Jan. 18, 1966 B. H. WATSON 3,229,315

POOL-CLEANING DEVICE

Filed Dec. 5, 1963 3 Sheets-Sheet 1

Fig. 1.

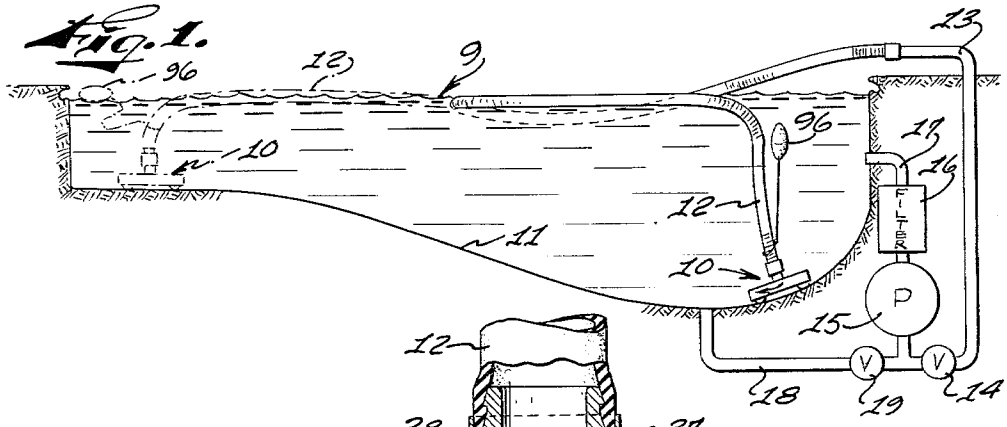


Fig. 3.

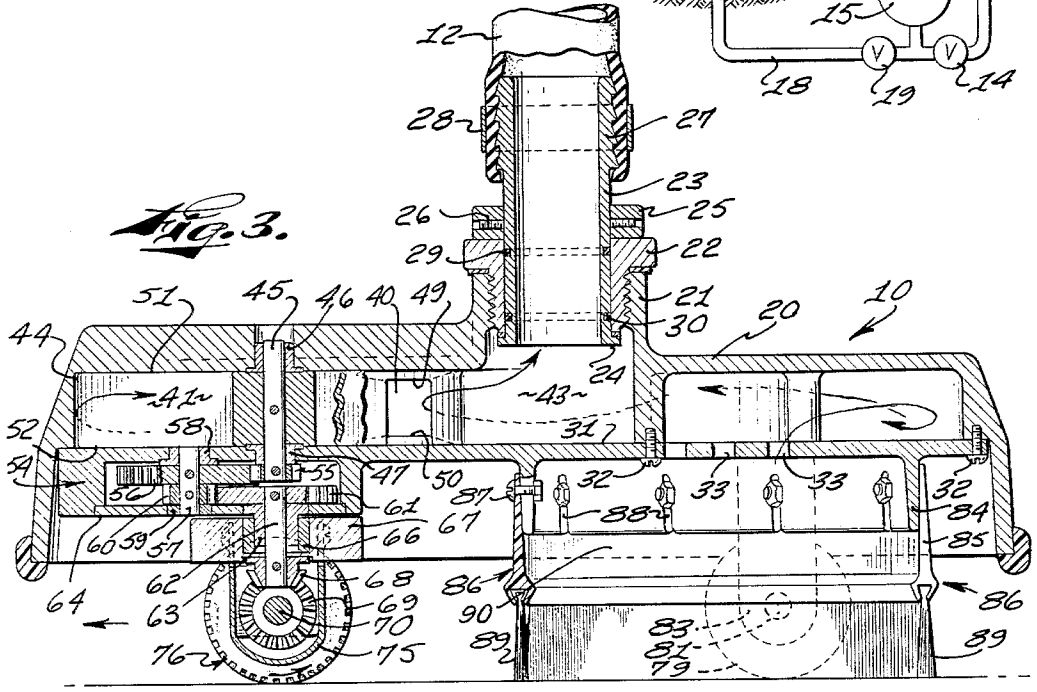


Fig. 5.

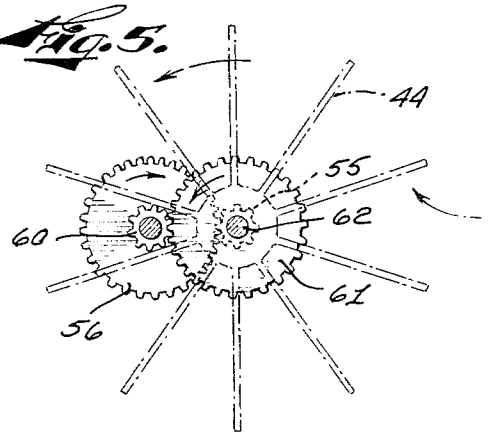
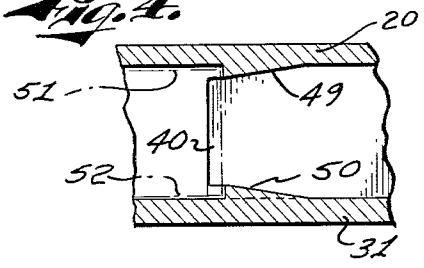


Fig. 4.



