FIG. 5.

FIG. 6.

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My invention relates to a family of devices designed to release, collect, and ultimately cause the removal of elements, and compounds such as salts, debris, dirt, sand, metallic particles, leaves small objects, newly formed algae, and fungus from the bottom and sides of reservoirs, tanks, swimming pools, and similar liquid containing vessels.

My invention further comprises a number of embodiments of devices and since the devices are functionally similar, have the same purpose, and somewhat resemble each other in their configuration, they have been grouped under the coined generic name of "octovac." This word being derived from the combination of the words octopus and vacuum. It is intended that appearance and actions of the devices will simulate those of an octopus. Consequently the word octovac will be used throughout the specification to signify the family of the herein described suction cleaners. A hypenated letter designator such as octovac-C will refer to a specific member of the octovac family, as is more fully set forth below.

An octovac's main purpose is to clean the wetted surfaces of containment (sides and bottom) of swimming pools automatically and thereby reduce the labor and vigilance associated with the effort. However, an octovac's object is to accomplish this effort with as little disturbance or agitation of the uncleaned surfaces immediately surrounding it as possible. For example, if a mechanical device is attached to a hose, or an electric cable, it is dragged along over the surface. As the cleaning device moves, the dirt on those surfaces that have not been cleaned is agitated and driven upward as it is agitations the media of the effective reach of the cleaner's suction head.

The classification of the octovac family of embodiments is as follows:

<table>
<thead>
<tr>
<th>Octovac</th>
<th>Self-contained—Within octovac</th>
<th>Secondary energy source</th>
<th>Prime mover system</th>
<th>Externally and not part of octovac—Prime energy source (as seen by oct.)</th>
<th>Externally and part of octovac—Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Battery-rechargeable chemical</td>
<td>Reversible motor pump;</td>
<td>Moving fluid;</td>
<td>No.</td>
<td>Do.</td>
</tr>
<tr>
<td>C</td>
<td>Cell-reversible electrolyticfuel</td>
<td>reversible motor pump;</td>
<td>Moving fluid;</td>
<td>Do.</td>
<td>Do.</td>
</tr>
<tr>
<td>E</td>
<td>None</td>
<td>Motor pump</td>
<td>Compressed gas pump;</td>
<td>Electric cable;</td>
<td>Do.</td>
</tr>
<tr>
<td>H</td>
<td>Rechargeable chemical</td>
<td>Turbine pump</td>
<td>Hydraulic d. pos.</td>
<td>Electric power supply;</td>
<td>Do.</td>
</tr>
<tr>
<td>IV</td>
<td>Rechargeable chemical</td>
<td>Hydrostatic mech. linkage</td>
<td>Do.</td>
<td>Electric power supply;</td>
<td>N.</td>
</tr>
</tbody>
</table>

Occtovac B—Rechargeable—Battery operated. (Completely self-contained without remote electromechanical links to a source.)

Occtovac C—Regenerative—Rechargeable—Fuel cell operated. (Completely self-contained and without remote electromechanical links to a source.)

Occtovac E—Regenerative—Electric operated from a remote power source. (Requires electric conductors or electric cable link to sources.)

Occtovac H—Hydraulic operated from a remote source. (Requires a fluid conductor or hose link to source.)

Occtovac IV—Operate on a controlled chamber pressure programmed into the system to minimize the disturbing effects due to dragging cables and hoses over uncleaned areas. Also, reeds are required at part of their system to control the slack and prevent linking to their respective cables or hoses linking them to their respective power sources.

Occtovac M—Motor—Must be attached to an electric outlet to recharge the secondary battery, and replace gas containers. Also must be placed into the container requiring cleaning and at the end of the cleaning cycle, placed over the hydraulic intake for backwashing the filter.

Occtovac-C comprises the broadest embodiment and will be described in greatest detail. The other embodiments of the octovac family are variations of occtovac-C.

Reference should now be had to the figures in which:

FIG. 1 is an elevation partly in section showing my invention positioned over the outlet drain of a swimming pool.

FIG. 2 is an elevation partly in section showing my invention in operation and traveling along the bottom and towards a side wall of a swimming pool.

FIG. 3 shows my invention on a vertical wall and broaching the surface of the water.

FIG. 4 is a plan view of my invention operating on the bottom of a pool.

FIG. 5 is a longitudinal section through a swimming pool showing my invention in various positions of operation.

