

[54] **POOL CLEANER**

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1972, abandoned.

[52] **U.S. Cl.**..... 134/52; 4/172.16; 134/167 R

[51] **Int. Cl.**..... B08b 3/02; B08b 9/08

[58] **Field of Search**..... 134/44, 52, 167 R, 168 R;
4/172.15, 172.16; 15/1.7; 210/169

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Primary Examiner—Robert L. Bleutge

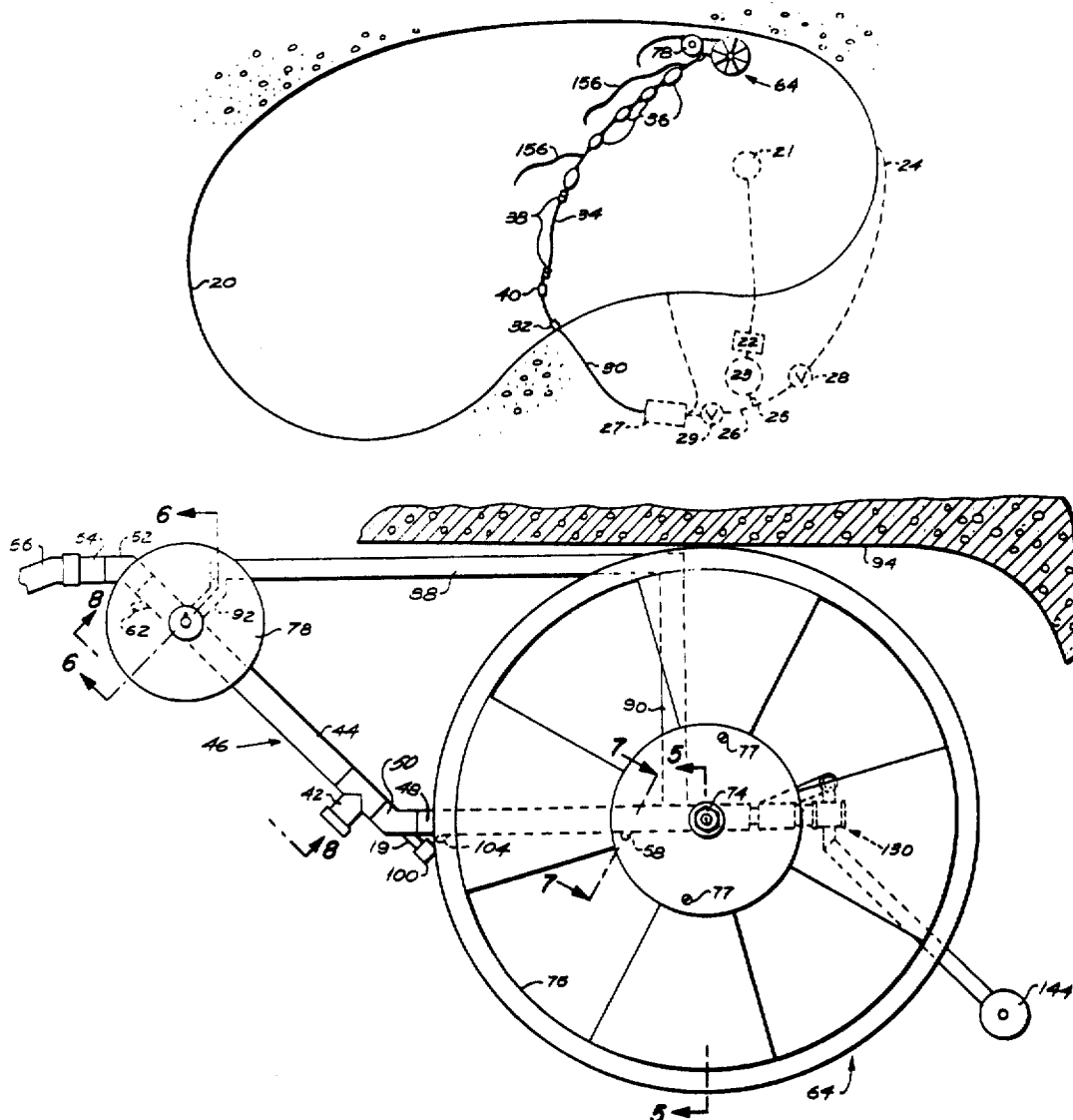
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[57]

ABSTRACT

Apparatus for cleaning sediment from a pool of liquid includes an elongated conduit with buoyant means to support the conduit in the pool. Liquid is supplied to the conduit under pressure. First jet means associated with the conduit urge it to move laterally toward a wall of the pool. Second jet means associated with the conduit drive it forward. At least one downwardly extending flexible hose secured to the conduit stirs up sediment, which is removed through a drain in the pool.

