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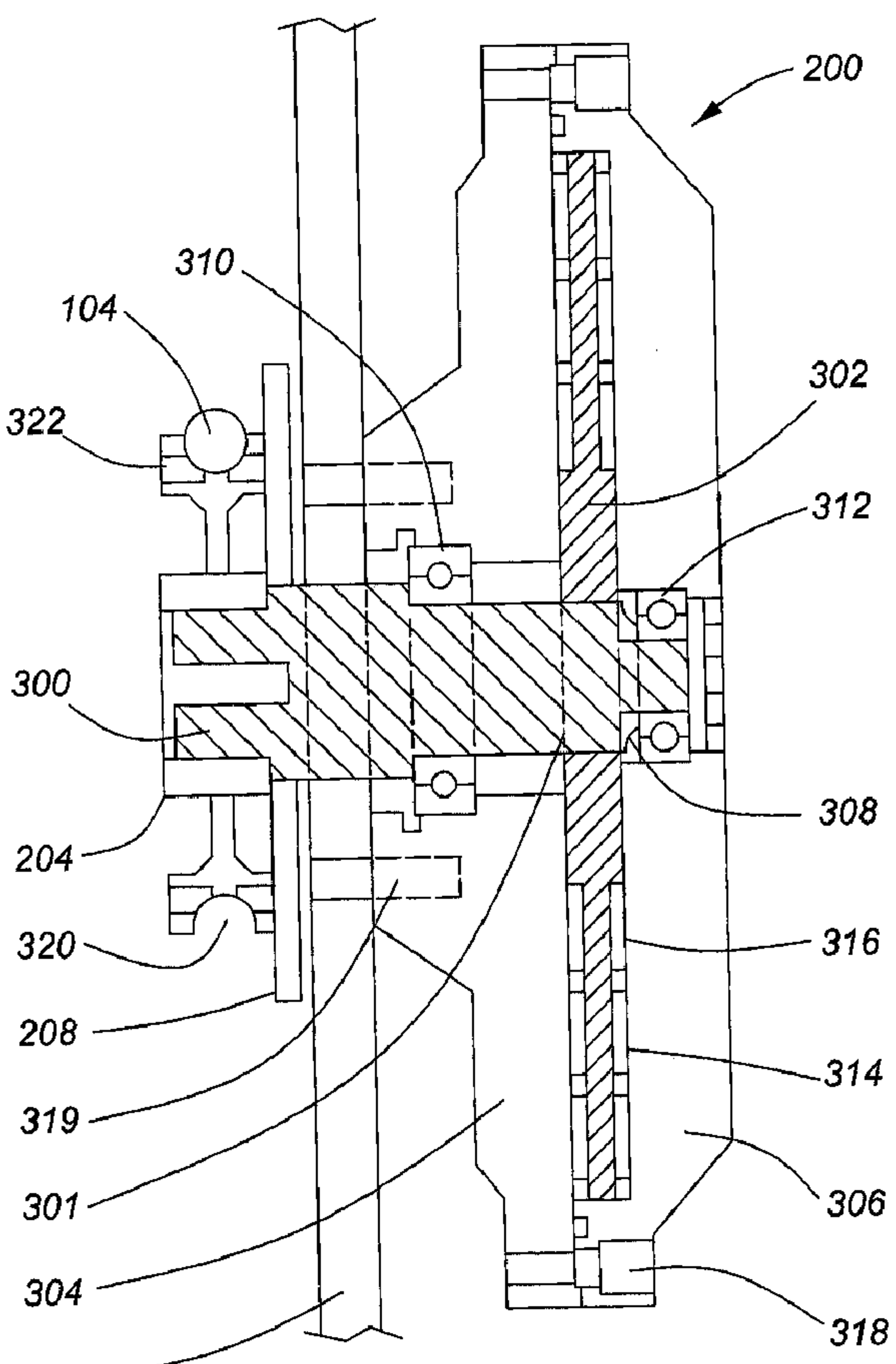
(72) **Inventeurs/Inventors:**
HARTMAN, GREGORY A., CA;
SMITH, DAN S., CA

(73) **Propriétaire/Owner:**
RAPID EGRESS DESCENT SYSTEMS LTD., CA

(74) **Agent:** RIDOUT & MAYBEE LLP

(54) **Titre :** DISPOSITIF DE COMMANDE DE DESCENTE
(54) **Title:** DESCENT CONTROL DEVICE



(57) **Abrégé/Abstract:**
A magnetic descent control device is disclosed. The device comprises an input shaft affixed to a rotating driven sheave acting as a drive assembly, which grips a cable guiding the descent path of a body carrying cage. The input shaft has a shoulder upon which

(57) Abrégé(suite)/Abstract(continued):
rests a rotor. The rotor is encased within a front and back enclosure of conductive material. Disposed along at least one surface of the rotor and/or at least one of the conductors, is a series of magnets such that rotation of the rotor relative to the conductors creates relative motion between the magnets' magnetic field and the conductor inducing eddy currents in the conductor that oppose the magnetic field creating a rotational braking force. As a result, very precise and/or controllable descent may be obtained over a broad range of descent angles and/or distances with little or no mechanical wear or risk of overheating. Preferably, the sheave gripping the cable may have a circumferential groove to better improve traction and grip of the cable. A plurality of such devices may be applied to drive assemblies contacting a common cable, and a plurality of cables may support the cage, each affixed with at least one descent control device.

ABSTRACT

A magnetic descent control device is disclosed. The device comprises an input shaft affixed to a rotating driven sheave acting as a drive assembly, which grips a cable guiding the descent path of a body carrying cage. The input shaft has a shoulder upon which rests a rotor. The rotor is encased within a front and back enclosure of conductive material. Disposed along at least one surface of the rotor and/or at least one of the conductors, is a series of magnets such that rotation of the rotor relative to the conductors creates relative motion between the magnets' magnetic field and the conductor inducing eddy currents in the conductor that oppose the magnetic field creating a rotational braking force. As a result, very precise and/or controllable descent may be obtained over a broad range of descent angles and/or distances with little or no mechanical wear or risk of overheating. Preferably, the sheave gripping the cable may have a circumferential groove to better improve traction and grip of the cable. A plurality of such devices may be applied to drive assemblies contacting a common cable, and a plurality of cables may support the cage, each affixed with at least one descent control device.

DESCENT CONTROL DEVICE

RELATED APPLICATIONS

[0001] The present application claims priority from Canadian Patent Application No. 2,613,855 entitled "Egress Descent Control Device" and filed on December 10, 2007.

FIELD

[0002] The present application relates to apparatus for controlling the descent rate of a structure along a cable, and more particularly to a descent control device for controlling the speed of descent of a cable-suspended apparatus for emergency escape from a platform on a rig.

BACKGROUND

[0003] Often it is necessary to have someone working on a rig platform (such as a derrick tubing board, for example). Sometimes, however, rig workers on such platforms are faced with a blowout or fire or some other kind of accident and need to escape quickly from the platform in order to avoid being seriously or fatally injured. Various t-bar or chair-based systems exist for providing a means for escaping from such platforms; however a difficulty encountered with known escape systems is that functionally impaired workers (e.g. workers who are in a state of shock as a result of the accident, or workers who have been burned, or disoriented by gases as a result of the accident) can have difficulties in accessing and operating them.