FIG. 6 is a diagrammatic view of the principal components of a preferred embodiment of my invention showing especially the wiring and control.

FIG. 7 is a block diagram of the homing system of my invention.

FIG. 8 is a partial elevation, partly in section, showing the water circulation and propulsion means and directable nozzle of my invention.

The turbine pump 4 is a wheel made of specially designed blades that extend radially outward from a central point or hub and are so curved that when a fluid moves along the blade a force will be exerted between the blade and the fluid in such a manner that there will be relative motion between the fluid and the blades during all portions of the contacted path. If the fluid moves from the circumferential edge of the wheel (i.e., the outer extremities of the blades) towards its center a force is exerted against the blades such that it will rotate the wheel and thus perform work. The wheel is then in the turbine or generating mode of the regeneration or charging cycle. If the wheel is rotated by a force external to the fluid, the wheel will perform work on the fluid causing the fluid to move outward from the wheel center to its circumference. This is the pumping or sucking mode of the cleaning cycle.

The generator-motor 5 is a rotating device mechanically coupled to the turbine pump 4 such that the two components will rotate in some proportional correspondence, probably one to one, though not necessarily. When the turbine pump 4 is operating in the turbine or regenerative mode, it drives the generator-motor 5 in a direction that causes electrical energy to be produced. In the cleaning mode electrical energy is consumed in the generator motor 5 component in such a manner that the device operates as an electric motor and drives the turbine pump 4 so as to cause it to operate in the pumping mode.

Electrolytic cell fuel cell battery 6 is an arrangement of chemically treated surfaces mechanically shaped and married together in a configuration that when subjected to an electric current such that it is forced to flow through the surfaces the constituent gases of the electrolyte will be
produced in such a manner that the gases can be collected and stored in separate expansible containers. If the electrolyte is water, then the gases will be hydrogen and oxygen. If the electrical driving force applied to the cell 6 is reversed in its direction of application and a current is permitted to flow commensurate with the driven direction then hydrogen and oxygen will recombine at the appropriate electrode to form water again and release electrical energy. This energy is consumed in driving the generator-motor 5 in the motor or cleaning mode.

The fuel cell 6 may be any one of a number of such cells known to those skilled in the art. Commercial cells are manufactured by Allis-Chalmers Corporation and General Electric Company. Various types are described in Department of Commerce O.T.S., Bulletin, AD 417392, dated July 61, and in Lockheed Missiles and Space Company quarterly progress reports to NASA, entitled, Design and Development of a Water Vapor Electrolysis Unit April 1965 and June 1965.

Expandable storage containers 8 are devices, one for each constituent that make up the substance undergoing electrolysis in the electrolytic cell 6 that extend themselves in such a manner that an optimum displacement of the surrounding media for a given pressure will be exacted. The devices must contain the substance for which they are to receive and hold the substance for any given period of time or operating cycle. Specifically, for an octocat-C operating with water and potassium hydroxide as the electrolyte there must be one container to accept oxygen and another that will accept hydrogen. The limit of their expansion being only that amount required to displace a volume of liquid sufficient to cause octocat-C to float to the surface of the surrounding medium. The electrolyte does not have to be the same substance as the surrounding medium. For example, water and an ionizing solution such as potassium hydroxide (KOH) may be used as an electrolyte for an octocat-C operating in an oil storage tank.

Directable jet 2 is a moving mass of fluid, usually water so concentrated that the direction of its velocity, and also its force, vector is distinguishable and thereby capable of being controlled to be effective along a desired line of action. This moving mass itself may be directed or the nozzle through which the mass moves may be so directed.

FIG. 8 illustrates a directable nozzle 2 which is designed as an integral part of the volute 14. The volute 14 is supported to rotate around the turbine pump 4 impeller on a ball bearing assembly 14b. The complete assembly is shown designed to split in two parts at the bearing interface to provide access to the filter 13 and eye of the turbine pump 4 impeller. Consequently the locking seal 14b is shown as a means of keeping the two parts together while permitting rotation. Since about 120 angular degrees is the maximum amount of travel required; stops should be provided on the seal.

One method of coupling the servo master 19 to the servo slave 20 is by a magnetic field produced by suitably designed coils of wire and a solenoid plunger that is capable of seating in a dent in the volute 14 thereby locking the jet 2 in a position determined by the control components 19, 20, and 21 of FIG. 6 as described more fully below.

