(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 438 439 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.02.2019 Bulletin 2019/06

(51) Int Cl.:
F02M 27/04 *(2006.01)*

(21) Application number: **18187130.2**

(22) Date of filing: **02.08.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **04.08.2017 NL 1042492**

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(54) MAGNETIC TREATMENT DEVICE FOR MAGNETICALLY TREATING A FLUID

(57) A magnetic treatment device for magnetically treating a fluid comprises a housing, a ring-shaped first magnet and a first chamber. The first magnet is accommodated in the housing. The first magnet extends circularly, and comprises a flat lower magnet side, a flat upper magnet side being parallel to the lower magnet side, a cylindrical inner diameter magnet side having an inner diameter, and a cylindrical outer diameter magnet side having an outer diameter. Spacing elements extend between respective housing sides and first magnet sides facing each other. The first chamber extends circularly over an angle of less than 360 degrees from a first chamber inlet opening to a first chamber outlet opening, along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side, for allowing the fluid to flow in the first chamber from the first chamber inlet opening to the first chamber outlet opening in a circumferential direction along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side.

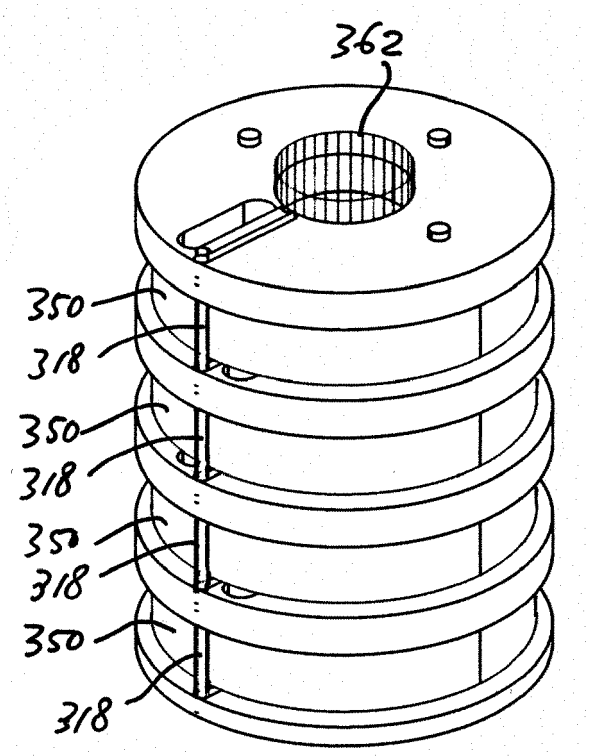

FIG. 16c

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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of treatment of a fluid by flowing through a magnetic field, and more specifically to a magnetic treatment device for magnetically treating a fluid.

[0002] Herein, a fluid is to be understood to be a liquid or a gas, or a mixture of a liquid and a gas.

BACKGROUND OF THE INVENTION

[0003] In a variety of processing systems, fluids are used for e.g. transfer of heat or cold, or for burning in a combustion process, such as in a combustion engine. In most of these processing systems, the fluid needs to be in a pure form as much as possible. However, often this is hard to reach, taking into account the processes in which the fluid is produced and used. As a result, the fluid may contain different contaminants, leading to scale formation, bacterial growth, clustering of particles, and/or sub-optimal performance of the fluid in components of the processing system. Clearly, this is undesirable.

[0004] It has been found that some of the above adverse effects can be reduced or suppressed by leading the fluid through a magnetic field. The magnetic field will interact with any substance that carries a charge. In the fluid, molecules or particles that start clustering together have charged surfaces. As they pass through the magnetic field, these charged molecules or particles experience considerable force through interaction with the magnetic field. Here, molecules or particles with opposite charges are pulled in opposite directions.

[0005] Important factors that influence the effectiveness of the magnetic field treatment are the proximity of the fluid to the source of the magnetic field, the angle of the magnetic field with respect to the flow direction of the fluid, the flow speed of the fluid, and the duration of time the fluid remains in the magnetic field.

[0006] Reference WO 2004/113708 discloses magnetic fuel treatment devices comprising a housing, a cover, an inner compartment, and a circular magnet, wherein the combination of these components forms a C-shaped (as seen in cross-section) inner fuel channel through which fuel may flow for treatment therein from an entry port to an exit port.

[0007] The magnetic fuel treatment device disclosed in the reference comprises a circular magnet (or ring magnet) having a rectangular cross-section and a central hole. The housing is provided with a central post and a lower platform, whereas the cover is provided with a similar platform-like extension which can be considered to form an upper platform. The circular magnet is radially fixed in the device by the central post completely filling the central hole of the magnet. The circular magnet is axially fixed in the device by being sandwiched between the lower platform of the housing and the upper platform of the cover.

[0008] A disadvantage of the known magnetic fuel treatment device is that fuel flowing in the inner fuel channel only contacts a part of the lower circular magnet surface facing downward, since the remainder of the lower circular magnet surface is covered by the lower platform of the housing, the lower platform having an upper surface contacting the lower circular magnet surface. A further disadvantage is that a fuel flowing in the inner fuel channel only contacts a part of the upper circular magnet surface facing upward, since the remainder of the upper circular magnet surface is covered by the upper platform of the cover, the upper platform having an lower surface contacting the upper circular magnet surface. A still further disadvantage is that a fuel flowing in the inner fuel channel is not in contact, and not even close to, the cylindrical magnet surface at the central hole of the circular magnet.

[0009] The above disadvantages lead to a relatively low treatment efficiency and/or effectiveness of the magnetic fuel treatment device according to the reference. Fuel does not flow in the proximity of a large part of the source of the magnetic field.

SUMMARY OF THE INVENTION

[0010] It would be desirable to provide an improved magnetic treatment device. It would also be desirable to provide a magnetic treatment device having an improved treatment efficiency and/or treatment effectiveness.

[0011] To better address one or more of these concerns, in a first aspect of the invention a magnetic treatment device for magnetically treating a fluid is provided. The magnetic treatment device comprises a housing, a first magnet, and a first chamber. The first magnet is ring-shaped and is accommodated in the housing. The first magnet extends circularly, and comprises a flat first magnet lower magnet side, a flat first magnet upper magnet side being parallel to the lower magnet side, a cylindrical first magnet inner diameter magnet side having an inner diameter, and a cylindrical first magnet outer diameter magnet side having an outer diameter. Spacing elements extend between respective housing sides and first magnet sides facing each other, for spacing the respective first magnet sides from their facing housing sides at the inside of the housing. The first chamber extends circularly over an angle of less than 360 degrees from a first chamber inlet opening to a first chamber outlet opening. The first chamber extends along the first magnet lower magnet side, the first magnet upper magnet side, the first magnet inner diameter magnet side and the first magnet outer diameter magnet side of the first magnet, for allowing the fluid to flow in the first chamber from the first chamber inlet opening to the first chamber outlet opening in a circumferential direction along the first magnet lower magnet side, the first magnet upper magnet side, the first magnet inner diameter magnet side and the first magnet outer diameter magnet side.

[0012] Herein, the terms 'upper' and 'lower' indicate a particular orientation of the magnet in the magnetic treatment device, with the upper magnet side facing upwards and the opposing lower magnet side facing downwards, to facilitate an indication of different faces of the magnet, and to facilitate an indication of further features of the magnetic treatment device. In other orientations of the magnetic treatment device, however, the upper magnet side will still be opposing the lower magnet side, but may not be facing upwards. It is noted that the magnetic treatment device of the present invention will operate to treat a fluid magnetically in any orientation as required during use.

[0013] The first magnet is ring-shaped, and has a toroid shape having an mathematical axis of revolution extending at right angles to the plane of the flat lower magnet side, and the plane of the flat upper magnet side. The first magnet extends circularly around the mathematical axis of revolution of the first magnet.

[0014] The first chamber forms a channel for the fluid to be magnetically treated, wherein the fluid can flow along, and can come into contact or can come close to almost the whole of the lower magnet side, the upper magnet side, the inner magnet side and the outer magnet side. Accordingly, the magnetic treatment of the fluid is greatly improved in the magnetic treatment device of the present invention. In particular, the fluid can flow along the inner diameter magnet side of the magnet, being a location where the strength of the magnetic field is highest.

[0015] The magnet is supported in the magnetic treatment device by spacing elements extending between respective facing housing sides and magnet sides. The number and locations of the spacing elements can be selected as appropriate.

[0016] In a preferred embodiment, spacing elements extend between an inner housing side and the inner diameter magnet side, between a lower housing side and the lower magnet side, and between an upper housing side and the upper magnet side. In another preferred embodiment, spacing elements extend between an inner housing side and the outer diameter magnet side, between a lower housing side and the lower magnet side, and between an upper housing side and the upper magnet side. Such configurations of spacing elements can fix the magnet within the magnetic treatment device to define the first chamber.

[0017] The first chamber extends circularly over an angle of less than 360 degrees from a first chamber inlet opening to a first chamber outlet opening. Thus, a first end of the chamber at the first chamber inlet opening may be formed by one side of an end structure, such as an end wall, while a second end of the chamber at the first chamber outlet opening may be formed by an opposite side of the end structure or end wall. The thickness of the end structure or end wall, seen in the circular direction of the first magnet, may be limited to occupy a limited number of degrees, in particular 1 to 10 degrees, along the 360 degrees extension of the first magnet.

[0018] In an embodiment of the magnetic treatment device, the first chamber inlet opening and the first chamber outlet opening are in the housing, in particular facing at least one of the first magnet lower magnet side, the first magnet upper magnet side and the first magnet outer diameter magnet side of the first magnet.

[0019] The first chamber inlet opening and the first chamber outlet opening may both be located facing the same magnet side, for ease of accommodating the magnetic treatment device in-line in a fluid line.

[0020] In other embodiments, the first chamber inlet opening is at one of the first magnet lower magnet side and the first magnet upper magnet side and/or the first magnet outer diameter magnet side, and the first chamber outlet opening is at the other one of the first magnet lower magnet side and the first magnet upper magnet side and/or the first magnet outer diameter magnet side. Then, a stacking of magnetic treatments devices, or a stacking of chambers in a magnetic treatment device is possible to obtain a compact assembled structure having a further improved treatment efficiency or treatment effectiveness. In such a stacked structure, a first chamber outlet opening may face a next chamber inlet opening, thereby allowing a simple fluid connection between the first chamber and the next chamber for connecting them in series. Still further magnetic treatment devices or chambers may be connected in series.

[0021] In an embodiment of a magnetic treatment device having chambers connected in series, the magnetic treatment device comprises:

a ring-shaped second magnet accommodated in the housing, the second magnet extending circularly, the second magnet comprising a flat second magnet lower magnet side, a flat second magnet upper magnet side being parallel to the second magnet lower magnet side, a cylindrical second magnet inner diameter magnet side having an inner diameter, and a cylindrical second magnet outer diameter magnet side having an outer diameter;

spacing elements extending between respective housing sides and second magnet sides facing each other, for spacing the respective second magnet sides from their facing housing sides at the inside of the housing;

a second chamber extending circularly over an angle of less than 360 degrees from a second chamber inlet opening to a second chamber outlet opening,

wherein the second chamber extends along the second magnet lower magnet side, the second magnet upper magnet side, the second magnet inner diameter magnet side and the second magnet outer diameter magnet side of the second magnet, for allowing the fluid to flow in the second chamber from the second chamber inlet opening to the second chamber outlet opening in a circumferential direction along the second magnet lower magnet side, the

second magnet upper magnet side, the second magnet inner diameter magnet side and the second magnet outer diameter magnet side, and

wherein the first chamber outlet opening and the second chamber inlet opening are in fluid communication with each other.

[0022] Similar to the first magnet, the second magnet is ring-shaped, and has a toroid shape having an mathematical axis of revolution extending at right angles to the plane of the flat lower magnet side, and the plane of the flat upper magnet side. Similar to the first magnet, the second magnet extends circularly around the mathematical axis of revolution of the second magnet.

[0023] Further embodiments of the magnetic treatment device of the present invention may comprise further magnets in further chambers of the housing, wherein a chamber outlet opening of a chamber may be in fluid communication with a chamber inlet opening of an adjacent chamber. Accordingly, the magnetic treatment device of the present invention may comprise one, two, three or even more chambers, each provided with its associated magnet.

[0024] In an embodiment of the magnetic treatment device having a first magnet in a first chamber and a second magnet in a second chamber, the first chamber inlet opening is in the housing, in particular facing at least one of the first magnet lower magnet side of the first magnet and the first magnet outer diameter magnet side of the first magnet, and the second chamber outlet opening is in the housing, in particular facing at least one of the second magnet upper magnet side of the second magnet and the second magnet outer diameter magnet side of the second magnet.

[0025] Here, the first chamber outlet opening can be facing the first magnet upper magnet side of the first magnet, an be aligned with, and/or joining, the second chamber inlet opening facing the second lower magnet side of the second magnet.

