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(54) WATER JET POOL CLEANER WITH OPPOSING DUAL PROPELLERS

POOLREINIGER MIT WASSERDÜSEN UND GEGENLÄUFIGEN DOPPELPROPELLERN

NETTOYEUR DE PISCINE À JET D'EAU DOTÉ DE PROPULSEURS DOUBLES OPPOSÉS

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EP 2 673 429 B1

Description

Field of the Invention

[0001] This invention relates to methods and apparatus for propelling automated or robotic swimming pool and tank cleaners employing water jet propulsion.

Background of the Invention

[0002] A conventional pool cleaner comprises a base plate on which are mounted a pump, at least one motor for driving the pump and optionally a second motor for propelling the apparatus via wheels, rollers or endless track belts; a housing having a top and depending sidewalls and end walls that encloses the pump and motor(s) that are secured to the interior structure and/or the base plate; one or more types of filter media are positioned internally and/or externally with respect to the housing; and a separate external handle is optionally secured to the housing. Power is supplied by floating electrical cables attached to an external source, such as a transformer or a battery contained in a floating housing at the surface of the pool; pressurized water can also be provided via a hose for water turbine-powered cleaners. Tank and pool cleaners of the prior art also operate in conjunction with a remote pump and/or filter system which is located outside of the pool and in fluid communication with the cleaner via a hose.

[0003] Automated or robotic swimming pool cleaners of the prior art have traditionally been powered by one or more drive motors which, in some instances are reversible; a separate water pump motor is employed to draw debris-containing water through one or more openings in a base plate close to the surface to be cleaned. The water passes through one or more filters positioned in the pool cleaner housing and is typically discharged vertically through one or more ports in an upper surface of the housing to thereby create an opposite force vector in the direction of the surface being cleaned. This configuration of the apparatus and its method of operation permit the movement of the pool cleaner across the bottom wall and optionally, permit it to climb the vertical sidewalls of the pool, while maintaining a firm contact with the surface being cleaned.

[0004] An innovative use of water jets to propel a pool cleaner is described in USP 6,412,133. A single propeller is attached to the drive shaft projecting from the upper end of a vertically-mounted pump motor positioned in the interior of a pool cleaner housing. The water drawn through the base plate and filter(s) is diverted from a direction that is generally normal to the surface being cleaned by means of a directional flap valve and is discharged in alternating directions through a conduit that is positioned along the longitudinal axis of the pool cleaner in the direction of movement of the pool cleaner; the discharge conduit is generally parallel to the surface being cleaned. In one embodiment, the position of the directional flap valve changes when the water pump stops, or is slowed sufficiently, thereby allowing the water jet to be discharged in the opposite direction and causing the pool cleaner to reverse its direction of movement.

[0005] Although the water jet reversing propulsion system of USP 6,412,133 has been commercially successful, the size and power requirements of the pump motor must account for certain energy losses associated with changing the direction of the flowing water abruptly as it comes into contact with the directional flap valve and undergoes essentially a 90° change in direction.

[0006] Some other examples of the state of the art can be seen on CN1538022 and US2004/168838.

[0007] It would therefore be desirable to provide an apparatus and method that reduces turbulent flow within the interior of the housing and facilitated the alternating directional discharge of the water jets used to propel the apparatus with a minimum loss in energy due to turbulence.

[0008] In the description that follows, it will be understood that the cleaner moves on supporting wheels, rollers or tracks, or a combination of these means that are aligned with the longitudinal axis of the cleaner body when it moves in a straight line. References to the front or forward end of the cleaner will be relative to its then-direction of movement.

Summary of the Invention

[0009] The above objects and other advantages are obtained by a self-propelled pool cleaner according to appended claim 1 and a corresponding method according to appended claim 11.

[0010] The present invention broadly comprehends positioning the pump motor horizontally within the pool cleaner housing, attaching a propeller to either end of the motor drive shaft which extends through and projects from opposing ends of the motor body, and providing opposing water jet discharge openings in the housing, each with a pressure-sensitive flap valve, in axial alignment with the motor's drive shaft and axis of rotation of the respective propellers. When the propellers rotate in one direction, the water is drawn through one or more openings in the base plate, passes through a filter or filters associated with the pool cleaner and is discharged through one of the discharge ports as a water jet of sufficient force to propel the pool cleaner along the surface being cleaned.

[0011] According to the present invention, each propeller is securely fixed or mounted to a respective end of the pump motor drive shaft. The water jet created by the propeller is aligned with the adjacent discharge port formed in the end wall of the housing. The force of the water jet is sufficient to open a valve that is positioned downstream of the propeller. The valve can be configured as a split flap valve that is hinged to fold outwardly from a normally closed position, and is designed to produce minimum resistance to the passage of the water jet as it

moves toward the discharge port.

[0012] A second flap valve is mounted in a second discharge port located at the opposite end of the housing. The second flap valve is pressed against a rim seal formed in the interior peripheral surface of a discharge duct to close the opposing (second) discharge port. The second flap valve is closed by a water pressure drop created adjacent the second valve in the interior of the housing as a result of the rapid flow of water entering an inlet port, passing through a filter device and flowing out of the open discharge port on the opposite end of the cleaner.

[0013] In one embodiment, the propeller adjacent the closed flap valve is also turning to enhance the flow of water towards the open flap valve at the opposite end of the housing. In order to minimize turbulent flow, the opposing ends of the motor body are provided with a curvilinear cap or cover having a streamlined surface configuration that enhances a more laminar flow of the pressurized water created by the rotating propeller. The movement of water-across the motor housing at a velocity in the direction of the opposing propeller also enhances the water jet force as it is eventually discharged through the port to provide a force to move the pool cleaner in the opposite direction.

[0014] In another embodiment, the propellers are provided with a clutch mechanism so that they will turn in only one direction. In this embodiment, the propeller adjacent the discharge port with its flap valve in the closed position does not rotate; rather, the shaft of the motor spins within the clutch mechanism and applies no force to the propeller mounting. During a cleaning operation, when the motor stops and is reversed, the propeller that had been turning is no longer driven by the drive shaft and the clutch of the propeller on the opposite end is engaged and the propeller rotates, thereby applying a pressurized stream of water against the flap valve, which then opens and discharges a water jet through the discharge duct and out the discharge port, causing the pool cleaner to be propelled in the opposite direction. As previously noted, the valve at the opposite end is closed by the biasing force.

[0015] According to the present invention, the propellers are positioned adjacent to, but outside of the opening of the discharge conduit in the region between the motor and the interior wall of the pool cleaner that defines the inlet of the discharge conduit. This configuration can be used to advantage when both propellers rotate with the motor drive shaft, that is, when no clutch mechanism is employed. When the propeller is outside of the discharge conduit, but in close proximity to its inlet, there is relatively less back pressure or drag experienced by the non-driving propeller that is at the forward end of the drive shaft in the direction of movement of the pool cleaner than is experienced by the forward propeller when it is surrounded by the discharge conduit. The reduction in drag on the propeller consequently reduces the power drawn by the pump motor, allowing it to operate more efficiently and at a lower cost.

[0016] The operation of the pump motor can be controlled in accordance with a predetermined program that interrupts and then reverses the polarity, or direction of the electrical current flowing to the pump motor in response to either a timed sequence, a sensor which detects movement, or lack of movement, or a sensor which is responsive to a vertical wall or other change in position of the pool cleaner, either in the generally horizontal or generally vertical position. Various apparatus, means and methods for controlling the stopping and starting of drive motors and/or pump motors are well-known in the art and form no specific part of the present invention. Similarly, other choices in addition to those specifically described and exemplified herein will be apparent to those of ordinary skill in the art without departing from the scope of the invention.

[0017] In one preferred embodiment of the invention, an auxiliary discharge port is positioned above the directional discharge port upstream of the flap valve and in the jet discharge conduit proximate the driving propeller. As used herein, the term "driving propeller" refers to the propeller adjacent the open flap which is producing a water jet that propels the pool cleaner. A reference to the "forward end" or "forward movement" will be understood as a reference to the end facing in the direction in which the pool cleaner is then moving.

[0018] The auxiliary discharge port is in fluid communication with a vertical discharge conduit which is generally of a smaller diameter than the conduit passing the propelling water jet, and has an outlet that is oriented vertically when the pool cleaner is positioned on a horizontal surface. Water exiting the vertical conduit produces a force vector that is generally normal to the surface being cleaned. When the pool cleaner is moving over the generally horizontal surface of the bottom wall of a pool or tank, the vertical discharge conduit has the effect of forcing the wheels or other supporting means of the pool cleaner onto contact with the surface. A vertical discharge conduit is positioned at either end of the pool cleaner. In one embodiment, a pressurized water jet exits vertically from only the end at which the water jet is discharged. In another embodiment, water can be discharged from both vertical conduits simultaneously. This relief of pressure by discharge of water through the vertical conduit adjacent the closed valve also serves the beneficial purpose of reducing turbulence. It will be understood that the direction of the "vertical discharge" is relative to the surface being cleaned. When the pool cleaner is ascending or descending a vertical wall, the discharge through the auxiliary discharge port produces an opposite force vector to maintain the pool cleaner in contact with the vertical surface.

[0019] The orientation of the discharged water jet can be varied to provide a downward component or force vector, lateral components, or a combination of such components or force vectors to complement the translational force produced by the exiting water jet. Other meth-

ods and apparatus can be adapted to achieve the desired combination of force vectors whose resultant provides a sufficient force to cause the pool cleaner to move along the surface being cleaned while also maintaining traction and to permit the unit to reliably ascend and descend vertical wall surfaces. Examples of suitable alternative configurations are also disclosed in USP 6,412,133, e.g., in Figs. 8, 9, 12A, 15 -17, 23 and 24 and the corresponding description in that patent's specification.

[0020] In one preferred embodiment of the pool cleaner of the present invention, the housing is supported by a pair of wheels mounted for rotation on a transverse axle secured at one end of the housing, and a third swivel-mounted wheel positioned at the opposite end of the housing and located substantially on the longitudinal center line of the cleaner. In the operation of this embodiment, movement of the pool cleaner in a direction in which the two wheels mounted on the transverse axle are at the leading end of the pool cleaner results in the swivel wheel at the opposite end of the housing typically following, and the pool cleaner moves in a generally straight line for cleaning. When the pump motor is stopped and reverses direction, the now-leading swivel-mounted wheel typically rotates to one side or the other, or back and forth between alternate positions, thereby causing the pool cleaner to assume a random or at least curvilinear path. This alternating straight-line or linear movement of the pool cleaner followed by curvilinear movement enables the pool cleaner to traverse most, if not all of the bottom surfaces of the pool during a cleaning cycle.

[0021] Another preferred aspect of the invention includes the use of at least one, but preferably, a pair of pleated filter units through which the pool water-containing debris is drawn and the debris retained as the water passes through the housing. In a particularly preferred embodiment, the pair of pleated filter paper cartridges extend longitudinally and their axes are parallel to the axis of the drive motor shaft. The use of these elongated pleated filters has the advantage of reducing the profile of the pool cleaner and thereby the energy required to move it through the water.

[0022] The pleated filters are preferably supported to prevent collapse and thereby to enhance their performance and useful life between cleanings and/or replacement. The supporting material can be a wire screen formed of a non-rusting material that is also able to withstand exposure to salt water and/or the treatment chemicals that may be present in the pool water. A particularly preferred support for the pleated filter is a Dutch weave stainless steel wire mesh or screen that is folded in the same configuration as the pleated paper or other natural or synthetic fibrous material that functions to filter the water and retain the debris. Porous plastic supporting materials can also be used.

[0023] In addition to using the pleated filter cartridge, the pool cleaner can also be provided with a conventional woven mesh or screen filter to remove larger debris from the incoming flow of water entering from the base plate. In a preferred embodiment, the flexible mesh filter is fitted into the lower region of the housing and positioned above the base plate. Water entering the body first passes through the mesh filter, which entrains larger pieces of debris, e.g. small twigs, leaves, and the like; the water leaving this first stage of filtration then passes into the interior or the pleated filter unit and the smaller debris is trapped on its interior as the filtered water passes through. The use of the primary mesh filter also serves the purpose of extending the life of the pleated filter medium, as well as reducing the frequency of maintenance. Assuming that the pleated filter medium is not punctured, the cartridge can be removed from the unit and back-flushed to permit its reuse.

[0024] From the above description, in its broadest construction, the invention further defines a method for cleaning a submerged surface of a pool with a self-propelled pool cleaner according to appended claim 11. The pool cleaner is self-propelled by means of a water jet that is alternatively discharged in at least a first and second direction that results in movement in opposite translational directions. The direction of the water jet is controlled by the direction of rotation of a horizontally mounted pump motor and propellers mounted on either end of the pump's driveshaft. Opposing discharge conduits are axially aligned with the motor's drive shaft and the pressurized water controls the movement of one or more valves that operate in one or more discharge conduits to pass the water for discharge in alternating directions. During the change from one direction to the alternate opposing direction, the motor is stopped and its direction reversed. This interrupts the discharge of water from one discharge conduit, causing the valve to close and the pressure created by the opposing propeller causes the valve to open permitting the discharge of the water jet to propel the unit in the opposite direction.

[0025] The movement of the pool cleaners can be characterized as systematic scanning patterns, scalloped or curvilinear patterns and controlled random motions with respect to the bottom surface of the pool or tank. For the purposes of this description, references to the front and rear of the cleaning apparatus or to its ends or end walls of its housing will be with respect to the direction of its movement.

[0026] In one embodiment of the invention described below and with reference to the drawings, the pool cleaner is supported by, and moves on a plurality of wheels, which contact the surface being cleaned. In a presently preferred embodiment, wheels are attached to a transverse axle attached to one end of the pool cleaner assembly and a third swivel wheel is mounted at the opposite end of the unit at a position corresponding to the longitudinal axis of the pool cleaner. The turning range or angle of radial movement around the pivot point of the swivel wheel is limited by either fixed or adjustable control elements. This combination of fixed wheels and a pivoting, or swivel wheel produces essentially straight-line

movement in the direction in which the third wheel is trailing and a curvilinear cleaning pattern when the third wheel is leading. Various mechanical and/or electro-mechanical means known to the art can be utilized to control and vary the directional position of the swivel wheel to thereby create different and varying patterns of curvilinear movement of the pool cleaner.

[0027] As will be understood by those of ordinary skill in the art, the pool cleaner can also be provided with a second pair of axle-mounted wheels in place of the single swivel-mounted wheel. The use of a set of wheels at opposing ends of the pool cleaner can be used to provide for more regular patterns of movement than the random movement associated with the swivel wheel. For example, one or both ends of one or both of the two axles can be positioned in fixed or adjustable slots that permit the respective portion(s) of the axle(s) to move in response to a change in direction.

[0028] The illustrative figures which accompany this application, and to which reference is made herein, schematically illustrate various embodiments of the invention as applied to robotic cleaners equipped with wheels; however it will be understood by those of ordinary skill in the art that the invention is equally applicable to cleaners which move on transverse rollers and endless tracks or belts.