25 Claims, 19 Drawing Figures



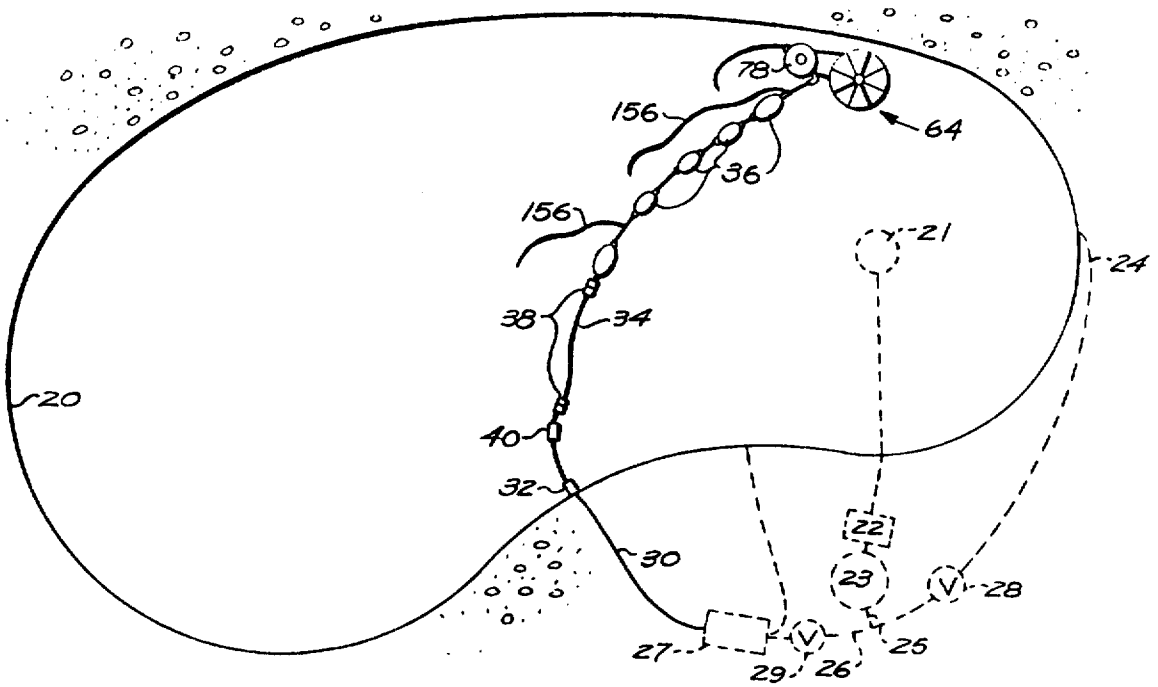


FIG. 1

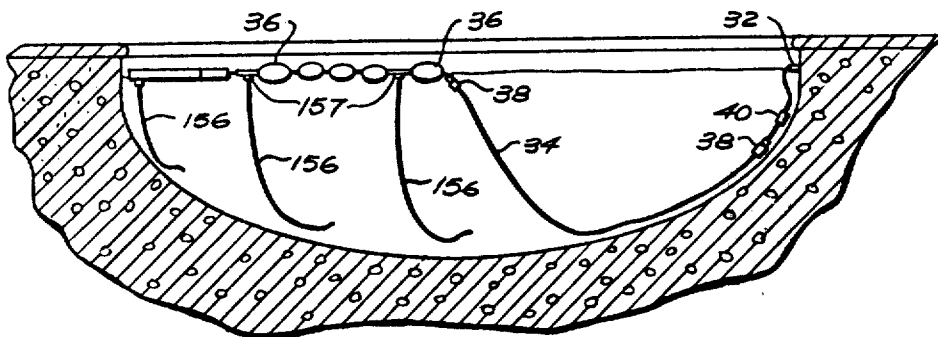


FIG. 2

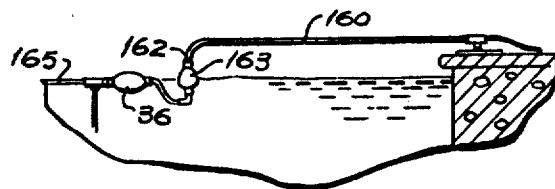


FIG. 3

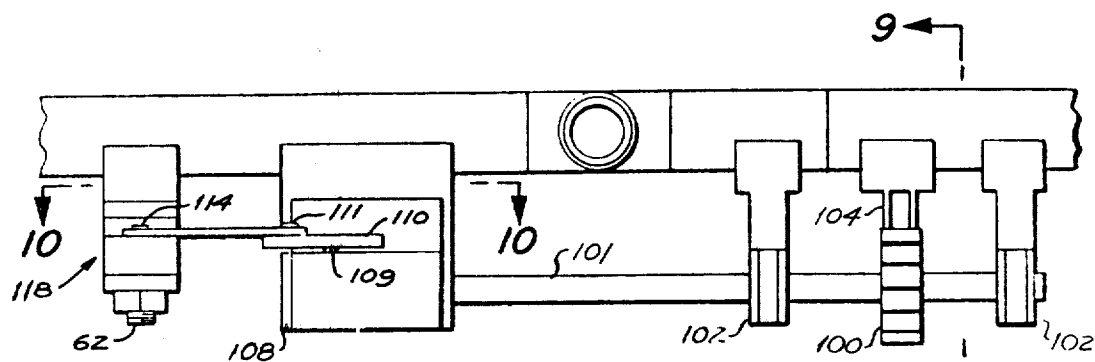


FIG. 8

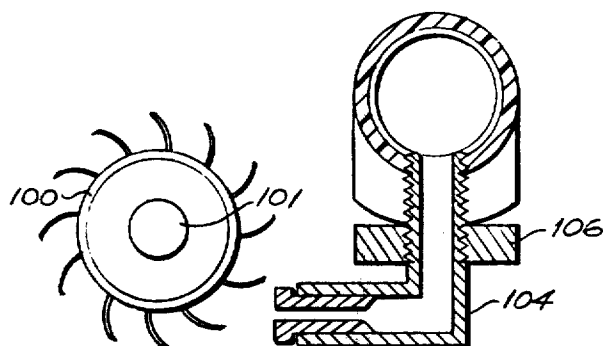


FIG. 9

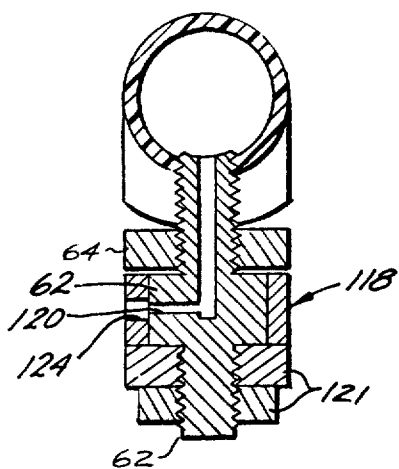


FIG. 11

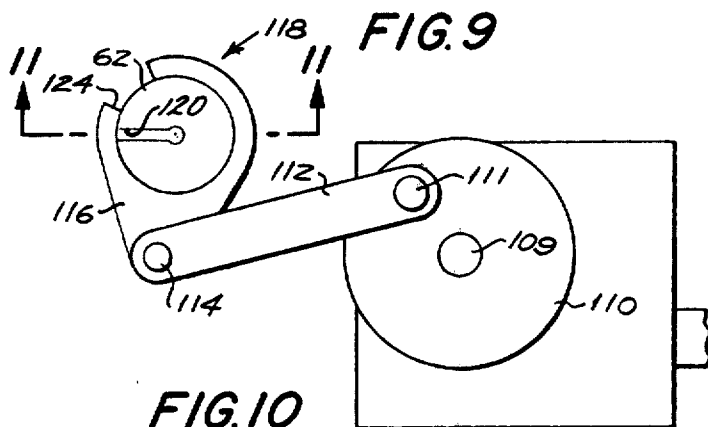
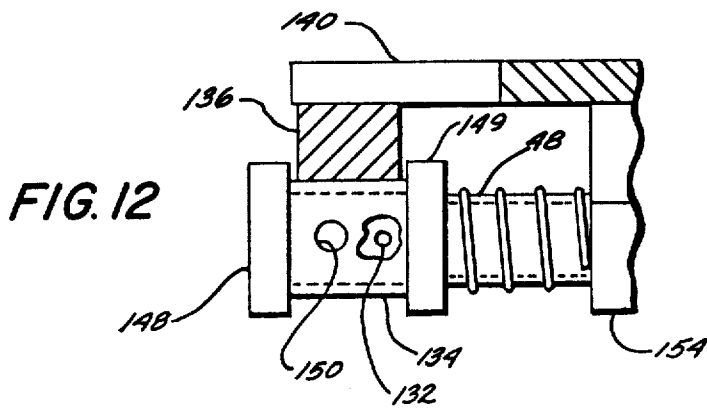
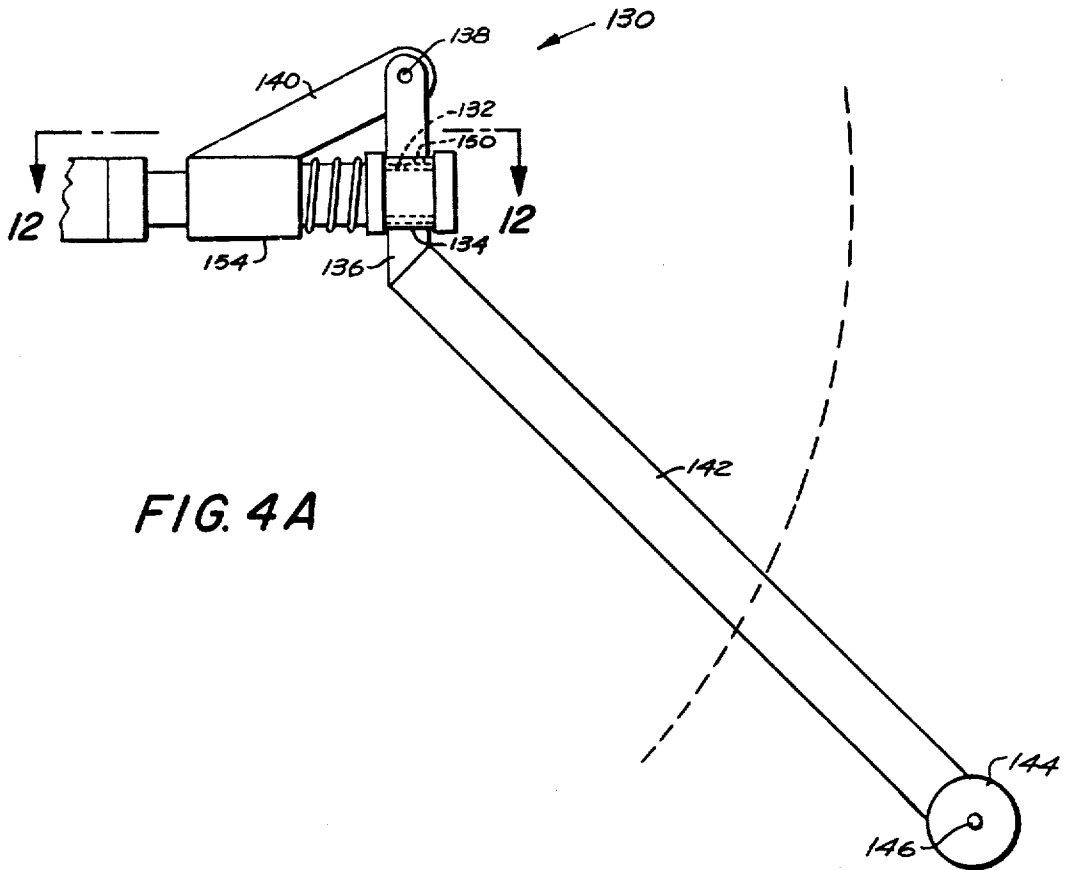