INVENTOR.
BENJAMIN H. WATSON
BY
GAUSEWITZ & CARR
ATTORNEYS

Jan. 18, 1966 B. H. WATSON 3,229,315

POOL-CLEANING DEVICE

Filed Dec. 5, 1963 3 Sheets-Sheet 2

Fig. 2.

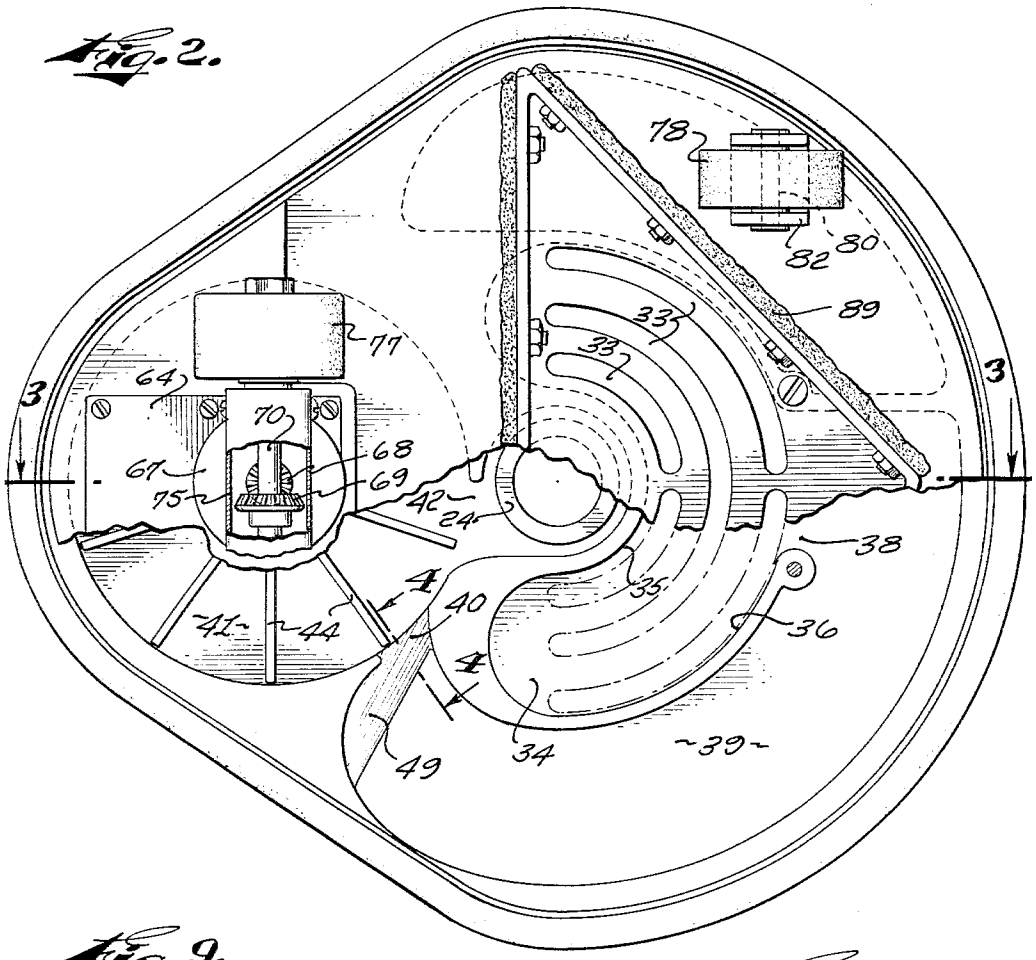


Fig. 9.

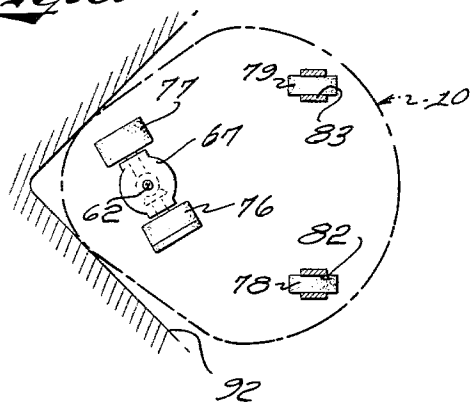
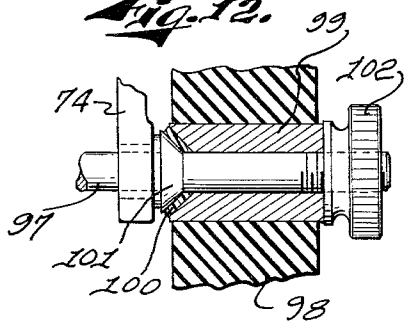


Fig. 12.