Brief Description of the Drawings

[0029] The invention will be described in further detail below and with reference to the attached drawings where the same or similar elements are referred to by the same number, and in which:

Fig. 1 is a top, side and end perspective view of a pool cleaner illustrating one embodiment of a directional water jet system;

Fig. 2 is a top view of the pool cleaner of Fig. 1 with the upper portion of the housing removed to reveal the interior arrangement of the components;

Fig. 3 is a partial side elevation view in cross-section taken along line 3-3 of Fig. 2;

Fig. 4 is another partial side elevation view in cross-section taken along line 4-4 of Fig. 2 illustrating a propulsion system having a motor and opposing propellers;

Fig. 5 is a top, enlarged view, partly in section, illustrating the propulsion system positioned between opposing discharge conduits, each of which includes a split flap valve and illustrated in an open and closed positions;

Fig. 6 is an exploded perspective view of a first embodiment of a filter and related components as shown, e.g., in Fig. 3;

Fig. 7 is an end view, partly in section taken along line 7-7 of Fig. 1, illustrating the flow path of water entering and passing through the filters and interior of the pool cleaner body;

Fig. 8 is a bottom view showing one embodiment of a base plate having two inlet ports for admitting water flow through the filters;

Fig. 9A is an enlarged cross-sectional view illustrating an embodiment of streamlined end caps fitted to the end plates of the motor and water alternately flowing through opposing vertical conduits, each of which being positioned proximate a respective propeller and discharge conduit;

Fig. 9B depicts an embodiment according to the present invention in which the propeller blades are positioned outside of, and adjacent to the openings of the discharge conduits;

Figs. 10A and 10B are, collectively, a schematic flow diagram of one method for operating a pool cleaner in accordance with the invention;

Fig. 11 is an exploded perspective view of a second embodiment of a filter and related components suitable for use in the cleaner of Fig. 1;

Fig. 12 is a cross-sectional view of the filter of Fig. 11 illustrating the flow of filtered water through the filter;

Fig. 13 is a partial side elevation view in cross-section illustrating the filter of Fig. 11 installed in the pool cleaner of Fig. 1;

Fig. 14 is a side elevation view illustrating the cleaner of Fig. 1 with a mercury switch responsive to changes in the orientation of the pool cleaner, e.g., during ascent and descent of sidewall of a pool;

Figs. 15 and 16 are side elevation views in cross-section illustrating the mercury switch of Fig. 14 in various conductive activation states;

Fig. 16 is a side elevation view in cross-section illustrating the mercury switch of Fig. 14 in a conductive activation state; and

Figs. 17-20 are bottom plan views of the pool cleaner of Fig. 1 illustrating optional mechanisms for adjusting the positioning of the transverse axle relative to the longitudinal axis of the cleaner.

[0030] To facilitate an understanding of the invention, identical reference numerals are used, when appropriate, to designate the same or similar elements that are common to the figures. Further, unless stated otherwise, the features shown in the figures are not drawn to scale, but are shown for illustrative purposes only.

Detailed Description of Preferred Embodiments

[0031] In the description that follows, a pool or tank cleaner 10 has an exterior cover or housing 12 with a top wall 12A, an internal pump and drive motor 60 that draws water and debris through openings in a base plate that are entrained by one or more filters 60.

[0032] Referring to Figs. 1-4, 7 and 8, illustrated is an embodiment of the cleaner 10 having a single motor that enables the robotic pool cleaner 10 to vacuum debris while being propelled over the submerged pool surface

using one relatively simple directional control means. In this embodiment, a reversal of the polarity of the power input to the motor results in the reversal in direction of the pool cleaner's movement. This change (e.g., polarity reversal) in the power to the motor can result from a programmable power control circuit that is initiated by physical conditions affecting the cleaner (e.g., sensing a wall of the pool or surface of the water), or in accordance with a timed program, i.e., 30 seconds to one minute in one direction and then a change in the direction of rotation of the pump motor for a like or different period of time.

[0033] With continuing reference to Fig. 1, the pool cleaner 10 includes a housing, referred to generally as 12, that includes of an upper cover portion 12A and a lower body portion 12B which are securely fitted or joined together to provide a unitary structure. A floating or buoyant power cable 13 supplies low voltage power from an external (remote) power source (not shown) as is well-known in the art. Means for controlling and reversing the polarity of the current supplied to the DC motor can be located at the remote power source or included in a processor/controller device 68 mounted in the interior of the pool cleaner housing 12. The processor/controller 68 can be programmed in accordance with methods known in the art to interact with a timer and/or one or more sensors or switches to effect the functioning and directional control of the pool cleaner.

[0034] The pool cleaner body is supported by a pair of wheels 30 mounted on axle 31, which is mounted or otherwise installed transversely to the longitudinal axis of the pool cleaner as defined by direction of movement. A third supporting wheel assembly 32 is mounted at the end opposite the transverse axle. For purposes of clarity in further describing the invention, the pair of wheels 30 are illustratively shown as being mounted proximate first end "A" of the cleaner 10 and the wheel assembly 32 is illustratively shown and labeled as being mounted at opposing second end "B" of the cleaner 10. In one embodiment, wheel assembly 32 includes a mounting bracket 34 with downward projecting flanges 36 that engage a wheel support member 38, which retains and controls the angular or radial range of movement of wheel 39. As will be apparent to those of ordinary skill in the art, the angular range of movement can be controlled by providing adjustable pins, which can be repositioned by the user. Further, the illustrative wheel assembly 32 shown in FIG. 1 is not considered limiting as a person of ordinary skill in the art will appreciate that other well-known wheel assemblies such as a center rotational wheel assembly, a mechanum wheel, a spherical wheel assembly, and the like can also be utilized.

[0035] With continuing reference to Figs. 1 and 4, the pool cleaner cover includes opposing front and rear end walls 14, in each of which there is formed a water jet discharge port 40. Also shown in Figs. 1 and 4 are opposing vertical discharge conduits 70, each of which has a lower end connected to a respective conduit section 71 mounted in the interior of the housing 12 and the upper end terminating in a vertical discharge port 72. The vertical discharge ports 72 are positioned at the opposing ends of the cleaner 10, and their function is described below in further detail. As will be described in further detail below, the discharge conduits 70 can be configured as a single straight section of conduit to minimize energy losses associated with directional changes.

[0036] Referring now to the top view of Fig. 2 from which cover portion 12A has been removed, horizontally mounted motor 60 with drive shaft 62 projecting from both ends supports opposing propellers 64. As can best be seen in the cross-sectional view of Fig. 4 the propellers 64 are, respectively, positioned in closely-spaced relation to longitudinal water jet discharge conduits 42, each of which terminate with discharge ports 40. Each of the longitudinal discharge conduits 42 are also provided with an outlet-43 positioned downstream of the propeller and in a zone of high hydraulic pressure. As clearly shown by reference to Figs. 1 and 4, the vertical discharge conduits sections 71 and 70 form a continuous path communicating with vertical discharge inlet opening 43 to direct a stream of pressurized water in a direction that is normal to the surface being cleaned, e.g., vertically when the unit is moving on the horizontal bottom wall of a pool or tank, the stream being discharged through vertical discharge port 72. In the embodiment illustrated in Figs. 1-4, the external portion of the vertical discharge conduits 70 is affixed to the end wall 14 of the upper cover portion 12A. A fluid-tight fitting is provided where the conduit section 71 is joined to the water jet discharge conduit 42.

[0037] Although the vertical discharge conduit section 71 and 70 are each illustratively configured with two right angle elbows, a person of ordinary skill in the art will appreciate that a straight or angled conduit can also be provided to extend from the outlet 43 positioned downstream of the propeller through the top surface of the upper cover portion 12A. For example, referring to Fig. 9A, the vertical discharge conduit extends upwards directly from the outlet 43 and through the upper cover portion 12A without directional change at the two elbow fittings 71 formed between the discharge inlet opening 43 and discharge port 72. In an alternative embodiment, the straight conduit can be angled from the inlet opening 43 and extend through the upper cover portion 12A to produce a force vector having a vertical component and a horizontal component. In this latter embodiment, the water discharged through the discharge port 72 produces a force vector that is perpendicular to the base plate 16 to maintain the cleaner along a surface of the pool, as well as a horizontal force vector to assist in propelling the cleaner along the longitudinal axis of the cleaner 10. As previously noted, the use of the terms "horizontal" and "vertical" are with reference to the surface on which the pool cleaner is positioned and/or moving.

[0038] The positioning and functioning of split flap valves 90 are now described with reference to the side elevation view in cross-section of Fig. 4 and the top, partial sectional view of Fig. 5. Each pair of valve sections

90 include a support element 92, which is secured into upper and lower recesses in the discharge conduit 42. A central partition element 98 is shown projecting from the interior wall of conduit 42 to prevent the valve elements from coming into contact with each other and from moving beyond the defined range, which will thereby enable them to close when the rotational direction of the propellers 64 is reversed. In actual practice, the spacing between the open flap valve sections can be minimized beyond that shown for purposes of illustration in Fig. 5. The interior wall of conduit 42 is also provided with a projecting peripheral band or seal 44 against which the closed valves on the right side of the figures are shown resting. In a preferred embodiment, the upstream portion of the projecting seal 44 is contoured to minimize turbulence in the passing jet stream.

[0039] Referring now to Fig. 6, a first embodiment of the filter 88 is provided with end caps 80 that include a body portion 82, and inlet 84 having extending walls 85 configured to produce a suction force in the vicinity of the base plate inlet ports 18, as described in more detail below, and an outlet tube 86 which mates in close-fitting relationship with the inlet of pleated filter unit 88. In one embodiment, filter 88 can be formed of a paper material that is pleated or corrugated to increase surface area. The body portion 82 is also preferably provided with a projecting peripheral flange 83 that is dimensioned and configured to mate securely with the outer periphery of the end collar 89 of the filter 88. As clearly shown in Figs. 2, 3 and 5, the filter 88 is fitted with a cap 80 at each end through which water containing debris is admitted and circulates through the filter medium, which retains the debris and passes the filtered water through the open discharge conduit 42 under the influence of the motor-driven propellers 64.

[0040] Referring to Figs. 11, 12 and 13, an alternate embodiment of the filter 88 is illustratively shown that include use of a conventional mesh material 116 in place of the pleated paper material of the cartridge-type filter described above. The mesh material 116 can be supported on an open framework or by an associated stainless steel Dutch weave wire mesh, although other types of woven open-mesh metal and fibers, as well as molded polymeric flexible and/or rigid filter screens can be used. The mesh material 116 is formed as a tubular member that extends between the opposing caps 80 as described above. A person of ordinary skill in the art will appreciate that the wire mesh can be woven loosely or tightly to form larger or finer spaces between the individual wire/fiber strands to remove various undesirable particles in different types of environments that the cleaner is used.

[0041] Preferably, the pleated paper or the woven mesh is supported by a larger mesh like structure or support member 110 that supports the inner circumference of the paper or woven mesh. In one embodiment, the support member 110 includes a plurality of spaced-apart concentric rings 112 that are aligned and secured together by a plurality of spaced-apart cross members 114. The support member 110 is sized to support the inner surface of the filter material 88 and the end caps 80. As shown in Figs. 12 and 13, water flows into the inlet 84, through the outlet tube 86 of the end caps 80 and out the tubular sidewall formed by the circumference of the paper or woven mesh to trap the undesirable debris within the filter 88.

[0042] As previously noted, upper cover portion 12A is removable to permit convenient access to the interior of the body, e.g., for maintenance of the filters 88. The filter assemblies are preferably supported and held in position by the upper and lower body portions 12A and 12B. Other configurations of filter supports and assemblies known in the prior art can be used with the invention.

[0043] As best shown in Figs. 3 and 4, the base plate 16 is positioned in close proximity to the surface of the pool or tank that is to be cleaned and water is drawn through a number of base plate inlet ports 18 that extend transversely to the longitudinal axis of the pool cleaner. In the preferred embodiment shown, inlet closing flaps 19 are bias-mounted so that they open under the influence of the water drawn through the inlet port 18 and close when the flow of water caused by the propellers 64 is discontinued. This arrangement has the advantage of preventing any loose debris that may have been drawn into the interior of the pool cleaner housing 12 to be retained for eventual removal by the user when the pool cleaner 10 is shut down and being removed from the pool.

[0044] In describing the method of operation of the pool cleaner of the invention, it will be understood that the direction of the rotation of the motor 60 is effected by changing the polarity of the power supply. This technique is well-known in the art and a particular means for accomplishing this change does not form part of the present invention. This reversal of polarity can be accomplished using a programmed controller 68 and other appropriate circuit elements well-known in the art. As previously noted, the change in direction of rotation of the motor can be the result of a predetermined program which is specifically designed to result in a random pattern of movement of the pool cleaner that will result in the cleaning of all or substantially all of the desired pool surface(s). Other changes can be the result of signals emanating from various types of optical, mechanical and/or radio frequency devices. Similarly, control signals can be generated by one or more sensors 120 which detect the motion of, or the absence of movement of the pool cleaner, e.g., when the pool cleaner's forward motion is stopped by encountering a wall or an obstacle such as a ladder.

[0045] Referring to Fig. 4, in one embodiment, a sensor 120 (shown in phantom) is illustratively provided at the end of the pool cleaner 10 having the pair of wheels 30 mounted thereto. The sensor 120 can be a switch having a push rod or button that actuates upon contact with the sidewall of the pool, or a sensor that uses sonar or light (laser) to detect the sidewall, among other well-known sensors capable of detecting a sidewall or vertical structure in the pool.

[0046] Preferably, the sensor 120 is a magnetic pickup switch 122 that is coupled to one or more wheels 30, as also illustratively shown in Fig. 4. One or more magnets are on the inner circumference of the wheel 30, and an inductor 124 is mounted to the chassis proximate the inner circumference of the wheel 30. The magnetic pick-up (inductor) senses the magnet as the wheel turns and sends a control signal to the controller 68. The controller 68 includes a timing circuit that determines whether the wheel(s) have stopped rotating for a predetermined time, such as when the unit has come to a stop at a sidewall of the pool. During operation, when the timing circuit times out or the sensor 120 detects the sidewall, the controller 68 optionally interrupts power to the motor 60, thereby terminating the discharge of water. In one embodiment, the polarity of the motor is reversed and the pool cleaner resume movement in a different direction. In an alternative embodiment described in more detail below, the pool cleaner is programmed to assume a wall-ascending position.

[0047] Other magnetic sensors of the types described in USP 6,758,226 can be coupled to the pool cleaner's processor/controller to provide a periodic signal while the unit is moving, while a predetermined delay will result in a change in direction of the pump motor. In one embodiment, a reed switch is opened or closed to generate the signal. Other motion detecting systems known in the art can be adapted for use.

[0048] The pool cleaner 10 is placed on the bottom of the pool or tank to be cleaned and power supplied-to the motor 60, which causes one or both of the propellers 64 to rotate with-the motor's drive shaft 62. In accordance with the directional references indicated in Figs. 4 and 5, water containing debris is drawn from below the base plate 16 through inlet port 18 and passes through end caps 80 and into filter intake opening 84 located at either end of the two pleated filter units 88. Debris is trapped in the filter medium and the filtered water flows through the external pleated (or mesh) filter 88 material and is drawn through the housing by the rotating propeller 64 on the left side and a principal water jet is directed by discharge conduit 42 to exit via discharge port 40, thereby moving the unit to the right. Simultaneously, a lesser volume of water is discharged from downstream of the propeller through opening 43 in conduit 42 and discharged via communicating conduits 71 and 70 vertically through port 72 to provide a force vector normal to the base plate 16 that acts to maintain the moving pool cleaner in contact with the surface being cleaned.

[0049] As will be understood by one of ordinary skill in the art, the water jet discharge conduits 40 can alternatively be positioned at an angle other than horizontal to the surface being traversed by the pool cleaning apparatus. For example, a downward thrust or force vector can be provided to assist in maintaining the apparatus in contact with the surface over which it is traveling by positioning the respective discharge conduits 40 at an acute angle to the horizontal. Similarly, an upward thrust or vertical force vector can be provided by declining the exhaust tube below the horizontal. The end of the discharge conduit 40 can be divided so that the exiting water jet stream is split into a horizontal vector and an upward (or downward) discharge stream. A further method for controlling the directional discharge is by use of a plate or rudder, either fixed or adjustable by the user that is positioned in the end of the discharge conduit.

[0050] In the embodiment in which both propellers 64 rotate simultaneously, the propeller shown on the right end of the pool cleaner in Fig. 4 also is pushing water in the direction of the open flap valve 90 located at the left end of the pool cleaner. In order to facilitate the flow of water around the intervening pump motor housing 60, contoured caps 66 are optionally fitted to the end plates of the motor housing as shown in Fig. 9A. The contours of the caps 66 are dimensioned and configured to reduce turbulence and facilitate the most energy-efficient flow of water along the longitudinal path defined by the housing 12 and the body of motor 60.

[0051] Referring to Fig. 9A, a flap valve 96 or other water flow restraining device is optionally provided in each vertical discharge tube 70 to alternatively preclude or permit movement of water into or out of the housing through the vertical discharge port 72. In one embodiment, a flap valve 96 is mounted in the interior of the vertical discharge tube 70 proximate the discharge inlet 43, although such location along the interior is not intended to be limiting. For example, the flap valve 96 or a cap (not shown) can be mounted proximate the vertical discharge port 72 to preclude or permit the passage of water. Referring to Fig. 4, the flap valves (not shown) are also preferably mounted in the interior of the vertical discharge tubes 70 proximate the discharge inlets 43, although such location is not intended to be limiting.

