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(54) **POSITIVE PRESSURE AUTOMATIC SWIMMING POOL CLEANING SYSTEM**

SYSTEM MIT POSITIVEM DRUCK ZUM AUTOMATISCHEN REINIGEN EINES SCHWIMMBECKENS

SYSTEME DE NETTOYAGE AUTOMATIQUE DE PISCINE A PRESSION POSITIVE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method and apparatus powered from the pressure side of a pump for cleaning a water pool, e.g., swimming pool.

BACKGROUND OF THE INVENTION

[0002] The prior art is replete with different types of automatic swimming pool cleaners. They include water surface cleaning devices which typically float at the water surface and skim floating debris therefrom. The prior art also shows pool wall surface cleaning devices which typically rest at the pool bottom and can be moved along the wall (which term should be understood to include bottom and side portions) for wall cleaning, as by vacuuming and/or sweeping. Some prior art assemblies include both water surface cleaning and wall surface cleaning components tethered together.

[0003] US-A-3805815 describes a pool cleaning apparatus including means for moving sweeper hoses up and down within the pool water and at the same time moving the hoses horizontally. The hoses are attached to a sweeper head which includes a mechanism for periodically varying buoyancy to enable the hoses to alternately rise and fall.

[0004] US-A-4686728 describes a pool cleaning device comprising a housing which periodically rises from the pool floor to brush the pool sides in response to the injection of air via a hose into housing sections. A compressor is periodically actuated to supply air to the hose. A rudder causes the housing to move laterally during ascent and descent. A vacuum hose draws pool water via a wall opening.

[0005] US-A-4154680 describes an apparatus for underwater cleaning of a swimming pool wall. The apparatus is characterized by a chassis carrying three electric motors. Two electric motors drive a traction assembly which propels the chassis along the wall surface. The third electric motor is used to create suction for drawing dirt from the wall surface. The apparatus incorporates a controlled diving cell mounted on the chassis which is powered by the third electric motor to facilitate raising the chassis.

SUMMARY OF THE INVENTION

[0006] The present invention is directed to a method and apparatus driven by a positive pressure water source for cleaning the interior surface of a pool containment wall and the upper surface of a water pool contained therein, as defined in the independent claims.

[0007] Apparatus in accordance with the invention includes (1) a unitary structure, i.e., a cleaner body, capable of being immersed in a water pool and (2) a level control subsystem for selectively moving the body to a position either (1) proximate to the surface of the water pool for water surface cleaning or (2) proximate to the interior surface of the containment wall for wall surface cleaning.

[0008] The invention can be embodied in a cleaner body having a weight/buoyancy characteristic to cause it to normally rest either (1) proximate to the pool bottom adjacent to the wall surface (i.e., heavier-than-water) or (2) proximate to the water surface (i.e., lighter-than-water). With the heavier-than-water body, the level control subsystem in an active state produces a vertical force component for lifting the body to proximate to the water surface for operation in a water surface cleaning mode. With the lighter-than-water body, the level control subsystem in an active state produces a vertical force component for causing the body to descend to the wall surface for operation in the wall surface cleaning mode.

[0009] A level control subsystem in accordance with the invention can produce the desired vertical force component either by discharging an appropriately directed water outflow from the body, and/or by modifying the body's weight/buoyancy characteristic.

[0010] Embodiments of the invention preferably also include a propulsion subsystem for producing a nominally horizontal (relative to the body) force component for moving the body along (1) a path adjacent to the water surface when the body is in the water surface cleaning mode and (2) a path adjacent to the wall surface when the body is in the wall surface cleaning mode. When in the water surface cleaning mode, debris is collected from the water surface, e.g., by skimming either with or without a weir. When in the wall surface cleaning mode, debris is collected from the wall surface, e.g., by suction.

[0011] Embodiments of the invention are configured to be hydraulically powered, from the positive pressure side of an external hydraulic pump typically driven by an electric motor. In a typical installation, this pump can comprise a normally available pool pump used for water circulation and/or a supplemental booster pump. Proximal and distal ends of a flexible supply hose are respectively coupled to the pump and cleaner body for producing a water supply flow to the body for powering the aforementioned subsystems. The hose is preferably configured with portions having a specific gravity > 1.0 so that it typically lies at the bottom of the pool close to the wall surface with the hose distal end being pulled along by the movement of the body.

[0012] In preferred embodiments of the invention, the water supply flow from the pump is distributed by one or more control elements (e.g., valves) to directly or indirectly, create water flows for producing vertical and horizontal force components for affecting level control and propulsion. A preferred propulsion subsystem is operable in either a normal state to produce a force component for moving the body in a forward direction or a backup state to produce a force component for moving the body in a rearward direction. Water surface cleaning and wall surface cleaning preferably occur during the normal propulsion state. The backup propulsion state assists the body in freeing itself from obstructions.

[0013] In a preferred heavier-than-water embodiment, a water distribution subsystem carried by the cleaner body selectively discharges water flows via the following outlets:

1. forward thrust jet
2. rearward ("backup") thrust jet
3. forward thrust/lift jet
4. vacuum jet pump nozzle
5. skimmer jets
6. debris retention jets
7. sweep hose
8. front chamber fill

The water flows discharged from these outlets produce force components which primarily determine the motion and orientation of the body. However, the actual motion and orientation at any instant in time is determined by the net effect of all forces acting on the body. Additional forces which effect the motion and orientation are attributable, inter alia, to the following:

a. the weight and buoyancy characteristics of the body itself
b. the hydrodynamic effects resulting from the relative movement between the water and body
c. the reaction forces attributable to sweep hose action
d. the drag forces attributable to the supply hose, debris container, etc.
e. the contact forces of cleaner body parts against the wall surface and other obstruction surfaces

[0014] A preferred cleaner body in accordance with the invention is comprised of a chassis supported on a front wheel and first and second rear wheels. The wheels are mounted for rotation around horizontally oriented axles. The chassis is preferably configured with a nose portion proximate to the front wheel and front shoulders extending rearwardly therefrom. The shoulders taper outwardly from the nose portion to facilitate deflection off obstructions and to minimize drag as the body moves forwardly through the water. Side rails extending rearwardly from the outer ends of the shoulders preferably taper inwardly toward a tail portion to facilitate movement of the body past obstruction surfaces, particularly in the water surface cleaning mode.

[0015] The body is preferably configured so that, when at rest on a horizontal portion of the wall surface, it exhibits a nose-down, tail-up attitude. One or more hydrodynamic surfaces, e.g., a wing or deck surface, is formed on the body to create a vertical force component for maintaining this attitude as the body moves through the water along a wall surface in the wall surface cleaning mode. This attitude facilitates hold down of the traction wheels against the wall surface and properly orients a vacuum inlet opening relative to the wall surface. When in the water surface cleaning mode, a hydrodynamic surface preferably rises above the water surface thereby reducing the aforementioned vertical force component and allowing the body to assume a more horizontally oriented attitude in the water surface cleaning mode. This attitude facilitates movement along the water surface and/or facilitates skimming water from the surface into a debris container.

[0016] A preferred cleaner body in accordance with the invention is configured with a hollow front fin extending above the water surface when the body is operating in the water surface cleaning mode. The fin has an interior chamber which can be water filled to provide a downward weight to help stabilize the operating level of the body near the water surface. In the wall surface cleaning mode, the water filled fin has negligible effect when the body is submerged but when the body climbs above the water surface, the weight of the filled fin creates a vertical downward force tending to cause the body to turn and re-enter the water.

[0017] The cleaner body in accordance with the invention carries a water permeable debris container. In the water surface cleaning mode, water skimmed from the surface flows through the debris container which removes and collects debris therefrom. In the wall surface cleaning mode, water from adjacent to the wall surface is drawn into the vacuum inlet opening and directed through the debris container which removes and collects debris from the wall surface.

[0018] The debris container, in one embodiment, comprises a main bag formed of mesh material extending from a first frame. The first frame is configured to be removably mounted on the chassis and defines an open mouth for accepting (1) surface water flowing over a skim deck when in the water surface cleaning mode and (2) outflow from a vacuum path discharge opening when in the wall surface cleaning mode. In accordance with a significant feature of a preferred

embodiment, the debris container may also include a second water permeable bag interposed between the vacuum path discharge opening and the aforementioned main bag. The second or inner bag is preferably formed of a finer mesh than the main bag and functions to trap silt and other fine material. The inner bag is preferably formed by a length of mesh material rolled into an essentially cylindrical form closed at one end and secured on the other end to a second frame configured for mounting adjacent to said vacuum path discharge opening. The edges of the mesh material are overlapped to retain fine debris in the inner bag.

[0019] The operating modes of the level control subsystem (i.e., (1) water surface and (2) wall surface) are preferably switched automatically in response to the occurrence of a particular event such as (1) the expiration of a time interval, (2) the cycling of the external pump, or (3) a state change of the propulsion subsystem (i.e., (1) normal forward and (2) backup rearward). The operating states of the propulsion subsystem (i.e., (1) normal forward and (2) backup rearward) are preferably switched automatically in response to the occurrence of a particular event such as the expiration of a time interval and/or the interruption of body motion.

[0020] In a first embodiment using a heavier-than-water body, the level control subsystem in an active state produces a water outflow from the body in a direction having a vertical component sufficient to lift the body to the water surface for water surface cleaning.

[0021] In a second heavier-than-water embodiment, the body is configured with at least one chamber which is selectively evacuated by an on-board water driven pump when the body is at the water surface to enable outside air to be pulled into the chamber to increase the body's buoyancy and stability.

[0022] In a third heavier-than-water embodiment, a body chamber contains an air bag coupled to an on-board air reservoir. When in a quiescent state, the chamber is water filled and the air bag is collapsed. In order to lift the body to the water surface, an on-board water driven pump pulls water out of the chamber enabling the air bag to expand to thus increase the body's buoyancy and allow it to float to the water surface.

[0023] In a fourth embodiment, the body is configured with at least one chamber which contains a bag filled with air when in its quiescent state. The contained air volume is sufficient to float the body to the water surface. In order to sink the body to the wall surface, the level control subsystem in its active state supplies pressurized water to fill the chamber and collapse the bag, pushing the contained air under pressure into an air reservoir.

[0024] Although four specific embodiments of the invention are described herein, it should be recognized that many alternative implementations can be configured within the scope of the appended claims to satisfy particular operational or cost objectives.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Figure 1 schematically depicts a positive pressure driven cleaner in accordance with the invention in a water pool operating respectively in (1) a water surface cleaning mode (dashed line) and (2) a wall surface cleaning mode (solid line);

Figure 2 schematically depicts a side view of a first cleaner body in accordance with the invention showing multiple water flow outlets which are selectively activated to enable the cleaner to operate in the water surface or wall surface cleaning mode and forward or backup state;

Figure 3 is a functional block diagram depicting water flow distribution in the embodiment of Figure 2;

Figure 4 is a rear isometric view, partially broken away of a preferred cleaner body in accordance with the invention;

Figure 5 is a sectional view taken substantially along the plane 5-5 of Figure 4;

Figure 6 is a bottom plan view of the cleaner body of Figure 4;

Figure 7 is an exploded isometric view of the cleaner body of Figure 4 showing the primary parts including the chassis, the water flow distributor, and the upper frame;

Figure 8 is a sectional view of the front fin taken substantially along the plane 8-8 of Figure 4;

Figure 9 is a side view similar to Figure 2 particularly showing the water flow outlets active during the wall surface cleaning mode;

Figure 10 is a side view similar to Figure 2 particularly showing the water flow outlets active during the water surface cleaning mode;

Figure 11 is a side view similar to Figure 2 particularly showing the water flow outlets active during the backup state;

Figure 12A is a schematic representation of a preferred implementation of the water flow distributor of Figure 3, Figure 12B comprises a sectional view through the direction controller of Figure 12A;

Figure 13 is a schematic representation of a preferred implementation of the water flow distributor of Figure 3 including a motion sensor;

Figure 14 is a side view of a preferred debris container inner bag;

Figure 15 is a sectional view taken substantially along the plane 15-15 of Figure 14 showing how the overlapped edges of the inner debris container bag are overlapped;

Figure 16 is a sectional view taken substantially along the plane 16-16 of Figure 5 showing how the inner bag of Figures 14, 15 is mounted to the cleaner body chassis;

Figures 17A, 17B and 17C depict a second heavier-than-water embodiment of the invention respectively schematically showing a side view, an isometric view, and a functional block diagram;

. Figures 18A, 18B and 18C depict a third heavier-than-water embodiment of the invention respectively schematically showing a side view, an isometric view, and a functional block diagram;

Figures 19A, 19B, and 19C depict a fourth lighter-than-water embodiment of the invention respectively schematically showing a side view, an isometric view, and a functional block diagram;

Figure 20 is a schematic representation of a water flow distributor implementation alternative to Figure 12A; and

Figure 21 is a schematic representation of a water flow distributor implementation alternative to Figure 13.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0026] With reference to Figure 1, the present invention is directed to a method and apparatus for cleaning a water pool 1 contained in an open vessel 2 defined by a containment wall 3 having bottom 4 and side 5 portions. Embodiments of the invention utilize a unitary structure or body 6 configured for immersion in the water pool 1 for selective operation proximate to the water surface 7 in a water surface cleaning mode or proximate to the interior wall surface 8 in a wall surface cleaning mode.

[0027] The unitary body 6 preferably comprises an essentially rigid structure having a hydrodynamically contoured exterior surface for efficient travel through the water. Although the body 6 can be variously configured in accordance with the invention, it is intended that it be relatively compact in size, preferably fitting within a two foot cube envelope. Figure 1 depicts a heavier-than-water body 6 which in its quiescent or rest state typically sinks to a position (represented in solid line) proximate to the bottom of the pool 1. For operation in the water surface cleaning mode, a vertical force is produced to lift the body 6 to proximate to the water surface 7 (represented in dash line). Alternatively, body 6 can be configured to be lighter-than-water such that in its quiescent or rest state, it floats proximate to the water surface 7. For operation in the wall surface cleaning mode, a vertical force is produced to cause the lighter-than-water body to descend to the pool bottom. In either case, the vertical force is produced as a consequence of a positive pressure water flow supplied via flexible hose 9 from an electrically driven motor and hydraulic pump assembly 10. The assembly 10 defines a pressure side outlet 11 preferably coupled via a pressure regulator 12A and quick disconnect coupling 12B to the flexible hose 9. The hose 9 is preferably formed of multiple sections coupled in tandem by hose nuts and swivels 13. Further, the hose is preferably configured with appropriately placed floats 14 and distributed weight so that a significant portion of its length normally rests on the bottom of wall surface 8.

[0028] As represented in Figure 1, the body 6 generally comprises a top portion or frame 6T and a bottom portion or chassis 6B, spaced in a nominally vertical direction. The body also generally defines a front or nose portion 6F and a rear or tail portion 6R spaced in a nominally horizontal direction. The body is supported on a traction means such as wheels 15 which are mounted for engaging the wall surface 8 when operating in the wall surface cleaning mode.

[0029] Embodiments of the invention are based, in part, on a recognition of the following considerations:

1. Inasmuch as most debris initially floats on the water surface, prior to sinking to the wall surface, the overall cleaning task can be optimized by cleaning the water surface to remove debris before it sinks.
2. A water cleaner capable of floating or otherwise traveling to the same place that debris floats to can capture debris more effectively than a fixed position skimmer.
3. The water surface can be cleaned by skimming with or without a weir, by a water entrainment device, or by scooping up debris as the cleaner body moves across the water surface. The debris can be collected in a water permeable container.
4. A single essentially rigid unitary structure or body can be used to selectively operate proximate to the water surface in a water surface cleaning mode and proximate to the wall surface in a wall surface cleaning mode.
5. The level of the cleaner body in the water pool, i.e., proximate to the water surface or proximate to the wall surface, can be controlled by a level control subsystem capable of selectively defining either a water surface mode or a wall surface mode. The mode defined by the subsystem can be selected via a user control, e.g., a manual switch or valve, or via an event sensor responsive to an event such as the expiration of a time interval.
6. The movement of the body in the water pool can be controlled by a propulsion subsystem, preferably operable to selectively propel the body in either a forward or rearward direction. The direction is preferably selected via an event sensor which responds to an event such as the expiration of a time interval or an interruption of the body's motion.
7. A cleaning subsystem can be operated in either a water surface cleaning mode (e.g., skimming) or a wall surface cleaning mode (e.g., vacuuming or sweeping).
8. The aforementioned subsystems can be powered by a positive pressure water flow supplied preferably by an electrically driven hydraulic pump.

[0030] As will be explained in greater detail hereinafter, in typical operation, the body 6 alternately operates in (1) a water surface cleaning mode to capture floating debris and (2) a wall surface cleaning mode in which it travels along bottom and side wall portions to clean debris from the wall surface 8. The body 6 preferably tows a flexible hose 16 configured to be whipped by a water outflow from a nozzle at its free end to sweep against the wall surface 8.

[0031] Four exemplary embodiments of the invention will be described hereinafter. The first three of these embodiments will be assumed to have a weight/buoyancy characteristic to cause it to normally rest proximate to the bottom of pool 1 adjacent to the wall surface 8 (i.e., heavier-than-water). The fourth embodiment (Figures 19A,19B, 19C) will be assumed to have a characteristic to cause it to rest (i.e., float) proximate to the water surface 7 (i.e., lighter-than-water).

[0032] With a heavier-than-water embodiment, an on-board level control subsystem in an active state produces a vertical force component for lifting the body to proximate to the water surface 7 for operation in a water surface cleaning mode. With a lighter-than-water embodiment, the level control subsystem in an active state produces a vertical force component for causing the body to descend to the wall surface 8 for operation in the wall surface cleaning mode.

FIRST EMBODIMENT (FIGURES 2-16)

[0033] Attention is now directed to Figure 2 which schematically depicts a first embodiment comprised of a unitary body 100 having a positive pressure water supply inlet 101 and multiple water outlets which are variously used by the body 100 in its different modes and states. The particular outlets active during particular modes and states are represented in Figures 9, 10 and 11 which schematically respectively represent (1) wall surface cleaning mode, (2) water surface cleaning mode, and (3) backup state.

[0034] With reference to Figure 2, the following water outlets are depicted:

102 - Forward Thrust Jet; provides forward propulsion and a downward force in the wall surface cleaning mode (Figure 9) to assist in holding the traction wheels against the wall surface 8;

104 - Rearward ("backup") Thrust Jet; provides backward propulsion and rotation of the body around a vertical axis when in the backup state (Figure 11);

106 - Forward Thrust/Lift Jet; provides thrust to lift the cleaner body to the water surface and to hold it there and propel it forwardly when operating in the water surface cleaning mode (Figure 10);

108 - Vacuum Jet Pump Nozzle; produces a high velocity jet to create a suction at the vacuum inlet opening 109 to pull in water and debris from the adjacent wall surface 8 in the wall surface cleaning mode (Figure 9);

110 - Skimmer Jets; provide a flow of surface water and debris into a debris container 111 when operating in the water surface cleaning mode (Figure 10);

112 - Debris Retention Jets; provides a flow of water toward the mouth of the debris container 111 to keep debris from escaping when operating in the backup state (Figure 11). This function could also be performed or enhanced by the Skimmer Jets 110;

114 - Sweep Hose; discharges a water flow through hose 115 to cause it to whip and sweep against wall surface 8;

116 - Front Chamber Fill; provides water to fill a chamber interior to hollow front fin 117 for creating a downward force on the front of body 100 when operating in the water surface cleaning mode (Figure 10).

[0035] Attention is now directed to Figure 3 which schematically depicts how positive pressure water supplied to inlet 101 from pump 10 is distributed to the various outlets of the body 100 of Figure 2. The pump 10 is typically controlled by an optional timer 120 to periodically supply positive pressure water via supply hose 9 to inlet 101. The supplied water is then variously distributed as shown in Figure 3 to the several outlets depending upon the defined mode and state.

[0036] More particularly, water supplied to inlet 101 is primarily directed to an optional timing assembly 122 (to be discussed in detail in connection with Figure 12) which operates a level controller 124 and a direction controller 126. The direction controller 126 controls a direction valve 128 to place it either in a normal forward state or a backup rearward state. When in the backup state, water from supply inlet 101 is directed via valve supply inlet 130 to rearward outlet 132 for discharge through the aforementioned Rearward Thrust Jet 104 and Debris Retention Jets 112. When in the forward state, water from supply inlet 101 is directed through outlet 134 to supply inlet 136 of level valve 138.

[0037] Level valve 138 is controlled by controller 124 capable of defining either a wall surface cleaning mode or a water surface cleaning mode. When in the wall surface cleaning mode, water flow to supply port 136 is discharged via outlet 140 to Vacuum Jet Pump Nozzle 108 and Forward Thrust Jet 102. When the level control valve 138 is in the water surface cleaning mode, water flow supplied to port 136 is directed via outlet port 142 to Forward Thrust/Lift Jet 106 and to Skimmer Jets 110.

[0038] Note also in Figure 3 that an override control 146 is provided for enabling a user to selectively place the level valve 138 in either the wall surface cleaning mode or the water surface cleaning mode. Also note that positive pressure water delivered to supply inlet 101 is preferably also distributed via an adjustable flow control device 150 and the aforementioned Sweep Hose outlet 114 to sweep hose 115. Additionally, note that the positive pressure water supplied to inlet 101 is preferably also directed to Fill outlet 116 for filling a chamber interior to hollow front fin 117 to be discussed in detail in connection with Figure 8.

[0039] The system of Figure 3 can be implemented and operated in many different manners, but it will be assumed for purposes of explanation that the level valve 138 is caused to be in the water surface cleaning mode about fifty percent of the time and the wall surface cleaning mode about fifty percent of the time. This scenario can be implemented by, for example, responding to a particular event such as the cycling of external pump 10 or by the expiration of a time interval defined by timing assembly 122. The timing assembly 122 will typically, via direction controller 126, place the direction valve 128 in its normal forward state a majority of the time and will periodically switch it to its backup state. For example, in typical operation the direction valve 128 will remain in its forward state for between one and one half to five minutes and then be switched to its backup state for between five to thirty seconds, before returning to the forward state. In a typical swimming pool situation this manner of operation will minimize the possibility of the cleaner body becoming trapped behind an obstruction for an extended period of time. In certain pool environments, where obstructions are more likely to be encountered, it may be desirable to more promptly initiate the backup state once the forward motion of the body has diminished below a threshold rate. Accordingly, the distribution system of Figure 3 is preferably equipped with an optional motion sensor 152 which is configured to recognize a diminished forward motion of the body to cause the direction valve 128 to switch to its backup state. An exemplary implementation of the water flow distribution system of Figure 3 will be described hereinafter in connection with Figure 12. An exemplary implementation of the water distribution system of Figure 3 including the motion sensor 152 will be described hereinafter with reference to Figure 13.

