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(54) **LOW ENERGY MAGNETIC SPA CIRCULATION SYSTEM**

(57) **ABSTRACT**

(71) Applicant: **Eugene McDougall**, Oakville (CA)

(72) Inventor: **Eugene McDougall**, Oakville (CA)

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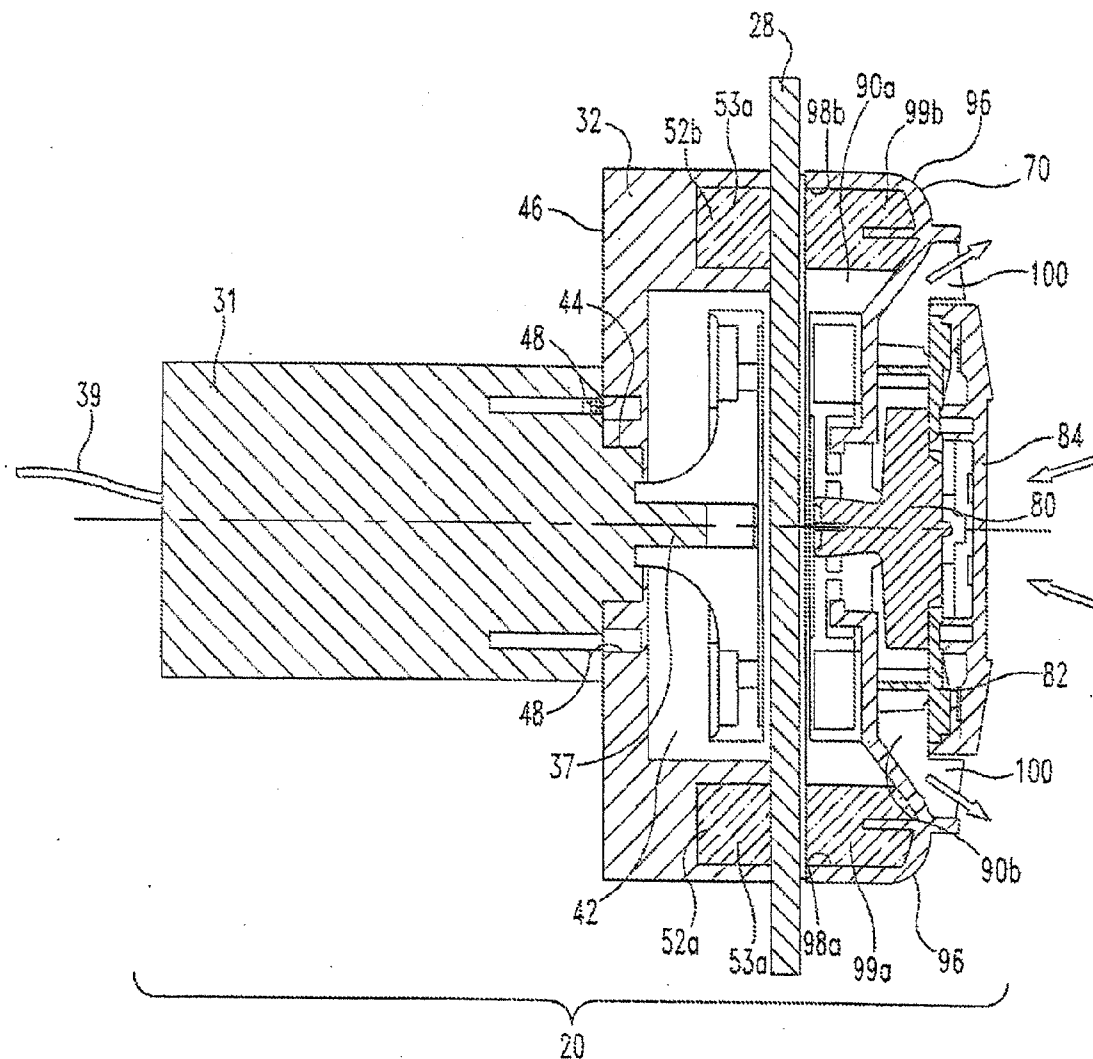
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USPC **417/423.1**

A powered pipeless circulation system for a container holding a fluid includes first and second motor assemblies. The first motor assembly has multiple coil members. Each coil member is electrically charged for generating a magnetic field. A first housing is configured for accommodating the first motor assembly, and fixedly attached to a dry surface of a wall of the container. A second motor assembly has at least one impeller and an impeller magnet plate. A second housing is configured for rotatably accommodating the second motor assembly and being disposed on a wet surface of the wall opposite the first housing. The impeller magnet plate is aligned to magnetically engage with the coil members. In use, the second motor assembly is magnetically coupled to the first motor assembly having a wall in-between the assemblies for forming a motor configured for rotating the impeller.