[0052] During operation, when a main discharge flap valve 90, e.g., flap valve on the left side of Fig. 9A, is open and water is moving (expelled) through the discharge opening 40, the turbulent pressure created by the rotation of the adjacent left side propeller 64 will also cause the left vertical flap valve 96 to open. Accordingly, pressurized water can flow through the vertical tube 70 and is discharged through the vertical discharge port 72 to produce a downward force vector or component normal to the base plate 16. At the opposite end of the cleaner 10, the turbulent pressure created by the rotation of the right side propeller 64 that is positioned adjacent the closed discharge flap valve 90 causes the vertical flap valve 96 to return to its normally biased closed position. In this manner, water from the pool is prevented from being drawn into the right side vertical tube 70 and flow into the high velocity/low pressure region downstream of the propeller.

[0053] In an alternative embodiment, the invention comprehends the use of two separate motors (not shown) whose axes of shaft rotation are coincident, instead of a single motor 60. Preferably, a programmable processor controller regulates the rotations of the shafts

of the two axially aligned motors. In this embodiment, a first motor is provided with power to turn the propeller that produces the motive jet stream and the adjacent and opposing (second) motor is stopped to reduce turbulence inside the housing 12. When the directional movement of the cleaner is reversed, the power to the rotating motor is interrupted and the second motor is activated. The flap valves 90 and 96 operate in a similar manner as described above with respect to the embodiment shown with a single motor 60.

[0054] In addition to, or in place of the discharge of a vertical stream, pressurized water can also be delivered via a tube or tubes to the underside of the pool cleaner for the purpose of lifting debris into suspension for capture by the water flowing into the inlet ports 18 formed in the baseplate 16. Various examples of arrangements for creating a pressurized stream and various modes of delivering it to the underside of the baseplate 16 for this purpose are shown and described in USP 6,412,133, as well as in USP 6,971,136 and USP 6,742,613.

[0055] Referring now to Fig. 9B, an embodiment of the invention is shown in which each of the respective propellers are displaced to a position that is adjacent and in close proximity to the discharge conduit (42), rather than being located within the conduit as shown, for example in Figs. 2, 4, 5 and 9A. As shown in Fig. 9B, each propeller is mounted on a drive shaft (62) extending from either end of the motor (60). The diameter of each of-the propeller blades (43) is somewhat smaller than the diameter of the blades shown in the embodiment, for example, of Fig. 4. The blades are positioned in the open interior space between the end caps (63) of the motor (60) and the interior wall surface (15) of the housing that surrounds the inlet opening of the conduit (42).

[0056] In operation, the rotation of the propeller at the end of the motor opposite the direction of movement produces a jet of water that is discharged through conduit (40) to propel the pool cleaner forward. Reducing the size of the propeller allows the water pushed away from the propeller blade to enter the adjacent discharge conduit (42) with a minimum of turbulence produced by direct impact with interior wall (15) surrounding the conduit opening. As will be understood by those of ordinary skill in the art, the volumetric flow rate of water from the moving propeller blade into the discharge conduit is related to the diameter of the propeller blade and its position with respect to the inlet opening of the conduit. These dimensional and spacial relationships will also effect the current drawn by the motor which is related to the turbulence, back pressure and drag experienced by the respective propellers.

[0057] This arrangement also has been found to be advantageous when no clutch is installed to discontinue rotation of the non-driving propeller at the opposite end of the motor, i.e., at the end of the pool cleaner that is moving forward. Although the elements (90) of the door are closed across the conduit opening (40) at the forward end, the turbulence created by the rotating propeller blade moving in the open region between the end of the motor and the central wall (15) surrounding the closed conduit creates less drag or resistance force on the rotating propeller than when the propeller is in the confined space surrounded by the discharge conduit (40) and closed door panels (90) as in the embodiment illustrated in Fig. 4.

[0058] The beneficial effects of reducing the diameter of the propeller and moving the propeller from a position inside of the discharge conduit, as illustrated in Fig. 4, to a position proximate to, but just outside of the discharge conduit, as illustrated in the embodiment of Fig. 9B, was determined by measuring the amps drawn by the motor (60) with the propellers in the alternative configuration displaced from the interior of the discharge conduit. With the propellers positioned as in Fig. 4 and the propeller at the forward end immobilized by virtue of an optional clutch (67), shown in phantom, the motor (60) was observed to draw 2.5 amps during operation of the jet drive. When the motor was used to rotate both propellers in the configuration of Fig. 9B, the current drawn was 3.5 amps. This is an acceptable value that will not adversely affect the useful life of the motor. When both propellers were rotated in the configuration of Fig. 4, i.e., with each propeller inside of, and surrounded by its respective discharge conduits and the forward conduit door (9) closed, the current drawn by the motor was about 30% greater than measured for the test using the configuration represented by Fig. 9B. Regular operation of the motor at this higher current value represents a significant load and could be expected to shorten the life of the motor. The only alternative would be to employ a larger and more powerful motor that would require more current to produce the same driving force. Thus, the configuration of Fig. 9B has the dual advantages of reducing the capital cost to the manufacturer and the operational electric power costs to the user.

[0059] The effect on the force of the water jet, as determined by measuring the rate of movement of the pool cleaner in feet/minute was found to be negligible with the propeller in the position displaced from the discharge conduit in the embodiment shown in Fig. 9B. Although the diameter of the propellers is slightly smaller in this arrangement, it is apparent that the great majority of the moving water jet is directed into to the conduit (40) and discharged efficiently to propel the pool cleaner in the opposite forward directions.

[0060] From the above description of the comparative test results, it can be concluded that the desired propelling forces can be produced using a relatively smaller motor that is both less expensive to purchase and consumes less electrical energy, thereby resulting in reduced operating costs to the user.

[0061] Referring to Figs. 14-16, the pool cleaner of the present invention not only cleans the bottom surface of the pool, but also is capable of ascending and cleaning the sidewalls of the pool. Referring again to Figs. 4, 7 and 9, the pool cleaner 10 includes a floatation device

140 positioned along the upper interior surface of the upper housing cover 12A towards the end A of the cleaner proximate the pair of wheels 30. The flotation device 140 is fabricated from a material that has sufficient buoyancy to lift end A of the cleaner at least a predetermined angle when the vertical discharge conduit is occluded by the flap valve 96 or the propulsion system is turned off. The floatation device 140 can be an air-filled bladder, or be fabricated from polystyrene, polyethylene or other water stable foam blocks or sheets, or any other well-known material that provides sufficient buoyancy capable of raising the pair of wheels 30 at end A of the pool cleaner off the bottom surface of the pool.

[0062] The pool cleaner 10 can include a ballast member 142 at a position on the base plate 16 towards the opposing second end B of the cleaner that is opposite the flotation device 140 and proximate the single wheel assembly 32. The ballast member 142 can be fabricated from a material that is resistant to water and salt, such as stainless steel, ceramic materials, and the like, and is preferably in the form of a plate. The ballast member 142 is preferably mounted to the interior surface of the base plate 16, so that it does not interfere with the flow of water through the inlet ports 18 and filters 88, although the shape and positioning of the ballast 142 is not to be considered limiting. The ballast 142 can be used to provide stability to the cleaner as it traverses the pool surfaces. The ballast 142 also serves as a counter-weight to the floatation device 140, such that when end A of the cleaner 10 floats upward, the opposite end B with the ballast will not float upwards and the single wheel assembly 32 maintains contact with the surface of the pool. Accordingly, the weight of the ballast 142 is selected to prevent end B of the cleaner from floating upward, but does not prevent the cleaner 10 from climbing a sidewall of the pool when the propulsion system is activated, as described below in further detail with respect to the flow diagram of Figs. 10A and 10B.

[0063] Referring again to Figs. 4, 9, and 14-16, the pool cleaner 10 includes a propulsion cutoff switch 130, which is electrically coupled to the controller 68 via conductor 138 and the electric motor 60 via conductors 136. Preferably the cutoff switch 130 is a mercury switch that opens or closes to control power to the propulsion system when encountering and negotiating a sidewall of the pool. As illustratively shown in Figs. 14-16, the mercury switch 130 includes a sealed housing 132 that contains a quantity of mercury 134 that is sufficient to flow between the pair of terminals of conductors 136 to form a conductive circuit path, as well as to contact a terminal of conductor 138 to complete a circuit path to the controller 68. Various types and configurations of mercury switches are well known and have long been used in the art as signal generating sources.

[0064] Figs. 10A and 10B collectively depict a flow diagram of a method 1000 for ascending and descending a vertical sidewall of a pool. Figs. 10A and 10B should be viewed in conjunction with Figs. 14-16.

[0065] Referring now to Figs 10A and 10B, starting with step 1001 in which the pool cleaner is in position on the surface of the bottom of the pool, the pump motor is activated in step 1002 to propel the pool cleaner in a forward direction as defined by the end of the unit having the axle-mounted wheels. As indicated in step 1004, the pool cleaner advances to a position adjacent a side wall of the pool, and a signal from an on-board sensor in step 1006 indicates that the forward end of the pool cleaner is in close proximity to the sidewall.

[0066] A signal is sent from the processor/controller in step 1008 to interrupt the vertical discharge of pressurized water through the auxiliary discharge port thereby eliminating the downward force vector at the forward end of the pool cleaner. Optionally, the power to the pump motor can also be terminated for a predetermined period of time, or until a signal is received from an orientation sensing device.

[0067] Since the forward end of the pool cleaner housing includes a flotation device, the forward end will float up under its effect in step 1010 to form an angle ranging from 45° to 60° with the horizontal.

[0068] When the pool cleaner body has achieved an angle of at least 45°, a tilt sensor transmits a signal to the processor/controller in step 1012 and a further signal is generated to reinstitute the discharge of water through the auxiliary discharge port and thereby provide an opposing force vector to direct the pool cleaner towards the side wall in a vertical orientation. In an optional embodiment of step 1012, a timer clock is activated when the vertical discharge of water is interrupted in step 1008 and after a predetermined period of time, the discharge is resumed. The time required for the unit to achieve the desired angular orientation of the forward end can be readily determined by those of ordinary skill in the art using simple experimentation for use in programming the processor/controller. As noted above in conjunction with the description of step 1008, the pump motor can remain activated so that the unit may be moved closer to the wall as the flotation lifts the forward end; if the pump has been interrupted, then it will be reactivated by a signal from the processor/controller at the same time that the discharge of water from the auxiliary discharge port resumes. With the pump motor running, the pool cleaner ascends the side wall of the pool.

[0069] When the pool cleaner reaches the water line in step 1014, a signal is sent either by an optional sensor or a time clock that initiated the count of a predetermined period of time after the reactivation of the vertical discharge of water in step 1012.

[0070] In accordance with step 1016, the interruption of power to the pump motor is continued for a predetermined period of time as measured by the timer clock, or until a sensor signal is generated indicating that the pool cleaner has again assumed a generally horizontal position on the bottom of the pool. Thereafter, the pump motor is activated in step 1018, in one embodiment with the opposite polarity to propel the pool cleaner in a new di-

rection with the swivel wheel in the forward position. The pool cleaner continues moving in accordance with a pattern determined by the setting of the swivel wheel, which direction may also be affected by encounters with arcuate curve surfaces joining the bottom and side walls of the pool which do not interrupt the movement of the unit and/or encounters with other objects/obstacles in the pool which may deflect the movement of the unit, but do not cause it to come to a complete stop. In accordance with step 1020, a signal is generated to interrupt power to the pump motor when a motion sensor detects that the pool cleaner has stopped moving. Thereafter, the processor/controller reverses the polarity and activates the pump motor in step 1022 to propel the unit in a new direction with the axle-mounted wheels defining the forward end. As indicated in step 1024, the sequence of steps of this process are repeated as in step 1006 when the forward end is proximate a side wall.

[0071] Referring to Figs. 17-20, bottom views schematically illustrating embodiments of the invention in which the cleaner's pair of supporting wheels 30 are mounted on the axle 31 that is offset at an angle to a line that is normal to the longitudinal axis of the cleaner are illustratively shown.

[0072] In Fig. 17, the axle 31 is mounted in a slot 160 on one side of the unit so that the wheel 30 adjacent the slot 160 can slide forward and backwardwith the axle to be either parallel to the cleaner's longitudinal axis, or at an angle thereto, depending on the direction of movement of the cleaner 10. In the embodiment of Fig. 18, the axle swivels in a larger slot 160 to achieve angular positioning of wheels to the robotic cleaner's body in both extreme positions.

[0073] From the above description, it will be understood that when operating in a rectangular pool or tank, the embodiments shown in Figs. 17 and 18 allow the robot to move parallel to the swimming pool's end walls, even when it travels other than perpendicular to the sidewalls. In other words, the correct scanning pattern does not require an angular change in the alignment of the robot's body caused by a forceful contact with a swimming pool wall as with the prior art. This feature is particularly important where a water jet propulsion means is employed because as the filter assembly accumulates debris in the jet propulsion system, the force of the water jet weakens and the force of impact lessens, so that the cleaner's body may not may not be able to complete the pivoting action required to put it into the correct position before it reverses direction. This disadvantage is especially true in Gunite or other rough-surfaced pools in which a pool cleaner with even a clean filter assembly may not be able to pivot into proper position, since the resistance or frictional forces between the wheels and the bottom surface of pool may be too great to allow the necessary side-ways sliding of the wheels before reversal of the motor occurs.

[0074] As shown in Fig. 19, one end of the axle 31 is mounted in a corresponding slot 160 to permit the axle 31 to move longitudinally at that end. This longitudinal sliding motion can be restricted by one or more repositionable guide pins 162. These pins 162 allow the user to adjust the angular positioning of the axle 31 to accommodate the width or other characteristics of the pool and achieve an optimum scanning pattern for the cleaner.

[0075] In Fig. 20, each end of the axle 31 is mounted in a corresponding slot 162 to permit longitudinal movement at both ends. This will allow the robotic cleaner 10 with proper positioning of the guide pins 162 to advance in a relatively small arcuate pattern in one direction and in a different larger one in the other.

[0076] The use of this method and apparatus are known in the art and are also described in detail in USP 6,412,133 referred to above. The optional predetermined movement of the end(s) of the axle(s) will provide patterned movement of the pool cleaner that afford the user the opportunity to make the selection in order to customize the unit to maximize the efficient cleaning of round, oval, rectangular and kidney-shaped pools of varying sizes.

[0077] The invention has been described and illustrated in detail and various modifications and enhancements will become apparent to those of ordinary skill in the art from this disclosure. The scope of the invention and its protection are defined by the appended claims.

Claims

1. A self-propelled pool cleaner for cleaning the submerged surface of a pool or tank that is propelled by the discharge of a water jet, the pool cleaner comprising:

   a water pump that includes a reversible electric pump motor (60) having a driveshaft that extends from either end of the pump motor (60), a propeller (64) operatively connected to each end of the drive shaft, the axis of the pump motor (60) and driveshaft extending along the longitudinal axis of the pool cleaner;

   a housing (12) having an interior in which the water pump is mounted, the housing (12) having a first water jet discharge port positioned at one end and a second water jet discharge port positioned at the opposite end of the housing (12), each of the discharge ports selectively being in an open position while the other is in a closed position to control the directional discharge of a water jet that is sufficient to propel the pool cleaner in a direction of movement corresponding generally to the longitudinal axis of the pool cleaner;

   a pair of water jet discharge conduits (42), each water discharge conduit being positioned between the pump motor (60) and the water jet discharge port at the respective ends of the pool

cleaner;
a water jet discharge valve positioned downstream of the propeller (64) in each water jet discharge conduit between the propeller and the discharge port, the operation of each discharge valve being responsive to the flow of pressurized water,
wherein pressurized water selectively flows through one or the other of the discharge ports in the form of a water jet as determined by the direction of rotation of the pump motor (60) to propel the pool cleaner;
characterized in that each of the propellers (64) being positioned adjacent to and outside of the interior end of one of the water jet discharge conduits (42) in an open interior space between the ends of the motor (60) and an interior wall surface (15) of the housing that surrounds the inlet opening of the conduit (42), said propellers (64) having a reduced size that allows the water pushed away to enter the adjacent discharge conduit (42) with a minimum of turbulence produced by direct impact with interior wall (15).

2. The pool cleaner of claim 1 in which each water jet discharge conduit is positioned at an acute angle with respect to the surface of the pool being cleaned.

