mathematical description may substantially overlay that of one of the stationary vectors.

**[0403]** Any two substantially overlaid vectors are considered identical. The changing relationships between vectors can be constantly tested and their actual or near co-incidence, even if lasting for only a very short time, can become known and used by the present embodiment. The system can thus compare the very large number of individual moveable vectors constantly being generated one at a time by the oar's gyro/accelerometer to the large number of stationary vectors of each stored tolerance zone. The system can then respond accordingly.

A First Use of Tolerance Zones: Has an Oar Entered or Left a Tolerance Zone?

**[0404]** When the oar's orientation vector, which constantly describes each instant of the oar's pivoting sweep through space, becomes substantially identical to one of the stationary wall vectors of a tolerance zone, the processor analyzes the event.

**[0405]** Substantial contact (co-incidence or overlay) between an orientation vector and any tolerance zone vector tells the system an important piece of information, namely that an oar is either entering or exiting a tolerance zone's cone. Which of the two scenarios is occurring is confirmed by immediately adjacent orientation data from the gyro/accelerometer. The case of an oar's orientation vector contacting the zone's wall, but not penetrating, will not affect the system and is ignored.

A SECOND USE OF TOLERANCE ZONES: What is Inside the Zones?

**[0406]** A tolerance zone contains two things from the set-up cycle beyond an oar's stopping point orientation: An "entrance data set" and an "exit data set".

**[0407]** Entrance and exit data sets track an oar's progress within each zone. The sets are groups of vectors that are sequentially generated by the gyro/accelerometer and permanently saved, unless a command is verbally given to discard the particular tolerance zone. As do all of the orientations of an oar, they represent angles of deviation from the zeroed-out calibration angles.

**[0408]** All oar orientations, including oar stopping point orientations, zone boundaries and entrance and exit data sets are of the same nature . . . vectors in 3-space . . . so that there

is no difference qualitatively inside a zone between an oar's stopping point orientation vector and the zone's entrance and exit vectors. The only difference is that of location in space.

**[0409]** The entrance data vectors are generated by the gyro/accelerometer from the point of crossing a zone's boundary to enter a zone, up to the stopping point. The exit vectors are generated from the stopping point out to the oar's exit through the zone's boundary to the outside.

**[0410]** A zone's data sets, in conjunction with the stopping point, serve to allow the system to know whether or not to change an applied force at the respective magnetic sphere to another force. A force change occurs at the system's determining that an oar's path in a zone substantially parallels both the entrance and exit data sets inside the zone, in either the forward or reverse direction, and has traveled sufficiently closely to those sets and the oar stopping point between the two data sets.

The Creation of Entrance Data Sets . . . The Set-Up Cycle

**[0411]** An entrance data set is a saved sequence of orientation data samples generated by a gyro/accelerometer during the set-up cycle. It extends from the point at which an oar enters a tolerance zone up to the oar's stopping point inside the zone.

**[0412]** Some reverse engineering is needed to create the entrance set. During the set-up cycle, as the oar is stopped momentarily and the conical zone boundaries (vectors) are created about the oar's stopping point orientation, the zone boundaries come into existence before the entrance data set has been created in its final form. This is because the zone's boundary is created after the oar has stopped within the space that will then contain the zone.

**[0413]** And since the boundary (the cone's wall) is created after the oar is inside and momentarily stopped, it is necessary to have temporarily saved the oar's path from prior to entering the zone up to the stopping point within the to-be-created zone. Then the orientation data that exists on the inside of the zone, from entry up to the stopping point, is permanently saved. The oar path data existing prior to the oar entering the newly created zone is discarded. This discarded orientation data lies outside the zone to the rear, so to speak.

Expanding this a Bit: Constructing the Entrance Data Set

**[0414]** An oar's gyro, once it has been energized and calibrated, is constantly sampling its orientation. As an oar reaches a momentary stopping point during the set-up cycle, and the zone has been created about it, oar path data that has been generated and temporarily saved is called into play. This oar path data extends all the way from the oar's point of exit from the immediately preceding zone's boundary forward to the current stopping point (see FIG. 19B).

**[0415]** The most recent part of this data, including that from the entrance point at the current zone on in to the oar's stopping point, will become the entrance data set within the current zone and permanently stored in the sequential order it was sampled. The rest of it to the rear, from the entrance point at the current zone on back to the exit point from the preceding tolerance zone, will be discarded. The entrance data set for a zone has now been created.

**[0416]** So that the scenario is: The oar stops momentarily; the conical zone is created about the stopping point; the temporarily saved oar path data extending from the exit from the immediately prior zone forward to the new stopping

point is analyzed in relation to the new tolerance zone's boundary vectors; the path data extending from the entrance into the new zone up to the stopping point is permanently saved in sequence; the oar path data found to be between the new zone's boundary vectors on back to the previous zone's boundary vectors is discarded.

**[0417]** Preserving the sequence of the data sampling is important, as there are choices to be made during actual use as to whether the oar is traveling in the forward direction of the set-up cycle, or in the reverse direction. This was mentioned in relation to the decision blocks of FIG. 17.

**[0418]** One proviso: During actual use the present embodiment allows for the creation of new tolerance zones disbursed among and incorporated within an existing exercise regime. Now since only the data inside the existing tolerance zones will have been permanently saved previously, there wouldn't be basis for the creation of new tolerance zones, i.e. all oar orientation data between zones would have been discarded during the set-up cycle, so that a new entrance data set couldn't be created using the discarded data formerly between zones. But . . .

**[0419]** A verbal command may be given during actual exercise that will cause the processor to temporarily save all of the oar path data from the point of issuance of the command up to the newly desired zone's oar stopping point. The new tolerance zone and its data sets, both entrance and exit, are then created in the same way as during the set-up cycle. Since after any of the tolerance zones are created there is no orientation data lying between them, the processor treats this new zone just like the originals. None of the data or the automatic force change levels within prior existing zones is disturbed.

#### Creating Exit Data Sets . . . The Set-Up Cycle

**[0420]** During the set-up cycle, with the tolerance zone and the entrance data set having just been created at the oar's stopping point, verbal commands would typically be given to assign a force while the oar is still stopped temporarily.

**[0421]** As an oar begins to move beyond its stopping point, the oar's data path is in the process of exiting the zone. The data between the stopping point and the oar's crossing over the zone's boundary in exiting is permanently saved. This data is the exit data set. The data is kept in sequential order just as with the entrance data set. This allows differentiation between oar movement in the forward direction or the reverse direction later during actual use.

**[0422]** When the oar path within the zone reaches as far as the tolerance zone boundary, that part of the path that extends beyond the boundary is temporarily saved, not permanently so. It is kept available for the creation of the entrance set of a next zone further on. And once a further zone and its entrance data set are created, the oar path data to the rear, between the zone just exited and this further one is discarded.

#### Operation of the First Embodiment

**[0423]** In addition to this first embodiment being designed to be kept in assembled form at a location such as a home, office, fitness center or permanent sales location, it is also designed to be moved around in those locations or carried in disassembled form into and from homes or businesses by those wishing to demonstrate its use.

**[0424]** The embodiment is modularized and light weight. This allows the home party-plan to be used in marketing. The demonstrator would unload the modules from her car, carry them into the home of the party giver, easily put the modules together and demonstrate the embodiment's use. Disassembly in order to load the demonstration unit into the car after taking orders for the product is also a simple process.

**[0425]** FIGS. 6A and 6B: Note that the part of the power cable 112 that spans the distance from the power control module 420 on the right spherical electromagnet canister assembly 162 to the one on the left side, connecting the two, can be replaced by a power track system, not shown, which would run within the embodiment to connect the two electromagnet assemblies electrically. This will eliminate the need for the externally visible interconnection shown, producing a cleaner appearance and greater ease of use.

**[0426]** FIGS. 6, 7, 8 and 10: The embodiment is modular. FIGS. 6A and 6B depict the following module types. There are two spherical electromagnet canister assemblies 162 (FIGS. 6A, 6B and 10B) affixed to their canister mounting assemblies 222 (FIG. 10C). There are two oars 102 (FIGS. 6A and 6B); two tower assemblies 160 (FIGS. 6A, 6B and 10B, not including the canister assemblies 162); two swing arms 158 (FIGS. 6A, 6B and 8A); the locking swivel base 156 (FIGS. 6A, 6B and 7A); and the platform 152 (FIGS. 6A, 6B and 7A). Counting the electrical cables 112 to be among the power control system comprised of the module 420 and the two gyro/accelerometers 421 (FIGS. 5 and 6A, 6B), there are eleven modules in all.

**[0427]** Should the non-electric, non-magnetic components be made of light weight material, for instance carbon fiber, it will be the case that the two spherical canister assemblies 162 could be carried by hand as a unit, in similar fashion to two bowling balls in one bowling bag, together with the power control system 420, 421. One tower assembly 160, one oar 102 and one swing arm 158 would be a unit, making two of those particular portable units, with both units able to be carried in one trip into and out from a home. The platform 152 is a third transportable unit and the locking swivel base 156 a fourth. The platform 152 and the swivel base 156 could become a combined third transportable unit. This can make for three comfortable trips from a car to the party giver's home.

#### Assembly of the Modules

**[0428]** FIG. 7A: The locking swivel base 156 is placed on the floor. The platform 152 is placed on top of the swivel base with the swivel base in the desired platform trough 164.

**[0429]** FIGS. 8A, 8B and 6: For each swing arm 158 the handle of the levered cam 178 on the locking swivel assembly 176 is raised to allow insertion of the swing arm to the vice jaws (182, 186) of the locking swivel assembly. The swing arm is inserted while being watchful to not insert the end of the swing arm that has the button locking hole 214 of FIG. 9B, should the swing arms have locking holes.

**[0430]** The approximate desired operating length of the swing arm is then adjusted by sliding it inward or outward at the locking swivel assembly 176. The swing arm is then rotated parallel to the floor through to the approximate angle at which to connect the tower assembly 160 to the swing arm. At this time the levered cam 178 of the locking swivel assembly is left up, in the unlocked position for further adjustment if necessary.

[0431] As FIGS. 9A and 9B show, for tower assemblies 160 with swing arm studs 210, the tower assembly is attached and locked to the swing arm 158 by depressing the spring button 212 in the swing arm stud and sliding the swing arm onto and along the stud until the button locking hole 214 of the swing arm allows the spring button to come up through the locking hole.

[0432] FIG. 10: With the swing arm 158 having been rotated through to its approximate desired floor position and loosely held in place by the procedure so far, a sliding collar 226 and its integral canister mounting assembly 222 and affixed spherical electromagnet canister assembly 162, can be slid down over the top of the tower 220 and secured in position by pulling back on the sliding collar lock 228 and lowering the collar down along the tower. The spring loaded bolt of the sliding collar lock is then released into the appropriate locking hole 230.

[0433] FIGS. 6, 8: Assuming the embodiment does not utilize an offset vice system 232 (FIG. 14), the user at his discretion may give the swing arm 158, along with the tower assembly 160, an adjustment for floor position. This can occur by comparing position of the handle of an oar 102 installed at a sphere 104 in a mounted canister assembly 162 to the desired position of the handle when the embodiment is to be used. Using this as a gage, adjustments can be made as necessary.

[0434] FIG. 8: At the swing arm's locking swivel assembly 176 the handle of the levered cam 178 on the swivel assembly is then lowered, locking the swing arm tightly in the jaws (182, 186). Relocating a tower assembly upon the floor, or adjusting the height of the electromagnet canister assembly on a tower (FIG. 10) during an exercise session is easily done.

