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[57] ABSTRACT

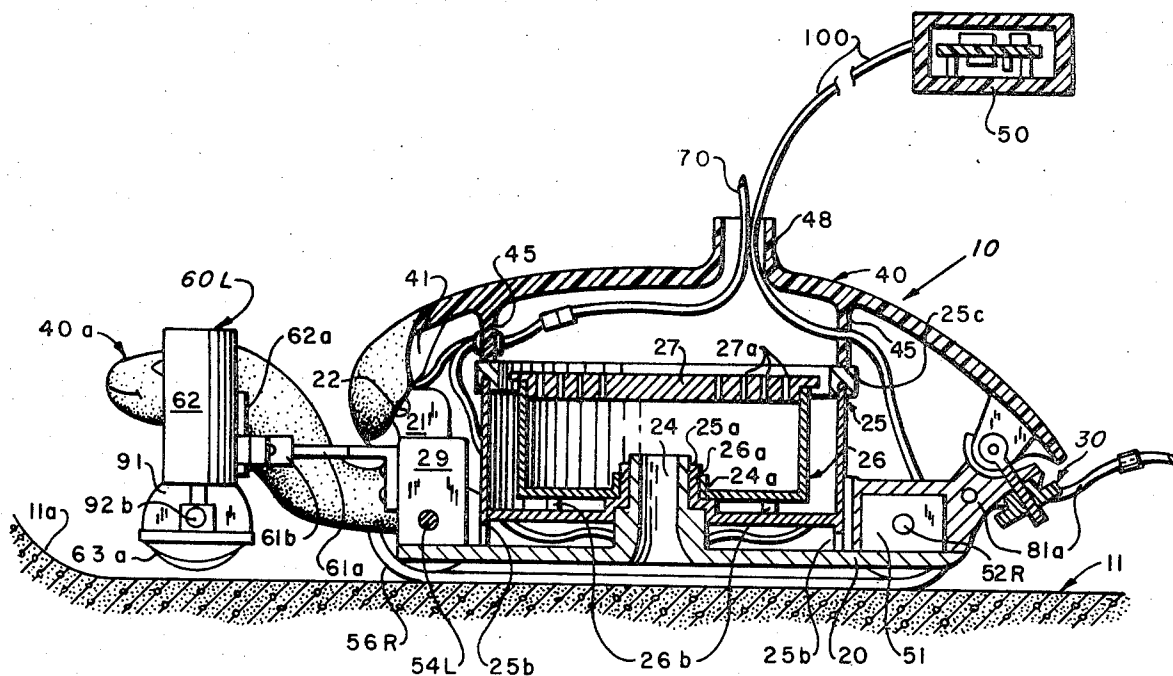
An improved translatable suction cleaning vehicle which is adapted to moveably interface with a bottom surface of a pool and remove extraneous particulates therefrom. The improved cleaner incorporates suction inlet mechanisms, driving and sensing means for cooperation with logic and control mechanisms within a control box located external to and substantially displaced from the main body of the cleaner vehicle. An improvement to the cleaning vehicle provides for a plurality of mercury switches to act as the sensing means. When an obstacle is struck, the mercury switches are inclined and actuate the remotely positioned logic and control mechanisms. A further improvement to the vehicle provides for a driving mechanism which is manually controlled by an operator wherein the appropriate logic circuitry is removed from the logic and control mechanism.