INVENTOR.
BENJAMIN H. WATSON
BY
GAUSEWITZ & CARR
ATTORNEYS

Jan. 18, 1966 B. H. WATSON 3,229,315

POOL-CLEANING DEVICE

Filed Dec. 5, 1963 3 Sheets-Sheet 3

Fig. 11.

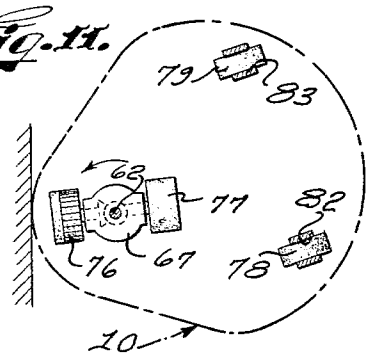


Fig. 10.

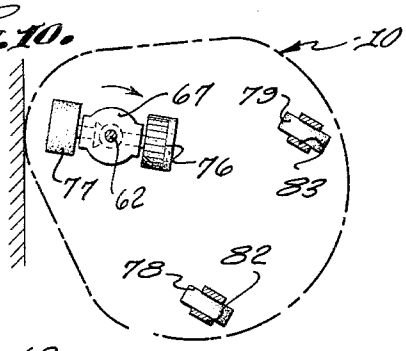


Fig. 6.

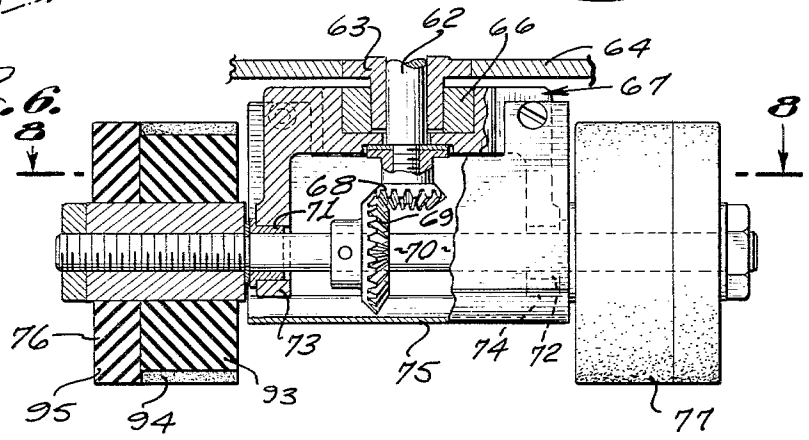


Fig. 8.

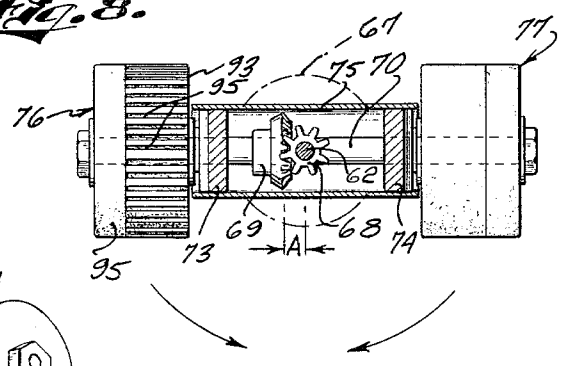
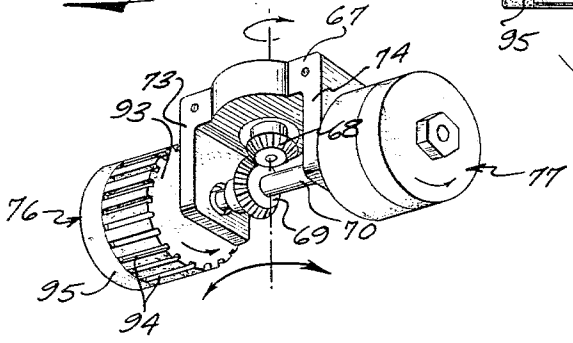


Fig. 7.



INVENTOR.
BENJAMIN H. WATSON
BY
GAUSEWITZ & CARR
ATTORNEYS

United States Patent Office 3,229,315 Patented Jan. 18, 1966

3,229,315

POOL-CLEANING DEVICE

Benjamin H. Watson, Newport Beach, Calif., assignor to Swimline, Inc., Santa Ana, Calif., a corporation of California

Filed Dec. 5, 1963, Ser. No. 328,374
15 Claims. (Cl. 15—1.7)

This invention pertains to an arrangement for automatically cleaning the floor of a swimming pool or the like.