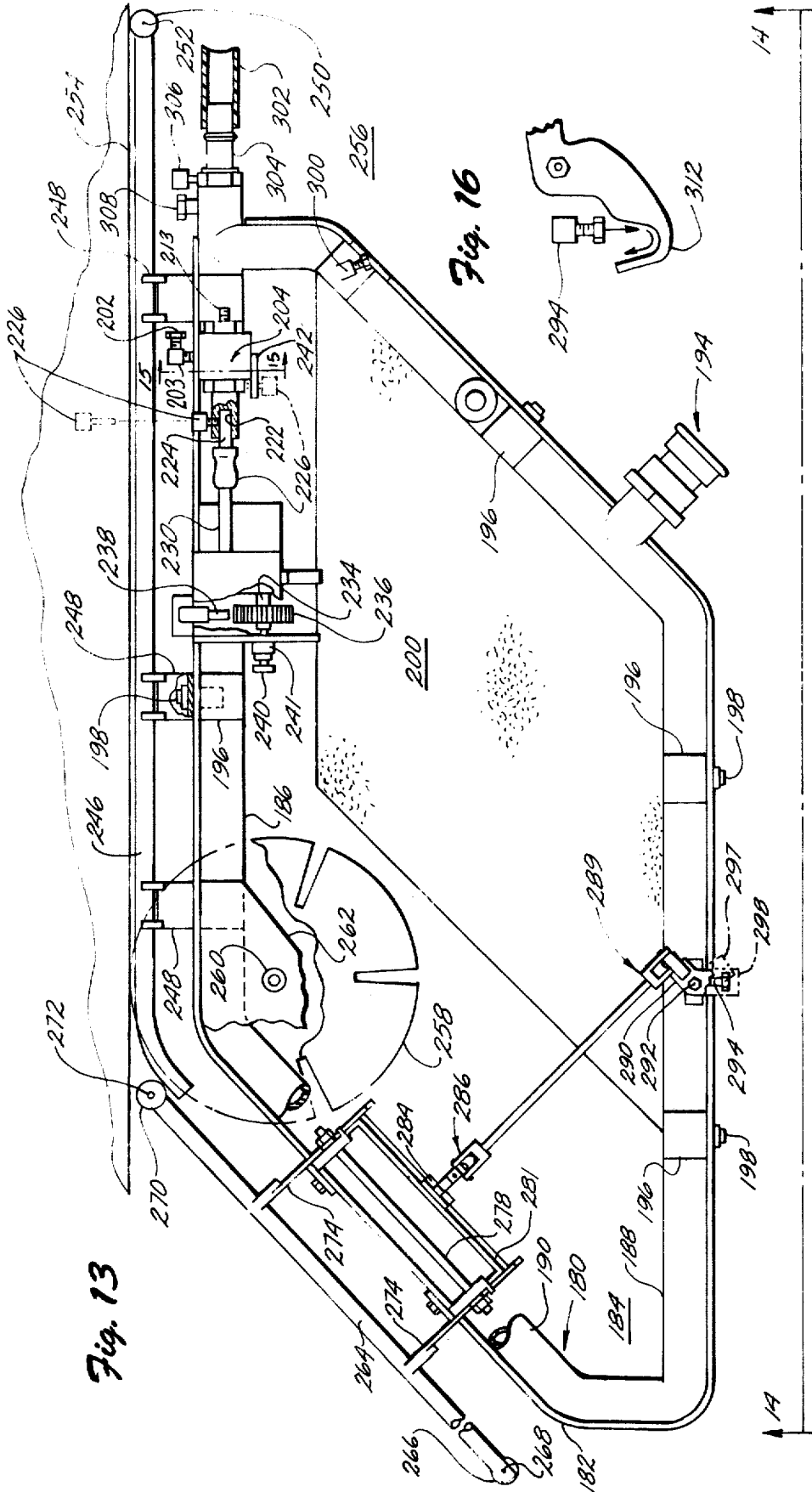
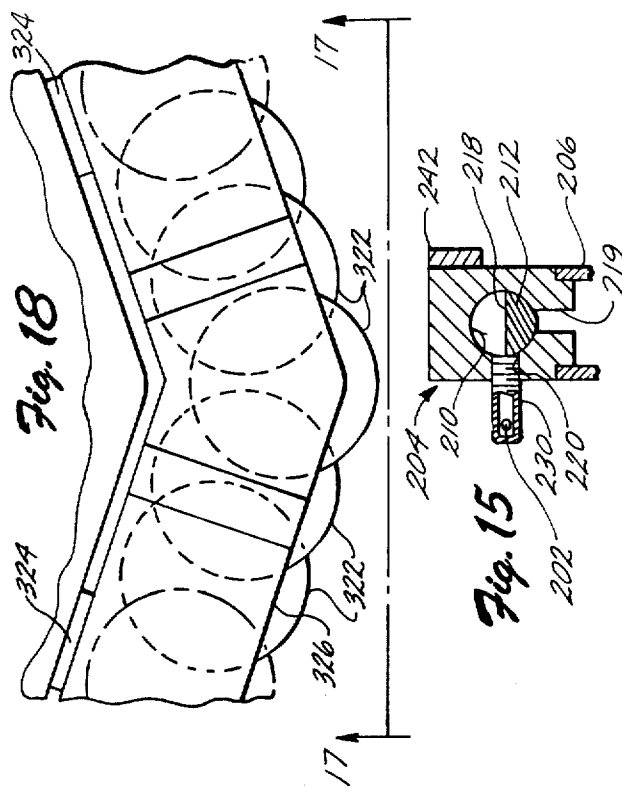
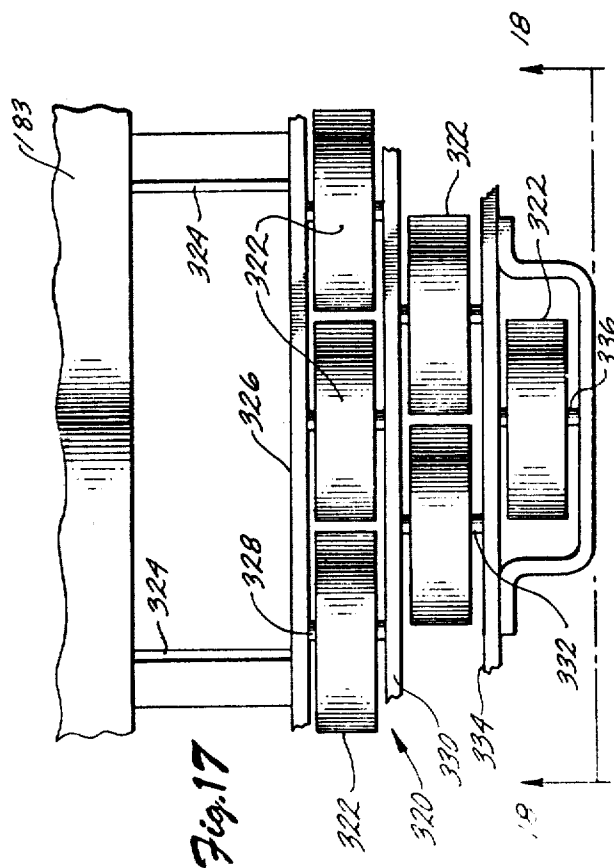
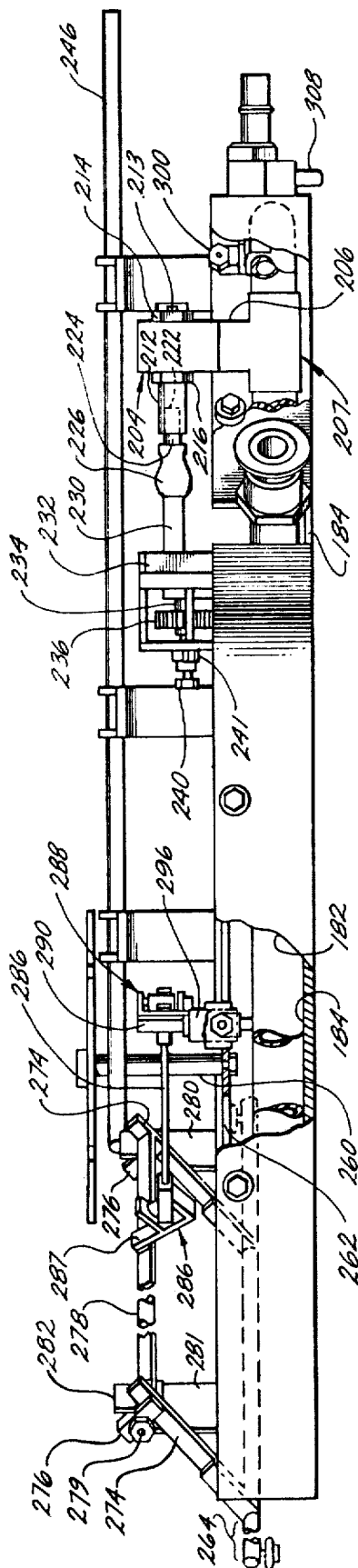


FIG. 10







POOL CLEANER

This invention provides apparatus for automatically cleaning sediment from a pool of liquid, such as a swimming pool, and is a continuation-in-part of my copending application Ser. No. 221,942, filed Jan. 31, 1972, now abandoned.