[0004] In Canadian Patent Application no. 2,539,883 filed March 16, 2006 by Boscher *et al* and entitled APPARATUS FOR ESCAPING AREA OF ACCIDENT, an apparatus is provided for emergency escape from a drilling rig platform along a path defined by at least one cable extending between the platform and a remote, terminal location. The apparatus includes a frame in which a top of the frame is located above a bottom of the frame when the frame is erect. The frame defines an interior space large enough to accommodate a worker.

A locking system includes a locking mechanism and also a foot-actuated disengager that is located at least proximate to the bottom of the frame. The locking mechanism is adapted to interlock with a mating portion on the platform to prevent the frame from traveling away from the platform when the locking mechanism engages the mating portion. The disengager is connected to the locking mechanism and has a foot receiving surface region upon which force can be applied to displace the disengager between a first, engaged position and a second position to disengage the locking mechanism from the mating portion. The frame will travel away from the platform to the terminal location under gravity when the locking mechanism is disengaged.

[0005] The Boscher *et al.* device uses an automatic braking system attached at the bottom of the frame, beneath the disengager to permit quick descent along the path defined by the cable, but still sufficiently slowed down to prevent an excessively forceful impact when the frame arrives at the terminal location.

[0006] Conventional systems include braking systems that employ hand actuated levers (including overriding automatic brake settings). A preferred system disclosed in the Boscher *et al* device is the Rollgliss® Rescue Emergency Descent Device friction brake, model no. 3303001 manufactured by DBI/SALA & Protecta. This system employs a series of brake pads that expand into a brake drum during descent to slow descent to a rate of about 15 feet/second.

[0007] Because of the intangible factors that will affect braking power with such systems, the rate at which enclosures equipped with such systems will fail will invariably have considerable variability, which makes it difficult to ensure compliance with applicable safety standards, such as those mandated by the Canadian Association of Oilwell Drilling Contractors (CAODC). Such standards mandate, amongst other things, that the enclosure land with a speed no greater than 12 ft/s.

[0008] The release of the pod pulls on the spooled cable, causing the pads to be placed in frictional contact with a drum to slow the descent of the pod. The physical contact between the pads and the drum creates a potentially hazardous risk of overheating of the components and cable and causes wear on both items which must be taken into account in maintenance operations, especially given that the device is hopefully only sporadically used. Additionally, both the pads and the drum should be subjected to regular maintenance and/or inspections to ensure that corrosion does not build up on either surface which may deleteriously impact the gripping performance of the braking system. Indeed, such braking systems face recertification inspections after use and on a semi-annual or annual basis.

[0009] Moreover, such braking systems have a latch mechanism that call for manual engagement of a spooled cable clasp when the enclosure was brought to the side of the derrick or structure. Such manual engagement necessarily incurs a risk of human error, which, in the frenetic occasions when the pod is to be used, could have catastrophic consequences.

SUMMARY

[0010] The present disclosure provides a magnetic descent control device that makes use of the creation of eddy or Foucault currents in a conductor when a magnetic field moves across the conductor. As a result, a very precise and/or controllable descent may be obtained over a broad range of descent angles and/or distances with little or no mechanical wear or risk of overheating. Moreover, the length of time or number of uses of the descent control device between recertification and inspection may conceivably be increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The embodiments of the present application will now be described by reference to the following figures, in which identical reference numerals in different figures indicate identical elements and in which:

[0012] **FIGURE 1** is a perspective view of a platform with an enclosure attached by means of a cable between the platform and a terminal location;

[0013] **FIGURE 2** is a detailed side view inside of a braking assembly of an enclosure of **FIGURE 1** wherein the braking assembly includes a descent control device partially behind and partially extending through the mounting plate of the braking assembly;

[0014] **FIGURE 3** is a detailed cross-sectional view of the braking assembly and the descent control device of **FIGURE 2** taken along line A-A;

[0015] **FIGURE 4** is a plan view of a rotor for use in an example embodiment of the descent control device of **FIGURE 3**;

[0016] **FIGURE 5** is a cross-sectional view of the rotor of **FIGURE 4** along the line B-B.

DETAILED DESCRIPTION

[0017] The present application will now be described for the purposes of illustration only, in conjunction with certain embodiments shown in the enclosed drawings. While preferred embodiments are disclosed, this is not intended to be limiting. Rather, the general principles set forth herein are considered to be merely illustrative of the scope of the present application and it is to be further understood that numerous changes covering alternatives, modifications and equivalents may be made without straying from the scope of the present application, as defined by the appended claims.

[0018] In particular, all dimensions described herein are intended solely to be exemplary for purposes of illustrating certain embodiments and are not intended to limit the scope of the invention to any embodiments that may depart from such dimensions as may be specified.

[0019] Referring first to **FIGURE 1**, there is shown, an existing embodiment of an enclosure shown generally at **100** that is secured in position next to a platform **102** by a cable **104** and a locking mechanism **106**. The enclosure **100** is accessible from the platform **102** by an exit **108**. The enclosure **100** includes a braking assembly **110** affixed to a metal frame **112** of the enclosure **100**. The cable **104** is affixed, at one end, to the platform **102** by a platform anchor **114**, and at the other end, to a terminal anchor (not shown) at the terminal location (not shown). The cable **104** runs through the braking assembly **110** such that the cable **104** defines the path of descent of the enclosure **100** when the enclosure **100** is released from the platform **102**. As will be described in greater detail in **FIGURE 2** and **FIGURE 3**, the cable **104** is acted upon by the braking assembly **110** to slow the descent of the enclosure **100**.

[0020] Preferably, the cables **104** used are ½" diameter steel cables.

[0021] Preferably, the platform anchor **114**, connected to one end of cable **104**, is several feet above the exit **108**. The other end of cable **104** is connected to a terminal anchor (not shown) at the terminal location (not shown). The terminal location is located at a lower elevation and safely distant from the platform **102**. Preferably, the terminal location is horizontally distanced about 80 to 100 feet from the platform **102**. Preferably, each cable **104** is connected between the platform **102** and the terminal location by screwed in anchors that have been pull tested.

[0022] The platform **102** is generally of such design that an exit **108** is formed at the location where the enclosure **100** is releasably secured to the platform **102** such that a rig worker **116** can depart the platform **102** through exit **108** and enter enclosure **100**.

[0023] Preferably, the platform **102** is at an elevated location on a rig of the type used for drilling or servicing of wells, for example. Those skilled in the art will appreciate that at least some example embodiments of the enclosure with descent control device disclosed herein are suitable for use in conjunction with other types of platforms such as a racking board or monkey board, for example.

[0024] The enclosure **100** is a rigid structure designed for providing a vehicle for a rig worker **116** to depart the platform **102** in the case of an accident such as a blowout or the like. Preferably, the enclosure **100** comprises a metal frame **112** composed of a plurality of metal members that define an interior space of the enclosure **100** at least sufficiently large to accommodate one rig worker **116**. A rig worker **116** on the platform **102** can enter the enclosure **100** by departing the platform **102** through the exit **108** to enter the interior space of the enclosure **100**.