My homing system 1, FIGS. 6 and 7, is a combination of elements designed to automatically cause the octocat-C to go to the place where it can be regenerated and charged with energy as a cyclical necessity to fulfill its designed purpose. A specific homing system would be a sonar system which may operate in the inaudible frequency range should sound be a disturbing factor in the environment. This system would consist of a wave generator 14 located in a place of maximum concentration of fluid motion such as in a swimming pool drain, and either driven by the moving water being circulated by or some other type of power source such as electricity. The vibrations or disturbances emanating from the wave generator 14 will pervade the surrounding media and be "heard" by the octocat-C's listening or wave frequency sensitive device 1b. The device 1b will respond by causing an electric switch to complete the circuit between the fuel cells 6 and motor 5 to reactivate octocat-C in the cleaning mode, and to couple the directable jet 2 to the wave control 1c system. An intensity discriminating component will select the direction from whence comes the maximum wave disturbance and cause the jet 2 to be so directed that octocat-C will be propelled towards the disturbance. At some place in the immediate vicinity of the disturbance octocat-C's skirt 9 will begin to envelop the wave generator 14 and cause the disturbance to be attenuated such that the jet 2 will be no longer controlled. However, the concentrated moving surrounding media will force octocat-C to settle in a position that will block the flow, like a flat rubber stopper over a sink drain. Octocat-C has now completed its homing phase.

Electromagnetic waves generated in appropriate frequencies may also be similarly employed as a homing system such as those described in "Electrical Design" for Sept. 27, 1965, p. 4. The energy monitor 16 is a calibrated instrument of the orifice category that interconnects the depth sensor 10's inner chamber to the expansion containers 8. The device is used during the operating cycle to assure octocat-C of having a sufficient supply of remaining reagent gases after shut down to enable it to return as directly as possible to a place determined or selected by the homing system 1.

The guide bumper 18 is necessary to assure octocat-C's safe passage around obstacles that might cause octocat-C to become lodged therein. Ladders, steps, pipes, and such things that protrude from the sides and bottom of containing vessels are such obstacles. The bumper 18 may be nothing more than a properly configured rod or surface so attached to octocat-C that the rod or surface slides over the obstacle causing the skirt 9 to deflect away.

The pressure switch 10 is a static pressure actuated device that is capable of exerting sufficient mechanical force to make or break an electric circuit, or modulate the flow of a gas or fluid, or couple or decouple or activate mechanical linkages. Its purpose is to start octocat-C when it rises to the liquid surface for the start-cleaning phase of operation and to cause the jet 2 to be positioned for propulsion in that mode. It also switches from the cleaning phase to the regenerative phase when octocat-C has properly positioned itself for that phase. Specifically, when octocat-C has settled to the pool drain the pressure switch's 10 reference to pressure would be subjected to an extreme change; which initiates the mode switch 1d and causes octocat-C to go into its regenerative cycle.

The intake valve 3 is a device that will admit a greater quantity of the surrounding media into the volute 14 during the regenerative phase of operation than could be admitted through the nozzle 2.

The manifolds 7 are separate conductors for each sub- stance connected to various groups or banks of cells and arranged to collect and guide the respective constituents of electrolysis as they flow into or out from the storage containers 8.

The particle centrifuge trap 12 is a space so engineered and designed that the surrounding medium spirals into it from the mouth 11 with sufficient vortex action to create a centrifuge that will force the heavier particles to move to the extreme radial distance where they will lose their inertia and deposit on the cyclically revolving main stream of the medium. The bottom part of the trap is equipped with a submerge clean out ports 17 that automatically open during the regenerative cycle to permit the trap 12 to be sucked clean.

The mouth 11 is the entrance to the body 15 and is the locus of flow under the sweeper skirt 9.

Body 15 is moreover the supporting structure of all the components.
5 Volute 14 is the circumferential case surrounding the turbine pump 4 that serves as the collector and distributor for the medium active therein. The sweeper skirt 9 is an extremely flexible device properly shaped to yield to the contours of the container or pool and to offer the maximum resistance to rubbing and scrapping action to various arrangements of cleaning attachments 9a, such as brushes, bristles, scrapers, and nodules fastened to the underside of the skirt 9 for the purpose of causing the detachment of elements and/or compounds foreign to the surface of the container being contacted. The skirt 9 and the said cleaning attachments are so designed that the space between the skirt 9 structure or arms 9b and the surface being contacted is such that the velocity of the medium being sucked between the skirt 9 and contacted surface and around the attachments 9a is sufficient to erode and transport the said elements and/or compounds into octavoc's mouth 11. The skirt 9 is also rigid enough to transfer the force of the positive hydrostatic pressure that will occur on its outer skin to the attachments, without itself being pushed on to the containing surface to the extent that octavoc's mobility is impaired.