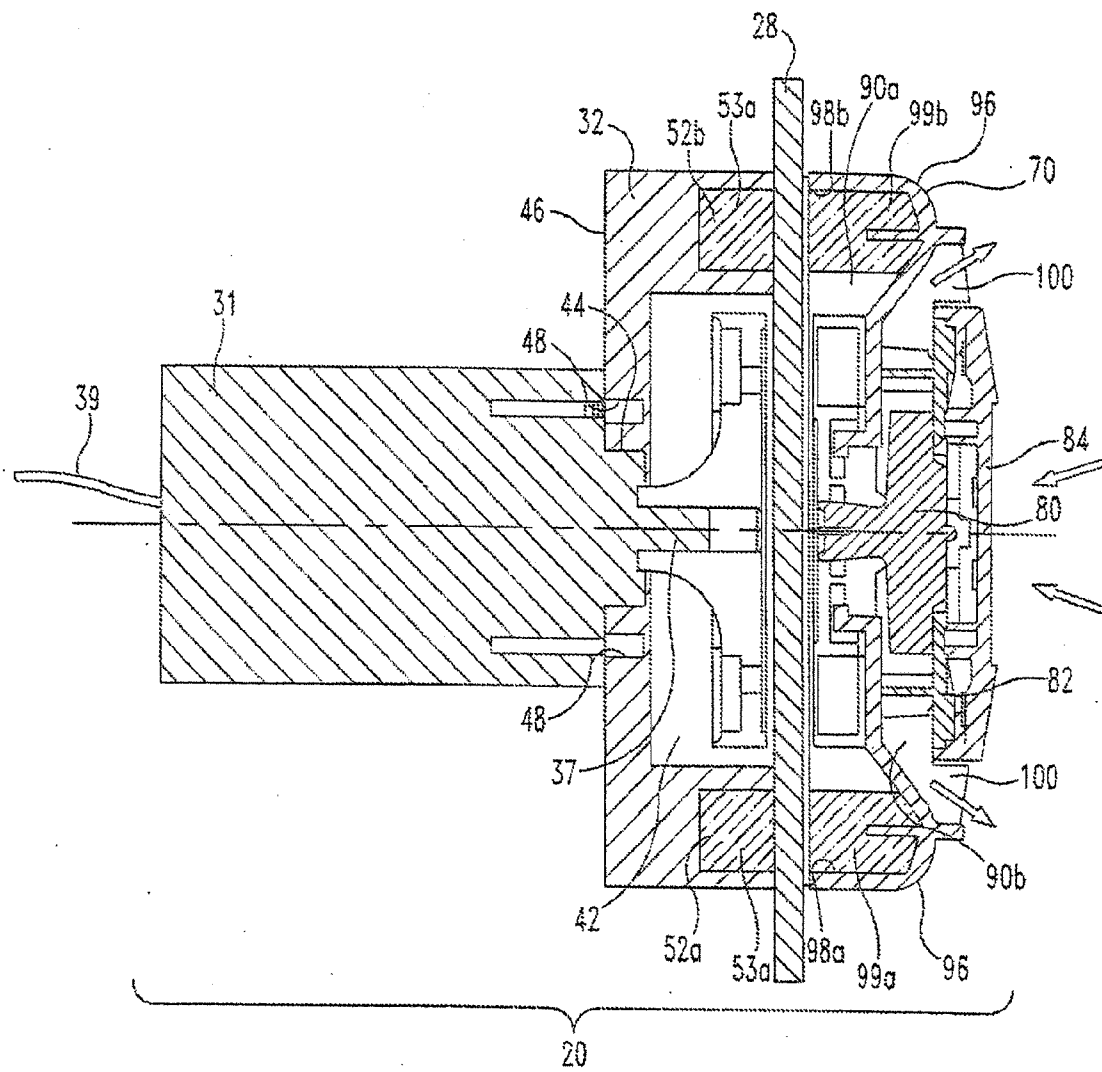


Fig. 1

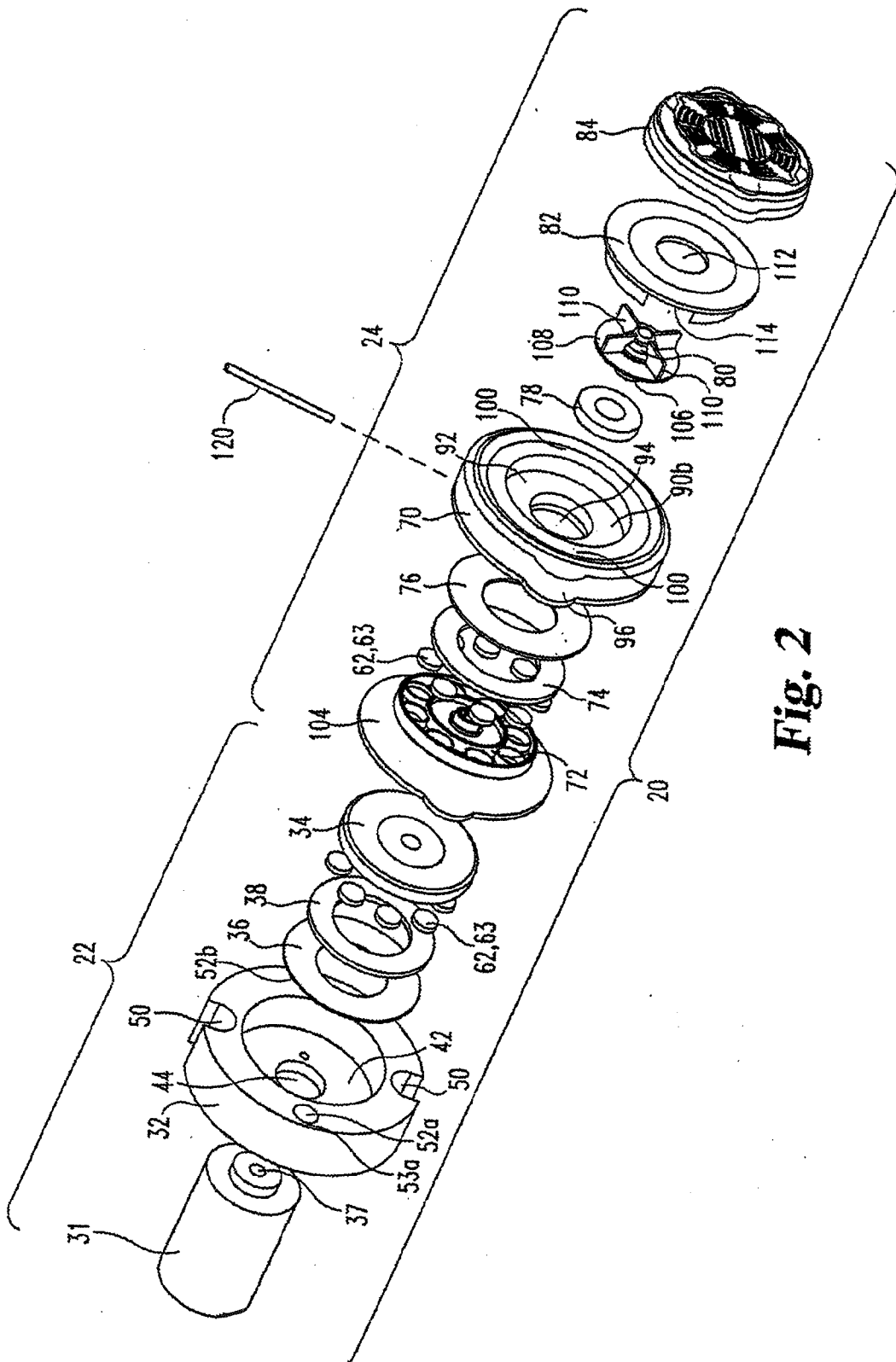


Fig. 2

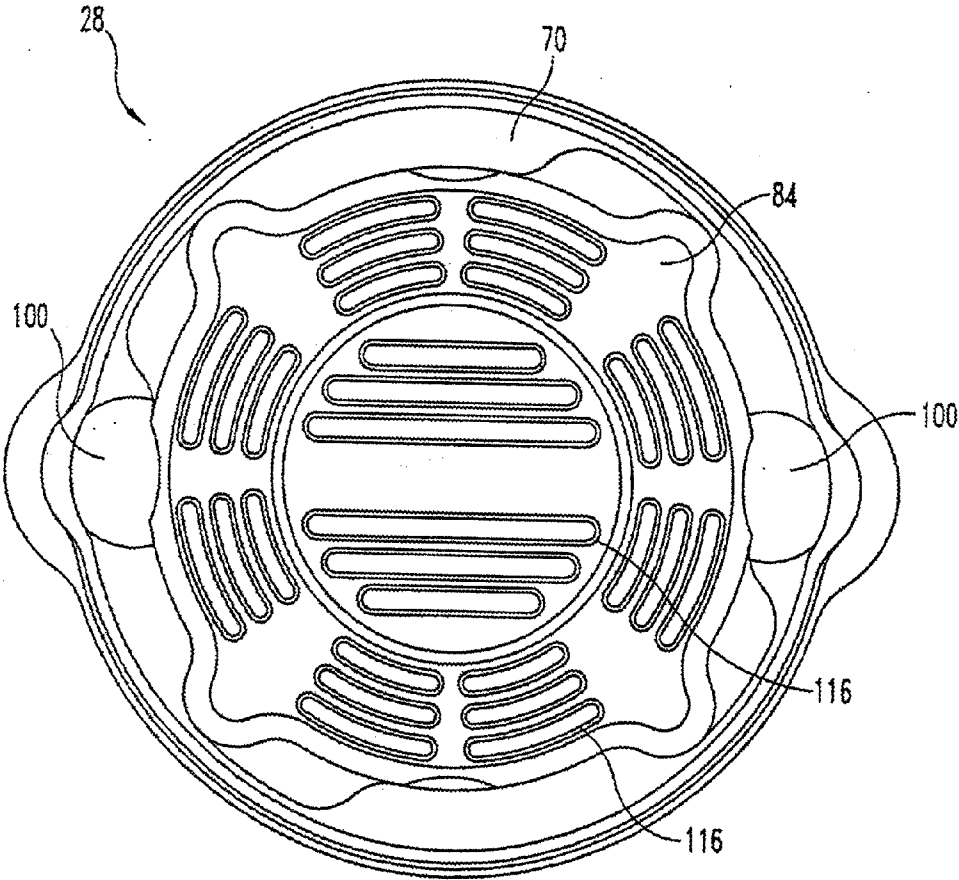


Fig. 3

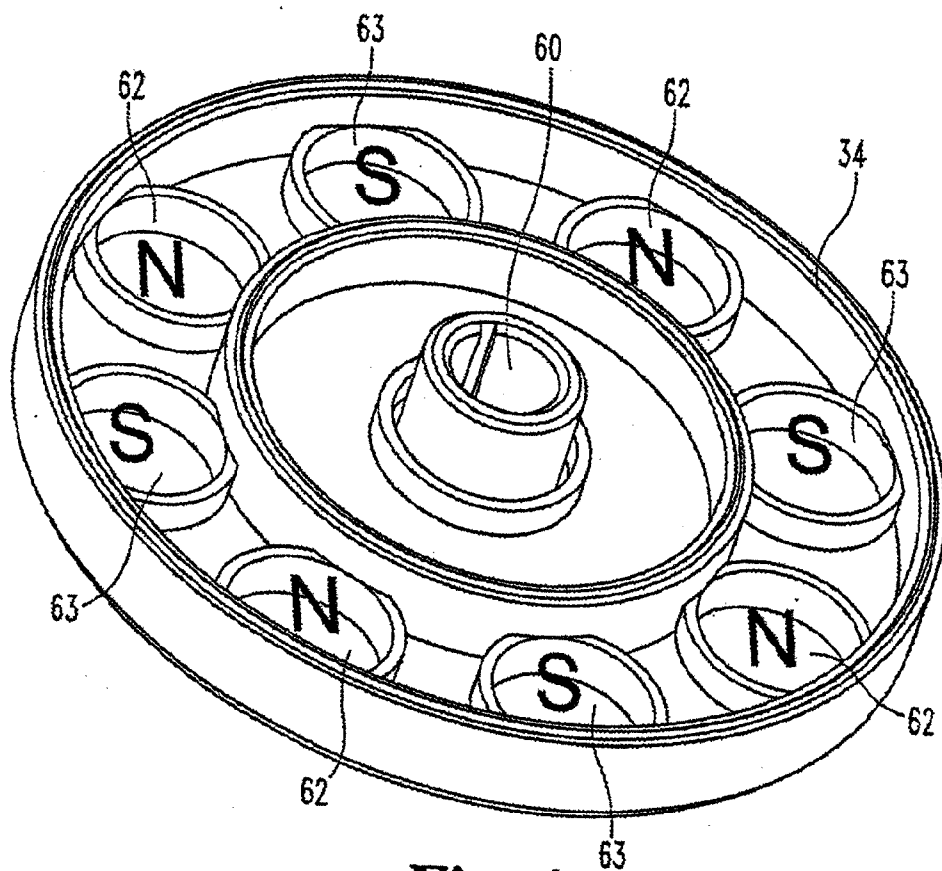


Fig. 4

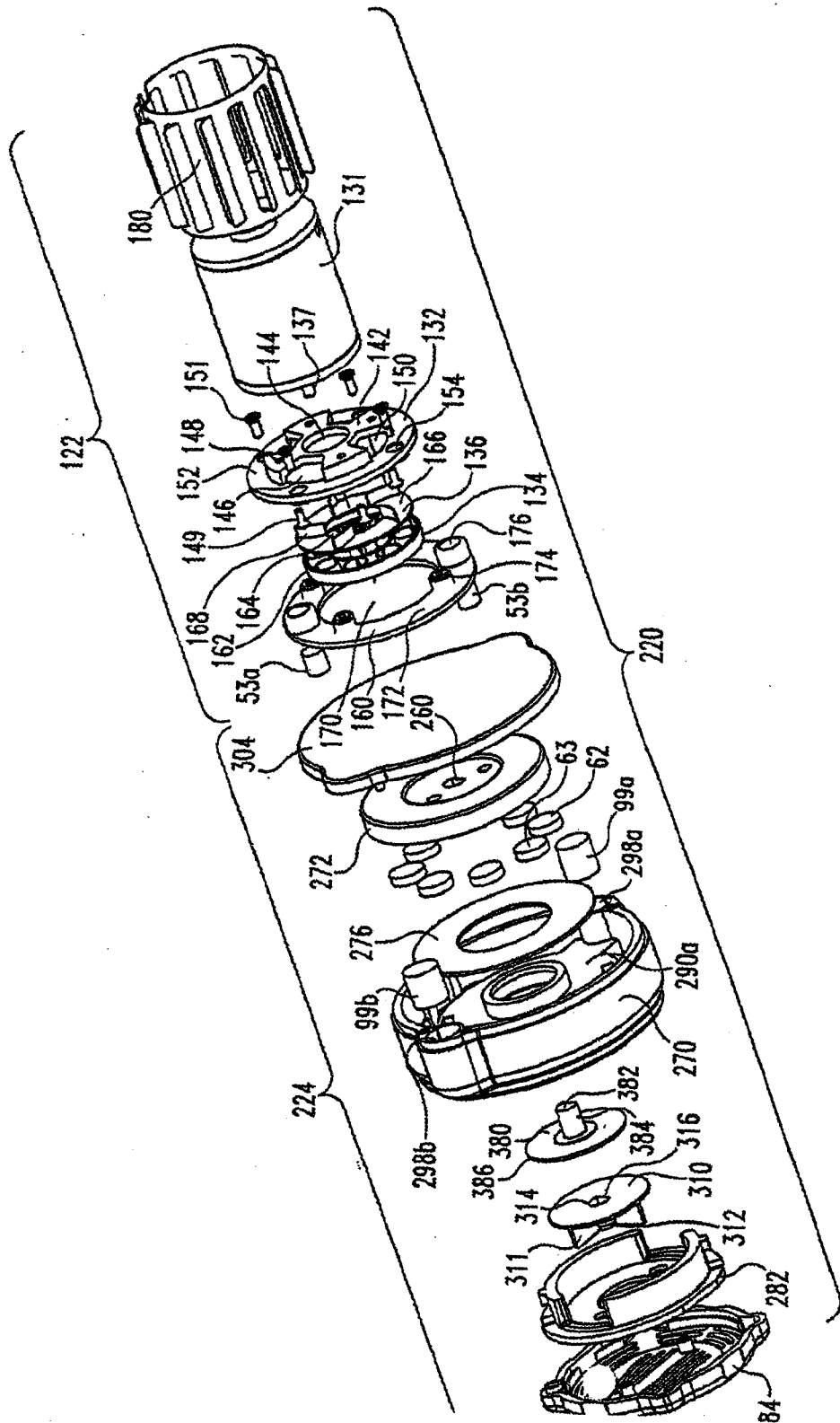


Fig. 5

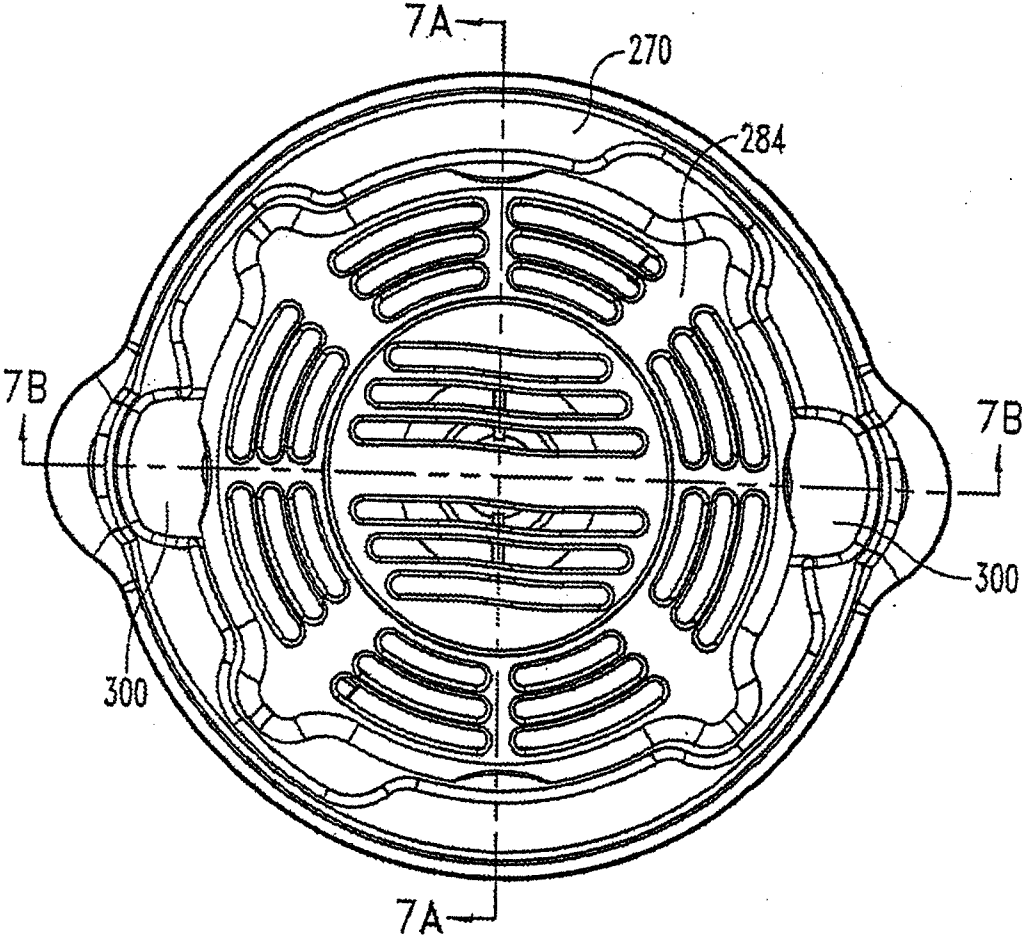


Fig. 6

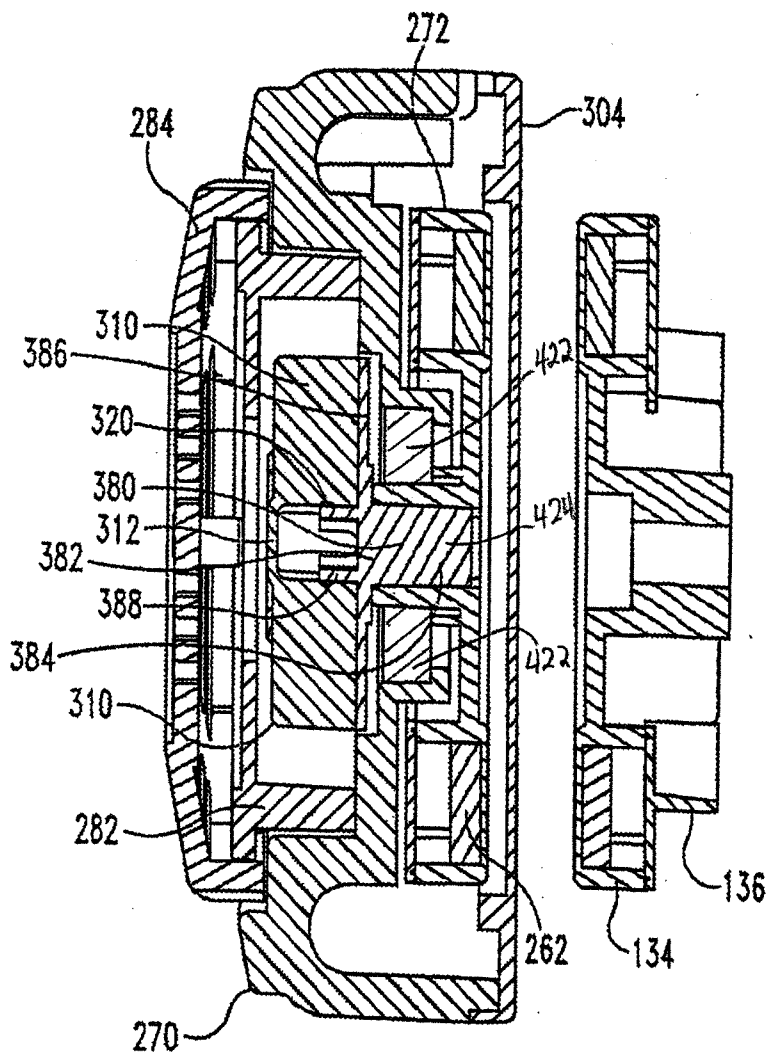


Fig. 7A

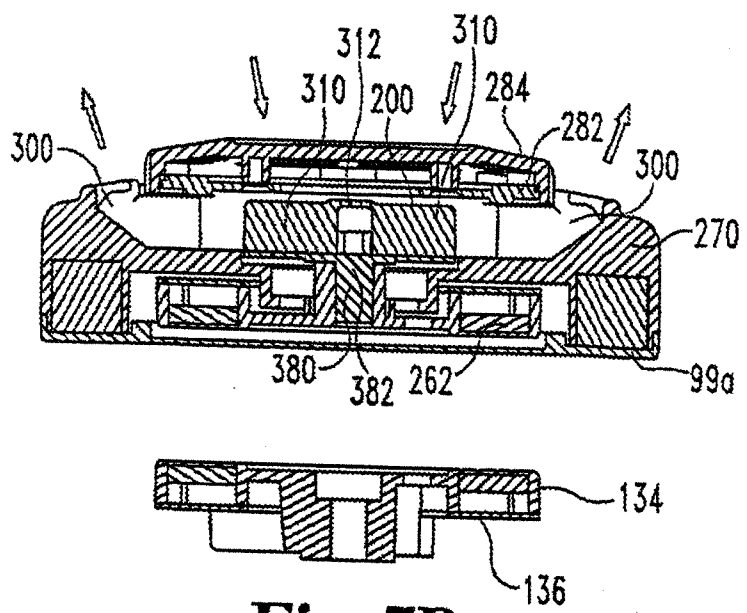


Fig. 7B

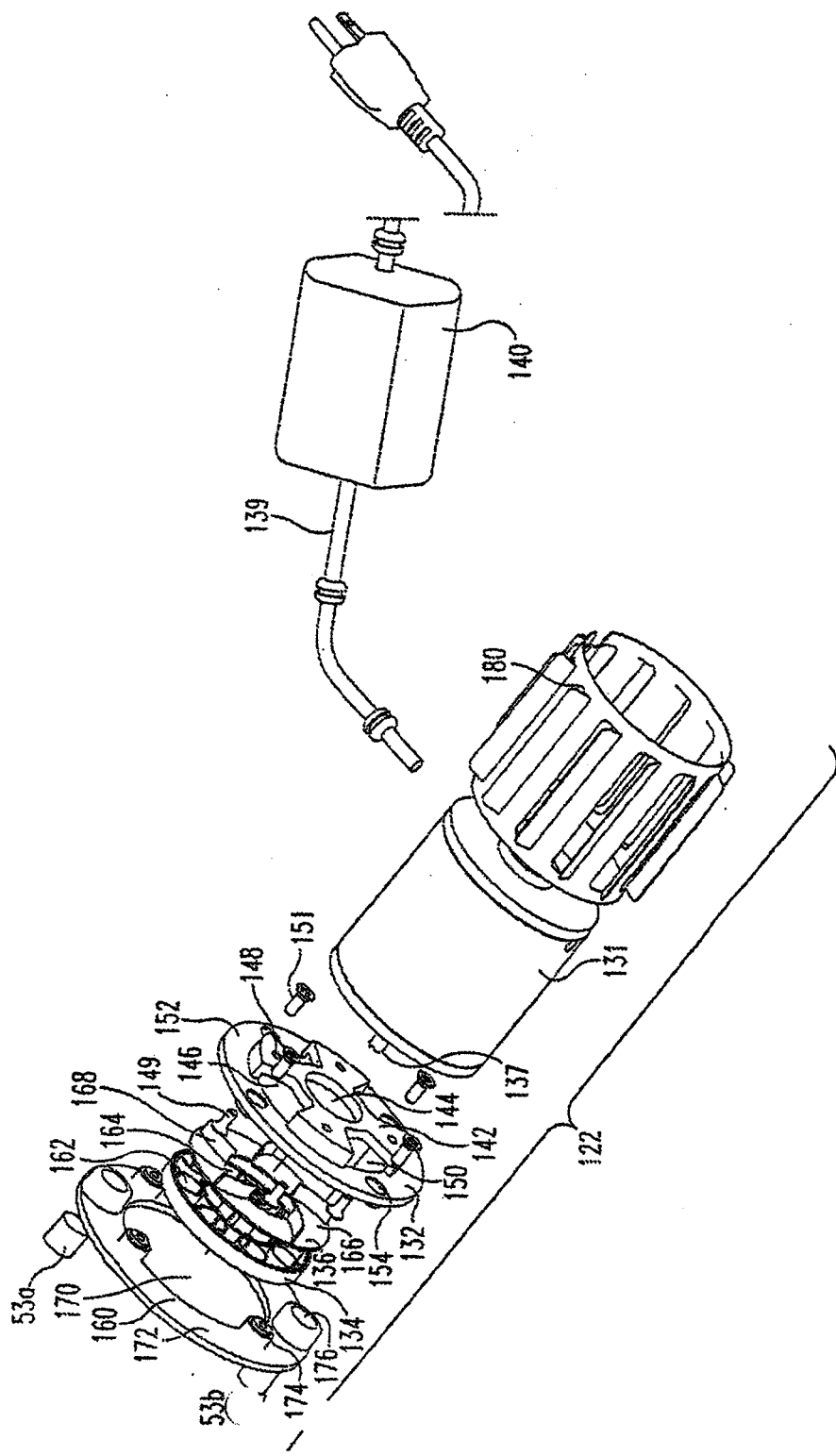


Fig. 8

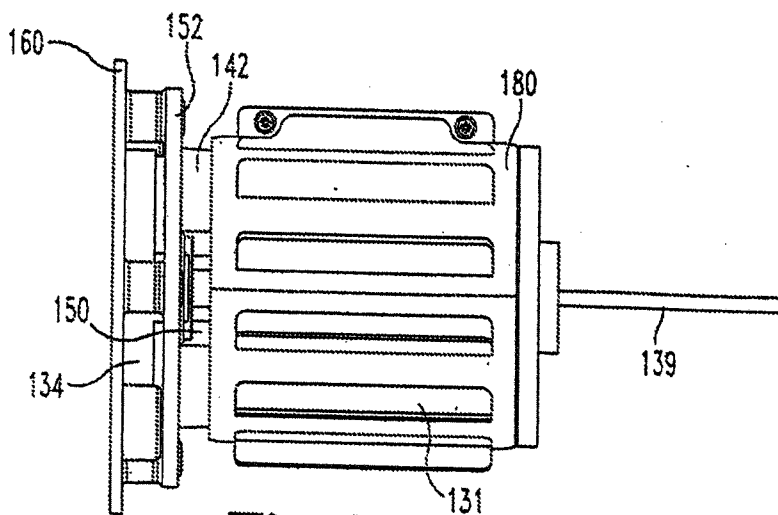


Fig. 9

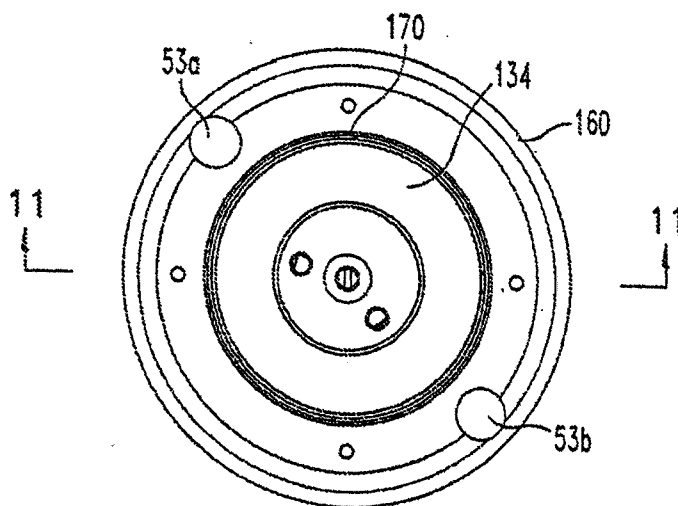


Fig. 10

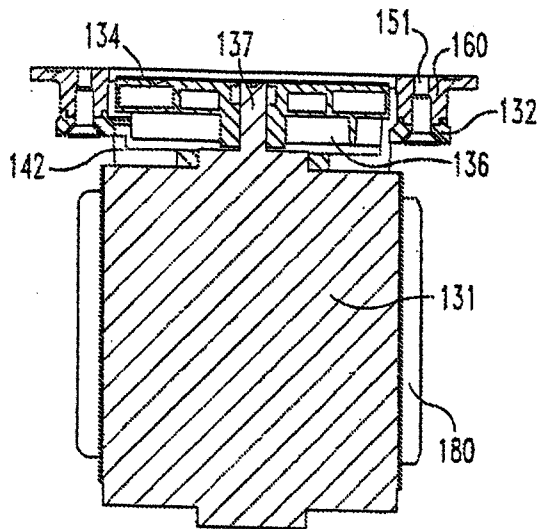


Fig. 11

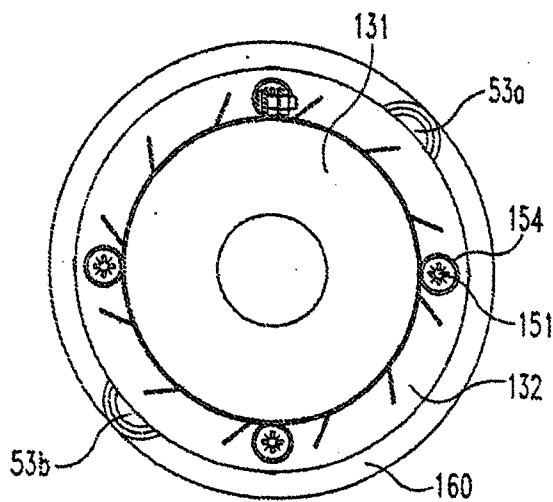


Fig. 12

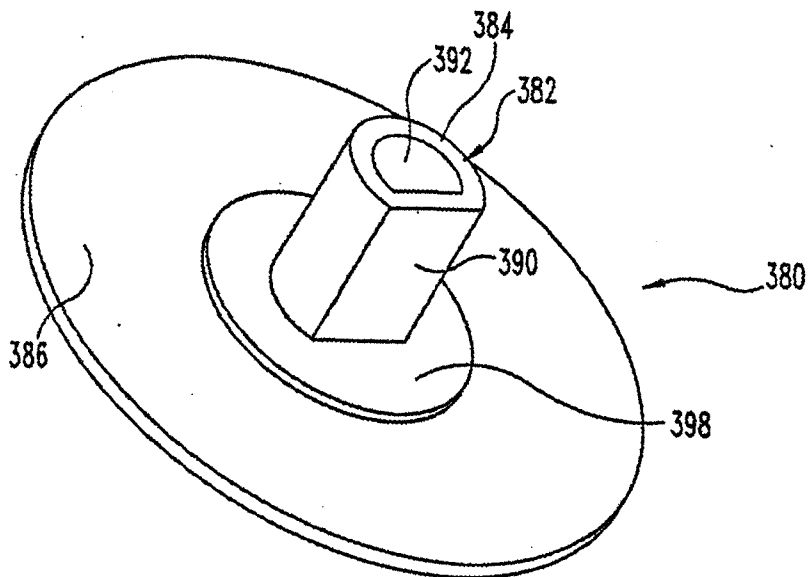


Fig. 13

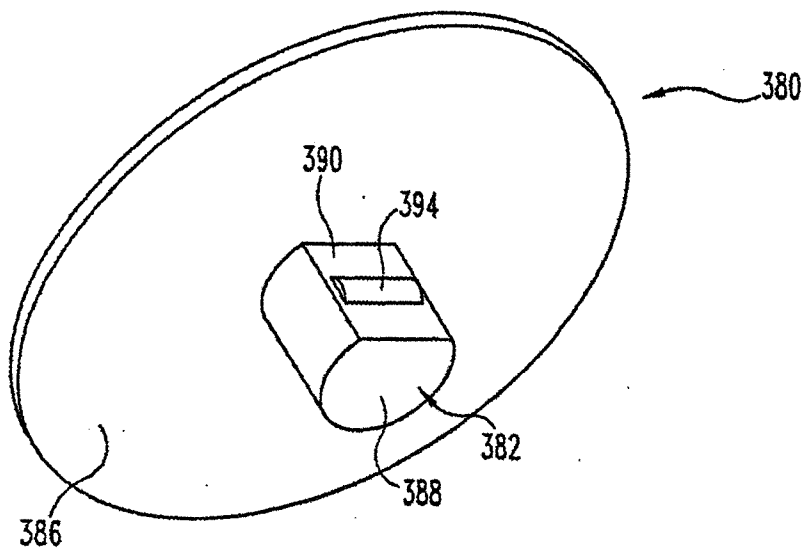


Fig. 14

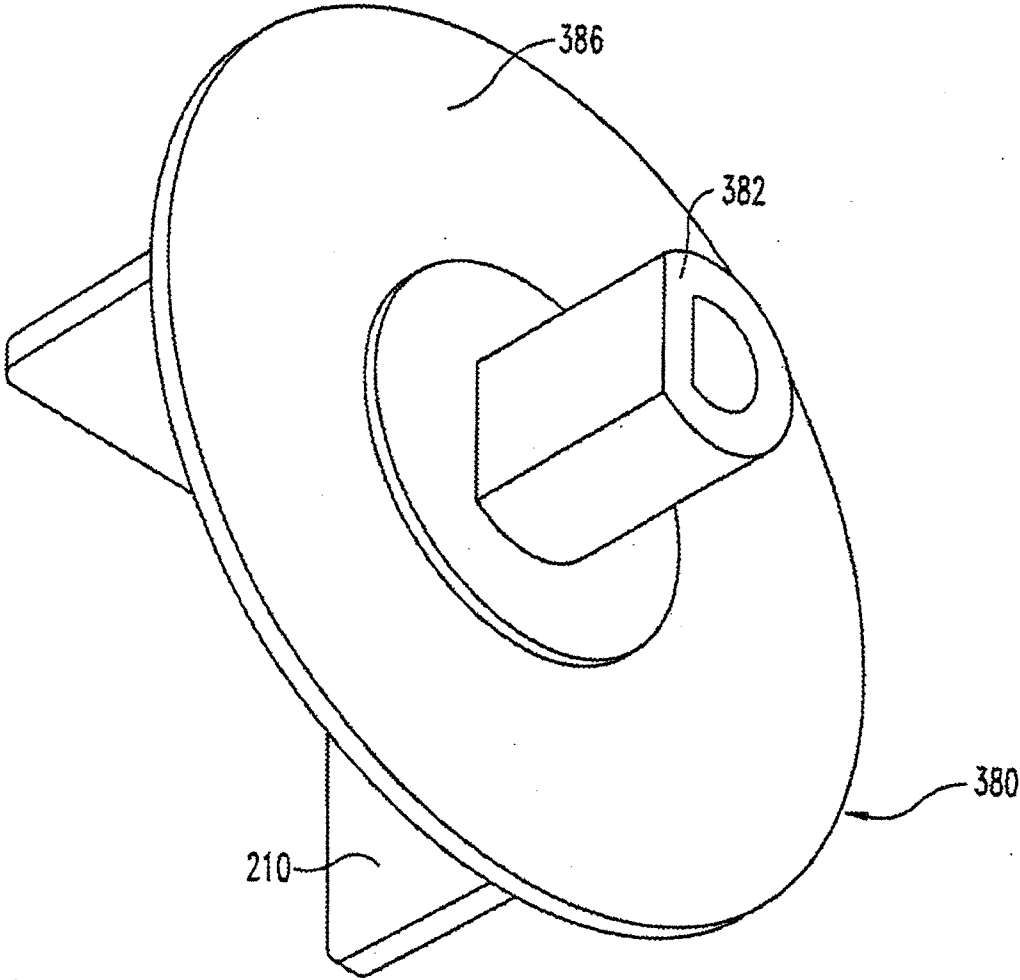


Fig. 15

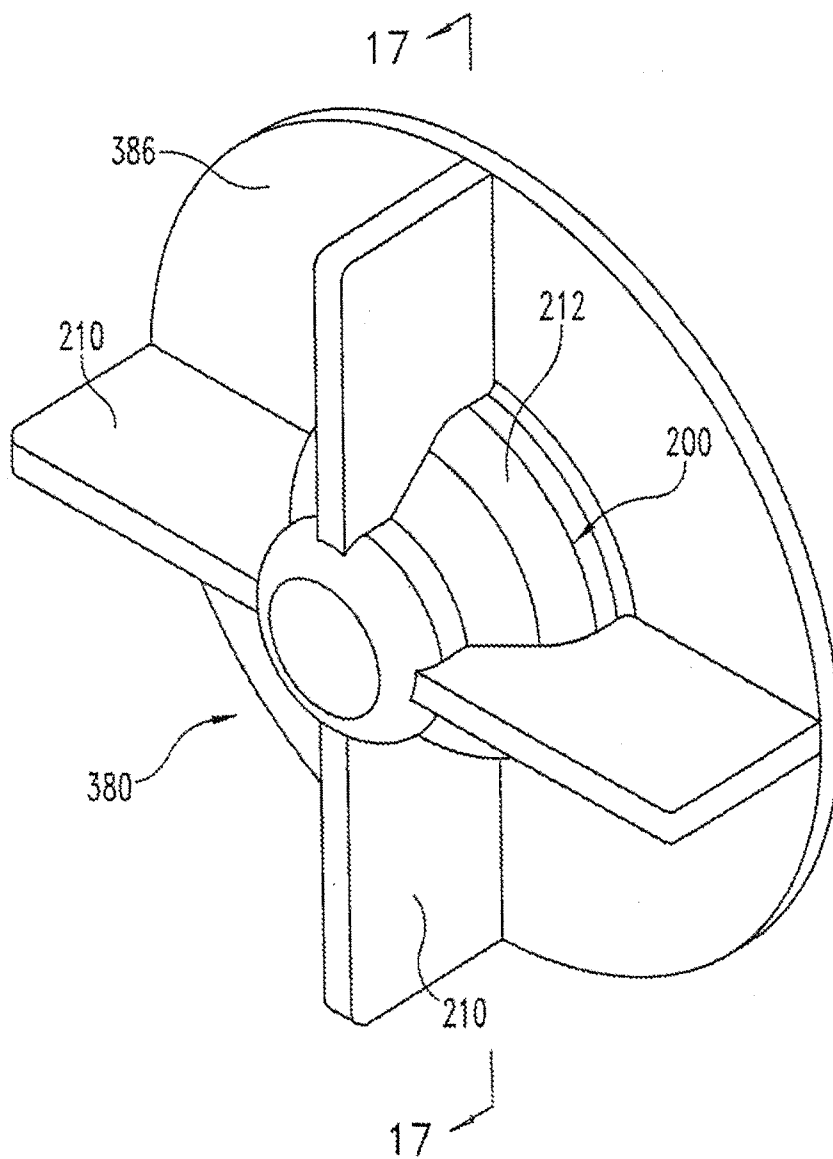


Fig. 16

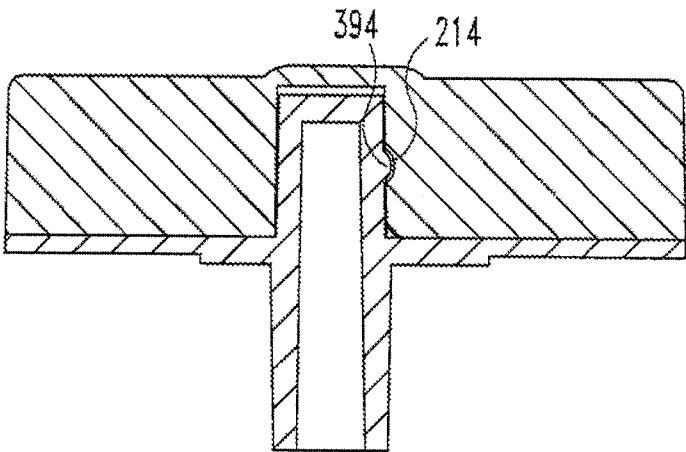


Fig. 17

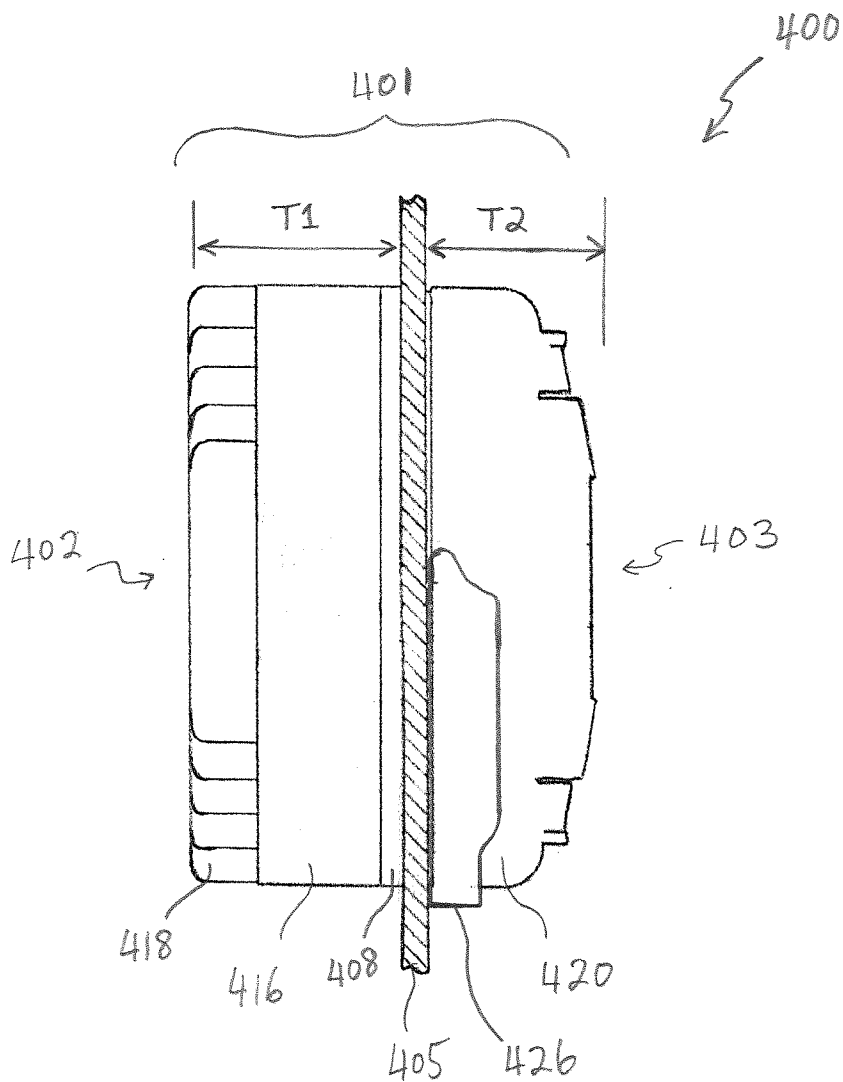


FIG. 18

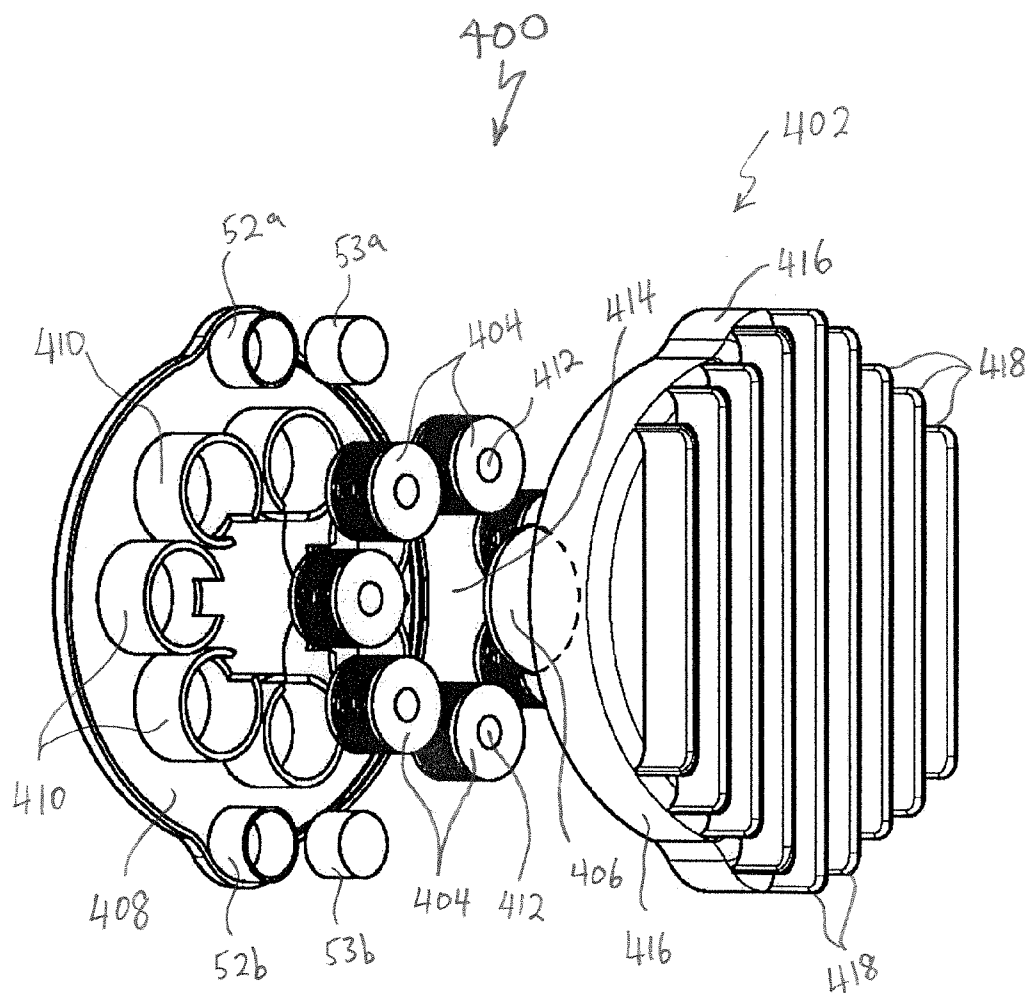


FIG. 19

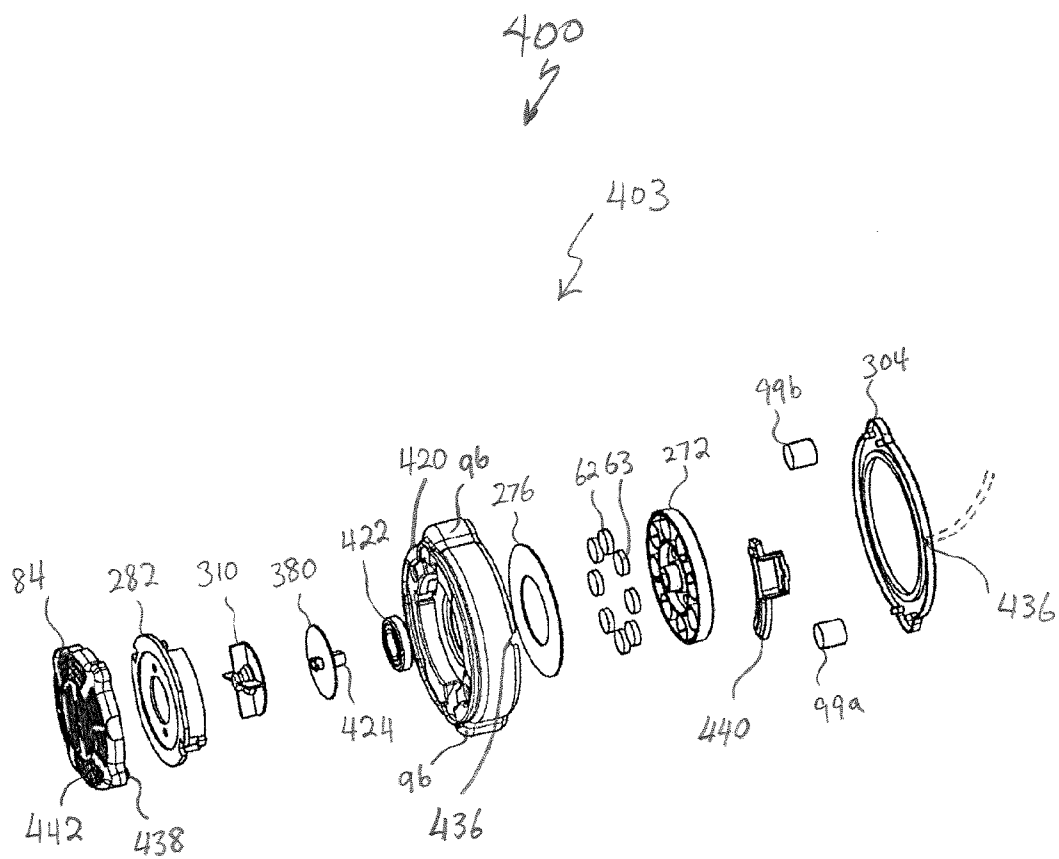


FIG. 20

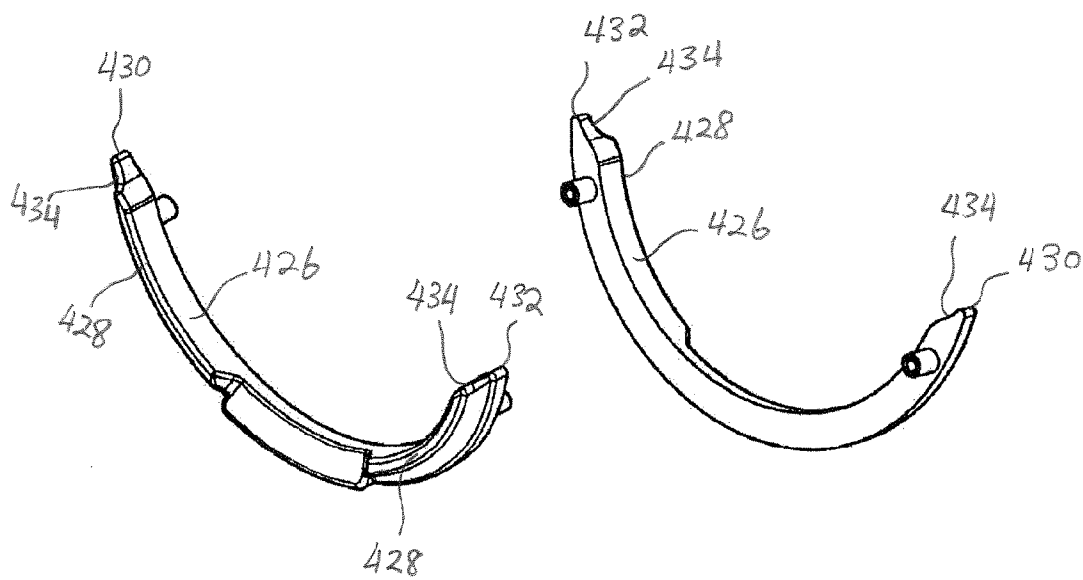


FIG. 21A

FIG. 21B

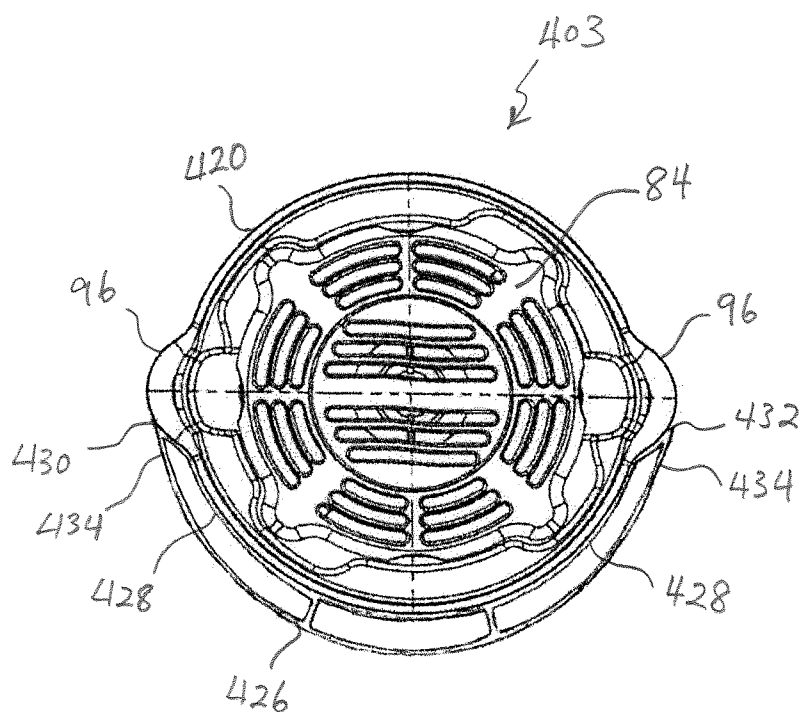


FIG. 22

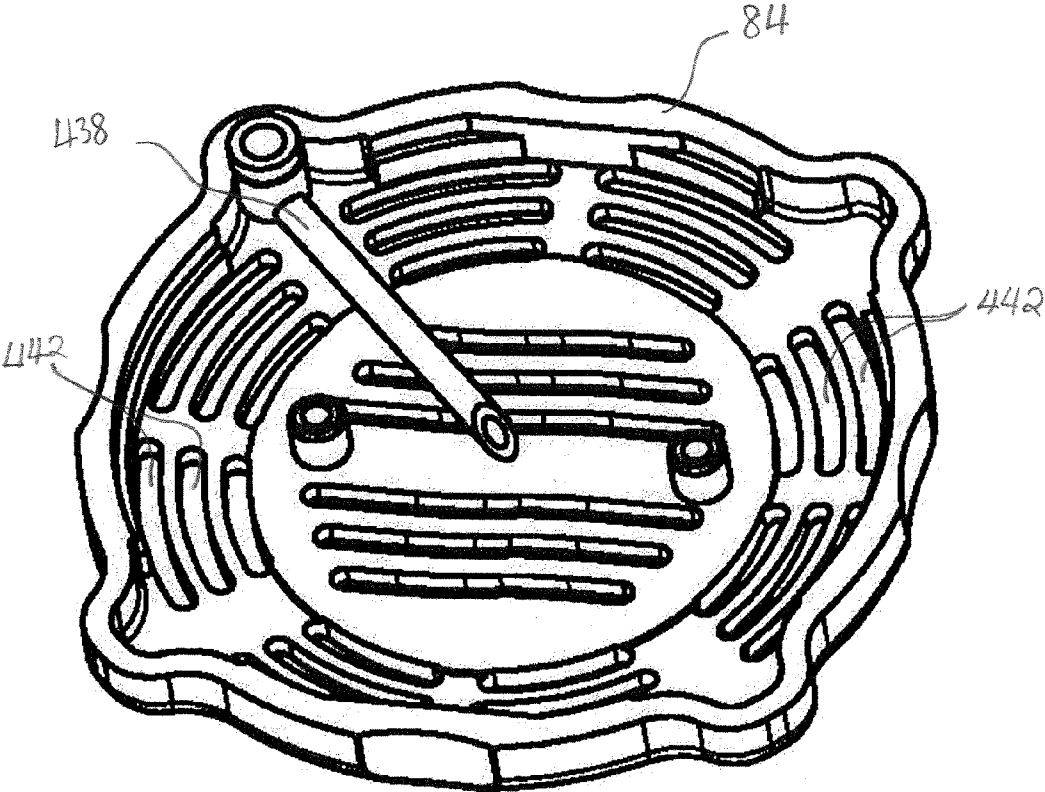


FIG. 23

LOW ENERGY MAGNETIC SPA CIRCULATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part of U.S. Non-provisional application Ser. No. 12/838,664 filed Jul. 19, 2010, which claims the benefit of U.S. Provisional Application No. 61/226,413 filed Jul. 17, 2009, all of which are hereby incorporated by reference in its entirety.

BACKGROUND

[0002] The present disclosure concerns a pipeless fluid circulator for a pedicure spa, hydrotherapy system or other fluid container. The system relates to the field of fluid circulation, the elimination of bacteria growth within pipes and pump and the use of oriented magnetism for the improvement of performance and reduction of energy consumption.

[0003] Conventional pedicure spas, hot tubs and similar devices in which humans or animals soak or bathe generally utilize a central pump or motor, which is connected to several outlet jets that circulate the water in the tub around the user's body, e.g. feet in the case of a pedicure spa. Such circulation systems have the potential for significant health risk since water trapped in the pipes after the tub is drained has been proven to permit or promote the growth of bacteria, algae, fungus and mold. In dealing particularly with pedicure spas, users are very concerned about bacteria or other disease-causing agents that grow within the pipes and pumps and even in crevices or on surfaces of the spas. Consequently, pipes, pumps and inlets of spas or tubs may need periodic disassembly for cleaning, which in conventional systems is quite involved.

[0004] Conventional pumping systems for pedicure spas and hydrotherapy systems require one or more holes to be placed through the wall of the tub or other vessel to allow for fluid (e.g. water) circulation within. Each such hole has the potential for both leaking and creating small fissures where the growth of bacteria may harbor contagious diseases. A circulation system that eliminates holes through a tub or vessel would accordingly eliminate those possible contamination areas.