[0025] It will be understood that the enclosure **100** could be brought up from the terminal location to a position adjacent to the platform **102** by one of a number of different methods. In some embodiments, the weight of the enclosure **100**, including contents such as passengers or cargo may be, but is not limited to, approximately 700 lbs.

[0026] To releasably secure the enclosure **100** to the platform **102**, a locking mechanism **106** is employed between the enclosure **100** and platform **102**. The enclosure **100** remains secured to the platform **102** adjacent to the exit **108** when the locking mechanism **106** is engaged. The locking mechanism **106** is disengaged by a rig worker **116** entering the enclosure **100**.

[0027] Disengaging the locking mechanism **106** triggers the release of the enclosure **100** from the platform **102** commencing descent of the enclosure **100** from its location adjacent to platform **102** along the path defined by cable **104** to a terminal location (not shown).

[0028] To protect a rig worker **116** from an accidental fall off of a rig platform, it is typical for a number of safety lines **118** to be employed. Each safety line **118** connects the rig worker **116** to either the platform **102** or the enclosure **100**. Lanyards **120** connect each end of a safety line **118** to one of the rig worker **116**, platform **102**, or enclosure **100**.

[0029] Referring for instance to the example embodiment illustrated in **FIGURE 1**, the two safety lines **118** connect the rig worker **116** to the enclosure **100** rather than the platform **102**. The impact of this setup is that a rig worker **116** in an accident situation can save the time and effort of disconnecting lanyards **120** from the platform **102** and reconnecting them to the enclosure **100** before exiting the platform **102**.

[0030] When a rig worker **116** enters the enclosure **100** releasing the locking mechanism **106**, the enclosure **100** will automatically commence its descent from its initial location proximate to platform **102** to a terminal location at a decreased elevation and increased horizontal displacement from the platform **102**. The path of descent of the enclosure **100** is defined by the cable **104** which runs through the braking assembly **110**. The cable **104** is anchored to the platform **102** at one end by platform anchor **114**, and anchored at the other end to the terminal location (not shown) by a terminal anchor (not shown).

[0031] In **FIGURE 1**, a single cable **104** and a single braking assembly **110** are shown, however embodiments of an enclosure **100** with multiple braking assemblies **110** each operating upon a different cable **104** are also envisioned within the scope of the present invention. Preferably, two braking assemblies **110** are affixed on opposite sides of the enclosure **100**. Each braking assembly **110** operates upon one of two cables **104**, with those cables **104** appropriately anchored to define a path of descent of the enclosure **100** from a position adjacent to the platform **102** to a terminal location (not shown).

[0032] **FIGURE 2** shows a detailed side view inside of a braking assembly **110** of an enclosure **100** of the example embodiment in **FIGURE 1**. The braking assembly **110** includes at least one descent control device **200** partially visible in front of mounting plate **202** in **FIGURE 2** and extending behind the mounting plate **202** to which the braking assembly **110** is attached. Preferably, one or more descent control devices **200** are used to ensure that the enclosure **100** descends at a controlled rate and manner.

[0033] In the example embodiment, the braking assembly **110** includes two driven sheaves **204** between two idler sheaves **206**. All four sheaves are attached to the mounting plate **202**. Each sheave has a peripheral surface in contact with the cable **104**. In at least one example, the cable **104** runs through the braking assembly **110** passing under or over each of the four sheaves in such a manner that the cable **104** is in contact with a maximum of about ¼ of the diameter of any single sheave. At least one of the driven sheaves **204** is attached to, rotationally drives, and receives a rotational braking force from a descent control device **200** and thus acts as a drive assembly.

[0034] In the example embodiment, a drive gear **208** is attached to each descent control device **200**. The teeth of the drive gears **208** are mutually interlocked so as to synchronize the rate of rotation of each driven sheave **204** preventing them from slipping against the cable **104** and losing synchronization. This configuration also allows the two driven sheaves **204** to cooperatively grip the cable **104** without slipping during descent. It will be understood that alternative examples wherein a different number of driven sheaves and idler sheaves are employed may be possible. Furthermore, although in the illustrated example embodiment the cable **104** passes directly over the top of the sheave **204** and directly under the bottom of the sheave **206**, those skilled in the art will appreciate that other cable engagement configurations are possible.

[0035] During descent of the enclosure **100** from the platform **102**, the sheaves **204**, **206** rotate as the enclosure **100** travels down the path defined by cable **104** from a position proximate to the platform **102** to the terminal location. During rotation, the idler sheaves **206** bear no load and offer minimal resistance to the descent of the enclosure **100**. They primarily aid in maintaining the position of the cable **104** as it passes along the driven sheaves **204**. However, each driven sheave **204** drives a descent control device **200** which generates rotational braking force slowing the descent of the enclosure **100**. How this braking force is generated is best explained with reference to **FIGURE 3**.

[0036] **FIGURE 3** is an enlarged cross-sectional view along line A-A of a descent control device **200** mounted through the mounting plate **202** of **FIGURE 2**. Descent control device **200** includes an input shaft **300** affixed to a rotor **302**, a flange plate **304** connected to a back plate **306** which together form a conductor surrounding the rotor **302**, a spacer **308** affixed to the input shaft **300** and holding the rotor **302** in place between the back plate **306** and the flange plate **304**, a flange bushing or bearing **310** rotatably connecting the input shaft **300** to the flange plate **304** and a back bushing or bearing **312** rotatably connecting the input shaft **300** to the back plate **306**. The rotor **302** includes a plurality of recesses **314** which receive magnets **316** in such a configuration that forms several distinct regions of polarity on the rotor **302**. In the embodiment shown in **FIGURE 3**, the descent control device **200** is attached to the mounting plate **304** by fasteners **319**.

[0037] The input shaft **300** is preferably an elongate cylindrical member having a first end and a second end, through which the axis of rotation is defined, and a shoulder **301** about which the diameter of the input shaft **300** changes. The first end of the input shaft **300** is affixed to a driven sheave **204**. The second end of the input shaft rotationally engages the flange bearing **310** and back bearing **312**. The rotor **302** is mounted on the input shaft **300** at the shoulder **301**. The spacer **308** is mounted on the input shaft **300** on the other side of the rotor **302** such that the position of the rotor **302** relative to the input shaft **300** is fixed both rotationally and longitudinally. The input shaft **300** drives rotation of the rotor **302** when it is rotated with the rotation of a driven sheave **204**.

[0038] The rotor **302** is preferably a substantially planar ferromagnetic steel cylindrical disc which is centrally affixed to the input shaft **300** and held in place on the input shaft **300** between the shoulder **301** and the spacer **308**. A side view of an example rotor **302** is displayed in **FIGURE 4** and in cross-sectional view in **FIGURE 5**. The rotor **302** includes a plurality of recesses **314**. In one embodiment, recesses **314** are present on both sides of the rotor **302**. In an alternative embodiment (not shown) recesses **314** could pass completely through the rotor **302**. Each recess **314** receives a magnet **316** having axial magnetization. All magnets **316** are mounted in the same magnetic pole orientation such that the main flux exiting the rotor **302** is of the same polarity. The return flux goes back to the rotor **302** in the area adjacent to each magnet **316**.

