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(54) **Titre : ACCUMULATEUR D'ENERGIE A MASSE TOURNANTE**
(54) **Title: ROTATING MASS ENERGY STORE**

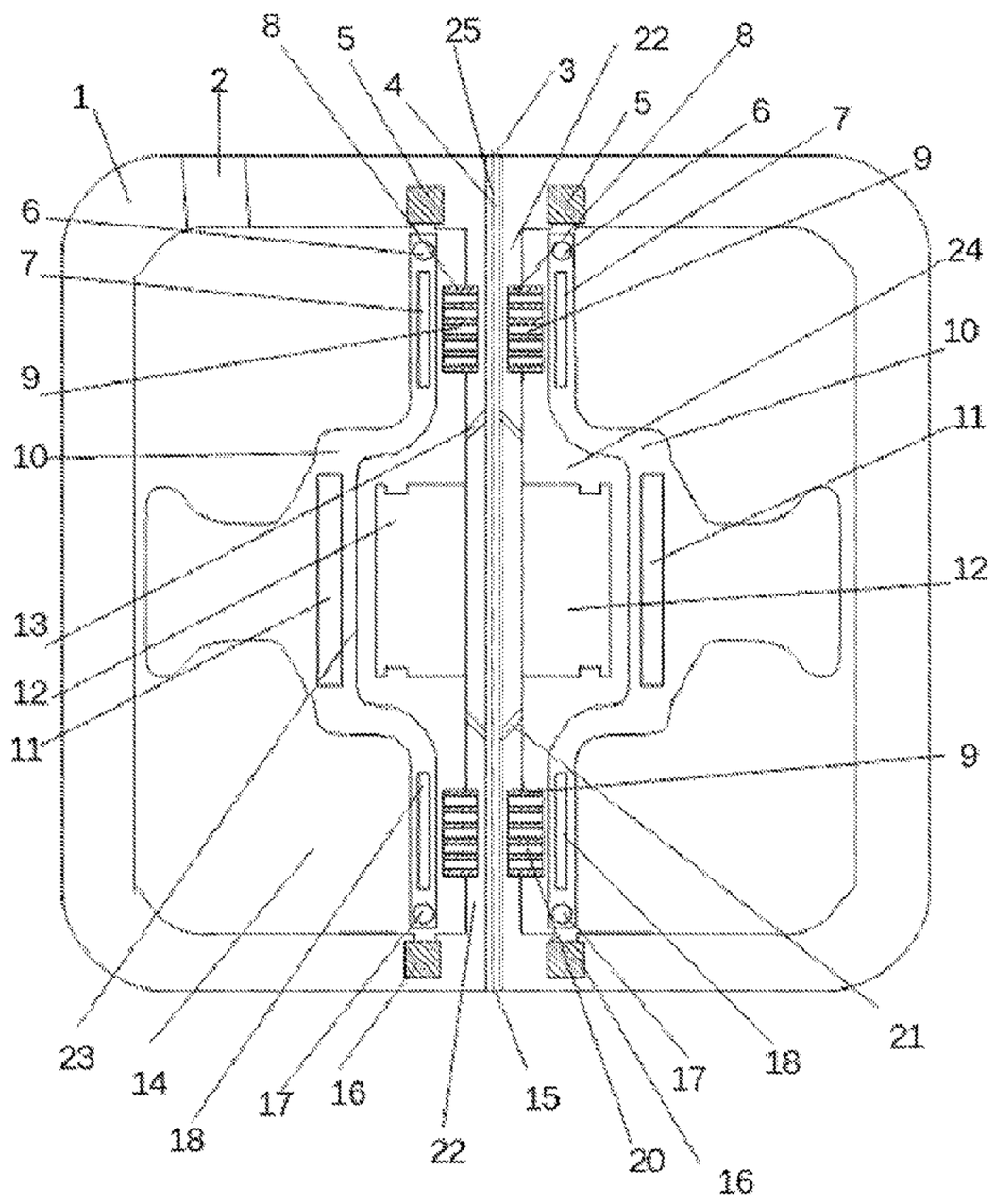


FIGURE 6

(57) **Abrégé/Abstract:**
A rotating mass energy store includes a rotor (10) that contains conductors (6), (7), (18), (17) and magnet arrangement (11). The rotating mass is symmetrical about axis of rotation and is hollow with a cavity (24), wherean electrical stator (12) is located in the

CA 3025439 A1 2017/12/14

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(57) **Abrégé(suite)/Abstract(continued):**
cavity. All components of the energy store are enclosed in a housing (1) which has a fitting/connection (2) for a vacuum pump and or seal, and wire connection seals (3) and (15) for conductive wire to pass through. The rotor (10) is permanently magnetically levitated axially and radially. Electrical energy is exchanged and stored as kinetic energy in a rotating mass, otherwise known as the rotor (10).

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(54) Title: ROTATING MASS ENERGY STORE

(57) Abstract: A rotating mass energy store includes a rotor (10) that contains conductors (6), (7), (18), (17) and magnet arrangement (11). The rotating mass is symmetrical about axis of rotation and is hollow with a cavity (24), wherean electrical stator (12) is located in the cavity. All components of the energy store are enclosed in a housing (1) which has a fitting/connection (2) for a vacuum pump and or seal, and wire connection seals (3) and (15) for conductive wire to pass through. The rotor (10) is permanently magnetically levitated axially and radially. Electrical energy is exchanged and stored as kinetic energy in a rotating mass, otherwise known as the rotor (10).

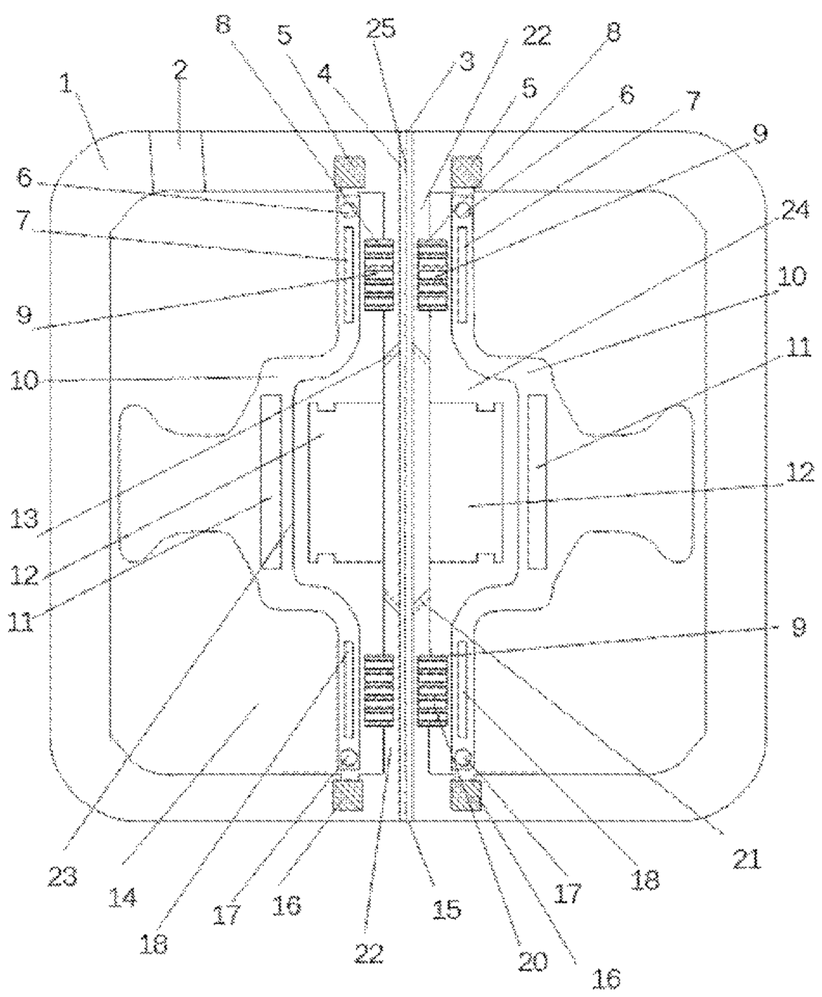


FIGURE 6

WO 2017/212244 A1

TITLE: ROTATING MASS ENERGY STORE

DESCRIPTION

This invention relates to a rotating mass energy store.