Swimming pool cleaning has long been a laborious hand operation. It has been necessary to manually manipulate the vacuum head by means of a long pole extended down into the swimming pool. In order to keep a swimming pool in a clean and sanitary condition, it has been necessary to vacuum with frequency. Heretofore, automatic vacuuming arrangements have been almost unknown on the commercial market. One type of device available does nothing more than agitate the water sufficiently to place the dirt in suspension in the hope that it will be drawn through the intake to the pool filter. With this system, therefore, the dirt is not removed from the bottom, where it naturally settles, but instead is found dispersed throughout the water, where it can be irritating and harmful to the swimmer. Moreover, these cleaning systems have been quite expensive and require special installation. Other prior devices have required relatively complex switching arrangements to reverse the movement of the cleaning device on the pool floor, and have required precise directional setting while being inoperative in pools of irregular contour.

The present invention provides a truly automatic pool-cleaning device, giving positive results by drawing the dirt directly from the pool bottom. It includes a housing supported on four wheels, two of which are power-driven and mounted on a pivotal yoke. There is an off-center drive to the yoke so that the yoke will pivot when an obstruction is encountered. Moreover, the drive wheels are unbalanced insofar as their frictional characteristics are concerned in engaging the bottom of the pool. This is to give the yoke the ability to pivot in either direction, which permits the device to move about the pool bottom in a random pattern without ever becoming blocked and prevented from further movement. Consequently, it gradually covers the entire bottom pool surface, removing the dirt from it regardless of the shape of the pool. The housing is connected through a hose to the pump inlet so that water, and hence the dirt, is drawn directly from the pool bottom surface. The water is conducted through a small hydraulic motor in the housing where it rotates an impeller that serves as the power source for turning the wheels of the unit.

An object of this invention is to provide an improved automatic pool-cleaning device.

Another object of this invention is to provide a pool-cleaning device of economical construction and which is reliable in its performance.

A further object of this invention is to provide a pool-cleaning device that draws dirt directly from the bottom surface.

An additional object of this invention is to provide a pool-cleaning device that will cover all areas of a pool floor without attention.

Yet another object of this invention is to provide an automatic pool-cleaning device of universal applicability that requires no special installation and will operate in pools of any configuration.

A still further object of this invention is to provide an automatic pool-cleaning device capable of random movement about the floor of a swimming pool to cover the entire floor surface over a period of time.

These and other objects will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

FIGURE 1 is a side elevational view, partially schematic and partially in section, showing the operation of the invention in cleaning a swimming pool;

FIGURE 2 is a bottom plan view, partially broken away, of the cleaning unit;

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged fragmentary sectional view of the entrance to the impeller chamber, taken along line 4—4 of FIGURE 2;

FIGURE 5 is a plan view of the gear train operated by the impeller;

FIGURE 6 is an enlarged transverse sectional view of the drive wheel arrangement;

FIGURE 7 is a perspective view of the drive wheel arrangement;

FIGURE 8 is a sectional view taken along line 8—8 of FIGURE 6;

FIGURE 9 is a schematic view illustrating the turning effect when an obstruction is met head on;

FIGURES 10 and 11 are schematic views, similar to FIGURE 9, showing the effect upon encountering an obstruction on the left and right sides, respectively; and

FIGURE 12 is an enlarged fragmentary sectional view of a modified arrangement for providing for the slipping of one of the drive wheels.

With reference to the drawing, FIGURE 1 illustrates the operation of the present invention in a swimming pool **9**. The device includes a unit **10** adapted to rest on the bottom **11** of the swimming pool. A flexible hose **12** extends from the upper end of the unit **10** and connects to hydraulic line **13**. This line extends through valve **14** to the pump **15** of the pool's filtration system, which discharges into a filter **16** and through outlet line **17** back into the pool. The pump includes an additional inlet line **18** from the pool bottom which is controlled by a valve **19** or other shut-off means. Normally, the valve **19** is closed during operation of the device of this invention, while valve **14** is left open. The hydraulic circuit of the lines **13** and **18**, together with the pump and filter arrangement, is conventional in swimming pool construction.