[56] **References Cited**

2,923,954	2/1960	Babcock	15/1.7
3,337,889	8/1967	West	15/1.7
3,676,884	7/1972	Wulc	15/1.7

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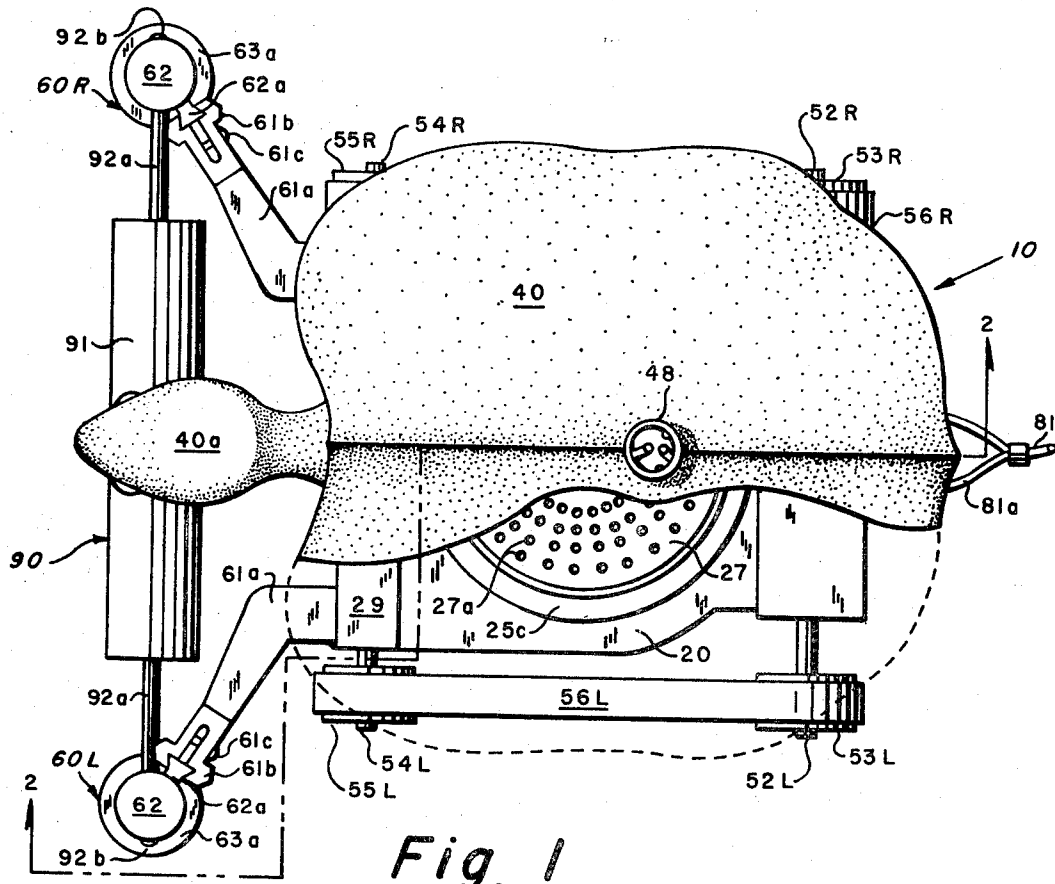
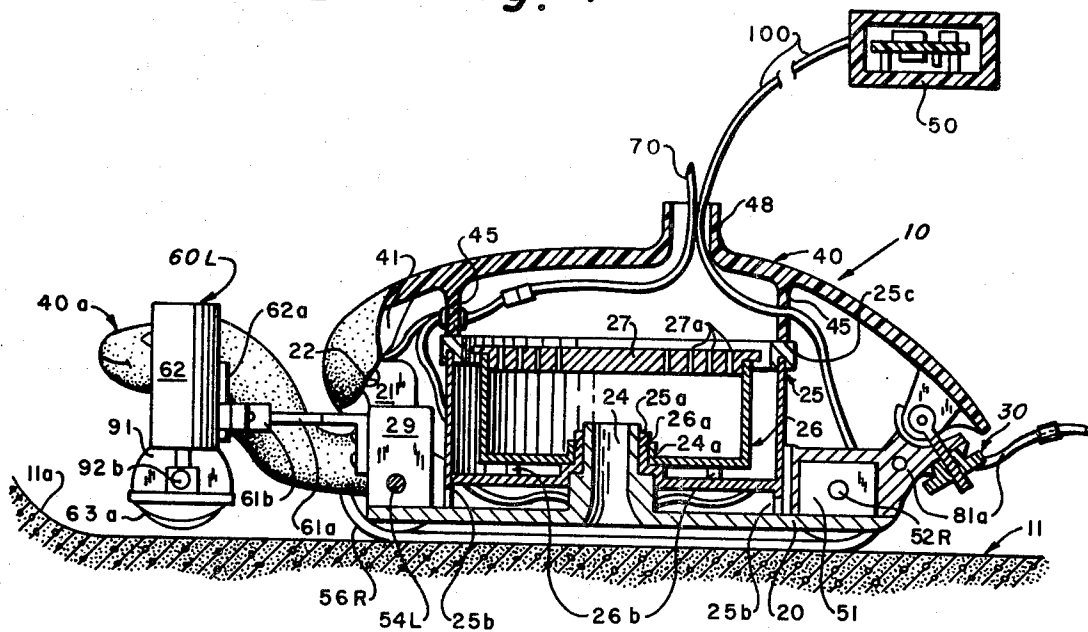
8 Claims, 6 Drawing Figures