Energy is required to be stored so that it can be used at a later time than when it was once generated. Energy can be stored in different ways. An energy store that uses chemicals to store potential energy is harmful to the environment when it is disposed or recycled.

To overcome this problem, this present invention proposes kinetic energy storage without using chemicals or dangerous materials. This invention stores energy kinetically by means of a rotating mass, also known as a rotor.

This invention eliminates some components that are in existing rotary energy store designs, which reduces material usage and increases energy and power density. Natural properties of materials are utilised to form a more effective and efficient energy store that does not harm the environment.

In accordance with the present invention there is provided a rotary energy store comprising a permanently magnetically levitated rotor.

In one embodiment, the permanently magnetically levitated rotor is part of an integrated motor-generator unit.

In one embodiment, the permanent magnetic levitation system comprises radial permanent magnetic bearings.

In one embodiment, the permanent magnetic levitation system comprises axial permanent magnetic bearings.

In one embodiment, the radial permanent magnetic bearings are electrodynamic bearings.

In one embodiment, the axial permanent magnetic bearings use Halbach array magnet arrangements to produce levitation forces.

In one embodiment, the rotor is in a sealed housing. The sealed housing may have a connected vacuum pump to form a vacuum environment for the rotor to rotate in.

In one embodiment, the housing secures one or more of (e.g. two or more of or all of): the stator of the motor-generator unit; the magnets of the radial electrodynamic bearings; and the axial permanent magnetic bearings.

In one embodiment, the stator is located equidistant between both axial permanent magnetic bearings.

In one embodiment, the rotor is a hollow body (e.g. hollow symmetrical body).

In one embodiment, the hollow body contains embedded magnets in its wall that form part of the motor-generator unit.

In one embodiment, the hollow body contains embedded conductors that form part of complete radial electrodynamic bearings and/or part of complete axial permanent magnetic bearings.

In one embodiment, the magnets embedded in the rotor rotate about the stator and are also equidistant between both axial permanent magnetic bearings.

In one embodiment, the conductors for the radial electrodynamic bearings are located such that the conductors are aligned with the radial bearing magnets (e.g. so the conductor within the wall rotates about the radial bearing magnets secured by the housing).

In one embodiment, the conductors for the axial permanent magnetic bearings are located such that the conductor is embedded in the rotor at the rotor's open end, so the sequence of arrangement is, rotor with embedded conductor, a gap, the axial permanent magnet arrangement which is secured in place by the housing. This sequence may change direction but remains in the same order as the arrangement will be at both ends of the rotor.

In one embodiment, the rotary energy store of the present invention has a rotor that is magnetically levitated axially and radially.

The rotor may have a hollow structure that is symmetric axially and radially, it has the majority of its mass at its circumference and contains magnets and conductors within its wall. In one embodiment, these magnets in the rotor wall are part of an integrated motor-generator unit where the rotor is forced to rotate about an electrical stator owing to induction.

The magnets within the wall of the rotor may have a polarisation sequence that forms a Halbach array producing an augmented magnetic field in the inner cavity of the rotor where the stator is located. An integrated motor-generator unit means that the motor-generator is not a separate part from the rotor, the rotor is used to be part of the motor-generator unit.

In one embodiment, the rotor is made of a composite material.

In one embodiment, the electrical stator is static. The stator may have multiple poles, which are extended parts of the geometry and are equally spaced radially. Each pole may hold a coil winding. A coil winding is where electrically conductive wire is wrapped around the bulk of the pole multiple times. Each coil winding has 'tails' that are where the coil begins and where the coil ends. When electrical current is conducted by the conductive wire of the coil windings, by induction, the rotor is forced to rotate about the stator. Depending on the direction of the current, the rotor will be forced to rotate faster relative to prior motion or rotate slower relative to prior motion. When electrical current is drawn from the coil winding wire, leaving the energy store, the rotor will slow down. When electrical current is applied to the wire, going into the energy store, the rotor will rotate faster.

In one embodiment, the stator is made of iron. In one embodiment, the electrically conductive wire is made of copper.

In one embodiment, a housing structure encloses all moving parts of the energy store. The housing may possess a fitting that is able to connect a vacuum pump and or vacuum system and or vacuum seal so that a vacuum or low pressure environment can be created within the housing cavity.

The housing may secure the location of the magnets and iron pole shoes of the radial electrodynamic bearings and the magnets of the axial permanent magnetic bearings, this may be by means of brackets or similar fixing preferably made from a non-conducting material.

In one embodiment, the coil winding tails extend to the housing and through a seal so that electrical current can be exchanged to and from the energy store, but without air leakage.

In one embodiment, the axial and radial levitation magnetic bearings are both permanent magnetic bearings.

In one embodiment, the radial magnetic bearings prevent gyration about the axis of rotation and contact between stationary and moving parts of the energy store. In one embodiment, the radial magnetic bearings are electrodynamic bearings, comprising a hollow cylindrical stack of alternating iron rings and ring magnets, the stack sequence begins and

ends with iron rings, these may be known as iron pole shoes. The iron pole shoes and ring magnets may have the geometry of a shallow hollow cylinder.

In one embodiment, a conductor is embedded in the wall of the rotor aligned with the location of the electrodynamic bearings, which gives rise to repulsive forces between the conductor itself and the electrodynamic bearing, levitating and stabilising the rotor. As the electrodynamic bearings are located near the ends of the rotor, the conductor for the electrodynamic bearing will be located in the wall of the rotor so that it aligns with the electrodynamic bearings. Each electrodynamic bearing may have at least one conductor that is embedded in the wall of the rotor.

In one embodiment, axial magnetic bearings prevent touchdown of the rotor. Touchdown is where levitation is lost and the rotor falls (possibly whilst rotating) and hits a static part of the energy store. In one embodiment, the axial magnetic bearings are arrangements of permanently polarised magnet segments that form a ring shape. The sequence of polarised magnets may be in the form of a Halbach array where the augmented field is where the rotor is located, wherein a conductor is embedded in the rotor wall. Repulsive forces arise between the conductor embedded in the rotor wall and the arrangement of polarised magnets. As the axial magnetic bearings are located at the extremities of the rotor length, the conductor in the rotor wall will be located close to the rotor end(s). The conductor can be in the form of a torus, or coil, or a combination of both, the conductor can be made from more than one piece.

A Halbach array is a sequence of magnets with a particular polarisation pattern. The sequence is of magnets that are alternatively polarised laterally and longitudinally. However, the longitudinally polarised magnets alternatively change polarity. The laterally polarised magnets also alternatively change polarity. So the base sequence is four magnets long, and this sequence repeats. This sequence can be formed into a geometrical shape but the relative sequence/pattern remains.

An embodiment of the present invention will now be described solely by way of example and reference to the accompanying drawings in which:

Figure 1 shows a Halbach array sequence where (5) is the augmented magnetic field, (2) and (4) are the longitudinally polarised magnets, alternating in direction, (3) and (1) are the laterally polarised magnets, alternating in direction. The magnets are equal in size.

Figure 2 shows the cross section of the electrodynamic bearing that provides radial stability and levitation. The interacting conductor and securing shaft/bracket is also shown,

as if it was cut in half down its centre. (1) Iron pole shoes that are ring shape, (2) ring magnets, (3) securing shaft that is attached to or part of the housing, (4) conductor embedded in the rotor wall, (5) the rotor.