[0005] Fluid-circulation systems have been previously proposed for aquariums which incorporate a magnetic connection between a driving motor and a fluid impeller. These devices have frequently suffered from drawbacks in terms of energy consumption, effective connection through walls of the aquarium, and their considerable bulk.

SUMMARY

[0006] The present system is a fluid circulation system, which features a dividable motor having first and second motor assemblies. It is preferred that the first motor assembly is installed on a dry surface of a container wall, and the second motor assembly is installed on a wet surface of the container wall. Electromagnetic energy is transmitted from the first motor assembly, through the wall, to the second motor assembly, which causes rotation of an impeller. Unlike conventional motors, the present system requires non-moving parts in the first motor assembly, i.e., stationary coil members for generating magnetic fields. Thus, the two assemblies operate in combination to form one motor for rotating the impeller located in the second motor assembly to circulate the fluid.

[0007] Due to the absence of a conventional induction motor in the first motor assembly, the size and profile of the first motor assembly is greatly reduced. This feature facilitates an easy mounting of the present system in a confined area, such as in-between walls of a bath tub. Further, because there are no moving parts in the first motor assembly, there will be less vibration and rotating noise during operation.

[0008] Unlike the conventional motor generating an inward suction force during operation, there will be no drawing of dust or debris into the first motor assembly. Having fewer parts in the first motor assembly generates other benefits, such as lowering maintenance costs for the parts, carrying lighter weight, and reducing energy consumption. For example, the electrical power required to operate the present system is reduced from 125-150 Watts to less than 50 Watts with the preferred configuration. Additionally, a control unit having programmable software can control the rotational speed and power of the impeller by adjusting the electric current supplied to the coil members.

[0009] In use, the coil members in the first motor assembly become heated. Because the coil members are disposed in proximate contact with the container wall, the heat from the coil members is readily transferred to the fluid in the container. Optionally, an aluminum mounting plate that holds the first motor assembly can help dissipate the generated heat.

[0010] More specifically, the present system provides a powered pipeless circulation system for a container configured to hold a fluid. Included in the system is a first motor assembly having multiple coil members. Each coil member is electrically charged for generating a magnetic field. A first housing is configured for accommodating the first motor assembly, and is fixedly attached to a dry surface of a wall of the container. A second motor assembly has at least one impeller and an impeller magnet plate. A second housing is configured for rotatably accommodating the second motor assembly and being disposed on a wet surface of the wall opposite the first housing. The impeller magnet plate is aligned to magnetically engage with the coil members. In use, the second motor assembly is magnetically coupled to the first motor assembly, and thus the first and second motor assemblies form a motor for rotating the impeller. As a result, the container wall is sandwiched between the first and second motor assemblies.