[0026] In an embodiment of the magnetic treatment device, the housing comprises:

a bottom wall having a housing bottom wall upper side facing the first magnet lower magnet side of the first magnet, the housing bottom wall upper side being spaced from the first magnet lower side;

a side wall having a housing side wall inner side facing the first magnet outer diameter magnet side of the first magnet, the housing side wall inner side being spaced from the first magnet outer diameter magnet side;

a central wall having a housing central wall outer side facing the first magnet inner diameter magnet side of the first magnet, the housing central wall outer side being spaced from the first magnet inner diameter magnet side; and

a first top wall having a housing first top wall lower side facing the first magnet upper magnet side of the first magnet, the housing first top wall lower side being spaced from the first magnet upper magnet side.

[0027] In an embodiment of the magnetic treatment device, the side wall is formed by a tubular member, in particular a cylindrical tubular member having an inner diameter larger than the outer diameter of the first magnet. In an embodiment of the magnetic treatment device, the central wall is formed by a tubular member, in particular a cylindrical tubular member having an outer diameter smaller than the inner diameter of the first magnet.

[0028] As mentioned above, in the magnetic treatment device, the first chamber is delimited by a first end structure having a first end side and a second end side, and the first chamber extends circularly between the first end side and the second end side of the first end structure. In an embodiment of the magnetic treatment device, the first end structure comprises:

a first magnet lower sealing element providing a fluid seal between the housing bottom wall upper side and the first magnet lower magnet side of the first magnet;

a first magnet upper sealing element providing a fluid seal between the housing first top wall lower side and the first magnet upper magnet side of the first magnet;

a first magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the first magnet outer diameter magnet side of the first magnet; and

a first magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the first magnet inner diameter magnet side of the first magnet.

[0029] Similarly, a second chamber or a next chamber is delimited by an end structure having a first end side and a second end side, and the second chamber or the next chamber extends circularly between the first end side and the second end side of the end structure. In an embodiment of the magnetic treatment device having a second chamber or a next chamber and an associated ring-shaped magnet, the end structure comprises:

a second or next magnet lower sealing element providing a fluid seal between a chamber bottom wall upper side and the lower magnet side of the associated magnet;

a second or next magnet upper sealing element providing a fluid seal between the chamber top wall lower side and the upper magnet side of the associated magnet;

a second or next magnet outer diameter sealing element providing a fluid seal between the chamber side wall inner side and the outer diameter magnet side of the associated magnet; and

a second or next magnet inner diameter sealing el-

ement providing a fluid seal between the chamber central wall outer side and the inner diameter side of the associated magnet.

[0030] The respective first magnet sealing elements and second or next magnet sealing elements may provide a fluid-tight sealing, or a sealing allowing limited leakage less than 5% of the fluid flow in the chamber.

[0031] In an embodiment of the magnetic treatment device having a first magnet in a first chamber and a second magnet in a second chamber, the housing comprises:

a bottom wall having a housing bottom wall upper side facing the first magnet lower magnet side of the first magnet, the housing bottom wall upper side being spaced from the firm magnet lower magnet side;
a side wall having a housing side wall inner side facing the first magnet outer diameter magnet side of the first magnet and the second magnet outer diameter magnet side of the second magnet, the housing side wall inner side being spaced from the first magnet outer diameter magnet side and the second magnet outer diameter magnet side;
a central wall having a housing central wall outer side facing the first magnet inner diameter magnet side of the first magnet and the second magnet inner diameter magnet side of the second magnet, the housing central wall outer side being spaced from the first magnet inner diameter magnet side and the second magnet inner diameter magnet side;
a separation wall having a separation wall lower side facing the first upper magnet side of the first magnet, and a separation wall upper side facing the second magnet lower magnet side of the second magnet, the separation wall lower side being spaced from the first magnet upper magnet side, and the separation wall upper side being spaced from the second magnet lower magnet side; and
a second top wall having a housing second top wall lower side facing the second magnet upper magnet side of the second magnet, the housing second top wall lower side being spaced from the second magnet upper magnet side.

[0032] The separation wall separates the first chamber from the second chamber in the magnetic treatment device. The separation wall may comprise a passage forming a fluid connection between the first chamber and the second chamber, that is, comprising a fluid outlet opening of one of the first chamber and the second chamber, and comprising a fluid inlet opening of the other one of the first chamber and the second chamber.

[0033] In the embodiment of the magnetic treatment device having a first magnet in a first chamber and a second magnet in a second chamber, the first chamber is delimited by a first end structure having a first end side and a second end side, and the first chamber extends circularly between the first end side and the second end side of the first end structure. The second chamber is delimited by a second end structure having a first end side and a second end side, and the second chamber extends circularly between the first end side and the second end side of the second end structure.

[0034] In an embodiment of the magnetic treatment device having a first magnet in a first chamber and a second magnet in a second chamber, the first end structure comprises:

a first magnet lower sealing element providing a fluid seal between the housing bottom wall upper side and the first magnet lower magnet side of the first magnet;
a first magnet upper sealing element providing a fluid seal between the separation wall lower side and the first magnet upper magnet side of the first magnet;
a first magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the first magnet outer diameter magnet side of the first magnet; and
a first magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the first magnet inner diameter magnet side of the first magnet, and
wherein the second end structure comprises:

a second magnet lower sealing element providing a fluid seal between the separation wall upper side and the second magnet lower magnet side of the second magnet;
a second magnet upper sealing element providing a fluid seal between the housing second top wall lower side and the second magnet upper magnet side of the second magnet;
a second magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the second magnet outer diameter magnet side of the second magnet; and
a second magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the second magnet inner diameter magnet side of the second magnet.

[0035] The respective first magnet sealing elements and second magnet sealing elements may provide a fluid-tight sealing, or a sealing allowing limited leakage less than 5% of the fluid flow in the chamber.

[0036] In an embodiment of the magnetic treatment device having a first magnet in a first chamber and a second magnet in a second chamber, the side wall is formed by a tubular member, in particular a cylindrical tubular member having an inner diameter larger than the outer diameter of the first magnet and the second magnet. In an embodiment of the magnetic treatment device

having a first magnet in a first chamber and a second magnet in a second chamber, the central wall is formed by a tubular member, in particular a cylindrical tubular member having an outer diameter smaller than the inner diameter of the first magnet and the second magnet.

[0037] The magnetic treatment device may have more than two chambers based on the principles explained in this disclosure. The magnetic treatment device having N chambers (N being integer and > 2) may have N-1 separation walls.

[0038] These and other aspects of the invention will be more readily appreciated as the same becomes better understood by reference to the following detailed description and considered in connection with the accompanying drawings in which like reference symbols designate like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

Figure 1 depicts a perspective view of a first housing portion.

Figure 2 depicts a perspective view of a cut-away part of the first housing portion on a side II of a plane A as indicated in Figure 1.

Figure 3 depicts a top view of the first housing portion of Figure 1.

Figure 4 depicts a top view of the first housing portion of Figure 1, with a ring-shaped first magnet illustrated therein.

Figure 5 depicts a perspective view of a separation member for forming a separation wall.

Figure 6 depicts a perspective view of the first housing portion of Figure 1 assembled with a separation member of Figure 5.

Figure 6a illustrates a first chamber of the magnetic treatment device folded out along a straight line.

Figure 7 depicts a perspective view of a second housing portion to be assembled with the first housing portion of Figure 1.

Figure 8 depicts a perspective view of a cut-away part of the second housing portion on a side VIII of a plane B as indicated in Figure 7.

Figure 9 depicts a bottom view of the second housing portion of Figure 7, with a ring-shaped second magnet shown therein.

Figure 10 depicts a perspective view of the second housing portion of Figure 7, assembled with a ring-shaped second magnet.

Figure 11 depicts a perspective view of the second housing portion of Figure 7, assembled with the separation member of Figure 5.

Figure 12 depicts a perspective view of a top wall member or a bottom wall member.

Figures 13a and 13b depict perspective views of a separation wall member, wherein Figure 13a does not show hidden lines, and Figure 13b shows hidden lines.

Figure 14 depicts, in a perspective view, an assembly of a bottom wall member and a separation wall member.

Figure 15 depicts a side view of an assembly of a bottom wall member, a ring-shaped magnet, and a separation wall member.

Figure 16a illustrates an arrangement of a bottom wall member and a number of alternatingly placed separation wall members.

Figure 16b illustrates the arrangement of Figure 16a, with an additional tubular member forming a central wall.

Figure 16c illustrates the arrangement of Figure 16b, with a ring-shaped magnet arranged between the bottom wall member and a neighbouring separation wall member, and with further ring-shaped magnets arranged between pairs of separation wall members.

DETAILED DESCRIPTION OF EMBODIMENTS

[0040] Figures 1 to 3 depict a perspective view of a block-shaped first housing portion 10 forming part of a magnetic treatment device. The first housing portion 10 comprises at least holes 11, 12, 13, 14 to allow the first housing portion 10 to be mounted to a second housing portion to be explained below.

[0041] The first housing portion 10 comprises a bottom wall 20 having a housing bottom wall upper side 22, a side wall 30 having a housing side wall inner side 32, and a central wall 40 having a central wall outer side 42.

[0042] The first housing portion 10 further comprises a first opening 61 and a second opening 62. The first opening 61 may be a fluid inlet opening, and the second opening 62 may be a fluid outlet opening. Alternatively, the second opening 62 may be a fluid inlet opening, and the first opening 61 may be a fluid outlet opening.

[0043] The first housing portion 10 comprises, as part of a first end structure, a lower sealing element 15 for providing a fluid seal between the housing bottom wall upper side 22 and a lower magnet side of a ring-shaped first magnet, an outer diameter sealing element 16 providing a fluid seal between the housing side wall inner side 32 and an outer diameter magnet side of the first magnet, and an inner diameter sealing element 17 providing a fluid seal between the housing central wall outer side 42 and an inner diameter side of the first magnet.

[0044] A first spacing element 71 protrudes from the housing side wall inner side 32. Second and third spacing elements 72, 73 protrude from the housing bottom wall upper side 22.

[0045] A lower opening sealing element 75 is provided on the housing bottom wall upper side 22 at an edge of the second opening 62. Two opposite side opening sealing elements 76, 77 are provided on the edge of the second opening 62.

[0046] The lower sealing element 15 has an upper surface 15a for supporting the first magnet at its lower mag-

net side. The lower opening sealing element 75 has an upper surface 75a for supporting the first magnet at its lower magnet side. The second and third spacing elements 72, 73 have upper surfaces 72a, 73a, respectively, for supporting the first magnet at its lower magnet side. The outer diameter sealing element 16, the side opening sealing elements 76, 77 and the first spacing element 71 each have an inner surface 16a, 76a, 77a, 71 a, respectively for supporting the first magnet at its outer diameter magnet side. The inner diameter sealing element 17 has an outer surface 17a for supporting the first magnet at its inner diameter magnet side. With a combination of at least some of these supporting structures, the first magnet 80 is fixed against any downward movement or radial movement, as can be inferred from Figure 4.

[0047] The first magnet 80 and other magnets in other embodiments of the magnetic treatment device are ring-shaped and have a rectangular cross-section. The lower and upper magnet sides are flat. The magnets are polarized to have a north pole at one of the lower magnet side and the upper magnet side, and to have a south pole at the other one of the lower magnet side and the upper magnet side. The first magnet 80 extends circularly, along an imaginary O-shaped central first magnet line 122.

[0048] The first housing portion 10 comprises a central fluid passage 41 in the central wall 40.

[0049] Figure 5 depicts a perspective view, showing hidden lines, of a generally circular disk-shaped separation member 90 for forming a separation wall. The separation member 90 comprises a fluid passage 92, a central hole 94, a first sealing element 96 arranged on the separation member lower side, for forming an upper sealing element for providing a fluid seal between the separation member lower side and the upper magnet side of the first magnet 80, a second sealing element 98 arranged on the separation member upper side for forming a lower sealing element for providing a fluid seal between the separation member upper side and a lower magnet side of a second magnet, lower spacing elements 100, 101, and upper spacing elements 102, 103. The separation member 90 is provided with a recess 106 extending along part of the outer circumference of the separation member 90, for example tangentially along 20 to 45°. As seen in tangential direction, the first sealing element 96 is arranged at one side of the fluid passage 92, and the second sealing element 98 is arranged at another, opposite side of the fluid passage 92. One end of the first and second sealing elements 96, 98 may be aligned with an outer diameter magnet side of a respective associated ring-shaped magnet, and the opposite end of the first and second sealing elements 96, 98 may be aligned with an inner diameter magnet side of the respective associated ring-shaped magnet.

[0050] Figure 6 depicts a perspective view of the first housing portion of Figure 1 assembled with the separation member 90 of Figure 5. The separation member lower side is supported on an upper surface 17b (see Figure 1) of the inner diameter sealing element 17, and an upper rim 30a (see Figure 1) of the side wall 30 of the first housing portion 10. The first sealing element 96 of the separation member 90 extends parallel to the lower sealing element 15, and fittingly extends between the outer diameter sealing element 16 and the inner diameter sealing element 17, i.e., one end of the first sealing element 96 abuts the inner surface 16a of the outer diameter sealing element 16, and the opposite end of the first sealing element 96 abuts the outer surface 17a or the upper surface 17b of the inner diameter sealing element 17.