3. The pool cleaner of claim 1 in which a one-way drive clutch is mounted between the pump motor (60) and each of the respective propellers (64), wherein the propeller (64) on the end of the driveshaft in the direction of movement of the pool cleaner does not rotate.

4. The pool cleaner of claim 1 wherein the water jet discharge valve associated with each discharge port being responsive to the flow of pressurized water from the propellers (64).

5. The pool cleaner of claim 1, wherein the first propeller (64) provides a first output water flow generally longitudinally aligned with the first discharge port, and the second propeller (64) provides a second output water flow generally longitudinally aligned with the second discharge port.

6. The pool cleaner of claim 1, wherein rotation of the driveshaft in one direction causes both first and second propellers (64) to rotate in a like direction to produce a low pressure zone at one end of the housing (12) that closes the adjacent discharge port, and to produce a high pressure zone that opens the other discharge port at the opposite end of the housing (12).

7. The pool cleaner of claim 1, further comprising at least one filter mounted in the housing (12) to capture debris entrained in water flowing between at least one inlet port, which is provided in a bottom portion of the housing (12), and one of the first and second discharge ports.

8. The pool cleaner of claim 1, further comprising a controller operably coupled to the water pump, said controller providing control signals to regulate the direction of rotation of the pump motor (60).

9. The pool cleaner of claim 1, wherein the pump motor (60) includes opposing streamlined end plates extending from the periphery of the pump motor (60) to the driveshaft to minimize turbulence adjacent the end of the pump motor (60).

10. The pool cleaner of claim 1 further comprising a vertical discharge port at either end of the housing (12) and in fluid communication with the interior of the housing (12) for discharging a water jet that is generally normal to the surface being cleaned to thereby exert a downward force vector.

11. A method for cleaning a submerged surface of a pool with a self-propelled pool cleaner, said pool cleaner including a housing (12) having a first discharge port at a front end thereof and a second discharge port at a rear end thereof, traversing means attached to the housing (12) for supporting above and moving the cleaner along the surface of the pool to be cleaned, at least one inlet port formed in a bottom surface of the housing (12), a water pump having a pair of propellers (64), each of which is affixed to an opposing end of a driveshaft which extends within the housing (12), along the longitudinal axis of the cleaner, a water jet discharge conduit positioned between the pump motor (60) and the water jet discharge port at the respective ends of the pool cleaner, and each one of the propellers (64) being positioned adjacent to and outside an interior end of the water jet discharge conduit in an open interior space between the ends of the motor (60) and an interior wall surface (15) of the housing that surrounds the inlet opening of the conduit (42), said propellers (64) having a reduced size that allows the water pushed away to enter the adjacent discharge conduit (42) with a minimum of turbulence produced by direct impact with interior wall (15), the method comprising:

- rotating the pair of propellers (64) simultaneously in a common rotational direction;
- drawing water from the pool into the housing (12) through the at least one inlet port for filtering;
- closing a first valve to close one of the water jet discharge ports;
- opening a second valve to open the other water jet discharge port; and
- discharging filtered water from the interior of

the housing (12) through the open water jet discharge port in the form of a water jet having sufficient force to propel the cleaner in a direction of movement generally corresponding to the longitudinal axis.

12. The method of claim 11 further comprising the step of controlling the rotational direction of the pair of propellers (64) to open and close the respective water jet discharge ports.

13. The method of claim 11 further comprising the step of controlling the rotational direction of the pair of propellers (64) to provide an output water flow in a direction to open one of the water jet discharge ports, such that water flowing into the at least one inlet port and through the housing (12) is discharged through the open water jet discharge port in the form of the water jet to propel the cleaner in the opposite direction.

14. The method of claim 11 further comprising the step of providing a vertical discharge port positioned generally normal to the longitudinal axis of the cleaner, said vertical discharge port discharging a third water jet that exerts a downward force vector that is generally normal to longitudinal axis of the housing (12).

15. The method of claim 11 wherein reversing the direction of rotation of both first and second propeller (64) reverses the low and high pressure zones at the respective ends of the housing (12) and thereby closes the previously open discharge port and opens the previously closed discharge port.

16. The method of claim 11 further comprising the step of discharging the water jet through the open water jet discharge port at an acute angle with respect to a pool surface beneath the cleaner.

Patentansprüche

1. Ein selbstfahrender Schwimmbeckenreiniger zum Reinigen der untergetauchten Oberfläche eines Schwimmbeckens oder Tanks, welcher durch den Ausstoß eines Wasserstrahls angetrieben wird, wobei der Schwimmbeckenreiniger aufweist:

eine Wasserpumpe, die einen reversiblen elektrischen Pumpenmotor (60) mit einer Antriebswelle umfasst, die sich von beiden Ende des Pumpenmotors (60) aus erstreckt, einen Propeller (64), der mit jedem Ende der Antriebswelle in Wirkverbindung steht, wobei sich die Achse des Pumpenmotors (60) und die Antriebswelle entlang der Längsachse des Schwimmbeckenreinigers erstrecken;

ein Gehäuse (12) mit einem Innenraum, in dem die Wasserpumpe montiert ist, wobei das Gehäuse (12) eine erste Wasserstrahlauslassöffnung aufweist, die an einem Ende positioniert ist, und eine zweite Wasserstrahlauslassöffnung, die am gegenüberliegenden Ende des Gehäuses (12) positioniert ist, wobei sich jede der Auslassöffnungen selektiv in einer offenen Position befindet, während sich die andere in einer geschlossenen Position befindet, um den gerichteten Ausstoß eines Wasserstrahls zu steuern, welche ausreicht, um den Schwimmbeckenreiniger in einer Bewegungsrichtung anzutreiben, die im Allgemeinen der Längsachse des Schwimmbeckenreinigers entspricht;

ein paar Wasserstrahlauslassleitungen (42), wobei jede Wasserstrahlauslassleitung zwischen dem Pumpenmotor (60) und der Wasserstrahlauslassöffnung an den jeweiligen Enden des Schwimmbeckenreinigers angeordnet ist;

ein Wasserstrahlauslassventil, das stromabwärts des Propellers (64) in jeder Wasserstrahlauslassleitung zwischen dem Propeller und der Auslassöffnung angeordnet ist, wobei der Betrieb jedes Auslassventils auf die Strömung von unter Druck stehenden Wasser reagiert, wobei unter Druck stehendes Wasser selektiv durch die eine oder andere der Auslassöffnungen in Form eines Wasserstrahls fließt, wie durch die Drehrichtung des Pumpenmotors (60) bestimmt ist, um den Schwimmbeckenreiniger anzutreiben;

dadurch gekennzeichnet, dass jeder der Propeller (64) angrenzend an und außerhalb des inneren Endes einer der Wasserstrahlauslassleitung (42) in einem offenen Innenraum zwischen den Enden des Motors (60) und einer Innenwandfläche (15) des Gehäuses, die die Einlassöffnung der Leitung (42) umgibt, angeordnet ist, wobei die Propeller (64) eine reduzierte Größe aufweisen, die es dem verdrängten Wasser ermöglicht, mit einem Minimum an Turbulenzen, die durch direkten Aufprall auf die Innenwand (15) erzeugt werden, in die angrenzende Auslassleitung (42) einzutreten.

2. Der Schwimmbeckenreiniger nach Anspruch 1, bei dem jede Wasserstrahlauslassleitung in einem spitzen Winkel zur Oberfläche des zu reinigenden Schwimmbeckens angeordnet ist.

3. Der Schwimmbeckenreiniger nach Anspruch 1, bei dem eine Einweg-Antriebskupplung zwischen dem Pumpenmotor (60) und jedem der entsprechenden Propeller (64) montiert ist, wobei sich der Propeller (64) am Ende der Antriebswelle in Bewegungsrichtung des Schwimmbeckenreinigers nicht dreht.

4. Der Schwimmbeckenreiniger nach Anspruch 1, wobei das Wasserstrahlauslassventil, das jeder Auslassöffnung zugeordnet ist, auf die Strömung von unter Druck stehenden Wasser aus dem Propellern (64) reagiert.

5. Der Schwimmbeckenreiniger nach Anspruch 1, wobei der erste Propeller (64) einen ersten Ausgangswasserstrom liefert, der im Allgemeinen in Längsrichtung mit der ersten Auslassöffnung ausgerichtet ist, und der zweite Propeller (64) einen zweiten Ausgangswasserstrom liefert, der im Allgemeinen in Längsrichtung mit der zweiten Auslassöffnung ausgerichtet ist.

6. Der Schwimmbeckenreiniger nach Anspruch 1, wobei eine Drehung der Antriebswelle in eine Richtung sowohl den ersten als auch den zweiten Propeller (64) veranlasst, sich in eine gleiche Richtung zu drehen, um einen Niederdruckzone an einem Ende des Gehäuses (12) zu erzeugen, die die benachbarte Auslassöffnung verschließt, und eine Hochdruckzone zu erzeugen, die die andere Auslassöffnung am gegenüberliegenden Ende des Gehäuses (12) öffnet.

7. Der Schwimmbeckenreiniger nach Anspruch 1, weiterhin aufweisend mindestens einen Filter, der in dem Gehäuse (12) montiert ist, um Verunreinigungen, die in dem Wasser, welches zwischen der mindestens einen Einlassöffnung, welche in einem unteren Abschnitt des Gehäuses (12) vorgesehen ist, und einer der ersten und zweiten Auslassöffnungen fließt, aufzufangen.

8. Der Schwimmbeckenreiniger nach Anspruch 1, weiterhin aufweisend eine Steuerung, die operativ mit der Wasserpumpe gekoppelt ist, wobei die Steuerung Steuerungssignale bereitstellt, um die Richtung der Drehung des Pumpenmotors (60) zu regulieren.

9. Der Schwimmbeckenreiniger nach Anspruch 1, wobei der Pumpenmotor (60) gegenüberliegende stromlinienförmige Endplatten aufweist, die sich vom Umfang des Pumpenmotors (60) zur Antriebswelle erstrecken, um Turbulenzen in der Nähe des Endes des Pumpenmotors (60) zu minimieren.

10. Der Schwimmbeckenreiniger nach Anspruch 1, weiterhin aufweisend eine vertikale Auslassöffnung an beiden Enden des Gehäuses (12) und in Fluidkommunikation stehend mit dem Inneren des Gehäuses (12), zum Ausstoßen eines Wasserstrahls, der im Allgemeinen senkrecht zur zu reinigenden Oberfläche steht, um dadurch einen nach unten gerichteten Kraftvektor auszuüben.

11. Ein Verfahren zum Reinigen einer untergetauchten Oberfläche eines Schwimmbeckens mit einem selbstfahrenden Schwimmbeckenreiniger, wobei der Schwimmbeckenreiniger ein Gehäuse (12) mit einer ersten Auslassöffnung an einem vorderen Ende aufweist und eine zweite Auslassöffnung an einem hinteren Ende, ein am Gehäuse (12) angebrachtes Verfahrmittel, um den Reiniger oben zu stützen und entlang der Oberfläche des zu reinigenden Schwimmbeckens zu bewegen, mindestens eine in einer Bodenfläche des Gehäuses (12) ausgebildete Einlassöffnung, eine Wasserpumpe mit einem Paar von Propellern (64), von denen jeder an einem gegenüberliegenden Ende einer Antriebswelle befestigt ist, die sich innerhalb des Gehäuses (12) erstreckt, entlang der Längsachse des Schwimmbeckenreinigers, eine Wasserstrahlauslassleitung, die zwischen dem Pumpenmotor (60) und einer Wasserstahlauslassöffnung an den jeweiligen Enden des Schwimmbeckenreinigers angeordnet ist, und wobei jeder der Propeller (64) angrenzend an und außerhalb eines inneren Endes der Wasserstrahlauslassleitung in einem offenen Innenraum zwischen den Enden des Motors (60) und einer inneren Wandfläche (15) des Gehäuses, welches die Einlassöffnung der Leitung (42) umgibt, positioniert ist, wobei die Propeller (64) eine reduzierte Größe aufweisen, die es dem verdrängten Wasser erlaubt, mit einem Minimum an Turbulenzen, die durch direkten Aufprall auf die Innenwand (15) erzeugt werden, in die benachbarte Auslassleitung (42) einzutreten, wobei das Verfahren umfasst:

- gleichzeitiges Rotieren des Propellerpaares (64) in eine gemeinsame Drehrichtung;
- Ansaugen von Wasser aus dem Schwimmbecken in das Gehäuse (12) durch die mindestens eine Einlassöffnung zur Filterung;
- Schließen eines ersten Ventils zum Verschließen einer der Wasserstrahlauslassöffnungen;
- Öffnen eines zweiten Ventils, um die andere Wasserstrahlauslassöffnung zu öffnen; und
- Ausstoßen von gefilterten Wasser aus dem Inneren des Gehäuses (12) durch die offene Wasserstrahlaustrittsöffnung in Form eines Wasserstrahls mit ausreichender Kraft, um den Reiniger in eine Bewegungsrichtung anzutreiben, die im Allgemeinen der Längsachse entspricht.

12. Das Verfahren nach Anspruch 11, weiterhin aufweisend den Schritt der Steuerung der Drehrichtung des Propellerpaares (64) zum Öffnen und Schließen der jeweiligen Wasserstrahlauslassöffnungen.

13. Das Verfahren nach Anspruch 11, weiterhin aufweisend den Schritt der Steuerung der Drehrichtung des Propellerpaares (64), um einen Ausgangswasserstrom in einer Richtung bereitzustellen, um eine der Wasserstrahlauslassöffnungen zu öffnen, sodass

Wasser, welches in die mindestens eine Einlassöffnung und durch das Gehäuse (12) fließt, durch die offene Wasserstrahlauslassöffnung in Form des Wasserstrahls ausgestoßen wird, um den Reiniger in die entgegengesetzte Richtung anzutreiben.

14. Das Verfahren nach Anspruch 11, weiterhin aufweisend den Schritt des Bereitstellens einer vertikalen Auslassöffnung, die im Allgemeinen senkrecht zur Längsachse des Reinigers positioniert ist, wobei die vertikale Auslassöffnung einen dritten Wasserstrahl ausstößt, der einen nach unten gerichteten Kraftvektor ausübt, der im Allgemeinen senkrecht zur Längsachse des Gehäuses (12) steht.

15. Das Verfahren nach Anspruch 11, wobei die Umkehrung der Drehrichtung der ersten und zweiten Propeller (64) die Nieder- und Hochdruckzonen an den jeweiligen Enden des Gehäuses (12) umkehrt, und dadurch die zuvor geöffnete Auslassöffnung verschließt und die zuvor geschlossene Auslassöffnung öffnet.

16. Das Verfahren nach Anspruch 11, weiterhin aufweisend den Schritt des Ausstoßens des Wasserstrahls durch die offene Wasserstrahlauslassöffnung in einem spitzen Winkel in Bezug auf eine Schwimmbeckenoberfläche unter dem Reiniger.

Revendications

1. Nettoyeur de piscine autopropulsé pour nettoyer la surface immergée d'une piscine ou d'un réservoir, qui est propulsé par la décharge d'un jet d'eau, le nettoyeur de piscine comprenant :

une pompe à eau qui comprend un moteur de pompe électrique réversible (60) ayant un arbre d'entraînement qui s'étend à partir de chaque extrémité du moteur de pompe (60), une hélice (64) connectée fonctionnellement à chaque extrémité de l'arbre d'entraînement, l'axe du moteur de pompe (60) et de l'arbre d'entraînement s'étendant le long de l'axe longitudinal du nettoyeur de piscine ;
un boîtier (12) ayant un intérieur dans lequel la pompe à eau est montée, le boîtier (12) ayant un premier orifice de décharge de jet d'eau positionné à une extrémité et un second orifice de décharge de jet d'eau positionné à l'extrémité opposée du boîtier (12), chacun des orifices de décharge étant sélectivement dans une position ouverte, tandis que l'autre est dans une position fermée pour contrôler la décharge directionnelle d'un jet d'eau qui est suffisant pour propulser le nettoyeur de piscine dans une direction de mouvement correspondant généralement à l'axe longitudinal du nettoyeur de piscine ;
une paire de conduits de décharge de jet d'eau (42), chaque conduit de décharge d'eau étant positionné entre le moteur de pompe (60) et l'orifice de décharge de jet d'eau aux extrémités respectives du nettoyeur de piscine ;
une vanne de décharge de jet d'eau positionnée en aval de l'hélice (64) dans chaque conduit de décharge de jet d'eau entre l'hélice et l'orifice de décharge, le fonctionnement de chaque vanne de décharge étant sensible à l'écoulement d'eau sous pression, dans lequel l'eau sous pression s'écoule sélectivement à travers l'un ou l'autre des orifices de décharge sous la forme d'un jet d'eau tel que déterminé par le sens de rotation du moteur de pompe (60) pour propulser le nettoyeur de piscine ;
caractérisé en ce que chacune des hélices (64) est positionnée de manière adjacente et à l'extérieur de l'extrémité intérieure de l'un des conduits de décharge de jet d'eau (42) dans un espace intérieur ouvert entre les extrémités du moteur (60) et une surface de paroi intérieure (15) du boîtier qui entoure l'ouverture d'entrée du conduit (42), lesdites hélices (64) ayant une taille réduite qui permet à l'eau repoussée de pénétrer dans le conduit de décharge adjacent (42) avec un minimum de turbulence produite par l'impact direct avec la paroi intérieure (15).