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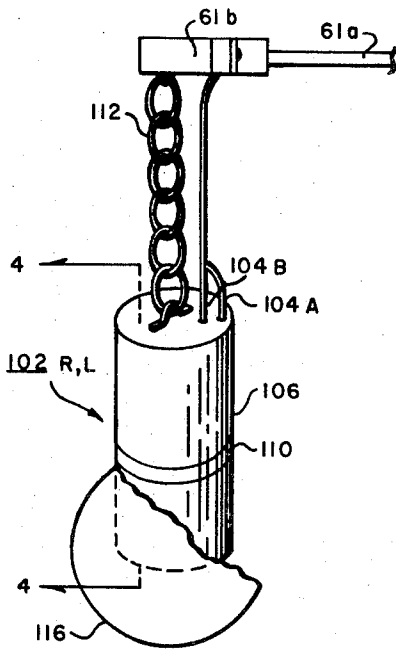


Fig. 3

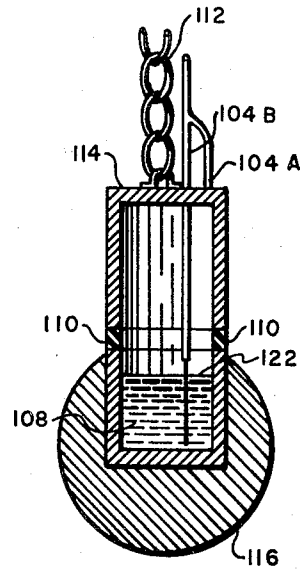


Fig. 4

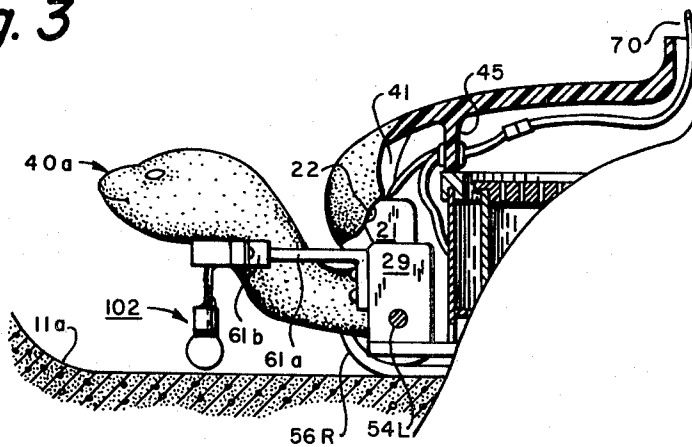