[0051] The ring-shaped first magnet 80 may be accommodated between the first housing portion 10 and the separation member 90. Then, the first magnet 80 is supported at its upper magnet side by a lower surface of the first sealing element 96, and the lower spacing elements 100, 101. Thus, the first magnet 80 is not only fixed against any downward movement or radial movement, as explained above, but is also fixed against any upward movement by the separation member 90.

[0052] Taking into account that the first magnet 80 is ring-shaped and extends circularly, wherein the first magnet 80 comprises a flat lower magnet side, a flat upper magnet side being parallel to the lower magnet side, a cylindrical inner diameter magnet side having an inner diameter, and a cylindrical outer diameter magnet side having an outer diameter, then the lower sealing element 15, outer diameter sealing element 16, inner diameter sealing element 17 and first sealing element 96 in combination form an end structure, or first end structure, of a first chamber extending between a first end side and a second end side in a circular direction over an angle of less than 360 degrees from a first chamber inlet opening which may be first opening 61 to a first chamber outlet opening which may be formed by fluid passage 92, central fluid passage 41 and central hole 94. The first chamber extends along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side of the first magnet 80.

[0053] This is illustrated in Figure 6a, illustrating the first chamber 120 as seen folded out along the central first magnet line 122 being straightened. From this illustration, it appears that fluid may flow in the first chamber 120 along, and can come into contact or can come close to almost the whole of the lower magnet side, upper magnet side, inner magnet side and outer magnet side of the first magnet 80. The first chamber 120 extends along the central first magnet line 122 over (360 - α)°, wherein α indicates a dimension of the first end structure in the direction of the central first magnet line 122.

[0054] Figures 7 to 10 depict a perspective view of a second housing portion 130 to be assembled with the first housing portion 10, wherein the first housing portion 10 and the second housing portion 130 together may form a housing of a magnetic treatment device. The second housing portion 130 comprises at least holes 11 a, 12a, 13a, 14a to allow the second housing portion 130 to be mounted to the first housing portion 10. In particular,

holes 11 and 11a, and holes 12 and 12a, and holes 13 and 13a, and holes 14 and 14a are to be aligned to serve to clamp the first housing portion 10 and the second housing portion 130 together, wherein face 128 of the first housing portion 10 and face 129 of the second housing portion 130 are facing each other. Accordingly, Figure 7 can be considered to show the second housing portion 130 from its lower side.

[0055] The second housing portion 130 comprises a top wall 220 having a housing top wall lower side 222, a side wall 230 having a housing side wall inner side 232, and a central wall 240 having a central wall outer side 242.

[0056] The second housing portion 130 comprises, as part of a second end structure, an upper sealing element 215 for providing a fluid seal between the housing top wall lower side 222 and an upper magnet side of a ring-shaped second magnet 282, an outer diameter sealing element 216 providing a fluid seal between the housing side wall inner side 232 and an outer diameter magnet side of the second magnet 282, and an inner diameter sealing element 217 providing a fluid seal between the housing central wall outer side 242 and an inner diameter side of the second magnet 282.

[0057] Fourth and fifth spacing elements 271, 272 protrude from the housing side wall inner side 232. Sixth, seventh and eighth spacing elements 273, 274 and 275 protrude from the housing top wall lower side 222.

[0058] The upper sealing element 215 has an upper surface 215a for supporting the second magnet 282 at its upper magnet side. The sixth, seventh and eighth spacing elements 273, 274 and 275 have upper surfaces 273a, 274a, 275a respectively, for supporting the second magnet 282 at its upper magnet side. The outer diameter sealing element 216, and the fourth and fifth spacing elements 271, 272 each have an inner surface 216a, 271a, 272a, respectively for supporting the second magnet 282 at its outer diameter magnet side. The inner diameter sealing element 217 has an outer surface 217a for supporting the second magnet 282 at its inner diameter magnet side. With a combination of at least some of these supporting structures, the second magnet 282 is fixed against any upwards movement or radial movement, as can be inferred from Figure 9. The second magnet 80 extends circularly, along an imaginary O-shaped central second magnet line 284.

[0059] The second housing portion 130 comprises a central fluid passage 241 in the central wall 240.

[0060] The second housing portion 130 comprises a groove 280 for a sealing element, such as an O-ring, to provide a fluid seal between face 128 of the first housing portion 10 and face 129 of the second housing portion 130, when the first housing portion 10 and the second housing portion 130 are mounted together.

[0061] Figure 11 depicts a perspective view of the second housing portion 130 of Figure 7, assembled with the separation member 90 of Figure 5. The separation member upper side is supported on an lower surface 217b (see Figure 7) of the inner diameter sealing element 217, and an lower rim 230a (see Figure 7) of the side wall 230 of the second housing portion 130. The second sealing element 98 of the separation member 90 extends parallel to the upper sealing element 215, and fittingly extends between the outer diameter sealing element 216 and the inner diameter sealing element 217, i.e., one end of the second sealing element 98 abuts the inner surface 216a of the outer diameter sealing element 216, and the opposite end of the second sealing element 98 abuts the outer surface 217a or the upper surface 217b of the inner diameter sealing element 217.

[0062] The ring-shaped second magnet 282 may be accommodated between the second housing portion 130 and the separation member 90. Then, the second magnet 282 is supported at its lower magnet side by an upper surface of the second sealing element 98, and the upper spacing elements 102, 103. Thus, the second magnet 282 is not only fixed against any upward movement or radial movement, as explained above, but is also fixed against any downward movement by the separation member 90.

[0063] Taking into account that the second magnet 282 is ring-shaped and extends circularly, wherein the second magnet 282 comprises a flat lower magnet side, a flat upper magnet side being parallel to the lower magnet side, a cylindrical inner diameter magnet side having an inner diameter, and a cylindrical outer diameter magnet side having an outer diameter, then the upper sealing element 215, outer diameter sealing element 216, inner diameter sealing element 217 and second sealing element 98 in combination form an end structure of a second chamber extending circularly over an angle of less than 360 degrees from a second chamber inlet opening formed by fluid passage 92, central fluid passages 41 and 241, and central hole 94, to a second chamber outlet opening formed by recess 106 of separation member 90, leading to second opening 62 of the first housing portion 10. The second chamber in the second housing portion 130 extends along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side of the second magnet 282, and thus is similar to the first chamber in the first housing portion 10.

[0064] The first housing portion 10, with the first magnet 80 mounted therein, is to be assembled with the second housing portion 130 with the second magnet 282 mounted therein, wherein one separation member 90 is mounted between the first magnet 80 and the second magnet 282 in the orientation as shown in Figures 6 and 11, to form a magnetic treatment device. The first housing portion 10 and the second housing portion 130 may be clamped together, e.g. using four bolts extending respectively through holes 11 and 11a, 12 and 12a, 13 and 13a, and 14 and 14a.

[0065] In such assembled magnetic treatment device, a fluid may flow through the first chamber and the second chamber. In a flow direction from opening 61, the fluid may flow in the first chamber along all sides of the first

magnet 80 around the central wall 40 in a counterclockwise direction, as indicated in Figure 3 by arrows 300. In particular, the fluid may flow substantially in a circumferential direction along the housing bottom wall upper side 22 and the lower magnet side of the first magnet 80, along the housing side wall inner side 32 and the outer diameter magnet side of the first magnet 80, along the housing central wall outer side 42 and the inner diameter magnet side of the first magnet 80, and along the separation member lower side and the upper magnet side of the first magnet 80. At the end of the flow path in the first chamber, the end structure formed by the lower sealing element 15, outer diameter sealing element 16, inner diameter sealing element 17 and first sealing element 96 causes the fluid flow to continue through fluid passage 92 of the separation member 90 and through the central fluid passage 41 and central hole 94 of the separation member 90 into the central fluid passage 241, as indicated by the arrows 300 in Figure 6.

[0066] An end structure formed by the upper sealing element 215, outer diameter sealing element 216, inner diameter sealing element 217 and second sealing element 98 in combination then causes the fluid to flow around the central wall 240 in a counterclockwise direction in the second chamber along all sides of the second magnet 282 to the recess 106 of the separation member 90, as indicated in Figure 9. The fact that the arrows 300 in Figure 9 point in clockwise direction is due to Figure 9 being a bottom view of the second housing portion 130. In particular, the fluid may flow substantially in a circumferential direction along the separation member upper side and the lower magnet side of the second magnet 282, along the housing side wall inner side 232 and the outer diameter magnet side of the second magnet 282, along the housing central wall outer side 242 and the inner diameter magnet side of the second magnet 282, and along the housing top wall lower side 222 and the upper magnet side of the second magnet 282.

[0067] From the recess 106, the fluid continues its flow to the second opening 62 of the first housing portion 10. Accordingly, fluid may flow through the first opening 61 to enter the fluid treatment device, then through the first chamber, then through the second chamber, and then through the second opening 62 to leave the fluid treatment device. A reverse flow direction is equally possible, and will expose the fluid to the first and second magnets equally well.

[0068] Figure 12 depicts a perspective view of a top wall member or a bottom wall member. For the following explanation, it will be assumed that a bottom wall member 310 is shown. The bottom wall member 310 is shaped as a ring-shaped circular disc, and is provided with a central bottom wall member opening 312, and an eccentric bottom wall member opening 314. A lower sealing element 316 having upper surface 316a is provided on an upper side of the bottom wall member 310, and extends substantially radially. A cylindrically shaped outer diameter sealing element 318 and a cylindrically shaped inner diameter sealing element 320 extend axially from the respective opposite ends of the lower sealing element 316. The upper side of the bottom wall member 310 is provided with distributed spacing elements 322 having upper surfaces 322a. The spacing elements 322 and the lower sealing element 316 each have the same height from the upper surface of the bottom wall member 310.

[0069] Figures 13a and 13b depict perspective views of a separation wall member 330, wherein Figure 13a does not show hidden lines, and Figure 13b shows the same separation wall member 330 including hidden lines. The separation wall member 330 is shaped as a ring-shaped circular disc, and is provided with a central separation wall member opening 332, and a radially extending eccentric separation wall member opening 334.

[0070] A lower sealing element 336 having an upper surface 336a is provided on an upper side of the separation wall member 330, and extends substantially radially. At the respective opposite ends of the lower sealing element 336, blind mounting holes 338a, 338b are provided in the separation wall member 330.

[0071] An upper sealing element 346 having an lower surface 346a is provided on an lower side of the separation wall member 330, and extends substantially radially. At the respective opposite ends of the upper sealing element 346, blind mounting holes 338c, 338d are provided in the separation wall member 330.

[0072] The upper side of the separation wall member 330 is provided with distributed spacing elements 342 having upper surfaces 342a. The lower side of the separation wall member 330 is provided with distributed spacing elements 344 having lower surfaces 344a. The spacing elements 342 and the lower sealing element 336 each have the same height from the upper surface of the separation wall member 330. The spacing elements 344 and the upper sealing element 346 each have the same height from the lower surface of the separation wall member 330. The separation wall member 330 has a same diameter as the bottom wall member 310. The central separation wall member opening 332 has a same diameter as the central bottom wall member opening 312.

[0073] Figure 14 depicts, in a perspective view, an assembly of a bottom wall member 310 of Figure 12 and a separation wall member 330 of Figures 13a, 13b. An end of the outer diameter sealing element 318 is inserted into mounting hole 338d, and an end of the inner diameter sealing element 320 is inserted into mounting hole 338c. In this arrangement, and end structure, or first end structure, is formed by the lower sealing element 316, the outer diameter sealing element 318, the inner diameter sealing element 320 and the upper sealing element 346.

[0074] Figure 15 depicts a side view of an assembly, or stack, of a bottom wall member 310 of Figure 12, a ring-shaped magnet 350, and a separation wall member 330, as seen from a direction indicated by arrow XV in Figure 14.

[0075] The magnet 350 is supported at its lower side by the spacing elements 322 on the upper surfaces 322a

thereof, and on the upper surface of the lower sealing element 316. The magnet 350 is supported at its upper side by the spacing elements 344 on the lower surfaces 344a thereof, and on the lower surface of the upper sealing element 346.

[0076] As further indicated in Figure 15, an outer diameter wall member 360, or housing outer wall, or pipe having a circular cross-section, may be mounted fitting to the outer circumference of the bottom wall member 310 and to the outer circumference of the separation wall member 330. Thus, the outer diameter wall member 360 forms an outer wall of a magnetic treatment device. An inner diameter wall member 362, or housing central wall, or pipe having a circular cross section, may be mounted fitting to the inner circumference of the central bottom wall member opening 312 and to the inner circumference of the central separation wall member opening 332. Thus, the inner diameter wall member 362 forms an inner wall of the magnetic treatment device. The bottom wall member 310 forms a lower wall of a housing of the magnetic treatment device. The upper separation wall member 330 forms a an upper wall of the magnetic treatment device.