[0039] In one embodiment, each recess **314** may be ¾" in diameter and 1/8" deep to receive a Neodymium rare earth or other fixed magnet **316**. In some example embodiments, two rings of recesses **314** contain 48 magnets **316**, on each side of the rotor **302**. In an alternative embodiment, the rotor **302** may itself be a magnet **316**, having a corresponding magnetic pole orientation, and obviating any use of recesses **314**.

[0040] The flange plate **304** is formed of a conductive metal in such a shape as to encircle the input shaft **300** and enclose one side of the rotor **302**. The flange plate **304** is connected to the flange bushing **310** which secures the axial position of the flange plate **304** relative to the input shaft **300** but permits rotational movement of the input shaft **300** relative to the flange plate **304**. In one embodiment, the flange plate **304** is attached to the mounting plate **202** by fasteners **319** to secure the descent control device **200** to the enclosure **100** and to prevent axial rotation of the flange plate **304** during rotation of the input shaft **300**. The flange plate **304** is connected to the back plate **306** at points radially distal from the rotor **302** such that the connected flange plate **304** and back plate **306** form a cavity inside of which the rotor **302** is proximate to both the flange plate **304** and the back plate **306** but may freely rotate relative thereto. The flange plate **304** forms part of the conductor in which eddy currents are induced.

[0041] The back plate **306** is formed of a conductive metal in a shape to enclose the second end of the input shaft **300** and the side of the rotor **302** not otherwise enclosed by the flange plate **304**. The back plate **306** is connected to the back bushing **312**, which secures the axial position of the back plate **306** relative to the input shaft **300** but permits rotational movement of the input shaft **300** relative to the back plate **306**. The back plate **306** is connected to the flange plate **304** at points radially distal from the rotor **302** by means of a plate fastener **318** such that the connected back plate **306** and flange plate **304** form a cavity inside of which the rotor **302** is proximate to both the back plate **306** and flange plate **304** but may freely rotate. The back plate **306** forms another part of the conductor in which eddy currents are induced.

[0042] Thus, the rotation of the rotor **302** creates a traveling wave of magnetic field relative to the conductor which induces eddy currents between the conductor and the rotor. As such, the descent control device **200** operates passively in that there is no applied power or control to operate it. As long as the magnets **316** remain magnetized and relative motion is developed between the magnets **316** and the conductor, a braking force is generated. During rotation, a traveling wave magnetic field is in motion relative to a conducting medium. The relative motion of this wave induces eddy currents in the conductive medium in a pattern which mirrors that of the driving field. The induced eddy currents interact with the field of the magnets **316** to develop a braking force. The braking force is a function of the relative strengths of the magnets **316** and induced currents and their relative phase offsets. The magnitude and phase offset of the induced current varies as a function of the relative wave velocity, magnetic field strengths, wavelength of the field and conductor resistivity.

[0043] The shoulder **301** surrounds and forms a portion of the input shaft **300** around which the diameter of the input shaft **300** changes. One side of the rotor **302** abuts the shoulder **301** so as to maintain a minimum spacing between the rotor **302** and the flange plate **304**.

[0044] The spacer **308** surrounds and abuts the input shaft **300** and abuts the other side of the rotor **302** opposite the shoulder **301** by contacting the inner race of back bearing **312**. The spacer **308** holds the rotor **302** securely in place against the shoulder **301** of the input shaft **300** to maintain a spacing between the backing plate **306** and the rotor **302**. The spacing between the rotor **302** and flange plate **306** and the spacing between the rotor **302** and the backing plate **306** prevent frictional contact between the rotor **302** and the flange plate **304** or back plate **306** and yet maintain a desired braking force of the descent control device **200**.

[0045] The flange bearing **310** surrounds the input shaft **300** to hold the flange plate **304** in place axially while permitting rotation of the input shaft **300**. The flange bearing **310** may be a ball bearing, bushing, spacer, sleeve, coupling or other such instrument which holds the flange plate **304** in place axially while permitting rotation of the input shaft **300**.

[0046] The back bearing **312** surrounds the input shaft **300** to hold the back plate **306** in place axially while permitting rotation of the input shaft **300**. The back bearing **312** may be a ball bearing, bushing, spacer, sleeve, coupling or other such instrument which holds the back plate **306** in place axially while permitting rotation of the input shaft **300**.

[0047] The strength of the braking force is also proportional to the distance between the rotor **302** and the conductors and thickness of the conductors. Those having ordinary skill in this art will appreciate that the braking force may be controlled by adding or removing magnets **316**; changing the displacement between the flange plate **304** and rotor **302**; changing the displacement between the back plate **306** and rotor **302**; changing the diameter of back plate **306**, flange plate **304** or the rotor **302**; changing the type or strength of the magnets **316**; and changing the material from which the back plate **306**, flange plate **304** and the rotor **302** are composed. For example, the back plate **306** and flange plate **304** could be composed of steel, while the rotor **302** could be composed of aluminum, especially if the magnets **316** were housed in the conductor plates **304** and **306**. Alternatively, the rotor **302** could be composed of copper or laminated steel and copper or plastic.

[0048] Also visible in **FIGURE 3**, a sheave channel **320** preferably semicircular in shape is carved into the circumferential end surface of each driven sheave **204** and idler sheave **206**. The sheave channel **320** guides and increases traction of the cable **104**. In an example embodiment, each sheave channel **320** is slotted to a specific size and spacing to accept the cable **104** there around in a traction fit and also acts to displace any debris that may have built up on the cable **104** such as snow, ice, grease, dirt, wax or the like.

[0049] To further assist in the removal of snow, ice, grease, dirt, wax, or the like, and to increase heat dissipation when the cable moves through the sheave channel **320**, each driven sheave **204** or idler sheave **206**, may include a series of channel bores **322** bored parallel to the axis of rotation near the circumferential end surface of each sheave and partially through the sheave channel **320**.

[0050] Turning now to **FIGURE 4** and **FIGURE 5**, an example rotor **302** is further described. In **FIGURE 4** a rotor **302** shaped as a cylindrical disc includes three rings of recesses **314** each recess **314** adapted to accept a magnet **316**. At the center of the rotor **302** a key **400** is cut out of the rotor

302 to receive the shoulder **301** of the input shaft **300** in such a manner to affix the rotor **302** to the input shaft **300** for rotation together.

[0051] In **FIGURE 5**, a cross section of the rotor of **FIGURE 4** along the line **B-B** illustrates one embodiment where a plurality of recesses **314** exist on both sides of rotor **302** for receiving magnets **316**.

[0052] In a preferred example embodiment, the descent control device **200** consists of a steel rotor **302**, aluminum (6061-T6) flange plate **304** and aluminum (6061-T6) back plate **306**. The surface of the rotor **302** is spaced 0.040 inches from the flange plate **304** on one side and the same distance from the back plate **306** on the other. The flange bearing **310** and back bearing **312** are both ball bearings. The magnets **316** are NdFeB N42 .750" diameter, 0.125" thick and 13,200 Gauss / 3,240 surface field Gauss.