Fig. 5

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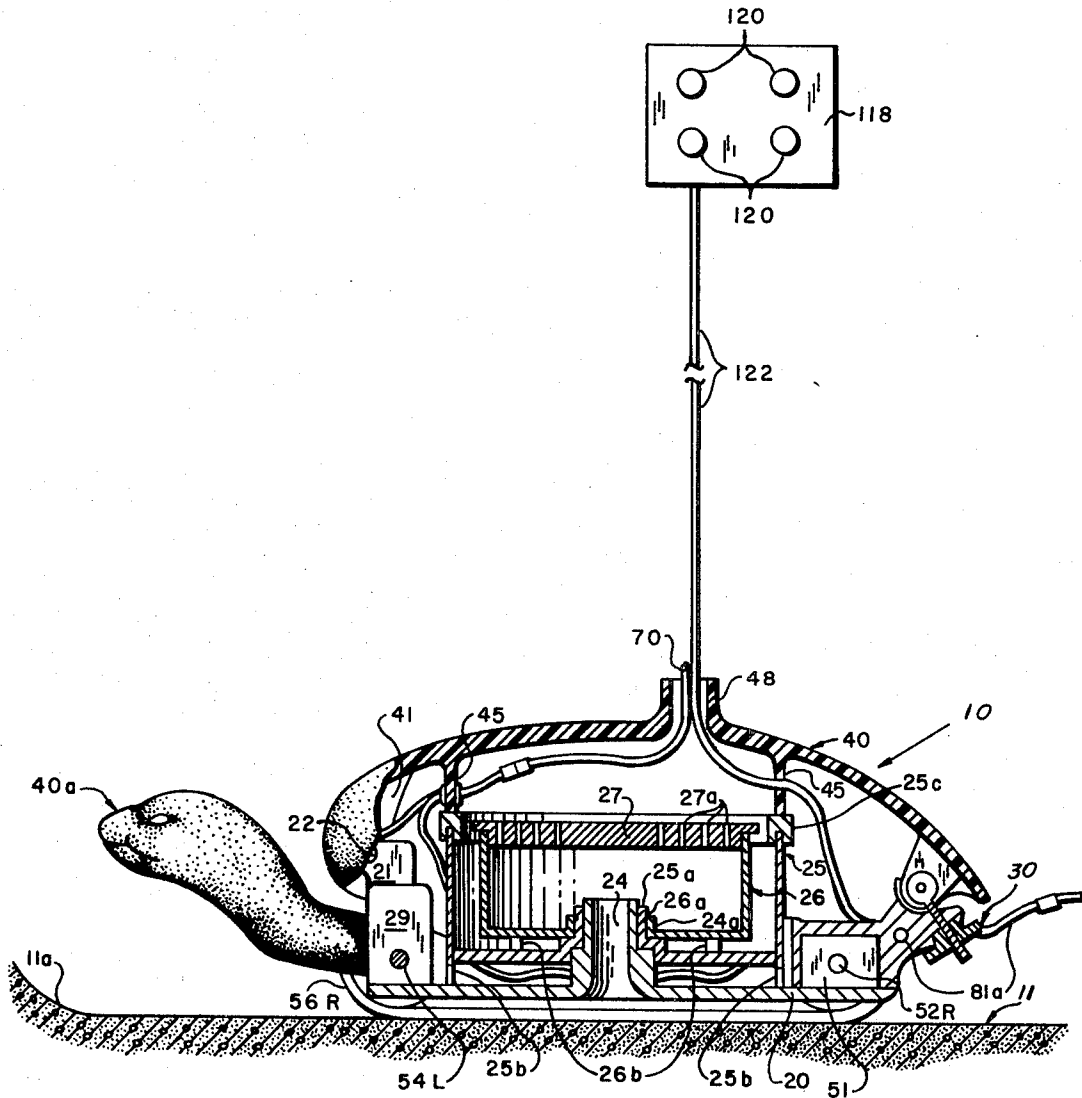


Fig. 6

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TRANSLATABLE SUCTION CLEANING VEHICLE