[0040] Attention is now directed to Figures 4-8 showing a structural implementation of the first body embodiment 100 which is essentially comprised of upper and lower molded sections 154T and 154B. The lower section or chassis 154B is formed of a concave floor member 160 having side rails extending around its periphery. More particularly, note left and right shoulder side rails 162L, 162R which diverge rearwardly from a chassis nose portion 164. Side rails 166L, 166R extend rearwardly from the shoulder rails 162L, 162R converging toward the rear or tail end 168 of the chassis 154B. The chassis is supported on three traction wheels 170 mounted for free rotation around horizontally oriented parallel axes. More particularly, the wheels 170 are comprised of a front center wheel 170F, mounted proximate to the chassis nose portion 164, and rear left and rear right wheels 170RL and 170RR. The wheels typically carry tires 171 which provide circumferential surfaces preferably having a sufficiently high coefficient of friction to normally guide the body along a path essentially parallel to its longitudinal axis. However, front wheel 170F preferably has a somewhat lower coeffient of friction than wheels 170RL and 170RR to facilitate turning.

[0041] The chassis preferably carries a plurality of horizontally oriented guide wheels 176 mounted around the perimeter

of the chassis for free rotation around vertical axes to facilitate movement of the body past wall and other obstruction surfaces.

[0042] As can best be seen in Figures 2, 6 and 7, the chassis 154B defines an inclined vertical passageway 180 which extends upwardly from a vacuum inlet opening 109 on the underside of the chassis (see Figure 6). The passageway 180 is inclined rearwardly from the opening 109 extending to a vacuum discharge opening 182 proximate to the tail end 168 of the chassis 154B. The aforementioned Vacuum Jet Pump Nozzle 108 is mounted within the passageway 180 proximate to the opening 109 and oriented to discharge a high velocity stream upwardly and rearwardly along the passageway 180, as represented in Figure 2. This high velocity stream creates a suction at the vacuum opening 109 which draws water and debris from adjacent the wall surface 8 into the passageway 180 for discharge at the opening 182. The vertical component of the stream assists in producing a hold down force when the unit is operating in the wall surface cleaning mode acting to urge the wheels 170 against the wall surface 8.

[0043] The body 100 upper portion or frame 154T defines a perimeter essentially matching that of the chassis 154B. The frame is comprised of a deck 200 having upstanding side walls 202L and 202R extending therefrom. Each of the walls 202 defines an interior volume containing material 203 (Figure 5), e.g., solid foam, which provides a weight/buoyancy characteristic to enable the body 100 to assume a desired operating level in the water surface cleaning mode. The frame 154T also defines the aforementioned front fin 117 which is centrally mounted on deck 200 proximate to the forward or nose portion. The fin 117 is shaped with a rounded front surface 208 and with side surfaces 210L and 210R converging toward a rear edge 212. Aforementioned Skimmer Jets 110 and Debris Retention Jets 112 are mounted proximate to the rear edge 212. The Jets 110 are comprised of three rearwardly directed outlets including a center outlet 110C and left and right outlets 110L and 110R. The outlet 110C is directed essentially along the center line of the body 100 whereas the Jets 110L and 11 OR diverge or fan out slightly from the center line. All of the Jets 110 are preferably oriented slightly downwardly with respect to deck 200 (see Figure 10) to produce a vertical lift force component when active. The Debris Retention Jets 112 are also comprised of three outlets including a center outlet 112C and left and right outlets 112L and 112R. Outlets 112L, 112R also diverge in an essentially fan pattern similar to the Skimmer Jets 110. However, whereas the Skimmer Jets 110 are oriented slightly downwardly, the Debris Retention Jets 112 are oriented slightly upwardly (see Figure 11) directed toward a rear debris entrance opening 218.

[0044] More particularly, the side walls 202L, 202R respectively define inner surfaces 220L, 220R which converge rearwardly to guide water moving past fin 117 toward the rear debris opening 218 which is framed by rear cross member 227, deck 200, and the side wall surfaces 220L, 220R. A slot 228 is formed around opening 218 for removably accommodating an open frame member 230. The frame member 230 has the aforementioned debris container 111, preferably comprising a bag formed of flexible mesh material 231, secured thereto so that water flow through opening 218 will flow into the container 111.

[0045] A front cross member 240 extends between the walls 202L and 202R, preferably supported by the fin 117 proximate to the rear edge 212. The cross member 240 defines rearwardly inclined hydrodynamic surfaces 242 (see Figure 2) which, together with deck surface 200, act to produce a downward force on the body as the body moves forward in the wall surface cleaning mode. This force assists in maintaining the traction wheels 170 against the wall surface 8 to properly position the vacuum inlet opening 109 in close proximity to the wall surface 8 (see Figure 9).

[0046] The vacuum passageway 180 extends from vacuum inlet opening 109 and terminates at vacuum discharge opening 182 in close proximity to the upper surface of deck 200. Thus, water drawn from the wall surface 8 through the vacuum passageway 180 will exit at the discharge opening 182 and be directed rearwardly through opening 218 and into the aforementioned debris container 111. In order to assure relatively unobstructed water flow through debris container 111, it is formed of a relatively coarse mesh material 231 sufficient to trap small pieces of leaves, for example, but insufficient to trap finer debris such as silt. In order to trap such finer material which sometimes accumulates on the wall surface 8, a second or auxiliary debris container 250 is provided for mounting adjacent the vacuum discharge opening 182 (Figure 7). The details of a preferred implementation of container 250 will be discussed in connection with Figures 14-16. However, at this juncture, it is to be noted that the container 250 comprises a bag formed of mesh material 253 (preferably having a finer mesh than that of bag 111) closed at an upper end 254 (Figure 14). The bag 250 lower end 255 defines an open mouth extending around frame member 256 which is configured to be mounted in the vacuum discharge opening 182 so that the bag 250 extends rearwardly, into the main debris container bag 111, as represented in Figure 4.

[0047] Attention is now specifically directed to Figures 5 and 7 which generally depict a "plumbing " subassembly 260 for implementing the water distribution system schematically represented in Figure 3. It will be recalled from Figure 3 that positive pressure water is supplied via supply inlet 101, and then distributed to the various outlets 102, 104, 106, 108, 110, 112, 114, and 116, all of which can be seen in Figure 7. The plumbing subassembly 260 is mounted between the body chassis 154B and the body frame 154T. More specifically, the chassis floor member 160 is concave and defines a recess for accommodating the plumbing subassembly 260 which is retained to the chassis by bracket 270. Although the plumbing subassembly 260 contains the various elements of the distribution system shown in Figure 3, including the timing assembly 122, the direction controller 126, the direction valve 128, the level controller 124, and the level valve

138, they are not visible in Figure 7 but will be discussed hereinafter in connection with Figure 12.

[0048] Figure 8 shows a cross-section of front fin 117 and depicts interior chamber 262 having a water inlet 263 in its bottom wall 264. The inlet 263 is coupled to aforementioned Front Chamber Fill outlet 116. Overflow tubes 265 are mounted in chamber 262 having entrances 266 positioned to establish the height of the water volume in the chamber. The tubes 265 are open at their lower ends 267 to permit overflow water to exit from the chamber 262.

[0049] Attention is now directed to Figures 9, 10, and 11 which respectively depict operation in the wall surface cleaning mode (forward state), the water surface cleaning mode (forward state), and the backup state (either mode). In each of Figures 9, 10, and 11, a water discharge stream is represented as exiting from the outlets active during that mode and/or state. The primary force components acting on the body are also represented in Figures 9-11.

[0050] Figure 9 shows the body 100 in the wall surface cleaning mode with its wheels 170 engaged against a horizontally oriented portion of wall surface 8. In this situation, note that the body assumes a nose down, tail up attitude, being oriented at an approximately 11° angle with respect to the horizontal. This attitude facilitates the development of appropriate vertical forces as the body moves forwardly through the water pool to hold the wheels against the wall surface 8. More particularly, when operating in the wall surface cleaning mode, water is discharged from the Forward Thrust Jet 102 and the Vacuum Jet pump Nozzle 108. Note that with the attitude depicted in Figure 9, both of these outflows are directed to develop nominal vertical force components in the direction to press the wheels 170 against the wall surface 8. Additionally, both of these outflows provide nominally horizontal thrust components acting to propel the body in a forward direction, i.e., to the left as depicted in Figure 9. This forward motion of the body through the water in turn develops vertical force components, e.g. 270, attributable to relative motion of the water acting against the various hydrodynamic surfaces, particularly surfaces 200 and 242. The motion of the body 100 through the water in the wall surface cleaning mode will be somewhat randomized by the totality of forces acting on the body including the drag force of the supply hose 9 and debris container 111, as well as the reaction forces produced by the whipping of the sweep hose 15. The precise path followed by the body 100 will additionally be largely affected by the contours of the containment wall surfaces acting against the traction wheels 170. As the body 100 moves along the wall surface different ones of the forces will dominate at different times to cause the body to deviate from an essentially straight line travel path defined by the traction wheels 170. This deviation is an intended consequence of the overall design of the apparatus and serves to randomize the motion of the body along the wall surface to clean the entire wall surface including bottom and side portions. To achieve optimum path travel for the contours of a particular containment wall, various ones of the thrust jets, e.g. Forward Thrust Jet 102, are preferably mounted so that they can be adjustably directed, e.g., via a ball and socket configuration 274 (Figure 7). Additionally, front wheel 170F preferably exhibits a lower coefficient of friction than the other wheels 170 to facilitate turning from a straight line path.

[0051] Attention is now directed to Figure 10 which depicts the body 100 operating in the water surface cleaning mode adjacent to the water surface 7. Note that in the water surface cleaning mode, Forward Thrust/Lift Jet- 106 and Skimmer Jets 110 discharge water with a downward component to produce a vertical lift force to overcome the weight of the unit and maintain the body with an essentially horizontal attitude adjacent the water surface 7. Note that in the water surface cleaning mode (Figure 10), deck surface 200 is essentially parallel to the water surface 7 and the hydrodynamic surface 242 is above the water surface. Thus, neither surface produces the vertical downward force component in the water surface cleaning mode that it does in the wall surface cleaning: mode of Figure 9. Also note that the water filled front fin 117 is at least partially lifted out of the water in Figure 10 so that its weight contributes a vertical downward force component. The path of travel along the water surface taken by the body 100 will be primarily determined by the direction of discharge of the Forward Thrust/Lift Jet 106 and Skimmer Jets 110. Additionally, of course, it will be affected by the totality of other forces acting on the body including the drag forces attributable to the supply hose 9 and debris bag 111, the reaction forces produced by the whipping of the sweep hose 115, and the contact with wall and other obstruction surfaces.

[0052] Attention is now directed to Figure 11 which depicts the active water outflows during the backup state which, it will be recalled, is defined by the direction valve 128 (Figure 3). In the backup state, water is discharged from the Debris Retention Jets 112 and the Rearward Thrust Jet 104. It will be recalled from Figure 6 that the Thrust Jet 104 is displaced from the center line of the body 100 so that in providing rearward thrust, the body will tend to rotate around a vertical axis and thus be able to work its way around obstructions. The Debris Retention Jets 112 discharge through opening 218 into the bag 111 and thus prevent debris from coming out of the bag when the body is moving rearward as represented in Figure 11.

[0053] Although the embodiment described in Figures 2-11 has been assumed to use a heavier-than-water body, which uses water outflows to thrust it to the water surface, it should be understood that it could alternatively use a lighter-than-water body with the water outflows being directed to thrust the body down to the wall surface.

[0054] Attention is now directed to Figure 12A which schematically represents a preferred implementation 300 of the water distribution system depicted in Figure 3. The implementation 300 is basically comprised of:

a. Direction valve 128 implemented by valve assembly 304;

b. Level valve 138 implemented by valve assembly 306;
c. Direction controller 126 implemented by controller assembly 308;
d. Level controller 124 implemented by controller assembly 310; and
e. Timing assembly 122 implemented by nozzle 312, turbine 314, timing gear train 316, and reduction gear train 318.

[0055] For clarity of explanation, it will be assumed that the implementation 300 is designed to cause the body 100 to operate in accordance with the following exemplary schedule:

CLEANING MODE DURATION	PROPULSION STATE	DURATION
WATER SURFACE 30 Min.	FORWARD	90 Sec.
	BACKUP	7 Sec.
WALL SURFACE 30 Min.	FORWARD	90 Sec.
	BACKUP	7 Sec.

[0056] Direction valve assembly 304 comprises a cylindrical valve body 330D having a first end 331 D defining a supply inlet 332D and a sealed second end 333D. Forward outlet 334D and rearward outlet 336D open through side wall 337D (respectively corresponding to outlets 134 and 132 in Figure 3). The inlet 332D communicates with either outlet 334D or 336D depending upon the position of valve element 338D. Valve element 338D is carried by rod 340D secured to piston 342D. A spring 346D contained within the valve body 330D normally pushes piston 342D toward the end 331 D of the valve body to seal outlet 334D and communicate inlet 332D with outlet 336D. The valve body 330D also defines a control port 350D which opens through side wall 337D between fixed partition 352D and piston 342D. Positive pressure water supplied to control port 350D acts to move piston 342D toward end 333D against spring 346D, thus causing valve element 338D to seal rearward outlet 336D and open forward outlet 334D.

[0057] Direction valve control port 350D is controlled by the output 364D of the direction controller assembly 308. The direction controller assembly 308 is preferably comprised of a cylindrical controller body 360D having a circumferential wall defining an inlet 362D and an outlet 364D. Additionally, body 360D defines an end wall 366D having an exhaust port 368D formed therein. A disk shaped valve element 370D is mounted on shaft 372D for rotation within the controller body as depicted in Figure 12B. During a portion of its rotation, the valve element 370D seals exhaust port 368D enabling positive pressure water supplied to controller inlet 362D to be transferred via outlet 364D to direction valve control port 350D. During the remaining portion of its rotation, exhaust port 368D is open, and positive pressure water from inlet 362D is exhausted through port 368D so that no significant pressure is applied to control port 350D. Positive pressure water is supplied to inlet 362D from tubing 380 coupled to direction valve body outlet 382D which communicates directly with supply inlet 332D.

[0058] In the implementation of Figure 12, the direction valve assembly 304 inlet 332D is connected to the aforementioned positive pressure supply inlet 101 shown in Figure 3. The direction valve assembly 304 forward outlet 334D is connected to the inlet 332L of level valve assembly 306. Level valve assembly 306 is implemented essentially identical to direction valve assembly 304 and defines outlets 334L and 336L which respectively correspond to the water surface cleaning outlet 142 and the wall surface cleaning outlet 140 of Figure 3.

[0059] The positive pressure water from outlet 382D is also delivered to turbine nozzle 312 and, via tubing 384, to the inlet 362L of the level controller assembly 310. The outlet 364L of the level controller assembly 310 is connected to the control port 350L of the level valve assembly 306. Level controller assembly 310 is implemented essentially identical to direction controller assembly 308.

[0060] Nozzle 312 is positioned to turn turbine 314 which rotates drive shaft 386 of timing gear train 316 which drives both output gear 388 and output drive shaft 390. Gear 388 forms part of a train to rotate the direction controller valve element 370D. Shaft 390 forms part of a train to rotate the level controller valve element 370L. More specifically, shaft 390 drives reduction gear train 318 to rotate the level controller valve element 370L at a slow rate, e.g., once per hour, to alternately define thirty minute intervals for the water surface and wall surface cleaning modes.

[0061] Gear 388 drives the direction controller valve element 370D via a clutch mechanism 392 depicted in Figure 12A. The clutch mechanism 392 normally disengages gear 388 from direction controller shaft 372D but periodically (e.g., seven seconds during each ninety second interval) engages to rotate the shaft 372D and direction controller valve element 370D. The clutch mechanism 392 is implemented via a throw-out gear 393 carried by swing arm 394. A tension spring 395 normally acts on swing arm 394 to disengage gears 393 and 388. However, gear 388 carries cam 396 which, once per cycle, forces cam follower 397 to pivot swing arm 394 so as to engage gears 393 and 388. Gear 393 is coupled via gear 398 to gear 399 which is mounted to rotate direction controller shaft 372D.

[0062] In the operation of the apparatus of Figure 12A, assume initially that the apparatus is in its quiescent state with

direction valve assembly 304 rearward outlet 336D open and forward outlet 334D closed and with level valve assembly 306 wall surface cleaning outlet 336L open and water surface cleaning outlet 334L closed. When positive pressure water is supplied via inlet 101 to inlet 332D of direction valve assembly 304, it will be directed via tubing 380 to inlet 362D of direction controller assembly 308. Positive pressure water will also be supplied to nozzle 312 to drive turbine 314. As a consequence, gear train 316 and reduction gear train 318 will rotate the level controller valve element 370L to periodically seal exhaust port 368L and periodically pressurize control port 350L of level valve assembly 306. When pressurized, it will move the piston of assembly 306 against spring 346L to open water surface cleaning outlet 334L. When control port 350L is not pressurized, wall surface cleaning port 336L will be open. Thus, the level valve assembly 306 will alternately open outlets 334L and 336L depending upon the position of the disk valve member 370L of the level controller assembly 310. In the assumed implementation, the water and wall surface cleaning modes will be alternatively defined for approximately equal periods of about thirty minutes each.

[0063] The direction valve assembly 304 similarly will open forward outlet 334D when its control port 350D is pressurized. When control port 350D is not pressurized, then the rearward outlet 336D will be open. Water pressure delivered to control port 350D is determined by the position of disk valve element 370D within direction controller 308. In the assumed implementation, the direction controller 308 defines the forward propulsion state for approximately ninety seconds and then switches the direction valve assembly 304 to the backup propulsion state for approximately seven seconds.

[0064] From the foregoing explanation of Figure 12A, it should be understood that the spring 395 normally acts to disengage gears 393 and 388 so that direction controller valve element 370D is not driven. However, cam 396 periodically raises cam follower 397 to engage gears 393 and 388 to rotate the valve element 370D to switch direction valve 304 to its backup state. Attention is now directed to Figure 13 which illustrates an alternative water distribution implementation which incorporates a motion sensor (152 in Figure 3) for the purpose of sensing when the forward motion of the body 100 has diminished below a certain threshold. This may occur, for example, when the body 100 gets trapped behind an obstruction, such as the entrance of a built-in skimmer. In such an instance, it is desirable to promptly switch the direction valve 128 to the back-up state. Whereas in Figure 12A, spring 395 operates to normally disengage gears 393 and 388, in the embodiment of Figure 13, spring 402 is connected to swing arm 404 to normally engage gear 406 and output drive gear 408. A motion sensor in the form of paddle 412 is structurally connected to the swing arm 404. The paddle 412 is mounted so that when the body 100 is moving through the water in a forward direction (413), the relative water flow will act to pivot the paddle in a clockwise direction (as viewed in Figure 13) to overcome the action of spring 402 to disengage gears 406 and 408. So long as the body keeps moving in a forward direction above a threshold rate, the paddle 412 will overcome the spring 402 to disengage gears 406, 408 and the direction controller shaft 372 will not rotate. However, when the forward motion of the body diminishes to below the threshold rate, the paddle 412 no longer overcomes the force of spring 402 and the shaft 372 is caused to rotate to switch the direction valve 304 to the backup state.

[0065] Notwithstanding the foregoing, even if the forward motion of the body is maintained, it is nevertheless desirable to periodically switch the direction valve 304 to its backup state. For this purpose, gear 408 carries a cam 414 which periodically lifts cam follower 415 to force engagement of gears 406 and 408.

[0066] As noted, it has been assumed that the embodiments of Figures 12A and 13 define substantially equal intervals for the water surface cleaning mode and the wall surface cleaning mode. The relative split between the modes is, of course, determined by the configuration of level controller valve element 370L. As depicted, valve element 370L defines an arc of about 180° and thus, during each full rotation of valve element 370L, it will open and close exhaust port 368 for essentially equal intervals. If desired, the valve element could be configured to define an arc either greater or less than 180° to extend one of the cleaning mode intervals relative to the other cleaning mode interval. For example, in order to extend the water surface cleaning interval, the exhaust port 368L must remain closed for a greater portion of the valve element rotation meaning that the valve element 370L should extend through an arc greater than 180°.

[0067] It is sometimes desirable to enable a user to maintain the apparatus in either the water surface cleaning mode or the wall surface cleaning mode for an extended period. For this purpose, the piston rod 340L of valve assembly 306 can be configured so that it extends through the closed end of the level control valve body 330L. The free end of rod 340L is connected to a U-shaped bracket 416 (Figure 13) having legs 416A and 416B. Bracket 416 moves with the piston rod 340L between the two positions respectively represented in solid and dash line in Figure 13. A user operable control knob 417 is provided for selectively rotating shaft 418, carrying a perpendicular arm 419, between the three positions shown in Figure 13 to selectively (1) bear against bracket leg 416A to hold piston rod 340L in its left-most position defining the wall surface cleaning mode, (2) bear against the bracket leg 416B to hold piston rod 340L in its right-most position defining the water surface cleaning mode, or (3) move clear of the bracket legs to allow the bracket 416 to move without interference. The control knob 417 is preferably provided with a ball 420 which can be urged by spring 421 into a fixed recess to selectively detent the knob in any of the three positions.

[0068] Attention is now directed to Figures 14 - 16 which illustrate the inner debris container 250 in greater detail. The container 250 is formed of fine mesh material 253 rolled into an essentially cylindrical form with edge 422A overlapping edge 422B. The material 253 is sewn or otherwise sealed to close end 254. The second bag end 255 is secured to

frame member 256 so that the position of the access opening defined by overlapping edges 422A, 422B is keyed to the frame member 256. More particularly, frame member 256 defines projecting key 424 which is configured to be received in keyway 426 adjacent vacuum discharge opening 182 to orient the overlapping edges 422A, 422B upwardly. This orientation allows silt to be collected in the bag 250 without tending to bear against and leak out from between the edges. However, this configuration still allows a user to readily remove the frame 256 from the discharge opening 182 and spread the edges 422A, 422B to empty debris from bag. Short pull tabs 430, 432 are preferably provided to facilitate spreading the edges.

SECOND EMBODIMENT (Figures 17A, 17B, 17C)

[0069] In the first embodiment depicted in Figures 2-16, the heavier-than-water body 100 is lifted to and maintained at the water surface by a vertical force produced primarily by water outflow from the body (e.g., outlets 106, 110) in a direction having a vertical component.

