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(54) **Pool cleaner with brush**

(57) A pool cleaner device (10) is configured to travel along an enclosing surface of a pool. The device (10) includes at least one elongated brush having a long axis that is oriented at a nonzero angle to a lateral axis of the

device and substantially parallel to the surface when the pool cleaner (10) is traveling along the surface. The device also includes a mechanism for causing bristles of the elongated brush to vibrate against the surface when the device is operating on that surface.

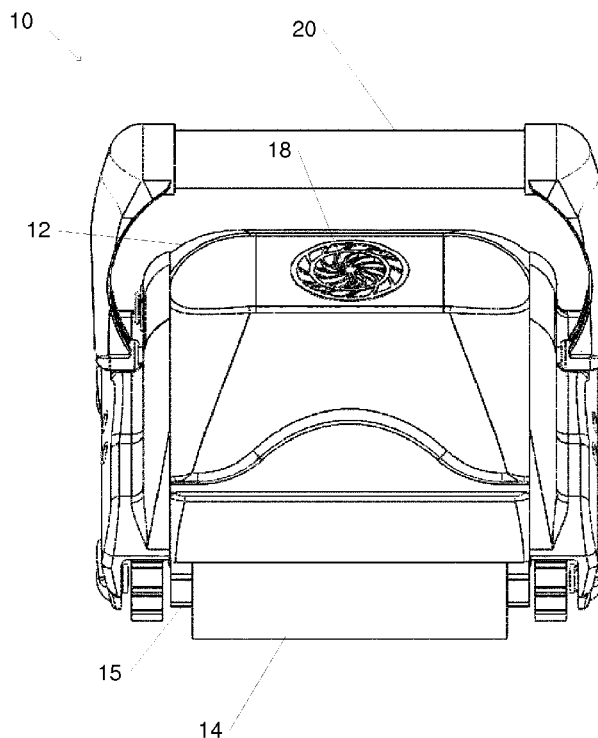


Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to pool cleaners. More particularly, the present invention relates to a pool cleaner with a brush.

BACKGROUND OF THE INVENTION

[0002] Swimming pools require frequent cleaning, often on a daily basis. Thus, autonomous devices for cleaning swimming pools often present an attractive alternative to manual cleaning. The use of electrically powered robotic swimming pool cleaners is a common method of cleaning dirt and debris from the bottom and sides of such pools.

[0003] Robotic swimming pool cleaners have been described, for example, by Garti in US 2007/0028405. A robotic pool cleaner typically includes a drive motor and rollers, wheels, or tracks for locomotion. A robotic pool cleaner also typically includes a pump for drawing water through a filter assembly, and an internal filter bag or cartridge where dirt and debris is entrapped and collected during the cleaning process. A robotic pool cleaner may be programmed to traverse the bottom and walls of a pool randomly, or in a manner that ensures coverage in a finite amount of time. For example, a method for operation of a robotic pool cleaner is described by Porat in US 6,099,658.

[0004] A robotic pool cleaner may also include one or more brushes that rotate about an axis that is parallel to the axes of the locomotion rollers or wheels. The brushes may aid locomotion of the robotic pool cleaner, and help to lift debris and dirt from the floor of the pool so as to improve the cleaning operation. These cleaners operate on the principle of lifting debris from the floor of the pool by suction and typically can only remove loose particles.

[0005] Many robotic pool cleaners are adapted to climb and clean vertical or inclined surfaces of a swimming pool. Loose particles generally do not adhere to a vertical surface. Thus any dirt that is found on the pool walls, typically oil-bound or of a biological nature, is often firmly attached to the surface and thus cannot be removed by suction alone. The rotating action of a typical cleaner's brushes is generally insufficient to remove much of this dirt.

[0006] Several types of brush have been described in the past for improving the operation of robotic pool cleaners. In US 2010/0299852 Fayyad describes a brush attachment which can be retroactively fitted to an automatic pool cleaner. The brush is static, being passively pushed by motion of the automatic pool cleaner to which it is attached. Such passive pushing would be unlikely to remove any debris other than loose particles.

[0007] In US 6,115,864, for example, Davidsson et al. describe a robotic cleaner with motor driven counter-rotating brushes. Track belts for locomotion are driven by

a separate motor. In US 2011/0000030, Pichon et al. describe a brush for a robotic cleaner that is coupled to the locomotion wheels and which can be configured to rotate at speed which is higher than the rotational speed of the locomotion wheels. In both of these cases, the direction of rotation is parallel to the direction of motion of the robotic cleaner.

[0008] Sebor in US 5,797,156 describes a submersible cleaner with rows of segmented tread elements that are angled such that a vibratory oscillator causes the tread elements to propel that cleaner and dislodging debris. Such brushes or elements do not generally impart sufficient scrubbing action to remove dirt or biological debris which has firmly adhered to the walls or vertical surfaces of a swimming pool. Furthermore, during normal programmed movement of the pool cleaner, the brushes do not reach the waterline.

[0009] In US 7,657,967, Nam et al. describe a vibrating brush for a vacuum cleaner. Motion of the brush is parallel to the direction of motion of the vacuum cleaner (as determined by the wheels of the vacuum cleaner). Aiyar in US 5,471,695 describes a circular static brush that is mounted to a sealed housing and that is vibrated by circular motion of an eccentric weight within the housing.

[0010] It is an object of embodiments of the invention to provide a brush for a robotic pool cleaner that provides an effective scrubbing action for removing dirt from the walls and waterline of a swimming pool.

[0011] Other aims and advantages of the present invention will become apparent after reading the present invention and reviewing the accompanying drawings.

SUMMARY OF THE INVENTION

[0012] There is thus provided, in accordance with some embodiments of the present invention, a pool cleaner device that is configured to travel along an enclosing surface of a pool, the device including: at least one elongated brush having a long axis that is oriented at a nonzero angle to a lateral axis of the device and substantially parallel to the surface when the pool cleaner is traveling along the surface; and a mechanism for causing bristles of the elongated brush to vibrate against the surface when the device is operating on that surface.

[0013] Furthermore, in accordance with some embodiments of the present invention, the mechanism is powered by a drive force for causing the device to travel along the surface.

[0014] Furthermore, in accordance with some embodiments of the present invention, the nonzero angle is selected such that when the device is operating on a wall of the pool at a waterline of the pool, the elongated brush extends above and below the waterline.