[0011] In another embodiment, a powered pipeless circulation system is provided that includes first and second motor assemblies. Included in the system is a first motor assembly having multiple coil members. Each coil member is electrically charged for generating a magnetic field. A control unit associated with the second motor assembly controls the magnetic field based on an electric current flowing through the coil members. A first housing is configured for accommodating the first motor assembly, and fixedly attached to a dry surface of a wall of the container. A second motor assembly has at least one impeller and an impeller magnet plate. A second housing is configured for rotatably accommodating the second motor assembly and being disposed on a wet surface of the wall opposite the first housing. The impeller magnet plate is aligned to magnetically engage with the coil members. In use, the second motor assembly is magnetically coupled to the first motor assembly and thus the first and second motor assemblies form a motor for rotating the impeller. As a result, the container wall is sandwiched between the first and second motor assemblies.

[0012] In yet another embodiment, a powered pipeless circulation system is provided that includes first and second motor assemblies. Included in the system is a first motor assembly having multiple coil members. Each coil member is electrically charged for generating a magnetic field. A control unit controls the magnetic field based on an electric current flowing through the coil members. A first housing is configured for accommodating the first motor assembly, and fixedly attached to a dry surface of a wall of the container. A second motor assembly has at least one impeller and an impeller magnet plate. A second housing is configured for rotatably accommodating the second motor assembly and is disposed on a wet surface of the wall opposite the first housing. The impeller magnet plate is aligned to magnetically engage with the coil members. Multiple rotational magnets are spaced in a circular pattern on the impeller magnet plate in an alternating polarity order such that polarities of the rotational magnets are magnetically attracted to polarities of the coil members when the coil members are magnetically charged to cause rotation of the impeller magnet plate. In use, the second motor assembly is magnetically coupled to the first motor assembly and thus the first and second motor assemblies form a motor for rotating the impeller. As a result, the container wall is sandwiched between the first and second motor assemblies.