Operation

To start the system:
(1) The wave generator 1a of the homing system 1 is placed inside the pool drain to remain therein.
(2) Octavoc-C is then placed on top of the drain or intake.
(3) The swimming pool filter pump is either started or permitted to start automatically from its own timer, if so arranged.
(4) The suction at the drain pulls water through octavoc-C entering through the directable jet 2 and intake valve 3 driving the hydraulic turbine 5 which generates power from the motor-generator 5 to the reversible electrolytic cell fuel cell 6 energizing it in a reverse direction as an electrolytic cell. Hydrogen and oxygen are directed through manifolds 7 and released into respective expansible containers 8 as the gases are generated.
(5) As the containers 8 expand, the surrounding medium is displaced and the buoyancy of the octavoc-C is increased, but not a sufficient amount to break away from the suction at the pool drain even when the containers 8 are completely filled or inflated.
(6) When the pool pump stops, the suction is broken and octavoc-C rises to the surface of the pool.
(7) As octavoc-C rises, the asymmetrical buoyant force causes it to turn sideways such that the geometric plane that makes the skirt 9 is approximately vertical. As octavoc-C continues to rise, the hydrostatic head on the pressure switch 10 decreases, causing it to activate a control that will relocate the directable jet 2 to a position designed to cause octavoc-C to move in the most desirable direction for optimum side-cleaning.
(8) Upon arrival at the surface, the pressure switch 10d completes the electric circuit connecting 5 and 6 together so that 6, operating as a fuel cell, transfers electrical energy to 5; which operates as an electric motor. The motor 5 being mechanically coupled to 4 drives 4 as a pump.
(9) The pump sucks up the medium and loose elements and compounds enveloped by the skirt 9 through octavoc's mouth 11 where the mixture flows into the particle trap 12. Particles whose densities are greater than the surrounding medium and are herein separated from the main stream and separated. The main stream continues to flow through the annular space between the filter 13 where susceptible and microscopic particles are filtered, i.e., are separated and entrapped within the interstices of the solid filter medium.
(10) The fluid emerging from the filter 13 enters the pump 4 through its center or eye and is forced radially outward into the circumferential case or volute 14 where the fluid finally spirals out through a nozzle creating a directable jet 2. The reactive force of the jet impacts a thrust to octavoc causing it to move.
(11) Octavoc is thus propelled around the side of the container at the liquid level line sweeping and cleaning that part of the container surface encompassed by the skirt 9.
When it arrives at the bottom, which is generally horizontal or slightly sloping, it assumes a random cleaning direction because of the imbalance and variation of forces between the jet 2 and fluid friction over the shrinking containers 8, body 15 and skirt 9 of its attached scrubbing devices. There will be no particular area selectivity other than remaining on a more or less level plane, octavoc-C will not climb up the side when it has once cycled itself to the bottom, because of its loss of buoyancy promoting an unstable attitude in other than a horizontal position.
(12) As the reactant gases are consumed by the fuel cell 6, the expansive containers 8 shrink causing octavoc-C to lose buoyancy and sink lower in the liquid. Octavoc-C continues to go around the side of the container. The jet 2, under the influence of the sensor 10 and altitude sensor switch 21 maintains octavoc-C along a gradually descending spiral as it proceeds around the side.
(13) When the energy monitor 16, FIG. 6, has permitted to remain in storage only that amount of energy required to return octavoc-C back to the main source of energy, i.e., the media's container drain or hydraulic intake, then the monitor 16 electrically disconnects the fuel cell 6 from the motor 5 stopping the entire cleaning operation. Octavoc-C rests on the bottom. However, the sonar homing system 1 is switched by 16 to the listening mode where only the minutest amount of electric power is consumed.
(14) When the pool circulating pump comes on, it drives the acoustic generator 1a sending out sound. The acoustic pick up 1b in octavoc-C responds and switches the fuel cell 6 and motor 5 electrically together, relowering the system. Octavoc-C starts to move but this time the jet 2 is under the influence of the sound control 1c and is directed so that octavoc-C moves toward the acoustic generator 1a.
(15) It arrives there, and when the acoustics have been sufficiently attenuated the control system is reverted to the regenerative mode by the mode switch 1d, FIG. 6, octavoc-C settles on top of the acoustic generator 1a which is in the drain or hydraulic intake where the surrounding fluid is sucked through to the main fluid filter. Octavoc's skirt 9 will cover the drain or intake completely attenuating the sound wave so that the control permitting octavoc to settle on top of the drain or intake and go through a process of regeneration.