[0015] Furthermore, in accordance with some embodiments of the present invention, the device is configured such that the lateral axis assumes an oblique angle to the waterline when the device is operating on the wall at the waterline and the nonzero angle is selected such that

the long axis is substantially vertical when the device is operating on the wall at the waterline.

[0016] Furthermore, in accordance with some embodiments of the present invention, the elongated brush is configured to vibrate with a rocking motion in a direction that is substantially perpendicular to the long axis.

[0017] Furthermore, in accordance with some embodiments of the present invention, the mechanism includes a transmission for converting a rotational motion of a component of a locomotion assembly of the device to a rocking motion of the elongated brush.

[0018] There is further provided, in accordance with some embodiments of the invention, a pool cleaner device that is configured to travel along an enclosing surface of a pool, the device including a plurality of rotatable brushes arranged substantially in a row, the row being oriented at a nonzero angle to a lateral axis of the device and substantially parallel to the surface when the pool cleaner is traveling along the surface; and a mechanism for causing the brushes to rotate..

[0019] Furthermore, in accordance with some embodiments of the present invention, the mechanism is powered by a drive force for causing the device to travel along the surface.

[0020] Furthermore, in accordance with some embodiments of the present invention, the plurality of rotatable brushes is configured to extend above and below a waterline of the pool when the device is operating on a wall of the pool at the waterline.

[0021] Furthermore, in accordance with some embodiments of the present invention, the device is configured such that the lateral axis assumes an oblique angle to the waterline when the device is operating on the wall at the waterline and the nonzero angle is selected such that the row is substantially vertical when the device is operating on the wall at the waterline.

[0022] Furthermore, in accordance with some embodiments of the present invention, adjacent rotatable brushes in the row are configured to counter-rotate with respect to one another.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] In order to better understand the present invention, and appreciate its practical applications, the following Figures are provided and referenced hereafter. It should be noted that the Figures are given as examples only and in no way limit the scope of the invention. Like components are denoted by like reference numerals.

[0024] Fig. 1 shows a pool cleaner in accordance with an embodiment of the invention, in an upright position..

[0025] Fig. 2 shows the pool cleaner shown in Fig. 1, in an upside down position with the bottom cover removed.

[0026] Fig. 3 shows components of the pool cleaner shown in Fig 1, in an upright position and with the top cover removed.

[0027] Fig. 4 shows a vibrating brush assembly trans-

mission in accordance with an embodiment of the present invention.

[0028] Fig. 5 shows another example of a vibrating brush assembly transmission in accordance with an embodiment of the present invention.

[0029] Fig. 6A shows an outer face of a bottom cover of a pool cleaner with a vibrating brush, in accordance with an embodiment of the present invention.

[0030] Fig. 6B is a side view of the bottom cover shown in Fig. 6A.

[0031] Fig. 7 shows a rotating brush assembly transmission in accordance with an embodiment of the present invention.

[0032] Fig. 8A shows outer face of a bottom cover of a pool cleaner with rotating brushes, in accordance with an embodiment of the present invention.

[0033] Fig. 8B is a side view of the bottom cover shown in Fig. 8A.

20 DETAILED DESCRIPTION OF EMBODIMENTS

[0034] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, modules, units and/or circuits have not been described in detail so as not to obscure the invention.

[0035] In accordance with an embodiment of the present invention, a pool cleaner is configured to travel along and clean an enclosing surface (e.g. a floor or wall) of a pool such as a swimming pool. For example, the pool cleaner may be an autonomously operating robotic pool cleaner. A front-rear axis of the pool cleaner is defined as an axis of the pool cleaner that is parallel to a nominal direction of motion of the pool cleaner (e.g. as determined by a direction of rolling of a wheel, roller, or track for propelling the pool cleaner along an enclosing surface). A lateral axis of the pool cleaner is defined as an axis that is perpendicular to the front-rear axis and that is substantially parallel to a surface along which the pool cleaner is operating (e.g. traveling or cleaning). The pool cleaner is provided with a brush assembly that includes a movable brush and a mechanism for causing the brush to move with a repetitive or periodic motion. Such motion includes, for example, vibratory, rocking, or linear motion of brush bristles, or a circular motion.

[0036] In accordance with an embodiment of the invention, the brush motion is at least in part transverse to the front-rear axis (direction of motion) of the pool cleaner, and is substantially parallel to a surface on which the pool cleaner is operating (or least to a wall of the pool when operating on the wall). Such motion include may include, for example, vibratory, rocking, or linear motion that is diagonal or perpendicular to the front-rear axis, or a circular motion.

[0037] When the pool cleaner is positioned so as to clean a wall (or other enclosing surface) of a swimming pool (or other similarly shaped container of water with vertical or steeply sloped walls and an open top), the motion of the brushes may provide a scrubbing action for scrubbing the wall of the pool. Such scrubbing action may be particularly advantageous in cleaning dirt (e.g. with oil-bound or biological components) that adheres to a wall of the pool in the vicinity of the waterline.

[0038] Although reference is made in this description to water in a pool or swimming pool, it should be understood that embodiments of the present invention may be applicable to cleaning a variety of tanks or containers that are configured to hold other types of liquids. Thus, the term "pool" is used herein to refer to any such liquid-filled enclosure.

[0039] A robotic pool cleaner for utilizing a brush assembly in accordance with an embodiment of the present invention typically includes an inlet opening, components for creating a suction force, and components for providing locomotion of the pool cleaner. The inlet opening is typically located on a bottom or downward-facing side of the pool cleaner.

[0040] For the purpose of this description, references to a bottom, or downward-facing, side of the pool cleaner refer to a surface or side of the pool cleaner that faces the surface to be cleaned - e.g. a pool bottom or wall - during cleaning operation, whether or not that surface is a horizontal surface. Similarly, references to a top, or upward-facing, side of the pool cleaner refer to a surface or side of the pool cleaner that faces away from the surface to be cleaned during cleaning operation. The pool cleaner is described as being in an upright position when the bottom surface faces downward and as upside down when the bottom surface faces upward.