The unit **10** includes a relatively heavy dome-like casting **20** having an upwardly extending neck **21** at its central portion, as may be seen in FIGURE 3. A fitting **22** is threaded into the neck **21** and is provided with a smooth cylindrical interior that receives a short tubular member **23**. The latter element has a flanged lower end **24** that extends beneath the bottom edge of the fitting **22** and prevents upward movement of the tube **23** relative to the fitting **22**. A collar **25** is fitted over the tube **23** and engages the upper end of the fitting **22**. Set screws **26** lock the collar **25** to the tube **23**. This retains the tube **23** on the fitting **22**, and hence the casting **20**, while permitting the tube **23** to rotate about its axis. The upper end of the tube **23** includes serrations **27** that engage the interior of the bottom end of the flexible hose **12**. A clamp **28** is included around the bottom end of the hose **12**, where it engages the tube **23**, thereby firmly securing the hose to the member **23**. A pair of O-ring seals **29** and **30** circumscribe the tube **23** within the fitting **22** to preclude leakage around the exterior of the tube **23**.

A plate **31** is fastened by screws **32** to the under portion of the casting **20**. Plate **31** includes a plurality of arcuate slots **33** that lead into a curved chamber **34** defined by vertical walls **35** and **36** as well as the plate **31** and the upper horizontal wall of the casting. An outlet **38** is provided in the wall **36**, leading to a passageway **39**. Outlet **40** from the passageway **39** empties into a circular

chamber 41 which discharges, in turn, through opening 42 to the space 43 beneath the tube 23 and the flexible hose 12.

It can be seen, therefore, that open communication is provided from beneath the unit 10 upwardly through the arcuate slots 33 to the chamber 34 and thence to the curved passageway 39, the chamber 41 and the flexible hose 12. Hence, there is a continuous passageway to the line 13, the pump 15 and the pool filter 16.

Within the chamber 41 is an impeller 44 connected to a vertical shaft 45, the ends of which are received in bearings 46 and 47 in the casting 20 and the bottom plate 31. Thus, the water passing through the chamber 41 strikes the vanes of the impeller 44, causing the impeller to rotate about the axis of shaft 45. The use of elongated slots 33 at the inlet to the chamber 34, where the water is drawn into the unit 10, screens out larger objects so that they do not enter the impeller chamber 41 to clog the impeller or damage it.

The exit 40 from the passageway 39 leading to the chamber 41 is contracted in width, as illustrated in FIGURE 2, causing the water to flow rapidly in the region of the impeller 44. This, in turn, assists in assuring that the impeller 44 is given rapid rotation.

As may be seen in the fragmentary sectional view of FIGURE 4, the exit 40 likewise is contracted in thickness. This is accomplished by providing inclined wall sections 49 and 50 on the casting 20 and the plate 31 at the location of outlet 40. This directs the water to the central area of the impeller vanes, rather than toward the radial edges 51 and 52 of the impeller. Consequently, the dirt entrained with the water passing through the chamber 41 will tend to remain at the axial mid portion of each of the impeller vanes, and the particular matter will not enter the narrow spaces between the radial edges 51 and 52 of the impeller and the top and bottom walls of the chamber 41. Hence, the dirt in the water passing through the chamber 41 will not clog the impeller, but instead will pass on through to the flexible hose 12.

The bottom end of the impeller shaft 45 enters a gear box 54 where it carries a pinion 55. Meshing with pinion 55 is a larger gear 56 which is mounted on short shaft 57. This shaft is parallel to the shaft 45 and received at its ends in bearings 58 and 59. Also connected to the shaft 57 is a smaller drive gear 60 that meshes with a larger gear 61. The latter gear is connected to a shaft 62 that is axially aligned with the shaft 45 and extends downwardly into a bearing 63 carried by the bottom plate 64 of the gear box 54.

Thus, as the impeller turns, it operates the gear train 55, 56, 60 and 61, providing a slower rotation of the output shaft 62. Typically, there will be an 8 to 1 reduction through the gear box 54.

The bearing 63, which is connected to the plate 64 of the gear box and hence is fixed, extends into a bearing 66 carried at the upper center of a yoke 67. This supports the yoke for rotation about the vertlical axis of the shaft 62.

The bottom end of the shaft 62 carries a bevel gear 68, which meshes with a second bevel gear 69. The latter is carried by and drives horizontal axle shaft 70 that extends through bearings 71 and 72 in spaced parallel end sections 73 and 74 of the yoke 67. Wheels 76 and 77 are carried on the ends of the axle shaft 70 outwardly of the sections 73 and 74 of the yoke. The bevel gears are protected by a light sheet metal housing 75 fastened by screws to the yoke 67.

By this construction, therefore, water drawn through the chamber 41 to rotate the impeller before leaving the unit 10 through the flexible hose 12 causes the gear train within the gear housing 54 to rotate shaft 62 that, through the bevel gears 68 and 69, turns the axle shaft 70 and, hence, rotates the wheels 76 and 77.