[0435] FIG. 14: If the tower assemblies do have the offset vice system 232 that adjustably fastens the swing arm 158 to the floor plate 218, there wouldn't be button locking holes 214 (FIG. 9B) in the swing arms, so it wouldn't matter which end of the swing arm is inserted to the locking swivel assembly 176 at the swivel base 156 (FIG. 8A). The procedure to fasten the swing arm to the tower assembly's floor plate would then be the same as for fastening the swing arm at the platform 152 end of the arm. The swing arm is inserted to the vice jaws (182, 186) at the tower's floor plate, but for adjustment purposes, perhaps not yet locked into place.

[0436] FIGS. 8, 14 and 15: Assume the embodiment uses the offset vice system 232 at the floor plates 218. With the swing arms 158 inserted to the platform's locking swivel assemblies 176, and with that assemblies' levered cams 178 unlocked, the arms can be swung to the angular positions desired on the floor and the lengths then adjusted by sliding the swing arms within the jaws of the platform's locking swivel assemblies 176. The levered cams at the platform's two locking swivels can then be locked down. This sets the swing arms' angular positions in relation to the platform, but not the towers' 220 distances from the platform.

[0437] Now assume the swing arms are locked in place at the platform's 152 swivel assembly 176. Referring to FIG. 15 the swing arms 158 in this scenario would be fully extended at right angles to the platform. At the outer ends, the levered cam 178 of each tower assembly's vice jaws (182, 186) of FIG. 14, is lifted to vertical, allowing the jaws to accept the insertion of the tower assembly 160 ends of the swing arms.

[0438] The tower assemblies can then be slid along the stationary swing arms to their desired locations (FIG. 15) using the oar-to-platform distances as a gage, and then locked in position. The offset vice system 232 allows each tower assembly 160 to be able to be adjusted and used with greater flexibility than if the swing arms are mounted to the floor plates 218 without this system.

[0439] FIGS. 1, 6 and 10B: If not already done, a sphere 104 is placed upon the spherically contoured shell halves 106 of each electromagnet canister assembly 162. An oar 102 is inserted to each sphere's oar tube 100 and cinched down with the lock ring 103. The gyro/accelerometers 421 can be installed to the oars.

[0440] FIGS. 6A and 6B: The power control module 420 is attached at the front of one of the canister mounting assemblies 222 and plugged in to an AC outlet. The inter-connecting cables, if the system uses them, are attached at the canister assemblies 162.

#### Using the First Embodiment

[0441] The truly beneficial effects of this embodiment shout to the world. Unlike weights, which can only offer a downward force to be overcome, the present embodiment can offer resistive force in any direction in which the oars are moved. This is revolutionary. This is a new world for exercise enthusiasts and spells the future for aerobics and cardio training, slimnastics, endurance training, bodybuilding, even weight lifting . . . almost any physical development activity.

[0442] The upper and lower body can receive a complete workout, virtually free from the possibility of injury. From the young and athletic to the geriatric, from the healthy to the physical therapy patient, and those in hospitals . . . all will benefit immensely. The embodiment can be utilized by patients in hospital beds, and even in aquatic therapy, as it is able to be used under water in therapy pools. The power control module 420, with its speech processing subsystem would not be submergible, but the gyro/accelerometers can be made water tight.

[0443] With resistance provided efficiently with any of the oars' orientations, complementary muscle systems can be exercised. For instance, the complementary system to that needed to push overhead in a pressing movement can then immediately be used to pull the oar handles downward as a lat pull-down. This works for any and all exercise movements. You can have it both ways. You can actually have it myriad ways. You cannot do this with free weights or weights with pulley systems. You cannot do this with springy exercise systems or momentum driven systems.

[0444] The user can exercise one muscle system, and in continuous fashion move into other directions and muscle systems, even unrelated ones such as triceps and then calf muscles, and then the lower back muscles, and on to others. This opens the door to wonderful circuit training of muscle groups, even complementary groups, all over the body. A large variety of dissimilar exercises can be strung together in ensembles. Curved motions can be mixed with linear, pushing with pulling, horizontally rotating with bending, all thrown together in logical series or eclectic mix. Whatever is desired. And the resistance forces offered can be controlled and varied throughout or stay constant, at user discretion. There has never been anything like this system.

#### A List of Possible Verbal Commands and a Foreseen Problem

**[0445]** A vocabulary of commands to be understood by the speech recognition processor may include, but isn't limited to, the following: "Initialize, Calibrate, Start or Begin, Stop or End, Terminate, Pounds—Plus (and then a force amount), Pounds—Minus (and then a force amount), Blend, New, Okay, Release, Any particular saved exercise name, Modify, Reserve, Save, Save as, Repeat, Reverse, Add zone, Subtract zone, Exit, Temporary exit, Re-enter, Incorporate, Timer (and then a specific number of minutes and seconds), Speak, Feedback, Delete, Accelerate". Some of these terms are used in the following explanation of the embodiment's use. It is possible that other words would be substituted for the above for ease of recognition by the processor. It is also contemplated that the user may develop a personal vocabulary to be used.

**[0446]** In a fitness club situation, where there may be multiple pieces of this equipment operated concurrently, there is the possibility that a user, in giving verbal commands to the equipment he is operating, will have his commands recognized by another speech processor nearby. This would obviously cause problems. It may be necessary for each piece of equipment to be addressed with its own prefix, for instance "Number Eight . . . (and then the command)". There are other things that could be done to solve this problem . . . perhaps directional microphones that will only pick up sound from particularly narrow corridors, or a microphone sub-system located in one of the gyro/accelerometers attached to an oar that will only pick up a voice in close proximity.

#### Using the First Embodiment . . . Non-Tolerance Zone Exercises

**[0447]** After setting up, the gyro/accelerometers **421** can be turned on. The power control module **420** can be turned on and then initialized to zero force at the spheres by giving the verbal command to initialize. Initialization sets the magnetic force at the spheres to zero at any time while the power control module is turned on.

**[0448]** Initialization is different than calibration. Initialization is useful when oar orientations are not important to the exercise, in other words, for non-tolerance zone exercises. These occur as two types: As verbally directed free-form exercises, which are those that have force changes brought about only by spoken command. The other type is timed exercises, which are exercises that have force changes according to elapsed time, not oar position.

**[0449]** Initializing the system can be done with the oars in any position. To initialize the system all that is necessary is to give the verbal command "initialize" or its equivalent at any time while the power control module **420** is on. This will clear any applied forces at the magnetic spheres, setting them to zero. The oars can then be moved in any direction without resistance, and force can be added with the knowledge that that particular force was added to "zero", not a pre-existing force.

**[0450]** An important reason for a distinction between initialization and calibration is that calibration is reserved for exercises that utilize tolerance zones and oar position. Since tolerance zone exercises require the onboard batteries to be powering the Patent gyro/accelerometers in order to produce position vectors, there is battery drain during these

exercises. Free-form and timed exercises don't use the gyro/accelerometers, so don't cause battery drain, allowing the gyros' onboard batteries to hold their charge longer. The method and importance of calibration is brought out in the section "USING THE EMBODIMENT . . . Tolerance zone exercises", below.

#### Timed Exercises

**[0451]** Timed exercises use forces that have been verbally designated to be applied for desired time increments, independent of oar position. The time duration at each force level is controlled by a timer in the power control module. Timed exercises can be created, saved and called up for use.

**[0452]** As an example of a timed exercise the user may give the command: "Timer—two minutes—force twenty. Timer—one minute—force fifteen. Timer—thirty seconds—force ten. Save as Cool-Down". This will create and save an exercise regime with the name "Cool-Down" that utilizes those three forces, each for the specified time duration, without regard to oar position. At the end of the three time periods the applied force will go to zero.

**[0453]** The user can go through the regime right away after creating and saving it. He would be able to take the oars in any direction for the specified times and with those forces. He could repeat this regime by saying "Repeat" at the end of the time periods. Or possibly the system will either be powered down by giving the verbal command "Terminate" or simply letting it be shut down automatically from inactivity.

**[0454]** During any period of a timed regime, it is possible to verbally institute and save force changes. If for instance in the midst of the first period, that of two minutes and a force of twenty pounds, the user decides to increase the force to twenty-five pounds, he may say "Modify—force twenty-five—save". Even if only a short time remains in the two minute leg, the force will become twenty-five pounds from that point forward until the end of that particular time period. It will be the force applied during the entirety of that time period for all future uses of that particular saved exercise until modified again.

**[0455]** And the time segments can be changed on the fly. If during the two minute period the user wants to lengthen the time at that force to three minutes, she may say: "Modify—timer—three minutes—save".

#### Free-Form Exercises

**[0456]** Use of the embodiment for non-timed, non-saved, ad hoc exercises without tolerance zones is practically unlimited. And though this section concerns free-form exercises, the particular movements mentioned can also be incorporated to timed exercises and tolerance zone exercises.

**[0457]** After the power control module **420** is powered on and initialized, simply by speaking the word: "Initialize", there is no magnetic force applied at the spheres **104**. The user can bring the oars **102** to the desired exercise start position. Next the control system is told how much frictional force to produce at the spheres by the user speaking for instance, "Pounds—twenty". In metric countries the verbal commands for the numeric amounts would be in kilograms and probably in a different language.

**[0458]** It is to be noted that any exercise mode sees more than the verbally commanded attractive force being applied

at the spheres **104**. This is because the oars are in reality levers and are being used to cause the spheres to overcome a sliding friction, not directly lift a weight from a rest position as with free-weights. So that in order to create a stated “felt” force at the end of the oars something in excess of that force must be applied at the surfaces attracted to each other at the sliding interfaces of the spheres **104** and spherical shell halves **106**.

[0459] Also, the force of twenty pounds in the above example is predetermined to be felt orthogonally (at a right angle) to the oar handles, just as with a dumbbell or barbell being lifted straight up. This necessitates that forces applied at the spheres undergo compensation for the angular sweep through which the oars move. This will be explained more fully in the section: “USING THE EMBODIMENT . . . Tolerance zone exercises”.

[0460] As mentioned, in free-form exercises the user can move the oars in any arbitrary direction and any scheme of movements, changing resistances verbally as desired.

[0461] In quick overview of some exercises benefiting the arms and upper body, while the user is standing with the oars directed straight inward toward her from the sides at 90°, at approximately shoulder height, some combination movements she can do with an overhand grip of the handles are:

[0462] military presses and then lat pull-downs; triceps kick-ups (extensions) from behind the neck and then overhead reverse curls to bring the oars back to behind the neck; triceps extensions from shoulder height, pushing downward to the waist and then reverse curls bringing them back up to the start position; pressing to overhead and then straight arm pull-overs to the waist and then back to overhead; overhand rowing; chest-pulls from waist to chest height and then pushing the oars back down, simulating dips.

[0463] All of these and more can be done while standing in place. If the grip is reversed to underhand, regular curls plus relatives of each of the above movements can be accomplished. And note that all of the different movements can be joined together in ensembles to form non-stop series.

[0464] The following are a sampling, categorized within three body areas. As with any oar movements, they can also be performed as saved exercises with tolerance zones for automatically changing forces or within timed periods. Imagination really is the limit. Note the muscle group complementarity as these movements are performed in bi-directional couplets.

#### The Upper Body

[0465] While standing upright with the oar handles nearly touching and the oars directed in a line across the user’s front, and the spheres **104** at about waist height, a flaring movement from the thighs up to where the oars are steeply inclined above the head can be done with the arms straight or bent, and then returned in reverse fashion back to thigh height.

[0466] With the oars approaching the user from either the front or the rear, a flaring movement can be accomplished from a standing bent position, beginning from knee height, rotating the oars upward and outward to the limit of reach, and then back down.

[0467] With the oars coming in from the sides, while standing or reclining, straight or bent arm pull-overs, and then returns to the starting position can be performed. Rowing and presses/pull-downs can be added for great benefit.