Figures 3A-3B show the axial permanent magnetic bearing with its interacting conductor and securing method, shown as if it was cut in half through its centre. In Figure 3A a cross section of the axial permanent magnetic bearing and the securing method is shown, where (5) is the cross section for the magnet ring which comprises small ring magnet segments, (6) part of the housing which partially encloses the axial permanent magnetic bearing which comprises magnet segments, (7) the shaft attached to or part of the housing which leads to securing other components, (4) is the torus conductor, which can be slid or coil shaped and (8) the rotor wall. The housing section (6) is of geometry that partially encloses the axial permanent magnetic bearing (5), (7) is a section which can be part of the same body of (6) which can lead to securing the electrodynamic bearing and stator. The torus conductor (4) is embedded in the rotor wall(8). The rotor (8) including the embedded torus conductor(4) levitate about the axial permanent magnetic bearing (5) which is secured in place by (6).

Figure 3B shows the top view of the axial permanent magnetic bearing of (5, Figure 3A). The segments that form the 'ring' are shown with their polarisation directions. Every alternative magnet is polarised tangentially, and each other magnet is polarised either into or out of the paper, labelled as (2) and (1) respectively. The tangentially polarised magnets (3) alternate in the tangential direction. The magnets with polarisation direction into the paper are labelled (2). The magnets with polarisation direction out of the paper are labelled (1).

Figure 3C shows the top view of the torus conductor (4).

Figure 4A represents a rotor with its embedded magnets and conductors. Torus conductor (1) and radial conductor (2) are embedded in the rotor wall (3), rotor magnets (4) are embedded in the wall of the rotor near the inner surface of the rotor cavity (5) where the electrical stator would be located.

Figure 4B shows the top view of the rotor magnets and their polarisation direction. The polarisation pattern comprises tangentially polarised magnets and radially polarised magnets. The pattern alternates between tangentially and radially polarised magnets, and these alternate too. (1) and (2) are both radially polarised, but are in opposing directions, where (1) is polarised towards the circumference of the ring, and (2) is polarised towards the centre of the ring. (3) and (4) are both tangentially polarised magnets, but are polarised in

opposite directions. The base sequence comprises of (1), (2), (3) and (4) which repeats to form the pattern. The polarisation pattern of magnets creates an augmented magnetic field on the inside of the ring , labelled (5).

Figure 5A shows the top view of the electrical stator. (1), the pole head, (2), electrically conductive wire, (3) pole piece, (4) the stator core. The stator has more than one pole, usually five or six. The poles are equally spaced around the stator core (4). Each pole piece (3) has a pole head(1), the conductive wire (2) is wrapped around the pole piece (3) for at least one complete turn, but can have multiple turns.

Figure 5B shows how the conductive wire (2 of Figure 5A) is wrapped around the pole piece (3 of Figure 5A). In Figure 5B, (1) is the pole head, (4) is the pole piece, and (2) and (3) show the coil 'tails'. The coil tails (2) and (3) are extensions of the conductive wire that extend from where the coil starts and where the coil ends, in other words, where the coil leads to the coil and leaves the pole piece (4).

Figure 5C shows the pole piece (3 of Figure 5A) and how the conductive wire (2 of Figure 5A) wraps around it. In Figure 5C, (1) is the pole head, (4) is the pole piece and (2) and (3) are the coil 'tails'. The conductive wire wraps around the pole piece (4) for two whole turns and leaves the pole piece with the coil tail extension (3).

Figure 6 shows the rotary energy store with the majority of its components.

(1) the housing, can have a fitting or connection (2) that can connect with a vacuum pump and or seal that is able to create a vacuum environment within the cavity of the housing (14).

The housing (1) also has at least one seal that holds a wire through the housing and does not allow air leakage to occur to or from the energy store. The drawing shows the housing with two wire seals (3) and (15).

The housing (1) has a cavity (14) where most of the components go, and where the vacuum environment is created.

The housing (1) has a shaft (22) that is through its centre, with a channel (4), and at either end of the shaft are two wire seals (3) and (15).

The shaft (22) has additional small channels (13) and (21) that allow the coil tails of (2 and 3 of Figure 5B) to go from the poles of the stator (12) through to the centre channel (4) of the shaft (22) and to the wire seals (3) and (15), that then leave the energy store for energy exchange.

The shaft (22) secures the stator (12) in place.

The stator (12) is located on the shaft (22) in the housing (1) so that it is equidistant from either axial magnetic bearing.

The housing (1) secures the location of the axial magnet bearing rings (5) and (16) by means of geometry of the housing.

The rotor (10) is levitated within the housing cavity (14) about the shaft (22), between the axial magnets (5) and (16) and about the electrodynamic bearings, which comprises multiple iron pole shoes (8) and (19) and multiple ring magnets (9) and (20), which are stacked alternatively, and explained in Figure 2. The electrodynamic bearings are secured in place on the shaft (22).

The rotor (10) has components embedded in its wall. The rotor (10) has 'open' ends so that it can rotate about the electrodynamic bearing that is secured by a shaft. Two torus conductors (6) and (17) are embedded in the rotor wall at the extremities of the rotor (10). Two conductors (7) and (18) are embedded in the rotor wall for each radial electrodynamic bearing, and are embedded so that they are aligned with the electrodynamic bearing. The rotor (10) also has magnets (11) embedded in its main bulk near the inner surface (23) of the rotor cavity (24). The rotor magnets (11) are located such that they are aligned with the stator (12) for interaction to occur.

Claims

1. A rotary energy store that comprises at least of a permanently magnetically levitated rotor.

2. A rotary energy store according to claim 1 where the permanently magnetically levitated rotor is part of an integrated motor-generator unit.

3. A rotary energy store according to claim 2 where the permanent magnetic levitation system comprises of radial permanent magnetic bearings and axial permanent magnetic bearings.

4. A rotary energy store according to claim 3 where the radial permanent magnetic bearings are electrodynamic bearings and the axial permanent magnetic bearings use Halbach array magnet arrangements to produce levitation forces.

5. A rotary energy store according to claim 4 where the rotor is in a sealed housing, that can have a connected vacuum pump to form a vacuum environment for the rotor to rotate in.

6. A rotary energy store according to claim 5 where the housing secures the stator of the motor-generator unit and the magnets of the radial electrodynamic bearings and the axial permanent magnetic bearings.

7. A rotary energy store according to claim 6 where the stator is located equidistant between both axial permanent magnetic bearings.

8. A rotary energy store according to claim 7 where the rotor is a hollow symmetrical body that contains embedded magnets in its wall that form part of the motor-generator unit and also contains embedded conductors that form part of complete radial electrodynamic bearings and part of complete axial permanent magnetic bearings.

9. A rotary energy store according to claim 8 where the magnets embedded in the rotor rotate about the stator and are also equidistant between both axial permanent magnetic bearings.

10. A rotary energy store according to claim 9 where the conductors for the radial electrodynamic bearings are located such that the conductors are aligned with the radial bearing magnets, so the conductor within the wall rotates about the radial bearing magnets secured by the housing.

11. A rotary energy store according to claim 10 where the conductors for the axial permanent magnetic bearings are located such that the conductor is embedded in the rotor at the rotor's open end, so the sequence of arrangement is, rotor with embedded conductor, a gap, the axial permanent magnet arrangement which is secured in place by the housing.