In recent years it has become common practice to clean swimming pools by jetting water against the sides and bottom of the pool to stir up sediment which is removed through the swimming pool drain and separated from the water by conventional filtering systems. The cleaning hose is supported at its upper end by a buoyant support, which is moved around the pool by various means. Such pool cleaning apparatus is shown in my U.S. Pat. Nos. 2,919,027 and 3,265,079. Cleaners using the same basic principle are also shown in U.S. Pats. Nos. 2,975,791; 3,032,044; 3,170,180; and 3,291,145.

Although the cleaners developed to date have found wide acceptance because they have substantially reduced the labor required to keep swimming pools clean, none of them are 100 percent effective. They hang up on ladders or steps in the pool, "stall" in the corners of the pool, or simply fail to do an efficient job of moving stirred-up sediment toward the drain.

This invention provides an improved pool cleaner which moves easily past all normal obstructions in a pool without requiring the installation of any special "ramps" or deflectors to help the cleaner move past the obstructions. It is self-freeing if it becomes trapped in a corner, and it does a more efficient job of moving stirred-up sediment toward the pool drain.

Briefly, the pool cleaner of this invention includes a conduit with buoyant means to support it in the vicinity of the surface of the liquid. Means are provided for supplying liquid under pressure to the conduit. First jet means associated with the conduit move it toward a wall of the pool. Second jet means are provided for moving the conduit, preferably intermittently, along the side of the pool. The second jet means can be independent or combined with the first jet means which move the conduit laterally. The upper end of a downwardly extending flexible hose is secured to the conduit. The lower end of the hose carries a nozzle which jets a stream against the sides and bottom of the pool to stir up sediment. The liquid with stirred-up sediment is removed from a drain in the pool.

Preferably, a pair of wheels are mounted on the conduit at longitudinally spaced locations to be rotatable about respective upright axes. The wheels roll against the side of the pool to reduce friction and permit the cleaner to be driven forward with low power requirements from the second jet means. The wheels and conduit have a relatively shallow draft (about 3 inches) so they ride over rather than around submerged steps or seats which are more than about 3 inches below the surface of the water.

In the preferred form of the invention, the wheels are freewheeling, and not driven so that unless the conduit is provided propulsion in a longitudinal direction, the cleaner is held substantially stationary against the side of the pool. Thus, the cleaning hose or hoses extending down from the conduit move stirred-up sediment a substantial distance toward the drain before the conduit and wheels move on to a new location.

The preferred embodiment also includes means for sensing when the forward end of the cleaner encoun-

ters an obstruction such as an end wall, and controls jet means to cause the forward end of the cleaner to move away from the pool wall toward which it is normally urged by the first jet means. Preferably, the first jet means include two longitudinally spaced jet nozzles which direct horizontal streams from the same side of the conduit and perpendicularly to the longitudinal axis of the conduit. The forward jet nozzle is inactivated when the obstruction-sensing means encounters an obstruction so the forward end of the conduit is free to move in a direction away from that normally urged by the forward jet. This movement is aided by a resilient support for the wheels on the conduit. In another form of the invention, the obstruction-sensing means opens a jet at the forward end of the conduit which moves the forward end laterally in a direction opposite from that in which the conduit is normally urged laterally.

These and other aspects of the invention will be more fully understood from the following detailed description and the accompanying drawings in which:

FIG. 1 is a plan view of one embodiment of the invention disposed in a conventional swimming pool;

FIG. 2 is an elevation of the pool cleaner shown in FIG. 1;

FIG. 3 is a fragmentary elevation of an alternate embodiment for supplying water under pressure to the cleaner shown in FIG. 1;

FIG. 4 is an enlarged fragmentary plan view of the pool cleaner shown in FIG. 1;

FIG. 4A is an enlarged fragmentary plan view of the forward end of the elongated conduit with the forward wheel removed to show in detail a de-stalling jet and actuation mechanism;

FIG. 5 is a view taken on line 5—5 of FIG. 4;

FIG. 6 is a view taken on line 6—6 of FIG. 4;

FIG. 7 is a view taken on line 7—7 of FIG. 4;

FIG. 8 is a view taken on line 8—8 of FIG. 4;

FIG. 9 is a view taken on line 9—9 of FIG. 4;

FIG. 10 is a view taken on line 10—10 of FIG. 8;

FIG. 11 is a view taken on line 11—11 of FIG. 10;

FIG. 12 is a fragmentary side elevation, partly broken away, taken on line 12—12 of FIG. 4A showing the mechanism for deflecting the cleaner out of a corner;

FIG. 13 is a plan view of the underside of the presently preferred embodiment of the cleaner of this invention;

FIG. 14 is a side elevation taken on line 14—14 of FIG. 13;

FIG. 15 is a sectional view taken on line 15—15 of FIG. 13;

FIG. 16 is a schematic diagram of an alternate embodiment of the jet control means used on the preferred embodiment of the cleaner shown in FIGS. 13 and 14;

FIG. 17 is a fragmentary side elevation taken on line 17—17 of FIG. 18 of an alternate fenderbar arrangement for the cleaner of this invention; and

FIG. 18 is a view taken on line 18—18 of FIG. 17.

Referring to FIG. 1, a conventional swimming pool 20 includes the usual drain 21, pump 22, filter 23 and a return line 24.

A T-joint 25 at the outlet side of the filter connects to conventional return line 24 and a booster line 26, which is connected to the inlet of a booster pump 27. Valves 28 and 29 in lines 24 and 26, respectively, control the flow of water through those lines.

The discharge side of the booster pump is connected by a supply line 30 to a fitting 32 in the side of the swimming pool. A flexible supply hose 34 is connected to the fitting and extends down the side of the pool and across the bottom up through a series of buoys 36 and swivels 38. A weight 40 is secured to the supply hose a few feet from the fitting 32 to hold the hose down against the side and bottom of the pool under the fitting. Thus, the proximal portion of the supply hose is submerged, and the distal portion of the hose is supported on the surface of the water by the buoys 36.

The discharge end of the supply hose is connected to an inlet T-joint 42 (FIG. 4) at the forward end of a rear section 44 of an elongated, stiff, horizontal and laterally movable conduit 46 disposed about one inch below the surface of the water. The rear end of a forward section 48 of the conduit is connected by a first 45° elbow 50 to the forward end of the T-joint 42.

A second 45° elbow 52 is connected to the rear end of the rear section of the conduit and terminates in a short straight section 54, which is parallel to the forward end of the conduit. The upper end of a downwardly extending wallcleaning hose 56 is connected to the rear end of the conduit. A first or forward jet 58 (shown in detail in FIG. 7) is threaded into the bottom of the forward section 48 of the conduit a short distance from the forward end of the forward section. A lock nut 60 on the jet locks the jet at the desired angle. Preferably jet 58 is set between about 5° and about 15° to the rear and right (with respect to the direction of travel of the conduit) of a vertical plane passing through the longitudinal axis of the conduit. Thus, water emerging from jet 58 imparts a substantial lateral force to urge the conduit slightly forward, but mainly toward the left (with respect to which way the conduit travels).

A second or propulsion jet 62 is screwed into the bottom of the rear end of the rear section 44 of the conduit, and held in the desired position by an upper lock nut 64 (FIG. 11). The second or propulsion jet is set to create a force in a direction substantially parallel to the forward portion of the conduit, and slightly to the right with respect to the direction of travel of the conduit. The propulsion jet is intermittently opened and closed by a mechanism described in detail below so that the conduit is intermittently moved in the forward direction (to the right as viewed in FIGS. 1 and 4).