#### The Trunk Area

[0468] With the oars either spaced apart and parallel from the front or rear, or in a line across the front coming in from the sides, front bending stiff-leg crunchies can be performed while standing, and then their complementary stiff-legged dead-lifts in returning.

[0469] If the spherical electromagnet canister assemblies **162** are lowered on their towers **220**, which have been rotated around on the floor to be close to each other, and the oars brought to a substantially vertical orientation and held to the chest, twisting movements can be performed by rotating the trunk and shoulders in clockwise/counter-clockwise motions. This can also be done with one oar. An important feature is that the spine is not compressed by this exercise, as when having a weight bar atop the shoulders and twisting to perform “helicopters”, so a harmful grinding of the vertebrae against each other isn’t as likely.

[0470] And again, if the oars are held in the near vertical position, but while extending the arms out in front, the trunk-twisting benefit of the exercise can be amplified. Too, the towers can be spaced apart and the arms outstretched from the sides while gripping the inclined oars and twisting from side-to-side. Spacing the towers apart and extending the arms to the sides will cause resistance to be transmitted through the shoulders, upper chest and upper back, to their benefit also.

[0471] Side bends can also be done to good effect with this configuration. With arms straight out from the sides, standing side bends can be done that use the trunk muscles to do pulls from one side while simultaneously crunchies are being done toward the other side. And then reverse. And again, notice that the grinding from spinal compression would be minimized. Six-pack abs can be developed using these various trunk exercises.

#### The Legs and Lower Body

[0472] With the oars directed toward the user from any direction at shoulder height, squats may be performed. And the abdominals, chest and shoulders will benefit from their stressing in nearly isometric fashion during the downward movement. If desired the exercise can be performed with negligible or even zero resistance offered on the way down and a resistance designated for the upward return. If there is resistance in both directions there won’t need to be as much care as to body balance, since the oars will serve as steadying devices for the user, providing much greater safety compared to a weight bar on the shoulders.

[0473] The canister assemblies **162** can be placed at waist height or lower on the towers **220**, and squats performed with the oars held close at the user’s sides with arms stiff, or the oars held between the legs. Again, negligible or even zero resistance can be chosen for the dipping part of the squats. Ankle raises for the lower legs may be performed with the oars in similar positions.

[0474] From the standing position, with the canister assemblies lowered on the towers, and the oars directed at the user from any angle, the oar handles can be fastened to the feet or ankles by Velcro® bands or special shoes or slippers. This allows knee raises and then leg presses downward to return, a pulling upward and then a complementary pushing downward movement.

[0475] While standing, with the oars fastened to the feet and coming toward the user from the front, and the legs

straight, leg swings to the sides in a flaring movement, and returns, are a terrific toner and shaper, working the thighs, hips, buttocks and lower back in complementary fashion.

[0476] With oars oriented toward the user from the sides and fastened at the feet, stiff-legged front raises, also called “goose stepping”, can be performed. And then back-swings that pass beyond the vertical centerline of the body, can be performed. This will work the abdominals, thighs, hamstrings and lower back. And also with this oar orientation, standing leg curls to the rear can be performed, and complementary leg extensions in return, straightening the leg back down to the standing position.

[0477] With the canister assemblies 162 lowered and the oars coming in from the sides and fastened to the feet or ankles, the user can perform heel slides by sitting or lying at platform 152 level and drawing the heels up toward the buttocks and then performing presses to the straight-legged position with the heels still on the platform, or even elevated slightly. A fantastic bicycle movement that is fully complementary, with the feet elevated above the platform, is able to be performed while the user is lying on her back or even sitting in a chair.

#### With a Crossbar Attachment

[0478] By attaching a cross-bar to the oars that can slide along a portion of them in a way that doesn't allow contact with the gyro/accelerometers, an expanded exercise experience is provided, one that can closely resemble the use of a barbell, but without the dangers . . . but also experiences that are completely unique and unattainable otherwise.

[0479] One example of this uniqueness is the following: If the spherical canister assemblies 162 are at near shoulder height and the oars approach the user from the front and are spaced apart so as to be roughly in parallel, the crossbar allows a very different twisting movement. Starting from a horizontal crossbar orientation, and with arms extended to the front with a wide grip, the crossbar can be rotated in substantially the vertical plane, something like an aircraft propeller in a partial rotation. For instance the right arm could be rotated circularly upward to the left, while the left arm is rotated downward to the right, as far as comfort allows, and then reversing in the clockwise direction . . . and repeating. This will benefit the shoulders, upper chest and trunk areas.

[0480] Another interesting exercise with a crossbar is for the user to stand between the oars, which pass in parallel along the user's sides from the rear, and grasp the bar at the user's front with arms that are straight. To begin, bring the crossbar downward while bending forward with either bent legs or straight, and then come back to the upright position while bringing the crossbar from the knees to the overhead position with arms straight. Reversing and repeating benefits the abdominals, shoulders and back areas.

[0481] These two examples are simple two motion exercises. There are of course movements with a crossbar that haven't been mentioned that will benefit the upper, middle and lower body. Users will come up with personalized exercises to suit individuality.

#### Further Flexibility with the Embodiment in Free-Form Exercises

[0482] Assume the user starts out with twenty pounds of resistance in some free-form exercise. If the words “Pounds—plus three” are spoken at any point, or some other amount, the control module 420 will instantly increase the

force by three pounds, providing twenty-three pounds of resistance. This becomes a new constant resistance applied at the oar handles until the amount is changed by another verbal command.

[0483] A similar procedure is used for decreasing the poundage, where “Pounds—minus five” may be the command. Of course a decrease cannot take the resistance to below zero. “Pounds—zero” is a valid command, removing all resistance. Resistance can then be added back if desired.

[0484] Further, the user may desire to change the resistance at one of the oars 102 and not the other. For instance in the case of the right oar, the spoken command “Right—pounds—plus four” may be given. Or to decrease only the left side's force, the command “Left—pounds—minus two” would bring that about. And it's possible to use only one oar for an exercise or series of them. This merely requires that the appropriate command be spoken, such as “Right—pounds—fifteen; Left—pounds—zero”, when desiring to use only the right oar. And too, the left oar could simply not be used, its magnet changing force all the while as though being used.

[0485] Should the speech processor be programmed for it, and the hardware provided, if the user forgets the amount of force currently being applied, as can happen, the voice command “Speak” or “Feedback” could cause the control module 420 to audibly recount the force amount in pounds through a speaker. Adjustments to the applied force can then be conveniently made if desired.

#### Something Very Unique

[0486] Prior to this the accelerometers haven't played a prominent part beyond calibration. But their incorporation to the system provides an opportunity to create an exercise device even further differentiated from anything else on the market.

[0487] As an example using the two zones at the extremes of FIG. 19A, that is, zone 1', 2 at the top and zone 4', 5 at the bottom, an exercise can easily be created . . . with automatic force changes . . . that doesn't utilize tolerance zones.

[0488] Let's say the user wants 30 pounds of resistance on the way down and 40 pounds on the way up. Starting at the top and with the oars stationary, she might say: “Accelerate—30 pounds”. Moving the oars under that force to the bottom and stopping, she could then say: “Accelerate—40 pounds.” The accelerometer, sensing whenever the oars' acceleration comes to zero, in being about to reverse direction, will trigger the power control processor to apply the appropriate force at the spheres 104. It is possible to bring about force changes at more than two places and in more than two directions, even continuously along a circuit such as a circle, if the system is programmed to do so.

#### Using the First Embodiment . . . Tolerance Zone Exercises

[0489] Calibration . . . Reasons for calibration and its procedure

[0490] Calibration has to be performed in order to create and save exercises based on oar orientation. With these exercises the system needs to know the orientations of the oars during automatic force changes. This is illustrated by the following three arguments:

[0491] ONE: The tolerance zones are created at fixed, repeatable oar orientations in space. They are spaced apart in

various directions from each other. They must be referenced to some standard. Without a reference standard to tie the orientations of the oars during the set-up cycle to the user's later exercise sessions, he will have much trouble trying to consistently attain the tolerance zones . . . improper readings will be provided. A true reference orientation is independent of the user's position at any time and also independent of the combined exercise positions of the towers 220 and the spherical canister assemblies 162.

[0492] TWO: The user may perform an exercise in a different bodily position or footprint on the platform than during the set-up cycle. Without an independent reference orientation and the monitoring of an exercise's starting oar position, the exercise could be started from a position that will not allow completion of the regime.

[0493] For instance, for an exercise with both oars there may be tolerance zones created at the top of a pressing movement, with immediately following zones created 4 ft. lower. Assume that these lower zones would normally cause the oars to be brought to positions where they almost touch the rims of the spherical shell halves 106. Then if the user were at some time to begin the exercise from a starting orientation lower than during the set-up cycle . . . either because of their then body position or canister assembly 162 height . . . the oars may not reach down to the tolerance zones 4 ft. lower without prying the magnetic spheres 104 away from their being held magnetically in their shell halves. The system needs to know from where the starting point is being attempted so that alerts can automatically be given.

[0494] THREE: Keep in mind that it is desired to have the embodiment provide a constant resistance for the user to overcome during oar movement unless verbally commanded otherwise. This is to emulate the constant resistance of free weights. Assume, using FIG. 15A for illustration, that the oars form a straight line across the user's front and the user is standing directly in line with the two swing arms 158, with the hands touching the chest in an overhand grip of the oars. Assume also that the spheres are at shoulder height so that the oars are nearly horizontal.

[0495] Now in pushing the oars away to the front to fully extended arm positions, the first six inches will require less strength per inch of the hands' travel than the last six inches. This is because the user's force vector is at 90° to the oars' orientations at the beginning, and is at less than that, perhaps 60°, when finishing the movement.

[0496] What this means is that if at the beginning of the exercise the force needed to push away at 90° to the oars has some numeric value, say "F", that force is still going to be needed at 90° to the oars at the end of the pressing movement. But at the end of the movement the user's straight ahead push is at 60° to the oars. So now the user has to supply forces (force vectors) in two directions. One direction is still straight ahead of him as originally, and the other is at right angles to that. This is the way to look at the contributions of component forces that go to make up the whole from a physics standpoint.

[0497] The total force supplied by the user is no longer F, but is now composed of two force vectors at right angles to each other, F' and F". The square root of the sum of the squares of F' and F" equals F. That is,  $((F')^2 + (F'')^2)^{1/2} = F$ . But in the user attempting to push straight ahead the arithmetic sum of the forces in the two orthogonal directions supplied by the user is greater than F, that is  $(F' + F'') > F$ .

[0498] To capsule this third argument, If the system is to maintain a substantially constant felt resistance to the user through these angular displacements, as would be the case were free weights being lifted . . . in of course the vertical direction only . . . then the resistance force at the spheres 104 will have to be different when the oars are at the near-in position at the chest compared to the arms in the extended position.

[0499] The processor will need to compensate for the felt difference in required force over the angular sweep of the oars. The processor can only do this if it 'knows' what orientations the oars have at any instant. And it can only know the orientations if it has been calibrated to some point of independent reference. Calibration forms a reference point that allows the system to compensate over all oar orientations, tailoring the forces to the angles of the oars.

Creating an Exercise with Tolerance Zones

[0500] With the power control module 420 and the gyro/accelerometers 421 turned on, bring the oars 102 to the calibration position. This position is arbitrary with the user within the parameters of two conditions: ONE . . . the same calibration position needs to be used every time an exercise originally calibrated to that position during its set-up cycle is called up to be used. And TWO . . . the calibration positions for the two oars should be symmetrical and easily replicated. This is to say that the placement of each swing arm 158, tower 220 and canister mounting assembly 222 is to be "opposite-handed" of its counterpart. These three components on one side of the platform 152 are to be placed as mirror images of their counterparts on the other side, as far as positioning during calibration. And the same positioning and procedure are to be easily replicated each time.