[0070] In the second heavier-than-water embodiment 500 depicted in Figures 17A - 17C, the vertical force to maintain the body at the water surface is produced in part by selectively modifying the weight/buoyancy characteristic of the body 502. The body 502 is configured similarly to body 100 but differs primarily in the following respects:

1 - Front fin 517 is provided with an air hole 518, preferably near its upper edge 520, opening into interior chamber 522.
2 - Side walls 526L, 526R respectively define interior chambers 528L, 528R.
3 - A water powered jet pump 530 is provided for selectively pulling water out of, and air into, chambers 522, 528L, 528R. Jet pump 530 is supplied by positive pressure water via inlet 532 to create a suction at port 534 and a discharge at outlet 536.
4 - Tubing 540 extends from suction port 534 to drain ports 542L, 542R in the bottom panel of chambers 528L, 528R. Tubing 544 extends from the top of chambers 528L, 528R to drain port 546 in the bottom panel of front chamber 522.
5 - Skimmer jets 110 can be deleted.

[0071] In the wall surface cleaning mode, the body 502 (Figures 17A - 17C) will operate essentially the same as the body 100 (Figures 2 - 16). However, in the water surface cleaning mode, the level valve 550 (Figure 1 7C) will supply positive pressure water to inlet 532 of pump 530 to draw water from chambers 522, 528L 528R, via tubing 540, 544, while the body is concurrently lifted by water outflow from Forward Thrust/Lift Jet 554. After the body rises sufficiently to place air hole 518 above the water surface, pump 530 will pull air in via hole 518 to fill chambers 522, 528L, 528R. By replacing the water in chambers 522, 528L, 528R with air, the weight/buoyancy characteristic of the body 502 is modified to first elevate and then stabilize body 502 proximate to the water surface with the deck 560 just below the water surface for effective skimming action. When level valve 550 next switches to the wall surface cleaning mode, positive pressure water flow to pump inlet 532 terminates, allowing pool water to backflow into jet pump 530 to fill the chambers 522, 528L, 528R with water, and force air out through hole 518, thus causing the body 500 to descend to the wall surface bottom.

[0072] The Skimmer Jets 110 of the first embodiment may be deleted from the embodiment 500. The other water outlets (i.e., Forward Thrust Jet 564, Rearward (backup) Thrust Jet 568, Debris Retention Jet 570, and Vacuum Jet Pump Nozzle 572) perform essentially the same in body 502 as in previously described body 100.

THIRD EMBODIMENT (Figures 18A, 18B, 18C)

[0073] Attention is now directed to Figures 18A - 18C which illustrate a third embodiment 600 comprising a heavier-than-water body 602. As will be seen, the embodiment 600 differs from the first embodiment depicted in Figures 2 - 16 in that the vertical force required to lift the body 602 to the water surface and maintain it at the water surface is produced primarily by selectively modifying the weight/buoyancy characteristic of the body 602 rather than directly by a water outflow. The body 602 is configured similarly to body 100 but differs primarily in the following respects:

1 - Sidewalls 620L, 620R respectively define air holes 624L, 624R near their upper surfaces which open into central interior chambers 626L, 626R. The chambers 626L, 626R respectively define drain ports 628L, 628R opening through bottom panel 629.

2 - A water powered jet pump 632 is provided having a supply inlet 634, a suction port 635, and a discharge outlet 636. The suction port 635 is coupled to drain ports 628L, 628R. When positive pressure water is supplied to pump inlet 634 from level valve 638 (Figure 18C) in the water surface cleaning mode, a suction is created at port 635 to draw water out of chambers 626L, 626R. When valve 638 switches to the wall surface cleaning mode, the positive

pressure supply to inlet 634 terminates and pool water flows backwards though pump 632 to fill central chambers 626L, 626R via drain ports 628L, 628R.

3 - Front fin 640 defines a front interior chamber 642 having a drain port 644 in bottom panel 645.

4 - A water powered jet pump 648 is provided having a supply inlet 650, a suction port 651 and a discharge outlet 652. When positive pressure water is supplied to jet pump 648 from level valve 638 (Figure 18C) in the water surface cleaning mode, a suction is created at port 651 to draw water out of chamber 642. When the supply to inlet 650 terminates, pool water flows backwards through pump 648 to fill front chamber 642 via drain port 644.

5 - Rear interior chambers 660L, 660R are respectively formed rearwardly of central chambers 626L, 626R by partition wall 662. The chambers 660L, 660R open via ports 664L, 644R and tubing 666 to a flaccid bag 668 physically contained within front chamber 642. The chambers 660L, 660R are filled with air at atmospheric pressure (prior to installation), via a removable plug 670.

6 - Skimmer Jets 110 and Forward Thrust Lift Jet 106 of the first embodiment can be deleted from the embodiment 600 of Figures 18A - 18C. Note in Figure 18C that the Thrust Jet 672 is supplied from the forward outlet 674 of the direction valve 676, rather than from the level valve 638.

[0074] When operating in the wall surface cleaning mode, the front chamber 642 and central chambers 626L, 626R will be filled with water, primarily via backflow through pumps 648, 632, and flaccid bag 668 will be collapsed by the water in chamber 642. When operation is switched to the water surface cleaning mode by level valve 638, jet pump 648 pumps water out of front chamber 642 to permit bag 668 to inflate with air supplied from rear chambers 660L, 660R. This action fills chamber 642 with air (at a pressure less than atmospheric) enabling the body 602 to float to the water surface and lift air holes 624L, 624R above the water surface. With the holes 624L, 624R above the water surface, jet pump 632 evacuates water from central chambers 626L, 626R and fills them with air thereby providing additional buoyancy to elevate and stabilize the body 602 and position the deck 678 at just below the water surface for effective skimming action.

[0075] When valve 638 switches back to the wall surface cleaning mode, the positive pressure water supply to pump inlets 634 and 650 terminates allowing pool water to backflow through jet pumps 632, 648 into central chambers 626L, 626R and front chamber 642. As a consequence bag 668 collapses forcing its interior air back into rear chambers 660L, 660R while the air in central chambers 626L, 626R flows out of air holes 624L, 624R as pool water fills the central chambers. As a consequence, the body 602 will descend to the wall surface bottom.

[0076] The Skimmer Jets 110 and Forward Thrust/Lift Jet 106 of the first embodiment may be deleted from the embodiment 600. The other water outlets (i.e., Forward Thrust Jet, Rearward (backup) Thrust Jet, and Vacuum Jet Pump Nozzle) perform essentially the same in body 602 as in previously described body 100. Note that the Thrust Jet 672, because of its placement at the forward outlet 674 of direction valve 676 (Figure 18C), operates to provide forward propulsion in both cleaning modes.

FOURTH EMBODIMENT (Figures 19A, 19B, 19C)

[0077] Attention is now directed to Figures 19A - 19C which illustrate a fourth embodiment 700 comprising a body 702. Whereas the first three embodiments thus far described were referred to as being heavier-than-water inasmuch as they sink in a quiescent or rest state and are lifted to the water surface in an active state, the body 702 can be considered as being lighter-than-water inasmuch as it floats in its quiescent state and is caused to descend in an active state. As will be described hereinafter, the body 702 is caused to descend in the wall surface cleaning mode primarily by selectively modifying its weight/buoyancy characteristic. The body 702 is configured similarly to body 100 but differs primarily in the following respects:

1 - Sidewalls 720L defines a rear interior chamber 726L and a central chamber 728L. Similarly sidewall 720R defines rear and central chambers 726R, 728R.

2 - Front fin 740 defines a front interior chamber 742.

3 - Central chambers 728L, 728R and front fin chamber 742 respectively contain flaccid bags 744L, 744R, and 746.

4 - An air tube 748 is provided opening into rear chambers 726L, 726R at 750L, 750R and into flaccid bags 744L, 744R and 746 at 752L, 752R and 754. The rear chambers 726L, 726R and flaccid bags 744L, 744R and 746 are filled with air at atmospheric pressure (prior to installation) via removable plugs 760.

5 - A tube 764 is provided to selectively supply positive pressure water to central chambers 728L, 728R via outlets 766L, 766R and to front fin chamber 742 via outlet 768.

6 - Skimmer Jets 110 and Forward Thrust Lift Jet 106 of the first embodiment can be deleted from the embodiment 700 of Figures 19A - 19C.

[0078] In operation in the water surface cleaning mode, rear chambers 726L, 726R and flaccid bags 744L, 744R and 746 will all be filled with air at atmospheric pressure to produce a net buoyancy which floats the body at the water surface. When operation is switched to the wall surface cleaning mode by valve 770 Figure 19C), this will supply pressurized water via water fill tube 764 to outlets 766L, 766R and 768. This action will collapse flaccid bags 744L, 744R, and 746 and force the air therein via air tube 748, into rear chambers 726L, 726R at a pressure above atmospheric.

[0079] When valve 770 (Figure 19C) switches back to the water surface cleaning mode, the positive water pressure supplied to tube 764 is terminated, permitting the compressed air in rear chambers 726L, 726R to expand to fill bags 744L, 744R and 746 thus modifying the weight/buoyancy characteristic of the body to enable it to float to the water surface.

[0080] The water outlets (i.e. Rearward (backup) Thrust Jet, and Vacuum Jet Pump Nozzle) perform essentially the same in body 702 as in previously described body 100. However, the Forward Thrust Jet 772 is supplied directly from the forward outlet 774 (Figure 19C) of the direction valve 776 (Figure 19C) so that it operates in both cleaning modes to provide forward propulsion.

[0081] The water distribution systems of Figures 17C, 18C, and 19C can each be implemented substantially as shown in Figures 12A or 13. Attention is now directed to Figures 20 and 21 which respectively depict implementations alternative to those shown in Figures 12 and 13.

[0082] More particularly, Figure 20 illustrates a water distribution system implementation 800 basically comprised:

a. Direction valve assembly 802
b. Level valve assembly 804
c. Direction controller 806
d. Level controller 808
e. Level controller timing assembly 810 primarily comprised of nozzle 812, turbine 814, timing gear train 816, output shaft 818, and timing disk 820.
f. Direction controller timing assembly 830 primarily comprised of nozzle 832, turbine 834, timing gear train 836, output shaft 838, and timing disk 840.

[0083] The direction valve assembly 802 and level valve assembly 804 can be substantially identical to the corresponding elements discussed in conjunction with Figure 12A. More particularly, direction valve assembly 802 is comprised of a cylindrical body 850 defining a supply inlet 852, a forward outlet 854, a rearward outlet 856, a control port 858, and a pressurized water outlet 860. Spring 862 biases valve element 864 to the backup state, i.e., with forward outlet 854 closed and rearward outlet 856 open. When positive water pressure is supplied to control port 858, valve element 864 moves downwardly to define the forward state, i.e., with forward outlet 854 open and rearward outlet 856 closed.

[0084] Level valve assembly 804 is similarly comprised of a cylindrical body 870 which defines a supply inlet 872, a wall surface outlet 874, a water surface outlet 876, and a control port 878. Spring 880 biases valve element 882 to the water surface cleaning mode, i.e., with wall surface outlet 874 closed and water surface outlet 876 open. When positive water pressure is supplied to control port 878, valve element 882 is moved to define the wall surface mode with water surface outlet 876 closed and wall surface outlet 874 open.

[0085] Direction controller 806 and level controller 808 are substantially identical to the corresponding elements discussed in conjunction with Figure 12A. Direction controller 806 is comprised of a cylindrical body 888 having a peripheral wall 890 and an end wall 892. The peripheral wall 890 defines an inlet 894 and an outlet 896. The end wall 892 defines an exhaust port 898. A disk shaped valve element 900 is mounted on the aforementioned output shaft 838 for rotation in the body 888. During a portion of its rotation, valve element 900 seals exhaust port 898 enabling positive pressure applied to inlet 894 to be transferred via outlet 896 and tube 902 to direction valve control port 858. During the remaining portion of its rotation, exhaust port 898 is open and positive pressure water from inlet 894 is exhausted through port 898 so that no significant pressure is applied to control port 858. Positive pressure water is supplied to inlet 894 via tubing 906 coupled to pressurized water outlet 860.

[0086] Level controller 808 also comprises a cylindrical body 908 having a peripheral wall 910 and an end wall 912. The peripheral wall 910 defines an inlet 914 and an outlet 916. The end wall defines an exhaust port 918. A disk shaped valve element 920 is mounted on aforementioned output shaft 818 for rotation in the level controller body 908. During a portion of its rotation, valve element 920 seals exhaust port 918 enabling positive pressure applied to inlet 914 to be transferred via outlet 916 to level valve control port 878. During the remaining portion of its rotation, exhaust port 918 is open and positive pressure water from inlet 914 is exhausted through port 918 so that no significant pressure is applied

to control port 878. Positive pressure water is supplied to inlet 910 via aforementioned tubing 906.

[0087] Tubing 906 also supplies positive pressure water to nozzles 812 and 832 to respectively rotate turbines 814 and 834. Turbine 814 is mounted on shaft 924 and drives gear train 816 to drive output shaft 818. Additionally, gear train 816 drives timing disk 820. Similarly, turbine 834 drives shaft 930 which via gear train 836 drives output shaft 838. Gear train 836 additionally drives timing disk 840.

[0088] As can be seen in Figure 20, timing disks 820 and 840 are mounted side by side in the same plane. A latch bar 950 mounted for hinged movement around pin 952 between a latched and unlatched position extends across the faces of disks 820 and 840. Spring 954 normally urges latch bar 950 toward the latched position proximate to the faces of disks 820 and 840. Disk 820 carries one or more lifter cams 960 on its face. Lifter cam 960 preferably has a ramp at its leading edge 962 configured to engage latch element 964 to lift latch bar 950 to its unlatched position as the disk 820 rotates in the direction of arrow 966.

[0089] Disk 840 carries one or more stop elements 970 on its face, each configured to engage latch element 964 to stall rotation of disk 840 and output shaft 838 in its forward state when latch bar 950 is in its latched position. Stop element 970 is oriented relative to valve element 900 such that its engagement against latch element 964 acts to maintain direction controller 806 and direction valve 802 in the forward state. Periodically, when lifter cam 960 on disk 820 lifts latch bar 950 to its unlatched position, stop element 970 moves past latch element 964 enabling disk 840 and valve element 900 to rotate through substantially 360° passing through the backup or rearward state and returning to the forward state. At some point in its cycle, stop member 970 again engages latch element 964 thus stalling direction controller 806 in the forward state.

[0090] Thus, to summarize the operation of Figure 20, rotation of the turbine 814 drives the gear train 816 to cause the level controller 808 to alternately define the wall surface and water surface cleaning modes. As the gear train 816 rotates, lifter cam 960 periodically lifts latch bar 950 to its unlatched position enabling stop element 970 of disk 840 (driven by turbine 834) to move past latch element 964 to cycle through the backup state. Although Figure 20 depicts a single fixedly positioned lifter cam 960 and a single fixedly positioned stop element 970 on the face of disks 820 and 840 respectively, it is pointed out that a more complex and detailed timing pattern could be achieved if desired by utilizing multiple lifter cams and/or stop elements, and/or mounting them so that their respective positions on the disks can be varied.

[0091] Attention is now directed to Figure 21 which illustrates a water distribution system 972 similar to that depicted in Figure 20 but modified to sense when the forward motion of the cleaner body diminishes below a certain threshold. This may occur, for example, when the body gets trapped by an obstruction, such as the entrance to a built-in pool skimmer. In such an instance, it is generally desirable to promptly cycle the direction controller 806 to the backup state in order to free the cleaner body. To introduce this capability, the system of Figure 21 differs from Figure 20 in that the latch bar 950 is no longer spring urged to the latched position. Rather, a paddle 974 is mounted at the free end of latch bar 950 and oriented such that forward motion of the cleaner body through the water pivots bar 950 around pin 952 toward the disks 820, 840, i.e., the latched position. As long as the forward motion of the cleaner body remains above a certain threshold sufficient to press the latch element 964 with sufficient force to prevent movement of stop element 970 past latch element 964, direction controller 806 will remain in its forward state (except for periodic interruption by lifter cam 960, e.g., once every five minutes). If, however, the forward motion of the cleaner body diminishes below the threshold, the ramped leading edge of stop element 970, will lift bar 950 and move past latch element 964 as disk 840 and output shaft 838 are allowed to turn. If disk 840 carries only a single stop element 970, this action immediately initiates the valve element 900 cycle through the backup state and then to the forward state. Figure 21, however, depicts multiple spaced stop elements 970_1, 970_2, 970_3 which function to essentially introduce a time delay in the forward state before the valve element 900 cycle is launched. Thus, if in the interval after the first stop element 970, passes latch element 964, and prior to a subsequent stop element, i.e., 970_2 or 970_3 passing latch element 964, the cleaner body frees itself and resumes its forward motion, then the initiation of the subsequent stop element will engage latch element 964 to stall output shaft 838 movement and defer rotation of valve element 900 to the backup state.

[0092] From the foregoing, it should now be appreciated that a method and apparatus has been disclosed herein responsive to a positive pressure water source for cleaning the interior surface of a pool containment wall and the upper surface of a water pool contained therein. Apparatus in accordance with the invention includes an essentially unitary cleaner body and a level control subsystem for selectively moving the body to a position either proximate to the surface of the water pool for water surface cleaning or proximate to the interior surface of the containment wall for wall surface cleaning.

[0093] The invention can be embodied in a cleaner body having a weight/buoyancy characteristic to cause it to normally rest either (1) proximate to the pool bottom adjacent to the wall surface (i.e., heavier-than-water) or (2) proximate to the water surface (i.e., lighter-than-water). With the heavier-than-water body, the level control subsystem in an active state produces a vertical force component for lifting the body to proximate to the water surface for operation in a water surface cleaning mode. With the lighter-than-water body, the level control subsystem in an active state produces a vertical force component for causing the body to descend to the wall surface for operation in the wall surface cleaning mode. The

level control subsystem can produce the desired vertical force component either by discharging an appropriately directed water outflow from the body, and/or by modifying the body's weight/buoyancy characteristic.

Claims

1. Apparatus configured to be driven by a positive pressure water source (10) for cleaning the interior surface (8) of a containment wall and the upper surface (7) of a water pool (1) contained therein, said apparatus comprising:

   a unitary body (6) configured for immersion in said water pool (1);
   means (9) for supplying a positive pressure water flow to said body from said source (10);
   a level control subsystem (124, 138) responsive to said water flow for producing a vertical force to selectively place said body either (1) in a first mode proximate to said water surface (7) or (2) in a second mode proximate to said wall surface (8) below said water surface;
   at least one pool water inlet (218, 109) in said body;
   a propulsion control subsystem (126, 128) responsive to said water flow for selectively moving said body either (1) along a path adjacent to said water surface (7) for collecting pool water through said inlet (218) from adjacent to said water surface or (2) along a path adjacent to said wall surface (8) for collecting pool water through said inlet (109) from adjacent to said wall surface; and
   a debris container (111) carried by said body for collecting debris from pool water collected through said water inlet (218, 109).

2. The apparatus of claim 1 wherein said body (6) has a weight/buoyancy characteristic biased to cause said body to normally rest proximate to said interior wall surface (8); and wherein said level control subsystem selectively defines an active state for producing a vertical force component for lifting said body to proximate to said water surface.

3. The apparatus of claim 2 wherein said level control subsystem (124,138) in said active state discharges a water outflow (106) from said body in a direction to produce a vertically upward force on said body to lift said body to said water surface.

4. The apparatus of claim 2 wherein said level control subsystem (124,138) in said active state produces a water flow (530) to modify said weight/buoyancy characteristic to lift said body to said water surface.

5. The apparatus of claim 1 wherein said body has a weight/buoyancy characteristic biased to cause said body to normally rest proximate to said water surface; and wherein
   said level control subsystem (124,138) selectively defines an active state for producing a vertical force component for holding said body proximate to said wall surface.

6. The apparatus of claim 1 wherein said propulsion control subsystem (124,138) is operable to produce a force on said body to either move said body along (1) a surface path proximate to said water pool surface (7) or (2) a submerged path adjacent to said interior wall surface (8).

7. The apparatus of claim 1 wherein said debris container (111) comprises a bag. (231) formed of mesh material and having an open mouth (218) removably mounted adjacent to said discharge port.

8. The apparatus of claim 1 wherein said propulsion control subsystem includes a direction controller (126) for selectively defining a first state to produce a force on said body for moving said body in a first direction and a second state to produce a force on said body for moving said body in a second direction.

9. The apparatus of claim 8 further including a timing device (122) coupled to said direction controller for periodically causing it to define said first and second states.

10. The apparatus of claim 8 further including a motion sensor (152) responsive to the forward motion of said body diminishing below a certain threshold for causing said direction controller to define said second state.

11. The apparatus of claim 1 further including a timing device (122) for alternately causing said level control subsystem to define said first and second modes.

12. The apparatus of claim 1 further including a user control (146) operable to selectively maintain said level control subsystem in either said first or said second modes.

13. The apparatus of claim 1 wherein said body defines a hydrodynamic surface (242) for interacting with said pool water to produce a force on said body substantially perpendicular to the direction of body movement through said water pool.

14. The apparatus of claim 1 wherein said body further defines a wall surface inlet port (189); and
a water path (180) extending from said wall surface inlet port to said debris container.

15. The apparatus of claim 14 wherein said debris container (111) includes a first portion defining a first mesh (231) for passing pool water from said water surface inlet port and a second portion (250) having a finer mesh than said first mesh for passing pool water from said wall surface inlet port.

16. The apparatus of claim 1 wherein said positive pressure water source comprises an electric motor/pump (10) assembly defining a pressure outlet; and
a flexible elongate supply hose (9) coupling said pressure outlet to said unitary body.

17. The apparatus of claim 16 further including a timer (120) for periodically activating said motor/pump assembly.

18. The apparatus of claim 16 wherein said supply hose (9) is configured to cause a portion of its length to normally rest against said interior wall surface (8).

19. The apparatus of claim 16 including a pressure/flow regulator coupled to said pressure outlet.

20. The apparatus of claim 1 wherein said unitary body defines a sweep hose outlet (114); and
a flexible sweep hose (9) coupled to said sweep hose outlet and responsive to water supplied therefrom for whipping against said interior wall surface.

21. The apparatus of claim 1 wherein said unitary body defines a top portion (154T) and a bottom portion (154B);
at least one support wheel (170); and
means mounting said support wheel to said body proximate to said bottom portion for rotation about a substantially horizontally oriented axis.

22. The apparatus of claim 1 wherein said unitary body defines a top portion (154T) and a bottom portion (154B);
a least one guide wheel (176); and
means mounting said guide wheel to said body for rotation about a substantially vertically oriented axis for engaging a vertical portion of said wall surface.