While one end of the unit 10 is supported upon the wheels 76 and 77, which are power-driven as described above, the opposite end is carried by idler wheels 78 and 79. These wheels are more widely spaced than the wheels 76 and 77 and are mounted on shafts 80 and 81 on U-shaped supports 82 and 83 fastened to the plate 31.

Consequently, the unit 10 is mobile, being advanced as the water drives the impeller. As the unit 10 moves along the floor 11 of the pool, dirt is drawn upwardly through the housing along with the water which is taken in from the area adjacent the pool floor surface. Preferably, there is a depending flange 84 on the bottom plate 31, to which are secured the rigid support portions 85 of brushes 86. The attachment is made by bolts 87 that extend through slots 88 so that the brushes are vertically adjustable to position the ends of the bristles 89 in engagement with the floor 11 of the pool. The flange 84 and the rigid sections 85 of the brushes 86 define an open-bottomed chamber 90 of triangular shape beneath and around the location of the inlet slots 33. Hence, as the unit moves, the bristles 89 stir up the dirt from the pool floor, permitting it to be drawn inwardly through the confined chamber 90 beneath the slots 33 and thence upwardly through the slots in the housing to the flexible hose 12. The hose, in turn, conducts the dirt-laden water through the line 13 and the pump 15, where it then is discharged and caught in the filter 16. Therefore, movement of the unit 10 vacuums the pool floor 11, removing dirt directly from wherever the unit 10 travels.

The torque from the impeller 44 transmitted to the shaft 70 will drive the wheels 76 and 77 to move the unit 10 toward the left, as viewed in FIGURES 2 and 3. This movement will progress until the unit meets with an obstruction. This might be, for example, the steep slope at a substantially vertical pool wall, steps in the shallow end of the pool, or the like. When an obstruction is met, the device automatically will change directions and continue on. This arises from the type of drive employed by which the bevel gear 69 that turns the shaft 70 is off center from the axis of the power shaft 62. Therefore, if the unit should meet a head-on obstruction 92, as shown schematically in FIGURE 9, obviously it cannot continue to move ahead. However, there is present a lever arm A defined by the distance between the axis of the shaft 62 and the pitch line of the bevel gear 69. When the unit 10 cannot move ahead, the driving force from the gear 68 nevertheless will continue to urge the unit forwardly. Since this forward movement cannot occur, the yoke then will pivot in a counterclockwise direction, as viewed from above, resulting from the torque as applied through the lever arm A. This will cause the wheel 76 on the side of the bevel gear 69, and hence on the side of the lever arm A, to rotate in its normal direction with the yoke as the yoke turns in this counterclockwise direction, as seen from above. The other wheel 77 will be forced to slip as this rotation of the yoke takes place. The yoke will turn around until completely reversed, at which time continued rotation will cause the unit to back up and move along in a reverse direction until again an obstruction is hit, causing the yoke to pivot a second time.

From the above discussion it can be seen that the wheel 76 will have a tendency to control and to cause the yoke to move rotationally counterclockwise in response to the torque input through the shaft 62. In order to counteract this tendency to a degree, the wheel 77 is made to have a greater coefficient of friction with respect to the pool floor 11 than does the wheel 76. Accordingly, the wheel 77 is made of a smooth surfaced disc of synthetic rubber of 80 Shore hardness. The wheel 76, on the other hand, constitutes for two-thirds of its width a disc 93 of synthetic rubber of 40 Shore hardness. In addition, axially extending grooves 94 are formed in the circumference of the wheel section 93. The remaining one-third of the width of the wheel 76 is of a thinner disc 95 of the 80 Shore hardness synthetic rubber.

While it may appear anomalous upon initial consideration, experiments have established that the smooth sur-

faced harder wheel will grip the pool bottom better than the softer wheel with the thread formed in its surface. Consequently, while the wheel **76** has the ability to rotate the yoke counterclockwise, it has more tendency to slip on the bottom of the pool than does the wheel **77**. This permits the yoke to be pivoted in either direction, depending upon which side an obstruction is met. The coefficients of friction of the wheels are balanced with respect to the torque arm A so that upon encountering a head-on obstruction, as shown in FIGURE 9, the wheel **76** causes the counterclockwise pivoting of the yoke. On the other hand, when an obstruction is encountered on the side of the unit **10** of the wheel **77**, such as shown in FIGURE 10, the yoke will then rotate clockwise instead of counterclockwise, as before. When the clockwise rotation is accomplished, it is a result of the greater coefficient of friction of the wheel **77** overcoming the effect of the lever arm A and the rotational wheel turning force governing over the tendency to pivot counterclockwise about the axis of rotation of the yoke, When wheel **77** moves the yoke clockwise, the wheel **76** will be caused to skid as it is moved backwardly by the yoke rotation. When the impediment is on the side of wheel **76**, the yoke moves counterclockwise, as indicated in FIGURE 11.