The operation of the system and particularly the electrical and acoustic controls and interlocks may be understood from the following where reference is had particularly to FIG. 6 and FIG. 7. Initial positions of control components: At startup and with acoustic generator 1a manually placed in position (FIG. 1 or A of FIG. 5). Pressure switch 10b at A; S1 closed, S15 and S16 open. Gas container 8 deflated. Attitude switch 21 at AQH; S11 closed, S12, S13 and S14 open; relay R1 latched down in G position; S2 closed, S4 open, S5 closed, Relay R2 latched down; S8 open, S9 closed, S10 closed. Relay R3 latched to the left; S7 closed, S6 opened; Relay R4 latched down; S17 closed, S18 open. Servo master 19 in A-Q-H position. Servo slave 20 in A-Q-H position; jet 2 and acoustic pickup 1b in A-Q-H position octavoc is now ready to start.
The initial supply of reactant gases is obtained by starting the pump that pulls fluid through the hydraulic intake on top of which octavoc-B or C has been placed, FIG. 1. The pump is started either manually or by a timer switch after which time the following sequence of events occur: A negative pressure is initiated inside the
hydraulic intake creating a positive pressure on the surfaces of octovac not exposed to the intake.

Octovac is forced down against the intake creating a seal between the edge of the intake and the surfaces within the envelope of the skirt 9. A portion of the total possible fluid flow through the system passes through the jet 2 in reverse direction. Dump valves 17, FIG. 1, are forced open. The flow rate demand is increased. Intake valve 3, FIG. 1, opens and the full flow capacity of the system is attained. The volute pressure sensor 22 is sucked down into the volute because of the negative pressure inside the volute and the positive pressure outside the piston or the depth sensor 10a. The pressure switch is forced down insisting that S1 makes a good electrical contact. The moving fluid drives the turbine pump 4 in the turbine mode which drives the motor-generator 5 in the generator mode.

Electrons are set into motion by the moving magnetic field of the rotating generator driving current into the electrolytic cell fuel cell 6 which forces 6 to function as an electrolytic cell.

The hydrogen and oxygen reactant gases generated by the electrolysis of the potassium hydroxide (KOH) electrolyte in the sealed system are conducted through manifold 26 to their respective containers in Fig. 8. (Pressures as high as 400 pounds per square inch could be generated by this system but it is anticipated that this is, of course, far in excess of requirements, more likely 100 pounds per square inch.)

Containers 8 expand displacing the surrounding medium and increasing the buoyancy of octovac.

When sufficient time has elapsed octovac will exert sufficient upward force to pull itself away from the hydraulic intake; or a timer will shut off the hydraulic intake pump releasing the suction force on octovac—in either case octovac will rise toward the surface of the surrounding medium. Due to the designed weight distribution and buoyant forces, octovac will rotate about its Y—Y axis, FIG. 5, as it ascends upward passing through a position similar to B. At this time the following events will take place. Fluid flow through the system will cease. The turbine 4 will no longer drive the generator 5. The volatile pressure sensor 22 will exert little or no force on the pressure switch 10b. The pressure switch 10b will move upward, opening S1, and electrically disconnect the generator 5 from the fuel cell 6.

As octovac—6 continues to rise, a position similar to C of Fig. 5 will be attained. At which time the attitude sensor switch 21 will have moved through a 90 degrees arc as indicated in Fig. 6, 2140, 2171, and 21CDEF. S11 opens as illustrated by the symbolic mercury contactor flowing from one compartment of switch 21 to the other. This releases the servo master 19 from its hold on the jet 2 in position A, Q, or H. At position C octovac might have rotated about its axis. (For a different point of view refer to position F of FIG. 5.)