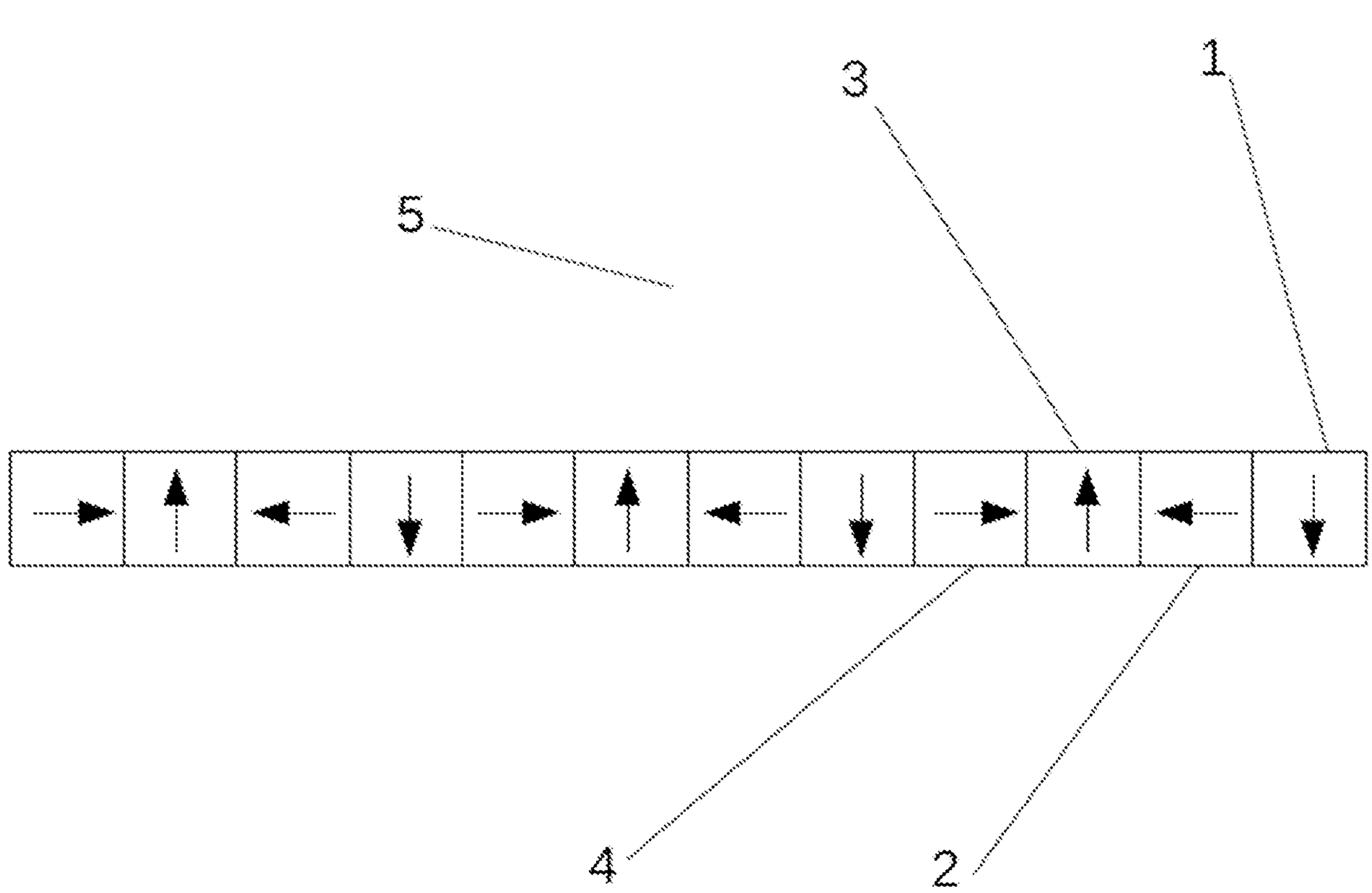


FIGURE 1

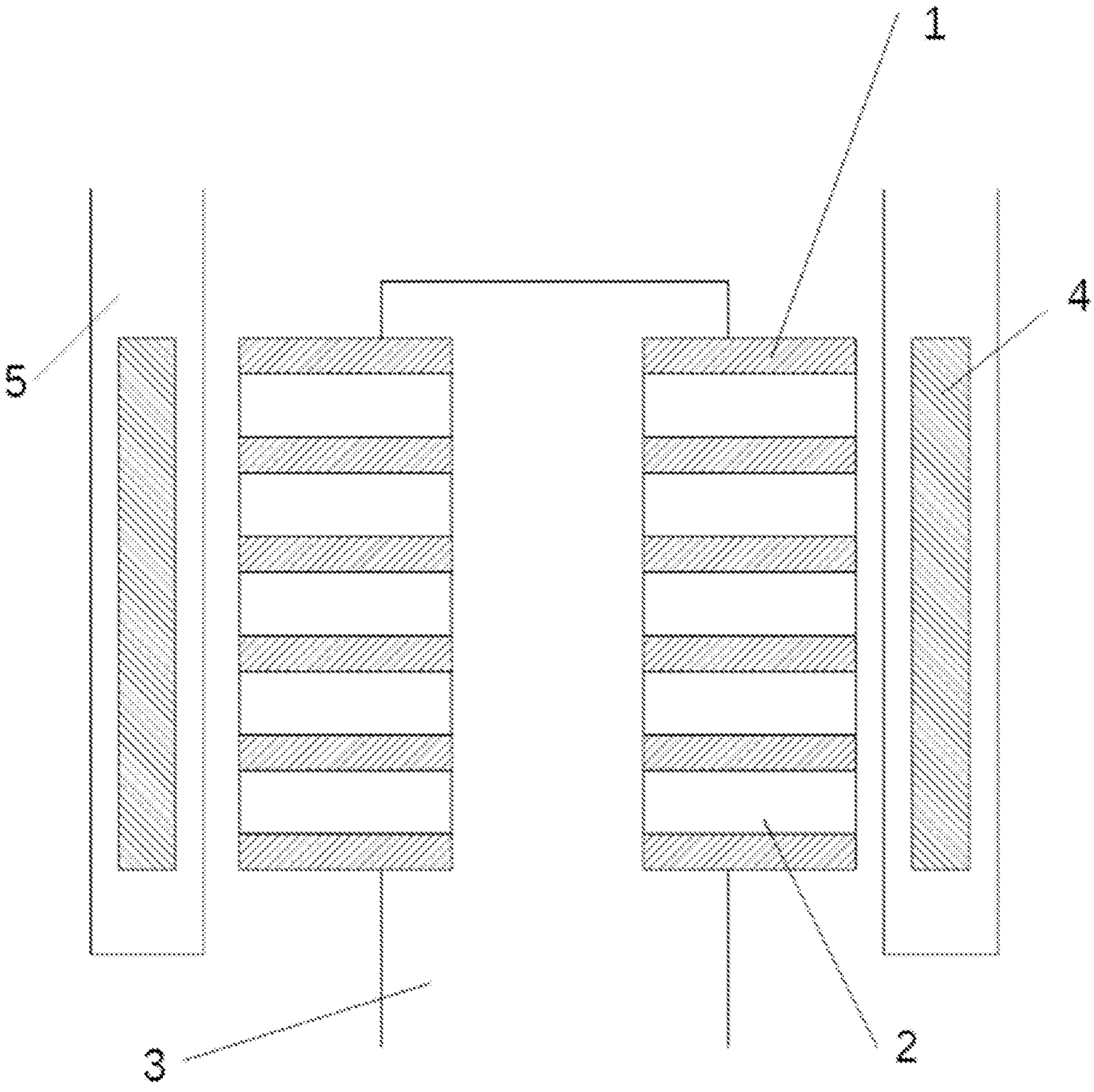


FIGURE 2

FIGURE 3A