This construction allows the device to operate satisfactorily in a pool of any size or shape, moving about the surface of the pool floor, never becoming blocked or prevented from further advancement. It will move around the pool bottom, following a random pattern until it has covered all portions of the floor of the pool in the course of its travels. The tube **23** rotates freely in fitting **22** as the unit **10** changes direction so that the hose **12** offers no interference to the random travel of the unit. After a few hours of operation, such as normally constitute the operating cycle of the filter, all floor surface of the pool will have been covered.

Without the unequal driving force of the two wheels **76** and **77**, this could not occur. It is necessary for the wheel remote from the lever arm A to exert a greater driving force than does the wheel adjacent the bevel gear **69**, which is accomplished by the difference in frictional characteristics of the wheel surfaces. If this is not done, the yoke will pivot only in the counterclockwise direction, and in that event the unit ultimately will be unable to turn away from an obstruction encountered at an angle which would require pivoting of the yoke in the clockwise direction. Should that occur, the unit would be rendered immobile.

The unit of this invention possesses considerable power by virtue of its gear reduction and can climb up slopes up to 30° inclination. Hence, it will travel over all areas where the dirt tends to accumulate.

In operation of the device, normally it is placed initially in the shallow end of the pool, as shown in phantom in FIGURE 1. A float **96** is secured to the vacuum hose **12**, positioned approximately three feet from the unit **10**. This height will be made such that at the shallow end of the pool the float exerts no upward force. It has been found that the unit operates best in the relatively level shallow part of the pool if this is the case. However, when the unit is moving across a substantial incline as found in the deeper end of the pool, the float **96** assists in maintaining the unit **10** on an even keel. In view of the wide spacing of the rear wheels **78** and **79**, as compared with that of the front wheels, there is a slight tendency of the unit **10** to tip when it is moving crosswise on a steep slope. The float pulling upwardly at the center of the unit counteracts this tendency and maintains the unit firmly implanted on its wheel support. Also, when the device is traveling up an incline, the float holds the hose in a generally vertical position so that it does not drag downwardly and to the rear on the unit. This assists in enabling the device to climb the slope.

Alternative to the variation in frictional characteristics of the wheel treads, the imbalance in driving force may be accomplished in some other means, such as by the use of a slipping clutch. This would permit the driving wheels to be interchangeable, each having the same hardness and circumferential surface.

One means of accomplishing this is shown in FIGURE 12, where axle shaft **97** fits through the leg **74** of the yoke and extends through the axis of wheel **98**. A sleeve **99** circumscribes the axle at the wheel. One end of the sleeve includes a frustoconical recess within which fits a complementary disc **100** of neoprene or other suitable material. A frustoconical enlargement **101** on the axle **97** engages the disc **100**. The outer end of the axle is threaded and received by a nut **102**. When the nut **102** is tightened, it forces the axle section **101** against the disc **100**. It is through this area that the drive torque is imparted to the wheel. The wheel can be made to slip a desired amount, depending on how much the nut **102** is tightened. Consequently, the wheel **98** can be made to slip at some predetermined torque load which overcomes the force which can be transmitted through the friction disc **100**. Therefore, instead of the slipping effect being realized at the periphery of the wheel, as in the previously described arrangement, the same result is accomplished by providing for slippage between the axle and the wheel. While this design has the advantage of permitting interchangeability of the wheels and avoiding any accelerated wearing of the slipping wheel, the adjustment of the clutch force is critical and must be carefully made. Hence, it is not quite as simple for the user of the device to be certain that the wheel slipping arrangement is in proper adjustment as with the design where the wheel tread provides the slipping.

The foregoing detailed description is to be clearly understood as given by way of illustration and example only, the spirit and scope of this invention being limited solely by the appended claims.

I claim:

1. A pool-cleaning device comprising
a housing,
fluid passage means through said housing,
an inlet to said fluid passage means at the bottom of said housing,
an outlet from said fluid passage means,
a flexible hose connected to said outlet,
said hose being adapted for connection to a pump inlet line,
wheel means on the bottom of said housing at either end thereof,
whereby said housing is movable along the floor of a pool,
pivotal mounting means for the wheel means at one end of said housing for permitting said wheel means to turn in either direction,
and hydraulic motor means in said housing communicating with said fluid passage means and operable by fluid traveling therethrough, said hydraulic motor means being connected to said wheel means at said one end of said housing for driving said wheel means at said one end.

2. A device as recited in claim **1** in which said motor means includes
an impeller rotatably mounted in said housing,
said impeller being in communication with said fluid passage means
and rotatable by fluid traveling through said fluid passage means.