[0077] A first chamber 364 is formed extending between a first end side and a second end side of the first end structure formed by the lower sealing element 316, outer diameter sealing element 318, inner diameter sealing element 320 and upper sealing element 346. The first chamber 364 extends circularly over an angle of less than 360 degrees from a first chamber inlet opening which may be formed by eccentric bottom wall member opening 314 to a first chamber outlet opening which may be formed by eccentric separation wall member opening 334. The first chamber extends along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side of the first magnet 350.

[0078] Further ring-shaped magnets and separation wall members 330, alternatingly oriented, may be stacked upon the structure of Figure 15, to provide for further chambers of an embodiment of a magnetic treatment device. This is suggested, leaving in Figures 16a (showing an arrangement of a bottom wall member 310 and four separation wall members 330 allowing for four magnetic treatment chambers to be formed), 16b (showing the arrangement of Figure 16a and a central wall 362 shaped as a pipe) and 16c (showing the arrangement of Figure 16b including a ring-shaped magnet in each chamber). A fluid to be magnetically treated in the magnetic treatment device may flow in from the eccentric bottom wall member opening 314 through the chambers connected in series through the respective eccentric separation wall member openings 334, and may flow out from the eccentric separation wall member opening 334 of the upper separation wall member 330. A flow in the reverse direction is equally possible.

[0079] As explained in detail above, a magnetic treatment device for magnetically treating a fluid comprises a housing, a ring-shaped first magnet and a first chamber. The first magnet is accommodated in the housing. The first magnet extends circularly, and comprises a flat lower magnet side, a flat upper magnet side being parallel to the lower magnet side, a cylindrical inner diameter magnet side having an inner diameter, and a cylindrical outer diameter magnet side having an outer diameter. Spacing elements extend between respective housing sides and first magnet sides facing each other. The first chamber extends circularly over an angle of less than 360 degrees from a first chamber inlet opening to a first chamber outlet opening, along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side, for allowing the fluid to flow in the first chamber from the first chamber inlet opening to the first chamber outlet opening in a circumferential direction along the lower magnet side, the upper magnet side, the inner diameter magnet side and the outer diameter magnet side.

[0080] As required, detailed embodiments of the present invention are disclosed herein. However, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the invention.

[0081] The terms "a"/"an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language, not excluding other elements or steps). Any reference signs in the claims should not be construed as limiting the scope of the claims or the invention.

[0082] The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. A magnetic treatment device for magnetically treating a fluid, the magnetic treatment device comprising:

   a housing;
   a ring-shaped first magnet accommodated in the housing, the first magnet extending circularly, the first magnet comprising a flat first magnet lower magnet side, a flat first magnet upper magnet side being parallel to the first magnet lower

magnet side, a cylindrical first magnet inner diameter magnet side having an inner diameter, and a cylindrical first magnet outer diameter magnet side having an outer diameter;
spacing elements extending between respective housing sides and first magnet sides facing each other;
a first chamber extending circularly over an angle of less than 360 degrees from a first chamber inlet opening to a first chamber outlet opening,
wherein the first chamber extends along the first magnet lower magnet side, the first magnet upper magnet side, the first magnet inner diameter magnet side and the first magnet outer diameter magnet side, for allowing the fluid to flow in the first chamber from the first chamber inlet opening to the first chamber outlet opening in a circumferential direction along the first magnet lower magnet side, the first magnet upper magnet side, the first magnet inner diameter magnet side and the first magnet outer diameter magnet side.

2. The magnetic treatment device according to claim 1, wherein the first chamber inlet opening and the first chamber outlet opening are in the housing, in particular facing at least one of the first magnet lower magnet side, the first magnet upper magnet side and the first magnet outer diameter magnet side.

3. The magnetic treatment device according to claim 1, further comprising:

a ring-shaped second magnet accommodated in the housing, the second magnet extending circularly, the second magnet comprising a flat second magnet lower magnet side, a flat second magnet upper magnet side being parallel to the second magnet lower magnet side, a cylindrical second magnet inner diameter magnet side having an inner diameter, and a cylindrical second magnet outer diameter magnet side having an outer diameter;
spacing elements extending between respective housing sides and second magnet sides facing each other;
a second chamber extending circularly over an angle of less than 360 degrees from a second chamber inlet opening to a second chamber outlet opening,
wherein the second chamber extends along the second magnet lower magnet side, the second magnet upper magnet side, the second magnet inner diameter magnet side and the second magnet outer diameter magnet side, for allowing the fluid to flow in the second chamber from the second chamber inlet opening to the second chamber outlet opening in a circumferential direction along the second magnet lower magnet side, the second magnet upper magnet side, the second magnet inner diameter magnet side and the second magnet outer diameter magnet side, and
wherein the first chamber outlet opening and the second chamber inlet opening are in fluid communication with each other.

4. The magnetic treatment device according to claim 3, wherein the first chamber inlet opening is in the housing, in particular facing at least one of the first magnet lower magnet side of the first magnet and the first magnet outer diameter magnet side, and
wherein the second chamber outlet opening is in the housing, in particular facing at least one of the second magnet upper magnet side and the second magnet outer diameter magnet side.

5. The magnetic treatment device according to claim 1, wherein the housing comprises:

a bottom wall having a housing bottom wall upper side facing the first magnet lower magnet side, the housing bottom wall upper side being spaced from the first magnet lower magnet side;
a side wall having a housing side wall inner side facing the first magnet outer diameter magnet side, the housing side wall inner side being spaced from the first magnet outer diameter magnet side;
a central wall having a housing central wall outer side facing the first magnet inner diameter magnet side, the housing central wall outer side being spaced from the first magnet inner diameter magnet side; and
a first top wall having a housing first top wall lower side facing the first magnet upper magnet side, the housing first top wall lower side being spaced from the first magnet upper magnet side.

6. The magnetic treatment device according to claim 5, wherein the first chamber is delimited by a first end structure having a first end side and a second end side, and
wherein the first chamber extends circularly between the first end side and the second end side of the first end structure.

7. The magnetic treatment device according to claim 6, wherein the first end structure comprises:

a first magnet lower sealing element providing a fluid seal between the housing bottom wall upper side and the first magnet lower magnet side;
a first magnet upper sealing element providing a fluid seal between the housing first top wall lower side and the first magnet upper magnet

side;
a first magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the first magnet outer diameter magnet side; and
a first magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the first magnet inner diameter magnet side.

8. The magnetic treatment device according to any one of claims 5 to 7, wherein the side wall is formed by a tubular member, in particular a cylindrical tubular member having an inner diameter larger than the outer diameter of the first magnet.

9. The magnetic treatment device according to any one of claims 5 to 8, wherein the central wall is formed by a tubular member, in particular a cylindrical tubular member having an outer diameter smaller than the inner diameter of the first magnet.

10. The magnetic treatment device according to claim 3, wherein the housing comprises:

a bottom wall having a housing bottom wall upper side facing the first magnet lower magnet side, the housing bottom wall upper side being spaced from the first magnet lower magnet side;
a side wall having a housing side wall inner side facing the first magnet outer diameter magnet side and the second magnet outer diameter magnet side, the housing side wall inner side being spaced from the first magnet outer diameter magnet side and the second magnet outer diameter magnet side;
a central wall having a housing central wall outer side facing the first magnet inner diameter magnet side and the second magnet inner diameter magnet side, the housing central wall outer side being spaced from the first magnet inner diameter magnet side and the second magnet inner diameter magnet side;
a separation wall having a separation wall lower side facing the first magnet upper magnet side, and a separation wall upper side facing the second magnet lower magnet side, the separation wall lower side being spaced from the first magnet upper magnet side, and the separation wall upper side being spaced from the second magnet lower magnet side; and
a second top wall having a housing second top wall lower side facing the second magnet upper magnet side, the housing second top wall lower side being spaced from the second magnet upper magnet side.

11. The magnetic treatment device according to claim 10, wherein the first chamber is delimited by a first end structure having a first end side and a second end side, and
wherein the first chamber extends extends circularly from the first end side to the second end side of the first end structure;
wherein the second chamber is delimited by a second end structure having a first end side and a second end side, and
wherein the second chamber extends circularly between the first end side and the second end side of the second end structure.

12. The magnetic treatment device according to claim 11, wherein the first end structure comprises:

a first magnet lower sealing element providing a fluid seal between the housing bottom wall upper side and the first magnet lower magnet side;
a first magnet upper sealing element providing a fluid seal between the separation wall lower side and the first magnet upper magnet side;
a first magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the first magnet outer diameter magnet side; and
a first magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the first magnet inner diameter magnet side, and
wherein the second end structure comprises:

a second magnet lower sealing element providing a fluid seal between the separation wall upper side and the second magnet lower magnet side;
a second magnet upper sealing element providing a fluid seal between the housing second top wall lower side and the second magnet upper magnet side;
a second magnet outer diameter sealing element providing a fluid seal between the housing side wall inner side and the second magnet outer diameter magnet side; and
a second magnet inner diameter sealing element providing a fluid seal between the housing central wall outer side and the second magnet inner diameter magnet side.

13. The magnetic treatment device according to any one of claims 10 to 12, wherein the side wall is formed by a tubular member, in particular a cylindrical tubular member having an inner diameter larger than the outer diameter of the first magnet and the second magnet.

14. The magnetic treatment device according to any one of claims 10 to 13, wherein the central wall is formed

by a tubular member, in particular a cylindrical tubular member having an outer diameter smaller than the inner diameter of the first magnet and the second magnet.