For a clockwise rotation which is depicted by position R of switch 21 in FIG. 6, S12 is closed permitting current to flow from the plus terminal to terminal C of the servo master 19; which causes the servo slave 20 to assume a commensurate position represented by jet 2 C—D—E—F, position R corresponding to the aforementioned position R of switch 21. Movements of the jet 2 are similarly exacted for counterclockwise rotation or for level normal operation—in each of the three cases the general position of the jet 2 is for the purpose of propelling octovac in a horizontal direction for the side cleaning operation, i.e., positions C, D, E, or F. At position C, depth sensor 10b has moved to its upward extreme limit, closing S15 permitting K2 to be energized thereby latching R1 up, S2 closes, enabling K1; S3 opens disconnecting generator circuit; S4 closes, permitting current to flow from the electrolytic cell fuel cell 6; which immediately responds to the demand acting as an electric power source. The motor-generator 5 now runs as a motor driving the turbine pump 4 as a pump. The pumps suck the dump valves 17 closed and the intake valve 3 closed at its discharges through the jet 2.

Since octovac—C is asymmetric and the fact that the jet 2 thrusts angularly to the line of zero moments octovac will be propelled in a curved path that will ultimately contact the side of the pool. Should by chance, the top of the body 15 present itself to the side, octovac will continue turning until the bottom of the skirt 9 contacts the side of the pool. At this time the force of the jet 2 will then drive octovac parallel to the plane of the side, while at the same time push against it. The friction forces experienced will promote random out-of-phase relations of all forces involved such that periodic resonant forces will occur.

The resultant of the resonant forces will cause octovac to oscillate about its Z—Z axis and impart a rubbing action to the surface. As octovac proceeds around the pool side the reactant gas from containers 8 are converted to water in the process of extracting electrons by the fuel cell 6. The volume displaced by the shrinking containers 8 reduces the buoyancy of octovac causing it to sink deeper in the water. The resultant path traced is that of a spiral as indicated by the sloping dashed arrow-headed lines in Fig. 8.

Along some point in the path octovac will contact the intersection of the vertical side and the horizontal bottom as shown in position J of FIG. 5. Attitude sensor switch 21 will shift to position J and the mercury contact will move back and forth between S11 and S12, S13 and S14 seeking some stable plane of operation. In so doing, the jet 2 will no longer be directly controlled, which will cause octovac to veer away from its course. Should it climb back up the side, the switch 21 will resume control and initiate corrective action to the jet in attempting to regain stability. Should octovac be forced to go horizontally, then it will do so in a randomly directed method and thereby clean the shallow end of the pool. However, one of the infinite set of random paths will lead it to the deep end of the pool. In which case the hydrodynamic forces acting on the moving octovac will cause it to rotate about an axis perpendicular to its line of direction and in the plane of the skirt 9. This forces octovac to cling to the bottom surface but with not as much tenacity as it would have, had it lost buoyancy equivalent to the depth to which it was just forced to go. This state of apparent insufficient density will not hinder the overall cleaning because less drag on the bottom will be experienced and hence less energy consumed in the operation. Octovac will proceed across to the opposite side of the feature at the side-bottom, such as shown in position J, FIG. 5, will deflect octovac upward. Immediately the attitude switch 21 rotates and causes S12, S13 or S14 to make contact. The jet 2 appropriately responds to the servo master 19 and directs octovac into a horizontal side cleaning attitude. By repetition of the above herein described actions octovac eventually cleans all surfaces of the pool regardless of their depths.

Position Q (not illustrated in FIG. 5) of the pressure switch 10b is a position of general bottom cleaning. In this position the attitude sensor switch 21 is in the AOH position of FIG. 6. The mercury closes contacts plus S11 and b permitting current to flow to the center terminal b of the servo master 19 which causes the jet 2 to lock in the center or b position of the A—Q—H quadrant. No directability in this position is possible. Octovac proceeds in a random direction.

At some time during the cleaning mode the reactant gases will be consumed to the point that the combination of forces acting on the depth sensor (i.e., integrated gas, volumetric and depth pressures) will cause it to reach position H, FIG. 5, which should occur on the bottom in the deepest part of the pool, near the drain or hydraulic intake as depicted in FIG. 5, position H. The energy monitor 16 shown here as an orifice retards the
flow from sensor 10a to container 8 and serves as a damping device such that when the moment the pressure switch arrives at position H it will remain there until the actuator S16 makes contact without a series of pulsations. Switch S16 is normally open, but it closes only when the pressure switch 10b is moving downward through the H position. When S16 is closed, K3 of R2 will be energized and R2 will latch up. S8 closes enabling K3 and permitting standby power to flow into the electronic package through S7, S9 opens, shutting off power to the motor 5 and the attitude sensor switch 21 and S10 opens disenabling K4.