[0501] The following is a useful component placement for calibration. It works for the stationary V-block swing arm mounting system 216 of FIGS. 9A and B and with only a slight modification for the offset vice mounting system 232 of FIG. 14.

[0502] Slide the swing arms 158 in to the center of the platform 152 so that they butt against one another at a mark at the platform's center. That mark should be provided in manufacture, one for each platform trough 164. The swing arms will then be in a straight line at right angles to the platform and symmetrically placed. Lock the swivel assemblies 176 to hold the swing arms in place.

[0503] A V-block mounting system 216 is always at maximum distance along the swing arms 158, but an offset vice system 232 may not already be. Slide that system out to its greatest distance along the swing arms if necessary. Lock it down.

[0504] Bring the spherical canister mounting assemblies 222 to their lowest locked positions on the towers 220. Rotate the oars upward to where they are resting against the inner edge of the towers.

[0505] Issue the verbal command "Calibrate". The gyroscopes and the accelerometers are thus set to zero. Any electromagnetic force at the magnetic spheres 104 is also set to zero.

[0506] Once the gyro/accelerometers are set to zero every movement from then on during the session will be processed and referenced to that zero. The accelerometer readings, in conjunction with the oar orientation readings of the gyroscopes, are important for the system to know where the starting tolerance zones are so they can be used.

[0507] The combination of the accelerometers and gyroscopes is sensitive to the towers **220** being moved along the floor in any direction and the canister mounting assemblies **222** being moved to a different height after calibration. This combination of gyroscopes and accelerometers is used to assess the spatial location of the starting tolerance zones. Once the locations of the starting zones are known, the system can operate in reference to those locations. And compensation can be provided by the processor according to this information when necessary.

[0508] Once the spheres' **104** locations are fixed in space prior to beginning the creation of an exercise by way of a set-up cycle or to use a previously saved exercise, the starting zones are then fixed in space according to the oar locations desired at the beginning of the exercise. This means that the oars are brought to their exercise starting points. From this point forward the gyroscopes come into play rather than the accelerometers. The gyros are free to accurately determine the orientation of the oars and cause the system to realize when the other tolerance zones are entered, and to provide the data used for automatic changes of force.

#### The Set-Up Cycle

[0509] FIGS. **19A** and **19B** are an example of a regime's set-up cycle to be created and saved.

[0510] After calibration the swing arms **158**, the towers **220** and the spherical canister assemblies **162** can be brought to their desired use positions, which for the regime of FIGS. **19A** and **19B** could be slightly less than shoulder high. The handles of the oars **102** are held with an overhand grip and brought to their starting positions near the shoulders.

[0511] At the verbal command "Start" the gyro/accelerometers send the starting zone's oar orientation to the processor. At that command a tolerance zone is created for the oars starting positions. This point is a reference orientation for locating the other tolerance zones of the regime.

[0512] At each stopping point of an oar a verbal command assigning a force level is usually given. If, say, Twenty-five pounds is designated at a stopping point, the processor would know to relate that force to that tolerance zone to bring about a change to that amount from a previous resistance force during actual runs of this exercise. Forces are assigned in this manner throughout the set-up cycle at the temporary oar stopping points. The exercise, with all of its tolerance zones and force changes is then saved.

[0513] Some Interesting Features

[0514] It will occur that the user's entrance to a zone will cause an alert and then the user will take the oar in the reverse direction, exiting the zone along a path in substantially the opposite direction of the entrance path it had just come in on.

[0515] This is what happens when the last tolerance zone in a string is reached and the processor alerts . . . for instance at the end of the standing crunchier at the bottom of the regime of FIG. **19A**, zone **4'**, **5**. The oar is then brought back up out of the zone in substantially the reverse of its entrance direction, causing the magnetic force to be applied that was called for during the set-up when the oar was moving in that particular reverse direction, **5** to **5'** of FIG. **19A**.

[0516] Because of the right side of FIG. **18**, the oar can continue on back through all of its previously traversed zones in reverse order, retracing the set-up cycle's movements in heading back toward the starting zone. This means

it re-enters the various zones, this time in the return direction, which is in reverse of their exit data sets in the outward bound or forward direction. The processor is alerted at the various oar stopping points and then the oar passes out of the zones in the reverse of their entrance data sets, for instance from **6** to **6'** of FIG. **19A** and then from **1** to **1'**.

[0517] In this fashion, cycling through the zones of FIG. **19A** from top-to-bottom, then bottom-to-top, can occur an unlimited number of times, with each compliant passage through a zone in the forward direction and then in the reverse, producing the force changes instituted during the set-up cycle.

A Deviation from the Set-Up Cycle of FIG. **19A**

[0518] After arriving at the bottom, which is zone **4'**, **5** of FIG. **19A**, the user may want to go from there directly to zone **1'**, **2** at the top, and then directly back down to zone **4'**, **5** at the bottom again, and then repeat between only those two positions, top and bottom. This is allowed. The changes to force will automatically occur. Any two or more zones can be used from a multi-zone regime to form a repeatable, temporary mini-regime during use. The zones merely need to be entered and exited compliantly. But an undesired zone shouldn't be accidentally compliantly gone through, otherwise the force will be changed to that of the mistakenly activated zone and remain that way until a further zone, hopefully a desired zone, is compliantly activated.

[0519] Tolerance zones can be created and yet not have a force level assigned to them at their creation. By stopping an oar temporarily at desired points during the set-up run, and then continuing on without verbally assigning a force, a tolerance zone is reserved for that stopping point, and can have a force change assigned to it at a later time, which may or may not occur, per the user's discretion. Until a change of force is assigned to a zone it is 'invisible' during an exercise regime, causing no change of force.

[0520] And new tolerance zones can be created within already existing saved exercises at any later time. And force changes at the zones can be modified or discarded verbally at any time.

[0521] Individual movements would usually be strung together in a series that has a change of oar direction and resistance at each tolerance zone, such as in FIG. **19A** as a whole. It is also possible that within a single movement of an exercise . . . as an example within the straight press upward from shoulder height, going from **1** up to **1'** of FIG. **19A** . . . that there could be several tolerance zones created by the user along that path. Each short segment could see a change of resistance. A series of short straight segments going from shoulder height to overhead, all in the same direction and linked together at their tolerance zones, could be created that would have an increase or a decrease along the way.

[0522] These changes of resistance could be stepwise changes . . . discrete changes that are individually noticeable, or the resistance changes could be caused to blend seamlessly into a continuous, smooth change of force. A stepwise change of force, or a blending, could take place within any part of an exercise, whether linear or curved.

[0523] Discrete steps of resistance change are brought about in the same way as ordinary resistance changes . . . by simply momentarily stopping an oar during the set-up cycle and calling out a force. Blending requires a separate verbal command. At an appropriate point the use of the word "Blend" can be used to accommodate this.

[0524] As mentioned, the user may not feel to assign a resistance change at every tolerance zone created during the set-up cycle. Those tolerance zones may be left in reserved status to have forces included at a later time. All that is necessary to reserve a zone is for the user to stop the oars temporarily at a unique point along the set-up cycle and give a verbal command, perhaps “Reserve”.

[0525] The tolerance zone is created there and both first and second sets of position data are saved, together with the stopping point location, just as when a force change is commanded. During some later run of the actual exercise the user may stop temporarily at the reserved position and give a verbal command to the processor, perhaps “Modify, force, fifteen”, to incorporate that force. This then becomes an integral part of the exercise regime,

[0526] Another interesting capability is illustrated as follows: Perhaps the user desires to exercise with a saved program involving one oar 102, moving in a circuit that is an equilateral triangle, one corner of the triangle being directly in front of her and close in, with the other two corners spaced equally to the sides and out from her. She is standing and the electromagnet canister assembly 162 is lowered all the way down on its tower 220 with the oar at a nearly vertical orientation.

[0527] Grasping the oar while it is in the zone to her left with both hands, and with arms outstretched, she could begin the exercise by compliantly exiting the start zone at her left, by twisting at the waist and using a programmed 15 pounds of force for example. With the oar reaching the tolerance zone at the right side of the triangle, and alerting the processor, she could then pull the oar back toward her at 60° with a different programmed force, say 25 pounds, to compliantly entering the zone at her immediate front. Then after alerting in that zone, to complete the clockwise circuit, she could compliantly push away, exiting at 60° to her left with for instance 18 pounds, compliantly entering the starting tolerance zone. She may repeat this triangular circuit as many times as desired.

[0528] The power control module could be programmed to create a mirror image of all poundage by recognizing a simple verbal command, perhaps the word “Reverse”. If spoken, the user could then go around the circuit in the reverse direction, counter-clockwise, encountering the resistances in the same order as in the clockwise direction.

[0529] And if desired, the user could enter a period of going back and forth between two zones of this triangular exercise. Perhaps she is going from left to right at the top of the triangle with arms extended, having compliantly exited the tolerance zone at her left.

[0530] 15 pounds is the only force the system knows to apply between the two zones at the top. When reaching the zone on the right there is no force change in going back to the left. This is because she doesn’t exit the zone on her right in compliant fashion for bringing the oar to her close front. She goes back to her left with arms outstretched instead. When she compliantly enters the zone on her left and alerts the processor, she can then exit the zone back toward the one on her right with the same 15 pounds of resistance. She can go back and forth in this fashion.

[0531] And should she want to re-enter the regime’s original sequence of movements to continue with it, she can simply proceed from one of the regime’s programmed zones and compliantly enter the next zone in the sequence as though not having taken a break from the saved program.

[0532] The ability to deviate from the sequence of any program and re-enter at will is a general feature of the embodiment. The same goes for her being able to temporarily leave a regime’s movements completely and then re-enter. Perhaps she decides to move the oar in a circular motion to the left, beginning from the zone in close to her front. Whatever force was being applied at the time of departure from the programmed regime is continually applied until re-entry to the regime, which will occur at a compliant entrance at some programmed zone of the regime, an alert and then a compliant exit toward the next zone in sequence. This allows for great flexibility.

#### A Second Ferromagnetic Embodiment

[0533] A second embodiment utilizes cylindrically contoured ferromagnetic contact surfaces. The drawings and discussion of this second embodiment do not include the detailed discussion of the operation of the power control module 420 or the gyro/accelerometer/wireless transmitters 421 as the first embodiment’s drawings and discussion do, though it is anticipated that those systems will be incorporated in this second embodiment. In this second embodiment optical movement sensors 150 are additionally utilized to track movement and are described.

[0534] FIG. 20A shows a second embodiment that utilizes components of the first embodiment. The spherical electromagnet canister assemblies 162, depicted at the bottom of drawing 20A are as those in the first embodiment. Those canister assemblies 162 have been incorporated here to facilitate overall flexibility of the embodiment.

[0535] The spherical canister assemblies 162 are mounted to a platform 310. This platform does not have the platform positioning troughs 164 nor the locking swivel base 156 of the first embodiment (See FIG. 7). The second embodiment’s oars 302 are different than the oars 102 of the first embodiment in that the surfaces of this second embodiment’s oars 302 are ferromagnetic. As mentioned, no gyro/accelerometers are depicted, though they could be incorporated along with a power control module that operates similarly to that of the first embodiment. FIG. 20B is an enlargement of the external view of a cylindrical electromagnet canister assembly 304 shown in FIG. 20A, along with a portion of its oar 302 and a u-joint 306 between the cylindrical electromagnet canister assembly 304 and a connecting bar 308 used to convey a user’s physical effort to the system.

[0536] Oars 302 are removably affixed to the spherical canister assemblies 162. These oars 302 differ from the oars 102 of the first embodiment in that the oars 302 are ferromagnetic over a portion of their lengths, at least at their exteriors, and are integral parts of the electromagnetic circuit providing exercise resistance. The oars 302 are attracted to and transmit magnetic force produced by an electromagnet 318 contained in each of the cylindrical electromagnet canister assemblies 304. This electromagnet 318 is here designated a gripper electromagnet to differentiate it from the electromagnet of the first embodiment.