A relatively large forward buoyant wheel 66 is mounted to rotate freely in a substantially horizontal plane about an upwardly extending threaded axle 66 secured at its lower end to a saddle 68 (FIG. 5) bonded to the forward end of the conduit. A wheel bearing 70 around the upper portion of the axle rests on a lower pair of lock nuts 72 threaded around the axle. An upper pair of lock nuts 74 around the upper end of the axle hold the bearing and buoyant wheel on the axle so that the wheel supports the conduit and is free to rotate around the axle. The forward wheel includes a rim 75 and four equi-angularly spaced wedge-shaped spokes 76 of buoyant material secured within the rim. The inner end of each spoke is secured by screws 77 to an outwardly extending flange 78 on the upper end of bearing 70.

A smaller rear wheel 78 is secured to the rear end of the rear section of the conduit. The rear wheel is made of a solid buoyant plastic, e.g., polystyrene foam, and is secured in a manner identical with that just described

for the forward wheel. Thus, the rear wheel is also free to rotate in a substantially horizontal plane about a vertical, hollow, threaded axle 79 (FIG. 6) secured at its lower end to a saddle 80 bonded to the rear section of the conduit. A rear wheel bearing 82 is disposed around the axle and clamped between a lower pair of lock nuts 84 and an upper pair of lock nuts 85. The lower end of the hollow axle communicates with the interior of the conduit. A horizontal jet 86 directs a stream of water against the side of the pool at, or just above, the water line to keep this troublesome area clean.

The rear wheel is also freewheeling in exactly the same fashion as the forward wheel, and is spaced the same height above the conduit. Thus, the front and rear buoyant wheels support the conduit in a substantially horizontal plane, and roll against the side wall of the pool to minimize frictional drag as the conduit travels around the pool.

A longitudinally extending fenderbar 88, which is parallel to the forward end of the conduit, is secured to the conduit by a front crossbar 90 bonded at one end to the fenderbar and at its other end to the conduit just to the rear of the front axle. The rear end of the fenderbar is bonded by a short rear crossbar 92 to the conduit where the rear axle is supported.

As shown best in FIGS. 1 and 4, the respective peripheries of the front and rear wheels engage a wall 94 of the pool, and the fenderbar is parallel to a line tangent to the two wheels where they touch the swimming pool wall. The fenderbar is spaced a short distance from the wall so that the fenderbar normally does not engage the pool wall. However, the fenderbar prevents obstructions, such as ladders, skimmers, steps, and the like, from entering the space between the two wheels, when the cleaner has a tendency to move into that position because of the lateral force imposed on the conduit by the jets. This prevents the cleaner from hanging-up on such obstructions.

The cleaner is intermittently driven forward (to the right as viewed in FIGS. 1 and 4) by the periodic opening and closing of the second jet 62 at the rear end of the conduit. This is accomplished by rotation of a turbine wheel 100 (FIGS. 4, 8 and 9) mounted on a horizontal shaft 101 extending through bearings 102 mounted on the underside of the rear section of the conduit (shown best in FIG. 8).

A third jet 104 (FIGS. 4, 8 and 9) threaded into the bottom of a conduit just forward of the elbow which joins the rear and forward sections of the conduit, and held in place by a lock nut 106 (FIG. 9), directs a stream of water against the turbine 100 to rotate shaft 101, which is connected at its rear end to the input of a conventional speed reduction box 108, secured to the under side of the rear section of the conduit. A vertical output shaft 109 (FIGS. 8 and 10) from the speed reduction box drives a crank wheel 110 secured by a crank pin 111 to the forward end of a crank arm 112 attached at its rear end by an upright pin 114 to a lobe 116 on a sleeve 118 disposed around the second jet 62, which has a rearwardly opening orifice 120. The sleeve is confined between upper lock nut 64 (FIG. 11) and a lower pair of lock nuts 121 on a threaded boss 123 extending down from the second jet. An arcuate slot 124 in the sleeve permits the second jet 62 to be opened and closed as the crank turns. Thus, as the sleeve is oscillated by the crank, the second jet 62 peri-

odically opens to drive the cleaner forward. When the jet is closed, the cleaner is virtually stationary, and is held against the side of the pool by forward or first jet 58. The second and third or turbine-driving jet 104 also helps hold the cleaner wheels against the side of the pool.

When the forward wheel reaches a portion of the swimming pool where the sides meet at a right angle or an acute angle, there is a tendency for it to stall, but this is prevented by a self-freeing mechanism 130 (FIGS. 4 and 4A) mounted on the forward end of the conduit, which has a transverse bore 132 opening horizontally out of its left (with respect to the direction in which the conduit travels) side. A spool 134, which is open at its left (as viewed in FIG. 12) end and closed at its right end, is slipped over the forward end of the conduit and is held in place by a transverse horizontal actuator bar 136 secured at its left (with respect to the direction of travel of the conduit) of the conduit and terminates forward of the front wheel. The forward end of the sensing arm 142 carries a roller 144 mounted to rotate in a horizontal plane about a pin 146.

The actuator bar makes a sliding fit between a forward flange 148 and a rear flange 149 on the spool. Thus, when the roller on the forward end of the sensing arm is forced against the side of the pool, the sensing arm is rotated in a clockwise direction (as viewed in FIG. 4A) about pivot pin 138, causing the spool to slide rearwardly until a horizontal, transverse bore 150 through the forward portion of the spool is moved back to overlie the transverse bore 132, which is then open to direct a stream of water to the left (with respect to the direction of travel) side of the forward end of the conduit, thus swinging the forward end to the right while the first and third jets urge the rear portion of the cleaner around the corner until the fenderbar is parallel with the side wall initially contacted by the sensing arm roller.

After the cleaner turns the corner, the spool and sensing arm are forced forward by water pressure in the conduit and by a compression spring 152 disposed around the forward end of the conduit between the rear flange 149 on the spool and a block 154 mounted on the conduit. Thus, the laterally directed jet 132 is closed. The spool is prevented from being forced off the end of the conduit by the transverse actuator bar engaging the forward and rear flanges on the spool as the spool moves forward.

In addition to the wall cleaning hose 56, a pair of intermediate hoses 156 are each secured at their upper ends to spaced T-joints 157 in the floating portion of the supply hose to clean the bottom of the pool.

To operate the pool cleaner just described, it is assembled and connected as shown in FIGS. 1 and 4. Water from the laterally directed jets 58 and 104 in the conduit urge it and the attached wheels in a lateral direction until the wheels contact a pool wall at their respective peripheries. The cleaner is held in this position, or else moved forward very slowly, until the rear jet 62 is opened by the action of the turbine and crank to oscillate the sleeve around the rear jet. In the meantime, water is jetted from the wall cleaning hose and the two intermediate hoses to stir up sediment. By holding the cleaner substantially stationary while the hoses jet water against the bottom and sides of the pool, greater cleaning efficiency is obtained than if the cleaner is permitted to move continuously around the pool. The

reason for this is that a certain amount of energy is required to suspend the settled solids in the first place. During the period the cleaner is substantially stationary, the cleaning hoses snake about in a limited area so that more of the energy imparted by their streams to the pool water moves the suspended solids toward the drain, and thus less energy is required to overcome the static or settled state of the solids. Time required to clean the pool is thereby reduced.

The standstill period of the cleaner increases efficiency in a second way. Practically all swimming pools have floors which slope, gently in some areas and steeply in others, toward the drain. This inclination of the floor tends to cause the heavier nozzle end of the cleaning hose to gravitate toward the outlet. This is a major factor in efficient cleaning. Anything interfering with movement of the nozzle toward the drain diminishes cleaning efficiency. As the cleaning hoses are tugged along by the traveling conduit, or its equivalent in other forms of cleaners, the pull on the hoses tends to make them trail behind the conduit. Where the pool floor slopes steeply, this usually does not counteract the effect of gravity on the nozzle end of the cleaning hose to any significant degree. However, where the floor slopes gently, the movement of the conduit usually interferes with gravitation of the nozzle end of the hose toward the drain. Therefore, part of the time the randomly moving nozzle end of the cleaning hose is on the more gentle slope it is directed away from the outlet. The slower the traveling conduit moves, the less is the counteraction of the trailing effect on gravity. In pools without ladders or steps, the jets on the conduit may be positioned to produce very slow continuous motion around the sides of the pool, and the trailing counteraction on gravity is negligible. If a pool has steeply sloping floors throughout, the trailing counteraction at almost any reasonable speed of the conduit is negligible. However, a majority of pools have partly gently sloping floors and steps or ladders, thereby precluding very slow movement of the traveling conduit because it will not move around such obstacles unless it has an adequate forward driving force.