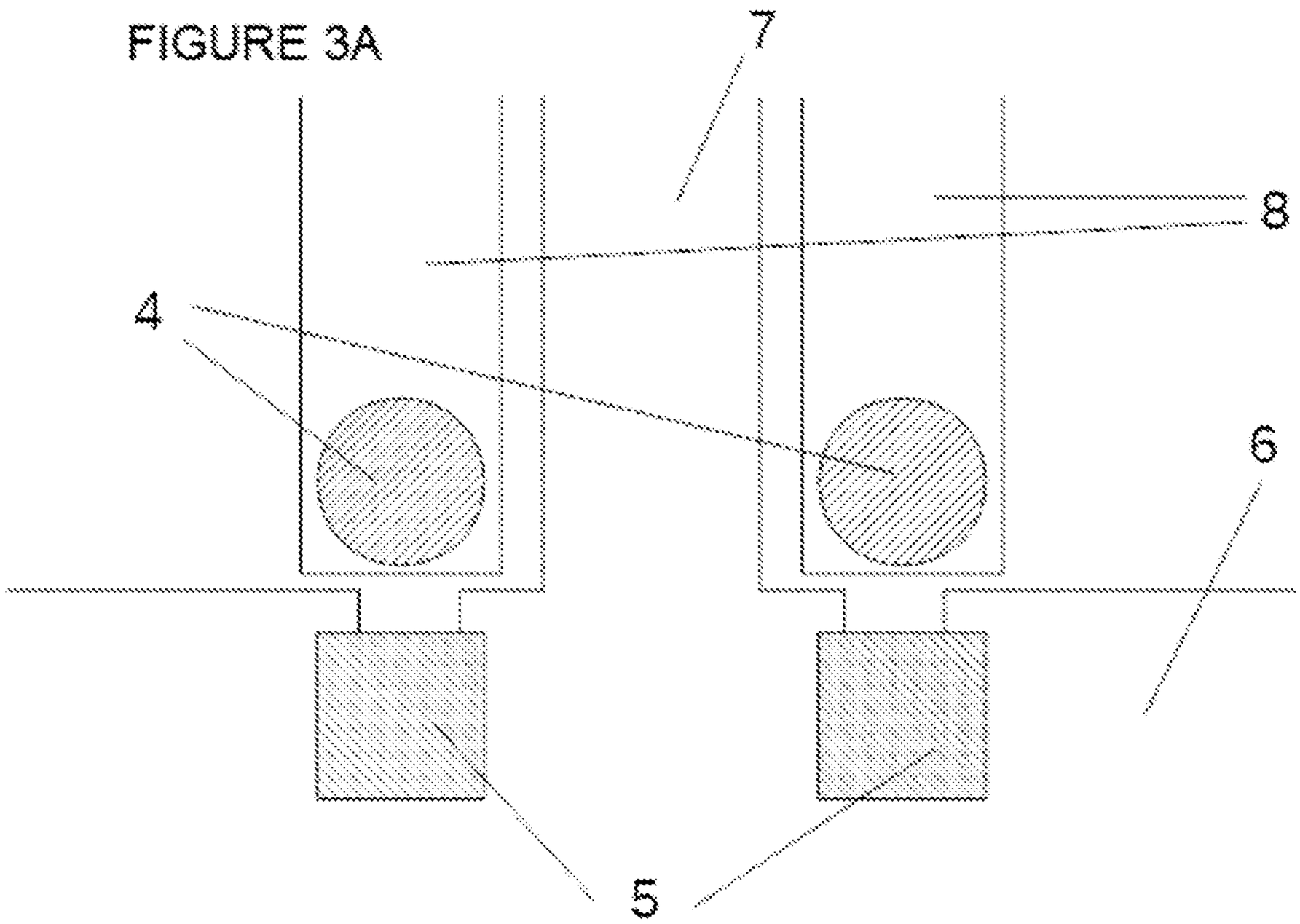


FIGURE 3B

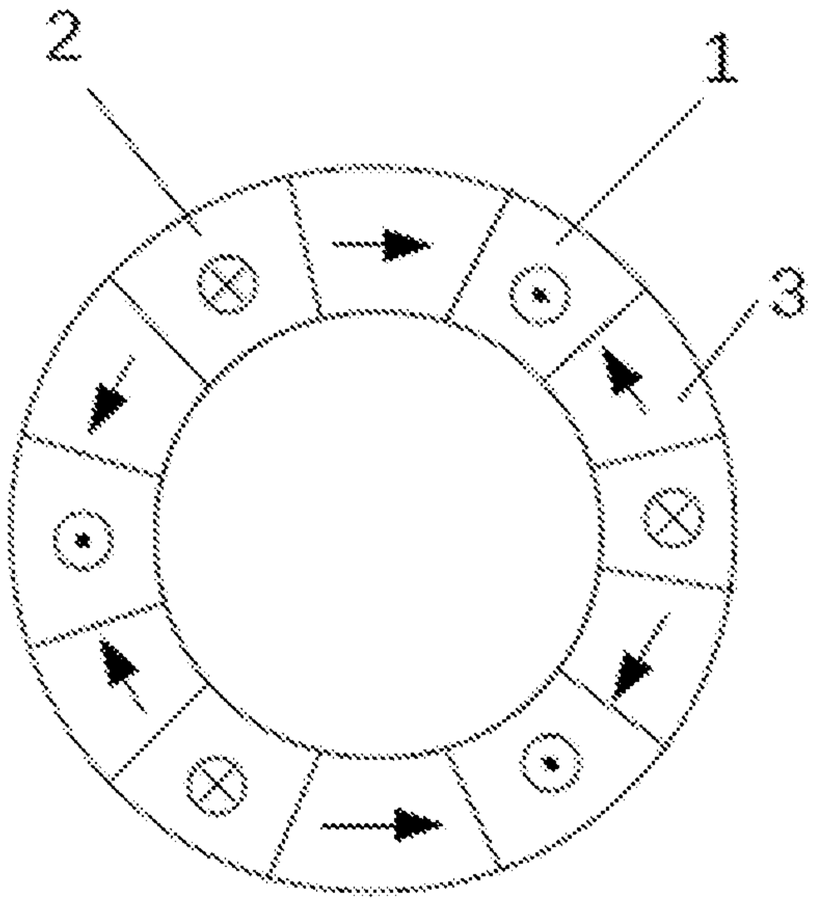


FIGURE 3C

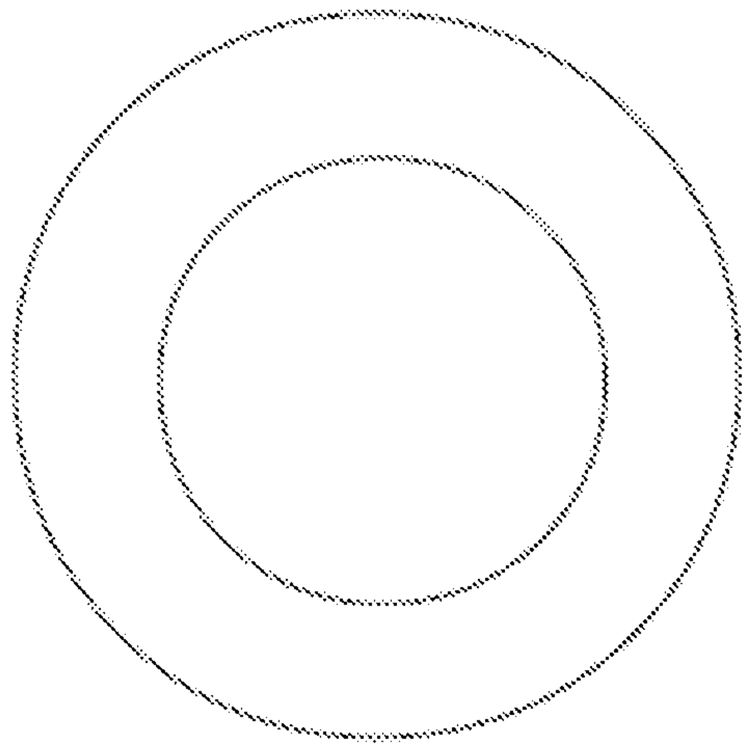