[0537] The cylindrical electromagnet canister assemblies 304 are able to be slid all along the length of the oars 302. That full length movement wouldn’t be inhibited by a gyro/accelerometer being used, since the gyro or gyros would need to be installed along the connecting bar 308 to detect compound movement. Two u-joints 306 are affixed to the cylindrical canister assemblies 304 and to the connecting

bar 308, with the connecting bar running between the two cylindrical canister assemblies 304. The connecting bar 308 provides hand holds for the user. Power cable 112 of FIGS. 20B and 21 supplies electrical power to the gripper electromagnet 318 of FIGS. 21A and 21B within each canister assembly, and cable 151 of FIGS. 20B and 21 sends data to a processor (not shown) for controlling the power of the gripper electromagnet 318.

[0538] FIGS. 21A and 21B depict external views of one cylindrical electromagnet canister assembly 304 and a portion of a magnetic oar 302. Power cord 112 and sensor cable 151 are also shown.

[0539] In FIG. 21A, a two part cylindrical canister body 312 is of a non-magnetic material, such as plastic or carbon fiber, and is of two halves joined along their height. Bands 314 are placed around these canister body halves, holding them together at top and bottom.

[0540] FIG. 21B is a partially exploded view of FIG. 21A and shows an electromagnet cover 316 separated from the canister body halves 312. Four screws 324 hold the cover to the canister body halves 312. When the electromagnet cover 316 is installed to the assembled canister body 312, four cover blocks 322, which are integral to the cover 316, are in positions adjacent above and below four flat horizontal surfaces 320 of the gripper electromagnet 318, and help to hold the electromagnet 318 in place when power is not applied.

[0541] The gripper electromagnet 318 is free-floating and can rest upon the bottom of the cylindrical canister body window 338 when the electromagnet 318 is not powered. Also holding the electromagnet in place when not in use are the cover blocks 322, which the electromagnet's flat horizontal surfaces 320 are able to rest upon when the electromagnet 318 is not being pulled into the oar 302 by the magnetic field it generates. When in use, the electromagnet is prevented from excessive movement by the proximal fit all around it of the cylindrical canister body window 338. The amount that the electromagnet 318 can move when in use is sufficient to allow positional self-adjustment to allow maximum magnetic field passage through the ferromagnetic surfaces in forming a magnetic circuit.

[0542] The cover blocks 322 are guides to keep the electromagnet in proper alignment should it move backward in the cylindrical canister body window during times of non-use. The cover blocks are slightly further away from the four flat surfaces 320 of the electromagnet 318 than is the periphery of the canister body window 338, so that the cover blocks do not contact the horizontal surfaces 320 of the electromagnet 318 while the device is in use, but the canister body window 338 does have contact with those horizontal surfaces. When the device is not in use it may be that the electromagnet will move backward in the canister body window 338, contacting the two lower cover blocks 322.

[0543] FIG. 22 is a partially exploded view. The bands 314 of FIG. 21A are omitted.

[0544] Sliding gripper halves 328 of high magnetic permeability (magnetic conductivity), are shown in close proximity to a ferromagnetic oar 302. The gripper electromagnet 318 is shown in the position it would occupy if the canister body window 338 were containing it in the assembled system.

[0545] The electromagnet's pole faces 326 span the two sliding gripper halves 328. The exercise resistance is produced by the electromagnet causing the sliding gripper

halves 328 to be forcefully drawn to the magnetically susceptible oar 302 along with the electromagnet. The gripper halves 328 and electromagnet 318 each self-adjust in position slightly to maintain maximum magnetic contact.

[0546] A separation (air gap) between the inner, concave surfaces of the two sliding gripper halves 328 and the oar 302 is shown with exaggerated distance for the purpose of illustration, and the sliding gripper spacing gap 330 between the two gripper halves 328 themselves, may appear different than would be the case at manufacture.

[0547] An optical movement sensor 150 of the type used in common optical computer mice to sense directed movement is shown extending from a movement sensor cavity 149 in the right side cylindrical canister body half 312 for viewing clarity. It is anticipated by the present author and intended that optical sensors, for instance cameras such as the types used in smart phones, can also be utilized to read predetermined patterns, such as barcodes or other markings on the oars or even the spheres, to judge directional movement and speed. Sensor cable 151 of the movement sensor 150 leads out of the canister body 312 and ultimately to a processor for controlling power to the electromagnet 318. Sensor port 329 is a hole in the right side sliding gripper 328 that allows the movement sensor to have access to the surface of the oar 302.

[0548] The concept of the embodiment allows for a plurality of electromagnets 318 and properly sized sliding grippers 328 to be utilized within a cylindrical canister body that would be able to accommodate such a design.

[0549] During use each pole face 326 is in continuous contact along its length with one of the two sliding gripper halves 328. The electromagnet 318 spans the sliding gripper spacing gap 330. A magnetic circuit is created that goes from one lengthwise pole face 326, through the gripper half it is in contact with, into the ferromagnetic oar 302 and then out through the second sliding gripper half and into the other pole face 326 of the electromagnet.

[0550] If it is necessary for a better balance of force, a second electromagnet 318 can be used to span the sliding gripper spacing gap 330 on the opposite, back, side of the oar 302. The canister body 312 would have to be designed accordingly. A multiplicity of differently designed or sized electromagnets, sliding grippers and canister body windows, could be incorporated to the embodiment. None are described here.

[0551] At the top and bottom of the cylindrical electromagnet canister assembly 304 are sliding gripper flanges 332 of FIG. 22 that overlap the ends of the canister body halves 312 as the canister body halves come together in assembly. By way of this gripper flange overlap the canister body 312 successfully transmits the mechanical force necessary to move the sliding gripper halves 328 along the lengthwise directions of the oars 302. Without the sliding gripper flanges 332 the canister body halves 312 and the electromagnet 318 would slip lengthwise along the sliding gripper halves 328 and beyond, destroying the system's exercise value.

[0552] When the cylindrical canister body halves 312 are assembled about the sliding gripper halves 328, there is a slight vertical clearance between the canister body ends 336 (top and bottom) and the sliding gripper flanges 332. As a result the sliding gripper halves can move slightly within this vertical clearance. This aids in self-adjustment and magnetic transfer.

[0553] Gripper flange screws 340 run through the sliding gripper flange slots 334 in the sliding gripper flanges 332 and into tapped holes 342 in the canister body halves 312, but don't advance so far as to squeeze the gripper flanges 332 tight to the canister body ends 336. The gripper flange screws 340 are used to prevent excessive rotation about the oar 302 of the sliding gripper halves within the cylindrical electromagnet canister assembly 304. The gripper flange slots 334 are of size and shape to allow the sliding gripper halves 328 a slight rotational and radial movement during use for self-adjustment and maximum magnetic field transfer.

[0554] FIG. 23 is a further exploded view of FIG. 22.

[0555] The sliding gripper halves 328 are shown separated from both the oar 302 and the electromagnet 318, which is shown in its approximate use position. The movement sensor 150 is shown mounted in its cavity 149 within the right cylindrical canister body half 312.

[0556] FIG. 24 is an exploded view depicting an oar electromagnet 344 that has oar electromagnet pole faces 346 that are oriented differently than the gripper electromagnet 318. The oar electromagnet's 344 pole gap 348 is vertical rather than horizontal. Note that magnetic lines of force will now traverse vertically within the ferromagnetic oar 302 from for instance the upper pole face 346 to the lower.

[0557] In the previous figures concerning this second embodiment the magnetic force lines entered the oar 302 and traveled horizontally from one sliding gripper half 328 to the other. Note the absence of sliding gripper halves 328, gripper flange screws 340 and tapped screw holes 342.

[0558] The oar electromagnet 344 is applied directly on the ferromagnetic oar 302. Direct application of the gripper electromagnet 318 to the oar 302 is also possible without the use of sliding gripper halves 328 and is anticipated by the author.

[0559] As with the cylindrical electromagnet canister assembly 304, bands 314 hold the canister body halves 312 together. A plurality of oar electromagnets 344 can be utilized with an appropriate canister body design.

#### Operation of the Second Embodiment

[0560] As mentioned above, this second embodiment's resistance control function is not discussed in detail here, as the first embodiment's type of power control module 420 and gyro/accelerometer/wireless transmitters 421 are utilized. Additionally, there are two optical pattern sensors 150 that utilize optical mouse technology known in the computer industry. In conjunction with the digital processor of power control module 420 the optical sensors 150, one in each of the two cylindrical electromagnet canister assemblies 304, recognize changing surface patterns as the sensors are moved along the ferromagnetic oar 302. This is similar to when an optical mouse is moved around on its mouse pad at a user's computer desk. The output of the optical sensors 150 is incorporated with the output of a gyro/accelerometer/wireless transmitter 421 removably attached at the connecting bar 308. These outputs are processed in the power control module 420 to control the embodiment's resistances along with output from gyro/accelerometers 421 at the ferromagnetic oars 302 as mentioned immediately below.

[0561] Spherical electromagnet canister assemblies 162 (FIGS. 10B and 20A) of the first embodiment are also used

with this second embodiment. The spherical canister assemblies 162 are removably mounted to a platform 310, see FIG. 20A.

[0562] In operation this second embodiment is similar to the first embodiment, with the exception that the connecting bar 308 is now employed. A gyro/accelerometer/transmitter 421 of the type used with the first embodiment is removably attached to the connecting bar 308, with one gyro accelerometer/transmitter also being removably attached at each ferromagnetic oar 302 as with the first embodiment's non-ferromagnetic oars 102. Should the connecting bar 308 be removed from the oars 302 to allow the embodiment to resemble and be used similarly to the first embodiment, the gyro/accelerometers 421 at the oars 302 will determine resistance changes.

[0563] During operation the spherical canister assemblies 162 provide resistance to moving the connecting bar 308 in any direction other than along the ferromagnetic oars 302 when they are stationary. That is when both oars 302 remain parallel to each other, no matter what their angle to the platform 310, and remain at that angle during a movement, the spherical canister assemblies 162 have no effect on the force necessary to move the cylindrical electromagnet canister assemblies 304 along the oars 302. However, during connecting bar 308 movement, if the angle between either or both of the oars 302 and the platform 310 changes, then the resistive force at the moving spherical canister assembly (ies) 162 is brought into play. The four sources of resistance: the two spherical electromagnetic assemblies 162 and the two cylindrical electromagnetic assemblies 304, can provide levels of compound resistance that are wonderful for performing interesting and unusual movements.

[0564] This second embodiment allows a more compact space to be utilized during exercises than does the first embodiment. For instance rowing while seated can take place almost within the footprint depicted in FIG. 20A. The user merely needs to lower the oars 302 to approximately horizontal, have enough magnetic field strength applied at the spherical canisters 162 to prevent the spheres 104 from being dislodged from their spherical shell halves 106 when pulling the connecting bar 308 to him, and while seated on the platform 310, alternately pull the connecting bar 308 toward him and then push the bar away. If desired, some resistance can be applied to his pushing the connecting bar 308 back to the starting point.

[0565] Not depicted, the spherical canisters 162 can be mounted to towers that adjustably elevate the canisters above the platform 310 to resemble in part the first embodiment (see FIG. 6) And too, the ferromagnetic oars 302 and cylindrical electromagnet canisters 304 of this second embodiment can be included as part of the first embodiment.

#### A Third Ferromagnetic Embodiment

[0566] FIGS. 25 and 26A and 26B depict a third embodiment, one with planar electromagnet pole faces 408, 410 being slid along planar ferromagnetic surfaces 404.