2. Nettoyeur de piscine selon la revendication 1, dans lequel chaque conduit de décharge de jet d'eau est positionné à un angle aigu par rapport à la surface de la piscine à nettoyer.

3. Nettoyeur de piscine selon la revendication 1, dans lequel un embrayage d'entraînement unidirectionnel est monté entre le moteur de pompe (60) et chacune des hélices respectives (64), dans lequel l'hélice (64) sur l'extrémité de l'arbre d'entraînement dans la direction du mouvement du nettoyeur de piscine ne tourne pas.

4. Nettoyeur de piscine selon la revendication 1, dans lequel la vanne de décharge de jet d'eau associée à chaque orifice de décharge est sensible à l'écoulement d'eau sous pression provenant des hélices (64).

5. Nettoyeur de piscine selon la revendication 1, dans lequel la première hélice (64) fournit un premier écoulement d'eau de sortie généralement aligné longitudinalement avec le premier orifice de décharge, et la seconde hélice (64) fournit un second écoulement d'eau de sortie généralement aligné longitudinalement avec le second orifice de décharge.

6. Nettoyeur de piscine selon la revendication 1, dans

lequel la rotation de l'arbre d'entraînement dans une direction amène les première et seconde hélices (64) à tourner dans une même direction pour produire une zone de basse pression à une extrémité du boîtier (12) qui ferme l'orifice de décharge adjacent, et à produire une zone de haute pression qui ouvre l'autre orifice de décharge à l'extrémité opposée du boîtier (12) .

7. Nettoyeur de piscine selon la revendication 1, comprenant en outre au moins un filtre monté dans le boîtier (12) pour capturer les débris entraînés dans l'eau s'écoulant entre au moins un orifice d'entrée, qui est prévu dans une partie inférieure du boîtier (12), et l'un des premier et second orifices de décharge.

8. Nettoyeur de piscine selon la revendication 1, comprenant en outre un contrôleur couplé fonctionnellement à la pompe à eau, ledit contrôleur fournissant des signaux de commande pour réguler le sens de rotation du moteur de pompe (60) .

9. Nettoyeur de piscine selon la revendication 1, dans lequel le moteur de pompe (60) comprend des plaques d'extrémité profilées opposées s'étendant de la périphérie du moteur de pompe (60) à l'arbre d'entraînement pour réduire la turbulence adjacente à l'extrémité du moteur de pompe (60).

10. Nettoyeur de piscine selon la revendication 1, comprenant en outre un orifice de décharge vertical à une extrémité quelconque du boîtier (12) et en communication fluidique avec l'intérieur du boîtier (12) pour décharger un jet d'eau qui est généralement perpendiculaire à la surface en cours de nettoyage afin d'exercer ainsi un vecteur de force vers le bas.

11. Procédé pour nettoyer une surface immergée d'une piscine avec un nettoyeur de piscine autopropulsé, ledit nettoyeur de piscine comprenant un boîtier (12) ayant un premier orifice de décharge à une extrémité avant de celui-ci et un second orifice de décharge à une extrémité arrière de celui-ci, des moyens de traversée fixés au boîtier (12) pour supporter au-dessus le nettoyeur, et le déplacer le long de la surface de la piscine à nettoyer, au moins un orifice d'entrée formé dans une surface inférieure du boîtier (12), une pompe à eau ayant une paire d'hélices (64), dont chacune est fixée à une extrémité opposée d'un arbre d'entraînement qui s'étend à l'intérieur du boîtier (12), le long de l'axe longitudinal du nettoyeur, un conduit de décharge de jet d'eau positionné entre le moteur de pompe (60) et l'orifice de décharge de jet d'eau aux extrémités respectives du nettoyeur de piscine, chacune des hélices (64) étant positionnée de manière adjacente et à l'extérieur d'une extrémité intérieure du conduit de décharge de jet d'eau dans un espace intérieur ouvert entre les extrémités du moteur (60) et une surface de paroi intérieure (15) du boîtier qui entoure l'ouverture d'entrée du conduit (42), lesdites hélices (64) ayant une taille réduite qui permet à l'eau repoussée de pénétrer dans le conduit de décharge adjacent (42) avec un minimum de turbulence produite par un impact direct avec la paroi intérieure (15), le procédé comprenant :

- la rotation de la paire d'hélices (64) simultanément dans un sens de rotation commun ;
- l'aspiration de l'eau de la piscine dans le boîtier (12) à travers ledit au moins un orifice d'entrée pour le filtrage ;
- la fermeture d'une première vanne pour fermer l'un des orifices de décharge de jet d'eau ;
- l'ouverture d'une seconde vanne pour ouvrir l'autre orifice de décharge de jet d'eau ; et
- la décharge de l'eau filtrée de l'intérieur du boîtier (12) à travers l'orifice ouvert de décharge de jet d'eau sous la forme d'un jet d'eau ayant une force suffisante pour propulser le nettoyeur dans une direction de mouvement correspondant généralement à l'axe longitudinal.

12. Procédé selon la revendication 11 comprenant en outre l'étape consistant à commander le sens de rotation de la paire d'hélices (64) pour ouvrir et fermer les orifices de décharge de jet d'eau respectifs.

13. Procédé selon la revendication 11 comprenant en outre l'étape consistant à commander le sens de rotation de la paire d'hélices (64) pour fournir un écoulement d'eau de sortie dans une direction pour ouvrir l'un des orifices de décharge de jet d'eau, de sorte que l'eau s'écoulant dans ledit au moins un orifice d'entrée et à travers le boîtier (12) est déchargée à travers l'orifice de décharge de jet d'eau ouvert sous la forme du jet d'eau pour propulser le nettoyeur dans la direction opposée.

14. Procédé selon la revendication 11 comprenant en outre l'étape consistant à fournir un orifice de décharge vertical positionné généralement perpendiculairement à l'axe longitudinal du nettoyeur, ledit orifice de décharge vertical déchargeant un troisième jet d'eau qui exerce un vecteur de force vers le bas qui est généralement perpendiculaire à l'axe longitudinal du boîtier (12).

15. Procédé selon la revendication 11, dans lequel l'inversion du sens de rotation de la première et de la seconde hélices (64) inverse les zones de basse et de haute pression aux extrémités respectives du boîtier (12) et ferme ainsi l'orifice de décharge précédemment ouvert et ouvre l'orifice de décharge précédemment fermé.

16. Procédé selon la revendication 11 comprenant en outre l'étape consistant à décharger le jet d'eau à travers l'orifice ouvert de décharge de jet d'eau à un angle aigu par rapport à une surface de piscine située sous le nettoyeur.

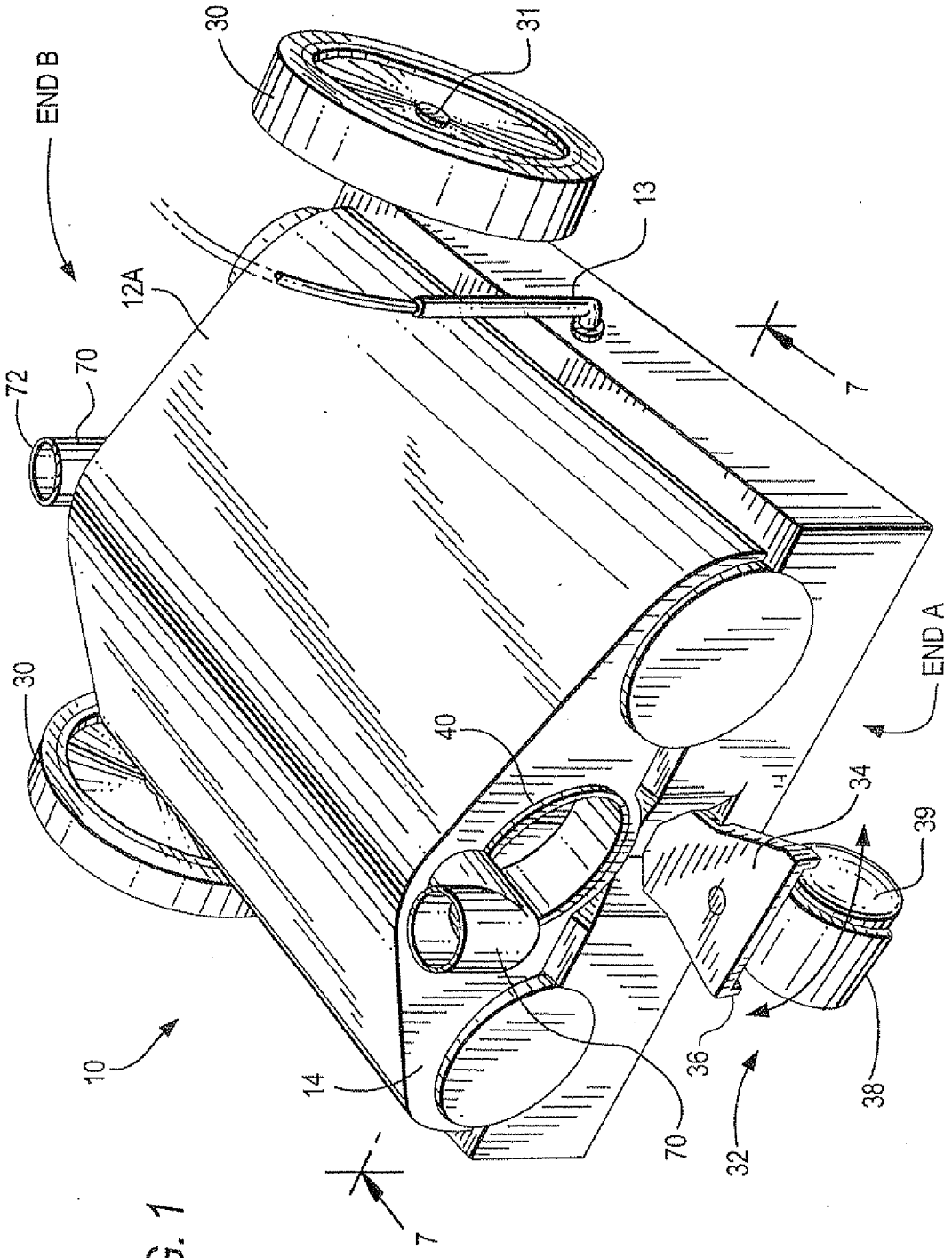


FIG. 1

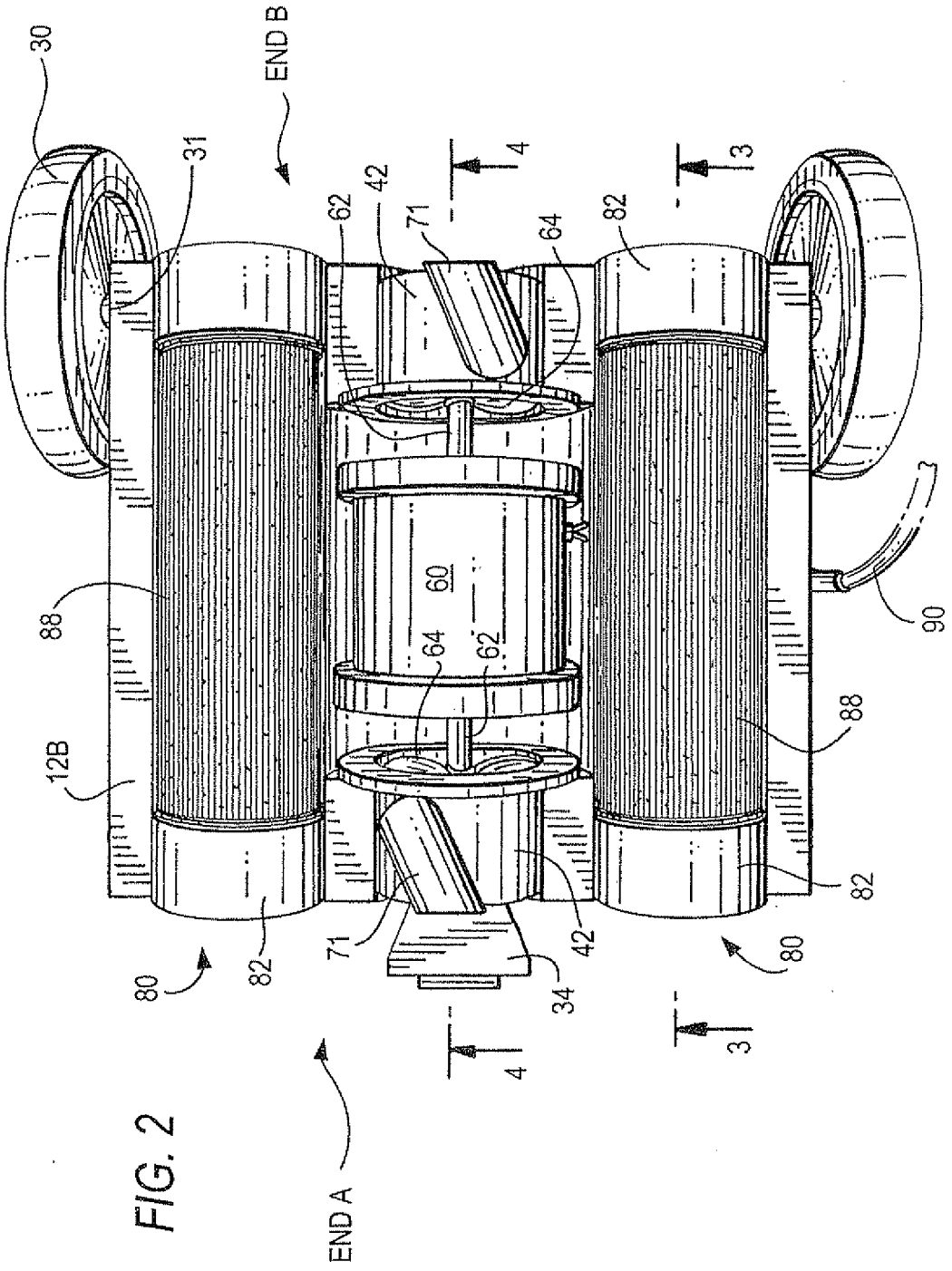
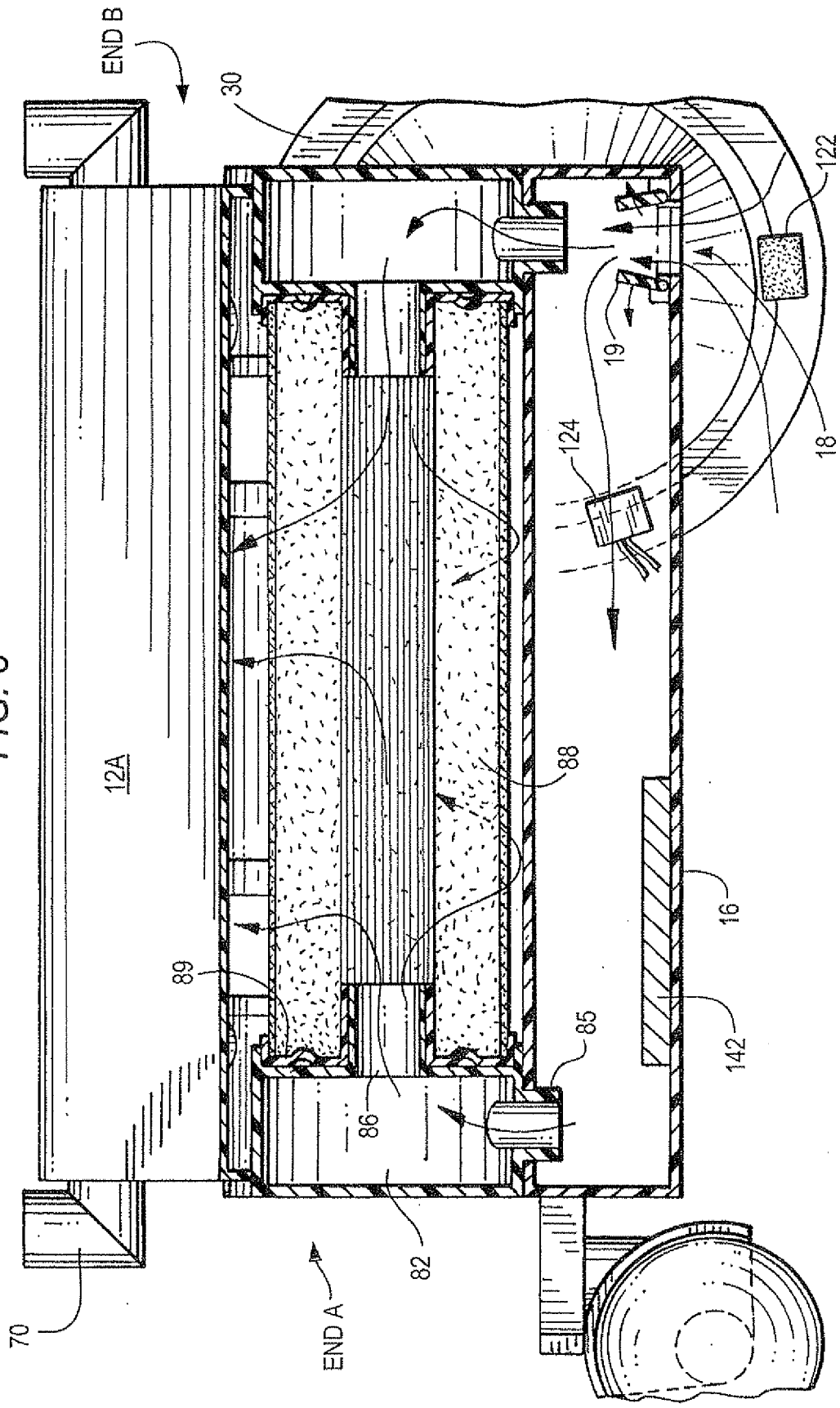