The electronic package 1C is energized for standby power consuming only that amount of energy required to activate the acoustic pickup 1b in a "listening" mode. All other power consuming functions of the cleaner are shut off and the cleaner "sleeps."

Automatically, at some predetermined time, or by manual operation, the hydraulic intake pump comes on causing the surrounding medium to flow through the intake and in so doing to drive the acoustic generator 1a. The device so illustrated is to depict a low head, hydraulically rotated blade type wheel supported on a stand resting on the bottom of the intake. The wheel is coupled to a cam device that imparts a vibration to a series of tuned reeds that produce a high frequency tone—a device similar to the works in a Swiss music box. There are many other ways of producing an acoustic disturbance, but this method serves as an illustration. The sound is directed through an appropriately designed speaker horn to produce as few side reflections as possible for the side lobes will certainly hinder octovac in selecting the most direct path to the intake.

The sound produced activates a diaphragm in the acoustic pickup 1b where the sound is converted into electrical impulses and conducted to the amplifier in the electronic package 1C. The amplified pulse causes K5 of R3 to latch to the right; S7 opens disconnecting standby power; S6 closes energizing K3 of R2 which latches down. S8 opens disenabling K3; S9 closes permitting current to flow to the motor 5 and to the servo master 19 by way of S11 and center terminals 6. The jet 2 is locked in the b position of the A-Q-H quadrant. K6 of the shutdown-preventer relay R4 is energized latching it up; S18 opens disenabling K6, and S17 opens disenabling K4 to lock out S16 since the pressure switch 10b still senses octovac in the H position.

Octovac waves, and the acoustic pickup sends pulses into the electronic package 1C. The circuits therein are designed to select the peak intensity at any instant and amplify the pulse if the intensity is plus or minus some angular unit say 5° to the right or left of the acoustic pickup 1b position. The amplified pulse is sent to the servo master 19 to the terminal that will ultimately cause the jet 2 to direct octovac along the line of maximum sound intensity. Say the sound intensity is 20 degrees to the right of the direction of travel of octovac as viewed in plan. The amplified pulse will go out to terminal plus y of servo master 19 which will release jet 2 from its b position and relock it in position plus y. Octovac will now proceed on a course approximately 15 degrees to the right of its previous course, which should be 5 degrees less than desired. However, since the source is fixed, soon the angle will increase to 15 degrees whereupon the plus y correction will be reentered, but this time octovac will be proceeding directly towards the maximum disturbance since the 15 degrees is the maximum correction possible as stipulated for this example. The same method for course correction and direction is applied to the left or minus y side.

The homing system soon brings octovac to the hydraulic intake, the source of the disturbance. As it approaches the intake the skirt 9 begins to cover the intake opening and shield the sound. At some position before completely covering the opening, the sound will be attenuated with respect to the acoustic pickup 1b to a level below the audible threshold of the homing sys-

tem which prevents the system from controlling the jet.

2. Octovac proceeds on a straight course for the few remaining inches across the intake until the intake is completely covered. The suction then pulls it down hard on top of the intake and causes S1 to close as in the initial start up position.

While I have described several preferred embodiments of my basic invention, other variations will now become evident to those skilled in the art and I do not limit myself to the embodiments disclosed herein except as I do so in the claims which follow.

I claim:

1. A submersible automatic solid surface cleansing apparatus for swimming pools and the like comprising:
   a. a cleansing means;
   b. a rotary impeller rotatably coupled to said cleansing means;
   c. an electric motor operably coupled to said impeller;
   d. an electrical storage battery positioned on said apparatus and connected to said motor;
   e. expansible gas containers positioned on said apparatus to effect a variable, positive buoyancy thereof;
   f. means for supplying and removing gas from said containers;
   g. filter means interposed between said cleansing means and said rotary impeller;
   h. means for conducting a flow of fluid between said cleansing means and the center of said rotary impeller through said filter means;
   i. means for removing a flow of fluid from the periphery of said impeller in a predetermined direction to effect an axial thrust on said apparatus.