[0013] The present disclosure includes, among other things, a low energy pipeless magnetic circulation system for use in a variety of liquid containers, such as pedicure spas and hydrotherapy tubs. In particular embodiments, the system can include a motor assembly and an impeller assembly held together magnetically with a wall of a tub, vessel or other container between them. The motor assembly may include a motor connected to a housing, with a mounting bracket for stabilizing the housing against a tub, vessel or other container. The housing includes two fixed peripheral cylindrical neodymium magnets for holding the two assemblies together. Within the housing and connected to the motor is a transfer plate holding eight neodymium magnets. The magnets are oriented so that the polarity alternates from magnet to magnet. Electronic hardware and software may be provided that allows for the sequential start up and safe operation of the total unit, and may include circuitry and inputs (e.g. a keypad) for programming start and stop times, as well as a reed switch or Hall-effect device for interrupting the operating circuit (and thus the operation of the device) when the motor assembly and impeller assembly (or parts of them) are disconnected from each other.

[0014] The impeller assembly includes in certain particular embodiments a housing having two fixed peripheral cylindrical neodymium magnets that correspond with the fixed peripheral magnets in the motor assembly's housing. Within the impeller assembly housing is a plate holding eight cylindrical neodymium magnets. As with the motor assembly, the magnets in the impeller assembly's plate are arranged in alternating polarity, so that they are matched in attraction to the magnets of the motor assembly's plate. An impeller is provided within a thrust bearing having eight small glass balls in a circular ring divided with plastic spacers. An inner cap covers the impeller while allowing passages for water to enter toward the impeller and be driven away from the impeller, and an outer cap has passages to allow for drawing in fluid toward the impeller. A tube extending from the impeller assembly to a point above the liquid level in the tub is provided in certain embodiments for the drawing of air and its addition into the water stream for greater hydrotherapy action.

[0015] The motor in the motor assembly is connected directly to the magnet plate in particular embodiments, and so operation of the motor turns the magnet plate. The magnet plate in the impeller assembly is magnetically coupled through the vessel wall with the magnet plate in the motor assembly. This coupling results in the plate of the impeller assembly turning in conjunction with the plate of the motor assembly. The plate of the impeller assembly is directly connected to the impeller in particular embodiments, so that its motion is imparted to the impeller. The impeller pulls water in, from the tub/vessel, and exhausts it directly back into the tub/vessel.

[0016] The magnetic force of the magnets on the motor head assembly and the magnets on the impeller assembly housing, in addition to holding the two assemblies together through the wall of the tub, provide magnetic assistance to reduce the energy required to drive the system. The magnets in their respective plates, with their alternating polarities, allow the motor to drive the impeller assembly, and add to and complete the strong attraction between the two assemblies and secure them as an operating unit. They also provide a magnetic boost to the rotational motion through interaction with the mounting magnets, and thus reduce overall energy consumption.