[0041] Suction is applied to the inlet opening during operation of the pool cleaner. The suction may force water from near a surface of the pool, and any debris or material that is carried by the water, into an internal cavity in which waste material is trapped. For example, the suction may be provided by a motorized pump or impeller that is enclosed within the pool cleaner, or by via a hose that connects the pool cleaner to an external pump. The water is forced out of the internal cavity through an outlet. A trapping mechanism retains debris within the cavity. The outlet is typically positioned on a top or upward-facing side of the pool cleaner.

[0042] The suction force may also hold the pool cleaner against a vertical or steep wall when climbing and cleaning the wall.

[0043] A typical robotic pool cleaner may be provided with locomotion assembly that utilizes a drive force for propelling the pool cleaner. For example, the drive force may be provided by a drive motor (e.g. an electrically powered motor). The locomotion assembly may include transmission components for powering one or more appropriate locomotion components (e.g. wheels, rollers, or tracks) that propel the pool cleaner along a floor or

wall of the pool. Motion of the locomotion components may propel the pool cleaner along an enclosing surface (e.g. floor or wall) of the pool. Alternatively, a drive force for propelling the pool cleaner, or locomotion components of the pool cleaner, may be provided by a water jet. For example, a water jet may be generated by an internal suction pump, by a separate pump, or by an external pump that is connected by a hose to the pool cleaner. The pool cleaner may be propelled by a jet that is expelled by the pool cleaner, or locomotion components of the pool cleaner may be driven by a jet (e.g. via a transmission).

[0044] A brush assembly in accordance with an embodiment of the present invention may include a transmission for engaging the locomotion assembly and the brush motion mechanism. For example, the brush assembly transmission may engage a transmission of the locomotion assembly, or may engage a water jet that is used in propelling the pool cleaner. The transmission may thus transmit a force that is provided by a drive motor to the brush assembly. Thus, the brush assembly may be operated continuously when the pool cleaner is being propelled.

[0045] Alternatively, the transmission may be provided with a clutch mechanism or similar mechanism such that the brush assembly may disengage from the locomotion assembly under particular circumstances. For example, a clutch mechanism may include a component that engages or disengages the transmission in accordance with an orientation of the pool cleaner. As a more specific example, a clutch mechanism may disengage the transmission when the direction of the travel of the pool cleaner is close to the horizontal (e.g. as indicated by a tilt switch or tilt-sensitive lever mechanism), being indicative of travel along the pool bottom. The clutch mechanism may cause the transmission to engage, on the other hand, when the pool cleaner is traveling close to the vertical, being indicative of travel along the pool wall.

[0046] Alternatively, a brush assembly in accordance with an embodiment of the present invention may be provided with a separate motor. Such a separate motor may be separately controllable, e.g. by a tilt switch, so as to operate the brush motion only when needed (e.g. when cleaning the pool wall or when the waterline is detected).

[0047] The brush or brushes of the brush assembly may be oriented so as to facilitate cleaning of a wall at and above the waterline of the pool. For example, a pool cleaner may be configured with a hinged handle that is extendible from the body of the pool cleaner. The handle when extended is typically oriented at an angle to the lateral axis of the pool cleaner. Thus, when the handle floats at the surface of the pool, the handle may float parallel to the water surface, thus causing the front-rear axis of the pool cleaner to be diagonal with respect to the vertical. The pool cleaner may also be configured to reverse direction when the waterline is reached (as indicated, for example, by a sensed change in the suction). Such a configuration may facilitate complete coverage

of all pool surfaces by causing the path that is traveled by the pool cleaner away from the waterline to be different from the path that was traveled when approaching the waterline.

[0048] In such a pool cleaner configuration, the brush or brushes may be oriented so as to extend above and below the waterline when the pool cleaner reaches the waterline. For example, an elongated brush may be oriented such that the brush's long dimension is substantially perpendicular to the waterline (e.g. approximately vertical) when the pool cleaner travels at the waterline with its front-rear axis at an oblique angle to the vertical. A row of two or more circular rotating brushes may be oriented such that the direction of the row is substantially perpendicular to the water line. With either example, a sidling motion of the pool cleaner at the waterline may clean a swath of pool wall that extends above and below the waterline.

[0049] Reference is now made to the accompanying Figures.

[0050] Fig. 1 shows a pool cleaner in accordance with an embodiment of the invention, in an upright position.. Fig. 2 shows the pool cleaner shown in Fig. 1, in an upside down position with the bottom cover removed. Fig. 3 shows components of the pool cleaner shown in Fig 1, in an upright position and with the top cover removed.

[0051] Pool cleaner 10 typically includes a cleaner frame 12. Cleaner frame 12 may house or support components of various assemblies of the pool cleaner. Such assemblies may include a brush assembly, a locomotion assembly, and a suction assembly. Power may be provided to various motors of pool cleaner 10 via a power cable or an internal power supply such as a battery. Alternatively to a cleaner frame, components of a pool cleaner in accordance with an embodiment of the invention may be assembled to one another, without a common frame for supporting the components.

[0052] Suction motor 22 may drive a pump, fan, or rotor so as to expel water through water outlet 18. (A water inlet and container and trap for trapping and holding debris that is sucked into pool cleaner 10 are not shown.)

[0053] Drive motor 24 may power one or more components that, when placed in contact with a surface of the pool (bottom or wall), may be moved or rotated so as to propel pool cleaner 10. For example, drive motor 24 may turn drive shaft 30. Rotation of drive shaft 30 may turn drive belt 34. Turning of drive belt 34 may rotate axles 15 on which locomotion rollers 14 are mounted. Rotation of locomotion rollers 14, when locomotion rollers 14 are placed in contact with a surface (and pressed against the surface by suction that is generated by suction motor 22) may propel pool cleaner 10 along the surface.

[0054] Alternatively or in addition to locomotion rollers 14, pool cleaner 10 may be provided with wheels or tracks for propelling pool cleaner 10 along a surface.

[0055] Flotation handle 20 may be hollow and watertight, or may be constructed of a solid material that is less

dense than water. Flotation handle 20 is extendible so as to extend at an oblique angle to a lateral axis (an axis parallel to the axes of locomotion rollers 14) of pool cleaner 10. Thus, when pool cleaner 10 reaches the waterline of a pool wall, flotation handle 20 tends to tilt the lateral axis of pool cleaner 10 to an oblique angle with respect to the waterline. Thus, when pool cleaner 10 is at the waterline, a front-back axis of pool cleaner 10 is laterally tilted with respect to the vertical.