30
31
END B
62
42
71
4
64
82
3
88
60
64
62
12B
88
90
82
80
82
71
42
34
80
4
3
END A

FIG. 2

FIG. 3



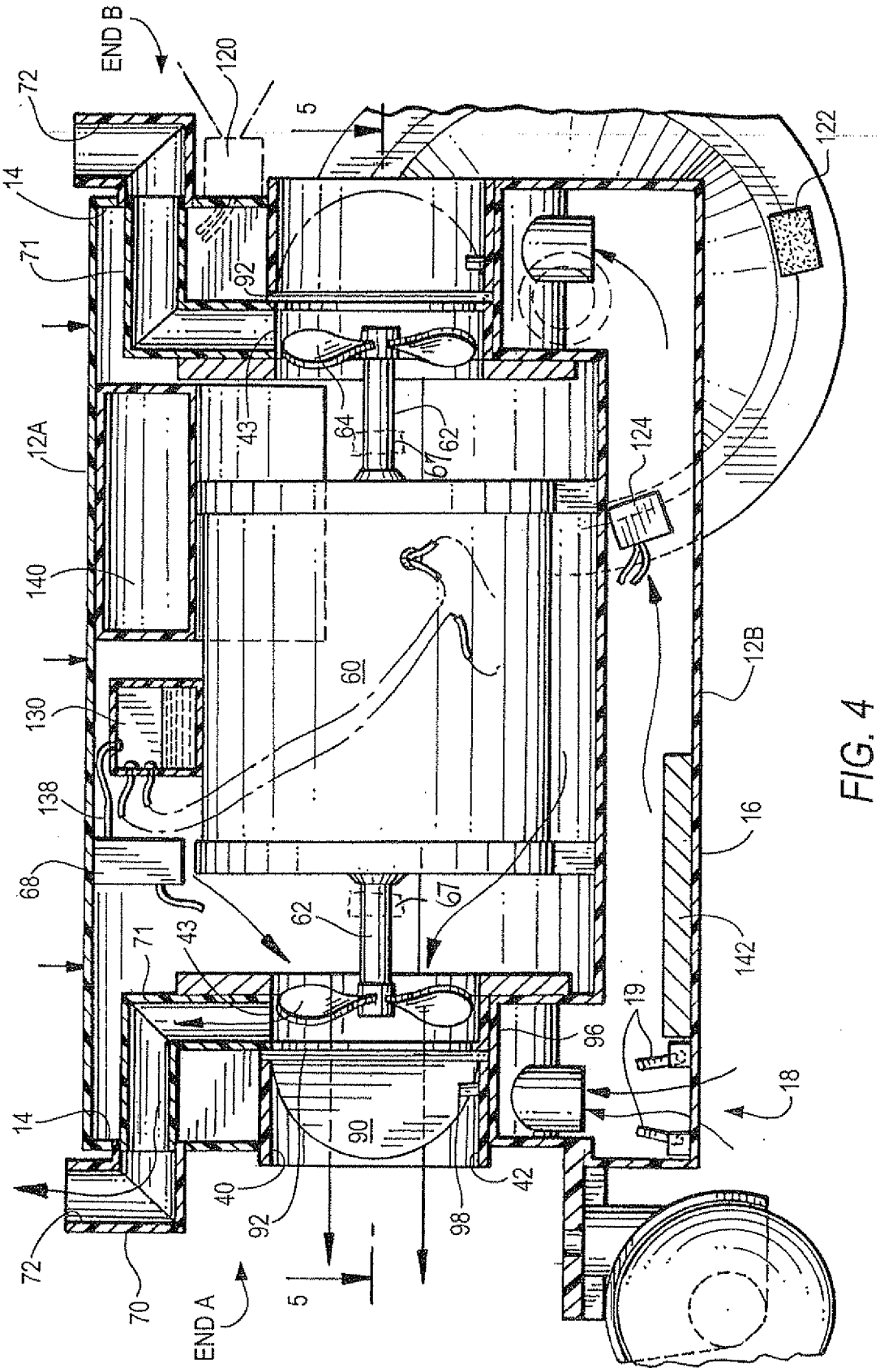

END B
120
72
5
122
14
71
92
43
64
62
67
124
12A
140
60
12B
130
138
16
68
62
67
71
43
142
19
96
18
14
90
40
92
98
42
72
70
END A
5

FIG. 4

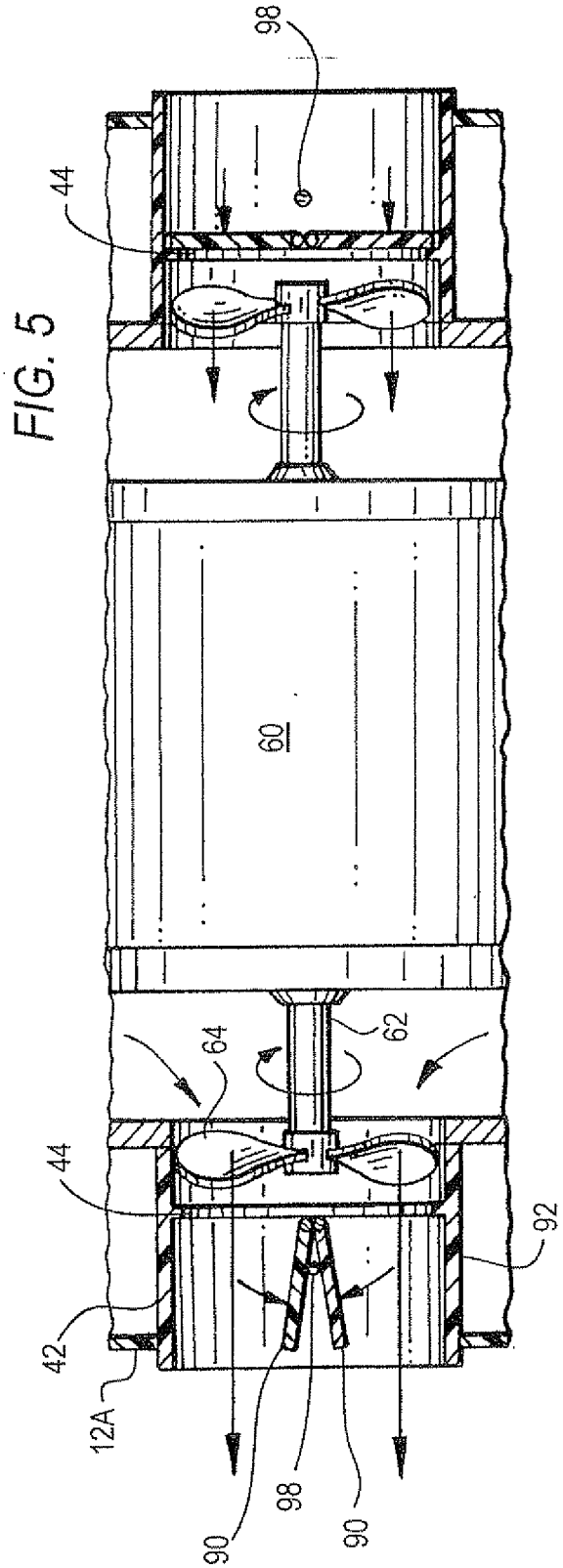


FIG. 5

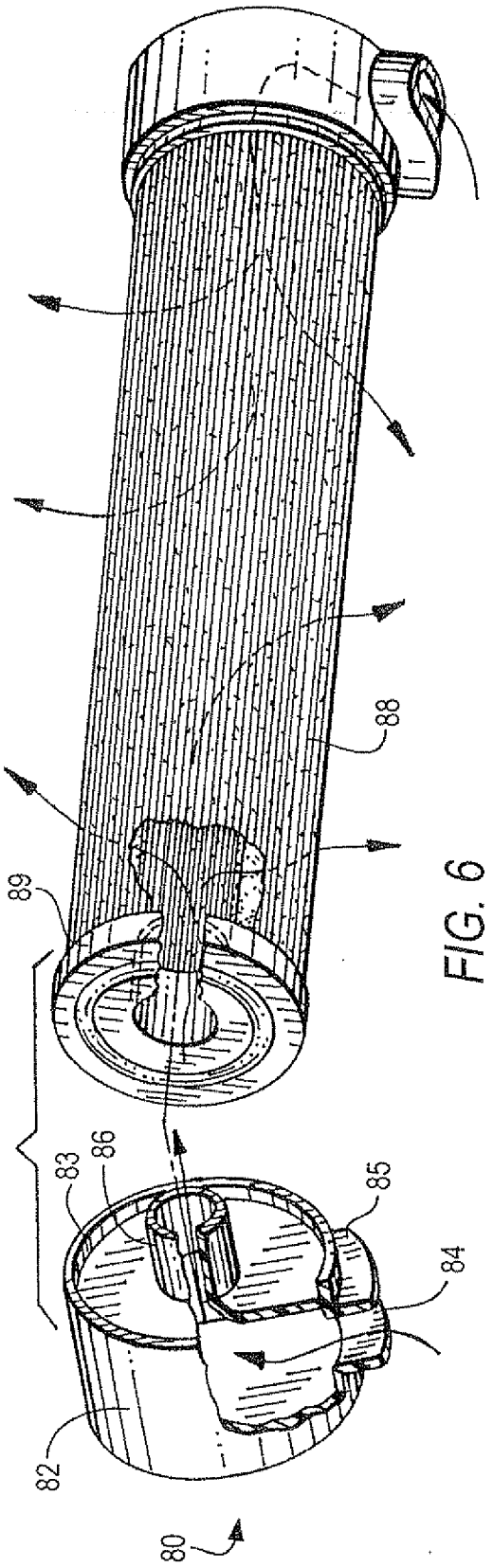
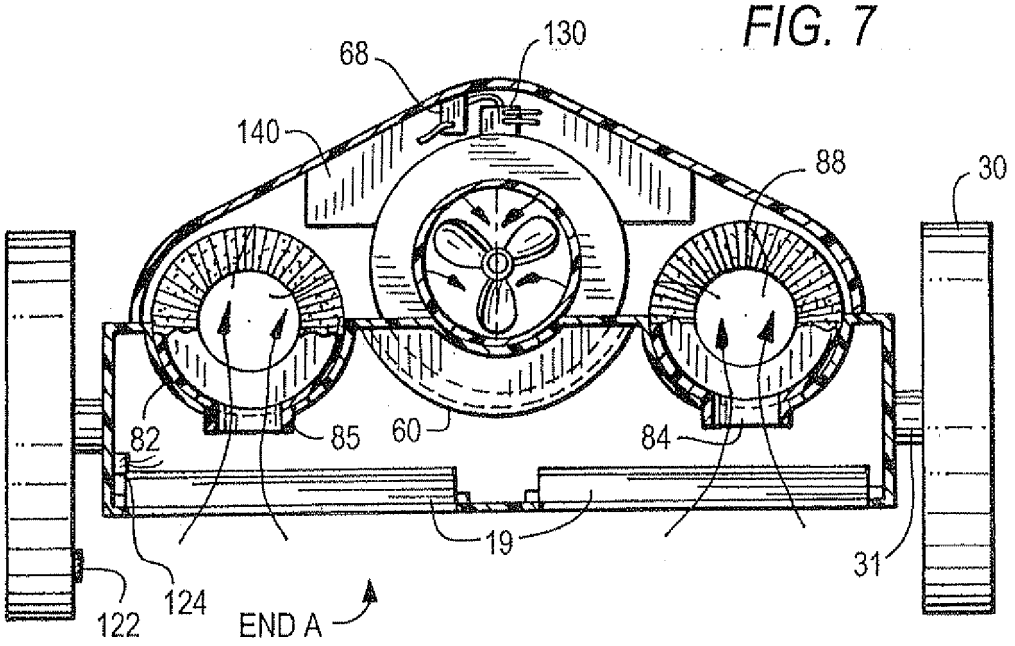