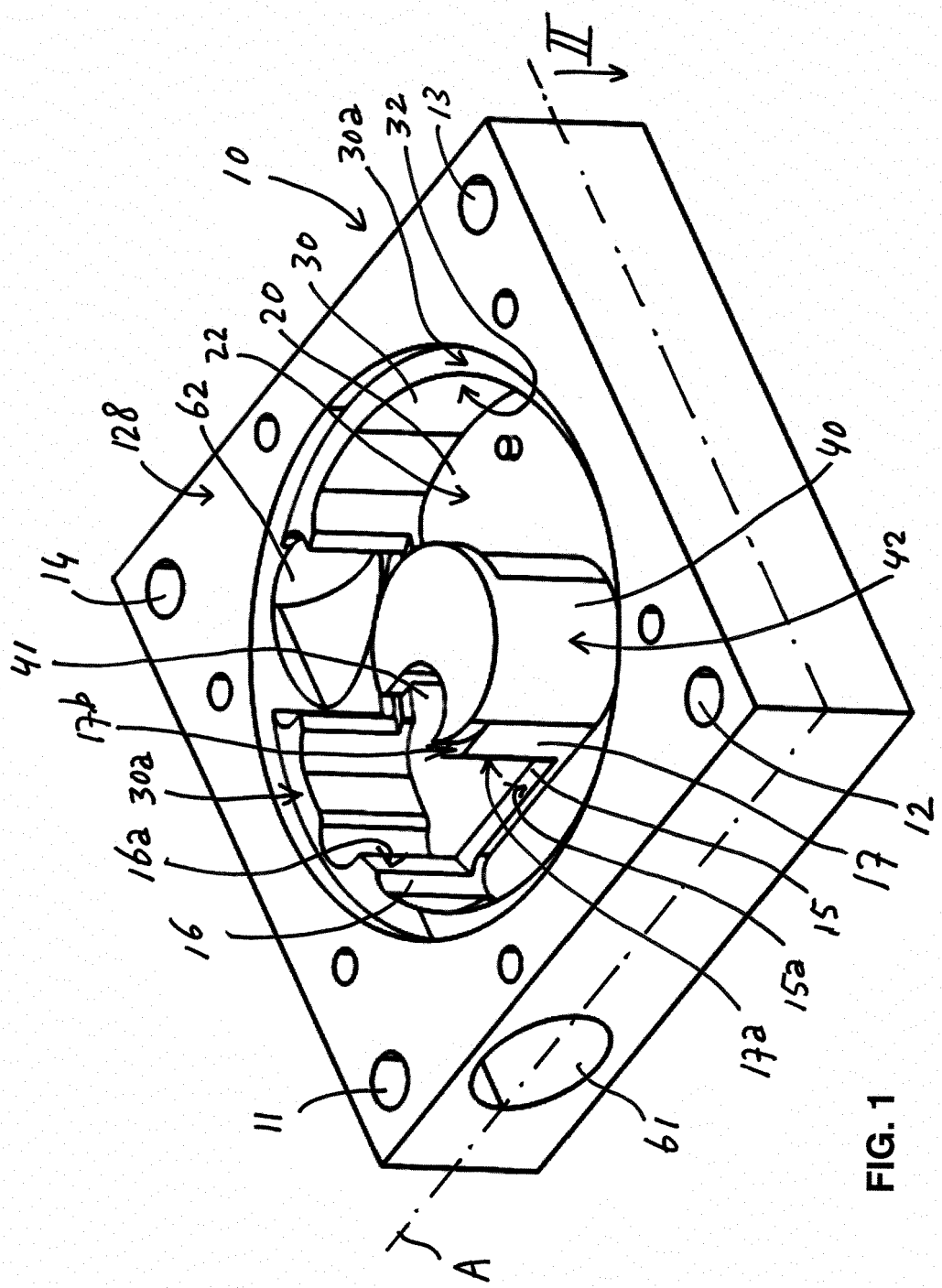
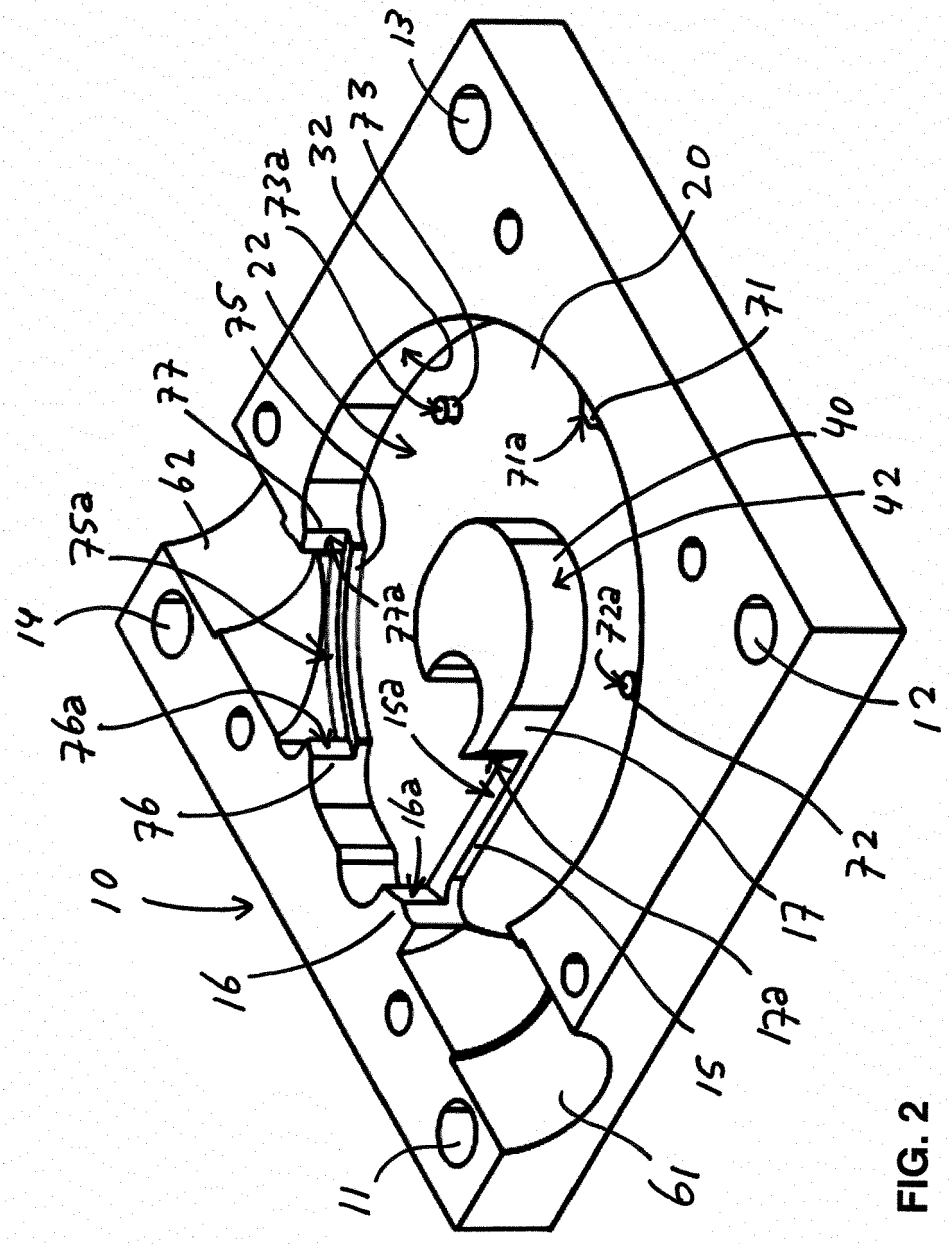

II
10
30a
32
13
30
20
22
62
128
8
40
42
14
41
17b
30a
16a
16
12
17
15
15a
17a
11
61
A

FIG. 1


13
73
32
73a
22
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62
75a
14
76a
76
10
16
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12
72a
16a
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77a
71a
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20
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42