[0053] In operation, the enclosure **100** descends along the path defined by at least one cable **104**. Descent of the enclosure **100** along cable **104** causes rotation of at least one driven sheave **204** which causes rotation of the input shaft **300** of the descent control device **200**. Rotation of the input shaft **300** causes rotation of the rotor **302** and the magnets **316** contained in the recesses **314** of the rotor **302**. Rotation of the magnets **316** causes the magnetic field created by the axial polarity of the magnets **316** to rotate. The rotational movement of the magnetic field relative to the conductor (formed in one embodiment by the flange plate **304** and back plate **306**) induces eddy currents in the conductor in a pattern which mirrors that of the magnetic field created by the magnets **316**. Because the eddy currents and the magnetic field mirror each other, they interact to oppose the rotation of the magnetic field. This opposition to rotation of the magnetic field translates to a braking force against the rotation of the magnets **316** in the rotor **302**, against the rotation of the input shaft **300**, against the rotation of the driven sheave **204** and against the enclosure **100** descending along the cable **104**. Consequently, the enclosure **100** descends along the path defined by the cable **104** at a rate controlled by the braking force of the descent control device **200**.

[0054] Because the strength of the eddy currents is proportional to the velocity of the rotor **302** relative to the stationary conductor, as the rate of descent of the enclosure **100** increases, the braking force increases. Similarly, decreasing the rate of descent of the enclosure **100** decreases the braking force. This proportionality produces a smoother deceleration and allows the enclosure **100** to descend in a controlled manner towards the terminal location (not shown), resulting in a gentle landing. Rates of descent of about 14 ft/s (peak at around 22ft/s) have been experienced for descents from high elevations, while more moderate descent elevations result in rates of descent of about 7-8 ft/s and landing speeds as low as 2 ft/s.

[0055] In simulation testing, a first-order analysis assumed a single pure sinusoid traveling magnetic wave due to field rotation. The simulation assumed a pole gap field amplitude of 3240 Gauss, conductor resistivity of 4×10^{-8} ohm-m (aluminum), approximate gap field wavelength of 25mm, drive sheave diameter of 4.0", effective rotor drag area (both sides) of 61 square inches, total weight of enclosure and contents of 600 lbs and descent by gravity at a 45 degree descent angle. This simulation of the magnetic drag (braking force) indicates that a pair of descent control devices applied to an enclosure is capable of producing a maximum of approximately 420 lbs of drag at a maximum descent speed of 28 ft/s, which is approximately equal to the gravity force of a 600 pound load descending at a 45° angle. The braking force decreases when descent speed exceeds 28 ft/s. At a descent speed of 12 ft/s, the drag force on the enclosure is approximately 180 lbs. However, this date should be treated as an estimate and approximate only.

[0056] In fact, the magnetic field is significantly more complex than a single pure sinusoid traveling magnetic wave, with higher order terms that will result in multiple traveling waves of different amplitudes and lengths. Each traveling wave will produce its own characteristic drag/speed curve. The total drag is the Fourier sum of the force contributed by each of these traveling waves. The higher order wave components due to edge effects tend to substantially increase the total braking force. As such, the total braking force may be in the range of 50% to 100% greater than that predicted by the single-wave analysis.

[0057] It will be apparent to those having ordinary skill in this art that various modifications and variations may be made to the embodiments disclosed herein, consistent with the present application, without departing from the spirit and scope of the present application.

[0058] For example, the magnets could be mounted in the back plate **306** and flange plate **304** and the conductor could be formed from the rotor **302**.

[0059] Similarly, a descent control device **200** can be mounted in a braking assembly **110** by rotationally connecting the input shaft **300** to the mounting plate **202** or by affixing the flange plate **304** to the mounting plate **202**.

[0060] In a further embodiment, the enclosure **100** includes a means for attachment to a trailer or fork lift to facilitate transportation when detached from cables **104** and/or the removable attachment of wheels to facilitate repositioning below the initial point.

[0061] Other embodiments consistent with the present application will become apparent from consideration of the specification and the practice of the application disclosed herein.

[0062] Accordingly, the specification and the embodiments disclosed therein are to be considered exemplary only, with a true scope and spirit of the invention being disclosed by the following claims.

WHAT IS CLAIMED IS:

1. A descent control device for controlling movement of an enclosure along a path defined by at least one cable extending from an initial point on a structure to a terminal point on a lower surface, the device comprising:

at least one drive assembly configured for rotationally engaging one of the at least one cables as the enclosure moves along the path;

a substantially planar moving element in rotationally locked engagement with the at least one drive assembly;

at least one conducting plate disposed proximate to the moving element whereby a magnetic field may be induced by rotational movement of the moving element relative to the at least one conducting plate in a direction to oppose acceleration of the at least one drive assembly as it rotationally engages the at least one cable.

2. The descent control device according to claim 1, wherein the magnetic field is created by at least one fixed magnet.

3. The descent control device according to claim 2, wherein the at least one fixed magnet is disposed on the moving element.

4. The descent control device according to claim 3, wherein the at least one fixed magnet is disposed on a face of the moving element facing one of the at least one conducting plates.

5 The descent control device according to claim 4, wherein a first one of the at least one fixed magnets is disposed at a point on a first face of the moving element having an outwardly facing first polarity and a second one of the at least one fixed magnets is disposed at a corresponding point on a second face of the moving element having an outwardly facing second polarity opposite to the first polarity.

6. The descent control device according to claim 2, wherein the at least one fixed magnet is disposed on one of the at least one conducting plates.

7. The descent control device according to claim 6, wherein the at least one fixed magnet is disposed on a face of the at least one conducting plate facing the moving element.

8. The descent control device according to any one of claims 2 through 7, wherein the at least one fixed magnet is a rare earth magnet.

9. The descent control device according to any one of claims 1 through 8, wherein the magnetic field is induced in a direction transverse to a direction of movement of the moving element.

10. The descent control device according to any one of claims 1 through 9, wherein the moving element is a rotor.

11. The descent control device according to any one of claims 1 through 10, further comprising a shaft fixed to and extending along the rotational axis of both the moving element and the at least one drive assembly.

12, The descent control device according to any one of claims 1 through 11, wherein the at least one conducting plates comprise first and second chamber portions surrounding the moving element.

13. The descent control device according to any one of claims 1 through 12, wherein a peripheral surface of the at least one drive assembly comprises a channel sized to accept the at least one cable in a friction fit.

14. The descent control device according to any one of claims 1 through 13, wherein a plurality of the at least one drive assemblies are in synchronous rotational engagement about the at least one cable.

15. The descent control device according to any one of claims 1 through 14, wherein the moving element is composed of a material selected from a group consisting of steel, copper, laminated steel and copper, aluminum and plastic.

16. The descent control device according to any one of claims 1 through 15, wherein the at least one conducting plate is composed of a material selected from a group consisting of aluminum and steel.