23. A method of cleaning both the interior wall surface of an open container and the water surface of a water pool contained therein, said method comprising:

placing a unitary body (6) in said water pool (1);
supplying a positive pressure water flow (10) to said body for producing a vertical force thereon (124, 138) to selectively move said body to either a first level proximate to said water surface (7) or a second level proximate to said wall surface (8) below said water surface;
urging said body against said wall surface (8) when said body is proximate to said wall surface;
supporting said body proximate to said water surface (7) when said body is proximate to said water surface; and
supplying a positive pressure water flow (10) to said body for propelling (126, 128) said body along either (1) a path adjacent to said water surface for collecting pool water from adjacent to said water surface when said body is at said first level or (2) a path adjacent to said wall surface for collecting pool water from adjacent to said wall surface when said body is at said second level; and
removing debris (111) from said collected pool water.

Patentansprüche

1. Vorrichtung, welche derart ausgebildet ist, dass sie von einer Überdruckwasserquelle (10) angetrieben wird, um

die Innenoberfläche (8) einer Behälterwand und die obere Oberfläche (7) eines darin enthaltenen Wassers eines Wasserbeckens (1) zu reinigen, wobei diese Vorrichtung umfasst:

einen unitären Körper (6), der zum Eintauchen in das Wasserbecken (1) ausgebildet ist;
Mittel (9) zum Zuführen eines Überdruckwasserstroms zu dem Körper von der Quelle (10);
ein Subsystem zur Niveau-Überwachung (124, 138), das auf den Wasserstrom anspricht und eine vertikale Kraft erzeugt, um den Körper selektiv entweder (1) in einer ersten Betriebsart in der Nähe der Wasseroberfläche (7) anzuordnen oder (2) in einer zweiten Betriebsart in der Nähe der Wandoberfläche (8) unter der Wasseroberfläche;
zumindest einen Wassereinlass (218, 109) in dem Körper;
ein Subsystem zur Antriebsüberwachung (126, 128), das auf den Wasserstrom anspricht und den Körper selektiv bewegt, entweder (1) entlang einem in der Nähe der Wasseroberfläche (7) liegenden Weg zum Sammeln von Beckenwasser aus der Nähe der Wasseroberfläche durch den Einlass (218), oder (2) entlang einem in der Nähe der Wandoberfläche (8) liegenden Weg zum Sammeln von Beckenwasser aus der Nähe der Wandoberfläche durch den Einlass (109); und
einen von dem Körper getragenen Abfallbehälter (111) zum Sammeln von Abfall aus dem Beckenwasser, das durch den Wassereinlass (218, 109) gesammelt ist.

2. Vorrichtung nach Anspruch 1, wobei der Körper (6) eine derart eingestellte Gewicht/Auftrieb-Charakteristik hat, dass sie den Körper veranlasst, normalerweise in der Nähe der Innenwandoberfläche (8) zu bleiben; und wobei das Subsystem zur Niveau-Überwachung selektiv einen aktiven Zustand zum Produzieren einer vertikalen Kraftkomponente definiert, mit der der Körper in die Nähe der Wasseroberfläche angehoben wird.

3. Vorrichtung nach Anspruch 2, wobei das Subsystem zur Niveau-Überwachung (124, 138) in dem aktiven Zustand einen Wasserausfluss (106) von dem Körper in eine solche Richtung ausströmen lässt, dass eine vertikale Aufwärtskraft auf den Körper erzeugt wird, um den Körper zu der Wasseroberfläche anzuheben.

4. Vorrichtung nach Anspruch 2, wobei das Subsystem zur Niveau-Überwachung (124, 138) in dem aktiven Zustand einen Wasserstrom (530) produziert, um die Gewicht/Auftrieb-Charakteristik derart zu modifizieren, dass sie den Körper an die Wasseroberfläche anhebt.

5. Vorrichtung nach Anspruch 1, wobei der Körper eine derart eingestellte Gewicht/Auftrieb-Charakteristik hat, dass sie den Körper veranlasst, normalerweise in der Nähe der Wasseroberfläche zu bleiben; und wobei
das Subsystem zur Niveau-Überwachung (124, 138) selektiv einen aktiven Zustand zum Produzieren einer vertikalen Kraftkomponente definiert, mit der der Körper in der Nähe der Wandoberfläche gehalten wird.

6. Vorrichtung nach Anspruch 1, wobei das Subsystem zur Antriebsüberwachung (124, 138) derart betrieben werden kann, dass es eine Kraft auf den Körper erzeugt, durch die der Körper entweder (1) entlang einem Oberflächenweg in der Nähe der Wasserbeckenoberfläche (7) geführt wird oder (2) entlang einem untergetauchten Weg in der Nähe der Innenwandoberfläche (8).

7. Vorrichtung nach Anspruch 1, wobei der Abfallbehälter (111) einen aus Gittermaterial gebildeten Beutel (231) mit einer Öffnung (218) umfasst, die in der Nähe der Ausströmöffnung lösbar montiert ist.

8. Vorrichtung nach Anspruch 1, wobei das Subsystem zur Antriebsüberwachung eine Richtungssteuerung (126) zum selektiven Bilden eines ersten Zustands enthält, um eine Kraft auf den Körper zu erzeugen, durch die der Körper in eine erste Richtung bewegt wird, sowie eines zweiten Zustands, um eine Kraft auf den Körper zu erzeugen, durch die der Körper in eine zweite Richtung bewegt wird.

9. Vorrichtung nach Anspruch 8, ferner enthaltend ein Zeitschaltgerät (122), das mit der Richtungssteuerung verbunden ist, um es periodisch zum Bilden des ersten und zweiten Zustands zu veranlassen.

10. Vorrichtung nach Anspruch 8, ferner enthaltend einen Bewegungssensor (152), der auf die Vorwärtsbewegung des Körpers anspricht, wenn diese unter eine bestimmte Schwelle absinkt, um die Richtungssteuerung zum Bilden des zweiten Zustands zu veranlassen.

11. Vorrichtung nach Anspruch 1, ferner enthaltend ein Zeitschaltgerät (122), das das Subsystem zur Niveau-Überwachung wechselweise veranlasst, die erste und die zweite Betriebsart einzustellen.

12. Vorrichtung nach Anspruch 1, ferner enthaltend eine Benützersteuerung (146), die derart betrieben werden kann, dass sie das Subsystem zur Niveau-Überwachung selektiv entweder in der ersten oder in der zweiten Betriebsart hält.

13. Vorrichtung nach Anspruch 1, wobei der Körper eine hydrodynamische Oberfläche (242) zum Zusammenwirken mit dem Beckenwasser bildet, um eine Kraft auf den Körper zu erzeugen, die im Wesentlichen senkrecht zu der Richtung der Körperbewegung durch das Wasserbecken ist.

14. Vorrichtung nach Anspruch 1, wobei der Körper ferner eine Wandoberflächeneinlassöffnung (189) bildet; und einen Wasserweg (180), der sich von der Wandoberflächeneinlassöffnung zu dem Abfallbehälter erstreckt.

15. Vorrichtung nach Anspruch 14, wobei der Abfallbehälter (111) einen ersten Abschnitt enthält, der ein erstes Gitter (231) bildet zum Durchlassen von Beckenwasser von der Wasseroberflächeneinlassöffnung, sowie einen zweiten Abschnitt (250) mit einem feineren Gitter als das erste Gitter zum Durchlassen von Beckenwasser von der Wandoberflächeneinlassöffnung.

16. Vorrichtung nach Anspruch 1, wobei die Überdruckwasserquelle eine elektrische Motor-/Pumpenanordnung (10) umfasst, die einen Druckauslass bildet; und
einen flexiblen länglichen Zufuhrschlauch (9), der den Druckauslass mit dem unitären Körper verbindet.

17. Vorrichtung nach Anspruch 16, ferner enthaltend ein Zeitschaltgerät (120) zum periodischen Einschalten der Motor-/Pumpenanordnung.

18. Vorrichtung nach Anspruch 16, wobei der Zufuhrschlauch (9) derart ausgebildet ist, dass er einen seiner Längenabschnitte dazu veranlasst, normalerweise an der Innenwandoberfläche (8) anzuliegen.

19. Vorrichtung nach Anspruch 16 einschließlich eines Druck/Stromreglers, der mit dem Druckauslass verbunden ist.

20. Vorrichtung nach Anspruch 1, wobei der unitäre Körper einen Reinigungsschlauchauslass (114) bildet; und einen flexiblen Reinigungsschlauch (9), der mit dem Reinigungsschlauchauslass verbunden ist und auf Wasser anspricht, das von diesem zugeführt wird, um gegen die Innenwandoberfläche zu schlagen.

21. Vorrichtung nach Anspruch 1, wobei der unitäre Körper einen oberen Abschnitt (154T) und einen unteren Abschnitt (154B) bildet;
zumindest ein Stützrad (170); und
Mittel, mit denen das Stützrad an dem Körper in der Nähe des unteren Abschnitts montiert ist zum Drehen um eine im Wesentlichen horizontal ausgerichtete Achse.

22. Vorrichtung nach Anspruch 1, wobei der unitäre Körper einen oberen Abschnitt (154T) und einen unteren Abschnitt (154B) bildet;
zumindest ein Führungsrad (176); und
Mittel, mit denen das Führungsrad an dem Körper montiert ist zum Drehen um eine im Wesentlichen vertikal ausgerichtete Achse, um mit einem vertikalen Abschnitt der Wandoberfläche in Eingriff zu kommen.

23. Verfahren zum Reinigen sowohl der Innenwandoberfläche eines geöffneten Behälters als auch der Wasseroberfläche eines darin enthaltenen Wasserbeckens, wobei dieses Verfahren umfasst:

Anordnen eines unitären Körpers (6) in dem Wasserbecken (1);
Zuführen eines Überdruckwasserstroms (10) zu dem Körper, um auf diesem (124, 138) eine vertikale Kraft zu erzeugen, um den Körper selektiv zu bewegen, entweder zu einem ersten Niveau in der Nähe der Wasseroberfläche (7), oder zu einem zweiten Niveau in der Nähe der Wandoberfläche (8) unter der Wasseroberfläche;
Drücken des Körpers an die Wandoberfläche (8), wenn sich der Körper in der Nähe der Wandoberfläche befindet;
Stützen des Körpers in der Nähe der Wasseroberfläche (7), wenn sich der Körper in der Nähe der Wasseroberfläche befindet; und
Zuführen eines Überdruckwasserstroms (10) zu dem Körper, um den Körper anzutreiben (126, 128), entweder (1) entlang einem in der Nähe der Wasseroberfläche liegenden Weg zum Sammeln von Beckenwasser aus der Nähe der Wasseroberfläche, wenn sich der Körper in dem ersten Niveau befindet, oder (2) entlang einem in der Nähe der Wandoberfläche liegenden Weg zum Sammeln von Beckenwasser aus der Nähe der Wandoberfläche, wenn sich der Körper in dem zweiten Niveau befindet; und

Entfernen von Abfall (111) aus dem gesammelten Beckenwasser.

Revendications

1. Dispositif configuré pour être entraîné par une source d'eau à pression positive (10) afin de nettoyer la surface intérieure (8) d'une paroi de retenue et la surface supérieure (7) d'une masse d'eau (1) contenue dans celle-ci, ledit dispositif comprenant :

   un corps unitaire (6) configuré en vue d'une immersion dans ledit bassin d'eau (1),
   des moyens (9) destinés à fournir un écoulement d'eau à pression positive audit corps à partir de ladite source (10),
   un sous-système de commande de niveau (124, 138) réagissant audit écoulement d'eau pour produire une force verticale afin de placer sélectivement ledit corps soit (1), dans un premier mode, à proximité de ladite surface d'eau (7), soit (2), dans un second mode, à proximité de ladite surface de paroi (8) en dessous de ladite surface d'eau,
   au moins une entrée d'eau de bassin (218, 109) ménagée dans ledit corps,
   un sous-système de commande à propulsion (126, 128) réagissant audit écoulement d'eau pour déplacer sélectivement ledit corps soit (1) le long d'une trajectoire adjacente à ladite surface d'eau (7), afin de recueillir l'eau de bassin par l'intermédiaire de ladite entrée (218) à partir d'une position adjacente à ladite surface d'eau, soit (2) le long d'une trajectoire adjacente à ladite surface de paroi (8), afin de recueillir l'eau de bassin par l'intermédiaire de ladite entrée (109) à partir d'une position adjacente à ladite surface de paroi, et
   un conteneur à débris (111) supporté par ledit corps, destiné à recueillir les débris provenant de l'eau de bassin recueillie par l'intermédiaire de ladite entrée d'eau (218, 109).

2. Dispositif selon la revendication 1, dans lequel ledit corps (6) présente une caractéristique sollicitée de poids/flottabilité afin d'amener ledit corps à reposer normalement à proximité de ladite surface de paroi intérieure (8), et dans lequel
   ledit sous-système de commande de niveau définit sélectivement un état actif destiné à produire une composante de force verticale pour élever ledit corps jusqu'à proximité de ladite surface d'eau.

3. Dispositif selon la revendication 2, dans lequel ledit sous-système de commande de niveau (124, 138) dans ledit état actif évacue un flux d'éjection d'eau (106) à partir dudit corps dans une direction afin de produire une force verticale ascendante sur ledit corps pour élever ledit corps jusqu'à ladite surface de l'eau.

4. Dispositif selon la revendication 2, dans lequel ledit sous-système de commande de niveau (124, 138) dans ledit état actif produit un écoulement d'eau (530) pour modifier ladite caractéristique de poids/flottabilité afin d'élever ledit corps jusqu'à ladite surface de l'eau.

5. Dispositif selon la revendication 1, dans lequel ledit corps présente une caractéristique sollicitée de poids/flottabilité afin d'amener ledit corps à reposer normalement à proximité de ladite surface de l'eau, et dans lequel
   ledit sous-système de commande de niveau (124, 138) définit sélectivement un état actif pour produire une composante de force verticale afin de maintenir ledit corps à proximité de ladite surface de l'eau.

6. Dispositif selon la revendication 1, dans lequel ledit sous-système de commande à propulsion (124, 138) peut être mis en oeuvre pour produire une force sur ledit corps afin de déplacer ledit corps suivant soit (1) une trajectoire de surface à proximité de ladite surface de bassin d'eau (7), soit (2) une trajectoire submergée adjacente à ladite surface de paroi intérieure (8).

7. Dispositif selon la revendication 1, dans lequel le conteneur à débris (111) comporte un sac (231) constitué d'un matériau de treillis et ayant un orifice d'ouverture (218) monté de façon amovible au voisinage dudit orifice d'évacuation.

8. Dispositif selon la revendication 1, dans lequel ledit sous-système de commande à propulsion comprend un contrôleur de direction (126) destiné à définir sélectivement un premier état afin de produire une force sur ledit corps afin de déplacer ledit corps dans une première direction, et un second état afin de produire une force sur ledit corps pour déplacer ledit corps dans une seconde direction.

9. Dispositif selon la revendication 8, comprenant en outre un dispositif de cadencement (122) couplé audit contrôleur de direction afin d'amener périodiquement celui-ci à définir lesdits premier et second états.

10. Dispositif selon la revendication 8, comprenant en outre un capteur de déplacement (152) répondant au déplacement vers l'avant dudit corps diminuant en dessous d'un certain seuil, afin d'amener ledit contrôleur de direction à définir un second état.

11. Dispositif selon la revendication 1, comprenant en outre un dispositif de cadencement (122) destiné à amener en alternance ledit sous-système de commande de niveau à définir lesdits premier et second modes.

12. Dispositif selon la revendication 1, comprenant en outre une commande d'utilisateur (146) pouvant être mise en oeuvre pour maintenir sélectivement ledit sous-système de commande de niveau soit dans ledit premier mode, soit dans ledit second mode.

13. Dispositif selon la revendication 1, dans lequel ledit corps définit une surface hydrodynamique (242) destinée à interagir avec ladite eau de bassin pour produire une force sur ledit corps dans une direction essentiellement perpendiculaire à la direction du déplacement du corps au travers dudit bassin d'eau.

14. Dispositif selon la revendication 1, dans lequel ledit corps définit en outre un orifice d'entrée de surface de paroi (189), et
une trajectoire d'eau (180) s'étendant depuis ledit orifice d'entrée de surface de paroi jusqu'audit conteneur à débris.

15. Dispositif selon la revendication 14, dans lequel ledit conteneur à débris (111) comprend une première partie définissant un premier treillis (231) destinée à laisser passer l'eau de bassin à partir dudit orifice d'entrée de surface d'eau, et une seconde partie (250) ayant un treillis plus fin que ledit premier treillis, destinée à laisser passer l'eau de bassin à partir dudit orifice d'entrée de surface de paroi.

16. Dispositif selon la revendication 1, dans lequel ladite source d'eau à pression positive comprend un ensemble de moteur électrique/pompe (10) définissant une sortie de pression, et
un tuyau d'alimentation allongé et flexible (9) couplant ladite sortie de pression audit corps unitaire.

17. Dispositif selon la revendication 16, comprenant en outre une minuterie (120) destinée à activer périodiquement ledit ensemble de moteur/pompe.

18. Dispositif selon la revendication 16, dans lequel ledit tuyau d'alimentation (9) est configuré pour amener une partie de sa longueur à reposer normalement contre ladite surface de paroi intérieure (8).

19. Dispositif selon la revendication 16, comprenant un régulateur de pression/débit couplé à ladite sortie de pression.

20. Dispositif selon la revendication 1, dans lequel ledit corps unitaire définit une sortie de tuyau de balayage (114), et un tuyau de balayage souple (9) couplé à ladite sortie de tuyau de balayage et réagissant à l'eau fournie à partir de celle-ci pour fouetter ladite surface de paroi intérieure.

21. Dispositif selon la revendication 1, dans lequel ledit corps unitaire définit une partie supérieure (154T) et une partie inférieure (154B),
au moins une roue de support (170), et
des moyens pour monter ladite roue de support sur ledit corps à proximité de ladite partie inférieure en vue d'une rotation autour d'un axe orienté essentiellement horizontalement.

22. Dispositif selon la revendication 1, dans lequel ledit corps unitaire définit une partie supérieure (154T) et une partie inférieure (154B),
au moins une roue de guidage (176), et
des moyens pour monter ladite roue de guidage sur ledit corps en vue d'une rotation autour d'un axe orienté essentiellement verticalement en vue de venir en engagement avec une partie verticale de ladite surface de paroi.

23. Procédé de nettoyage à la fois de la surface de paroi intérieure d'un conteneur ouvert et de la surface d'eau d'une masse d'eau contenue dans celui-ci, ledit procédé comprenant :

le placement d'un corps unitaire (6) dans ledit bassin d'eau (1),
l'application d'un écoulement d'eau à pression positive (10) audit corps afin de produire une force verticale sur celui-ci (124, 138), pour déplacer sélectivement ledit corps soit jusqu'à un premier niveau à proximité de ladite surface d'eau (7), soit jusqu'à un second niveau à proximité de ladite surface de paroi (8) en dessous de ladite surface d'eau,
la sollicitation dudit corps contre ladite surface de paroi (8) lorsque ledit corps est à proximité de ladite surface de paroi,
le support dudit corps à proximité de ladite surface d'eau (7) lorsque ledit corps est à proximité de ladite surface d'eau, et
l'application d'un écoulement d'eau à pression positive (10) audit corps afin de propulser (126, 128) ledit corps suivant soit (1) une trajectoire adjacente à ladite surface d'eau en vue de recueillir l'eau de bassin à partir d'une position adjacente à ladite surface d'eau lorsque ledit corps se trouve audit premier niveau, soit (2) une trajectoire adjacente à ladite surface de paroi en vue de recueillir l'eau de bassin à partir d'une position adjacente à ladite surface de paroi lorsque ledit corps se trouve audit second niveau, et
l'enlèvement des débris (111) de ladite eau de bassin recueillie.

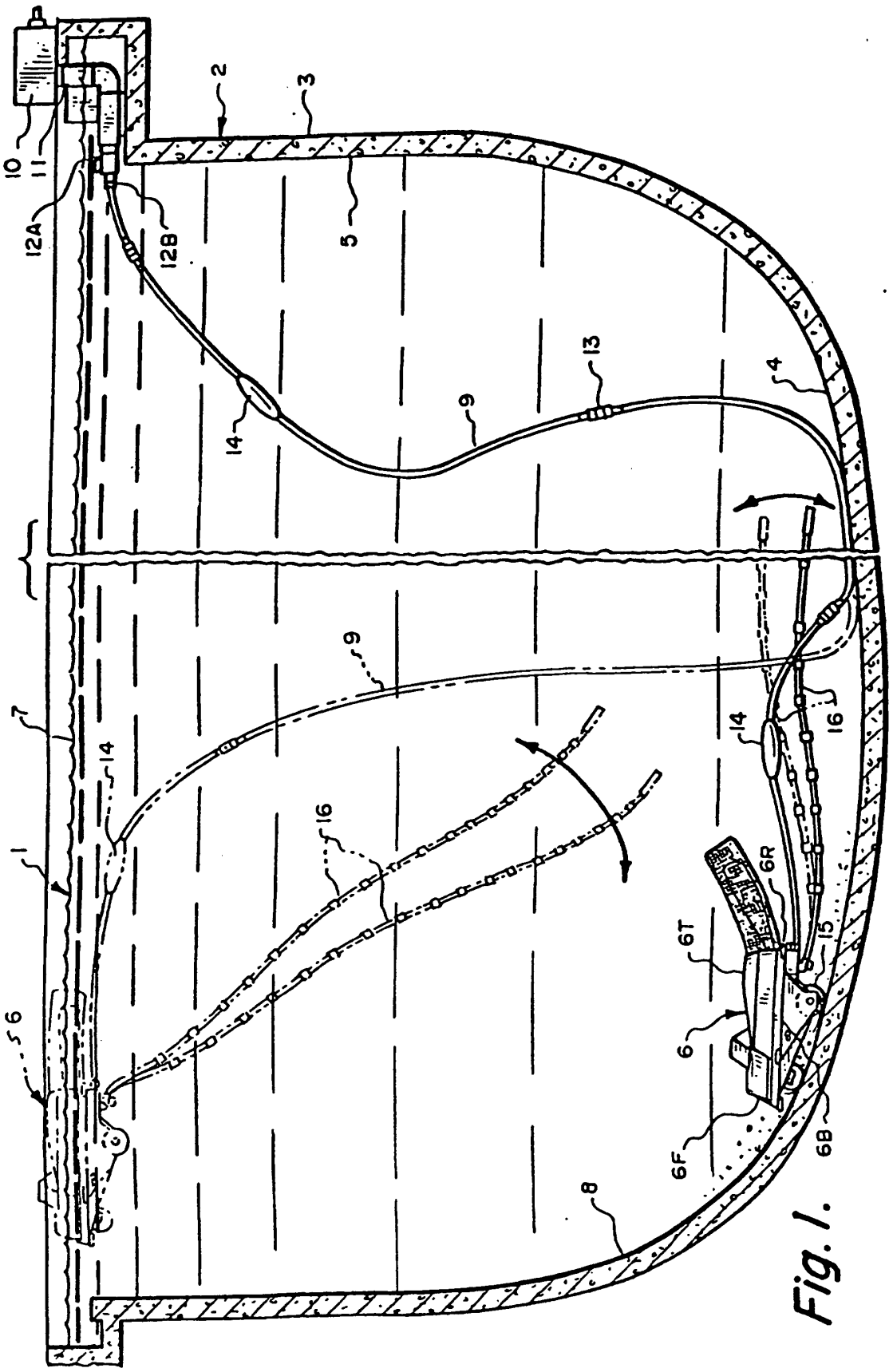


Fig. 1.