When the forward wheel encounters an obstacle, such as a ladder, and the forward driving jet is open to move the cleaner forward, the radius of the forward wheel is 2 or 3 inches greater than the distance the obstacle projects into the pool, thus the forward wheel rolls around the obstacle and directs the conduit clear of it. The fenderbar between the forward and rear wheels prevents the conduit from moving toward the obstacle as the cleaner slides past, thus avoiding the obstacle being hung-up in the space between the two wheels. The "dogleg" configuration of the conduit is useful because it prevents the floating supply hose from being disposed in between the two wheels, and it also permits the cleaning hose to be connected to the conduit as close as possible to the adjacent swimming pool wall.

FIG. 3 shows an alternate way for supplying water under pressure to the cleaner. The submerged flexible hose is replaced by an elongated stiff conduit 160 disposed above the surface of the pool and terminating in a downwardly extending section 162 supported by a buoy 163. The downwardly extending section extends through the buoy and is connected to a swivel 164, which is connected to the floating portion of the supply hose 165.

Referring to FIGS. 13-16, the presently preferred embodiment of the cleaner includes an endless conduit 180 in the shape of a rhomboid, the major plane of which is parallel to the surface of the water in the pool. A vertical skirt 182 extends around the outer periphery of the conduit, and projects slightly above and below the conduit. A flat top 184 with a rhomboidal shape matching that of the skirt and conduit is secured to the top edge of the skirt.

As viewed in FIG. 13, i.e., looking up at the under side of the cleaner, the conduit is adapted to move in a forward direction from right to left, and circle the pool in a clockwise (viewed from above) direction. Accordingly, when viewed from below, and facing in the direction of forward travel, the conduit includes parallel right and left sides 186, 188, respectively, connected across their front and rear ends by front and rear cross-pieces 190, 192, respectively. The right and left sides are the longer of the rhomboid.

Water is supplied to the conduit under pressure from a supply hose (not shown in FIGS. 13-16) connected to an inlet 194 at the forward end of the rear cross-piece.

The conduit is secured within the skirt against the under side of the top by blocks 196 spaced around the under side of the conduit and secured to the skirt by screws 198 threaded into each block.

A rhomboidal buoyant slab 200 of a shape similar to, but smaller than, the cleaner cover is secured by adhesive (not shown) to the under side and rear left portion of the cleaner cover. The center of buoyancy of the slab is such that the cleaner cover and major plane of the conduit is held in a substantially horizontal position when the cleaner is floating in the pool and operating.

The cleaner is driven forward by water discharged from a rearwardly and horizontally directed drive jet 202 secured by a fitting 203 into the right side of a control valve 204 mounted in the upper end 206 (FIG. 14) of a T-joint 207 in the rear end of the right side of the conduit. Thus, the drive jet is located to the right of the pool side of the conduit (i.e., between the side of the pool and the adjacent side of the conduit) and provides a propelling force to move the conduit and the cleaner forward (right to left as viewed in FIG. 13). The drive jet valve 204 includes a longitudinal cylindrical cavity 210 (FIG. 15) which receives a rotatable plug 212 (FIG. 14) that makes a close sliding fit within the cavity. The rear end 213 of the plug is threaded to receive a rear hexagonal cup 214 which makes a close sliding fit against the rear face of the control valve to seal the rear end of cavity 210. The plug 212 extends forwardly out of the cavity 210 in the valve body through a forward hexagonal cup 216 threaded onto the plug to make a close sliding fit against the front face of the control valve body and thus seal the forward end of cavity 210. The central part of the plug includes a notch 218 which extends halfway through the plug and intermittently connects a vertical bore 219 in the lower part of the valve body to a horizontal bore 220 into which the fitting 203 is screwed.

The forward end of plug 212 has a longitudinal recess 222 which receives the rear end of a stub shaft 224 held in the recess by a setscrew 226 threaded into the plug 212.

The forward end of the stub shaft 224 makes a snug friction fit into the rear end of a short piece of flexible tubing 226, the forward end of which makes a snug fric-

tion fit around the rear end of an output shaft 230 of a speed reduction box 232. An input shaft 234 of the speed reduction box is driven by a turbine wheel 236 turned by water from a transverse drive jet 238 (FIG. 13) connected to the interior portion of the right side of a conduit. The drive jet is located below the axis of rotation of the turbine drive wheel, the speed of which is adjusted by turning a brake screw 240 threaded into a journal 241 for the forward end of the input power shaft, which carries the turbine wheel. The inner end of the brakescrew bears against the forward end of the input power shaft so that adjustment of the screw controls the speed of the turbine wheel.

The speed reduction box requires that the turbine turn the input power shaft about 500 times for each revolution of the output power shaft. Ordinarily, the brakescrew is set so the turbine turns at a rate which causes the drive jet 202 alternately to be open about 15 seconds, and then be closed about 45 seconds. As can be seen in FIG. 15, the drive jet is supplied water for about one-fourth of each revolution of the plug in the control valve. Thus, the cleaner is driven forward by intermittent discharge of water from the drive jet at the rear end of the cleaner. If the intermittent action is to be eliminated so that the cleaner is driven forward with a substantially constant force, the setscrew 226 is removed from the forward end of the plug extending through the control valve, the plug is rotated so that the drive jet continuously receives water from the conduit, and the setscrew is threaded (as shown in phantom line in FIG. 13) through a plate 242 secured to the left side of the forward end of the control valve to bear against the front cap and prevent rotation of the plug from the open position.

An elongated, horizontal and longitudinally extending cylindrical fenderbar 246 is secured outboard of the skirt along the right side of the conduit by L-shaped brackets 248 secured to the outside of the skirt by the screws 198 which hold the retaining blocks over the conduit within the skirt.

The rear end of the fenderbar carries a wheel 250 of a diameter slightly greater than the fenderbar. The rear wheel is mounted to rotate about an upright axis on a vertical shaft 252 extending through the bar and wheel. The periphery of the wheel bears against the side 254 of a swimming pool 256. The fenderbar can be of any suitable material, but preferably it is of an inert plastic, say, nylon, and extends a sufficient length past its rear support to provide some degree of flexibility of resilience.

A relatively large diameter wheel 258 is mounted to rotate about a downwardly (when the cleaner is inverted from the position shown in FIG. 14 for actual use) extending shaft 260 secured at its upper end to a platform 262 mounted within the skirt of the cleaner. The wheel is of such a diameter that it extends slightly beyond the forward end of the fenderbar about the same amount as the rear wheel, and engages the side 264 of the swimming pool at the forward end of the right side of the conduit. Thus, the forward and rear wheels provide minimum frictional drag as the cleaner is pushed along the side of the pool by the driving jet at the rear of the cleaner. The forward end of the fenderbar is curved to the left (as viewed in FIG. 13) and terminates inside the rear end of a horizontal sensor bar 264 disposed ahead of and parallel to that portion of the cleaner skirt disposed along the front crosspiece of

the conduit. A small diameter front wheel 266 is mounted at the forward end of the sensor bar to rotate about a vertical axis 268. A small diameter rear wheel 270 is mounted at the rear end of a sensor bar to rotate about a vertical axis 272. The small wheels on the sensor bar are each of a diameter slightly greater than that of the bar and project forward of the bar to provide low rolling friction if the cleaner should encounter an obstacle of substantial length extending transverse to the normal direction of travel of the cleaner. The bar can be of any suitable material, but preferably it is nylon and contains a weight (not shown) to cause it to sink in the water.

The sensor bar is supported from the cleaner by a pair of longitudinally spaced rearwardly extending parallel rocker arms 274, each secured at their forward ends to intermediate portions of the sensor bar. Each arm carries a laterally extending stop 276 (FIG. 14) which receives the respective end of a pivot shaft 278. Each lateral stop is secured to its respective end of the pivot shaft by a retainer nut 279. The pivot shaft is supported by brackets 280 secured to the skirt. When the cleaner is in its operating position (i.e., inverted from that shown in FIG. 14), gravity causes the sensor bar to move downwardly until the stops 276 rest against the distal portions 282 of the brackets 280. In this position, the elevation of the sensor bar is slightly above that of the pivot shaft so that when an obstruction (not shown) is encountered, the sensor bar is lifted to the position shown in FIG. 14.