CROSS-REFERENCES TO RELATED APPLICATIONS

1. This application is a continuation-in-part of U.S. Pat. application Ser. No. 124,318, filed March 15, 1971, now U.S. Pat. No. 3,676,885, granted July 18, 1972.
2. This application incorporates by reference U.S. Pat. application Ser. No. 28,453 filed Apr. 14, 1970 now U.S. Pat. 3,676,884, granted July 18, 1972.
3. This application incorporates by reference U.S. Pat. application Ser. No. 124,318 filed March 15, 1971 now U.S. Pat. 3,676,885, granted July 18, 1972.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of translatable suction cleaning vehicles. In particular this invention pertains to the field of moveable suction cleaners to clean the interior surfaces of pools or tanks. More in particular, this invention relates to the field of suction cleaners having remotely positioned logic and control mechanisms to redirect the motion of the vehicle after a pool or tank obstacle has been encountered.

2. Prior Art

Suction cleaning vehicles used to clean interior surfaces of tanks or pools are known in the art. It is also known in the art to provide devices adapted to be moved along surfaces in a pre-programmed manner and to turn away from the boundaries of an obstacle. However, such prior art demands the use of high voltage levels below the liquid surface in the pool thereby increasing the hazard of electrical discharge. In addition, such prior art does not provide for the logic and control mechanisms to be remotely located with respect to the vehicle thereby forcing the logic and control mechanisms to be enclosed in a hermetically sealed container. Such prior art which incorporates the logic and control mechanisms within the vehicle causes the cleaning vehicle to be heavier and less transportable. Some of the other prior art requires relatively heavy and otherwise cumbersome gear mechanisms as well as other mechanical elements to provide an adequate turning motion.

Additionally, none of the prior art found in this field has incorporated mercury inclination switches to sense obstacles in the pool or tank. Other prior art devices in this field utilizing control mechanisms for operation are bigger, more expensive, and control with less accuracy than the subject invention.

SUMMARY OF THE INVENTION

A translatable suction cleaning vehicle which is adapted to moveably interface with a bottom surface of a tank. The cleaning vehicle includes a base having an openable cover forming a vehicle chamber. The base has a suction opening passing therethrough. A plurality of obstacle contact sensing mechanisms are movably secured to the base. Independent drive mechanisms mounted on the base serve to drive the vehicle. Liquid intake mechanisms are removably mounted to the base and are positionally located within the base cover forming a continuous particle path from the suction opening to an outlet in the base cover. Logic and control mechanisms for controlling the translation of the cleaning vehicle in response to signals from the contact sensing

mechanisms are remotely positioned with respect to the vehicle chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 FIG. 1 is a plan view of the translatable suction cleaning vehicle with the outside covering partially fragmented;
- FIG. 2 is an elevation cross-sectional view of the vehicle taken along the section line 2—2 of FIG. 1;
- 10 FIG. 3 is a perspective view partially fragmented of an obstacle sensing mechanism;
- FIG. 4 is a cross-sectional view of the obstacle sensing mechanism taken along the section line 4—4 of FIG. 3;
- 15 FIG. 5 is an elevational cross-section partially fragmented of the vehicle incorporating the obstacle sensing mechanism of FIG. 3; and,
- FIG. 6 is an elevational cross-section of the vehicle showing a manual driving mechanism remotely positioned with respect to the vehicle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, there is shown translatable suction cleaning vehicle 10 which is adapted to moveably interface with a bottom or interior surface of pool or tank 11. Vehicle 10, although being moveable in essentially planar motion includes the capability of being redirectable after impacting obstacles or protuberances 11a which may be encountered during the translation path. The main objective of vehicle 10 is to promote the removal of various particulates of material which are extraneous to the natural environment within which vehicle 10 operates. These particulates may accumulate on the bottom surfaces of tank 11 and increase the pollutant level of the liquid contained therein thereby necessitating their removal.