[0056] Rotation of axles 15 may turn brush assembly drive belts 36. Turning of brush assembly drive belt 36 may rotate idler wheel 37. Idler wheel 37 is coupled to brush assembly drive shaft 38. Thus, rotation of idler wheel 37 causes rotation of brush assembly drive shaft 38. Rotation of brush assembly drive shaft 38 may operate brush assembly transmission 25 (shown schematically). Operation of brush assembly transmission 25 may cause a vibration or rotation of one or more bushes, as described below.

[0057] Fig. 4 shows a vibrating brush assembly transmission in accordance with an embodiment of the present invention.

[0058] Vibrating brush assembly transmission 26 converts rotational motion of brush assembly drive shaft 38 (Fig. 3) to a rocking motion of brush vibration arm 28. Vibrating brush assembly transmission drive shaft 39 may couple to (or may be identical with) brush assembly drive shaft 38. For example, a shaped end of brush assembly drive shaft 38 may insert into a correspondingly shaped socket at an end of vibrating brush assembly transmission drive shaft 39, or vice versa. Rotation of vibrating brush assembly transmission drive shaft 39 turns cam 40. Cam 40 is shaped such that its radius varies around its perimeter. In the example shown, cam 40 is provided with a triangular arrangement of lobes. In other examples, cam 40 may include more or fewer lobes. In other examples, cam 40 may have a triangular cross section (e.g. in the form of an equilateral triangle), or another polygonal cross section.

[0059] As cam 40 rotates, the varying radius of cam 40 may cause cam 40 to alternately push on and release arm 42. Arm 42 is connected to (e.g. may be molded as a single piece with) arm support structure 44 and brush vibration arm 28. When cam 40 pushes on arm 42, arm 42 may be tilted, causing brush vibration arm 28 to move in one direction. When cam 40 releases arm 42, arm support structure 44 may restore arm 42 and brush vibration arm 28 to their original positions. For example, arm 42 and connected brush vibration arm 28 may be hinged so as to enable a tilting or rocking motion. One or more of arm 42, brush vibration arm 28, arm support structure 44 may be provided with a restoring element (e.g. a spring, weight, or a resilient element, or may be made of a resilient material). The restoring element may restore arm 42 and brush vibration arm 28 to their original positions when cam 40 releases arm 42.

[0060] Fig. 5 shows another example of a vibrating brush assembly transmission in accordance with an em-

bodiment of the present invention.

[0061] Vibrating brush assembly transmission drive shaft 39 of vibrating brush assembly transmission 46 includes eccentrically mounted pin 48. Eccentrically mounted pin 48 is inserted into opening 50 of arm 52. Opening 50 of arm 52 may be open at the top, as shown in Fig. 5, or may include a closed section at a distal end of arm 52.

[0062] As vibrating brush assembly transmission drive shaft 39 rotates, eccentric rotation of eccentrically mounted pin 48 within opening 50 may push arm 52 alternatively to one side and the other with a back-and-forth motion. Arm 52 is connected to brush vibration arm 28. The back-and-forth motion of arm 52 may result in a similar back-and-forth rocking motion of brush vibration arm 28.

[0063] A brush vibration arm of a vibrating brush assembly transmission may be used to vibrate an appropriately configured brush.

[0064] Fig. 6A shows the outer face of a bottom cover of a pool cleaner with a vibrating brush, in accordance with an embodiment of the present invention. The vibrating brush is designed to be mounted on a pool cleaner so as to face a surface being cleaned. Fig. 6B is a side view of the bottom cover shown in Fig. 6A.

[0065] Vibrating brush shaft 62 is mounted on bottom cover 56. For example, bottom cover 56 may be configured to attach to and cover bottom opening 12a of cleaner frame 12 (as shown in Fig. 2 and in Fig. 3). One or more locking elements 58, clips 57, and guides 59 may be provided facilitating secure attachment of bottom cover 56 to bottom opening 12a of cleaner frame 12. Bottom cover 56 may include one or more inlet openings 60 for intake of water and debris into a bag or container inside of cleaner frame 12.

[0066] Vibrating brush shaft 62 is configured to vibrate substantially uniformly with a back-and-forth rocking motion in a direction that is substantially perpendicular to the long axis of vibrating brush shaft 62. For example, vibrating brush shaft 62 may be attached by bearings, hinges, or axles to bottom cover 56.

[0067] Vibrating brush shaft 62 is provided with bristles 63. Bristles 63 may include flexible bristles, typically made of strands of nylon or a similar hard-wearing, plastic material.

[0068] Vibrating brush tab 64 is configured to engage a rocking element of a brush vibration arm 28 of a vibrating brush assembly transmission. For example, vibrating brush tab 64 may fit into groove 29 of brush vibration arm 28 of vibrating brush assembly transmission 46 (Fig. 4).

[0069] Vibrating brush shaft 62 may be mounted at a nonzero oblique angle to the sides (e.g. a lateral axis) of bottom cover 56 (e.g. at an angle of 30° to a lateral axis of the pool cleaner - the angle may be constrained by the presence of other structure on bottom cover 56, such as inlet openings 60). For example, the oblique angle may be such that when the pool cleaner reaches the waterline of the pool at an angle to the vertical (as determined in part by the configuration of its flotation handle - e.g. at

about 60° to the vertical), the elongated axis of vibrating brush shaft 62 is close to vertical. In this manner, bristles 63 of vibrating brush shaft 62 may effectively clean the pool wall above and below the waterline of the pool.

[0070] Although a single vibrating brush shaft 62 is shown for simplicity, a vibrating brush assembly in accordance with an embodiment of the present invention may include two or more brushes. For example, the separate vibrating brushes may be arranged approximately parallel to one another. A coupling mechanism may couple the motion of the separate brushes, either to one another or each separately to a vibrating brush assembly transmission, such that a single vibrating brush assembly transmission may drive all of the vibrating brushes. Alternatively or in addition, some or all of the brushes may be driven by a separate motor.

[0071] Although the motion of vibration of vibrating brush shaft 62 is shown as a rocking motion, vibration, alternatively or in addition, may be linear along a dimension that is perpendicular to the elongated axis. For example, a transmission may be configured to laterally move an elongated brush back and forth in a direction perpendicular to its elongated axis.