A crossbar 284 is secured to the support arms 274 on the side of the pivot bar opposite from the sensor bar. A first universal joint 286 is secured by a crank throw arm 287 to the middle of the crossbar 284. The first universal joint is located below the crossbar 284 so that the universal joint is moved inwardly with respect to the rhomboidal conduit when the sensor bar is lifted by engaging an obstacle. The forward end of a push rod 288 is secured to the first universal joint, and the rear end of the push rod is secured to a second universal joint 289 connected to one end of a crank 290 mounted to rotate about a vertical shaft 292 secured to a front lateral thrust jet 294 connected to receive water under pressure from the left side of the conduit, and discharge a horizontal stream of water perpendicular to the sides of the conduit. The end of the crank remote from the second universal joint carries a vertical shield 296 which is moved from the phantom line position 297 shown in FIG. 13 to the phantom line position 298 when the sensor bar is raised by the cleaner engaging an obstacle. When there is no obstacle, the sensor bar is in its lower or normal position so that the shield 296 is in the phantom line position indicated by the number 297 in FIG. 13 so that the forward lateral jet is unobstructed.

A rear lateral thrust jet 300 is mounted on the rear end of the rear crosspiece of the conduit and connected to the conduit interior to direct a horizontal stream a few degrees to the rear of a line perpendicular to the sides of the conduit so that although the major portion of the thrust from the rear lateral jet urges the rear end of the cleaner toward the side of the pool, the rear jet provides a continuous slight forward thrust to the cleaner.

The forward lateral thrust jet is substantially perpendicular to the fenderbar so that virtually all of its thrust is directed to urging the forward end of the cleaner

against the side of the pool. As the shield 296 is moved from its rearward to its forward position to cover the forward lateral thrust jet, an inclined surface is presented to the jetstream from the forward lateral thrust jet so that water is deflected in a forward direction from the left side of the cleaner. Thus, the cleaner tends to rotate in a counterclockwise direction, (as viewed in FIG. 13) as the shield is moved forward when the sensor bar is lifted by encountering an obstacle. This causes the front end of the cleaner to veer away from the side of the pool and around the obstacle until the sensor bar is clear. At that time, the sensor bar moves back down to its normal position so that the forward lateral thrust just is again open and so that the cleaner is then moved laterally back against the side of the pool as shown in FIG. 13.

Water is supplied to a wall cleaning hose 302 secured to an outlet 304 at the rear end of the right side of the conduit. The flow of water to the wall cleaning hose is controlled by a valve 306 in the outlet 304.

The side of the pool is sprayed continuously by a jet of water from a tile cleaning jet 308 connected to the rear end of the right side of the conduit. This tile cleaning jet can furnish power for an attachment (not shown) which continuously supplies acid to tile scrubbing brushes (not shown) which engage the side of the pool and keep the tile clean.

In operating the cleaner shown in FIGS. 13, 14 and 15, it is placed to float in the pool in the position inverted from that shown in FIG. 14, i.e., with the top 184 horizontal and in the uppermost position. When viewed from above, the cleaner moves around the pool in a clockwise direction. The water supply hose shown in FIG. 1 is connected to the inlet for the conduit of the cleaner of FIGS. 13 and 14, and water is supplied under pressure to the cleaner. Water flows continually out of the turbine drive jet so that the main forward drive jet of the cleaner is intermittently opened and closed. The drive jet is open about 15 seconds, and then closed about 45 seconds. Ordinarily, the sensor bar hangs down in its normal position so that the forward lateral thrust jet is open, as is the rear lateral thrust jet. Thus, the cleaner is urged against the side of the pool, and moved around intermittently as the main drive jet opens and closes. The forward and rear wheels on the side of the cleaner engage the side wall of the pool to minimize frictional drag and decreases the amount of water power required to move the cleaner, thereby making available more water power for the hoses which clean the pool. The relatively slow and intermittent movement of the cleaner around the pool minimizes trailing of the central cleaning hoses connected to the supply line so the central portion of the pool is cleaned more effectively.

In normal operation, the hinged sensor bar is down, and the forward lateral thrust jet is not covered by the jet shield. When an obstacle is engaged, the sensor bar is raised, and the crank carrying the shield is pivoted in a clockwise direction (as viewed in FIG. 13) so that the shield moves from the rearwardly and inwardly inclined position shown in dotted line marked 297 in FIG. 13 to the phantom line position marked 298 where the vertical shield is then perpendicular to the stream of water emerging from the jet and thus effectively blocks its urging of the forward end of the cleaner toward the side of the pool. As the shield moves forward from the "jet open" to the "jet closed" position, it is momentarily in-

clined at an angle in front of the jet stream so that water is deflected by the shield in a forward direction, tending to force the left (as viewed in FIG. 13) side of the cleaner to the rear. Since the rear lateral thrust jet is on continuously, this produces a counterclockwise (as viewed in FIG. 13) torque, which tends to move the forward end of the cleaner away from the side of the pool. In addition, the supply hose is subjected to tugging and pulling induced by intermediate hoses 156 secured to the supply hose. With both lateral thrust jets in their normal operating position, the cleaner is held against the side of the pool, even in the presence of the force supplied through the cleaner to the supply hose. When the forward jet is closed, the counterclockwise torque previously described tends to move the forward end of the cleaner away from the pool, and the forward end of the cleaner is no longer held against the side of the pool so that force applied through the supply hose is also effective in moving the cleaner away. In addition, there is some resilience in the mounting of the forward and rear wheels which contact the side of the pool so that when the force of the lateral thrust jet is removed, the forward end of the cleaner is urged by the stored energy in the resilient mounting of the forward wheel to move away from the side of the pool.

Another force which tends to move the forward end of the cleaner away from the sides of the pool is the forwardly and outwardly inclined surface of the cleaner skirt at the forward end of the cleaner. As the cleaner moves forward through the water, the force on the forwardly and outwardly inclined portion of the skirt tends to push the forward end of the cleaner away from the side of the pool. This force is more than overcome by the force from the forward lateral thrust jet as long as it is uncovered by the shield. As soon as the sensor bar engages an obstacle, and starts to rise, the shield begins to close the forward jet. As previously described, the initial movement of the shield toward the closed position for the forward jet imparts a rearward thrust along the outboard side of the cleaner. At the same time, as the cleaner continues to move forward to complete the lifting of the sensor bar due to engagement with the obstacle, the force of the water against the forwardly and outwardly inclined surface of the cleaner skirt moves the forward end of the cleaner away from the pool wall.

The turning of the forward end of the pool cleaner away from the side of the pool can be done even more effectively where required by using a U-shaped vertical shield 312 (FIG. 16) secured to a crank 314 substituted for the crank 290 shown in FIGS. 13 and 14. When the crank is rotated to move the U-shaped shield in front of the forward lateral thrust jet, the water stream from the jet enters the rear side of the U, and is deflected about 180° to flow out of the forward side of the U in a direction opposite to that from which water normally flows out of the forward lateral thrust jet when it is open. This creates a force at the forward lateral thrust jet acting away from the side of the pool, and quickly turns the cleaner to clear the obstacle.

FIGS. 17 and 18 show an alternate arrangement for minimizing friction where the cleaner engages the side of the pool. The fenderbar of FIGS. 13 and 14 is replaced by an array 320 of stacked wheels 322. Downwardly extending brackets 324 are secured at their upper ends to the lower edge of the skirt 182. A first horizontal shelf 326 is secured to the lower end of the brackets, and a first set of wheels 322 is mounted to ro-

tate about vertical shafts 328 secured at their upper ends to the first shelf 326 and at their lower ends to a second shelf 330. The first set of wheels is arranged so their peripheries almost touch and so their outer portions project horizontally just beyond the outer edge of the first and second shelves. A second set of wheels 322 is mounted below the first set to rotate about vertical shafts 332 secured at their upper ends to the second horizontal shelf and at their lower ends to a third horizontal shelf 334. The shafts for the wheels in the second set are spaced equally between adjacent shafts for the wheels in the first set so that the outer portion of the wheels in the second set project beyond the outer edge of the horizontal shelves to provide an almost continuous roller surface as shown in FIG. 17. A third wheel 322 is mounted on a shaft 336 secured at its upper end to the third horizontal shelf and at its lower end to an upwardly opening U-shaped bracket secured to the underside of the third shelf. The third wheel on shaft 336 is provided only at the forward end of the side of the pool cleaner which rolls against the side of the swimming pool, since this portion of the cleaner ordinarily is subject to the most wear. The wheels in the first, second and third set are so closely spaced that no obstructions normally encountered in a swimming pool can hang up between them or provide enough friction to prevent the cleaner from moving along the side of the pool.