Important component mechanisms of vehicle 10 as shown in FIGS. 1 and 2 includes base 20 which has pivotally attached thereto openable cover 40. As seen, these components take the shape of a turtle or some like geometrical shape which would be esthetically pleasing while concurrently fitting in with the natural operational environment envisioned for vehicle 10. A pair of sensing mechanisms 60R, 60L are secured to leg extensions 61a through clamps 61b. Leg extensions 61a are in turn rigidly fastened through bolting or like means to bulkhead 29 which is contained within vehicle 10 as is shown. Mechanisms 60R, L upon impacting protuberances or obstacles 11a initiate a signal sent to logic and control means contained within control box 50. As shown, control box 50 is located external to assembly or vehicle 10 and has the function of redirecting the motion of wheel shafts 52R, 52L, 54R and 54L after contact has been made with obstacles 11a. Vehicle 10 is thus turned and translatably moved away from obstacle restraints through programmed linearly directed traction belts 56R, 56L.

An improvement to the operation of vehicle 10 includes the displacement of control box 50, containing logic and control board circuitry, away from the enclosed chamber formed by the combination of base 20 and openable cover 40. As has been mentioned, control box 50 contains the logic and control circuitry for programmed translation of vehicle 10. The circuitry contained within control box 50 is fully described within the incorporated application reference Ser. No.

28,453 filed Apr. 14, 1970 now U.S. Pat. No. 3,676,884, granted July 18, 1972, and is electrically drawn in FIG. 3 of that reference application. As shown, control box 50 is displaced from and located external to vehicle 10, being connected to motors 51 through flexible electrical cabling 100. Cable 100 passes internal to vehicle 10 through suction outlet 48 and is directly connected to appropriate motors 51 contained therein.

The liquid intake means and its associated structure is fully and exactly described in U.S. patent 3,676,885, incorporated herein by reference, from column 2, line 61, to column 3, line 46.

The removal of control box 50 from the interior of vehicle 10 provides a lighter vehicle assembly which may be moved manually by an operator with greater ease than in previous mechanisms. In addition, control box 50 no longer requires hermetic sealing thereby lowering manufacturing costs through use of a standard structural housing. Cable 100, as is obvious, is partially immersed in tank 11 liquid during the operation phase of vehicle 10. The cable may be further fit with a disconnect plug (not shown) in order that ease of connection between cable 100 and control box 50 be optimized. In this manner, box 50 may be permanently maintained at a predetermined location near pool or tank 11 but substantially removed therefrom.

Motors 51 are herein provided for ease of connection to electrical cable 100 and are further connected to rear wheel axles. Four motors 51 may be functionally incorporated within vehicle 10, although for each rear driven wheel two motors associated with each of such wheels share common elements and are commonly and standardly obtained as a commercial unit. Generally, motors 51 are designated as geared-motors wherein the output shaft runs at a substantially lower rotating speed than that of the rotors. The output shafts of motors 51 are directly connected to one or the other of the rear drive wheels.

General operating procedures show that vehicle 10 translates over an interior surface of tank or pool 11 wherein extraneous particulates are drawn through suction inlet 24 into an internal chamber formed by base 20 and openable cover 40. The suction is created by an external pump (not shown) which maintains a controlled pressure gradient. Liquid, containing particulates, is drawn into vehicle 10 and through outlet 48 into a filtration unit positioned external to vehicle 10, such being commercially available but not part of the inventive concept as herein detailed. When vehicle 10 impacts obstacles 11a through sensor assemblies 60R, L, the externally located logic and control means within control box 50 redirects the motion of vehicle 10 in another direction in order to continue the particulate straining process.