[0017] The system is designed so that when the impeller assembly is removed from the inside of the tub/vessel the motor assembly, located on the exterior wall of the unit will automatically shut down. As previously indicated, a reed switch, Hall-effect device, or other hardware can be incorporated to interrupt the operating circuit(s) when the impeller assembly, or part of it, is removed from the inside of the tub.

[0018] The growth of bacteria within the pipes has led to this new system which eliminates the piping and replaces the jet with a removable impeller assembly that can be easily cleaned and disinfected by removing it from the spa or hydrotherapy system and submersing in an appropriate cleaning/disinfecting solution. Cleanliness and safety of the system are enhanced since there are no areas of standing water to collect bacteria or other agents between uses. In addition, the design eliminates apertures on the pedicure spa or tub by instead using magnetic force to couple the motor assembly to the impeller assembly. The system not only eliminates the potential for any leakage from the pedicure spa or hydrotherapy system but it also provides a smooth unencumbered acrylic surface for ease of cleaning and sanitation.

[0019] By alternating the north and south poles of the magnets in the magnet plates and placing them at a 45 degree angle to each other around the circumference of the magnet plate, an improvement in the performance of the motor and reduced energy consumption have been observed. The strength of the magnets in the magnet plate compared to the strength and location of the magnets on the periphery of the mounting plate and the impeller assembly have been found to provide the low energy performance of the assembled unit.

[0020] The circulation system can be positioned anywhere on the tub/vessel wall, based upon the interior characteristics of the tub in order to achieve optimized water flow for massage therapy. The system circulates water inside the tub or vessel and, in the case of a pedicure spa, around the user's feet. The design also allows air suction into the impeller assembly. This air is then blended into the water stream to aid in hydrotherapy. The aeration of water also reduces bacteria and algae growth by adding oxygen into the water. The whole assembly is small in size so that it can fit into tight spaces of

the existing tubs, and can easily be retrofitted. In addition, the motor automatically shuts down when the cap is removed for cleaning, making the whole system safe. In some embodiments, a set of two or more impeller assemblies can be included in a kit with a motor assembly, so that when one impeller assembly is removed for cleaning, a second is attached to the motor assembly so that the pedicure spa or other device can continue in use during cleaning of the original impeller assembly.

[0021] In addition to the ease of removal of the impeller assembly, the motor unit can be easily removable for servicing. Since there are no holes required through the device wall, the unit is easily removed for maintenance should it be necessary.

[0022] The use of multi-directional magnets placed in strategic orientation within the coupling assemblies allows for the impeller assembly to have an ultra low profile. Such a profile satisfies aesthetic needs of the spa industry and allows it to fit into existing tubs and pedicure spas as original or retrofitted equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a cross-sectional view of the motor assembly, the wall and impeller assembly.

[0024] FIG. 2 is an exploded view of impeller and motor assemblies.

[0025] FIG. 3 is front view of the impeller assembly cap.

[0026] FIG. 4 is a front view of the magnetic drive plate showing the alternating polarity of the magnets.

[0027] FIG. 5 is an exploded view of another embodiment of impeller and motor assemblies.

[0028] FIG. 6 is a front view of the FIG. 5 impeller assembly and the magnet plate and cover of the FIG. 5 motor assembly.

[0029] FIG. 7A is a cross-sectional view of the FIG. 6 embodiment.

[0030] FIG. 7B is another cross-sectional view of the FIG. 6 embodiment.

[0031] FIG. 8 is an exploded view of the FIG. 5 motor assembly.

[0032] FIG. 9 is a side view of the FIG. 8 embodiment assembled.

[0033] FIG. 10 is a front end view of the FIG. 9 embodiment.

[0034] FIG. 11 is a cross-sectional view of the FIG. 10 embodiment.

[0035] FIG. 12 is an end view of the FIG. 8 embodiment.

[0036] FIG. 13 is a front perspective view of the FIG. 5 impeller.

[0037] FIG. 14 is a rear perspective view of the FIG. 13 embodiment.

[0038] FIG. 15 is a front perspective view of the FIG. 14 embodiment with one or more blades assembled therewith.

[0039] FIG. 16 is a rear perspective view of the FIG. 15 embodiment.

[0040] FIG. 17 is a cross-sectional view the FIG. 16 embodiment.

[0041] FIG. 18 is a side view of another embodiment of the motor assembly and impeller assembly, showing the wall in a cross-sectional view.

[0042] FIG. 19 is an exploded view of the FIG. 18 motor assembly.

[0043] FIG. 20 is an exploded view of the FIG. 18 impeller assembly.

[0044] FIG. 21A is a front perspective view of a locating bracket.

[0045] FIG. 21B is a rear perspective view of the FIG. 21A locating bracket.

[0046] FIG. 22 is a front view of the FIG. 18 impeller assembly and the FIG. 21A locating bracket.

[0047] FIG. 23 is a rear perspective view of the impeller assembly cap with an air hose.

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

[0048] For the purposes of promoting an understanding of the principles of the disclosure, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the claims is thereby intended, and alterations and modifications in the illustrated device, and further applications of the principles of the disclosure as illustrated therein are herein contemplated as would normally occur to one skilled in the art to which the disclosure relates.

[0049] In the following description, certain terms are used for convenience only and is not limiting. The words such as “inner”, “outer”, “inside”, “outside” and “between” describe parts in the diagrams to which reference is made. Furthermore, the words “a” means that there is “at least one” object or part in the assemblies.

[0050] FIG. 1 illustrates a cross-sectional view of a circulation system 20 attached to a wall of a tub or other vessel. FIG. 2 is an exploded view of circulation system 20. In the illustrated embodiment, circulation system 20 includes a motor assembly 22 and an impeller motor assembly 24 which are aligned with each other through wall 28 of a tub or vessel. The motor assembly 22 includes a motor 31, a motor mounting or housing 32, and a first magnet plate 34 along with a backing plate 36 and a first washer 38. The motor 31 is a small DC motor in a particular embodiment, having a drive shaft 37 and is powered by an electric source (e.g. rechargeable battery or wall current) through electric wire 39.

[0051] The mounting 32 is a cover or housing for magnet plate 34, and so includes an internal space 42 for plate 34, backing plate 36 and washer 38. An opening 44 in the rearward surface 46 of the mounting 32 allows at least a part of the motor 31 to be inserted into the mounting 32. In the illustrated embodiment, the mounting 32 has two holes 48 on either side of opening 44 for dowels, bolts or other connecting members to make a secure connection between motor 31 and mounting 32. The mounting 32 also includes at least one gap or slot 50 (two open slots are shown in the illustrated embodiment) for accommodating a bracket (not shown) for stabilizing motor assembly 22 against wall 28. Mounting receptacles or openings 52a and 52b, which in the illustrated embodiment are cylindrical with a central axis parallel to the central axis of mounting 32, are also in the peripheral wall of the mounting 32. Two mounting magnets 53a and 53b are provided, each inserted in a respective mounting receptacles or openings 52a, 52b. The mounting magnets 53a, 53b are neodymium magnets in a particular embodiment that are 1/2 inch in diameter and 1/4 inch in length. The mounting magnets 53a, 53b are held within mounting receptacles or openings 52a, 52b by magnetic attraction to mounting 32, by interference fit, and/or by adhesives. The mounting magnets 53a, 53b are set with opposite polarity, that is, if the mounting magnet 53a has a north pole facing out from mounting 32, then the mounting

magnet **53b** has a south pole facing out from mounting **32**. The magnets **53a**, **53b** hold motor assembly **22** against wall **28** with the impeller assembly **24** as illustrated in FIG. 1, as will be discussed further below.

[0052] Plate **34** in the illustrated embodiment is a circular disc having a central opening **60** for direct connection with the motor **31**. A set of eight equiangularly spaced rotational magnets **62**, **63** (preferably also of neodymium) are positioned in a circular pattern at or near the periphery of the disc. Rotational magnets **62**, **63** are attached to the plate **34** by magnetic force, adhesives, or other ways of holding rotational magnets **62**, **63** in place in the plate **34**. In particular embodiments, plate **34** may be fashioned with indentations or receptacles in which rotational magnets **62**, **63** are placed, and may use an interference fit along with or instead of the holding methods noted above.

[0053] In a particular embodiment, each of rotational magnets **62**, **63** is in the form of a cylinder $\frac{3}{8}$ inch in diameter and $\frac{3}{8}$ inch in length, and neodymium magnets were chosen for their small volume and high magnetic force. Rotational magnets **62**, **63** have polarities facing outward (i.e. as seen in FIG. 4) that alternate. For example, rotational magnets **62** have a North pole facing outward from plate **34**, while rotational magnets **63** have a South pole facing outward from plate **34**. As seen in FIG. 4, no neighboring magnets have the same polarity. With eight magnets equiangularly spaced as in the illustrated embodiment, the center of each rotational magnet **62**, **63** is 45 degrees apart from the centers of its neighboring magnets. The magnetic poles (whether north faces outward or south) are parallel to the drive shaft **37** of the motor **31**, and thus perpendicular to the direction of rotation of the drive shaft **37** and the plate **34**. As noted above, the plate **34** is operatively associated with the motor **31** (e.g. directly connected to drive shaft **37**), rotating about an axis with a drive shaft.

[0054] Washer **38** is made of steel in a particular embodiment with a thickness of $\frac{3}{8}$ inch. The washer **38** functions as a magnetic force multiplier, as the flux lines from the magnetic fields between the motor and impeller assemblies are concentrated through the steel. Thus, the washer **38** increases the coupling efficiency of circulation system **20**, so that a very low profile of circulation system **20** can be maintained, aiding retrofitting of tubs and minimizing the space needed to use them. It will be understood that other ferromagnetic substances could be used for the washer **38**. The backing plate **36** lies atop the washer **38** and either atop or within the periphery of plate **34**. In particular embodiments, the washer **38** and the backing plate **36** are fixedly attached to the plate **34** (either individually or as a group) so that the washer **38** and the rotational magnets **62**, **63** remain in their designated locations with respect to the plate **34**.

[0055] With backing plate **36**, washer **38**, and rotational magnets **62**, **63** attached to plate **34** as indicated, plate **34** is inserted into the internal space **42** of the mounting **32**. Motor **31** is inserted into opening **44** of mounting **32**, with drive shaft **37** being inserted into central opening **30** of plate **34**. In the illustrated embodiment, the drive shaft **37** is fixedly attached to the plate **34** via mechanical, adhesive or other methods so that rotation of the drive shaft **37** is transmitted directly to the plate **34**. Plate **34** maintains a clearance from the sides of mounting **32** in internal space **42** and its surface facing out from internal space **42** is below the level of the peripheral edge of the mounting **32** around it, to prevent rubbing friction when the plate **34** rotates.

[0056] The illustrated embodiment of the impeller assembly **24** includes a mounting or housing **70**, a second magnet plate **72**, a second washer **74**, a second backing or base plate **76**, a thrust bearing **78**, an impeller **80**, an inner cap **82** and a front cover **84**. Generally, the plate **72** with its washer **74** and backing plate **76** are within one side of the housing **70**, and the impeller **80**, the inner cap **82** and the cover **84** are in or on the other side of housing **70**.

[0057] Included in the housing **70** is an internal space **90**, with a magnet plate chamber or area **90a** on one side for the plate **72**, the washer **74** and the backing plate **76**, and a part **90b** on the other side, separated by a wall **92** with an opening **94**. In the illustrated embodiment, the housing **70** has a generally circular exterior edge with two bulges or ears **96**. Each bulge **96** has a respective mounting receptacles or openings **98a**, **98b**, which in the illustrated embodiment are cylindrical with a central axis parallel to the central axis of housing **70**. Two mounting magnets **99a**, **99b** are provided, each inserted in respective mounting receptacles or openings **98a**, **98b**. Mounting magnets **99a**, **99b** are substantially identical to mounting magnets **53a**, **53b** in a particular embodiment, and are held within mounting receptacles or openings **98a**, **98b** by magnetic attraction to mounting **70**, by interference fit, mechanical holder and/or by adhesives. As with mounting magnets **53a**, **53b**, mounting magnets **99a**, **99b** are positioned with opposite polarities, so that they hold the motor assembly **22** against the wall **28** with the impeller assembly **24**. Thus, if mounting magnet **53a** has a North pole facing to the right as seen in FIG. 1, then mounting magnet **53b** will have a South pole facing to the right. Magnet **99a** will have a South pole and mounting magnet **99b** will have a North pole each facing to the left as seen in FIG. 1, so that mounting magnets **99a** and **53a** attract and mounting magnets **99b** and **53b** attract. Housing **70** also includes two side channels **100** for allowing the passage of fluid out of impeller assembly **24**, as will be discussed further below.

[0058] Plate **72**, the washer **74**, and the backing plate **76** are identical to the plate **34**, the washer **38** and the backing plate **36** described above, in the illustrated embodiment. A set of eight rotational magnets **62**, **63** are placed in plate **72** around a central opening **60**, just as discussed previously. On the outside of plate **72**, an external cover or seal **104** is placed, which abuts wall **28** of a tub or vessel in use and inhibits or prevents water or other fluid from entering plate **72**.

[0059] Thrust bearing **78** is positioned within or adjacent to the opening **94** through the housing **70**, and supports impeller **80** and/or plate **72**. Bearing **78** features glass balls (eight glass balls, in one embodiment) sufficient to tolerate the axial load applied to the shaft, so as to minimize the friction of rotation. The glass balls are placed in a circular ring divided with plastic spacers. Thrust bearing **78** is made from glass and plastic to eliminate observed problems of metallic parts, such as rusting or decomposition in a water (particularly salt-water) environment and interference with the magnetic fields of the magnets discussed above.

[0060] Impeller **80** includes a stern **106** extending from one side of a base **108** and one or more blades **110** on the other side of base **108**. Stern **106** is generally perpendicular to base **108** and connects to opening **60** in plate **72** through thrust bearing **78**. Stern **106** thus is along the axis of rotation of plate **72** and impeller **80**. Blades **110** generally extend radially outward from the axis of rotation, and are configured to draw fluid in through the inner cap **82** and the cover **84** and force it outward

through channels 100. Impeller 80 also provides suction for drawing air into housing 70, as will be discussed below.

[0061] Inner cap 82 fits generally over and around the impeller 80 within housing 70. Inner cap 82 remains stationary as the impeller 80 rotates. Also, inner cap 82 has a central opening 112 and one or more side openings 114. Fluid is generally drawn into the housing 70 through the opening 112 and is pushed by the impeller 80 through side openings 114 into channels 100 of housing 70. Cover 84 contains one or more inlet ports 116 as seen in FIG. 3. Ports 116 may be straight, wavy, circular or other design that is aesthetically pleasing and allowing sufficient water throughput. Fluid flows through ports 116 toward impeller 80 and is then pushed to the periphery of impeller 80, channeled through the cavity in the housing 70 toward the channels 100 where it exits with sufficient pressure to form the water jets.