FIG. 6

FIG. 7


68
130
140
88
30
82
85
60
84
19
31
122
124
END A

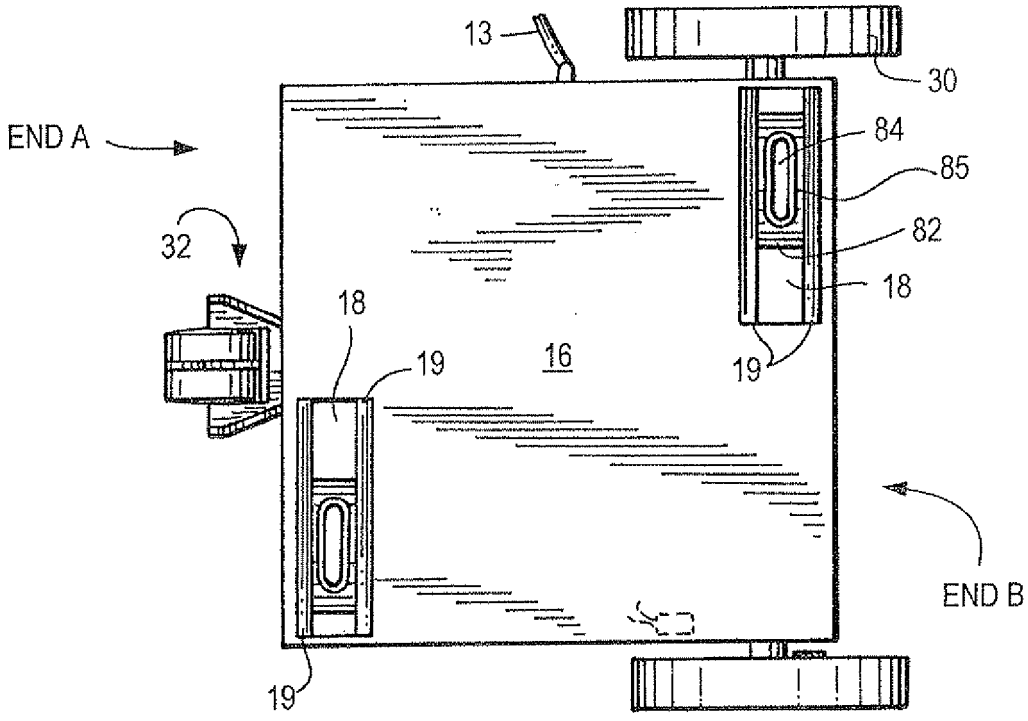

13
30
END A
84
85
32
82
18
18
19
16
19
END B
19

FIG. 8

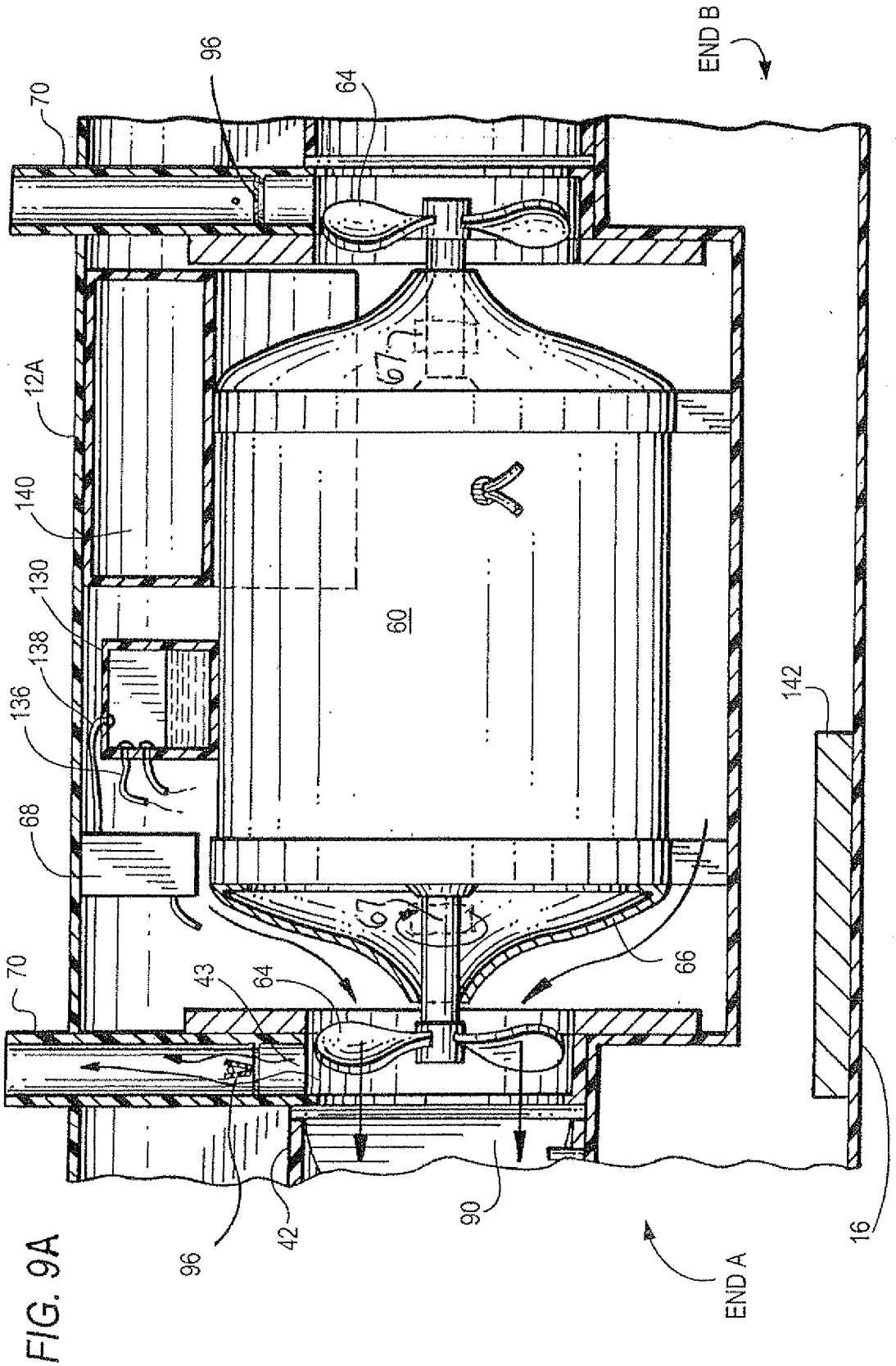

END B
96
64
70
12A
140
130
138
136
68
60
142
66
70
43
64
96
42
90
16
END A

FIG. 9A

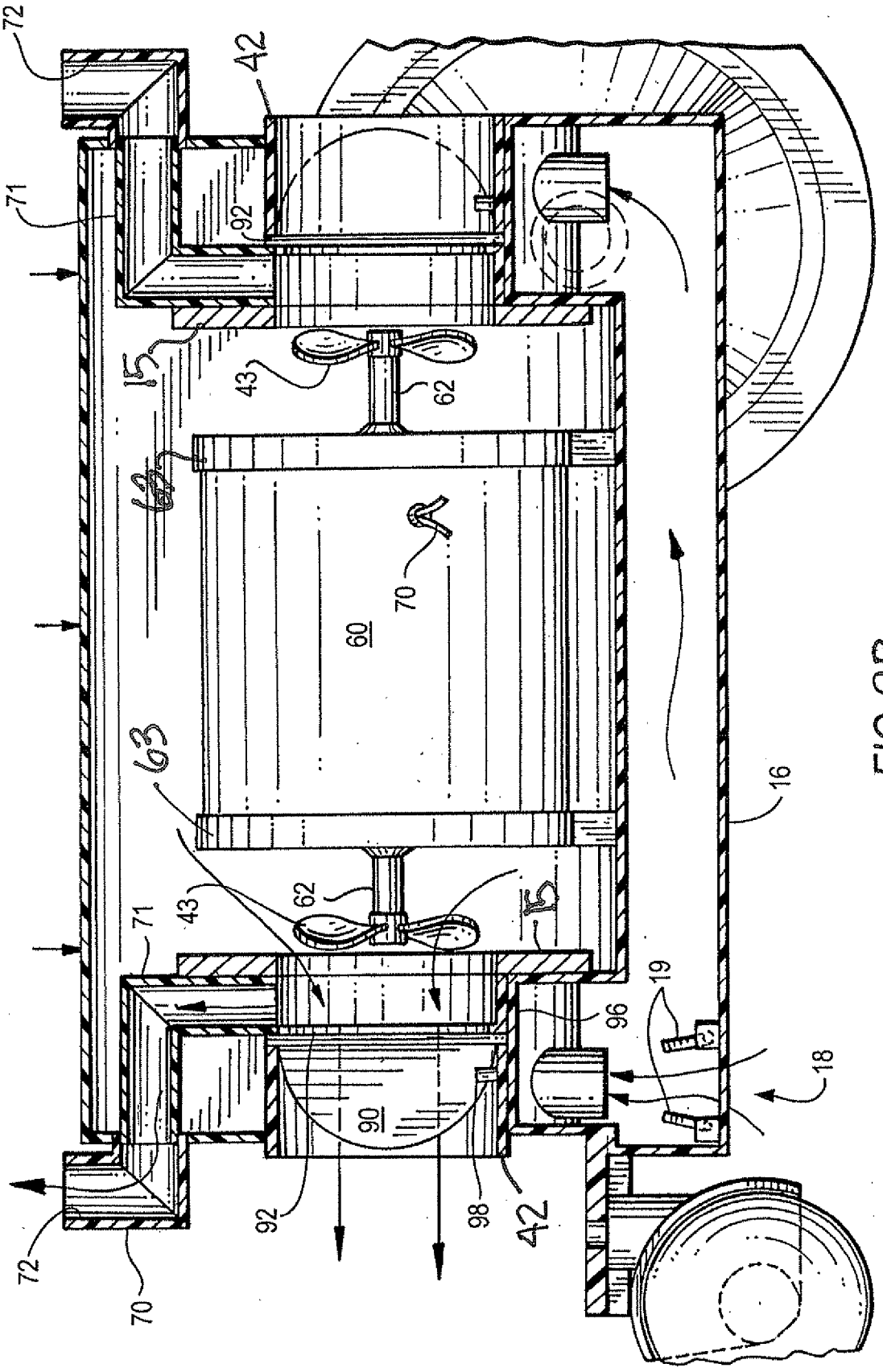


FIG.9B

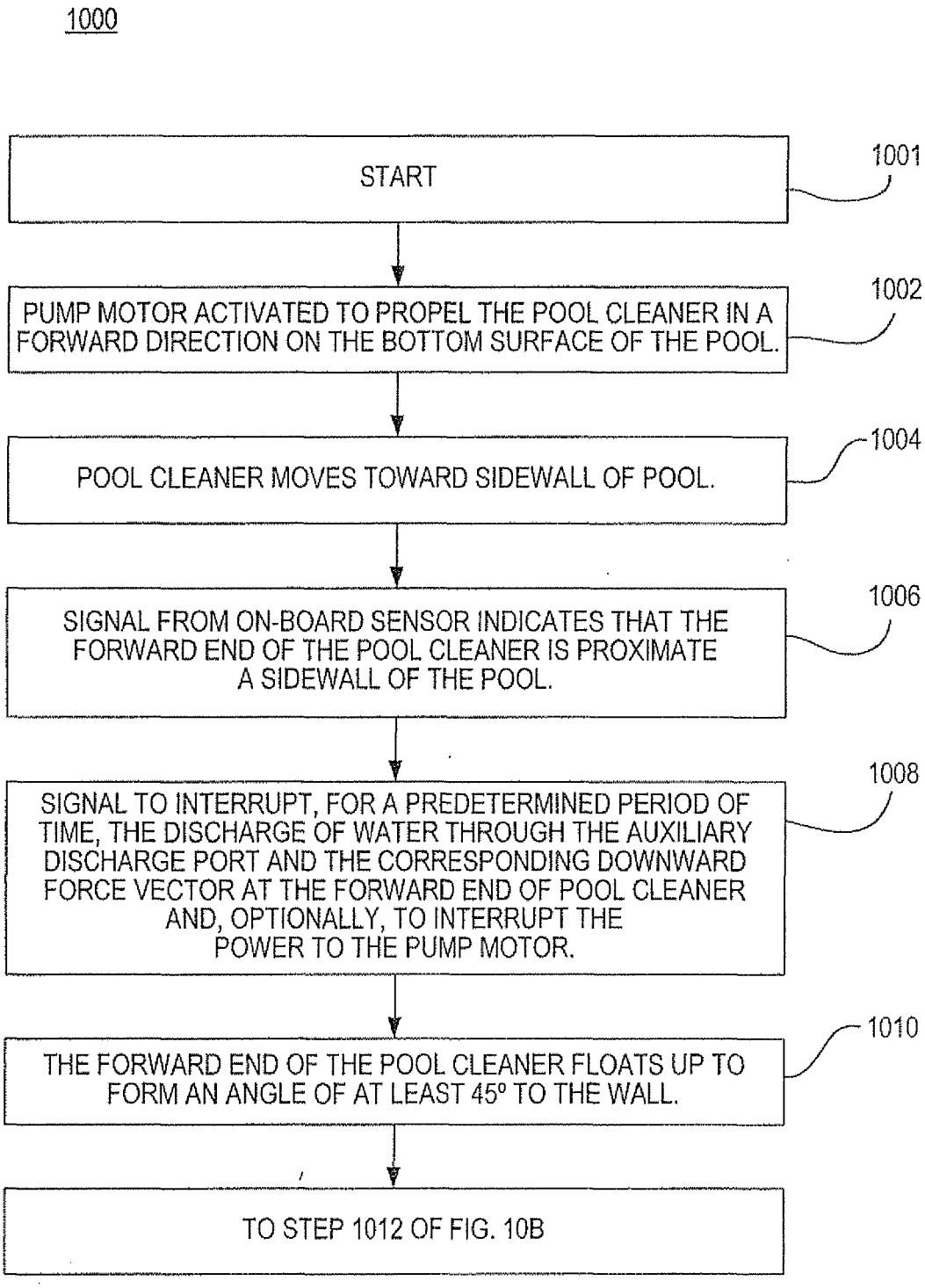

1000
START
1001
PUMP MOTOR ACTIVATED TO PROPEL THE POOL CLEANER IN A FORWARD DIRECTION ON THE BOTTOM SURFACE OF THE POOL.
1002
POOL CLEANER MOVES TOWARD SIDEWALL OF POOL.
1004
SIGNAL FROM ON-BOARD SENSOR INDICATES THAT THE FORWARD END OF THE POOL CLEANER IS PROXIMATE A SIDEWALL OF THE POOL.
1006
SIGNAL TO INTERRUPT, FOR A PREDETERMINED PERIOD OF TIME, THE DISCHARGE OF WATER THROUGH THE AUXILIARY DISCHARGE PORT AND THE CORRESPONDING DOWNWARD FORCE VECTOR AT THE FORWARD END OF POOL CLEANER AND, OPTIONALLY, TO INTERRUPT THE POWER TO THE PUMP MOTOR.
1008
THE FORWARD END OF THE POOL CLEANER FLOATS UP TO FORM AN ANGLE OF AT LEAST 45° TO THE WALL.
1010
TO STEP 1012 OF FIG. 10B