[0072] Alternatively to a vibrating brush, a brush assembly may include two or more aligned rotating circular brushes. Each rotating circular brush is mounted with its bristles facing downward, the axis of rotation being approximately perpendicular to the bottom of the pool cleaner.

[0073] Fig. 7 shows a rotating brush assembly transmission in accordance with an embodiment of the present invention.

[0074] Rotating brush assembly transmission 66 redirects rotational motion of brush assembly drive shaft 38 (Fig. 3) to a substantially perpendicular rotation motion of rotating brush drive shaft 74. Rotating brush assembly transmission drive shaft 68 may couple to brush assembly drive shaft 38. For example, hexagonal shaft socket 69 may fit over a corresponding hexagonally shaped end of brush assembly drive shaft 38. Rotation of rotating brush assembly transmission drive shaft 68 turns gear 70. Gear 70 couples to crown gear 72. Thus, rotation of gear 70 may cause rotation of crown gear 72 of rotating brush drive shaft 74. Alternatively, gear 70 and crown gear 72 may be replaced with a pair of suitably configured bevel gears.

[0075] Fig. 8A shows the outer face of a bottom cover of a pool cleaner with rotating brushes, in accordance with an embodiment of the present invention. The rotating brushes as shown are designed to be mounted on a pool cleaner so as to face a surface being cleaned. Fig. 8B is a side view of the bottom cover shown in Fig. 8A.

[0076] Rotating brush drive gear shaft 82 may be coupled to rotating brush drive shaft 74 of rotating brush assembly transmission 66 (Fig. 7). Rotation of rotating brush drive shaft 74 rotates rotating brush drive gear 78. Teeth of rotating brush drive gear 78 engage teeth of rotating brush base 80a. Teeth of rotating brush base

80a, in turn, engage teeth of rotating brush base 80a. Each rotating brush base 80a or 80b is mounted on a rotating brush axle 84. For example, rotating brush axle 84 may be provided with a suitable bearing, or may be supported by low-friction supports, so as to facilitate rotation of rotating brush base 80a or 80b. Thus, rotation of rotating brush drive gear 78 may cause rotation of rotating brush base 80a, and a counter-rotation of rotating brush base 80b. Rotation of rotating brush bases 80a and 80b in counter-rotating directions may prevent rotation of rotating brush bases 80a and 80b from applying a turning torque to the pool cleaner.

[0077] Rotating brush bases 80a and 80b are provided with bristles 63. Bristles 63 are, for the sake of simplicity, shown as typically arranged along the perimeter of a circular pattern. However, bristles 63 may be arranged in any pattern that may be provided on top of brush bases 80a and 80b. For example, bristles 63 may be arranged along the perimeter of a polygonal shape, of an oval shape, in a radial pattern, as concentric perimeters, in parallel rows, or as otherwise filling the interior of a shape.

[0078] A line connecting the axes of rotating brush bases 80a and 80b may be orientated at an oblique angle to the sides of bottom cover 76 (e.g. at an angle of 30° to a lateral axis of the pool cleaner - the angle may be constrained by the presence of other structure on bottom cover 76, such as inlet openings 60).. For example, the oblique angle may be such that when the pool cleaner reaches the waterline of the pool at an angle to the vertical (e.g. at about 60° to the vertical), the line connecting the axes of rotating brush bases 80a and 80b may be close to vertical. In this manner, rotating brush bases 80a and 80b may effectively clean the pool wall above and below the waterline of the pool.

[0079] Although two rotating brush bases 80a and 80b are shown for simplicity, a rotating brush assembly in accordance with an embodiment of the present invention may include three or more rotating brushes. For example, the rotating brushes may be arranged approximately collinear with to one another. Each rotating brush may be provided with gear teeth that engage adjacent rotating brushes. Thus, a pair adjacent rotating brushes may be counter-rotating with respect to each another. Alternatively or in addition, some or all of the rotating brushes may be driven by one or more separate motors.

[0080] In the embodiments illustrated in the Figures, a driving force for driving a vibrating brush or a rotating brush is provided by a motor that also provides a locomotive force for the pool cleaner. Alternatively, a separate motor may be provided for driving the brush assembly. For example, the separate motor may rotate brush assembly drive shaft 38 (Fig. 3). As another example, a separate motor may be incorporated into a transmission within the pool cleaner, or placed adjacent to the transmission inside the pool cleaner. Electrical power for the motor may be provided by a branch of an electrical cable that also provides electrical power for locomotion and suction motors, or may be provided by a battery.

[0081] As discussed above, the separate motor may be provided with a tilt switch or other automatically operated switch for automatically operating the motor and brush assembly only under predetermined circumstances. For example, the predetermined circumstances may include an approximately vertical orientation when cleaning a pool wall, or approaching a waterline of the pool. Alternatively or in addition, the separate motor may be provided with a manually operated switch for turning operation of the motor on or off. For example, a human operator may operate the manually operated switch in accordance with current pool conditions, or when initiating and ending pool cleaning (e.g. in the case that the separate motor is powered by a battery).

[0082] A brush assembly, in accordance with an embodiment of the invention, may be retrofitted to an existing pool cleaner. A method for retrofitting a brush assembly to a pool cleaner, in accordance with an embodiment of the invention typically includes installing brush assembly transmission components such that the installed brush assembly components engage existing locomotion components. For example, an existing idler wheel on a side panel of the pool cleaner may be replaced with an idler wheel that is configured to drive a brush assembly drive shaft. Alternatively, an additional idler wheel and belts may be installed. Alternatively, if the pool cleaner did not originally include a suitable idler wheel, a new idler wheel may be installed.

[0083] A brush assembly transmission is mounted to the interior of the pool cleaner. For example, the transmission may be connected to an interior side panel of the pool cleaner (e.g. using two or more screws). The bottom cover of the pool cleaner is replaced with a bottom cover that includes brushes. The replacement bottom cover may be attached to the pool cleaner using one or more latches or clips that are provided with the bottom cover and the pool cleaner.

[0084] Component for retrofitting a brush assembly to a pool cleaner may be provided in the form of a kit. The kit may be configured for a particular pool cleaner design, or may be configured (e.g. by including universal parts or a set of parts, that are compatible with a variety of pool cleaner designs) for a variety of pool cleaner designs. Such a kit may also include one or more tools (e.g. drill bit, wrench socket, screwdriver) that may be employed in retrofitting the brush assembly to the pool cleaner.