[0567] FIG. 25 is an overall view of this third embodiment. A planar electromagnet assembly 402 is attached at each end of a connecting bar 308 by u-joints 306. The connecting bar 308 provides hand holds for the user and has control module 420 (not shown) and gyro/accelerometer/wireless transmitter 421 (also not shown) removably attached. Battery packs, though not necessary, are contemplated as providing power to the controllers and the elec-

tromagnets for a greater degree of freedom and convenience than long power cords would provide. There is attraction between the planar electromagnet assemblies 402 and ferromagnetic planar surfaces 404, which are of material such as a metal or plastic or rubber that contains iron. Power from the control module 420 is brought to each magnet assembly through power cables 112. Cable 151 at each electromagnet assembly 402 is a data cable from an optical mouse pattern sensor 150, FIG. 26B, of the type and technology well known in the computer industry. The ferromagnetic planar surfaces 404 are removably affixed to a platform 406 and can remain either stationary or adjustable in orientation during use.

[0568] FIG. 26A shows a slightly enlarged view taken from FIG. 25, illustrating primarily the contact between the planar electromagnet assemblies 402 and the ferromagnetic planar surfaces 404. An outer planar electromagnet pole face 408 in FIG. 26B is co-planar with an inner planar electromagnet pole face 410. Co-planar faces 408 and 410 are in simultaneous contact with the ferromagnetic planar surface 404 during use.

[0569] FIG. 26B is an exploded view of the electromagnet assembly 402 of FIG. 26A together with a u-joint 306 and a portion of connecting bar 308. Planar electromagnet housing 416 forms the core of the electromagnet, and is affixed to a u-joint 306. A wire lead-out hole 418 in housing 416 enables lead-out for magnet windings 412. Magnet windings 412 are wound on windings form 414 and are tightly installed on the boss at the center of the electromagnet housing 416 that terminates in inner electromagnet pole 410. Power leads 112 exit housing 416 by way of lead-out hole 418. At the upper left of FIG. 26B movement sensor cavity 149 is shown at the center of the inner planar electromagnet pole face 410. Movement sensor 150 is shown both as extending out from the electromagnet housing 416 in the lower left portion of the FIG. 26B and also installed in the assembled view to the lower right of that figure. Housing cavity 149 for the sensor 150 is depicted at the upper left of FIG. 26B and elsewhere in the figure.

[0570] Note that at the lower right of FIG. 26B the windings form 414 is recessed inward from the two planar electromagnet pole faces 408 and 410 when installed. This is so that the windings form 414 won't be abraded during movement over planar surface 404. The windings form 414 can be press fit and affixed with adhesive to the boss of the inner pole 410 or else screwed on to it and adhered. This will make sure the windings form 414 stays in place.

[0571] Ferromagnetic planar surfaces 404 can be of flexible construction and either hung from above and tightly pulled from below or supported under tension from their sides or ends as volleyball or badminton nets would be. Planar surfaces 404 can be made of cloth that contains a ferromagnetic material such as iron. A flexible ferromagnetic surface 404 could also be constructed by laminating a rubber or other deformable material, such as a flexible plastic, to a woven or other flexible ferromagnetic surface containing iron.

[0572] Flexible ferromagnetic planar surfaces 404 open up a range of possibilities, such as an exercise area with two long, spaced apart flexible substrates hung like parallel volleyball nets. This third embodiment can be forcibly moved by the user along the lengths of these suspended surfaces 404 by pushing or pulling while walking or running on the floor. A harness that attaches the user to the connect-

ing bar 308 is also contemplated. Such harness can be helpful in building leg strength.

[0573] A multitude of planar electromagnetic assemblies 402 with their connecting bars 308 could be used between two flexible ferromagnetic surfaces 404 of the above two paragraphs simultaneously, allowing groups of users to exercise, such as a football team. In addition to moving horizontally, vertical movements can be undertaken. A battery pack to power the embodiment and to facilitate freedom of travel could be hung from the connecting bars 308 or worn by the users.

[0574] It is contemplated that ferromagnetic balls or rollers could be inserted or attached to both the outer planar electromagnet pole face 408 and the inner planar electromagnet pole face 410, such that the balls or rollers would come into contact with a ferromagnetic planar surface 404 in lieu of pole faces 408, 410. This will provide a different feel for the user than should the planar pole faces 408, 410 themselves contact the ferromagnetic planar surface 404.

[0575] This third embodiment, when used with platform 406, has a smaller footprint than the first embodiment. The ferromagnetic planar surfaces 404 of FIG. 25, when stationary in their mountings to the platform 406, provide a wide range of connecting bar 308 movements. If the ferromagnetic planar surfaces 404 can have their orientations adjusted, as an example, able to be rotated downward while remaining in the same planes as they are in FIG. 25, so that they form long fences beside the user who is seated or lying upon the platform 406, the number of full body exercise movements will be increased.

#### Operation of the Third Ferromagnetic Embodiment

[0576] Omitted here is a discussion of the power control aspects, since it is contemplated that the operation of the second embodiment's power control system, incorporating power control module 420 and gyro/accelerometer/wireless transmitter 421, in addition to the second embodiment's optical movement sensor 150, is similar in this third embodiment. The operation is as follows:

[0577] The user places himself between the two ferromagnetic surfaces 304, grasps the connecting bar 308, and with a chosen magnetic force applied at the two planar electromagnet assemblies 402, he moves the connecting bar in a desired direction. The gyro/accelerometer/wireless transmitter 421 (only one is necessary) relays positional and velocity information to the power control module 420, which provides electric power to the electromagnet assemblies 402 as appropriate for the frictional resistance desired between the electromagnet pole faces 408 and 410 and the ferromagnetic planar surfaces 404.

[0578] Should the ferromagnetic planar surfaces 404 be mounted to the platform 406 flexibly, so that they can rotate and tilt, then a full range of twisting motions can be incorporated, such as when the connecting bar 308 is upon the shoulders and the user twists at the trunk while bending forward and to the side, then returns and repeats to the other side.

[0579] And further, should the planar surfaces 404 be able to rotate toward the floor directly in line with their common orientation, so that they form fences that touch the platform 406 along their long dimensions, rowing can be accomplished, as well as sliding heel leg exercises and other kinds of movements, both upper and lower body.

#### Using Vacuum to Generate Resistance

**[0580]** Air pressure at sea level is approximately 14.7 pounds per square inch. If a smooth, planar eight inch diameter circular metal plate or sheet is laid flat on another smooth, planar metal surface of the same or larger size, and the air between the two is pumped out, the resulting vacuum will cause a pressure forcing the two together of  $(14.7) \times \pi \times \text{radius squared} = (14.7) (3.1416) (4^2) = 739$  pounds.

**[0581]** An eight inch diameter sphere rotatably mated in an eight inch diameter upward facing hemispheric cup undergoes the same 740 pounds of substantially downward pressure when the air between the two is evacuated. This downward pressure will result in frictional resistance at the sphere/cup interface when trying to rotate the sphere in the cup.

**[0582]** It is possible that in this way a greater resistance can be created by rotating a sphere in a mated cup than by rotating one planar plate on top of another. This is because the sphere, when forced downward, can act as a wedge that attempts to push the sides of the cup outward, creating great contact pressure.

**[0583]** The same technology that senses oar position and velocity and recognizes speech as is used with the magnetic embodiments described above, can be used in this vacuum embodiment. A vacuum pump and valving system, not shown in the drawings, but commercially available, is needed to control the applied vacuum according to the sensing input/output and user command technology previously described.

**[0584]** An embodiment using a straight vacuum system is described. A hybrid system that involves both vacuum and electromagnetism is also described. Each of these can use the same electronic user-defined resistance control technology as the previous embodiments, as well as the assembling of the modules and the mechanical aspects of affixing the components and positioning them for use as in the first two embodiments.

**[0585]** Specifically anticipated, but not described here in detail, modifications to both the vacuum and hybrid embodiments can be made to work with the planar and flexibly planar substrate surfaces of the third embodiment. An example is a vacuum embodiment that involves at least one suction cup embedded within a body that is then slidably attached by vacuum to a planar plastic or metal surface. Vacuum holds the body to the surface sufficiently to provide exercise resistance. Magnetism can be incorporated in hybrid fashion by adding elements that are either permanent magnets or electromagnetic, and having the planar substrate surfaces be magnetically susceptible.

#### A Fourth Embodiment: Vacuum

**[0586]** FIG. 27 depicts a resistance generating assembly, vacuum canister assembly 600.

**[0587]** A vacuum oar 602 may be one that does not have a magnetically susceptible portion, as with oar 102 of the first embodiment, or one that does, as with oar 302 of the second embodiment. Oar 602 is removably attached to a vacuum sphere 604. Sphere 604 can range in construction from being a hollow shell of metal or some other strong material such as carbon fiber or glass impregnated plastic, to being solid plastic such as a bowling ball is.

**[0588]** During operation sphere 604 rests with a substantial portion of its surface in contact with a spherically

contoured vacuum cup 608, which is permanently affixed to the concave side of a spherically contoured vacuum cup housing 610.

**[0589]** Vacuum cup 608 and vacuum cup housing 610 are permanently affixed and vacuum sealed to the inside of a vacuum canister 606. A vacuum line 612 is placed over a canister vacuum port 614 of FIG. 28 and provides user designated negative air pressure to the canister 606.

**[0590]** FIG. 28 is an exploded view of the components of vacuum assembly 600. Vacuum sphere 604 and vacuum line 612 are not included. There are four mounting holes 626 for bolts (not shown) to mount canister assembly 600 to its appropriate substructure, for instance as with spherical canister body 108 of the first embodiment.

**[0591]** Vacuum cup 608, which has a substantially spherically contoured inner surface, can be made of a material such as rubber, or something stiffer such as plastic or metal. A substantially flexible material such as rubber provides the advantage of not needing to be matingly contoured to the vacuum sphere 604 by way of machining. It can be produced by the much less expensive process of molding, as could a plastic vacuum sphere 604.

**[0592]** Vacuum cup 608 has at least one channel port 620. The channel port is a hole extending through the wall of cup 608. On the concave surface of vacuum cup 608 there is at least one channel 622 that forms a passageway along which air that is trapped between the vacuum sphere 604 and the inner surface of the cup 608 can travel to then be evacuated through a channel port 620.

**[0593]** As envisioned, there is a network of channels 622 that interconnects each of the channel ports 620 to each other channel port 620, assuming there is a plurality of them. Only a few of the interconnecting channels 622 are shown here and in the next drawing. And only six channel ports 620 are depicted, though more may be useful in the final product.

**[0594]** FIG. 29 shows the vacuum cup 608 having been set into the vacuum cup housing 610, which provides a good contact fit. The cup housing 610 is made of a stiff material such as a strong plastic or metal. Vacuum cup 608 is permanently affixed to the cup housing 610 by adhesive. In doing this the channel ports 620 of vacuum cup 608 are aligned with a like amount of vacuum cup housing ports 624, which are through holes placed in cup housing 610.

**[0595]** The assembled vacuum cup 608 and vacuum cup housing 610 are placed into the vacuum canister 606 in a press fit. Adhesive can be used to permanently affix the cup housing 610 to the vacuum canister 606, both along their rims and at the bottom exterior of cup housing 610. Gusseting can be used inside canister 606 to securely mount the cup housing 610 to the canister 606 if necessary. If both cup housing 610 and vacuum canister 606 are of plastic, sonic welding can be used along their rims to hold cup housing 610 in place, additionally to any adhesive and/or gusseting.

**[0596]** The vacuum canister assembly 600 is sealed against vacuum leak by adhesive and/or sonic welding, or some other sealant used at the rims of the vacuum cup 608, vacuum cup housing 610 and vacuum canister 606.