FIGURE 4A

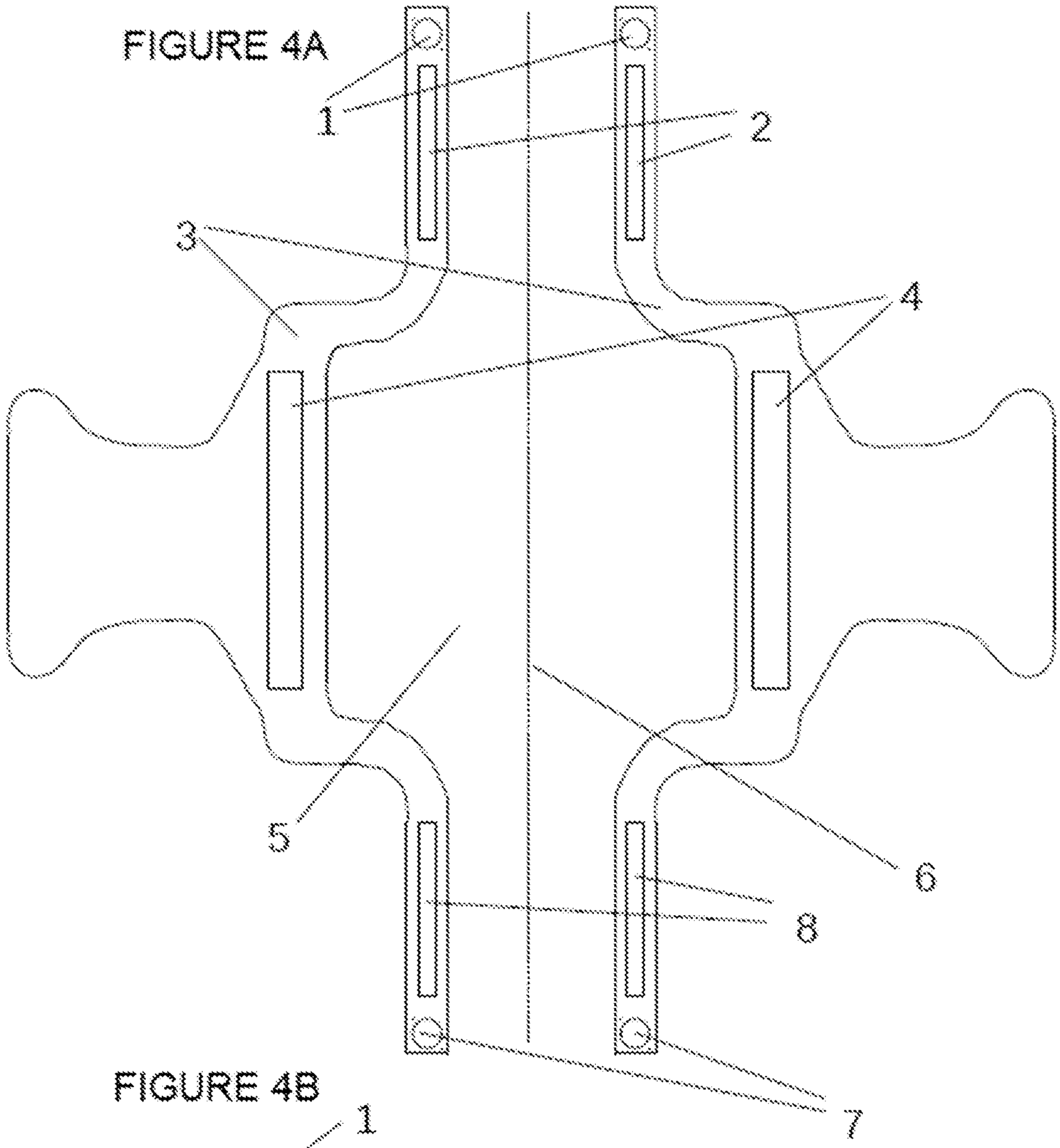


FIGURE 4B

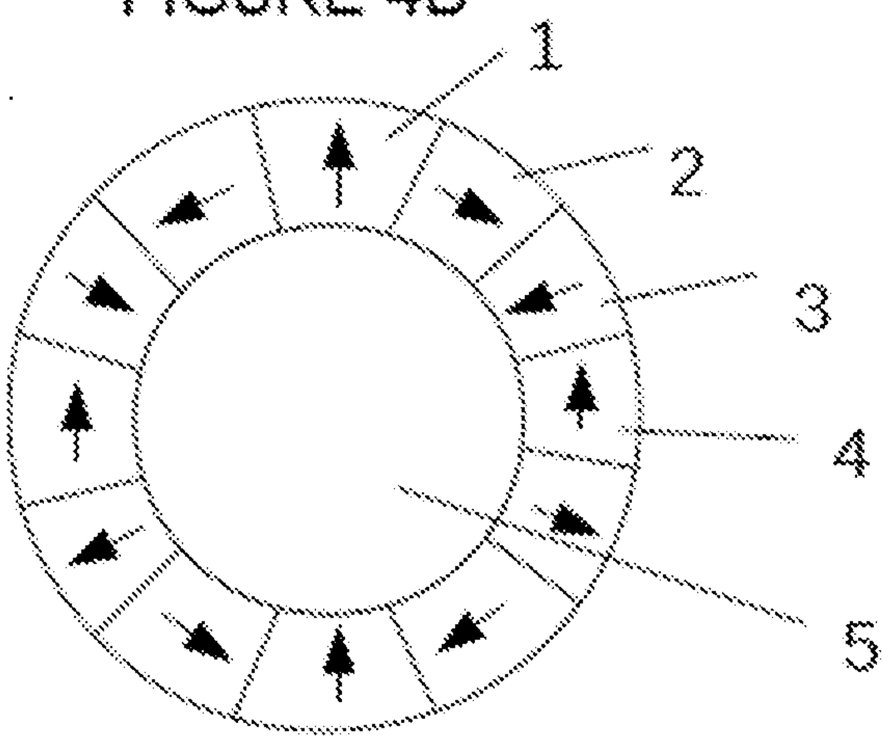


FIGURE 5A