FIG. 2

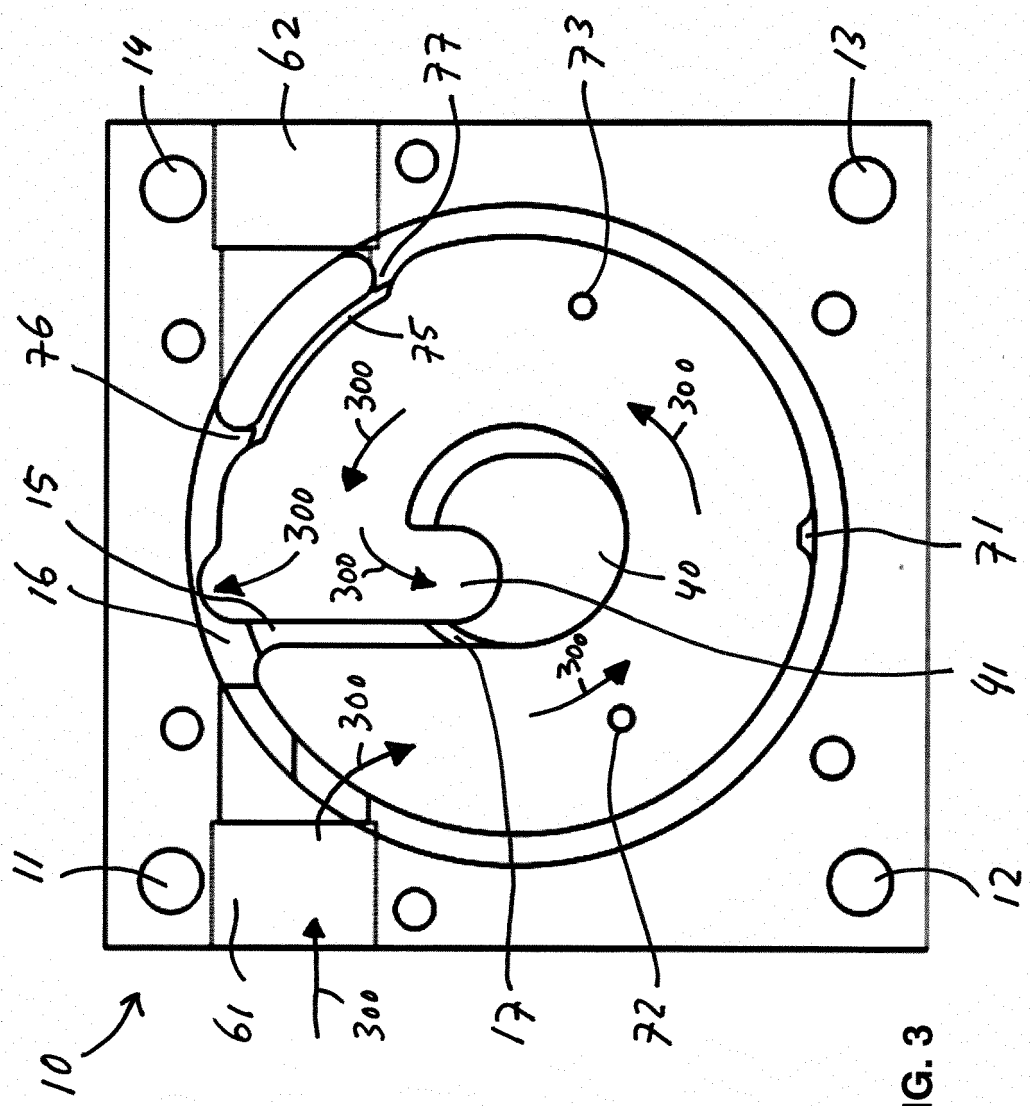


FIG. 3

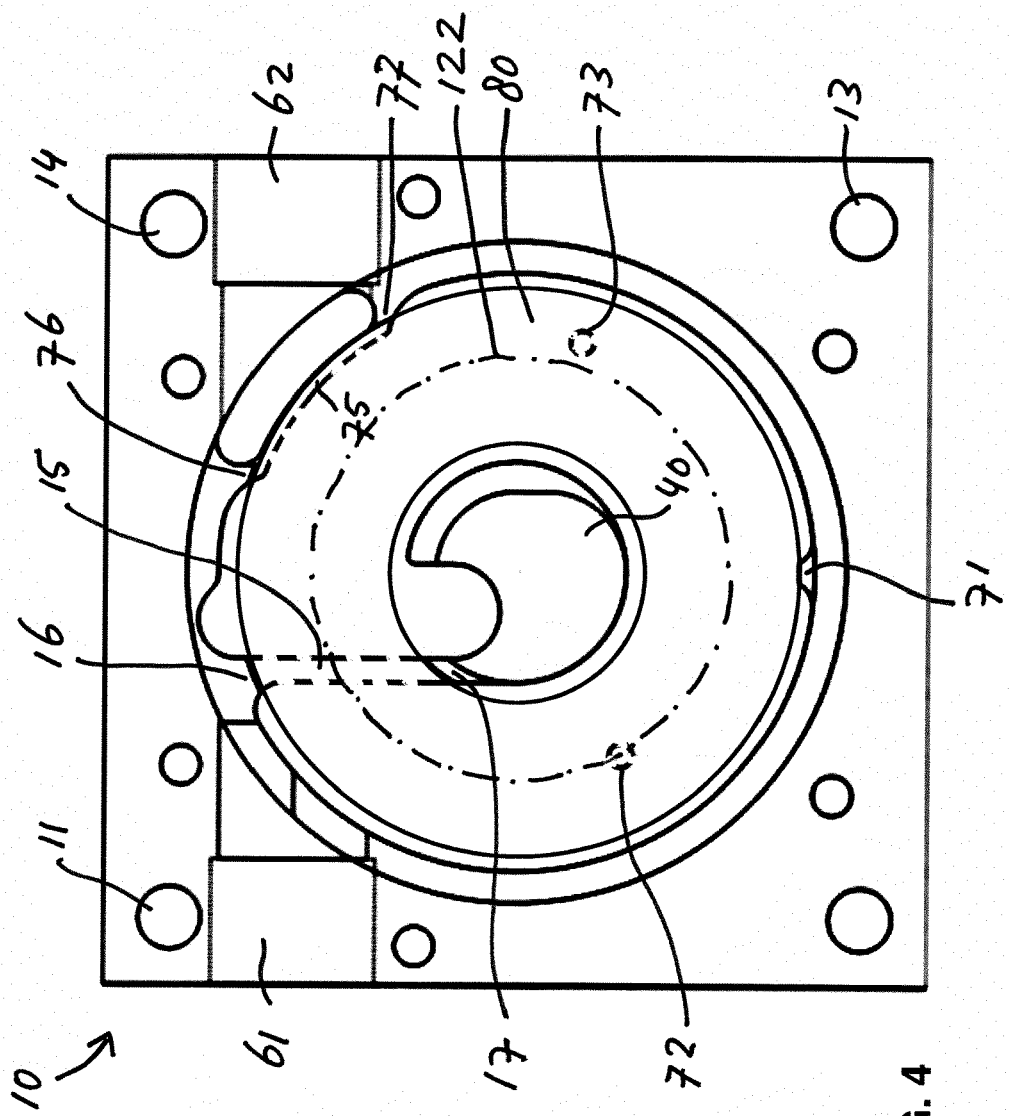


FIG. 4

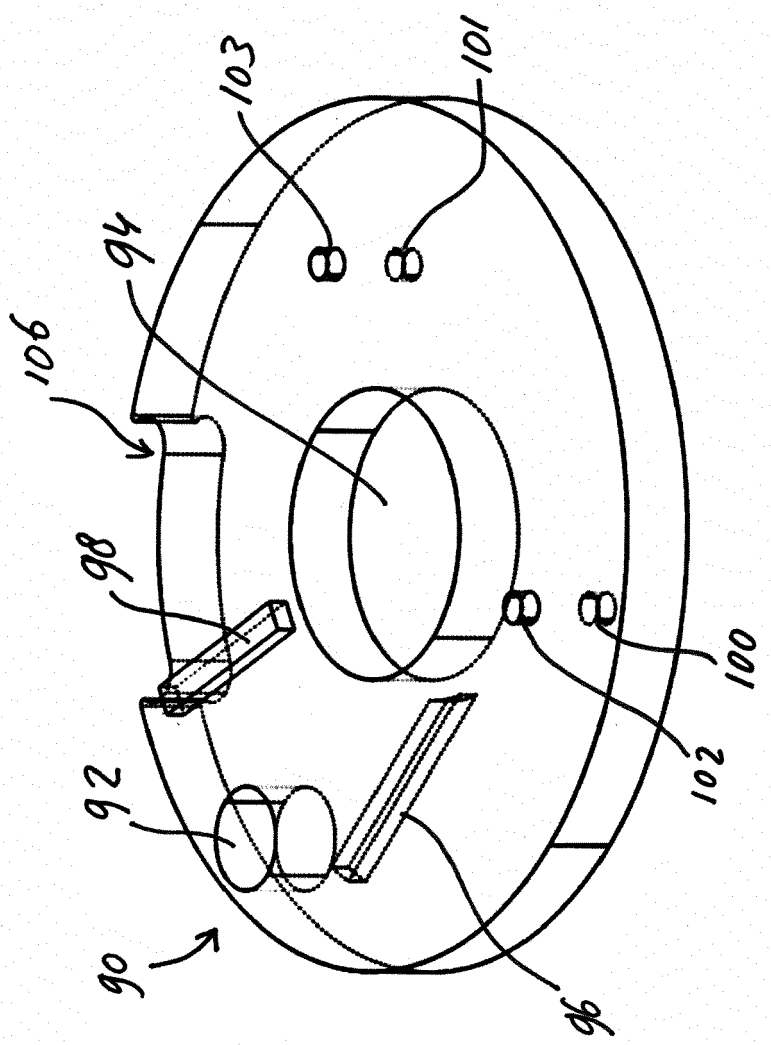


FIG. 5

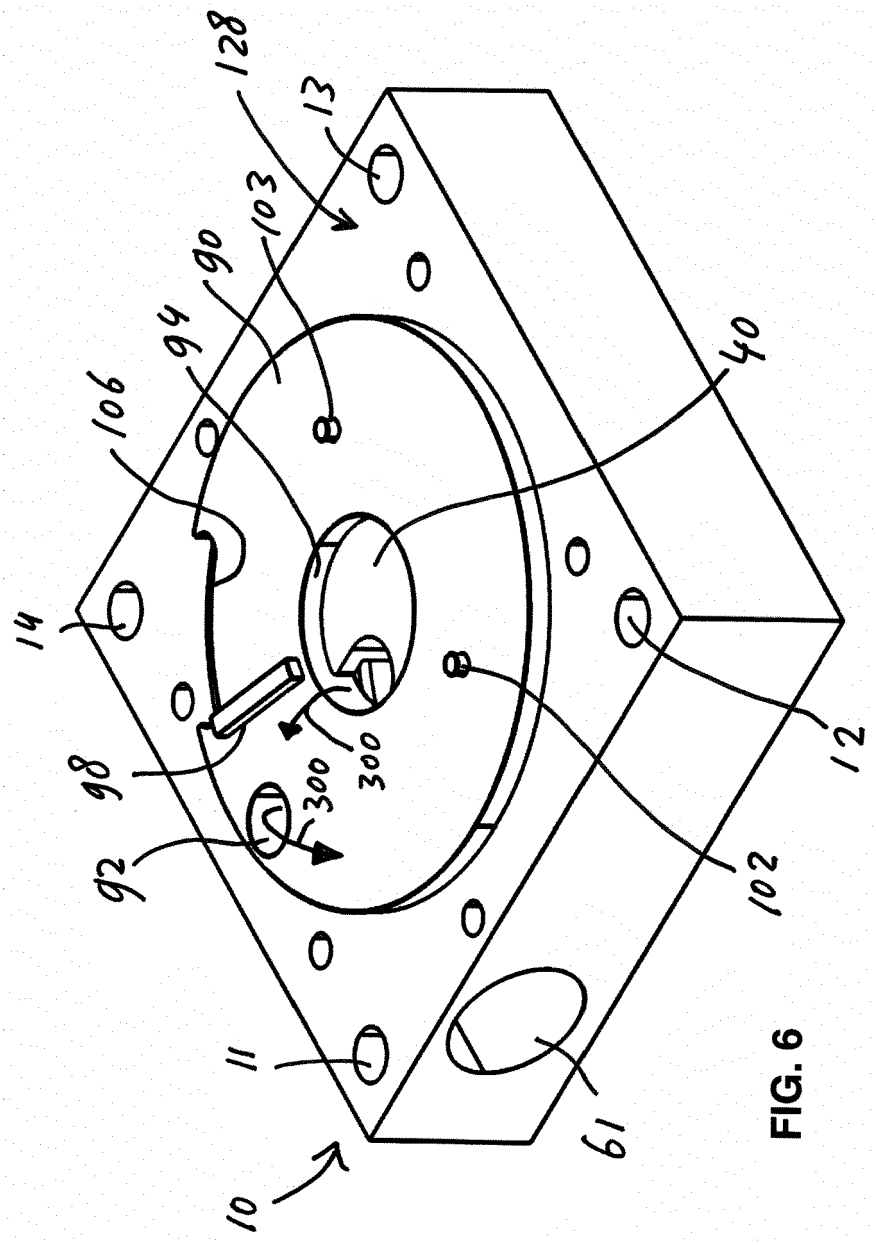


FIG. 6

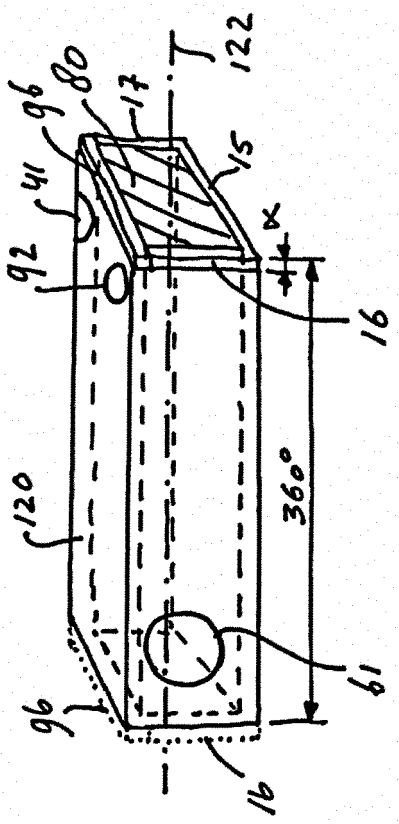


FIG. 6a

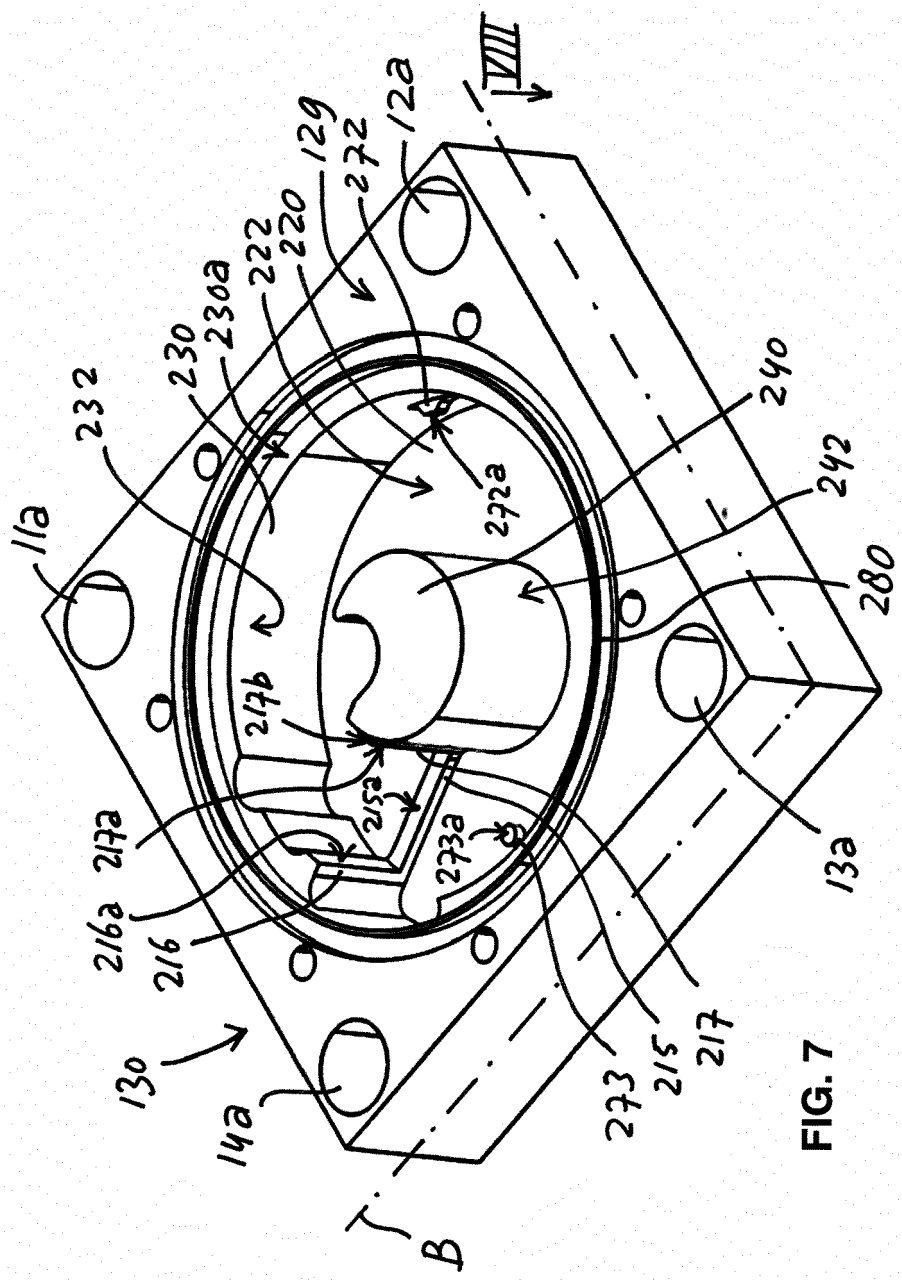
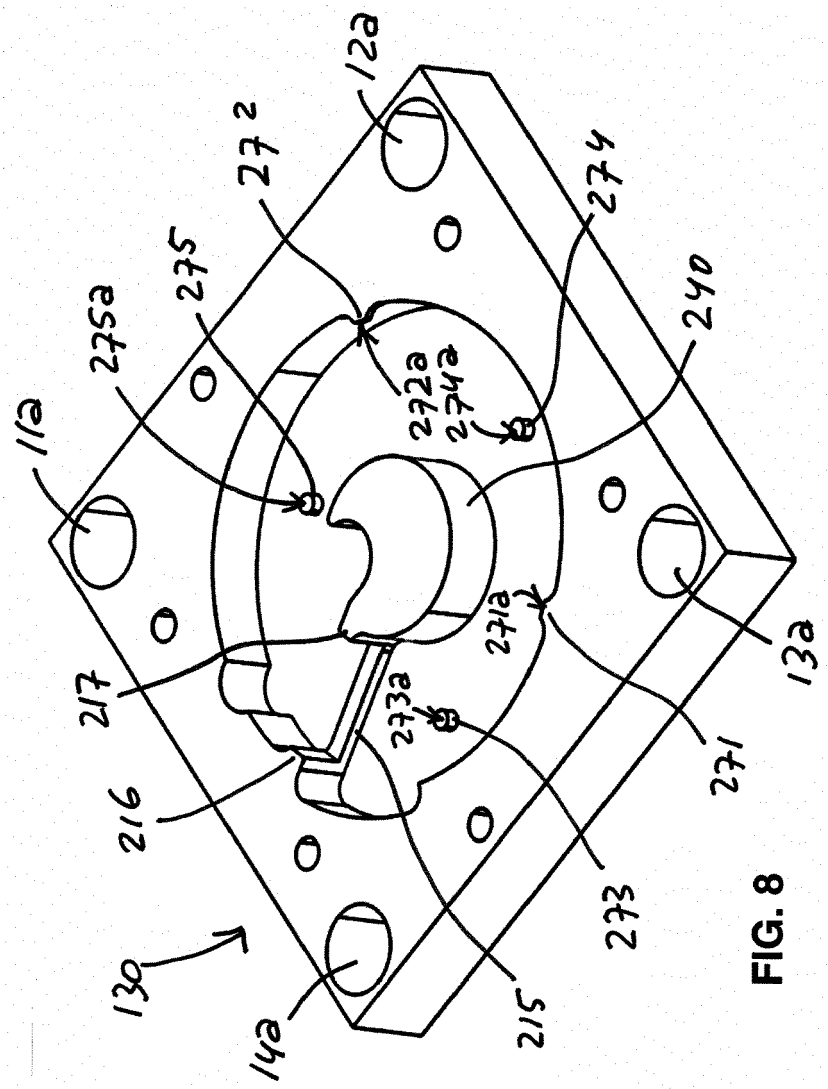