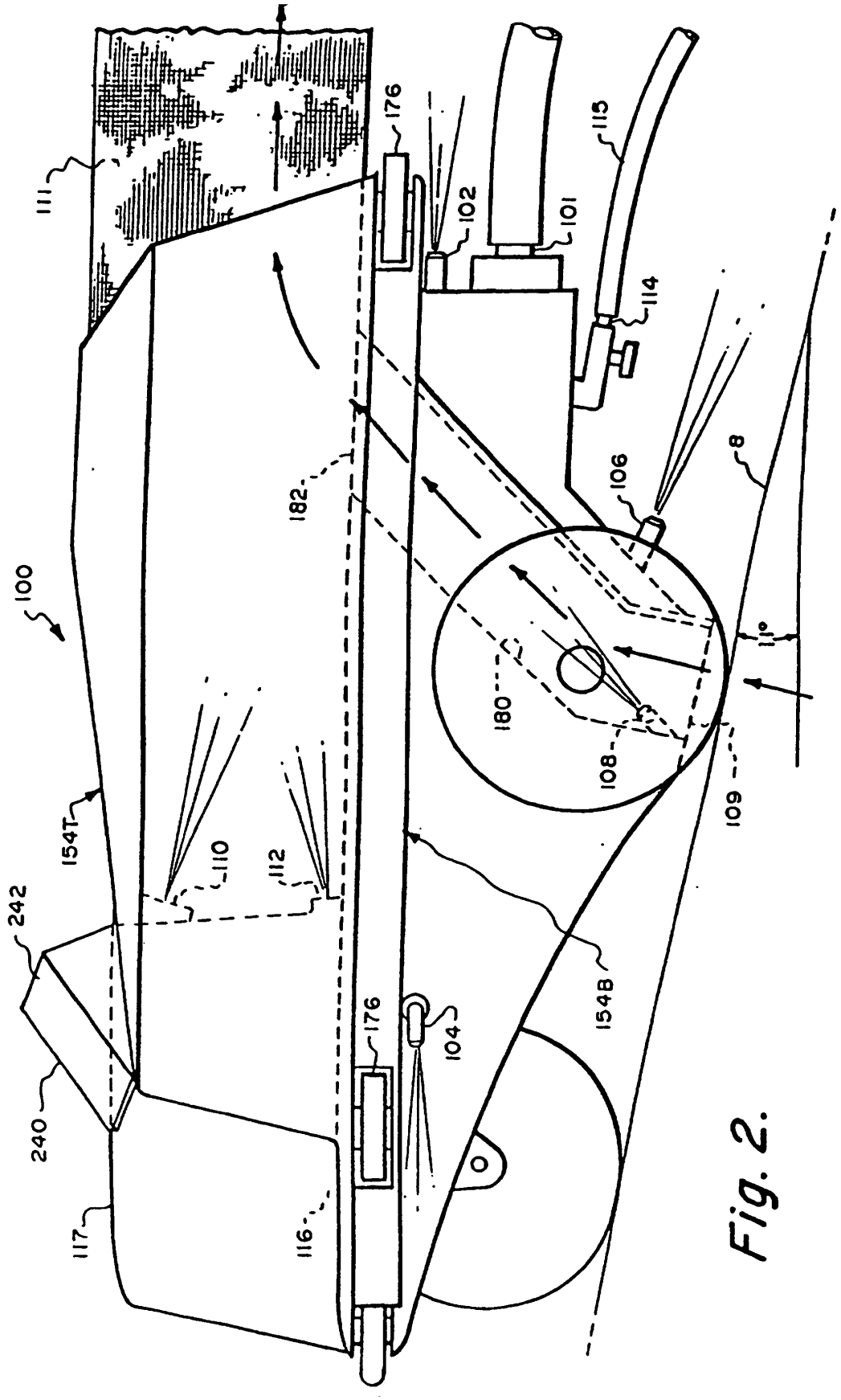

111
176
102
101
115
114
182
106
8
100
11°
180
108
109
154T
110
112
242
154B
176
104
240
117
116

Fig. 2.

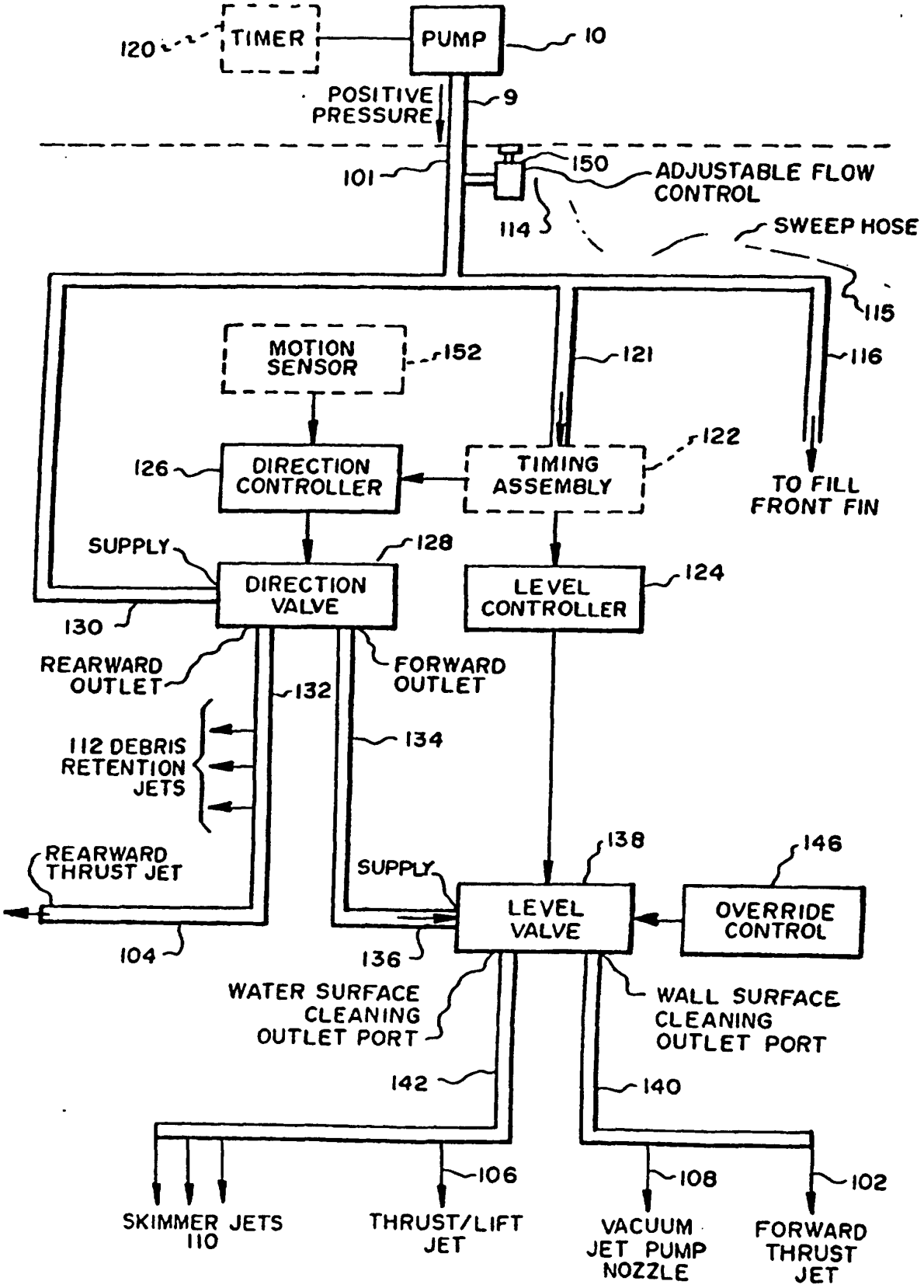

120
TIMER
PUMP
10
POSITIVE PRESSURE
9
101
150
ADJUSTABLE FLOW CONTROL
114
SWEEP HOSE
115
MOTION SENSOR
152
121
116
122
126
DIRECTION CONTROLLER
TIMING ASSEMBLY
TO FILL FRONT FIN
SUPPLY
128
DIRECTION VALVE
LEVEL CONTROLLER
124
130
REARWARD OUTLET
FORWARD OUTLET
132
112 DEBRIS RETENTION JETS
134
REARWARD THRUST JET
SUPPLY
138
146
LEVEL VALVE
OVERRIDE CONTROL
104
136
WATER SURFACE CLEANING OUTLET PORT
WALL SURFACE CLEANING OUTLET PORT
142
140
106
108
102
SKIMMER JETS 110
THRUST/LIFT JET
VACUUM JET PUMP NOZZLE
FORWARD THRUST JET

Fig. 3.

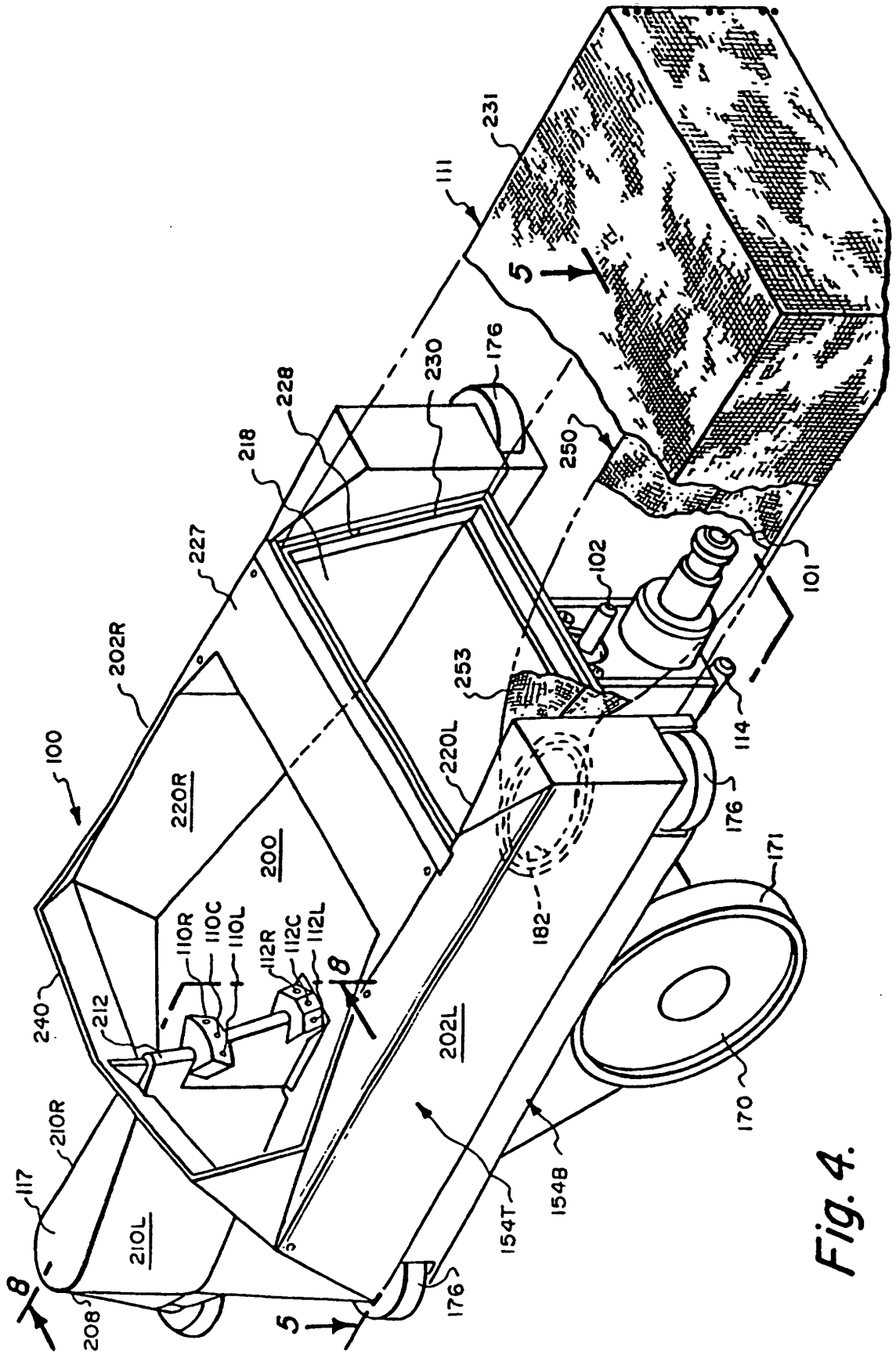

231
111
5
176
230
228
218
250
227
102
101
202R
253
100
220L
114
220R
200
176
182
171
110R
110C
110L
112R
112C
112L
8
240
212
202L
210R
170
117
210L
154T
1548
208
8
5
176

Fig. 4.

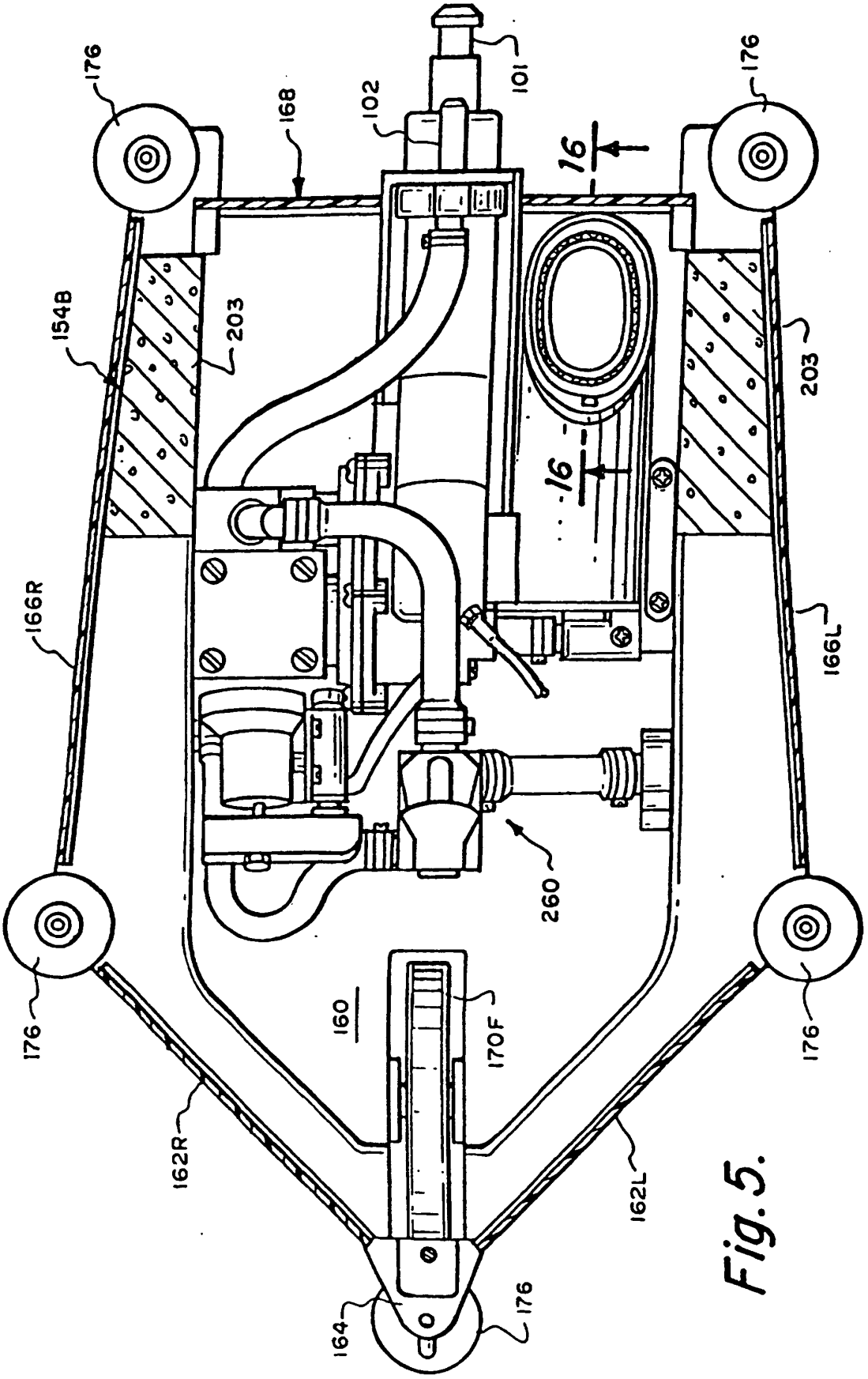

176
168
102
101
176
16
16
154B
203
203
166R
166L
260
176
160
170F
176
162R
162L
164
176

Fig. 5.

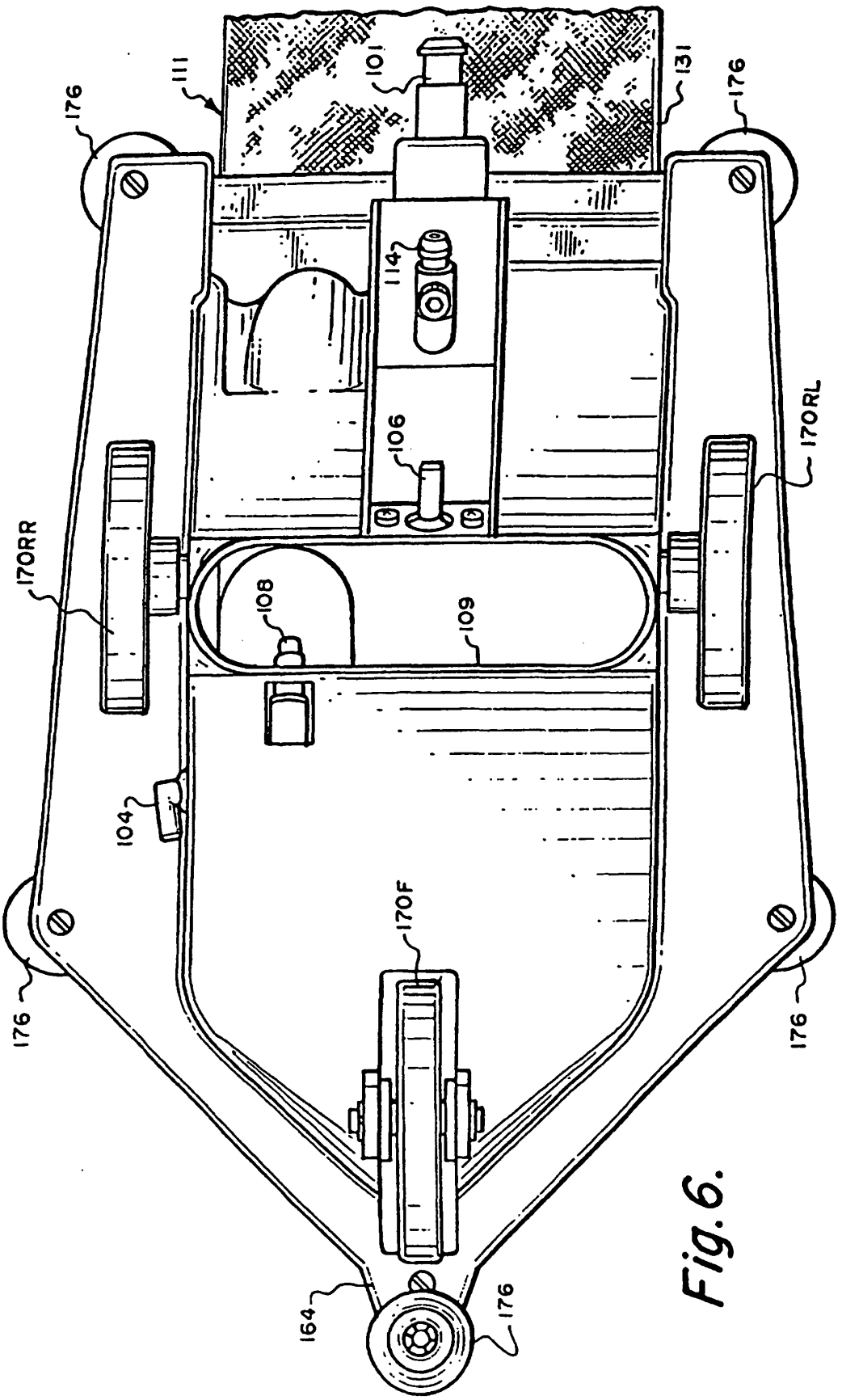

111
101
131
176
176
114
106
170RL
170RR
108
109
104
170F
176
176
164
176

Fig. 6.