**[0597]** Vacuum line 612 is to be installed over canister vacuum port 614 and connected to either a digitally or manually controlled vacuum pump. Vacuum canister assembly 600 mounts to the same mechanical support structure, interchangeably, with spherical canister body 108 of the first embodiment.

#### Operation of the Vacuum Embodiment

[0598] The use of the embodiment of FIGS. 27, 28 and 29 is the same as with the first electromagnetic embodiment of FIG. 1 through FIG. 19, save for there now being a vacuum pump and regulator to generate frictional resistance rather than an electromagnetic friction generating system. The same speech recognition, gyro/accelerometer technology, timed duration and manual input ability applies here as with the first embodiment, so too any control functions given in the claims. The human procedures for operation are the same for this embodiment as for the first one.

#### A Fifth Embodiment: Vacuum and Electromagnetic Hybrid

[0599] FIG. 30 is of a hybrid canister assembly 700 for a hybrid vacuum and electromagnetic exercise device. Depicted also are an associated hybrid sphere 704 and a hybrid oar 702 affixed to hybrid sphere 704. Hybrid sphere 704 is of a magnetically susceptible material, as in the case of sphere 104 of the first embodiment. Hybrid oar 702 may be made of either a non-magnetically susceptible material, as with oar 102 of the first embodiment, or contain a magnetically susceptible material along a portion of its length, as does oar 302 of the second embodiment.

[0600] The hybrid sphere 704 is shown seated in hybrid spherical cup halves 708. The tops of the cup halves 708 are shown near to the top of a hybrid canister 706. A hybrid canister vacuum port 710 and a portion of an electromagnet power cord 712 are shown. An evacuation gap 720 is also denoted.

[0601] FIG. 31A is an exploded view of the hybrid canister assembly 700. Hybrid spherical electromagnet assembly 707 is seen above hybrid canister 706.

[0602] The hybrid electromagnet assembly 707 is identical to the spherical electromagnet assembly 105 of the first embodiment, except for one modification. The difference is that the hybrid electromagnet assembly 707 has a vacuum channel network 722 incorporated in the concave surfaces of each of the two spherical cup halves 708, while the spherical shell halves 106 of the first embodiment do not.

[0603] The channel network 722 is shown in FIGS. 31A and 31B only partially on one spherical cup half 708, whereas in production, channel network 722 would be fully incorporated on both cup halves 708.

[0604] Vacuum channel network 722 provides passage out for air trapped between hybrid sphere 704 and each of the hybrid spherical cup halves 708 during use. Upon the trapped air entering the confined volume of the channel network 722 in each cup half 708, the air is routed to, and sucked into, an evacuation gap 720 which is under negative air pressure.

[0605] The negative pressure results from a vacuum pump, not shown, drawing a vacuum through a hybrid vacuum canister port 710 after the hybrid electromagnet assembly 707 and hybrid canister 706 are assembled together. Assembly 707 and canister 706 are vacuum sealed with a flexible seal at their adjacent exposed rims. FIG. 31B shows electromagnet assembly 707 positioned in canister 706. A flexible sealant is not shown.

[0606] Electromagnet assembly 707 is secured to the floor of the canister 706 by four bolts that pass through mounting holes 726 in the canister 706 floor and into four threaded mounting holes 732 in electromagnet assembly 707.

[0607] A well 730 in the floor of canister 706 provides clearance for the bottom of electromagnet assembly 700, and does not form a through-hole.

[0608] When the electromagnet assembly 707 is mounted into the canister 706, the hybrid cup halves 708 fit loosely enough at the inner wall of canister 706 to allow automatic self-adjustment under use, providing good transfer of the magnetic field from a first spherical magnetic pole face 734, into a cup 708, through the sphere 704, into the other cup 708 and out into an oppositely poled spherical magnetic pole face 734, the same as happens in the first embodiment.

[0609] There are two evacuation gap plugs 728 that protrude from the top of the interior of the hybrid canister 706, down along the canister's height a predetermined distance. The gap plugs 728, fit into the evacuation gap 720 when the electromagnet assembly 707 is mounted into the canister 706, helping to seal the hybrid assembly 700 against vacuum leaks.

[0610] The plugs 728 fit into the evacuation gap 720 with a fit sufficient to help prevent vacuum loss, but also with enough tolerance to allow automatic self-adjustment of the spherical cup halves 708 under use. As mentioned, there is also a flexible sealant along the exposed top edges of the hybrid spherical cup halves 708 and the canister 706 when assembly 700 is complete.

[0611] The combination of a vacuum being drawn at the interface of the hybrid sphere 704 and the cup halves 708, and also the magnetic attraction between the sphere 704 and the cup halves 708, causes a greater frictional resistance at the interface than would occur should only either vacuum or magnetic attraction be used by itself.

[0612] Hybrid canister assembly 700 mounts to the same mechanical support structure, interchangeably, with spherical canister body 108 of the first embodiment.

#### Operation of the Hybrid Embodiment

[0613] The electronic control function concepts that have been described for the first embodiment are extended for use also in this hybrid system. This is to say that speech recognition, gyro/accelerometer input and output, timed or manual control by keypad or equivalent can be used with this embodiment, with consideration now being given to controlling both the vacuum system and the magnetic system concurrently. Additionally, any other control function given in the claims is contemplated. The human procedures for operation are the same for this embodiment as for the first one.

### CONCLUSION, RAMIFICATIONS and SCOPE

#### Conclusion and Ramifications

[0614] In conclusion what is presented by one or more of these embodiments is an opportunity for those who desire physical training, weight loss, total body physical fitness or rehabilitation, to attain exercise goals in a very profitable and safe new way.

[0615] Thus the reader will see that one or more of the embodiments enables safer exercise sessions than does the use of free weights, which can easily cause muscle and ligament strains and joint hyper-flexure, or be dropped from the grasp of the user to cause injury, or can return dangerous potential energy to the user by coming down upon him with too much kinetic energy to be handled when tired or can

cause a fall from loss of balance when extended to the overhead or other positions. Too, accidents involving step-pers and elliptical cyclers, where hyper-flexure of the knee, or falling from the machine, even from treadmills, are eliminated.

**[0616]** Treadmills can cause injury by way of stumbling and falling from the belt having slipped and balance being lost. The author has stumbled several times over the years at this problem occurring. And the author knows a lady of older years who fell to the rear while using her treadmill, becoming wedged between some furniture and the treadmill, suffering severe burns on her face and upper body by the moving belt which she could not distance herself from. She was in that position for several minutes, crying for help.

**[0617]** Injuries from equipment that uses weights and pulleys, such as universal gyms . . . or spring-type resistance elements, including elastic bands . . . can be severe should the user lose control of his or her handhold or foothold during exertion. The uncontrolled bar or handles, returning potential energy stored by the apparatus, being converted to kinetic energy, can cause bodily harm.

**[0618]** The embodiments are convenient to use. There is no need for spotters. There is no need for multiple sets of weights, exchanging them at times when different resistances are desired. The tower assemblies **160** and spherical electromagnet canister assemblies **162** of the first embodiment, for instance, and canister assemblies **600** and **700** of the vacuum and hybrid embodiments respectively can be easily removed from the exercise area and stored in a nearby closet, while the platform **152**, locking swivel base **156** and swing arms **158** can be slid under a couch. The second and third embodiments likewise break down easily for storage.

**[0619]** The embodiments are almost infinitely versatile. The embodiments' oars and the two connecting bars can be brought into a vast number of differently oriented positions. Adding to that versatility is the ability to provide an infinite array of resistances at any of the oar or crossbar positions, that can be changed either by verbal command, automatically by way of set-up cycles or regimes in predetermined fashion according to location or orientation in three-space, or in timed fashion, or manually as desired through a keypad.

**[0620]** The embodiments represent a lower cost of investment than many exercise machine types. They are less complicated and are to be constructed of much less material than for example a universal gym or cycler, which implies they are lighter and more portable. Lower production costs and shipping and assembly costs are greatly facilitated by this. These lower costs are able to be passed on to the purchaser. A gym or spa for instance could purchase several units of these embodiments for less than the cost of one piece of some of the other equipment on the market.

**[0621]** A comfortable workout experience is provided. Comfort in use is important for all, and especially for rehabilitative users and the elderly, more so in a hospital situation. The strictly magnetic embodiments can even be used under water in therapy pools as long as the power control module **420**, with its speech processing capability, is not submerged.

**[0622]** The ability to exercise muscle groups in such highly complementary fashion sets these embodiments apart from other types of equipment. The world of exercise will

benefit greatly from this feature. As this is unique among today's equipment, it will lead the way toward greater health and exercise achievement.

**[0623]** Though the embodiments have been presented here as using electromagnets and vacuum to create a desired resistance, the ability to initiate and control the contact between elements can also be achieved through use of permanent magnets or several other means considered further on here.

**[0624]** In a machine shop setting magnetic-base gauge holders are very securely held to a metal benchtop using permanent magnets. Flipping a small lever in one direction causes the magnetic field holding the base to the bench to become substantially zero, allowing the user to reposition the base, while flipping it in the other direction brings the magnetic field transfer to a maximum, on the order of requiring 180 pounds of lifting force to pull the base straight up from the tabletop, thus securing it tightly.

**[0625]** It's possible to use permanent magnets to produce the resistance necessary for exercise. Varying the number of permanent magnets in contact with a ferromagnetic material will accomplish this, as will mechanically altering the alignment or the quantity of magnetic field lines being transmitted throughout a magnet or system of magnets.

**[0626]** Introducing a slight air gap between a magnet and one or more attracted elements is also a possibility. So that a mechanical approach with permanent magnets to generating and controlling exercise resistance is contemplated by the author. In addition, a combination of electromagnets and permanent magnets is contemplated.

**[0627]** An exercise embodiment contemplated by the present author is that of a sphere in conjunction with bicycle brake pads or pad equivalents. An example of the effectiveness of rubber bicycle pads in generating power is the following:

**[0628]** Let a bicycle and rider with a combined weight of 200 pounds be traveling at 45 miles per hour. Assume the bicycle has handbrakes, front and rear. Let the rider apply the brakes and stop in 200 feet in 5 seconds. The amount of power generated by the brake pads can be calculated.

**[0629]** Using metric measure, 200 lbs=90.7 kilograms; 45 mph=66 ft/sec=20.1 meters/sec; 200 ft=61.0 meters.

**[0630]**  $\text{Power} = \text{force} \times \text{distance} / \text{time}$ , which is equal to  $\text{mass} \times \text{acceleration} \times \text{distance} / \text{time}$ . The bicycle goes from 45 mph to zero in five seconds, which is 20.1 meters/sec to zero in 5 sec, therefore the average deceleration is  $(0 \text{ m/s} - 20.1 \text{ m/s}) / 5 \text{ sec} = -4.02 \text{ m/s}^2$ , or  $-4.02 \text{ m/s}^2$ .

**[0631]** The average power at the brake pads during deceleration is then seen to be  $(90.7 \text{ kg}) \times (-4.02 \text{ m/sec}^2) \times (61.0 \text{ m}) / 5 \text{ sec} = 4,448 \text{ watts}$ , neglecting the negative sign.

**[0632]** By definition there are 746 watts per horsepower, so the brake pads generate  $4448 / 746 = 5.96 \text{ hp}$ .

**[0633]** By contrast, a person lifting a 400 pound barbell, where the bar is resting at 1 ft above the floor, to an overhead height of 7.5 ft in 2 sec generates power during one lift in the amount of:  $(400 \text{ lb}) \times (6.5 \text{ ft}) / 2 \text{ sec} = 1,300 \text{ pound-feet/sec}$ . By definition  $550 \text{ lb-ft/sec} = 1 \text{ hp}$ , so the weightlifter generates  $1300 / 550 \text{ lb-ft/sec} = 2.36 \text{ hp}$ .