Another improvement to the operation of cleaner vehicle 10 includes the incorporation of obstacle sensing mechanisms 102R, L which are described in FIGS. 3, 4, and 5. The principal objective of mechanisms 102R, L is to pass an electrical signal to the logic and control means within remotely placed control box 50 when mechanisms 102R, L are impacted by obstacle 11a. As will be shown, actuation of mechanisms 102R, L is accomplished by inclining one or the other of the sensing mechanisms through a predetermined angle with respect to a vertical axis passing normal to the horizontal plane of the interior surface of tank or pool 11. This in-

clination is forced by mechanisms 102R, L striking or otherwise impacting obstacles or protuberances 11a which essentially tilts one or both of the mechanisms.

In general, sensing mechanisms 102R, L include a pair of electrodes 104A, B which are positive and negative respectively. Electrodes 104A, B are electrically connected on a first end to remotely located logic and control mechanisms within control box 50. As shown in FIGS. 3 and 4, electrodes 104A, B pass through an upper wall 114 of housing or enclosing member 106. Electrode 104A extends into the vicinity of a bottom surface of housing 106 and beneath the surface of electrically conducting liquid medium 108. In the operating condition, and throughout the translation history of vehicle 10, electrode 104A remains immersed within medium 108.

Electrode 104B also passing internal to housing 106 includes electrically conducting band 110 passing circumferential to an internal later wall of housing 106. Band 110, which may be incorporated into the lateral walls, is positioned above surface 122 of conducting medium 108 when the vertical axis of sensing mechanism 102R, L is vertically directed. In the relative positioning as detailed in FIG. 4, no electrical contact is maintained between electrodes 104A, B since band 110 is physically displaced from medium 108.

When mechanisms 102R, L strike obstacles 11a, then the mechanisms are inclined or tilted at a particular angle. As is evident, medium 108 will also be tilted and at a predetermined angle touch or immerse band 110 in liquid. This wetted contact then forms an electrical connection between electrodes 104A and B and an appropriate signal is sent to the logic and control means in order to redirect the direction motion of vehicle 10.

The operation of sensing mechanisms 102R, L are well known in the art and the medium often used is the highly electrically conductive liquid mercury. This type of switching mechanism is standardly known as mercury switches and may take on a variety of specific contours not important to the inventive concept as herein described. The positional displacement of band 110 and medium 108 within housing 106 provides the operationally predetermined angle through which switches 102R, L must be inclined before an appropriate signal may be sent. As herein envisioned, the predetermined angle wherein electrical contact is made, may be varied between 5 and 45 degrees with respect to a vertical axis passing normal to the horizontal interior surface of tank or pool 11.

The class of switch mechanisms 102 as herein shown is basically characterized by pool of refined mercury or other conducting medium 108 in liquid form, at the bottom of housing 106. Enclosure 106 is hermetically sealed and forms a chamber wherein electrodes 104A, B may be electrically contactable. The chamber wall, may if desired, be made to be one of the electrodes wherein at least a portion of the chamber wall is made of an electrically conductive material. Mercury switch devices are operated by tilting enclosure 106 through an angle sufficient to cause both electrodes 104A, B to be wetted by a continuous liquid path. Electrodes may be constructed of platinum, molybdenum or some like conductive material. Switches 102 provide a low circuit resistance as well as high make and break capacities for A.C. and D.C. loading. The torqueing requirements are usually low and such mechanisms are capable of operations through a very low tilt angle dependent on the

physical displacement between the surface 122 and band 110, such operational angles have been found to be as low as 0.15°.

Sensors 102 are connected to bulkhead 29 through flexible member or chain 112 as is shown in FIG. 3. Chain 112 is connected on opposing ends to upper surface 114 of housing 106 and clamp member 61b. Leg extension 61a is rigidly fastened to clamp 61b and bulkhead 29 thereby providing structural continuity between mechanisms 102R, L and the main body of vehicle 10. Chain, or other pendulum type structure 112 permits tilting of sensors 102 when the mechanisms strike protuberances or obstacles 11a.