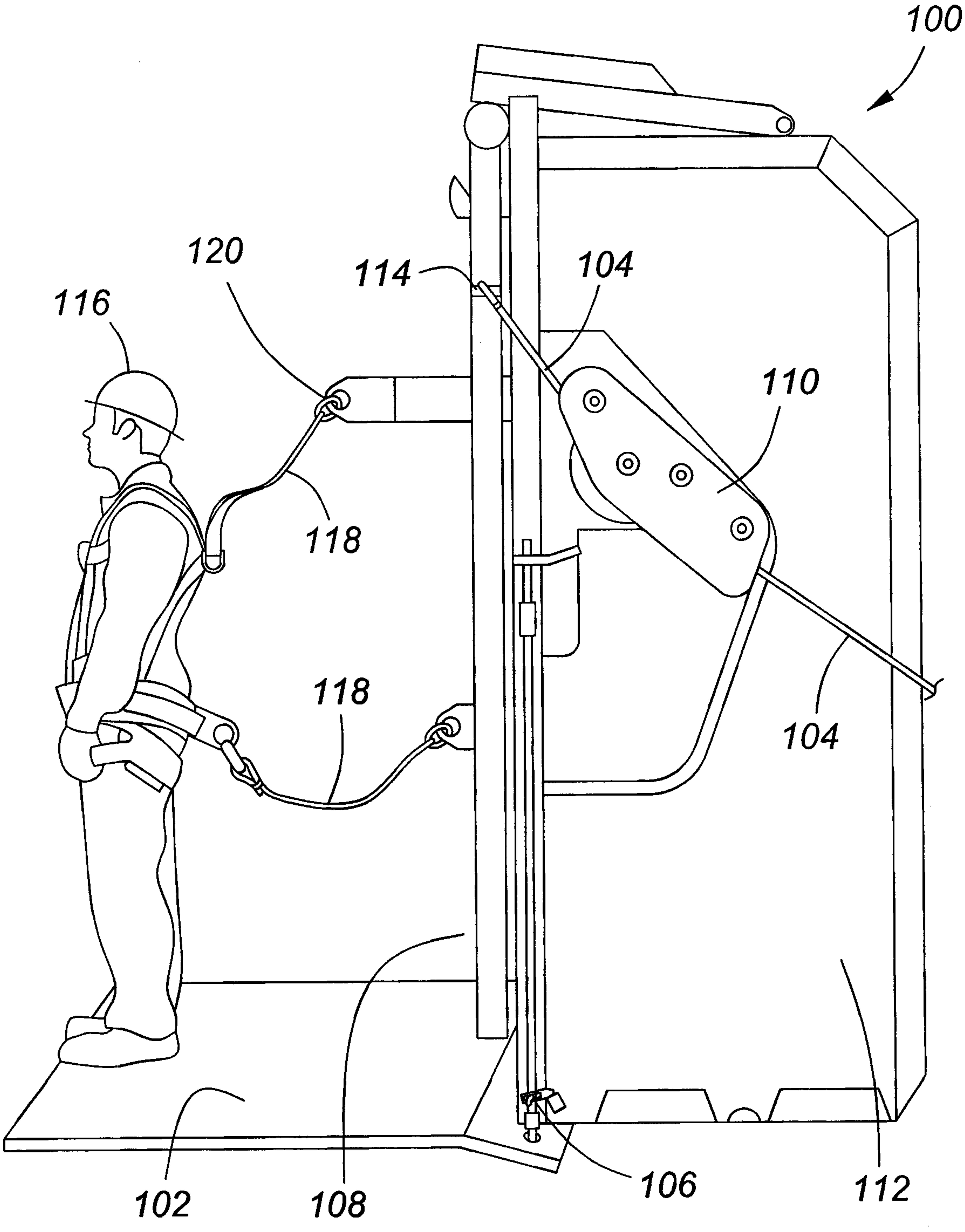


FIG. 1