Claims

1. A pool cleaner device that is configured to travel along an enclosing surface of a pool, the device comprising:

at least one elongated brush having a long axis that is oriented at a nonzero angle to a lateral axis of the device and substantially parallel to the surface when the pool cleaner is traveling

- along the surface; and
a mechanism for causing bristles of said at least one elongated brush to vibrate against the surface when the device is operating on that surface.
2. The device of claim 1, wherein the mechanism is powered by a drive force for causing the device to travel along the surface.
3. The device of claim 1, wherein the nonzero angle is selected such that when the device is operating on a wall of the pool at a waterline of the pool, the elongated brush extends above and below the waterline.
4. The device of claim 3, wherein the device is configured such that the lateral axis assumes an oblique angle to the waterline when the device is operating on the wall at the waterline and the nonzero angle is selected such that the long axis is substantially vertical when the device is operating on the wall at the waterline.
5. The device of claim 1, wherein said at least one elongated brush is configured to vibrate with a rocking motion in a direction that is substantially perpendicular to the long axis.
6. The device of claim 1, wherein the mechanism comprises a transmission for converting a rotational motion of a component of a locomotion assembly of the device to a rocking motion of said at least one elongated brush.
7. A pool cleaner device that is configured to travel along an enclosing surface of a pool, the device comprising:
a plurality of rotatable brushes arranged substantially in a row, the row being oriented at a nonzero angle to a lateral axis of the device and substantially parallel to the surface when the pool cleaner is traveling along the surface; and
a mechanism for causing the brushes to rotate.
8. The device of claim 7, wherein the mechanism is powered by a drive force for causing the device to travel along the surface.
9. The device of claim 7, wherein said plurality of rotatable brushes is configured to extend above and below a waterline of the pool when the device is operating on a wall of the pool at the waterline.
10. The device of claim 9, wherein the device is configured such that the lateral axis assumes an oblique angle to the waterline when the device is operating on the wall at the waterline and the nonzero angle
- is selected such that the row is substantially vertical when the device is operating on the wall at the waterline.
11. The device of claim 7, wherein adjacent rotatable brushes in the row are configured to counter-rotate with respect to one another.