In summary, the improved pool cleaner of this invention provides more efficient automatic cleaning of any and all sizes and shapes of pools at a minimum cost. The traveling conduit is unique because it rides over rather than around steps or seats which are more than about three inches below the surface of the water. Moreover, it navigates around inwardly projecting structures, such as ladders, without external aids such as ramps. For pools with right angle or near right angle corners, the self-freeing device prevents permanent hang-up. Although the traveling conduit can be moved continuously, its intermittent motion is advantageous because of the improved cleaning efficiency described above. The simple rotary adjustment of the jets adapts the traveling conduit to pools with various shapes and sizes.

The use of the three separate cleaning hoses spaced along the supply hose also improve the efficiency of the cleaner. The wall cleaning hose undulates up and down the side wall to knock off solid matter, which gravitates to the pool floor and is picked up and moved by the floor cleaning hoses to the drain. The intermediate cleaning hoses operate in an area including the bottom part of the wall, the peripheral part of the pool floor, and the central part of the pool floor. Solid matter brought to this area by the wall cleaning hose, or settling in this area, is moved toward the pool drain.

The central area of the pool floor is the hardest to clean. If there are only two cleaning hoses, e.g., one wall hose and one floor hose, the floor cleaning hose should not be so long that it will regularly override the pool outlet and thus sweep solid matter away from the drain. Pools having a broad shallow end show accumulation of solid matter in the central portion. The use of the innermost floor intermediate cleaning hose solves the problem simply, effectively, and relatively inexpensively.

The flexible submerged supply hose has the advantage of being out of the way, easier to handle and store.

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However, it is less durable and costs more. The rigid supply conduit (FIG. 3) costs less, is more durable, and can serve as a frame for storing the rest of the cleaner.

I claim:

1. Apparatus for cleaning sediment from a pool of liquid, the apparatus comprising:
 - an elongated conduit;
 - a front wheel secured to the conduit;
 - a rear wheel spaced from the front wheel and secured to the conduit;
 - buoyant means supporting the wheels in the vicinity of the surface of the liquid;
 - means for supplying liquid to the conduit;
 - lateral jet means associated with the conduit and arranged to move the conduit laterally and carry the wheels into contact with a wall of the pool;
 - intermittent jet means associated with the conduit and arranged to move it longitudinally along the side of the pool;
 - means for opening and closing the intermittent jet means to cause the conduit to move along the wall in a stop-and-go pattern;
 - a downwardly extending flexible hose secured to the conduit for stirring up sediment in the pool; and
 - means for removing liquid from stirred-up sediment from the pool.
2. A cleaner according to claim 1 in which the wheels are mounted to be rotatable about an upright axis and are free-wheeling.
3. A pool cleaner according to claim 1 in which the radius of at least one of the wheels is at least 10 inches.
4. A cleaner according to claim 1 in which the jet means are disposed in L-shaped fittings secured to the conduit and rotatable about a substantially upright axis to facilitate adjustment of the jets.
5. A cleaner according to claim 1 which includes a downwardly extending flexible cleaning hose secured at its upper end to the conduit to be adjacent a wall of the pool when the wheels are in contact with the wall.
6. A pool cleaner according to claim 1 in which a fenderbar is mounted on the conduit and extends from adjacent where the front wheel contacts the pool wall to adjacent where the rear wheel contacts the pool wall.
7. Apparatus according to claim 6 in which the fenderbar is spaced from the wall when the two wheels are in contact with the wall.
8. A cleaner according to claim 1 in which the elongated conduit includes a forward section which is substantially parallel to the pool wall when the front and rear wheels are in contact with the wall, and which includes a rear section which extends from the forward section toward the wall contacted by the front and rear wheels.
9. Apparatus for cleaning sediment from a pool of liquid, the apparatus comprising:
 - a conduit;
 - buoyant means supporting the conduit in the pool;
 - means for supplying liquid under pressure to the conduit;
 - first jet means mounted on the conduit to receive liquid under pressure and discharge liquid in a direction to impart a horizontal force to the conduit whereby the conduit is urged toward a side of the pool;
 - second jet means mounted on the conduit to receive liquid under pressure and discharge liquid to im-

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part a horizontal force to the conduit in a direction transverse to that imparted by the first jet means whereby the conduit is urged to move substantially parallel to the side of the pool;

means for intermittently activating and deactivating the second jet means to cause the conduit to move along the said side of the pool in a stop-and-go pattern;

a flexible hose connected to the conduit and arranged to discharge liquid into the pool to stir up sediment; and

means for removing liquid with stirred-up sediment from the pool.

10. Apparatus according to claim 9 which includes means for turning the second jet means off for a longer period of time than it is turned on.

11. Apparatus according to claim 9 which includes a rotary valve for controlling the second jet means, and a turbine powered by water supplied to the conduit for turning the rotary valve on and off.

12. Apparatus according to claim 9 which includes a tile-cleaning jet mounted on the conduit and aimed to direct a substantially continuous stream of water against the side of the pool.

13. Apparatus according to claim 9 in which the first jet means includes a pair of jets mounted on the conduit on opposite sides of the means for supplying liquid under pressure to the conduit.

14. Apparatus according to claim 9 which includes a fenderbar carried by the conduit to make sliding contact against objects along the side of the pool toward which the conduit is urged by first jet means.

15. Apparatus according to claim 14 which includes rollers mounted on the fenderbar to engage the side of the pool.

16. Apparatus according to claim 15 which includes a first set of rollers, each roller in the first set being mounted to rotate about a substantially upright axis and being located at approximately the same level, and a second set of rollers disposed below the first set, each roller in the second set being mounted to rotate about a respective upright axis, the axis of rotation of each roller in the lower set being disposed between adjacent axes of rotation of rollers in the first set.

17. Apparatus according to claim 17 which the first jet means includes a forward jet and a rear jet mounted on the conduit, means for sensing an obstruction to forward travel of the conduit, and means responsive to the sensing means for deactivating the forward jet of the first jet means when an obstruction is encountered.

18. Apparatus according to claim 17 which includes means for reactivating the forward jet of the first jet means when the obstruction is cleared.

19. Apparatus according to claim 18 in which the sensing means is a sensor bar mounted at the forward end of the conduit to be movable upwardly when an obstruction is encountered, and movable downwardly when an obstruction is cleared, a crank mounted on the conduit, a shield secured to the crank adjacent the forward jet of the first jet means, and means connecting the movable sensor bar to the crank so that the shield is carried by the crank into the path of liquid discharged from the forward jet of the first jet means when the sensor bar is moved by encountering an obstacle in the path of travel of the cleaner.

20. Apparatus for cleaning sediment from a pool of liquid, the apparatus comprising:

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an elongated conduit;

buoyant means supporting the conduit in the pool;
means for supplying liquid under pressure to the conduit;

intermittent means for moving the conduit longitudinally;

means for opening and closing the intermittent jet
means to cause the conduit to move along the wall in a stop-and-go pattern;

a front jet mounted on the conduit to discharge liquid in a substantially horizontal direction transverse to the longitudinal axis of the conduit to urge the front portion of the conduit toward a side of the pool;

a rear jet mounted on the conduit to discharge liquid in a substantially horizontal direction transverse to the longitudinal axis of the conduit to urge the rear portion of the conduit toward the side of the pool;
means responsive to an obstacle in the pool encountered as the conduit moves forward for reducing the force with which the front jet urges the front portion of the conduit toward the side of the pool;

a flexible hose connected to the conduit and arranged to discharge liquid into the pool to stir up sediment; and

means for removing liquid with stirred-up sediment from the pool.

21. Apparatus according to claim 20 which includes a movable shield mounted adjacent the front jet, and

means connecting the obstacle responsive means to the shield so the shield is moved to cover the front jet when an obstacle is encountered in the pool as the conduit moves forward.

22. Apparatus according to claim 21 in which the shield is inclined to deflect liquid discharged from the front jet in a forward direction as the shield is moved to cover the front jet.

23. Apparatus according to claim 20 in which the rear and forward jets are laterally spaced with respect to the direction in which the conduit normally travels, and which includes means for changing the direction of water discharged from the front jet responsive to the cleaner encountering an obstacle to impart torque to the conduit to cause the front end of the conduit to move away from the side of the pool.

24. Apparatus according to claim 20 in which the rear jet is directed rearwardly of a plane perpendicular to the direction normally traveled by the conduit and passing through the rear jet.

25. Apparatus according to claim 20 which includes a movable shield having a concave surface, and means responsive to the cleaner contacting an obstacle in the pool for moving the shield in the path of liquid discharged from the front jet so that the concave surface of the shield changes the direction of liquid discharged from the jet by about 180°.

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