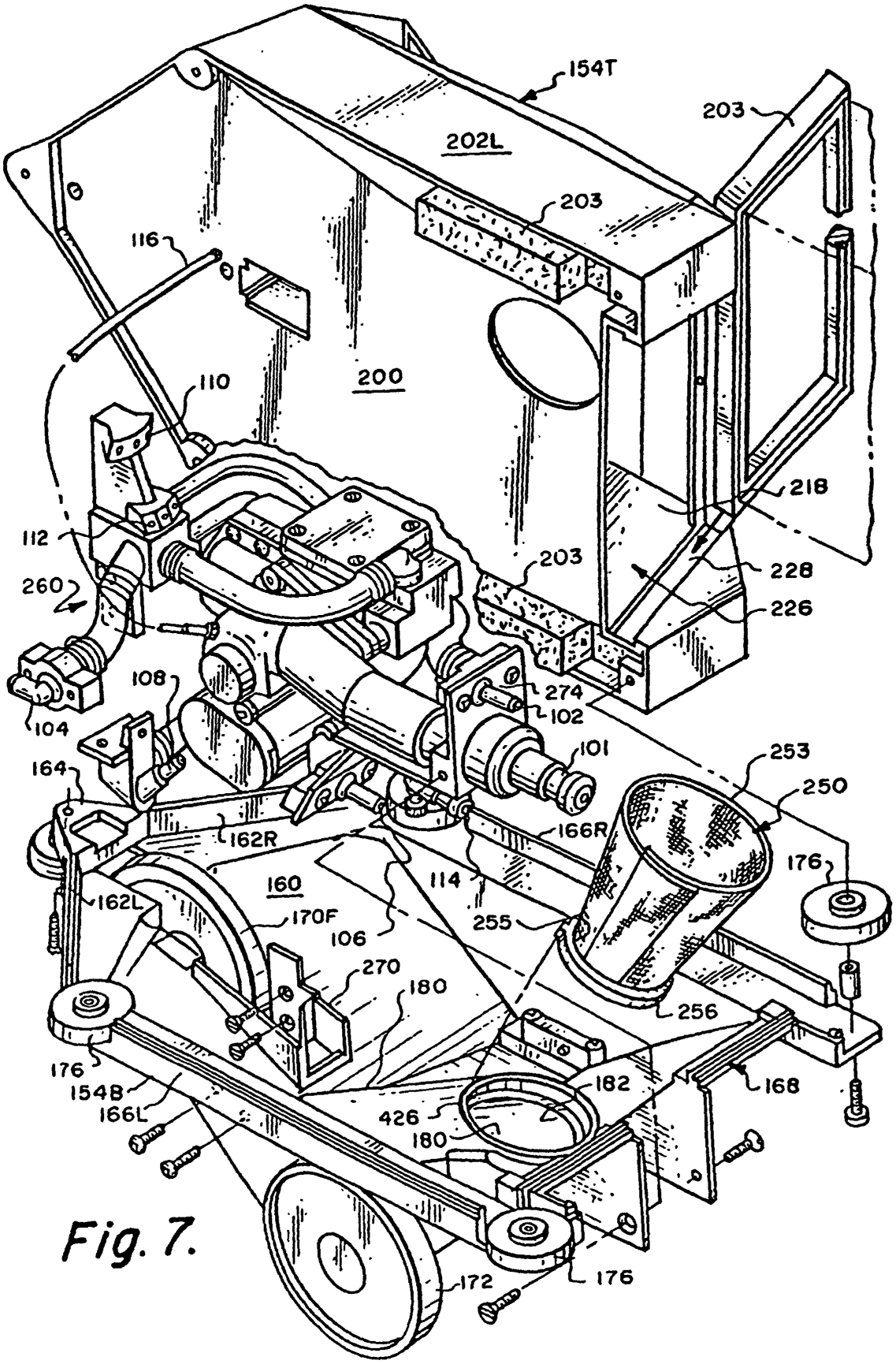

154T
203
202L
203
116
200
110
218
112
203
228
260
226
108
274
102
104
101
253
164
250
162R
166R
176
160
114
162L
170F
106
255
270
180
256
176
154B
166L
182
168
426
180
172
176

Fig. 7.

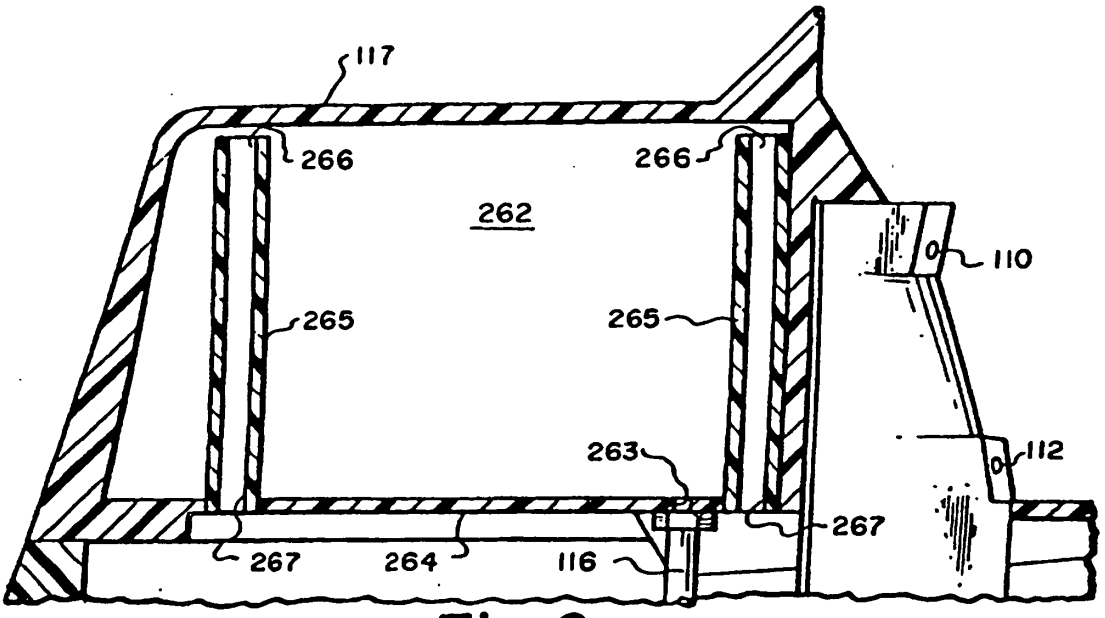


Fig. 8.

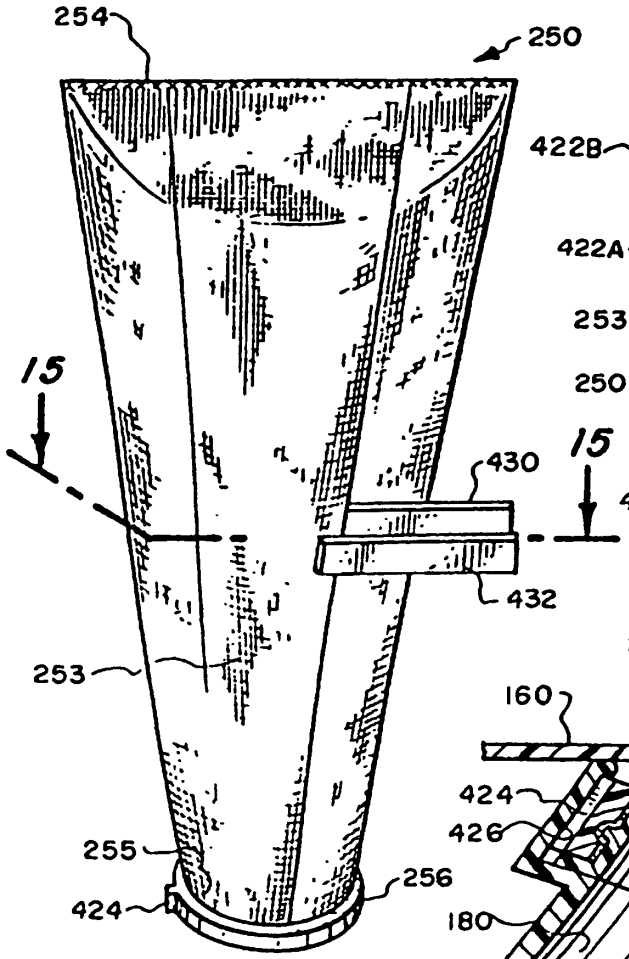
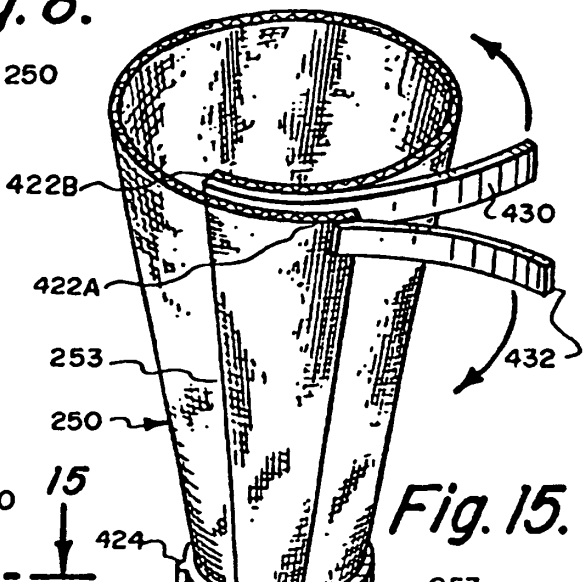


Fig. 14.



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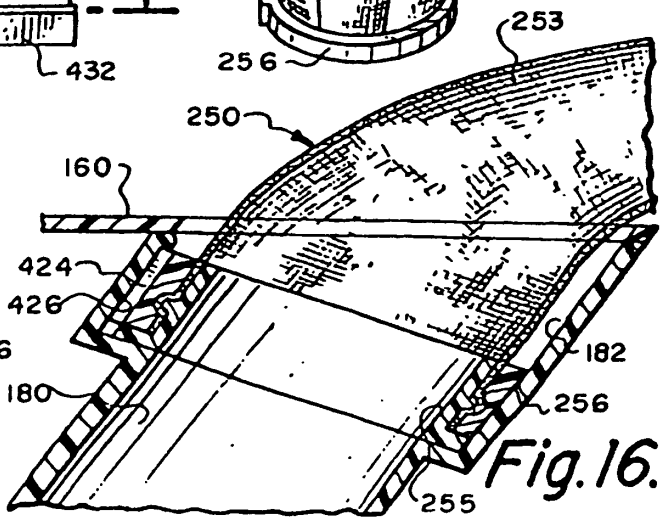


Fig. 16.

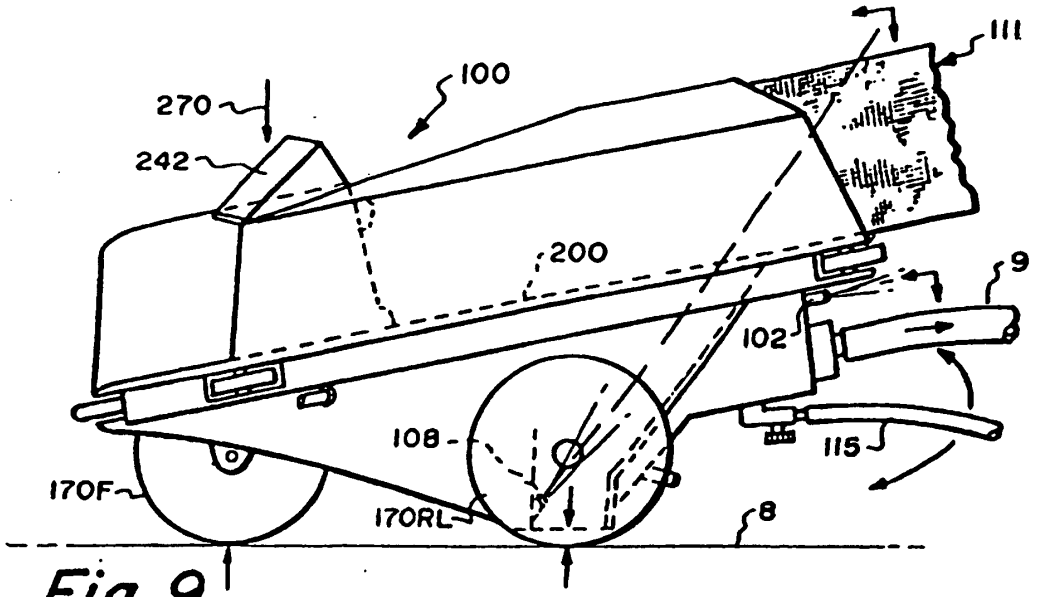


Fig. 9.

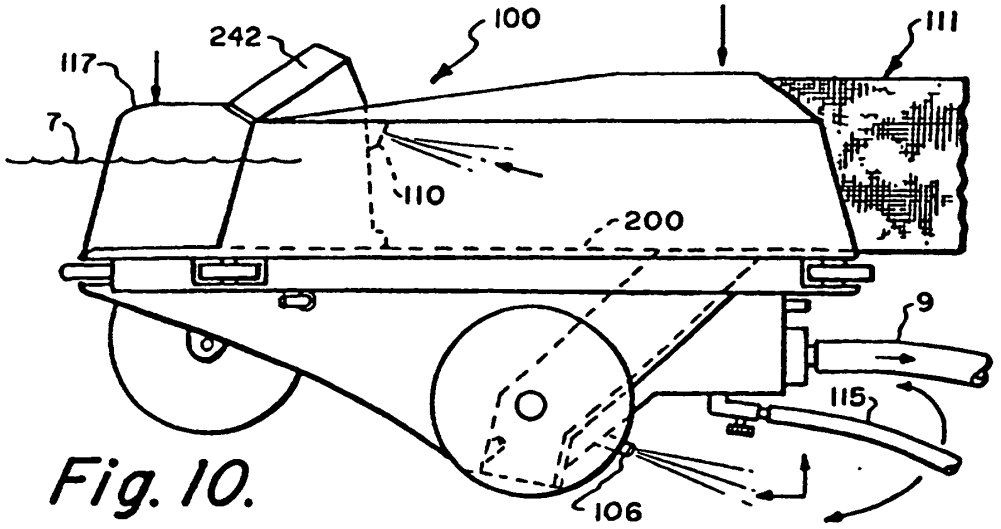


Fig. 10.

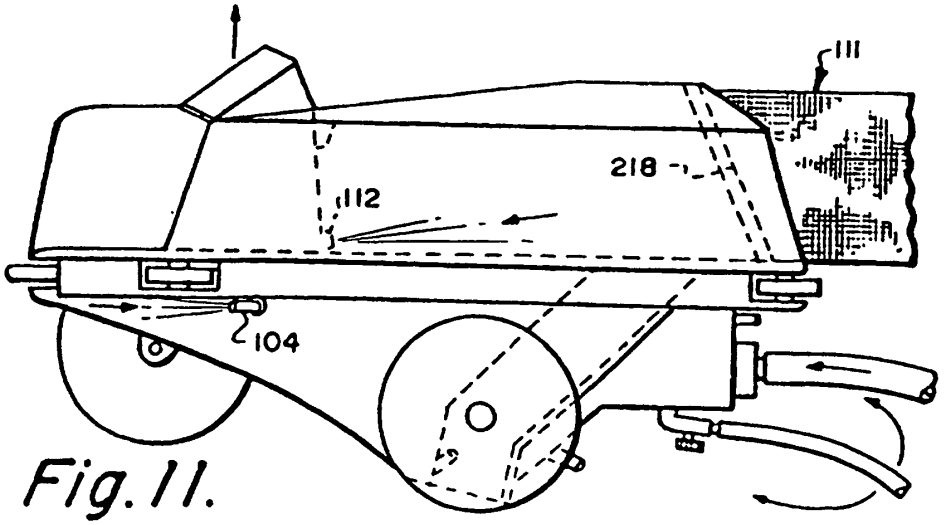


Fig. 11.

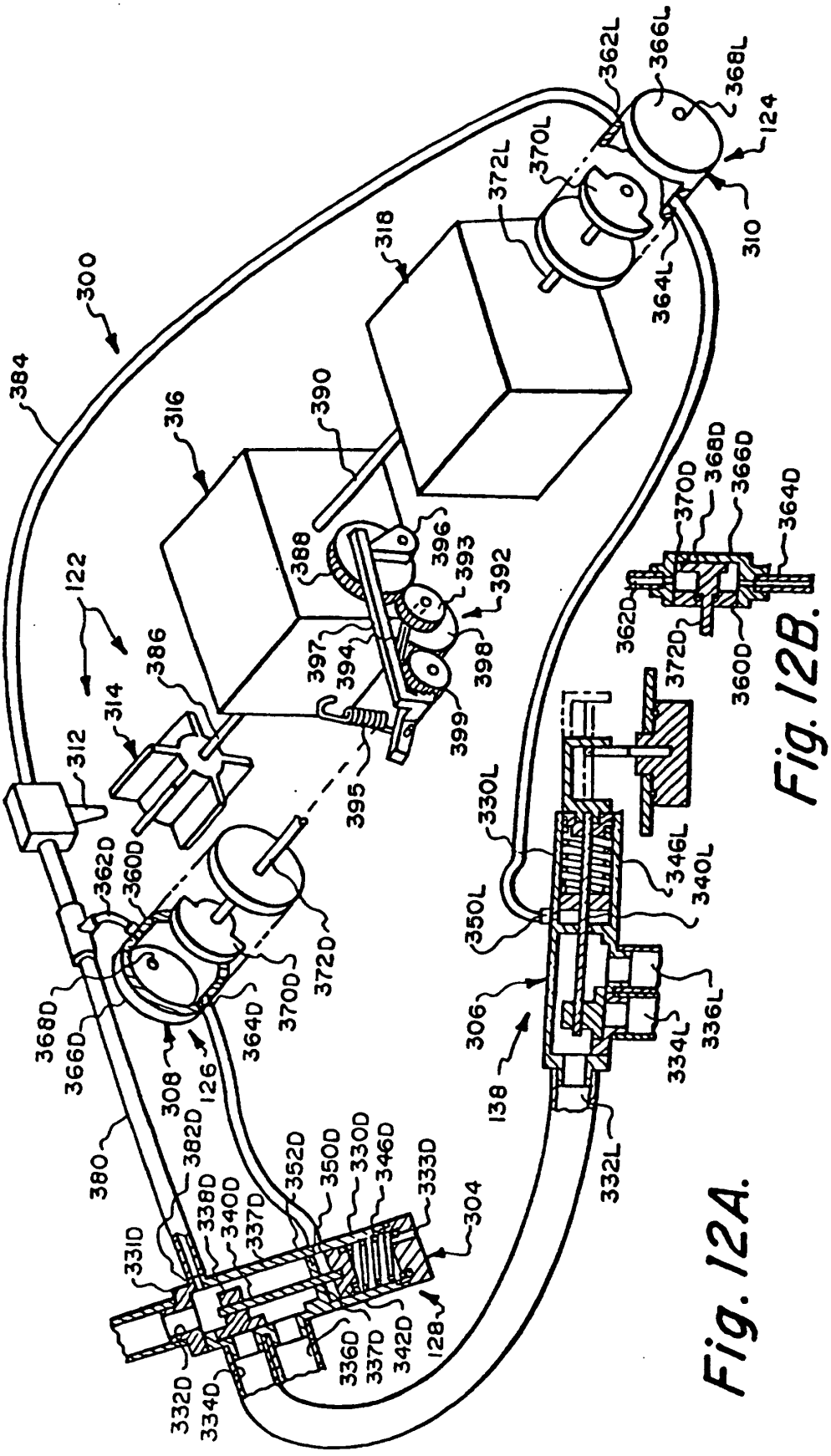


Fig. 12A.

Fig. 12B.

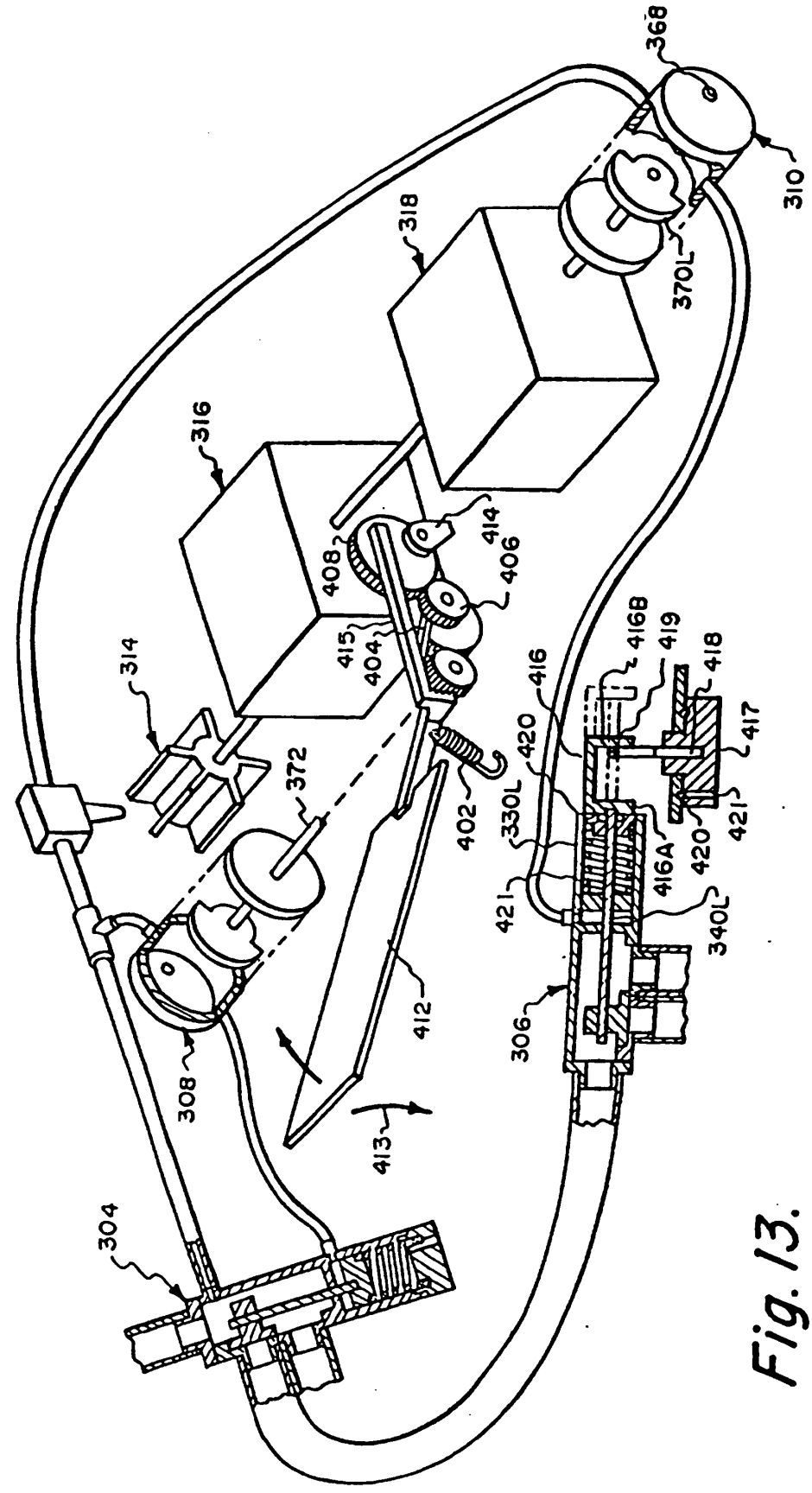

368
310
318
370L
316
414
408
406
415
404
314
416
416B
419
418
420
417
372
330L
402
421
420
421
416A
340L
412
306
308
413
304

Fig. 13.