In order to maintain sensors 102R, L in a vertically directed downward manner throughout translation of vehicle 10, weighted members 116 are rigidly secured to housing 106, as is shown in FIG. 3. Members 116 may be spherical as is shown or of some other contour not important to the inventive concept. Weighted members 116 are necessary due to the horizontal drag that may be encountered between sensors 102R, L and the tank liquid. This drag further has the tendency to incline the sensors thus possibly forcing an unwanted control signal to be sent to control box 50. Members 116 tend to keep sensors 102R, L vertically directed until obstacle 11a is contacted, and additionally force sensors 102R, L back to a vertical positioning after obstacle impact.

Another improvement of the invention as herein described is shown in FIG. 6 wherein a manual driving mechanism 118 is provided external to vehicle 10. Driving mechanism 118 permits operator control of vehicle 10 without the necessity of the logic and control circuitry as has been previously described. Manual driving mechanism 118 is connected directly to motors 51 through electrical cable member 112 which passes internal to vehicle 10 through cleaner outlet 48 as is shown. Operator manipulation of knob controls 120 cause vehicle 10 to correspondingly be transported in a predetermined path as a function of operator intent without regard to specific logic and control means. Driving mechanism 118 is connected to an appropriate power source to provide the necessary electrical motor response.

The improved invention as herein described has been shown to be an effective randomly oriented pool or tank cleaner which may be manufactured at a lower cost than others constructed for like operation. This improved tank cleaner provides increased reliability as well as ease of handling over previous mechanisms. While this invention has been described with certain specific embodiments thereof, it will now be understood that further modifications will suggest themselves to those skilled in the art and it is intended to cover such modifications when it is in the scope of the appended claims.

What is claimed is:

1. A translatable suction cleaning vehicle adapted to movably interface with a bottom surface of a tank,

comprising:

- a. a base having an openable cover forming a vehicle chamber therebetween, said base having a suction opening passing therethrough;
- b. a plurality of obstacle contact sensing means movably secured to said base, said plurality of obstacle contact sensing means passing an electrical signal to said logic and control means when said sensing means is predeterminedly inclined to a vertical axis passing normal said bottom surface of said tank;
- c. a plurality of independent drive means secured to said base;
- d. liquid intake means being removable from said suction cleaning vehicle, said liquid intake means positionally located within said base cover forming a continuous particle path from said suction opening to an outlet in said base cover; and,
- e. logic and control means for controlling translation of said cleaning vehicle in response to signals from said contact sensing means.

2. The suction cleaning vehicle as recited in claim 1 wherein said obstacle sensing means includes:

- a. a pair of electrodes being positive and negative respectively, said electrodes electrically connected to said logic and control means; and,
- b. an electrically conducting medium for forming an electrically conducting path between said positive and negative electrodes when said obstacle sensing means is inclined at a predetermined angle to said vertical axis.

3. The suction cleaning vehicle as recited in claim 1 wherein said obstacle contact sensing means comprises a plurality of mercury switches, said mercury switches being inclinable when contacting obstacles in said tank.

4. The suction vehicle as recited in claim 3 wherein said mercury switches are operationally conductive between the inclinable vertical angles of 5° and 45° with respect to said vertical axis passing normal said bottom surface of said tank.

5. The suction vehicle as recited in claim 4 wherein each of said mercury switches includes a weighted member rigidly secured to a bottom portion of each of said switches, said weighted members for maintaining said switches in a predetermined position during said vehicle translation before contacting a next obstacle.

6. The suction vehicle as recited in claim 5 wherein said weighted members are spheroid in shape, said weighted members extending in a forward direction with respect to said vehicle movement direction for providing an impact bumper for said mercury switches.

7. The suction vehicle as recited in claim 6 wherein said mercury switches are flexibly mounted to said base and base cover for providing freedom of movement of said mercury switches.

8. The suction vehicle as recited in claim 7 wherein said flexible mounting is a pendulum suspension of said mercury switches with respect said base and base cover.

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