**[0634]** The bicycle's brake pads in the example produce more than twice the power of a very strong man lifting weights, and can do so continuously as long as there is rubber left on them. The weightlifter on the other hand, if even able to do only a few continuous repetitions, will quickly become exhausted and have to quit.

**[0635]** The above example can be brought to use in one way by mounting a sphere on a vertical rod of arbitrary length that is anchored to a stable structure below that can be raised or lowered as desired. Let brake pads, or their operative equivalent, be attached to an open-framed triangulating mechanism that places the pads in negligible contact with the sphere below its equator while the brake pad mechanism is at its rest state. And let the mechanism be controllable so to cause the pads to move inwardly to contact the sphere with force as a user desires.

**[0636]** Further, let the triangulating mechanism, with the brake pads equidistant below the sphere's equator, extend upward to a common point above near the top-center surface of the sphere, with an oar attached to the mechanism in vertically upward, orthogonal, orientation to the sphere.

**[0637]** Placing a ball bearing or other type, either stiff or soft, under the mechanism's common junction at the top of the sphere, or even another rubber pad there, with the bearing riding on the sphere, will enable the oar to provide resistance to movement when the brake pads are brought against the sphere with force. The sphere, with the oar pointing straight upwardly will know forced contact at four points, three below its equator and one at its north pole. The user can move the oar around, experiencing exercise resistance

**[0638]** Operation of the device is enhanced by the addition of a ring passing around the sphere and fastened to the triangulating mechanism below the pads, in order to keep the pads from becoming hung up against the vertical support rod when the oar is moved through a large angle.

**[0639]** This embodiment, resembling the first embodiment in operation, would be capable of providing exercise, and is contemplated as a useful device by the author.

**[0640]** Areas other than exercise devices can have uses for either the magnetic or the vacuum approach of these embodiments. For instance a ferromagnetic sphere can have a splined axle inserted through to its center or even running all the way through it, so that as the axle is caused to revolve it turns the sphere at the same speed.

**[0641]** Should the sphere be in mated contact with at least one concave spherical surface that transmits a magnetic flux and is properly anchored, a braking system is created. This braking system allows the axle to be variously oriented during use, providing braking force while undergoing changes in pitch and yaw, independent from whatever the concave spherical surface(s) is anchored to. This is something that a planar brake system cannot do. A hybrid arrangement, to include vacuum capability, may increase the contact force and therefore the effectiveness of the braking system. Of course, the braking system could be designed as vacuum only.

**[0642]** The braking system can be accomplished by way of other effects and devices I claim. One advantage of magnetism and vacuum is that they can each be applied from one and the same direction, not needing at least two directions of application, as with, say, pneumatic cylinders that would have to provide a clamping function from opposite sides.

**[0643]** Contemplated also is that surfaces can be directly pushed together through positive gas or liquid pressure. This is true with pneumatic cylinders of both the liquid and gaseous type. Containers such as bellows or even balloons or expandable tubing are envisioned under the right design as able to be inflated to provide contact force between elements in much the same way as pneumatic cylinders or

other fluidic methods of applying the force to create frictional resistance between mated surfaces.

**[0644]** Of course motors and solenoids can force elements together to provide a contact force at mating surfaces, just as pneumatic cylinders can. They require a different design than either a magnetic or vacuum approach, since they provide force application from at least two generally opposing directions, while magnetism and vacuum require only one general direction of application. Their frictional resistance designs are contemplated.

**[0645]** Also in the mix of friction producing methods are piezoelectric crystals. These react to electrical stimulation by expansion/contraction along particular axes of their structure. The concept is used with elements on submarine hulls to emit sound pressure waves for sonar. Electric motors are currently made using them, as are fluid-controlling valves and propulsion devices. Ink jet printers are based on this. "Adaptive mirrors" for the "Star Wars" missile defense system are also.

**[0646]** Piezoelectrics are contemplated here as able to provide frictional force between contacting surfaces in causing friction to occur at the interface of two or more elements that are forced together by piezoelectrics caused to expand from a rest state.

**[0647]** The use of mechanical devices such as screws, levers, cams, wedges, springs and elastic bands are contemplated as force-generating implements to cause surfaces, spherical or otherwise, to be forced together. Even the gravitational attraction by which weights provide a downward force can be used to generate frictional resistance, as in the way a pry bar and fulcrum can be used to amplify force in causing one object to be jammed against another.

**[0648]** Any of the means for causing mating surfaces to be forced together to produce friction can be electrically controlled. Data transfer to control mechanisms can occur in several ways to cause, for example, magnetic fields to be changed or motors or solenoids or piezoelectric elements to be activated. And vacuum pumps are typically driven by electric motors, as pneumatic cylinders can be.

**[0649]** The inputs to force providers can come through gyroscopes, accelerometers, speech processors, radio transmitters, sound processors that read hand claps or whistling, etc, manual keypads, mechanically operated switches, capacitive switches, capacitive proximity devices, infra-red activated devices, personal computers, telephone lines, cell phones, eye movement processors, brainwave processors, optical ranging and location systems, sonic ranging and positioning devices that use echo location, and directional microphone systems, etc.

**[0650]** It is contemplated to generate friction between smooth surfaces of completely different kinds, not strictly surfaces of opposite curvature, such as concave/convex spherical or concave/convex cylindrical. As one example, a sphere and a planar surface will generate friction. This is seen when a spinning basketball hits the floor.

**[0651]** Substantially planar surfaces can be designed to work with convex spherical or cylindrical surfaces. Other combinations are possible: planar with convex elliptical, and planar together with virtually any smooth convex surface. Going further, a portion of any smooth convex surface with a portion of any other smooth surface, concave or convex, will generate useful friction if physical dimensions are chosen appropriately.

[0652] A concave spherical element can even be used with a convex spherical surface of larger radius in producing friction, as though a ball were placed on an upturned teacup.

[0653] And exercise in both directions of a straight line can be accomplished along the surface of flat bars or cylindrical rods or pipes. As one example, a device that resembles a Smith Machine, which is a large metal framework with four or more vertical pipes or rods that support weighted barbells in collars that are slidably attached to the framework.

[0654] A bar, with often times heavy poundage on it, is lifted by users up and down. This weight system, with its ever-present danger to the user, can for the most part be eliminated, substituting a brake pad concept or a magnetic or flat surface vacuum technology in place of heavy weights.

[0655] This will allow great safety in use, since there would be far less potential energy stored in the bar that can convert to kinetic energy in being brought down on the user in runaway fashion. Plus, the device would offer complementary movement, both pushing and pulling.

#### Scope

[0656] Accordingly the scope should be determined not by the embodiments illustrated, and not be limited to the category of exercise devices, but determined by the appended claims and their legal equivalents. Other uses of and approaches toward the frictional contact of slidable surfaces exist beyond the specific descriptions given. And none of the embodiments should be seen as limiting the scope of the other embodiments or uses of or approaches toward sliding frictional contact.

[0657] Each embodiment is greatly superior to the prior art and represents a unique step forward from the types of exercise equipment otherwise available. They each have aspects that are shared with the other embodiments, both of usage, safety, convenience, versatility, results and general superiority to the prior art. There has never been anything like these in the exercise world.

I claim:

1. A physical exercise apparatus comprising:

(a) in combination, at least one element, element 1, having at least one surface portion, surface 1, that is in forced, user controllable, frictional contact with at least one other surface portion, surface 2, of an at least one other element, element 2, where at least one of said surface portions, being either convex or concave or planar, is selected from the group consisting substantially of a sphere and a cylinder and a cone and a plane, with at least either element 1 or element 2 able to be slidably or rotatably displaced along the interface of the said at least two surfaces, and

(3) apparatus of claim 1 further comprising means for a user to manually convey to at least one of said elements in frictional contact an urging effort to slide, rotate or otherwise pass along while in forced contact with a surface of another of said at least one element.

(b) apparatus of claim 1 further comprising in combination, at least elements 1 and 2 being forced together at their said surface portions, 1 and 2, by at least one effect or device that is selected from the group consisting of magnetism and vacuum and gravitational attraction of a weight and motors and solenoids and piezoelectric materials and pneumatic cylinders and gas pressure and

liquid pressure and screws and springs and elastic bands and levers and cams and wedges and equivalents of said at least one effect or device, and

(5) apparatus of claim 1 further comprising means for applying or controlling said effect or device, thus facilitating exercise.

6. A method of exercising the body, comprising:

7. (a) providing at least two elements, each having at least one surface portion in friction-producing contact with at least one surface portion of at least one other of said at least two elements, with at least one of said surface portions able to be slid or rotated or passed along a mutual interface of the said surface portion in contact with it,

8. (b) the apparatus of claim 6 further comprising providing at least one of said surface portions in forced contact to either be substantially planar or a convex or concave portion selected from the group consisting of sphere and cylinder and cone,

9. (c) the apparatus of claim 6 further comprising providing that said elements having said surfaces in forced contact have said surfaces held together during exercise by way of at least one effect or device that is selected from the group consisting of magnetism and gravitational force and vacuum and motors and solenoids and piezoelectric materials and pneumatic cylinders and gas pressure and liquid pressure and screws and springs and elastic bands and levers and cams and wedges and equivalents of said at least one effect or device,

10. (d) the apparatus of claim 6 further comprising inputting information used in controlling said friction-producing forced contact by way of a device selected from the group consisting of speech processor and gyroscope and accelerometer and computer and optical movement sensor and sound detector and brainwave processor and eye movement processor and electrical switch and pressure sensitive resistor and rheostat and capacitance detector and telephone and optical or acoustic ranging/locating system and equivalents thereof,

11. (e) the apparatus of claim 6 further comprising conveying manually a user's urging to at least one said element of the at least two said elements by way of an implement or construction selected from the group consisting of lever and bar and arbor and crank arm and belt and flexible member under tension and handhold and hand/foot placement zone and foot/ankle attaching device.

Whereby exercise can occur.

12. A bodily exercise system that can operate in three dimensions and can be controlled automatically, comprising:

13. The exercise system of claim 12 wherein at least one surface portion on each of a plurality of elements is held in friction-generating contact with at least one other of said surface portions while there is relative movement between them.

14. The exercise system of claim 13 wherein at least one of said surface portions is either convex or concave or planar and is chosen from the group consisting of sphere and cylinder and cone and plane.

15. The exercise system of claim 13 wherein at least one of the said surface portions is held in contact with at least one other of said surface portions by

way of an effect or device chosen from the group consisting of magnetism and vacuum and gravitational force and motors and solenoids and pneumatic cylinders and air cylinders and liquid pressure and screws and levers and cams and springs and elastic bands and equivalents of said effect or device.

16. The exercise system of claim **13** wherein at least one of said surfaces of the said at least one element is caused to undergo its said relative movement by an urging device chosen from the group consisting of lever and bar and arbor and crank arm and flexible device under tension and handhold and foot or ankle attachment or zone.
17. The exercise system of claim **12** wherein said automatic control is brought about by at least one device chosen from the group consisting of speech processor and gyroscope and accelerometer and optical movement sensor and computer and cell phone and electrical device and equivalents.
18. The exercise system of claim **17** wherein said speech processor and computer or equivalent can

recognize and carry out commands that are either factory preset or remotely issued or user defined in order to control said friction generated at said surfaces.

19. The exercise system of claim **17** wherein said gyroscope, accelerometer or optical movement sensor or equivalent tracks and reports to said computer or equivalent the amount and direction of movement of either said urging device or the at least one said surface.
20. The exercise system of claim **17** wherein said automatic control is performed by a computing device or equivalent that utilizes a timing program and/or receives and interprets data from said speech processor or gyroscope or optical movement sensor, said computing device then controlling said effect or device that holds said mated surfaces in various degrees of frictional contact.

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