VIII
12a
129
272
220
222
230a
230
232
11a
240
242
280
272a
217b
215a
273a
216a
217a
216
130
14a
B
273
215
217
13a

FIG. 7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274a
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271a
217
273a
13a
271
216
273
130
14a
215

FIG. 8

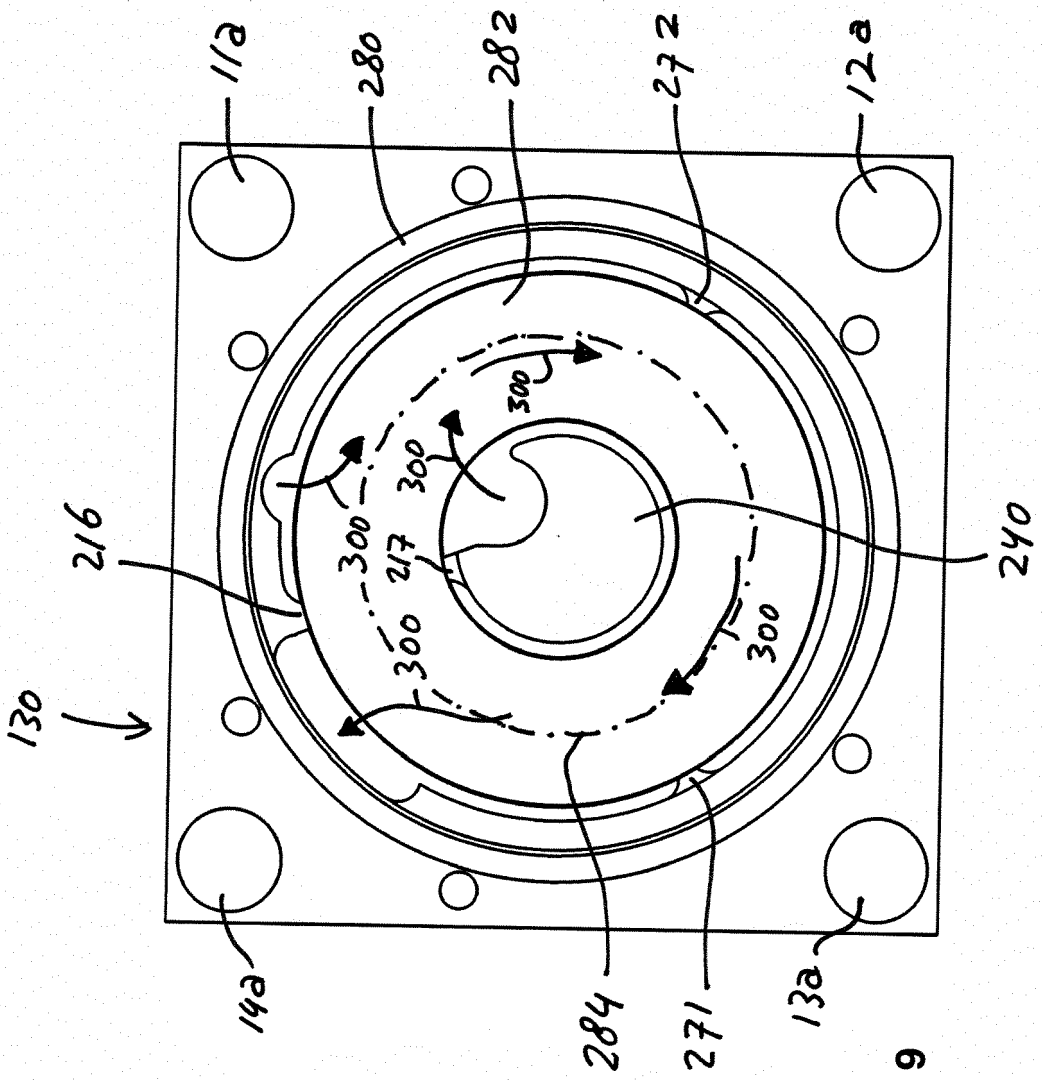

112
280
282
272
12a
216
130
300
300
300
300
300
217
240
14a
284
271
13a

FIG. 9

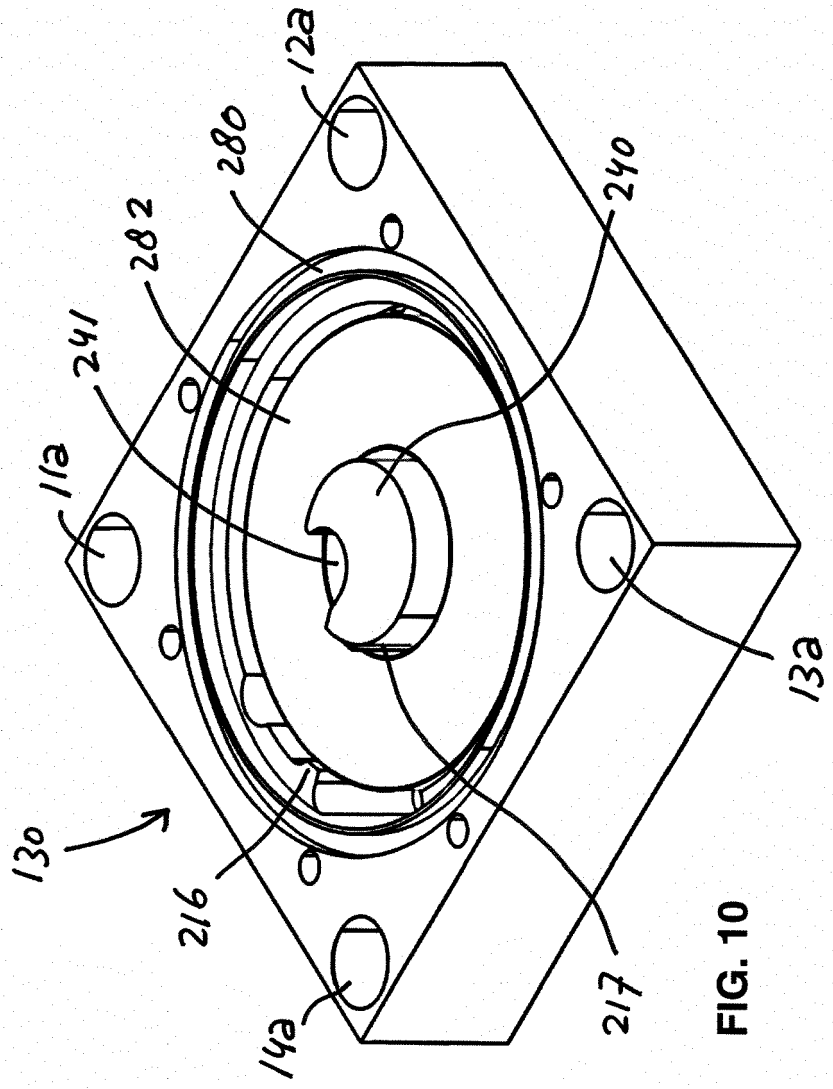


FIG. 10

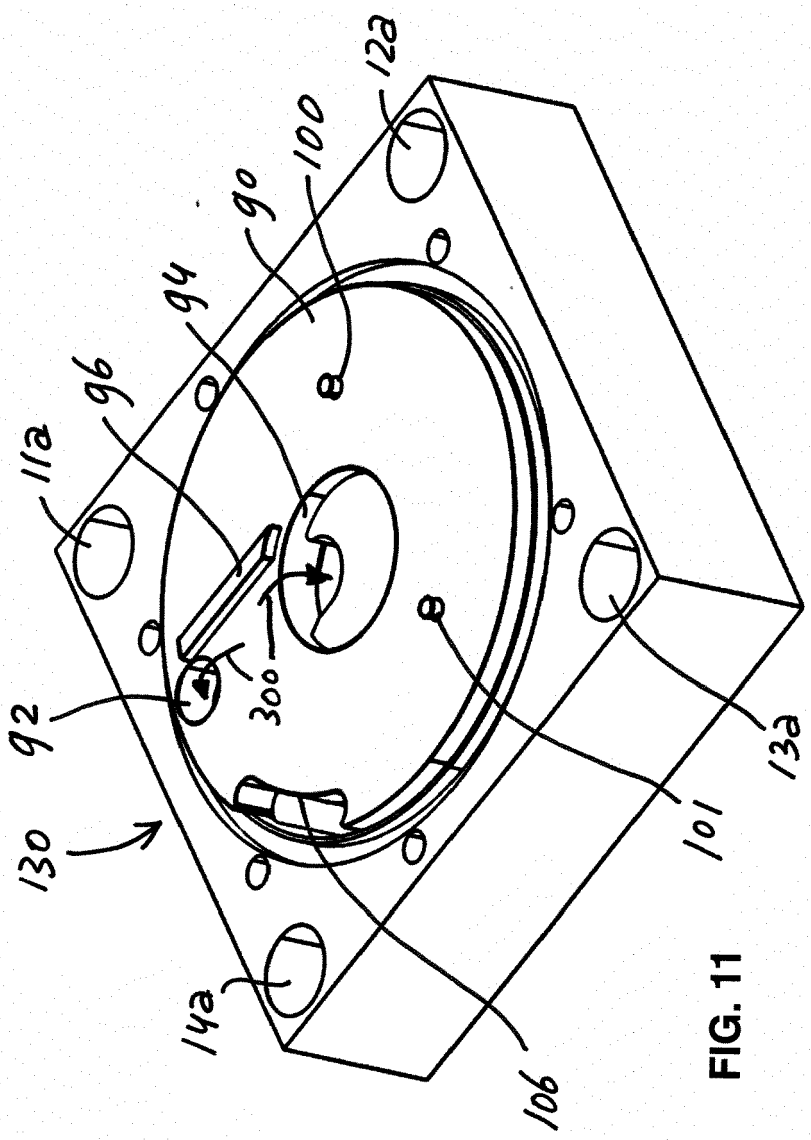


FIG. 11

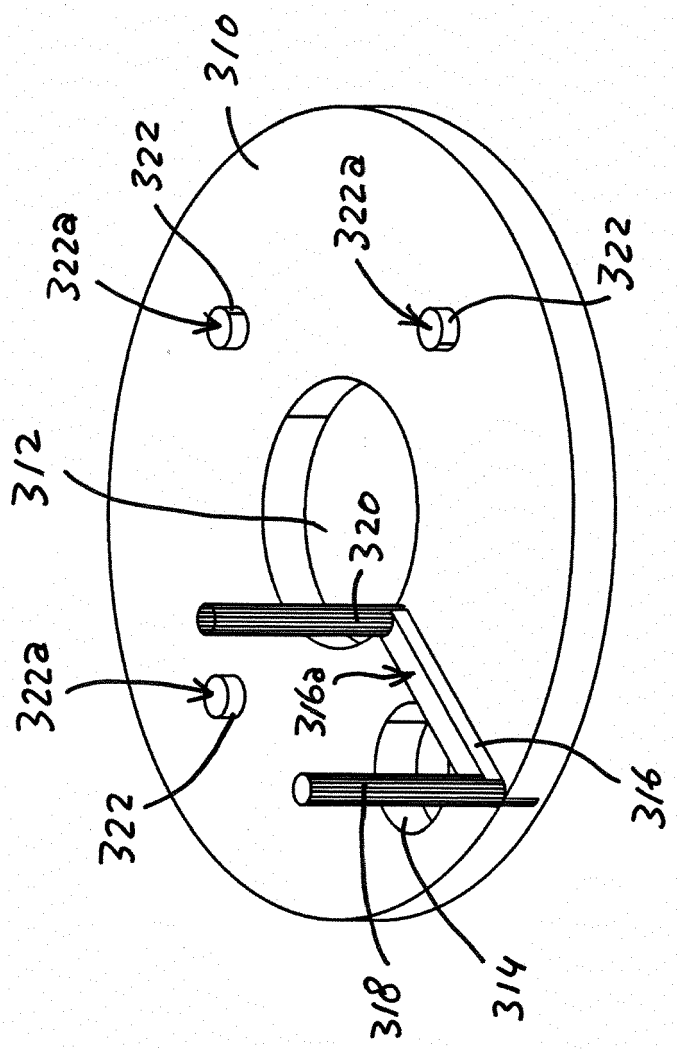


FIG. 12

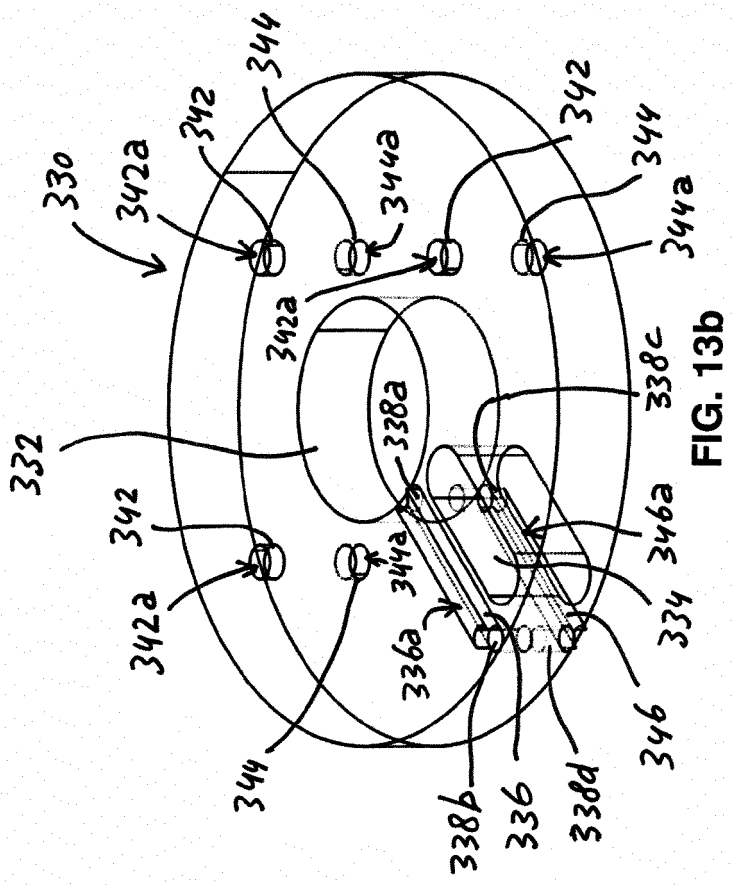


FIG. 13b

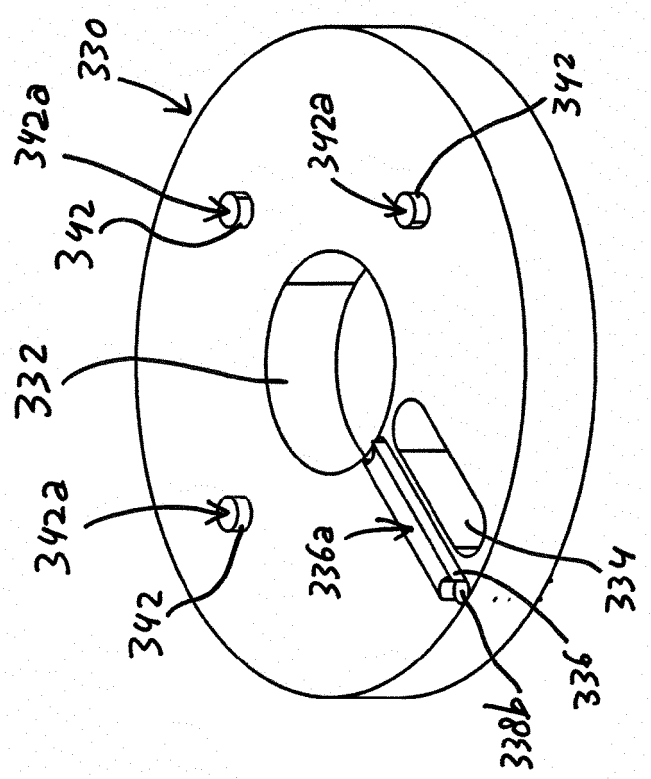


FIG. 13a

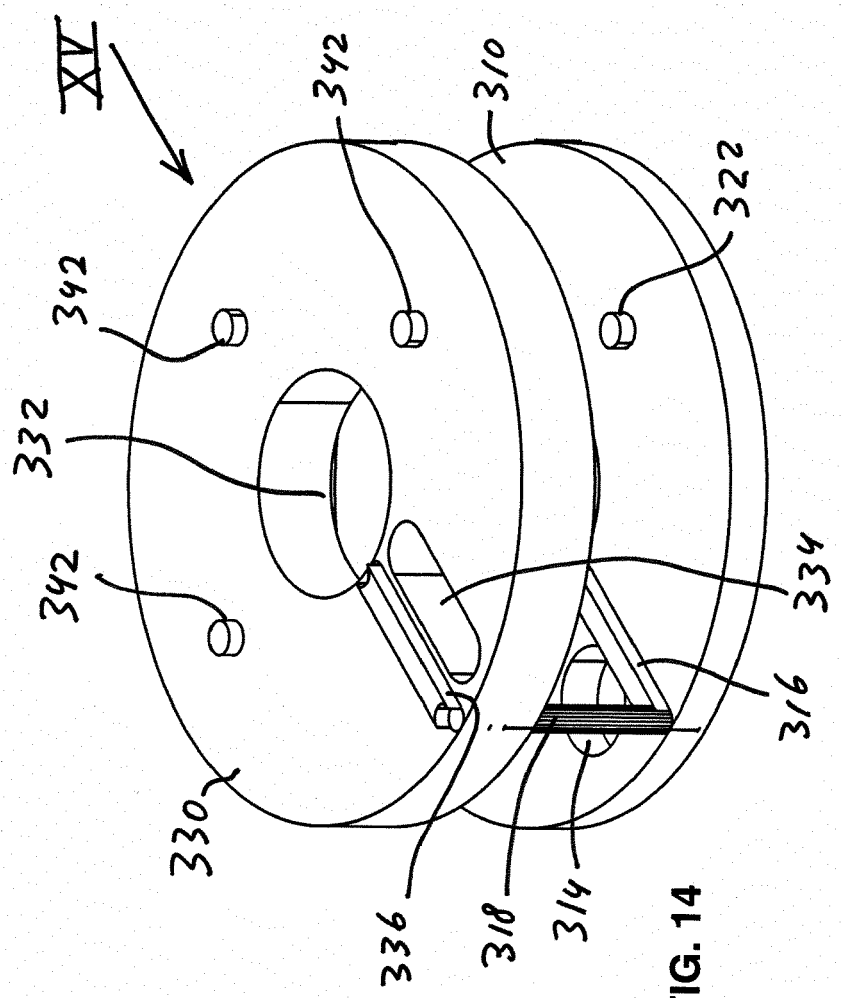
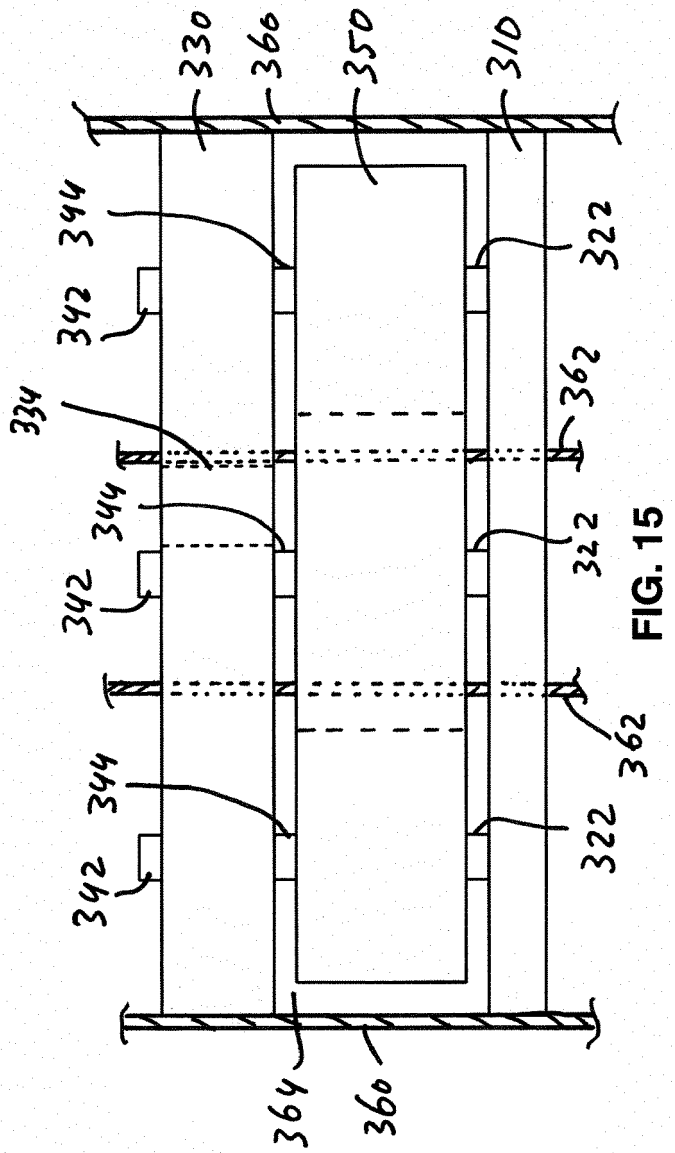


FIG. 14


330
366
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310
344
342
322
362
334
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322