3. A device as recited in claim **1** in which said wheel means at said one end of said housing includes
a yoke,
means pivotally mounting said yoke about its central portion for rotation about a vertical axis,
an axle extending through the outer portions of said yoke,

a wheel at either end of said axle for rotation by said axle,
and drive means operable by said motor means for rotating said axle,
said drive means being laterally displaced from said vertical axis
and relatively adjacent one of said wheels.

4. A device as recited in claim 3 in which
said one wheel relatively adjacent said drive means includes means for exerting a lesser driving force on a surface contacted thereby than the other of said wheels
upon resistance to movement of said housing above a predetermined value.

5. A device as recited in claim 4 in which for said means for exerting a lesser driving force
said one wheel as a circumferential surface capable of slipping on a pool floor when said predetermined resistance is encountered.

6. A device as recited in claim 5 in which said circumferential surface to be capable of slipping is of synthetic rubber,
the circumfererential surface of the other of said wheels being of synthetic rubber
said circumferential surface of said one wheel including substantial portions that are softer than said circumferential surface of said other wheel.

7. A swimming pool-cleaning device comprising
a housing,
wheel means supporting said housing,
said housing having a fluid inlet on the bottom surface thereof,
a flexible hose connected at one end to said housing,
said hose being adapted for connection at its other end to the suction line of a pool filtration system,
said housing having a fluid passageway between said inlet and said hose,
an impeller rotatably carried in said housing and engageable by fluid passing through said passageway for rotation of said impeller by said fluid,
gear means rotatable by said impeller,
an output shaft rotatable by said gear means,
said wheel means including a pair of idler wheels at one end of said housing,
a pair of drive wheels at the opposite end of said housing,
an axle interconnecting said drive wheels,
a yoke supporting said axle,
means pivotally connecting said yoke to said housing about an axis perpendicular to said axle and intermediate said drive wheels,
said output shaft including drive coupling means rotating said axle and engaging said axle at a position intermediate said wheel means
and laterally displaced from said axis of said output shaft,
whereby when said housing encounters an obstruction said yoke is caused to pivot relative to said housing for changing the direction of movement of said housing.

8. A device as recited in claim 7 in which
the drive wheel adjacent said drive coupling means includes a circumferential surface arranged to provide less gripping force on the floor of a swimming pool contacted thereby
than the circumferential surface of the drive wheel remote from said drive coupling means.

9. A swimming pool-cleaning device comprising
a housing,
said housing having a fluid inlet at the lower side thereof,

a fluid outlet at the upper side thereof,
and fluid passage means interconnecting said inlet and said outlet,
a flexible hose connected to said outlet
and being adapted for connection to the suction line of a swimming pool filtration system,
a substantially circular chamber in said housing
in communication with said fluid passage means,
an impeller in said circular chamber
engageable by fluid passing through said passage means for rotation of said impeller,
gear reduction means driveable by said impeller,
an output shaft rotatable by said gear reduction means,
a yoke rotatable about the axis of said output shaft,
a pair of wheels,
an axle interconnecting said wheels
and mounting said wheels on said yoke,
a drive gear on said axle for rotating said wheels,
said drive gear being at one side of said axis of said output shaft,
a gear interconnecting said output shaft and said drive gear
for causing said output shaft to drive said drive gear and rotate said wheels,
and an additional pair of wheels supporting said housing remote from said drive wheels
for permitting said housing to roll along the bottom of a swimming pool with said fluid inlet adjacent the surface of such a pool
for drawing dirt therein through said passage means and into said flexible hose.

10. A device as recited in claim 9 in which
said fluid passage means at the entrance to said substantially circular chamber is thinner than the thickness of said impeller,
and positioned so that fluid impinges on said impeller inwardly of the opposite radial edges of said impeller.

11. A device as recited in claim 9 including
float means on said flexible hose
for holding said hose in a substantially vertical position when said housing is relatively deep in a body of water.

12. A device as recited in claim 9 in which said fluid outlet means includes a tube engageable with said flexible hose, said tube being rotatable about its axis relative to said housing.

13. A device as recited in claim 9 in which
the drive wheel relatively adjacent said drive gear has a circumferential surface providing lesser gripping action with the surface of a swimming pool
than does the circumferential surface of the drive wheel relatively remote from said drive gear.

14. A device as recited in claim 9 in which
said cylindrical surface of said relatively adjacent drive wheel includes a substantial portion of relatively soft synthetic rubber,
and said circumferential surface of said relatively remote drive wheel includes substantial portions of relatively hard synthetic rubber.

15. A device as recited in claim 14 in which
said relatively soft synthetic rubber has substantially 40 Shore hardness,
and said relatively hard synthetic rubber has substantially 80 Shore hardness.

References Cited by the Examiner

UNITED STATES PATENTS

2,923,954 2/1960 Babcock ---------- 15—1.7

CHARLES A. WILLMUTH, *Primary Examiner.*