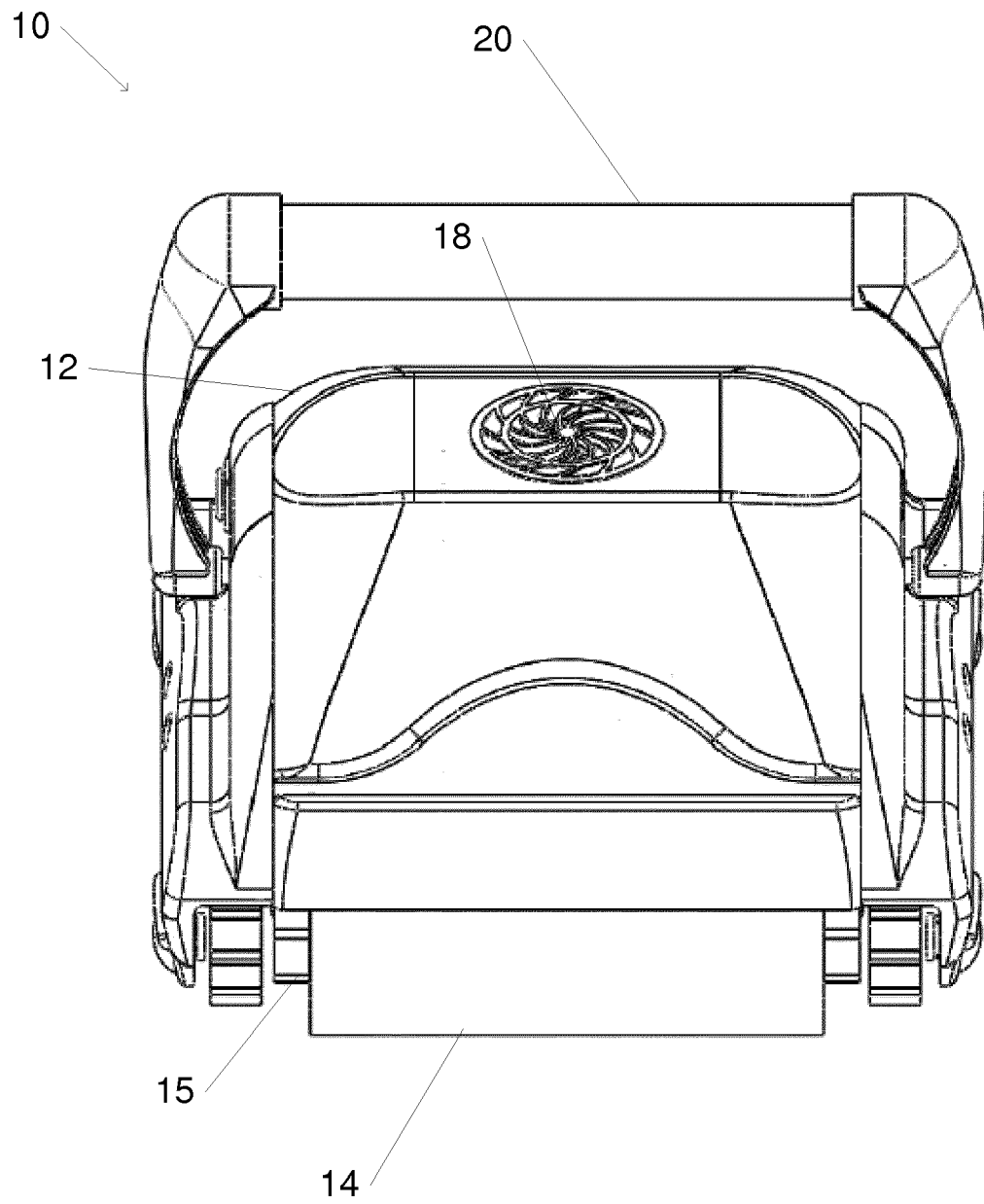


Fig. 1

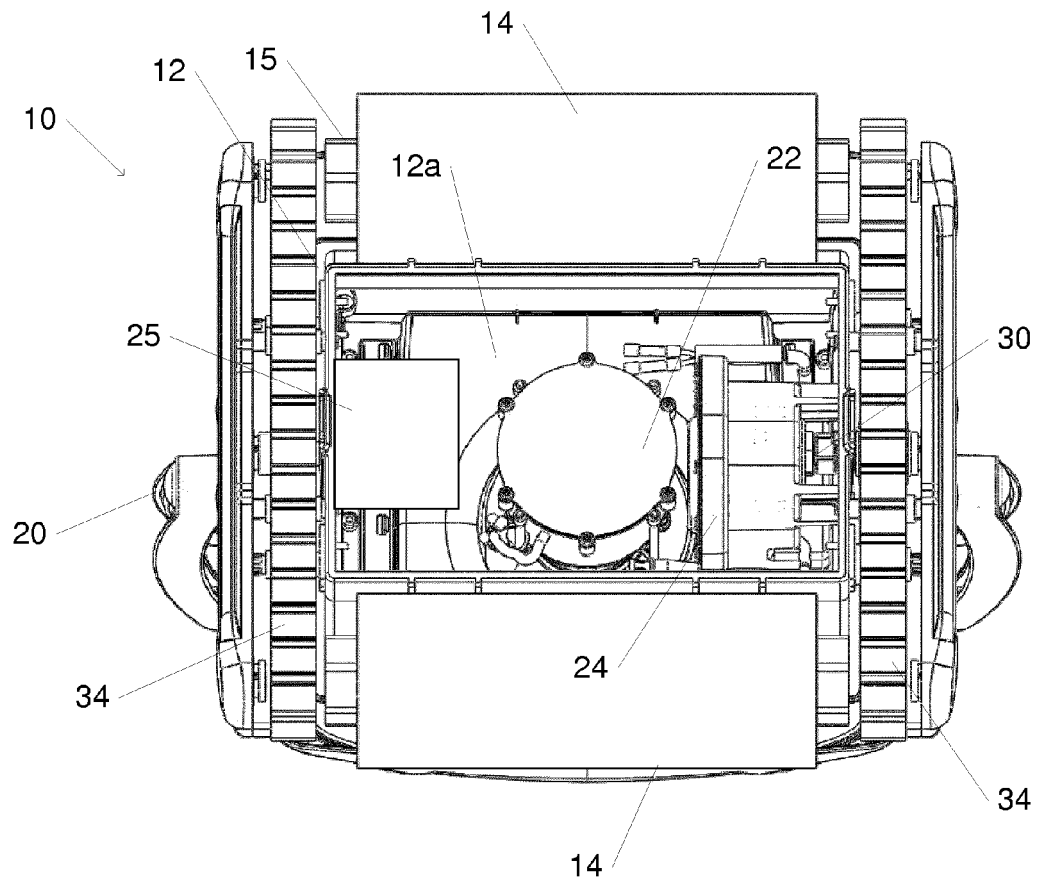


Fig. 2

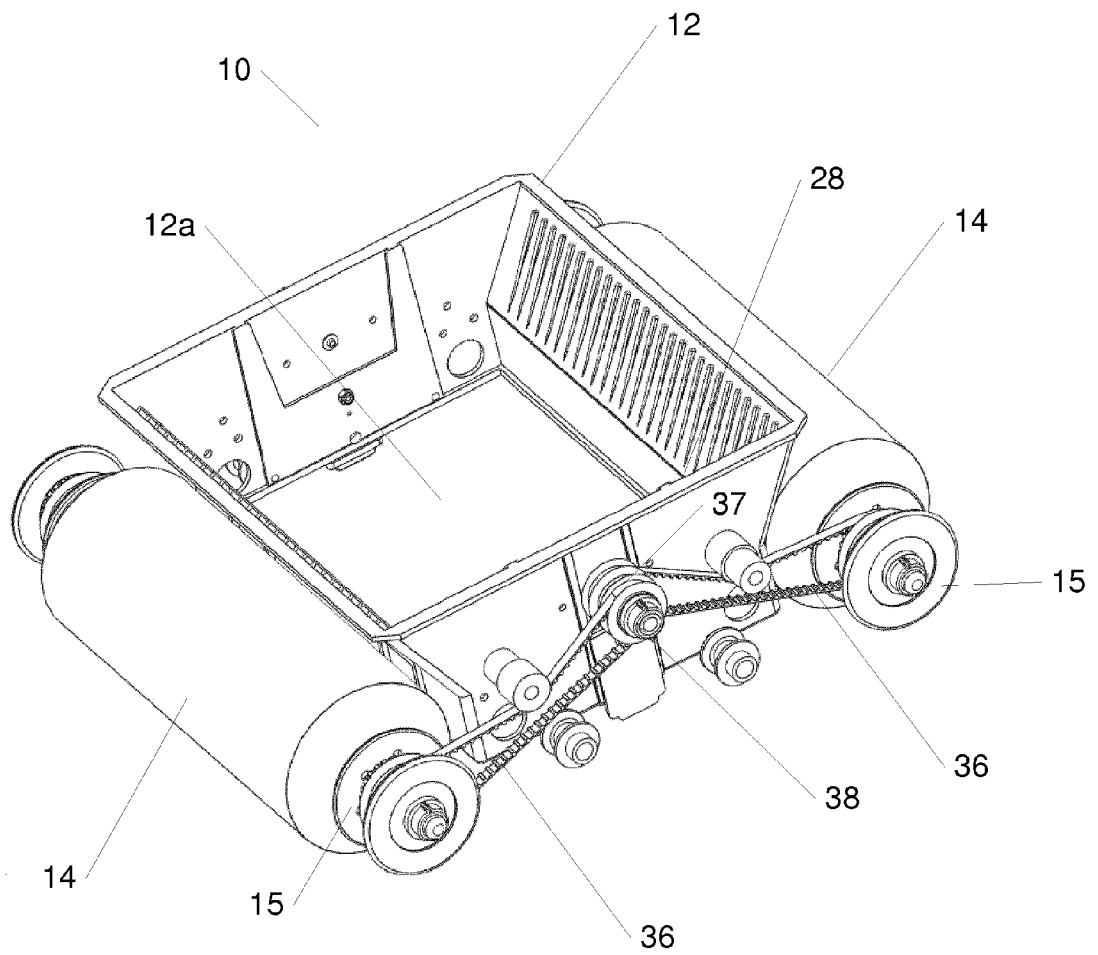