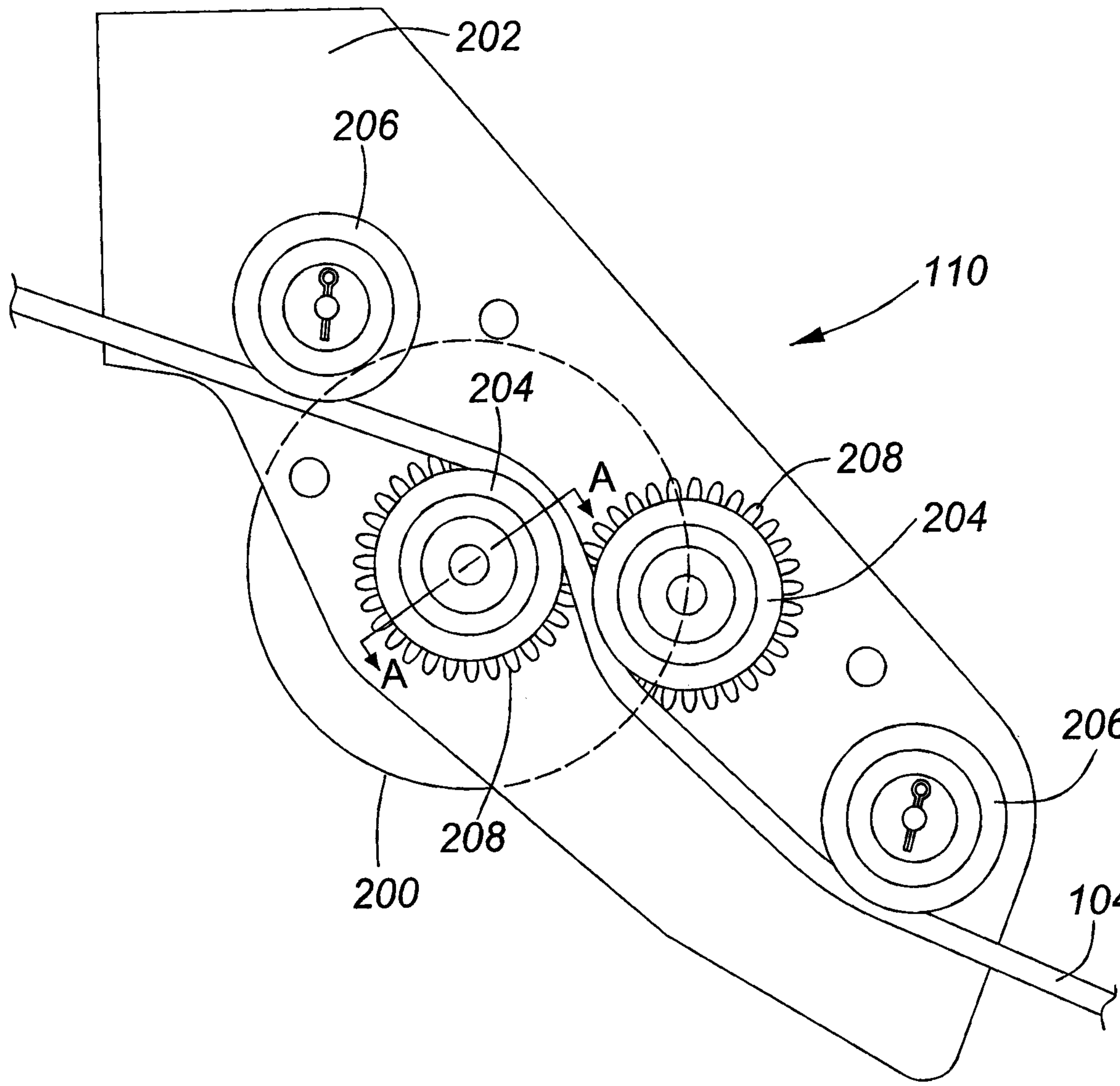
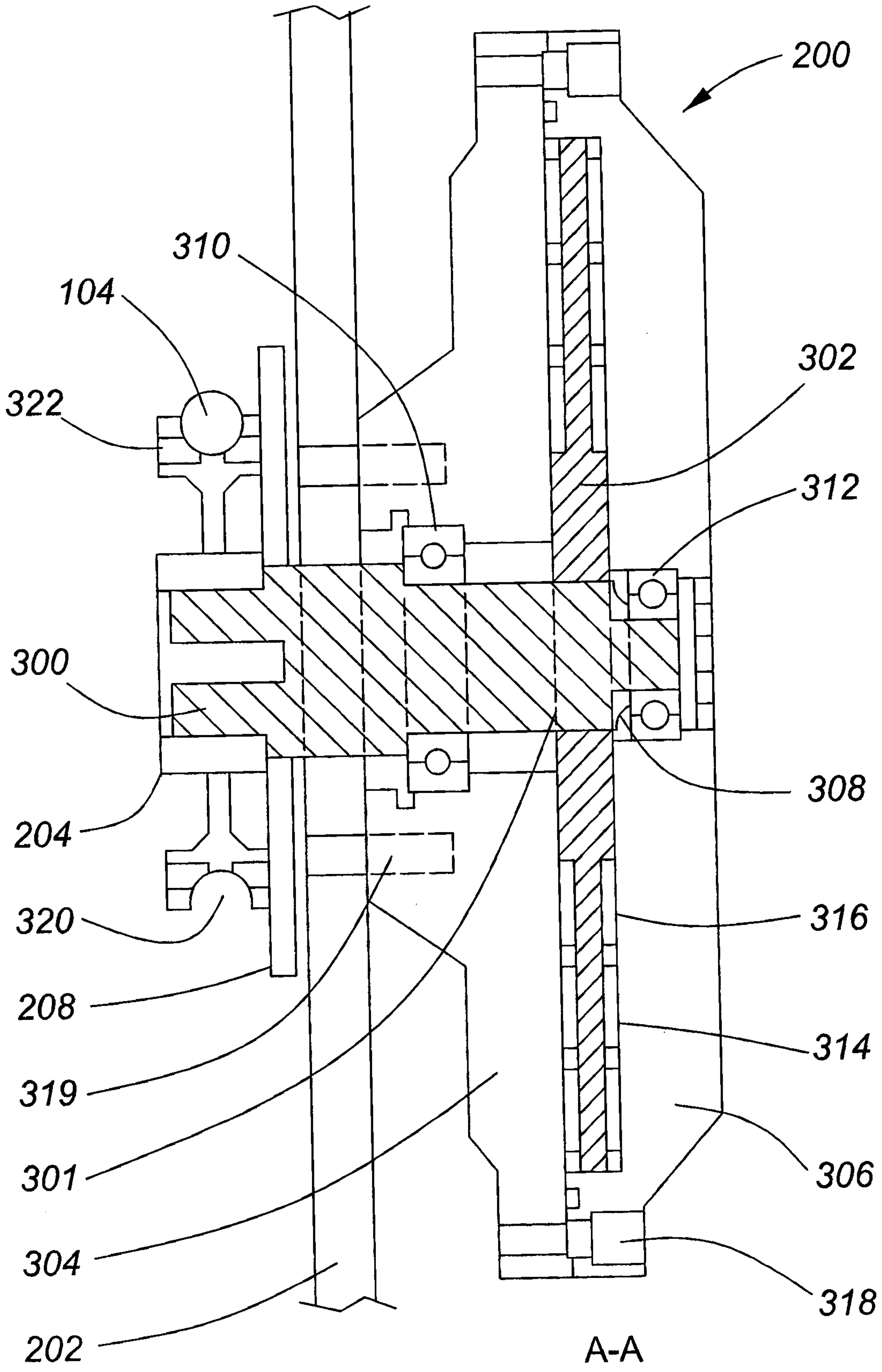