2. A submersible automatic solid surface cleansing apparatus for swimming pools and the like comprising:
   a. a cleansing means;
   b. a fluid actuated impeller rotatably coupled to said cleansing means;
   c. an electric generator operably coupled to said impeller;
   d. said generator being disposed to operate as an electric motor when supplied with electrical energy;
   e. electrical energy storage means connected to said generator;
   f. means for introducing a flow of fluid to the periphery of said impeller thereby causing rotation thereof;
   g. an opening communicating with the center of said impeller and with said cleaning means to function as a suction opening when said generator operates as an electric motor;
   h. filter means interposed between said opening and said impeller;
   i. means for removing a flow of fluid from the periphery of said impeller in a predetermined direction to effect an axial thrust therefrom when said generator operates as an electric motor;
   j. means for effecting a variable positive buoyancy to said apparatus.

3. A submersible automatic solid surface cleansing apparatus for swimming pools and the like comprising:
   a. a housing;
   b. a fluid actuated impeller and shaft positioned within said housing;
   c. a motor-generator coupled to said impeller shaft;
   d. means for introducing a flow of fluid alternately to the periphery and to the center of said impeller;
   e. means for directionally removing the flow of fluid from the periphery of said impeller and from said housing thereby producing an axial thrust therefrom, means for introducing a flow of fluid to the center of said impeller when said motor-generator operates as an electric motor;
   f. a concentric cylindrical chamber positioned within said housing and having openings at each end communicating respectively with the exterior of said apparatus and with the center of said impeller;
filter means interposed between said openings in said chamber;
cleaning means positioned on the exterior of said housing in axially spaced relation to said exterior openings in said chamber;
means positioned in said housing for storage of electrical energy generated by the rotation of said motor-generator when propelled by said impeller shaft;
means for supplying electrical energy from said storage means to said motor-generator thereby to cause it to rotate said impeller shaft;
expansible gas storage means positioned on said housing to effect a variable positive buoyancy on said apparatus;
means for supplying and removing gas from said storage means.

4. A submersible automatic solid surface cleansing apparatus for swimming pools and the like comprising:
a housing;
a fluid actuated impeller and shaft positioned within said housing;
a motor-generator coupled to said impeller shaft;
means for introducing a flow of fluid alternately to the periphery and to the center of said impeller;
jet means for directionally removing the flow of fluid from the periphery of said impeller and from said housing thereby producing an axial thrust therefrom, for introducing a flow of fluid to the center of said impeller when said motor-generator operates as an electric motor;
a concentric cylindrical chamber positioned within said housing axially along said shaft and having openings at each end communicating respectively with the exterior of said apparatus and with the center of said impeller;
filter means interposed between said openings in said chamber;
cleaning means positioned on the exterior of said housing in axially spaced relation to said exterior openings in said chamber;
an electrolytic cell fuel cell battery positioned in said housing connected across the terminals of said motor-generator and disposed to produce gases from an electrolyte contained in said cell;
expansible storage means for said gases positioned on said housing and communicating with said cell and importing a variable positive buoyancy to said apparatus;
means for effecting recombination of said gases within said cell to produce electrical current thereby causing said impeller shaft to rotate;
automatic electrical means responsive to pressure to control the operation of said apparatus;
5. The apparatus of claim 3 including in addition a homing means comprising:
an acoustic generator positioned at a predetermined location;
a sound sensor positioned in said housing for picking up sound produced by said generator;
means for converting said sound to electronic impulses;
an electromechanical actuator and steering means including said jet means positioned on said housing and connected to said sound converting means;
whereby said apparatus is caused to be propelled to said predetermined location.
6. The apparatus of claim 4 including in addition a housing means comprising:
an acoustic generator positioned at a predetermined location;
a sound sensor positioned in said housing for picking up sound produced by said generator;
means for converting said sound to electronic impulses;
an electromechanical actuator and steering means including said jet means positioned on said housing and connected to said sound converting means;
whereby said apparatus is caused to be propelled to said predetermined location.
7. The apparatus of claim 5 in which said acoustic generator comprises a source of electromagnetic waves.
8. The apparatus of claim 6 in which said acoustic generator comprises a source of electromagnetic waves.

References Cited
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EDWARD L. ROBERTS, Primary Examiner.