[0062] As indicated above, plate 72, washer 74 and backing plate 76 are assembled as discussed with respect to plate 34, washer 38 and backing plate 36. Next, the cover or seal 104 covers the surface of plate 72 opposite from backing plate 76. Plate 72 is placed in magnet plate chamber or area 90a of housing 70 and joined to stem 106 of impeller 80 through thrust bearing 78. Thrust bearing 78 is preferably fixed within the opening 94 of the housing 70. Inner cap 82 and cover 84 are attached over the impeller 80 to each other and/or to housing 70.

[0063] In use, the motor assembly 22 assembled as noted above is placed against the wall 28 of a tub or vessel on the outside of the tub or vessel, and impeller assembly 24 is placed against wall 28 on the inside of the tub or vessel. Mounting magnets 53a, 53b and 99a, 99b attract each other to hold motor assembly 22 and impeller assembly 24 together with wall 28 sandwiched between. In an appropriate assembled condition, the axis of rotation of plate 34 and plate 72 are aligned. If used, a bracket (e.g. an L-shaped bracket) glued or otherwise attached to mounting 32 via one or both of slots 50 is attached to the outside of wall 28 to brace motor assembly 22. When the motor assembly 22 and the impeller assembly 24 are magnetically held together by mounting magnets 53a, 53b and 99a, 99b, the magnet plates 34 and 72 orient themselves so that their respective rotational magnets 62, 63 attract each other, adding to the hold of the assemblies to each other. When electrical power is provided to motor 31, drive shaft 37 begins to turn plate 34. Because of the magnetic attraction between the respective rotational magnets 62, 63 or plates 34 and 72, plate 72 begins to turn as well. Plate 72 turns impeller 80 drawing water in through the cover 84 and the inner cap 82 and forcing it out through the channels 100.

[0064] As noted above, electronic hardware and software may be provided to control circulation system 20. For example, a reed switch or Hall-effect device may be connected into the operating circuitry providing power to the motor 31. As long as mounting magnets 53a, 53b and 99a, 99b are attracting each other to keep assemblies 22 and 24 together, such a reed switch or Hall-effect device maintains the circuit closed, and if motor 31 is activated, circulation system 20 can run. However, when assemblies 22 and 24 are separated, as when impeller assembly 24 is removed for cleaning, the reed switch or Hall-effect device opens or otherwise disrupts the operating circuit, preventing further operation of circulation system 20 until an impeller assembly 24 is reattached. As another example, circuitry and software, including a keypad in one embodiment, can be connected to motor 31 so as to be able to program motor 31 to turn on or off

at a certain time, or to increase or decrease revolutions of motor 31, plates 34 and 72, and impeller 80.

[0065] Circulation system 20 is able to operate at very low power as a result of the interaction between the “peripheral” magnets (mounting magnets 53a, 53b and 99a, 99b) and the “plate” magnets (rotational magnets 62, 63 of plates 34 and 72). While electrical power is needed to start plates 34 and 72 rotating and to maintain that rotation, the placement, size and orientation of the peripheral and plate magnets provide a rotational boost that keeps that power usage very low. Consider a pair of plate magnets, for example a magnet 62 on plate 34 that faces and attracts a rotational magnet 63 on plate 72. It has been found through experiment that as that pair of plate magnets or magnetic coupling approaches one of the sets of peripheral magnets (e.g. mounting magnets 53b and 99b) the pair of plate magnets is pulled toward that set of peripheral magnets, adding or maintaining speed of the plates 34 and 72 and relieving burden on the motor 31. On the other side of the system, as that pair of plate magnets passes the other set of peripheral magnets (mounting magnets 53a and 99a), the repulsion force adds or maintains speed. It has been found experimentally that the alternating polarity of the rotational magnets 62, 63 in the plates 34, 72, along with the strength and positioning of mounting magnets 53a, 53b and 99a, 99b with respect to rotational magnets 62, 63 is what provides such magnetic boost, and that in this way the operation of circulation system 20 can be maintained with about 0.1 horsepower or less in electrical power. It has been found experimentally that straight magnetic rings do not provide such boost, and other relative positions and strengths do not operate as well as the disclosed embodiments above.

[0066] A further feature that can be included with circulation system 20 is for aeration of the fluid in the tub or vessel. To that end, the housing 70 can be prepared with an opening for an air drawing tube or snorkel 120 that extends from a point adjacent impeller 80 to a point above the level of the fluid in the tub or vessel. When the impeller 80 turns and forces water out of housing 70 via channels 100, a lower pressure is created in the lower end of tube 120, so that air is drawn through air drawing tube 120. Air is thus added to the fluid being exhausted through channels 100, with the benefits of such aeration being realized by the user of circulation system 20.

[0067] It will be understood that a variety of tubs or vessels can use one or more circulation systems 20 at a time. A larger vessel (e.g. a hot tub) may use a number of circulation systems 20 in various locations around the vessel.

[0068] Another embodiment of a circulation system 220 is illustrated in FIG. 5 in an exploded view. In the illustrated embodiment, the system 220 includes a motor assembly 122 and an impeller assembly 224 which are aligned with each other through a wall of a tub or vessel. FIGS. 6 and 7 illustrate cross-sectional views of the circulation system 220.

[0069] Motor assembly 122 is illustrated in FIG. 8 in an exploded view and as assembled in FIGS. 9, 10, 11, and 12. Motor assembly 122 is similar to motor assembly 22. The motor assembly 122 includes a motor 131, a motor mounting or housing 132, a first magnet plate 134, and a backing plate 136. The motor 131 is a small DC motor in a particular embodiment, having a drive shaft 137 and is powered by an electric source (e.g. rechargeable battery or wall current) through an electric wire 139. In some embodiments, the wire 139 includes a circuit box 140. In some forms, one or more mounting grommets are positioned around electric wire 139.

In the illustrated embodiment, motor assembly 122 includes a heat dissipater 180 with fins which encircles motor 131.

[0070] Mounting 132 forms a housing for the first magnet plate 134, and includes an internal space 146 for backing plate 136 and magnet plate 134. An opening 144 in the rearward surface 142 of mounting 132 allows at least a part of motor 131 to be inserted into mounting 132. In the illustrated embodiment, mounting 132 has a plurality of holes 154 that are each sized to receive a screw or other fastener 151 to attach the mounting 132 to an outer ring 160 as described in more detail below. The rearward surface 142 of mounting 132 includes a plurality of holes 148 sized to receive a screw, bolt, dowels, or other connector 149 to make a secure connection between the motor 131 and the mounting 132. The rearward surface 142 of mounting 132 also defines a plurality of openings 150 that allows dissipation of heat produced by motor 131.

[0071] Mounting 132 includes a rim 152 that is sized to rest against and partially cover a pair of magnet receptacles or indentations in outer ring 160 when mounting 132 is assembled with the outer ring 160.

[0072] Magnet plate 134 is similar to plate 34 discussed previously. Similarly to plate 34, a set of eight equiangularly spaced magnets (not illustrated) (preferably of neodymium) are positioned in a circular pattern at or near the periphery of magnet plate 134. In the illustrated embodiment, magnet plate 134 includes a plurality of indentations or receptacles 162 that are positioned in a circular pattern and each of receptacles 162 is sized to receive one of the eight magnets.

[0073] Backing plate 136 is a disc shape with a central opening 164 that is sized to allow drive shaft 137 of motor 131 to connect to magnet plate 134. Backing plate 136 includes a rim 166 having a plurality of blades 168. Rim 166 is sized to cover the set of eight equiangularly spaced rotational magnets 62, 63 positioned in indentations or receptacles 162 of magnet plate 134. Arcuate blades 168 extend radially outward from the central opening 164. Each of blades 168 has a depth that is similar to the depth of depression or recess 146 of the mounting 132.

[0074] Outer ring 160 is a disc shape with a central opening 170 that is sized to receive the outer diameter of the magnet plate 134. Outer ring 160 includes a rim 172 having a plurality of projections 174 wherein each of projections 174 is configured to receive a fastener 151 to attach the mounting 132 to the outer ring 160 and to assemble the magnet plate 134 and backing plate 136 there between. Rim 172 includes a plurality of projections 174 that corresponds with the plurality of holes 154 on mounting plate 132. Rim 172 also includes a pair of openings 176 that are sized to receive mounting magnets 53a, 53b. When the outer ring 160 is assembled with magnet plate 134, rim 152 is held against and partially covers the openings 176 to prevent the mounting magnets 53a, 53b from falling out of the openings 176.

[0075] Impeller assembly 224 (see FIGS. 5-7) includes a mounting or housing 270, a second magnet plate 272, a second backing or base plate 276, an impeller 380, an impeller top 310, an inner cap 282, and a front cover 284. Generally, magnet plate 272 with its second backing plate 276 are on one side of housing 270, and impeller 380, impeller top 310, inner cap 282, and front cover 284 are on the other side of housing 270.

[0076] Housing 270 is substantially identical to housing 70. Two mounting magnets 99a, 99b are provided, each inserted into a respective one of openings 298a and 298b. Housing 270

also includes two side channels 300 for allowing passage of fluid out of the impeller assembly 224.

[0077] Plate 272 is similar to plate 72 as described above. However, plate 272 includes a central opening 260 for direct connection with the stem 382 of an impeller 380 as described in more detail below. Opening 260 in magnet plate 272 is sized and shaped to receive the stem 382 of impeller 380. In one form, opening 260 is non-circular cross-sectional shape. In the illustrated embodiment, opening 260 has a circular shape with a flat edge.

[0078] A set of eight rotational magnets 62, 63 are placed in plate 272 around the central opening 260. Second backing plate 276 is positioned between the plate 272 to cover rotational magnets 62, 63. Second backing plate 276 is the same as backing plate 76. The plate 272, the set of eight rotational magnets 62, 63, and the second backing plate 276 are positioned within an open area on the rear of housing 270. On the outside of housing 270, an external cover or seal 304 is placed to enclose magnet plate 272 with housing 270. The rear side of cover 304 is designed to closely abut a wall of a tub or vessel in use. Second backing plate 276 is similar to backing plate 76.

[0079] One embodiment of the impeller 380 is illustrated in FIGS. 13 and 14. Impeller 380 includes the stem 382 having a first portion 384 that extends rearward from one side of a base plate 386 and a second portion 388 that extends forward from the other side of the base plate 386. Stem 382 is generally perpendicular to base plate 386 and is along the axis of rotation of plate 272 and impeller 380. Stem 382 is cylindrically shaped with a substantially flat edge 390. Stem 382 further defines an opening 392 that tapers by about 2° from a first portion 384 to a second portion 388. First portion 384 is sized and shaped to be received in and to connect with the opening 260 in plate 272. In one embodiment, the stem 382 has a length of about 18 millimeters and first portion 384 has a diameter of about 7.8 millimeters if the stem 382 were circular. However, the flat edge 390 reduces the outside width of the first portion 384 to about 7 millimeters and the width of the opening 392 to about 4 millimeters. The second portion 388 includes a protrusion 394. In the illustrated embodiment, protrusion 394 has a radius of about 1.2 millimeters and is located at about 4 millimeters from the base plate 386. In this embodiment, base plate 386 has a diameter of about 39 millimeters. The base plate 386 can include a circular lip 398 that extends around the first portion 384. The illustrated embodiment includes the circular lip 398 having a diameter of about 16.5 millimeters and a height of about 0.5 millimeters.

[0080] Illustrated in FIGS. 15, 16, and 17 is an impeller top 200 mounted on the forward side of impeller 380. Impeller top 200 includes one or more blades 210 extending from a hub 212. Blades 210 generally extend radially outward from the axis of rotation, and are configured to draw fluid in through inner cap 282 and front cover 284 and force it outward through channels 300 in housing 270. The rear of hub 212 includes a cylindrical opening with a flat portion (not illustrated) wherein the cylindrical opening and flat portion are sized to receive and mate with second portion 188 and flat edge 190. In the illustrated embodiment, the flat portion on the interior of cap 212 includes a groove 214 sized to receive protrusion 194 when impeller top 200 is mounted on second portion 188 of impeller 180. In one form, the protrusion 194 has a radius of about 0.048 millimeters and the groove 214 has a radius of about 0.049 millimeters. The nesting of protrusion 194 with groove 214 and the interaction of the flat portion in

the interior of cap 212 with the flat edge 190 assists in maintaining the impeller top 200 on impeller 180.

[0081] An alternate version of the impeller 380 and the impeller top 310 are illustrated in FIGS. 7a and 7b. Impeller 380 includes the stem 382 having the first portion 384 that extends from one side of a base plate 386 like impeller 180. However, impeller 380 includes a stem with a pair of tabs 388 that extend from the opposite side of base plate 386. Pair of tabs 388 are configured to resiliently slightly flex inward to facilitate insertion into impeller top 310.

[0082] Impeller top 310 is similar to impeller top 200. Impeller top 310 includes one or more blades 311 that extend from a hub 312. The interior of hub 312 includes a cylindrical opening 314 with a flat portion 316 wherein the cylindrical opening 314 and flat portion 316 are sized and configured to receive the pair of tabs 366. In one embodiment, the interior of hub 312 includes one or more grooves 320 that are sized to receive and retain the pair of tabs 388 when impeller top 310 is mounted on impeller 380. In alternate embodiments, the one or more grooves 320 include one or more groove portions or is a continuous groove.

[0083] As shown in FIGS. 6 and 7, the inner cap 282 fits generally over and around the impeller 180 and the impeller top 200 within housing 270. Inner cap 282 is similar to inner cap 82 as described above. Front cover 284 is similar to cover 84 and contains one or more inlet ports. Fluid is drawn inward through the central ports toward impeller top 200 and impeller 180 and is then pushed to the periphery of the impeller 180, channeled through the cavity in housing 270 towards channels where it exits with sufficient pressure to form the water jets.

[0084] The assembly of plate 272 and second backing plate 276 is located in area 290a within housing 270. Cover 304 encloses plate 272 within housing 270. Plate 272 is joined to stem 382 placing impeller 380 on the outer side of housing 270. Inner cap 282 and front cover 284 are attached over impeller top 310.