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322
364
360

FIG. 15

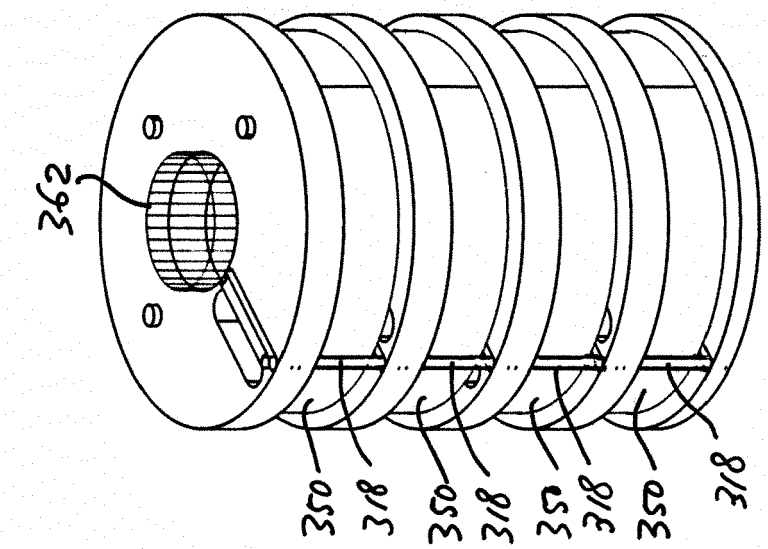

FIG. 16c

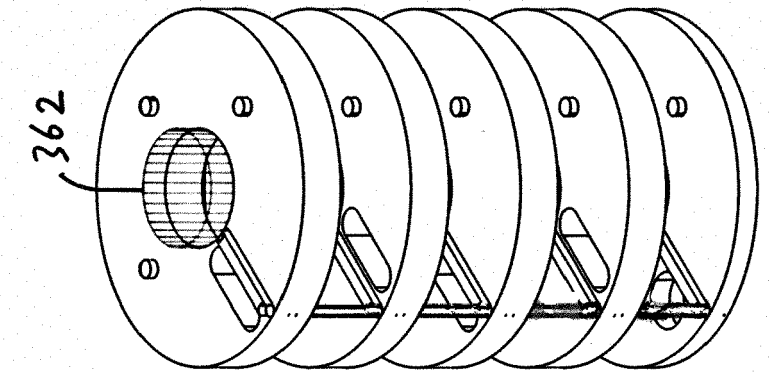

FIG. 16b

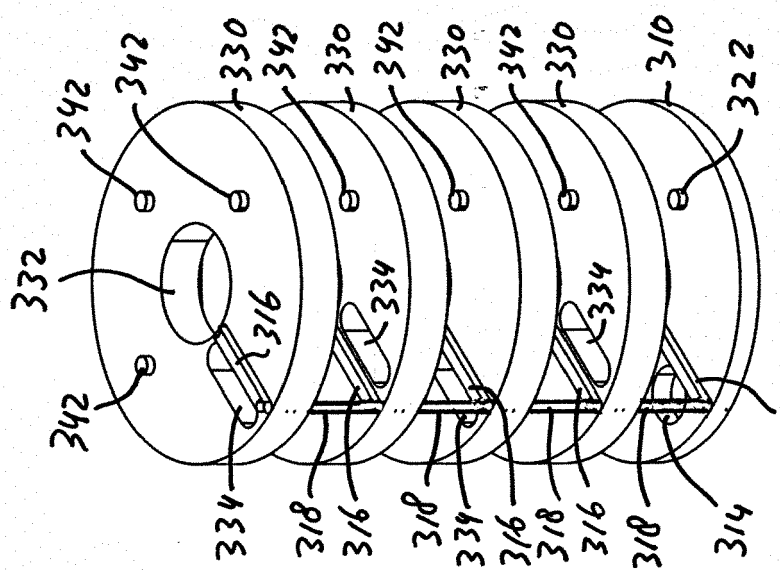

FIG. 16a

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 18 7130

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/065438 A1 (CHAU YIU CHAU [CA]) 12 March 2009 (2009-03-12) * paragraphs [0001], [0006], [0010], [0054], [0055], [0057], [0058], [0069]; figures 19-23 * * paragraphs [0089] - [0116] *	1-14	INV. F02M27/04
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X	GB 2 459 860 A (ECLIPSE MAGNETICS LTD [GB]) 11 November 2009 (2009-11-11) * page 6, line 19 - page 8, line 12; figures 4-7 *	1-14	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 September 2018	Karstens, Thede

CATEGORY OF CITED DOCUMENTS

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