FIG. 2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A-A

FIG. 3

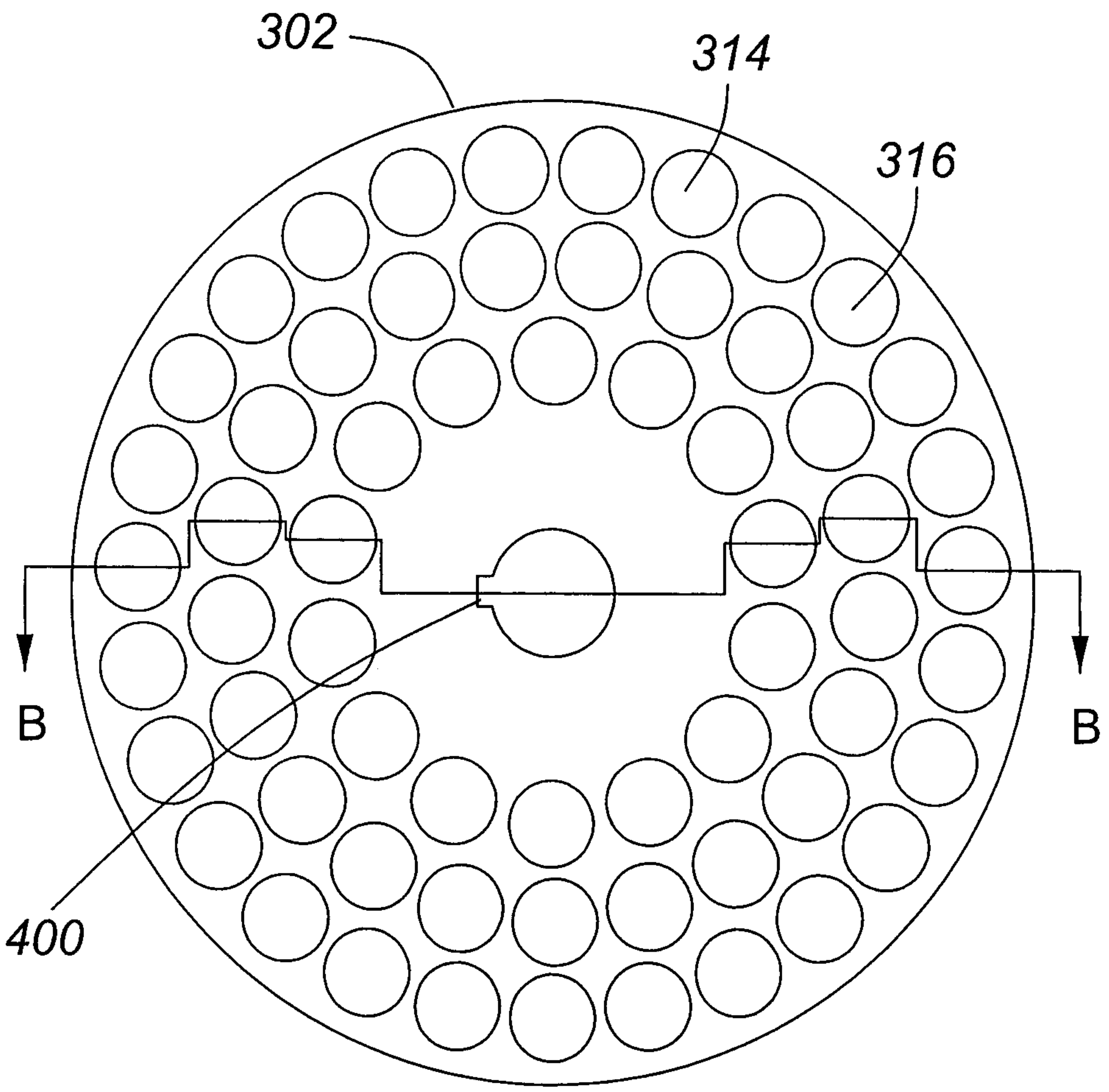
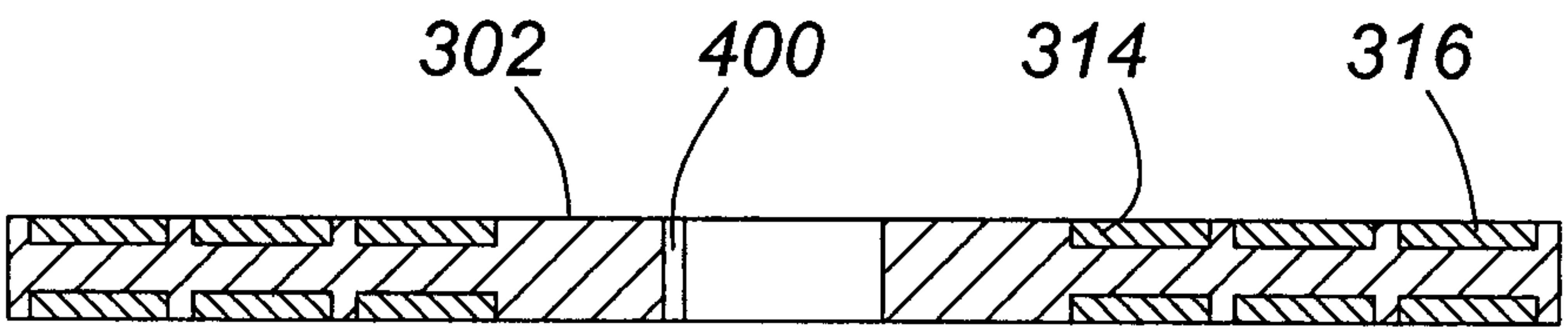
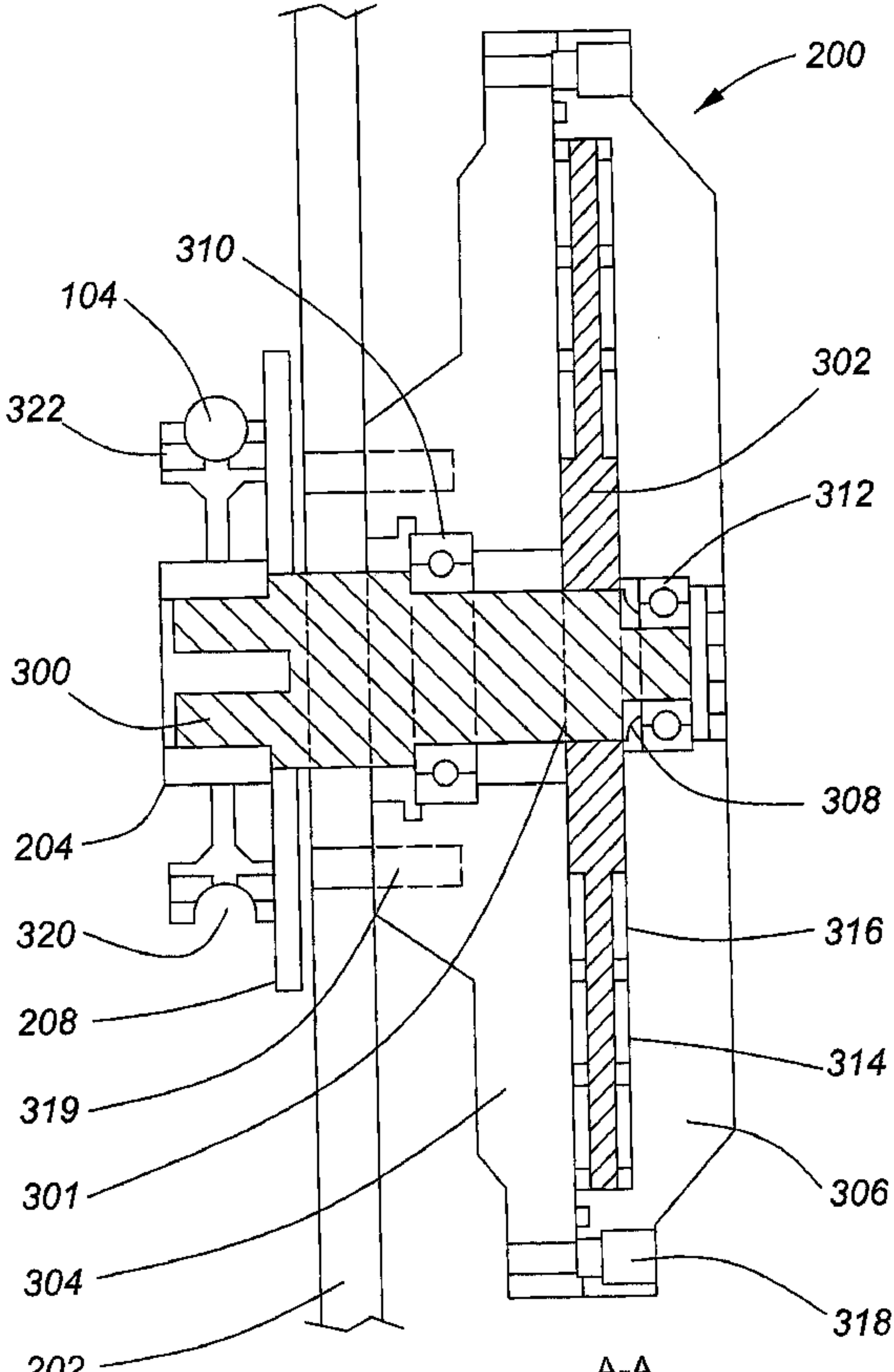


FIG. 4



B-B
FIG. 5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