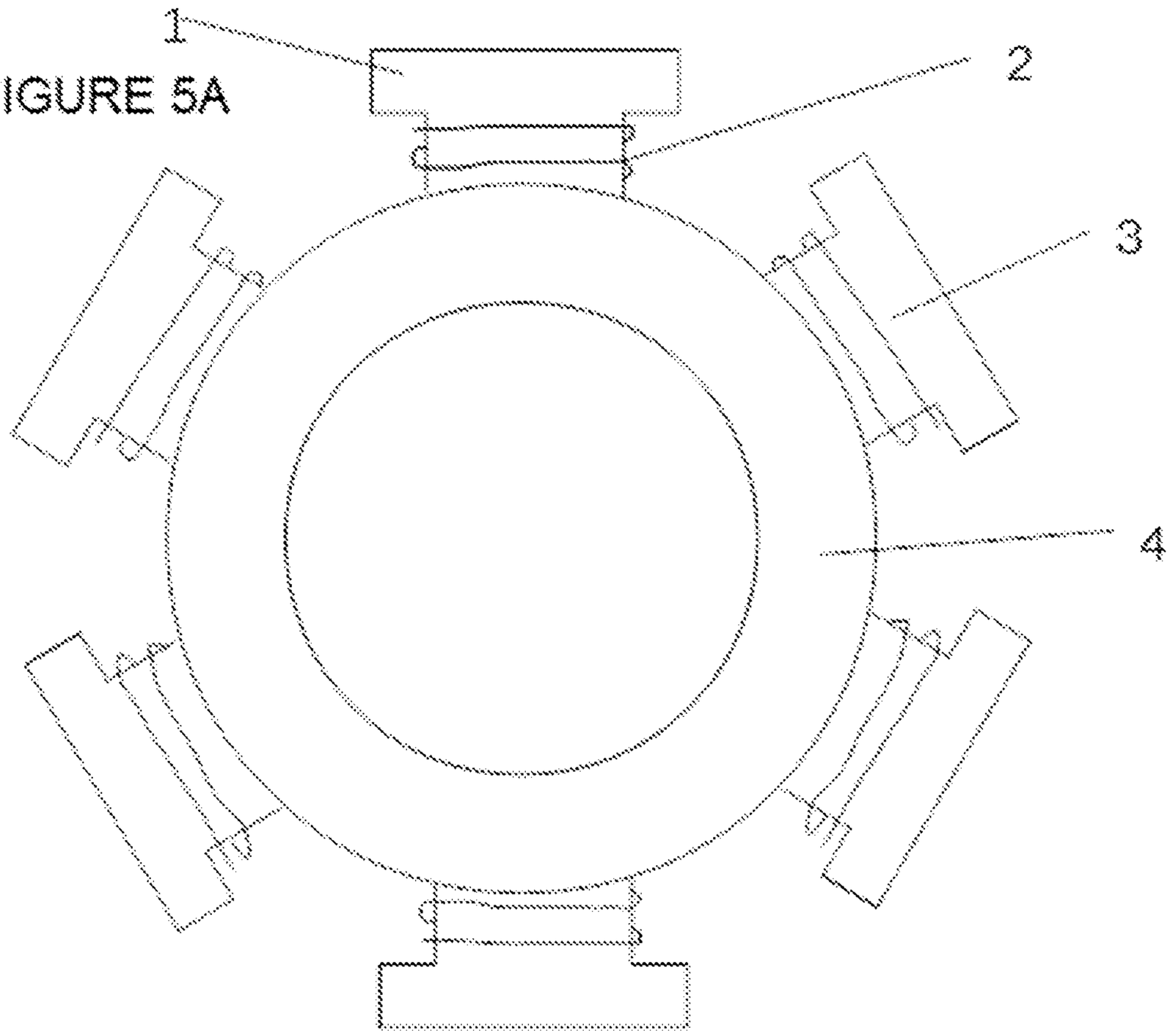


FIGURE 5B

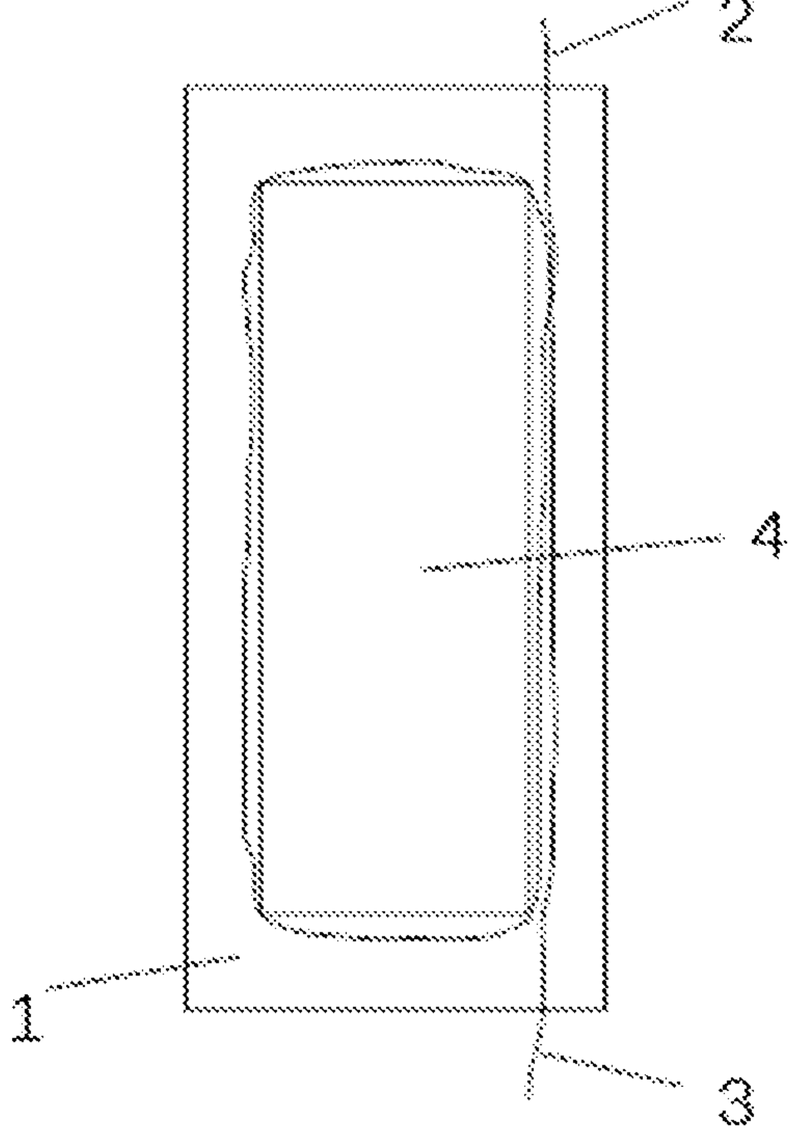
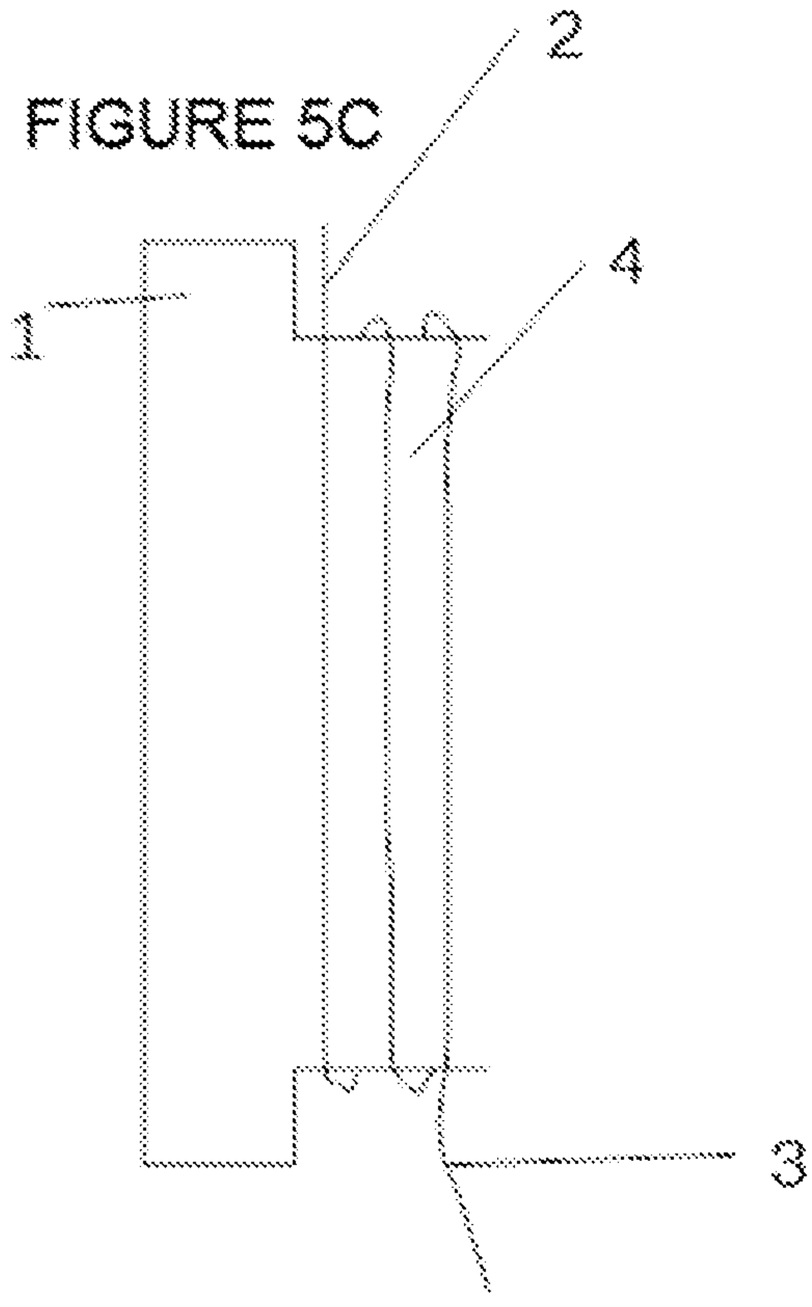