[0085] In use, motor assembly 122, assembled as noted above, is placed against a wall of a tub, vessel, or container on the outside (non-water side) of the tub or container, and impeller assembly 224 is placed against a wall on the inside of the tub or container. Mounting magnets 53a, 53b and mounting magnets 99a, 99b attract each other to align and hold the motor assembly 122 and impeller assembly 224 together with the wall sandwiched between. In assembled condition, the axis of rotation of plate 134 and plate 272 are aligned. When the motor assembly 122 and the impeller assembly 224 are magnetically held together by mounting magnets 53a, 53b and mounting magnets 99a, 99b, the plate 134 and the late 172 orient themselves so their respective alternating rotational magnets 62, 63 attract each other, adding to the hold of the assemblies to each other. When electrical power is provided to the motor 131, the shaft 137 begins to turn the plate 134. Because of the magnetic attraction between the respective rotational magnets 62, 63 or plates 134, 272, plate 272 begins to turn as well. Plate 272 turns impeller 380 and impeller top 310, drawing water in through front cover 284 and inner cap 282 and forcing it out through the channels 300 in housing 270.

[0086] Referring now to FIGS. 18-20, another embodiment of the circulation systems 20 and 220 is generally designated 400. Components shared with the circulation systems 20 and 220 are designated with identical reference numbers. A major difference featured in the system 400 is that the motor assembly

122 is replaced with another exemplary motor assembly 402 without the motor 131, and the impeller assembly 224 is similarly replaced with an exemplary impeller assembly 403 having additional parts. New features of the assemblies 402 and 403 are explained in greater detail below.

[0087] The circulation system 400 features a dividable motor 401 having two motor assemblies 402, 403. It is preferred that the motor assembly 402 is installed on a dry surface of a container wall 405 such as for a tub or vessel, including but not limited to, a pedicure tub, and the impeller assembly 403 is installed on a wet surface of the container wall 405. The impeller assembly 403 is magnetically coupled to the motor assembly 402 for forming the motor 401 configured for rotating the impeller 380. Accordingly, the wall 405 of the container is sandwiched between the motor assembly 402 and the impeller assembly 403.

[0088] A feature of the system 400 is that the motor assembly 402 has multiple coil members 404 (FIG. 19) instead of the magnet plate 134, eliminating the need for the motor 131 that rotates the magnet plate 134 (FIG. 5). Similarly to the plate 134, a set of seven angularly spaced coil members 404 are positioned in a circular pattern at or near the periphery of a mounting plate 408. The mounting plate 408 can be made of aluminum and fixedly attached to the dry surface of the container wall 405, and have at least one magnet for magnetic attachment of the impeller assembly 403. As similarly shown in FIG. 1, the two mounting magnets 53a and 53b are provided, each inserted in a respective mounting receptacles or openings 52a, 52b. The mounting magnets 53a, 53b are held within the mounting receptacles or openings 52a, 52b by magnetic attraction to the mounting plate 408, by interference fit, and/or by adhesives.

[0089] In the illustrated embodiment, the mounting plate 408 includes a plurality of indentations or receptacles 410 that are positioned in a circular pattern and each of receptacles 410 is sized to receive one of the coil members 404. Further, the set of coil members 404 has a coplanar configuration such that the coil members 404 lie on the same internal plane of the mounting plate 408. It is preferred that each coil member is fixedly attached inside each receptacle 410 using an adhesive, such as glue or epoxy resin, but any type of securing methods can be employed. Optionally, each coil member 404 has a hole 412 in the center of each coil member 404.

[0090] Although seven coil members 404 are shown, any number of the coil members 404 is contemplated. For example, a number of the rotational magnets 62, 63 is one more or less than the number of the coil members 404, so that each rotational magnet is positioned off-centered relative to each corresponding coil member. During operation, each coil member 404 is electrically charged for generating a magnetic field in lieu of the magnet plate 134 shown in the circulation systems 20 and 220 (FIGS. 2 and 5).

[0091] A control unit 406 having programmable software or hardware controls the magnetic field based on an electric current flowing from an external or internal power source (not shown; e.g., A/C or D/C) and passing through the control unit and through the coil members 404. In use, the control unit 406 generates alternating polarities for the coil members 404, so that magnetically coupled motor assemblies as a combination operate to rotate the impeller 380. An inner chamber 414 is defined by the coil members 404 and is dimensioned for accommodating the control unit 406.

[0092] A motor housing 416 is configured for accommodating the motor assembly 402, and is fixedly attached to a dry

surface of the container wall **405**, such as by screws or adhesive. As the coil members **404** become heated due to the electric current flowing through them, the mounting plate **408** and the motor housing **416** will become more predominantly heated. Accordingly, the motor assembly **402** including the plate **408** and the housing **416** is optionally made of heat-resistant material or any type of metal that readily dissipates the generated heat (e.g., aluminum). To further enhance the cooling effect, the motor assembly **402** optionally includes cooling fins **418** mounted on an outer surface of the motor assembly **402** (e.g., the motor housing **416**) to reduce heat generated from the coil members **404**. While the fins **418** are shown extending outwardly from the motor housing **416**, additional fins can extend laterally from the periphery of the motor housing **416**, or alternatively, at least one optional fan (not shown) can be installed in the motor assembly **402**.

[0093] Referring now to FIGS. **18** and **20**, another feature of the system **400** is that the impeller assembly **403** includes at least one impeller **380** and the impeller magnet plate **272**. An impeller housing **420** is configured for rotatably accommodating the impeller assembly **403** and is disposed on a wet surface of the wall **405** opposite the motor housing **416**. The impeller magnet plate **272** is aligned to magnetically engage with the coil members **404**.

[0094] More specifically, multiple rotational magnets **62**, **63** are spaced in a circular pattern on the impeller magnet plate **272** in an alternating polarity order such that polarities of the rotational magnets **62**, **63** are magnetically attracted to polarities of the coil members **404** when the coil members are electro-magnetically charged to cause rotation of the impeller magnet plate **272**. A thrust bearing **422** rotatably supports around a shaft **424** of the impeller **380**. The bearing **422** is indirectly in contact with the shaft **424** (e.g., as shown in FIG. **7A**). In other words, the bearing **422**, located between the magnet plate **272** and the impeller housing **420** is configured to withstand axial and rotational loading of the shaft **424**. The axial and rotational loading refers to force applied parallel to an axis of rotation of the shaft **424** for preventing movement of the impeller **380** along the axis of the loaded shaft.

[0095] Referring now to FIGS. **21-22**, in the preferred embodiment, a locating bracket **426** is provided having a semicircular protrusion **428** with a first end **430** and a second end **432**. The locating bracket **426** is fixedly mounted on the wet surface of the container wall **405** for accommodating the impeller housing **420**. Because the semicircular protrusion **428** directly abuts and upwardly supports the impeller housing **420** when the impeller assembly **403** is magnetically coupled to the motor assembly **402**, it prevents misalignment or disconnection of the impeller assembly **403** from the motor assembly **402** during use.

[0096] More specifically, as similarly shown in the circulation system **20** (FIG. **2**), the impeller housing **420** has a generally circular exterior edge with two bulges or ears **96**. As shown in FIG. **22**, the ears **96** directly respectively rest on the first and second ends **430**, **432**, of the locating bracket **426**, and prevent further rotation or movement of the impeller housing **420** due to impact.

[0097] As an example only, two first mounting magnets **53a**, **53b** are associated with the motor housing **416**, and two second mounting magnets **99a**, **99b** are associated with the impeller housing **420**. For operation, the corresponding first and second magnets **53a**, **53b**, **99a**, **99b** attract one another and magnetically couple the motor and impeller assemblies **402**, **403** together. Specifically, the second mounting magnets

99a, **99b** extending radially from the periphery of the impeller housing **420** engage tips **434** of the locating bracket **426**, wherein the second mounting magnets **99a**, **99b** assist or enhance the rotation of the impeller **380**. The tips **434** are respectively disposed on the first and second ends **430**, **432** of the locating bracket **426** for releasably cradling the impeller assembly **403** in position and preventing rotation of the impeller assembly **403** during operation. Returning to FIG. **18**, when the motor and impeller assemblies **402**, **403** are assembled, a thickness T1 of the motor assembly **402** is substantially equal to a thickness T2 of the impeller assembly **403**.

[0098] Referring now to FIGS. **20** and **23**, at least one cavity **436** is positioned on the periphery of the impeller housing **420** and/or the cover **304**. This cavity **436** is configured for accommodating an air tube **438** for drawing air into the impeller assembly **403**. In fluid communication with the air tube **438**, an air plug **440** is provided to create a vacuum effect (e.g., Venturi effect) for mixing the air and the fluid, and enhancing the velocity of the jet-like flow generated by the impeller assembly **403**, thereby reducing load bearing of the impeller **380** for circulating the fluid. Further included on the impeller housing **420** is at least one opening **442** for propelling the mixture of the air and water, where the mixture of the air and water reduces an amount of water pressure propelled from the opening **442**.

[0099] While the disclosure has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the disclosure are desired to be protected by the following claims.

1. A powered pipeless circulation system for a container configured to hold a fluid, said circulation system comprising:

- a first motor assembly having a plurality of coil members, each coil member being electrically charged for generating a magnetic field;
- a first housing configured for accommodating said first motor assembly, and fixedly attached to a dry surface of a wall of the container;
- a second motor assembly having at least one impeller and an impeller magnet plate;
- a second housing configured for rotatably accommodating said second motor assembly and being disposed on a wet surface of the wall opposite said first housing, said impeller magnet plate being aligned to magnetically engage with said plurality of coil members; and

wherein the wall of the container is sandwiched between said first and second motor assemblies when said second motor assembly is magnetically coupled to said first motor assembly for forming a motor configured for rotating said impeller.

2. The circulation system of claim **1**, further comprising a plurality of rotational magnets spaced in a circular pattern on said impeller magnet plate in an alternating polarity order such that polarities of said rotational magnets are magnetically attracted to polarities of said coil members when said coil members are magnetically charged to cause rotation of said impeller magnet plate.

3. The circulation system of claim **2**, wherein a number of said rotational magnets is one more or less than a number of

said coil members, so that each said rotational magnet is positioned off-centered relative to each corresponding coil member.

4. The circulation system of claim 1, further comprising a thrust bearing wrapped around a shaft of said impeller, said bearing being indirectly in contact with said shaft.

5. The circulation system of claim 4, wherein said bearing is configured to withstand axial and rotational loading of said shaft, the axial and rotational loading being force applied parallel to an axis of rotation of said shaft for preventing movement of said impeller along the axis of said loaded shaft.

6. The circulation system of claim 1, further comprising a locating bracket having a semicircular protrusion with first and second ends, said locating bracket fixedly mounted on the wet surface of the container wall for accommodating said second housing.

7. The circulation system of claim 6, wherein said semicircular protrusion directly abuts and upwardly supports said second housing when said second motor assembly is magnetically coupled to said first motor assembly for preventing misalignment or disconnection of said second motor assembly from said first motor assembly.

8. The circulation system of claim 6, further comprising at least one first mounting magnet associated with said first housing, and at least one second mounting magnet associated with said second housing, said second mounting magnet extending radially from the periphery of said second housing and engaging tips of said locating bracket, wherein said second mounting magnet assists or enhances the rotation of said impeller.

9. The circulation system of claim 8, wherein said tips respectively disposed on the first and second ends of said locating bracket for releasably cradling said second motor assembly in position and preventing rotation of said second motor assembly during operation.

10. The circulation system of claim 1, further comprising at least one cavity on the periphery of said second housing, said cavity configured for accommodating an air tube for drawing air into said second motor assembly, wherein said cavity in fluid communication with said air tube creates a vacuum effect for mixing the air and the fluid, thereby reducing load bearing of said impeller for circulating the fluid.

11. The circulation system of claim 10, further comprising at least one opening on said second housing for propelling the mixture of the air and water, said mixture of the air and water reducing an amount of water pressure propelled from said opening.

12. A powered pipeless circulation system for a container configured to hold a fluid, said circulation system comprising:
a first motor assembly having a plurality of coil members, each coil member being electrically charged for generating a magnetic field;
a control unit for controlling the magnetic field based on an electric current flowing through said coil members;
a first housing configured for accommodating said first motor assembly, and fixedly attached to a dry surface of a wall of the container;
a second motor assembly having at least one impeller and an impeller magnet plate;
a second housing configured for rotatably accommodating said second motor assembly and being disposed on a wet surface of the wall opposite said first housing, said

impeller magnet plate being aligned to magnetically engage with said plurality of coil members; and
wherein the wall of the container is sandwiched between said first and second motor assemblies when said second motor assembly is magnetically coupled to said first motor assembly for forming a motor configured for rotating said impeller.

13. The circulation system of claim 12, wherein said control unit generates alternating polarities for said coil members, so that said coupled first and second motor assemblies as a combination operate to rotate said impeller.

14. The circulation system of claim 12, wherein said first motor assembly including said coil members defines an inner chamber dimensioned for accommodating said control unit.

15. The circulation system of claim 12, further comprising an aluminum mounting plate fixedly attached to the dry surface of the container wall, said mounting plate having at least one magnet for magnetic attachment of said second motor assembly.

16. The circulation system of claim 12, wherein said first motor assembly is made of heat-resistant material.

17. The circulation system of claim 12, wherein a thickness of said first motor assembly is substantially equal to a thickness of said second motor assembly.

18. The circulation system of claim 12, wherein said first motor assembly includes cooling fins mounted on an outer surface of said first motor assembly to reduce heat generated from said coil members.

19. The circulation system of claim 12, wherein said first motor assembly comprises non-moving parts.

20. A powered pipeless circulation system for a container configured to hold a fluid, said circulation system comprising:

- a first motor assembly having a plurality of coil members, each coil member being electrically charged for generating a magnetic field;
- a control unit for controlling the magnetic field based on an electric current flowing through said coil members;
- a first housing configured for accommodating said first motor assembly, and fixedly attached to a dry surface of a wall of the container;
- a second motor assembly having at least one impeller and an impeller magnet plate;
- a second housing configured for rotatably accommodating said second motor assembly and being disposed on a wet surface of the wall opposite said first housing, said impeller magnet plate being aligned to magnetically engage with said plurality of coil members;
- a plurality of rotational magnets spaced in a circular pattern on said impeller magnet plate in an alternating polarity order such that polarities of said rotational magnets are magnetically attracted to polarities of said coil members when said coil members are magnetically charged to cause rotation of said impeller magnet plate; and
- wherein the wall of the container is sandwiched between said first and second motor assemblies when said second motor assembly is magnetically coupled to said first motor assembly for forming a motor configured for rotating said impeller.

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