FIG. 10A

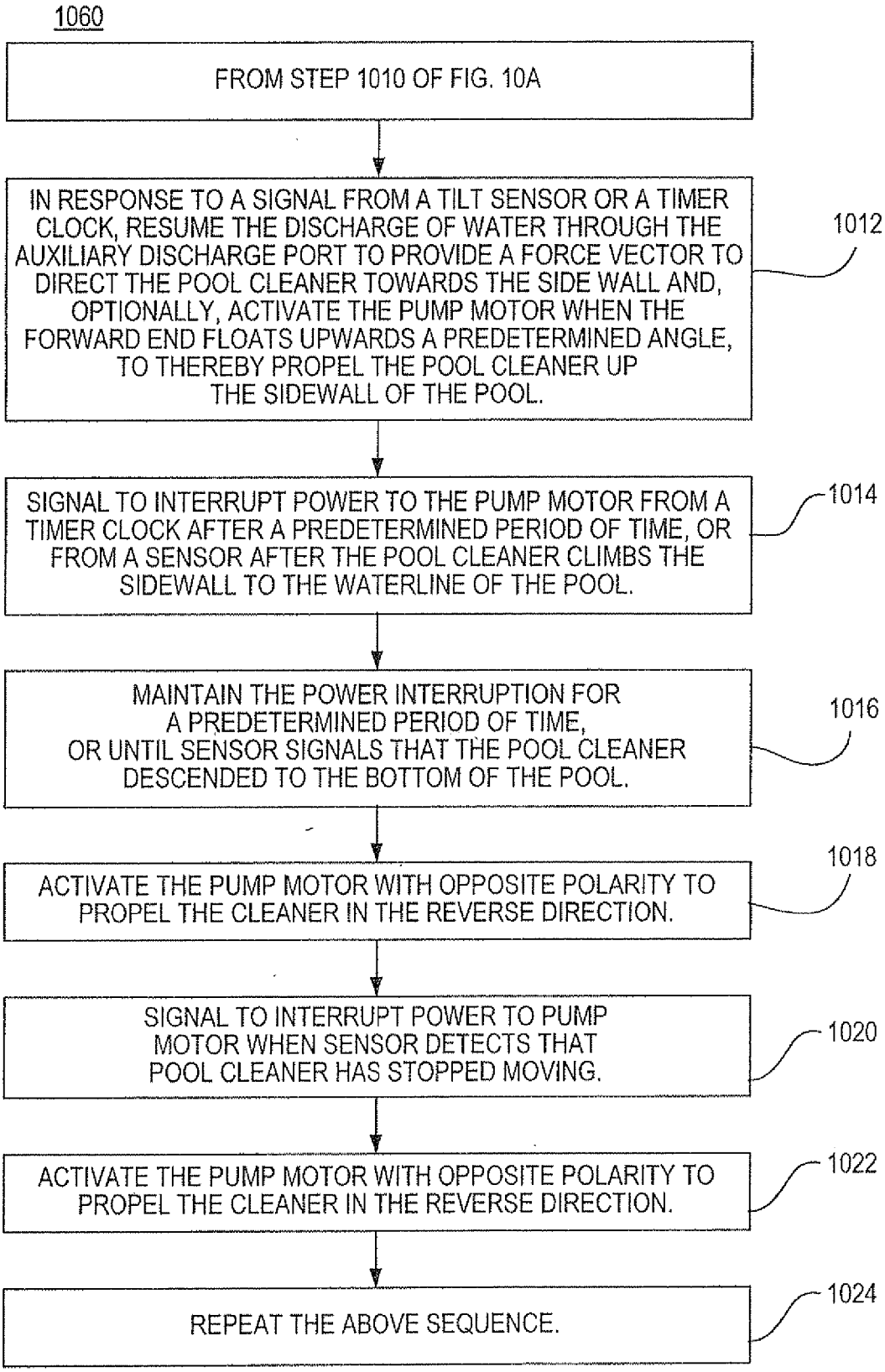

1060
FROM STEP 1010 OF FIG. 10A
IN RESPONSE TO A SIGNAL FROM A TILT SENSOR OR A TIMER CLOCK, RESUME THE DISCHARGE OF WATER THROUGH THE AUXILIARY DISCHARGE PORT TO PROVIDE A FORCE VECTOR TO DIRECT THE POOL CLEANER TOWARDS THE SIDE WALL AND, OPTIONALLY, ACTIVATE THE PUMP MOTOR WHEN THE FORWARD END FLOATS UPWARDS A PREDETERMINED ANGLE, TO THEREBY PROPEL THE POOL CLEANER UP THE SIDEWALL OF THE POOL.
1012
SIGNAL TO INTERRUPT POWER TO THE PUMP MOTOR FROM A TIMER CLOCK AFTER A PREDETERMINED PERIOD OF TIME, OR FROM A SENSOR AFTER THE POOL CLEANER CLIMBS THE SIDEWALL TO THE WATERLINE OF THE POOL.
1014
MAINTAIN THE POWER INTERRUPTION FOR A PREDETERMINED PERIOD OF TIME, OR UNTIL SENSOR SIGNALS THAT THE POOL CLEANER DESCENDED TO THE BOTTOM OF THE POOL.
1016
ACTIVATE THE PUMP MOTOR WITH OPPOSITE POLARITY TO PROPEL THE CLEANER IN THE REVERSE DIRECTION.
1018
SIGNAL TO INTERRUPT POWER TO PUMP MOTOR WHEN SENSOR DETECTS THAT POOL CLEANER HAS STOPPED MOVING.
1020
ACTIVATE THE PUMP MOTOR WITH OPPOSITE POLARITY TO PROPEL THE CLEANER IN THE REVERSE DIRECTION.
1022
REPEAT THE ABOVE SEQUENCE.
1024

FIG. 10B

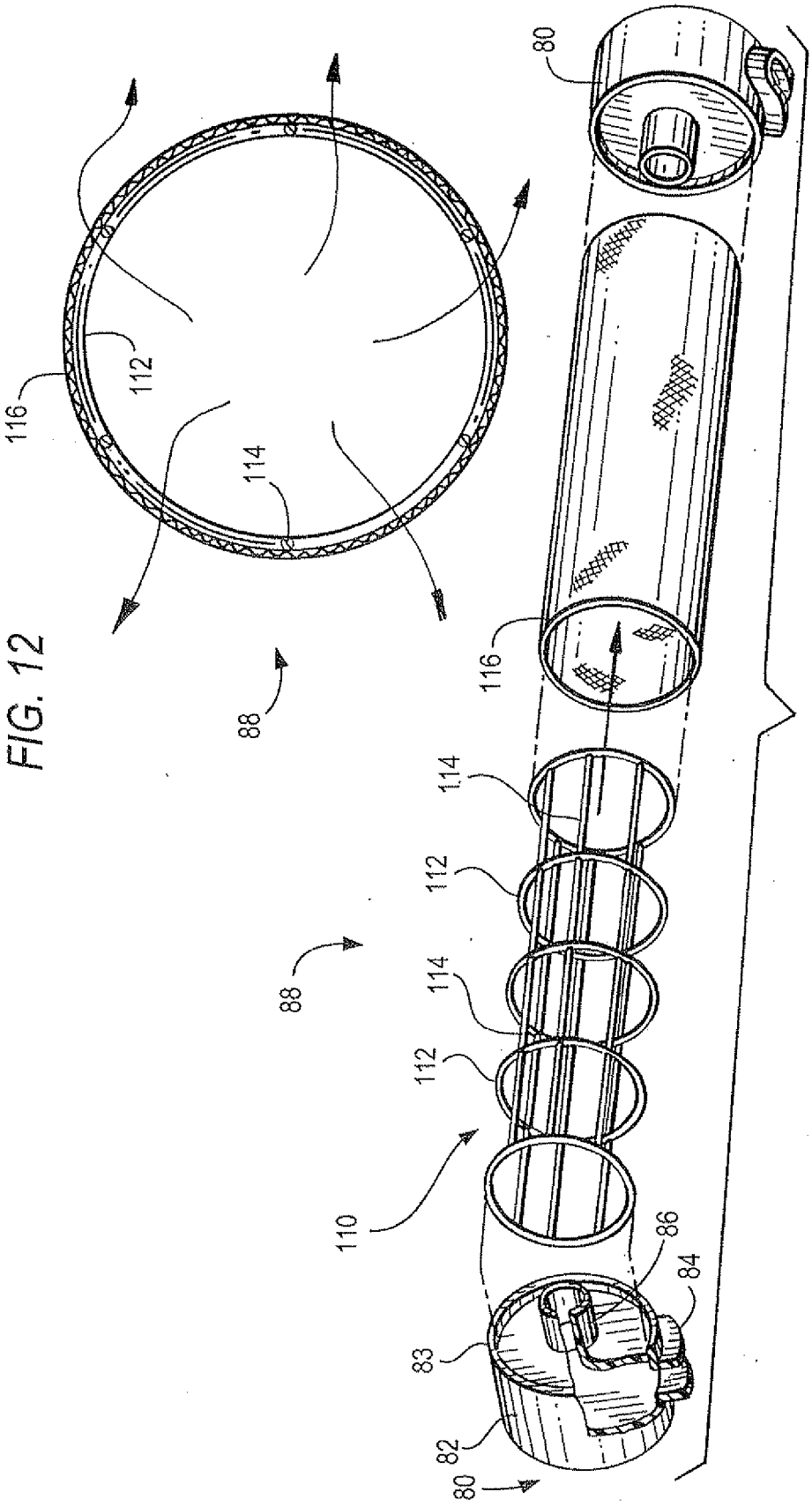


FIG. 12

FIG. 11

FIG. 13

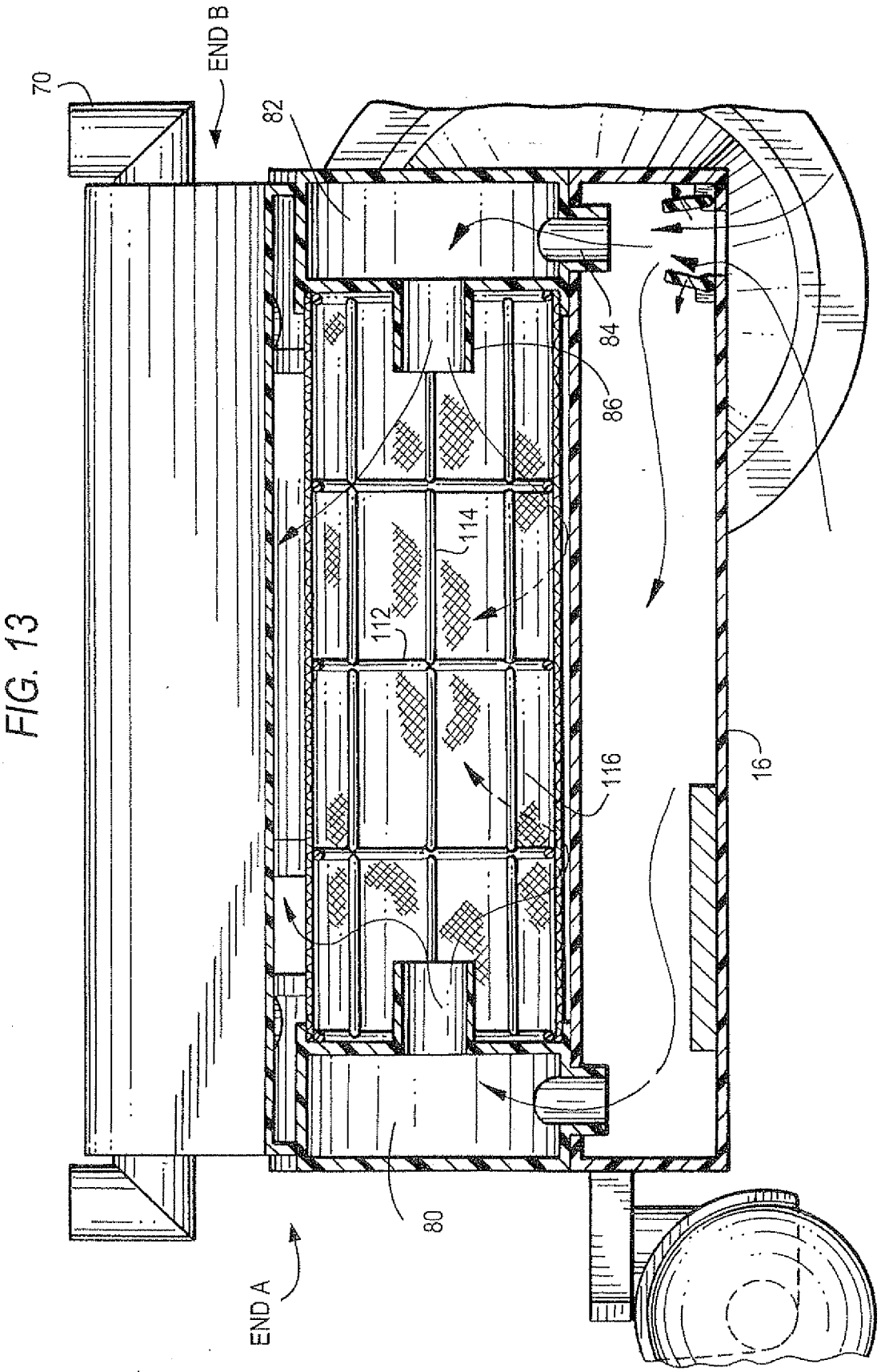


FIG. 15

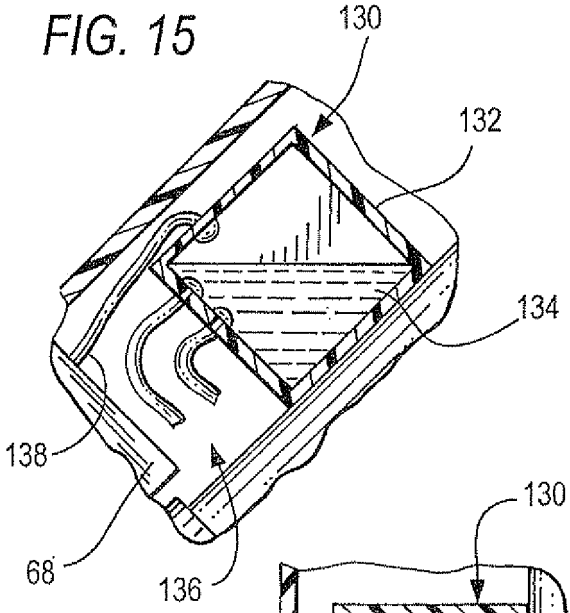


FIG. 16

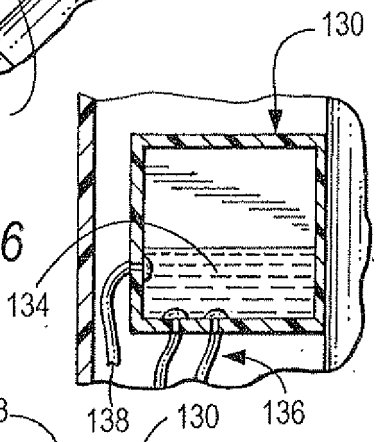


FIG. 14

FIG. 17

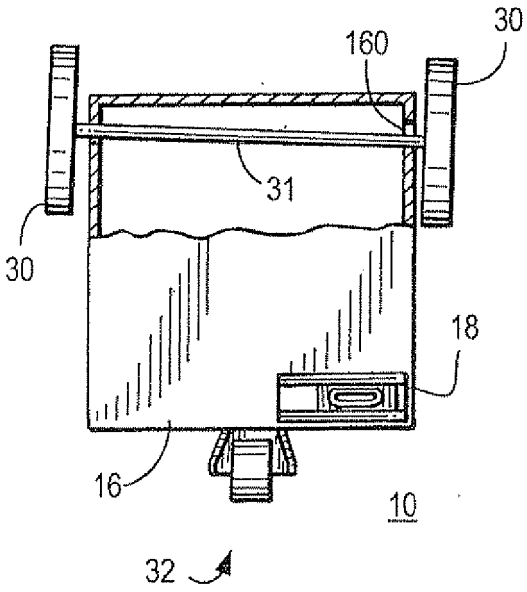


FIG. 18

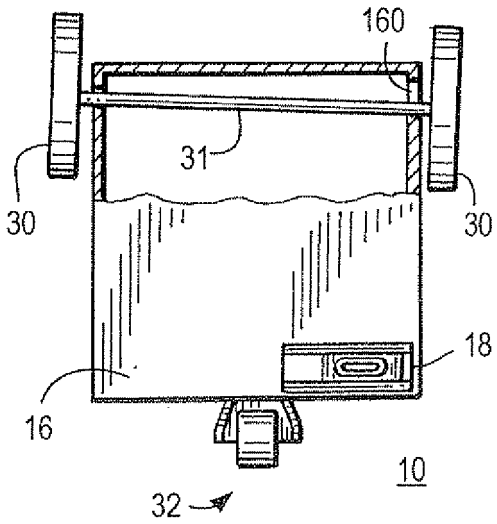


FIG. 19

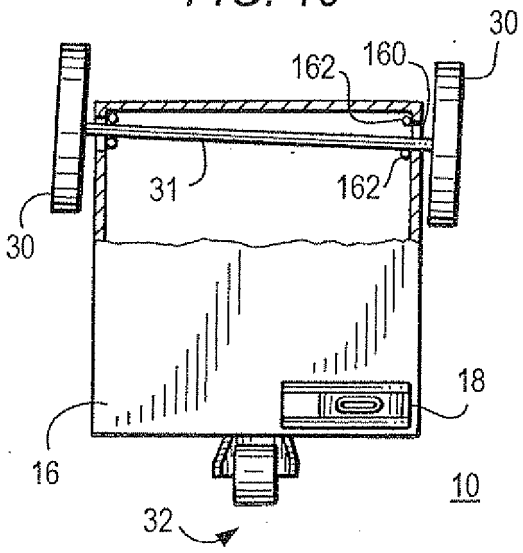
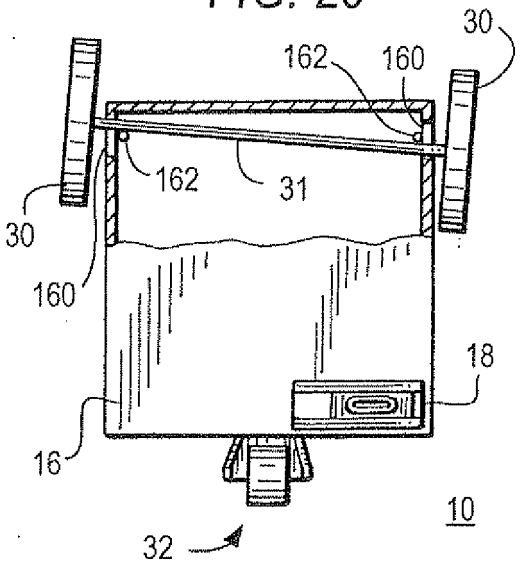


FIG. 20



REFERENCES CITED IN THE DESCRIPTION

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