FIGURE 5C



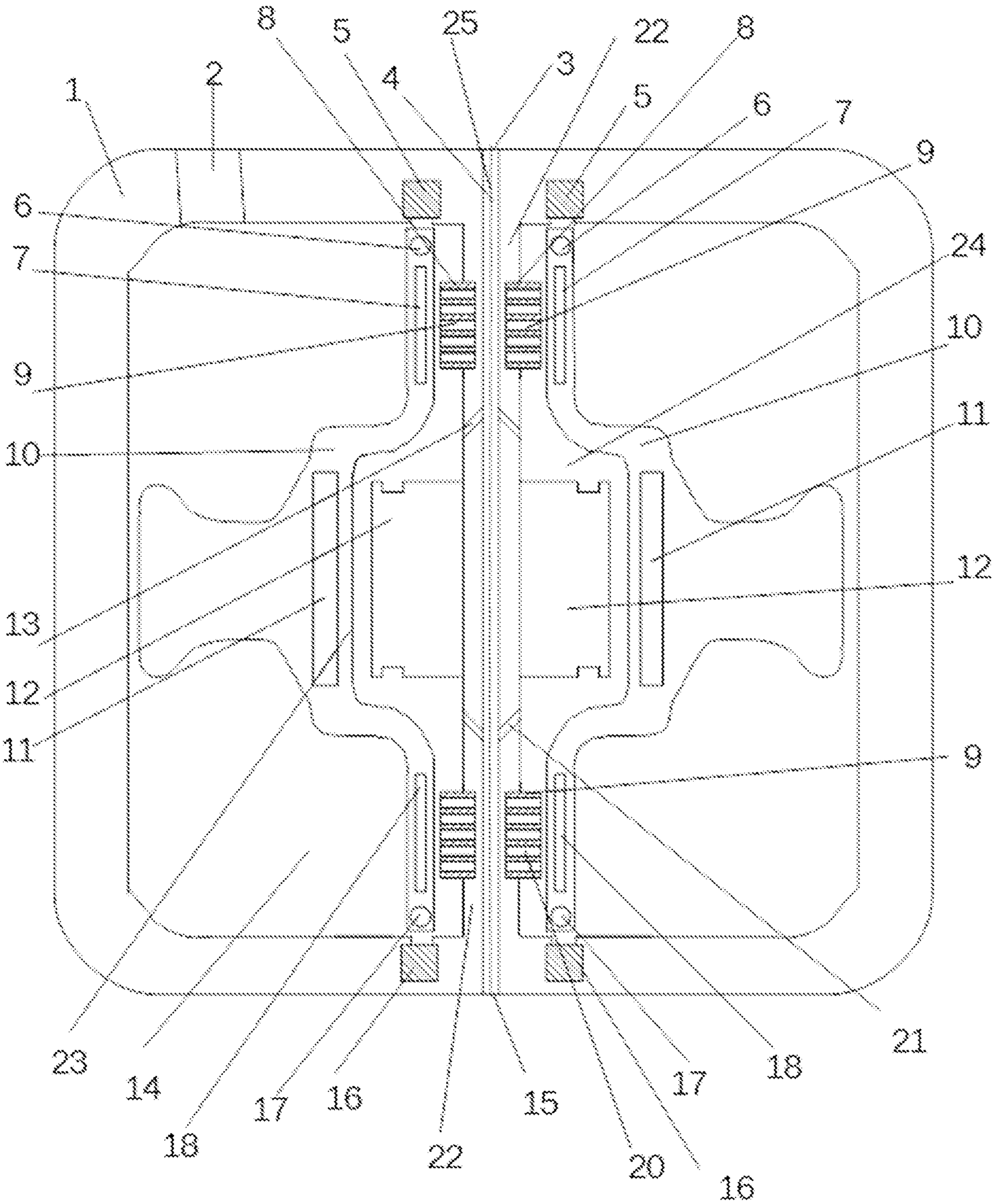

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FIGURE 6

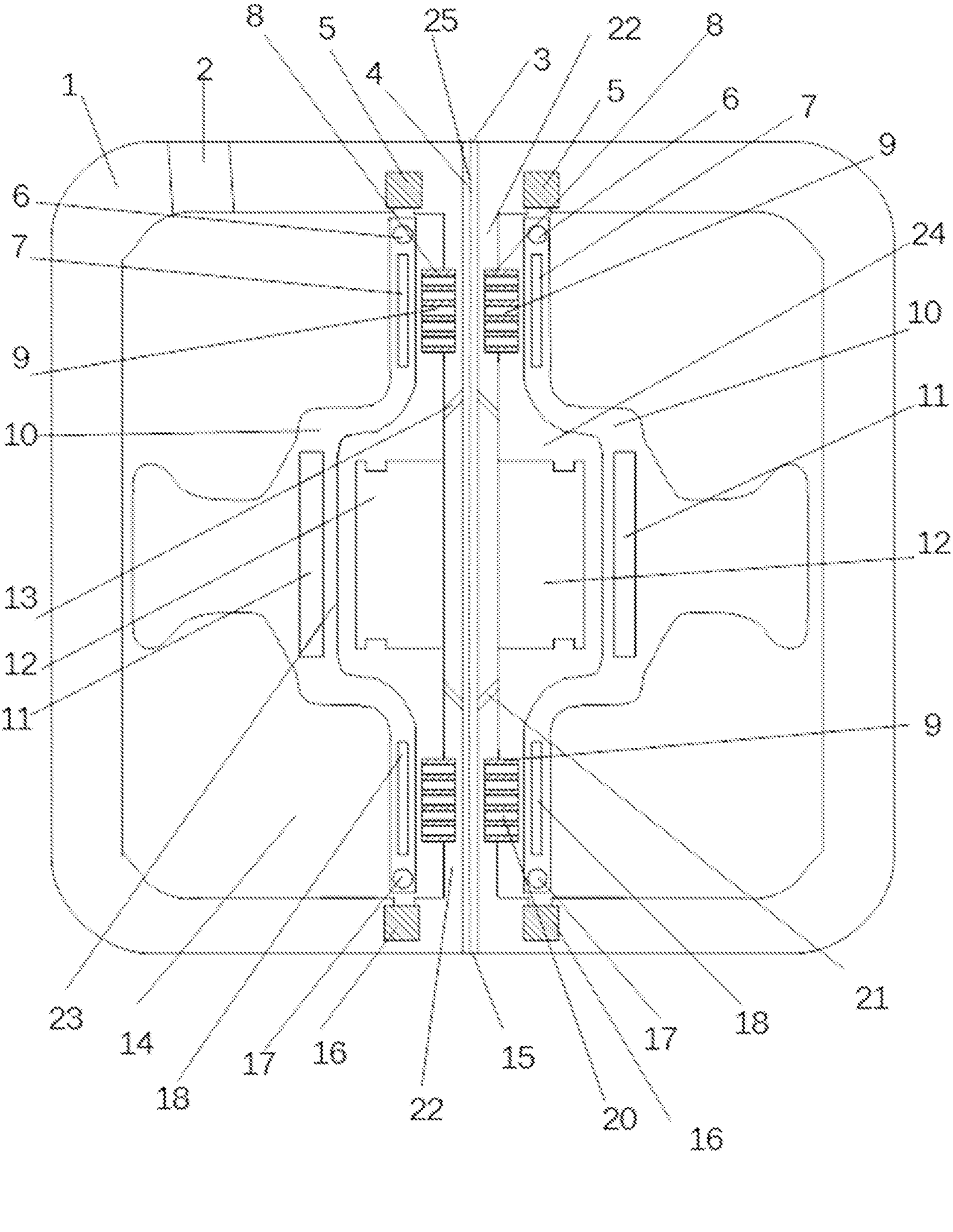

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FIGURE 6