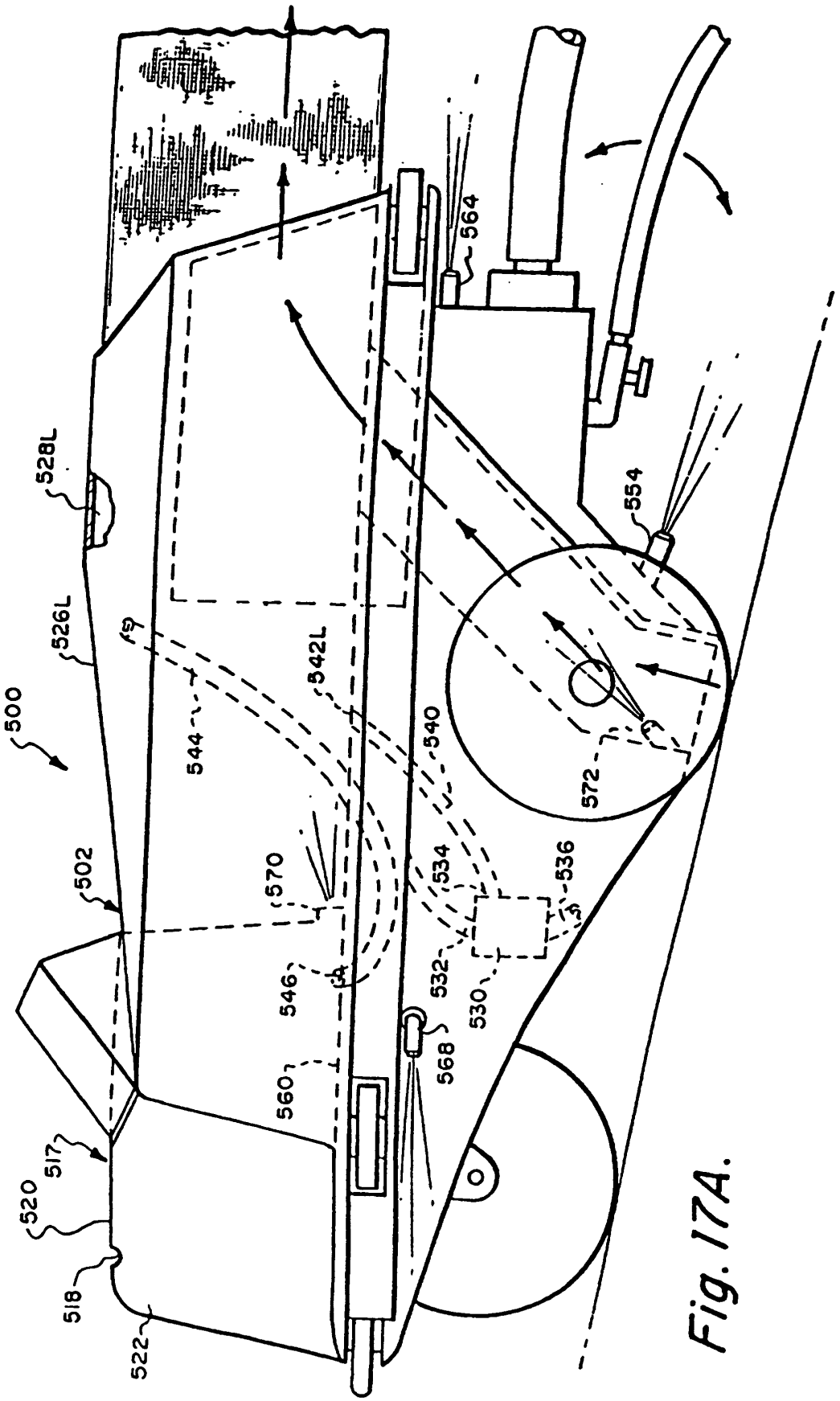

564
528L
554
526L
542L
544
540
500
572
502
570
534
536
546
532
530
568
560
517
520
518
522

Fig. 17A.

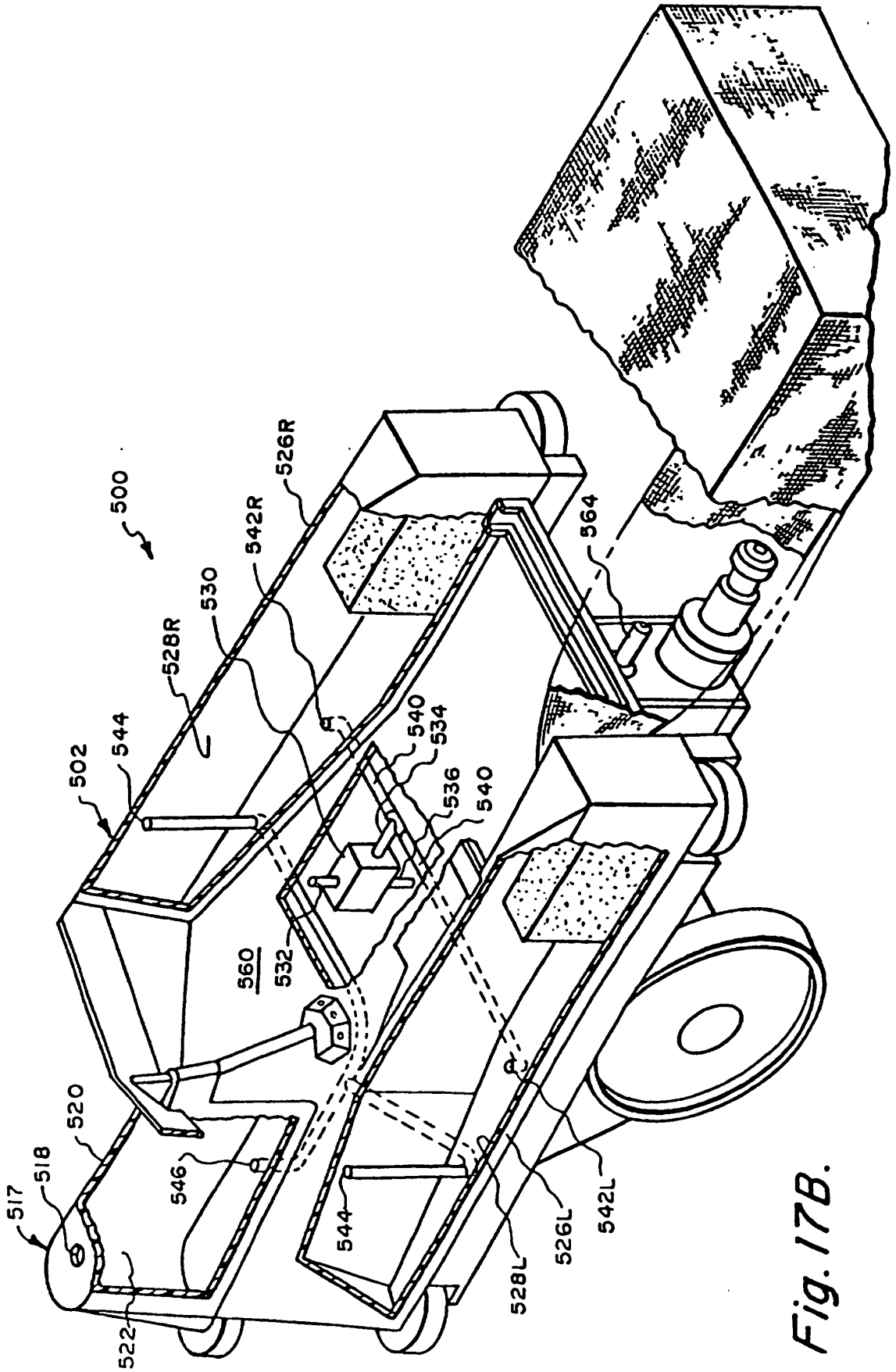

500
502
517
518
520
522
526L
526R
528L
528R
530
532
534
536
540
542L
542R
544
546
560
564

Fig. 17B.

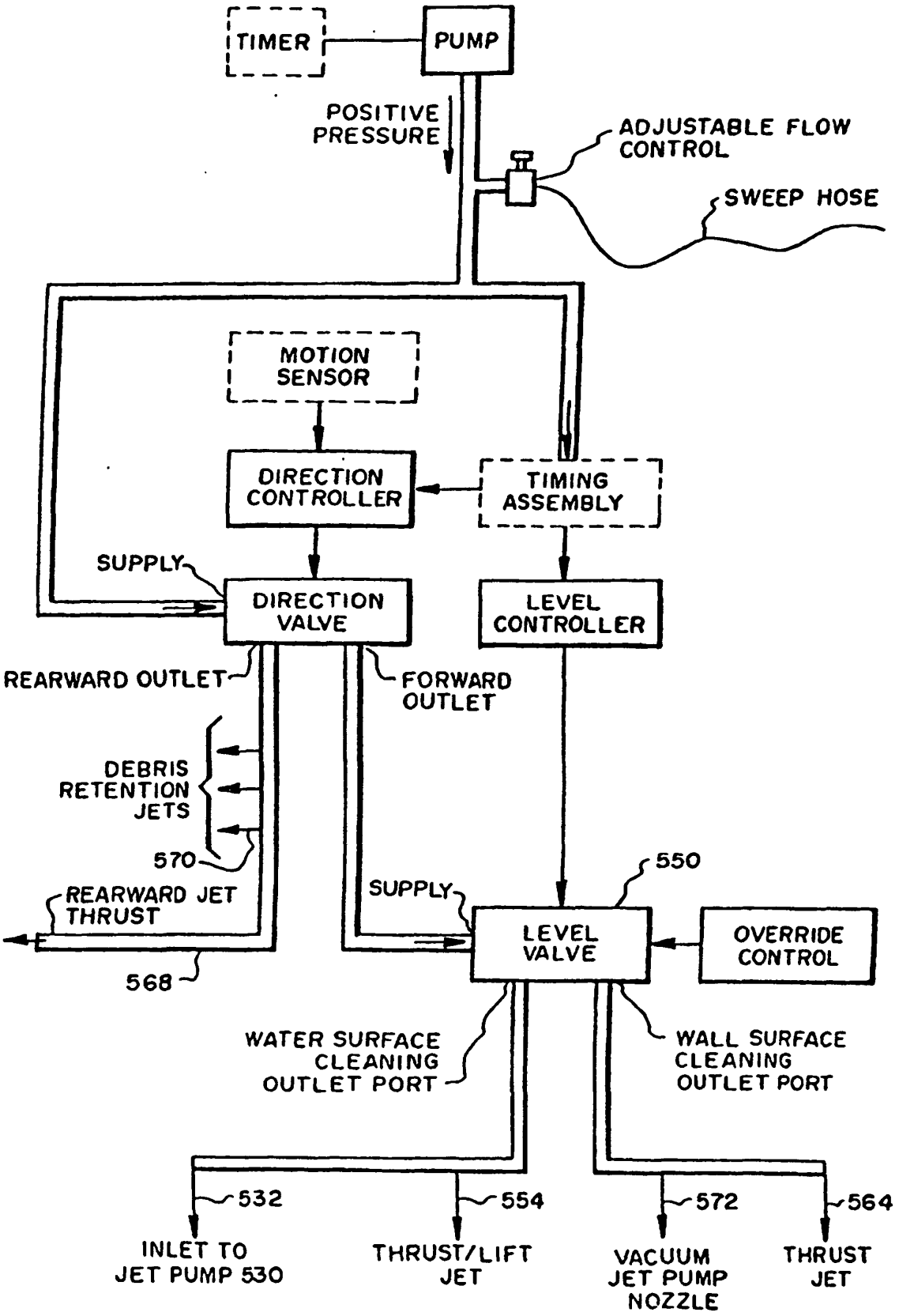

TIMER
PUMP
POSITIVE PRESSURE
ADJUSTABLE FLOW CONTROL
SWEEP HOSE
MOTION SENSOR
DIRECTION CONTROLLER
TIMING ASSEMBLY
SUPPLY
DIRECTION VALVE
LEVEL CONTROLLER
REARWARD OUTLET
FORWARD OUTLET
DEBRIS RETENTION JETS
570
REARWARD JET THRUST
568
SUPPLY
550
LEVEL VALVE
OVERRIDE CONTROL
WATER SURFACE CLEANING OUTLET PORT
WALL SURFACE CLEANING OUTLET PORT
532
554
572
564
INLET TO JET PUMP 530
THRUST/LIFT JET
VACUUM JET PUMP NOZZLE
THRUST JET

Fig. 17C.

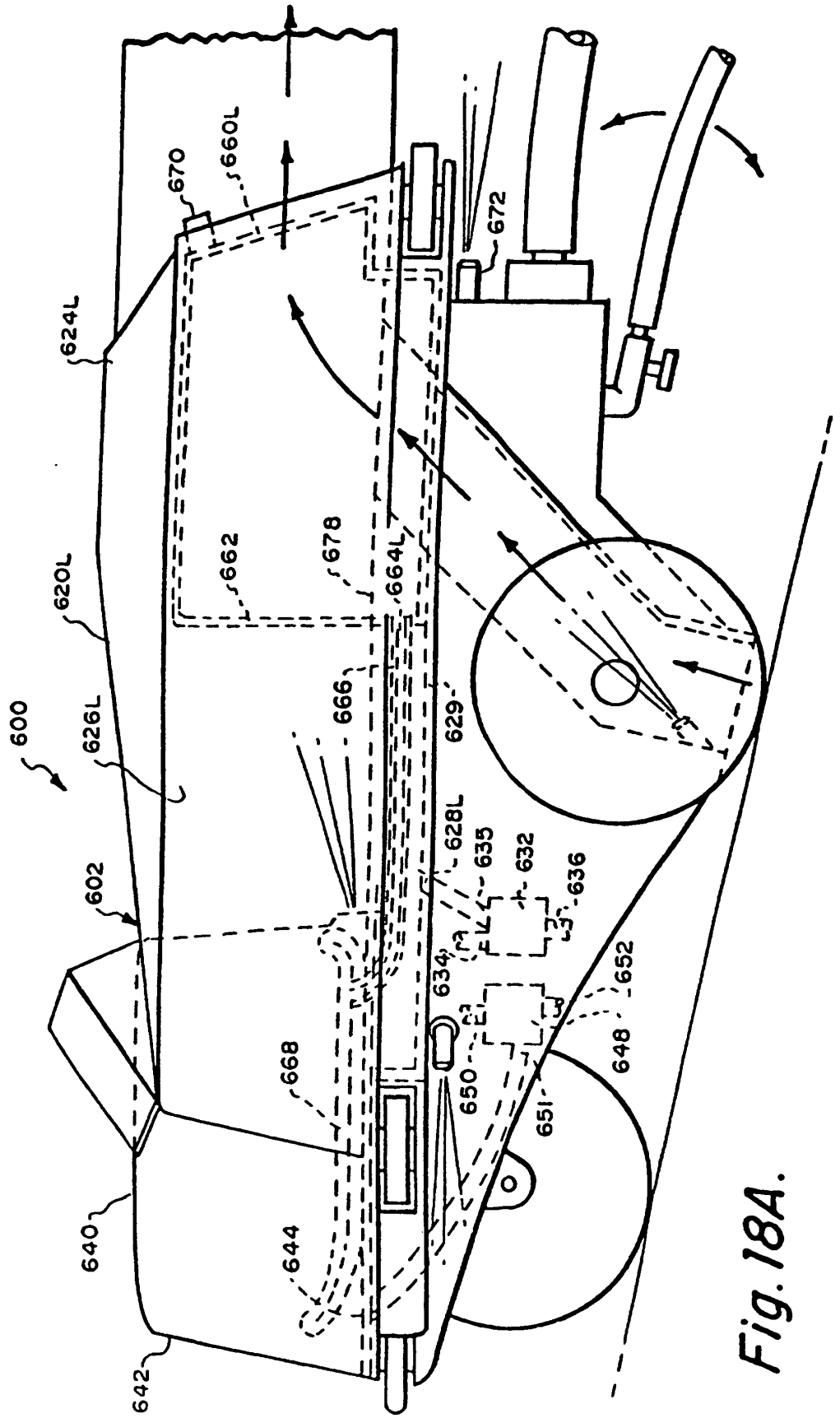

600
602
620L
624L
626L
628L
629
632
634
635
636
640
642
644
648
650
651
652
660L
662
664L
666
668
670
672
678

Fig. 18A.

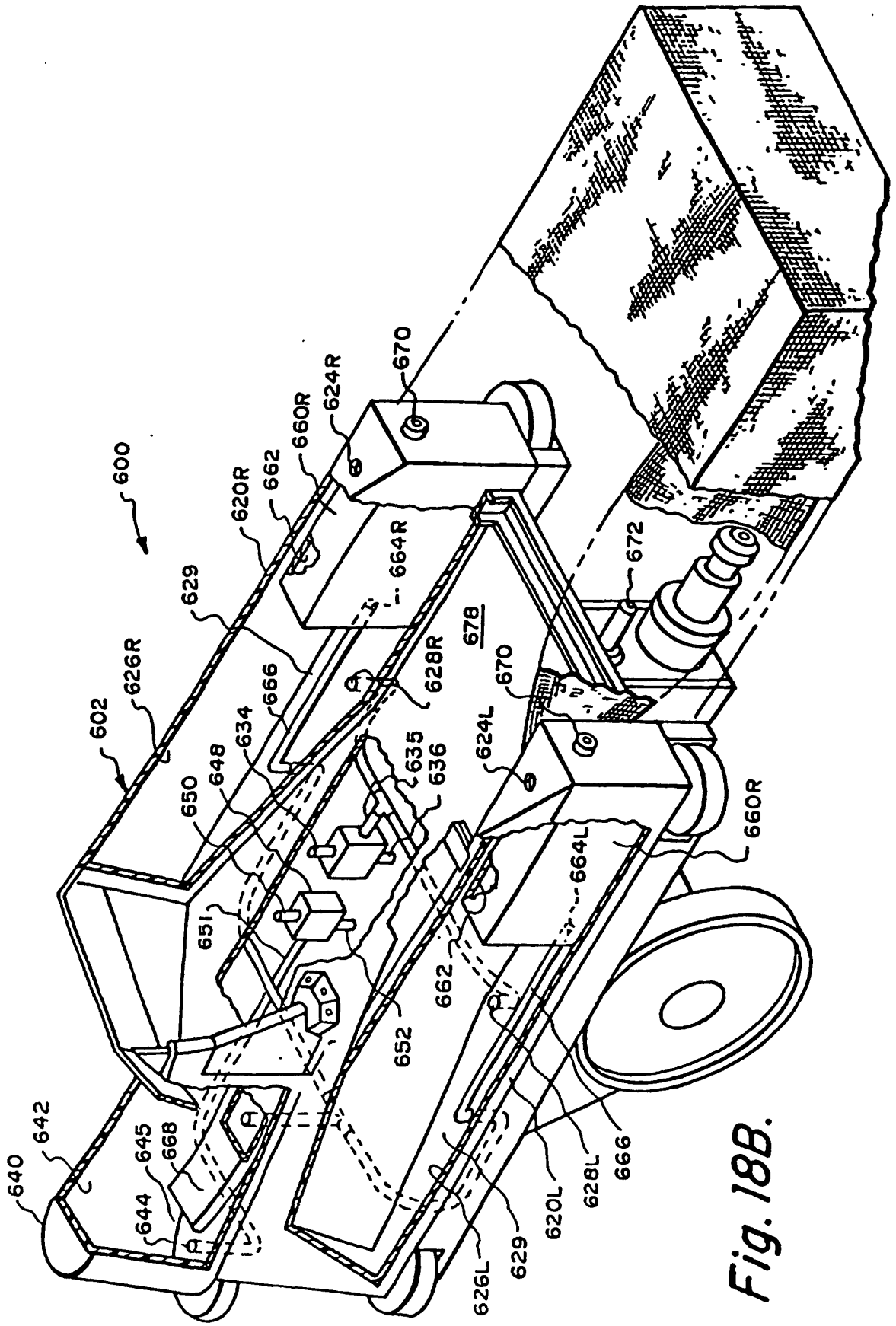

600
602
626R
629
620R
662
660R
624R
670
664R
672
678
628R
666
634
635
636
624L
650
648
651
652
664L
640
642
645
668
644
620L
628L
626L

Fig. 18B.

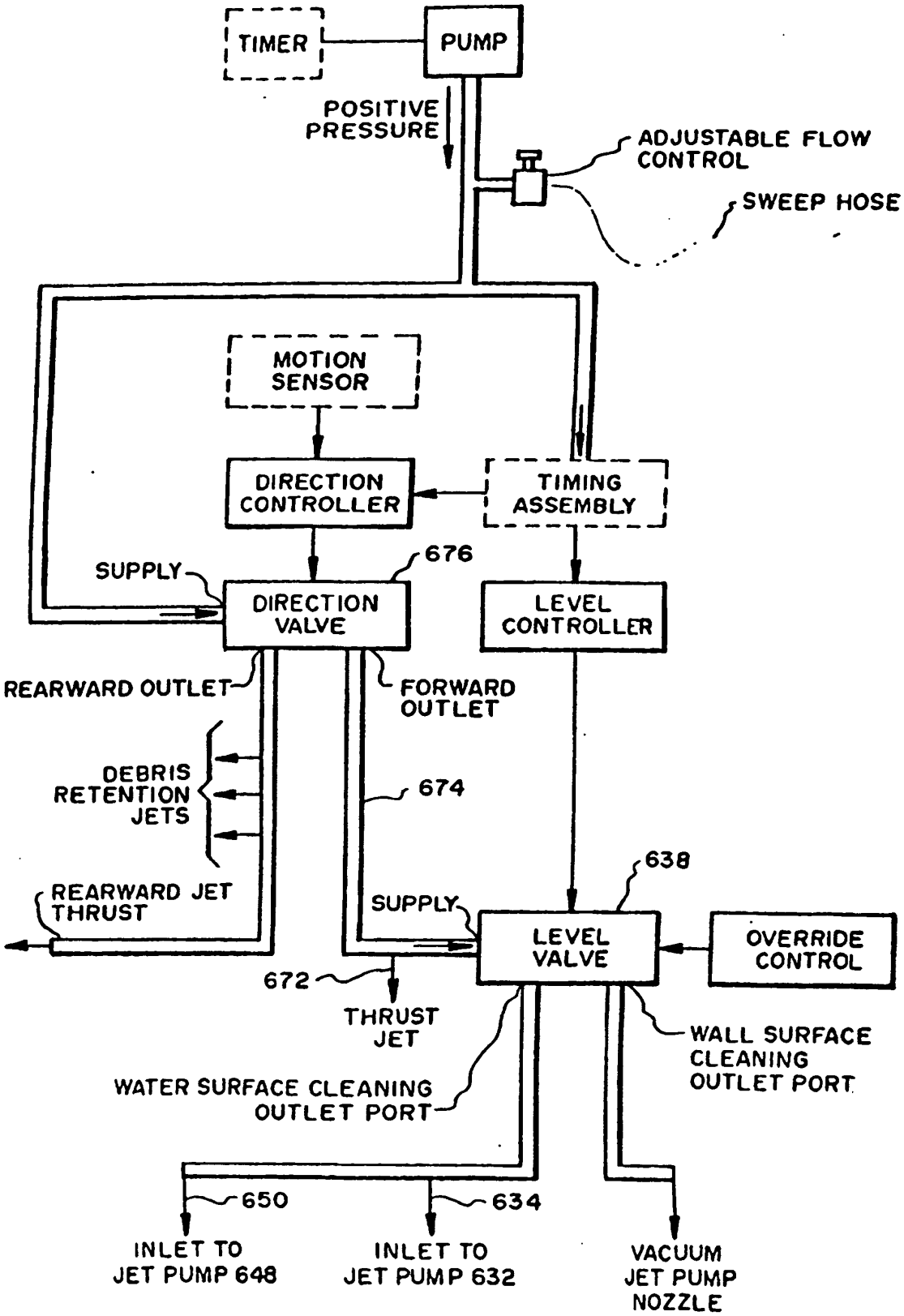

TIMER
PUMP
POSITIVE PRESSURE
ADJUSTABLE FLOW CONTROL
SWEEP HOSE
MOTION SENSOR
DIRECTION CONTROLLER
TIMING ASSEMBLY
SUPPLY
676
DIRECTION VALVE
LEVEL CONTROLLER
REARWARD OUTLET
FORWARD OUTLET
DEBRIS RETENTION JETS
674
638
REARWARD JET THRUST
SUPPLY
LEVEL VALVE
OVERRIDE CONTROL
672
THRUST JET
WALL SURFACE CLEANING OUTLET PORT
WATER SURFACE CLEANING OUTLET PORT
650
634
INLET TO JET PUMP 648
INLET TO JET PUMP 632
VACUUM JET PUMP NOZZLE

Fig. 18C.

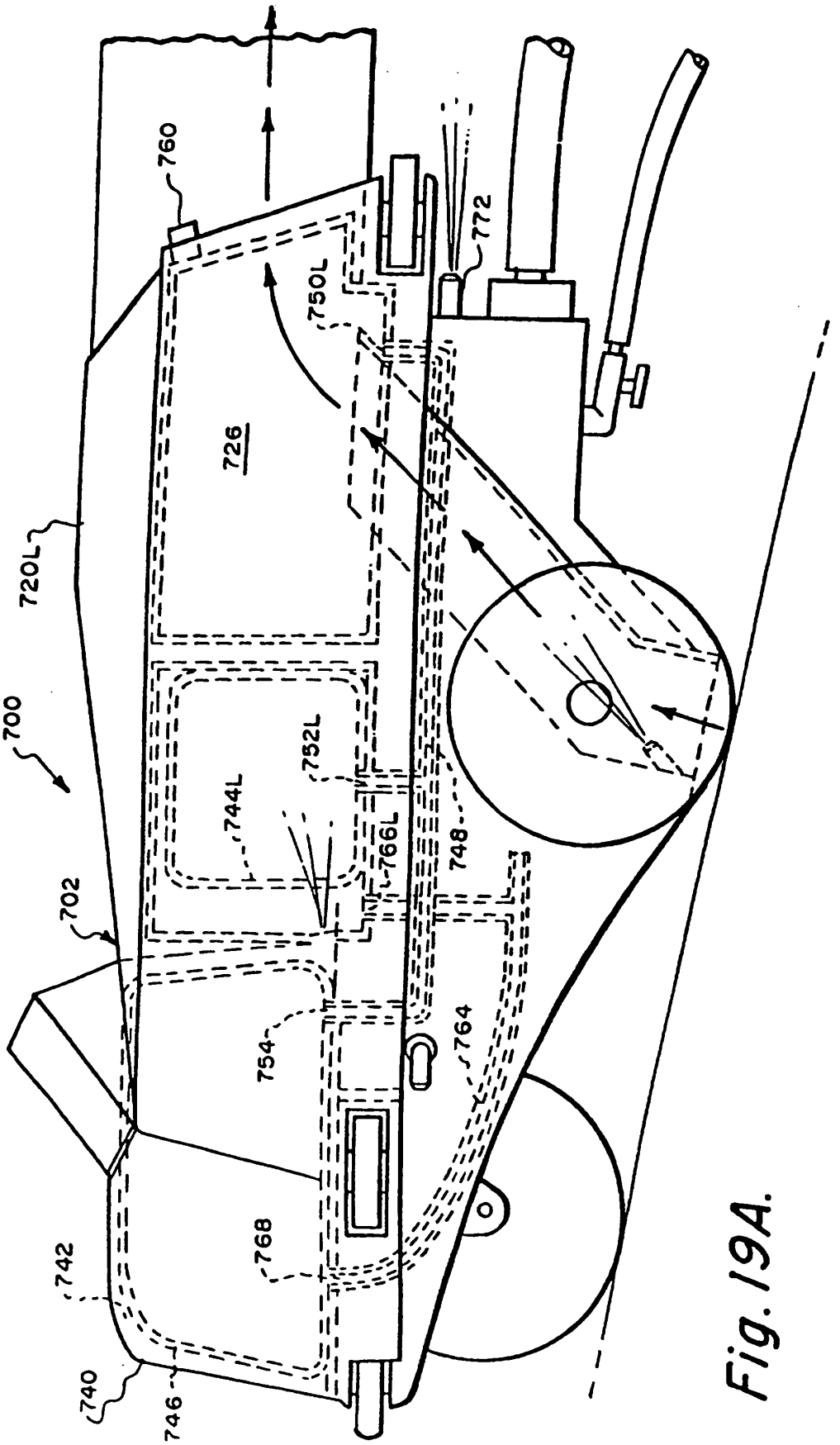

760
772
750L
726
720L
700
752L
744L
766L
748
702
764
754
768
742
740
746

Fig. 19A.

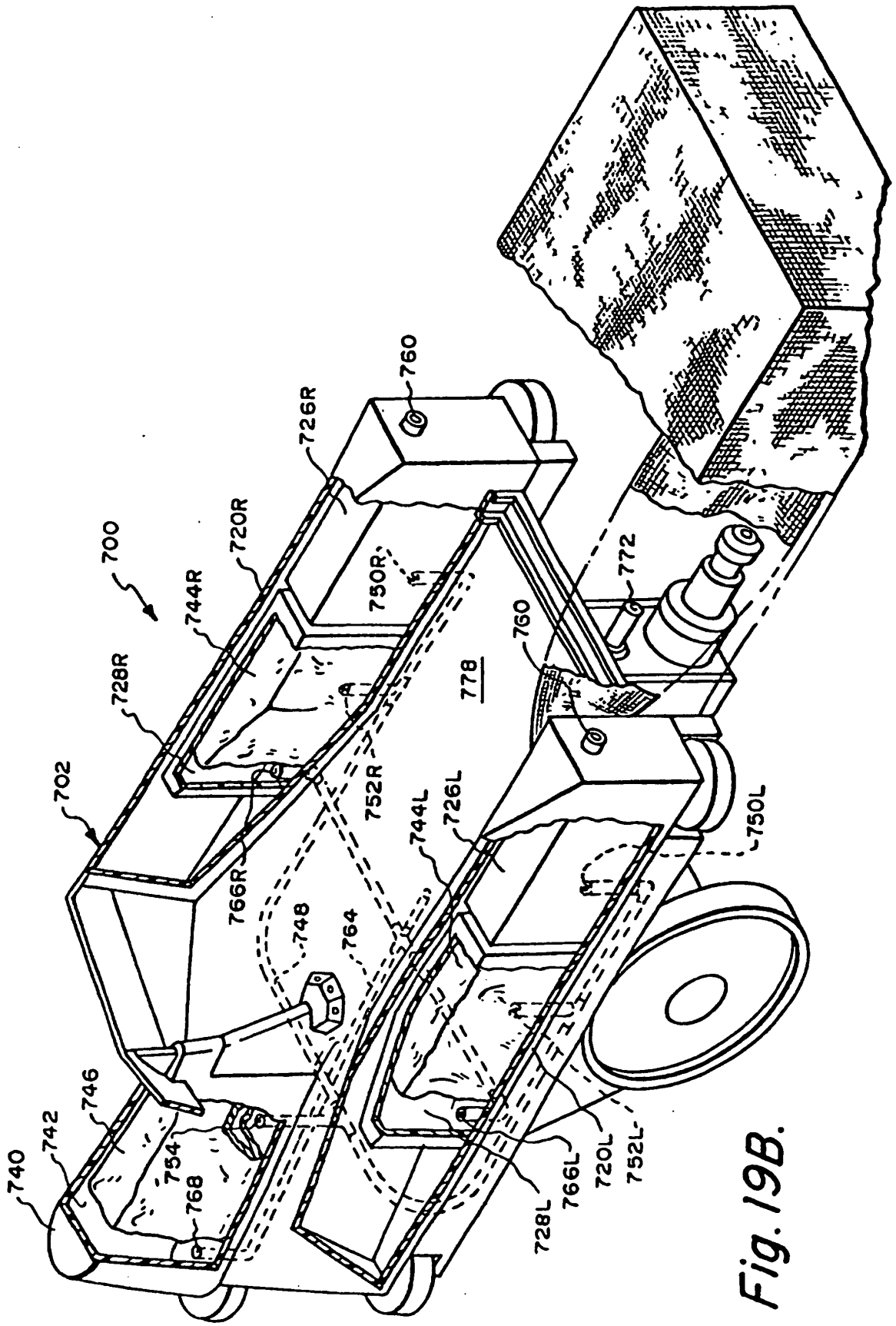

700
702
720R
726R
728R
730R
744R
746
748
750R
752R
754
760
764
766R
768
772
778
740
742
720L
726L
728L
730L
744L
750L
752L
766L

Fig. 19B.

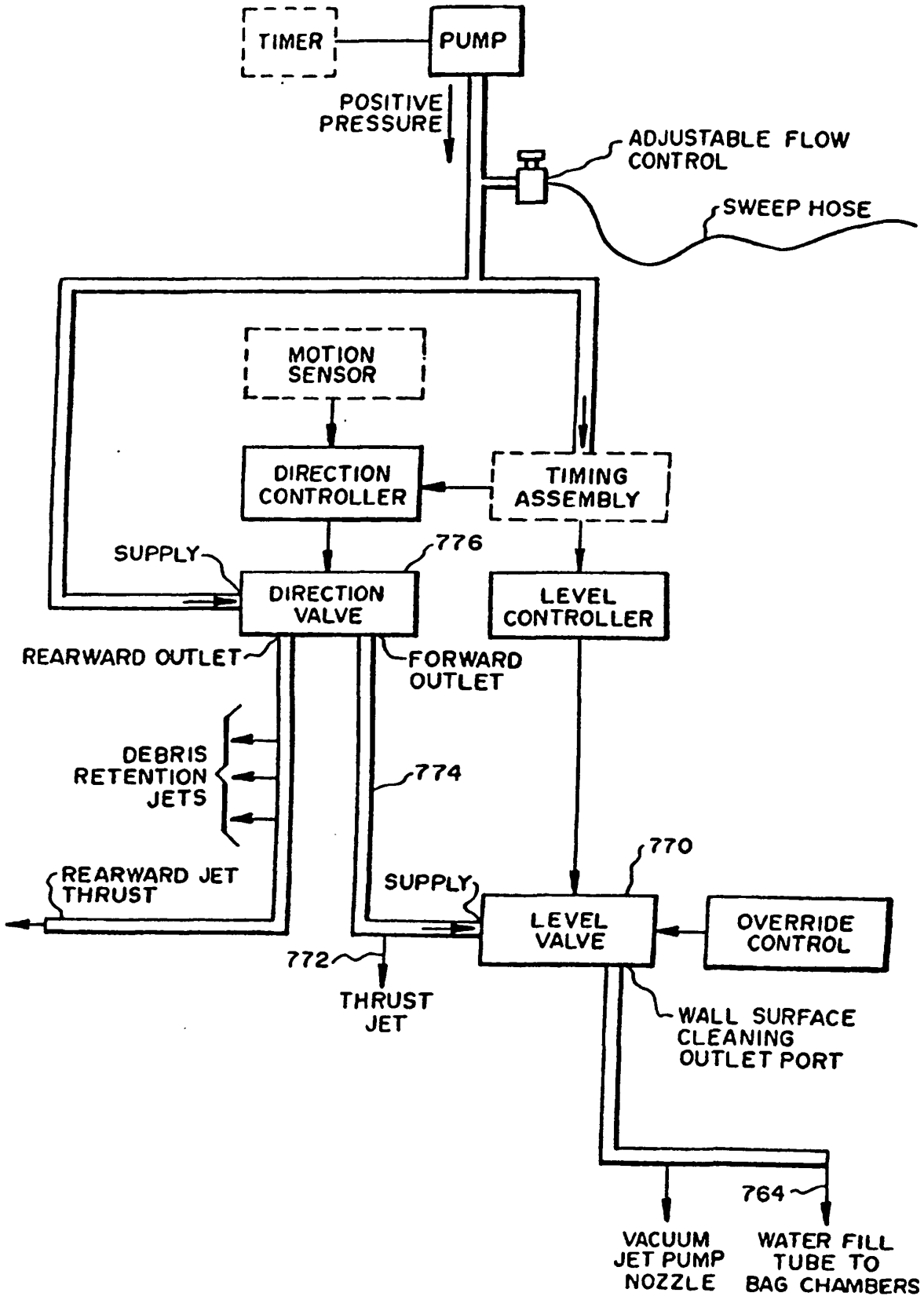
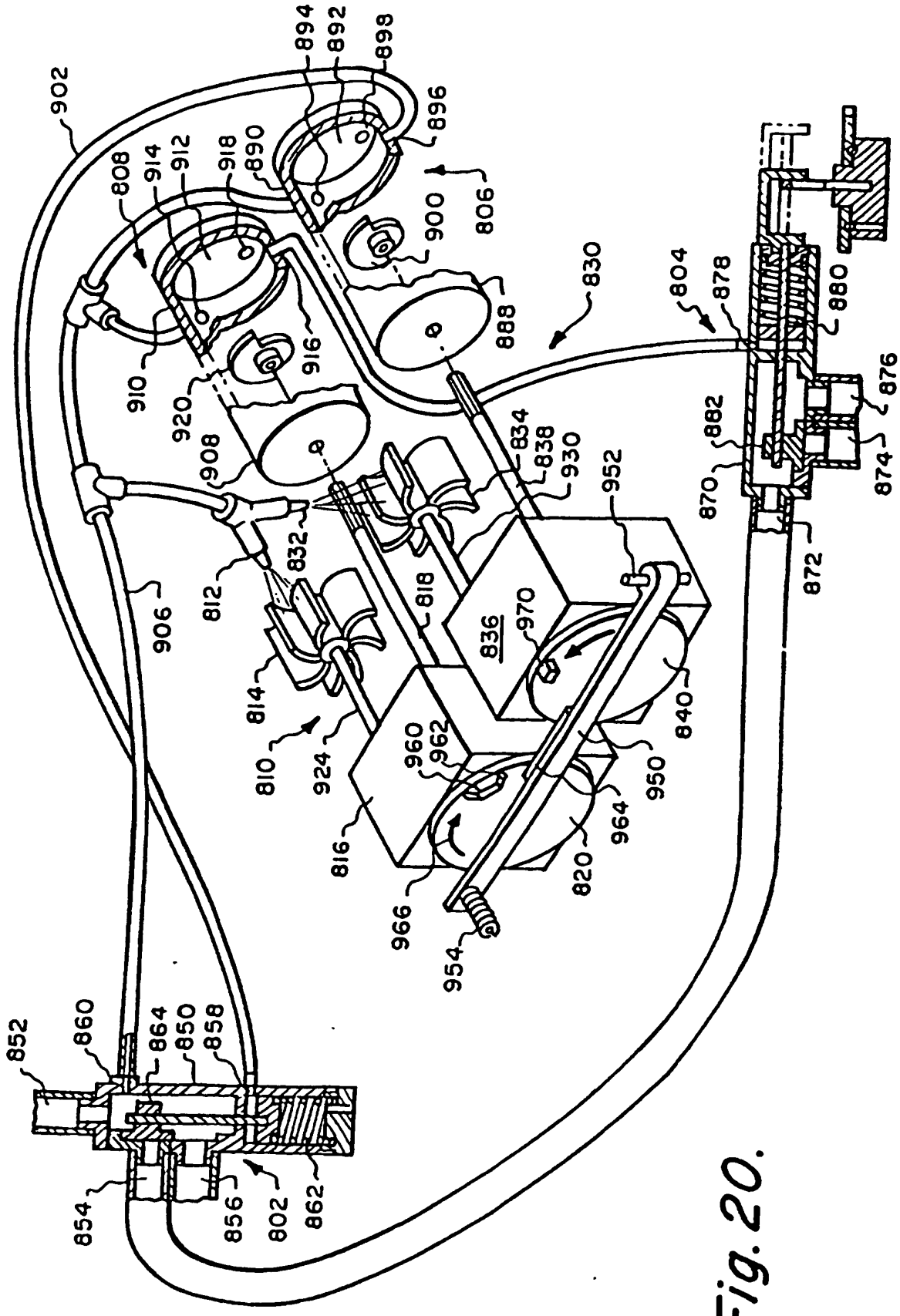

TIMER
PUMP
POSITIVE PRESSURE
ADJUSTABLE FLOW CONTROL
SWEEP HOSE
MOTION SENSOR
DIRECTION CONTROLLER
TIMING ASSEMBLY
SUPPLY
776
DIRECTION VALVE
LEVEL CONTROLLER
REARWARD OUTLET
FORWARD OUTLET
DEBRIS RETENTION JETS
774
REARWARD JET THRUST
SUPPLY
770
LEVEL VALVE
OVERRIDE CONTROL
772
THRUST JET
WALL SURFACE CLEANING OUTLET PORT
764
VACUUM JET PUMP NOZZLE
WATER FILL TUBE TO BAG CHAMBERS

Fig. 19C.


902
894
892
898
896
808
914
912
918
890
900
806
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916
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830
804
878
880
876
882
874
870
872
834
838
930
952
832
812
818
836
970
906
814
810
924
960
962
840
950
964
816
820
966
954
852
860
864
850
858
854
856
802
862

Fig. 20.

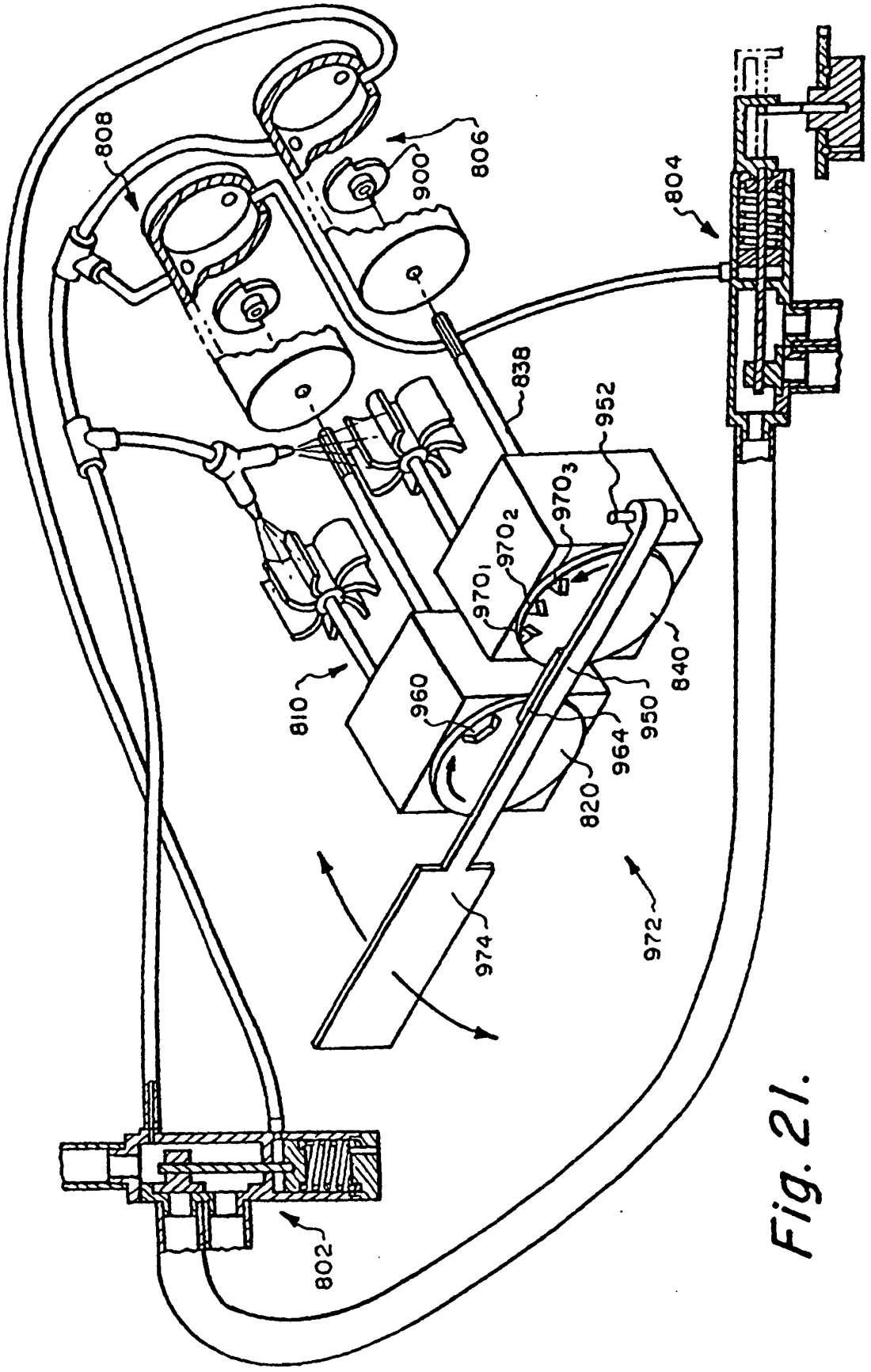
808
900
806
804
838
952
970₃
970₂
970₁
840
810
960
950
964
820
974
972
802

Fig. 21.