Fig. 3

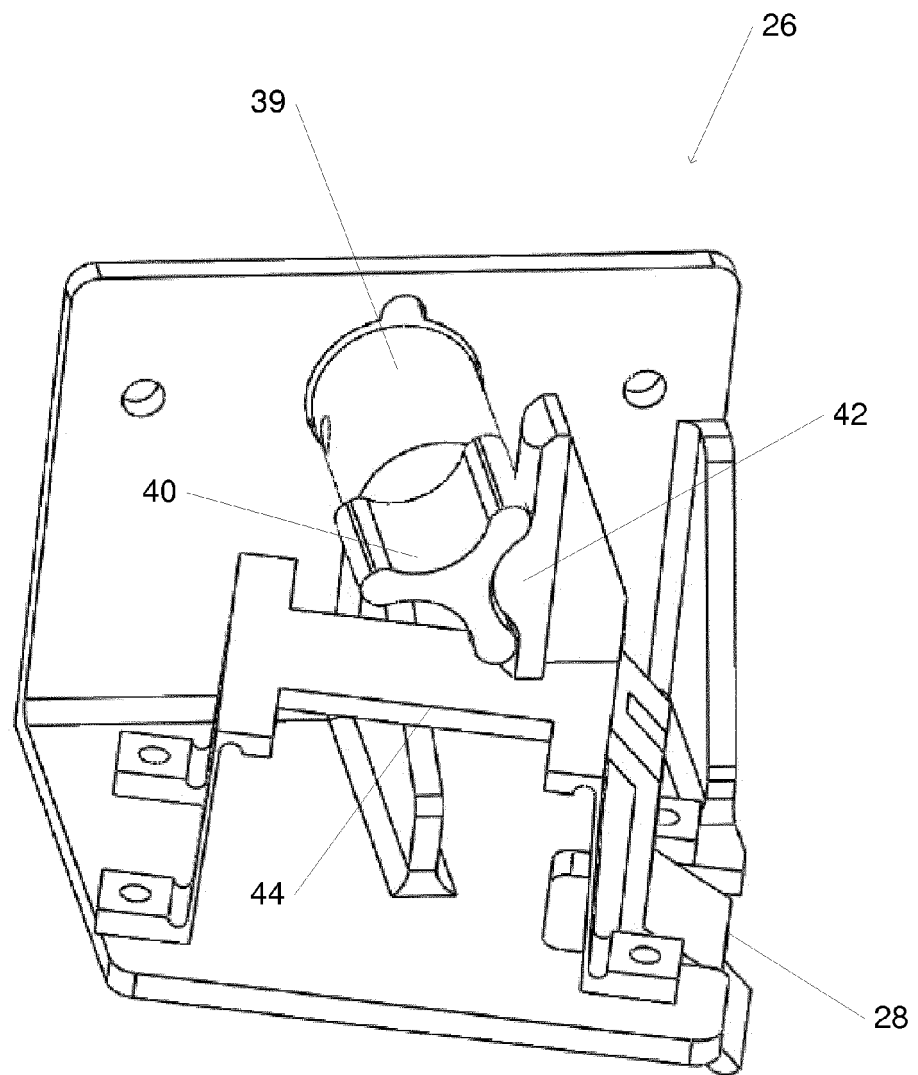


Fig. 4

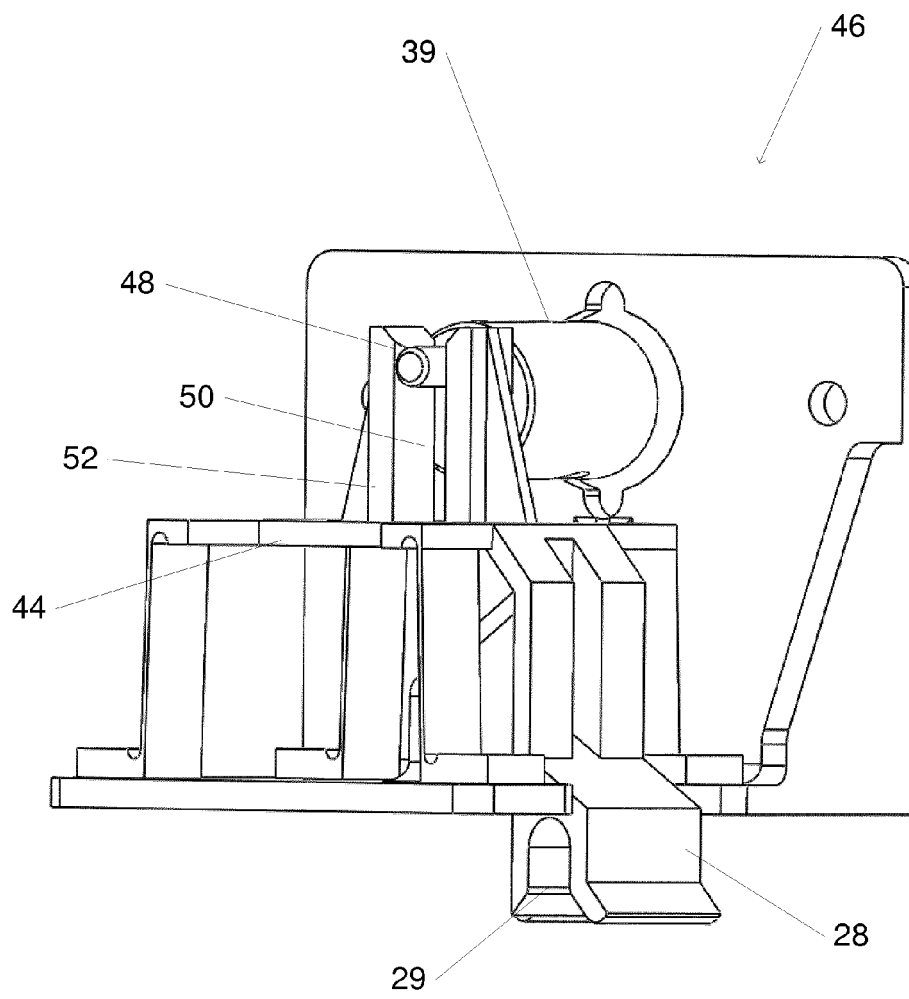


Fig. 5

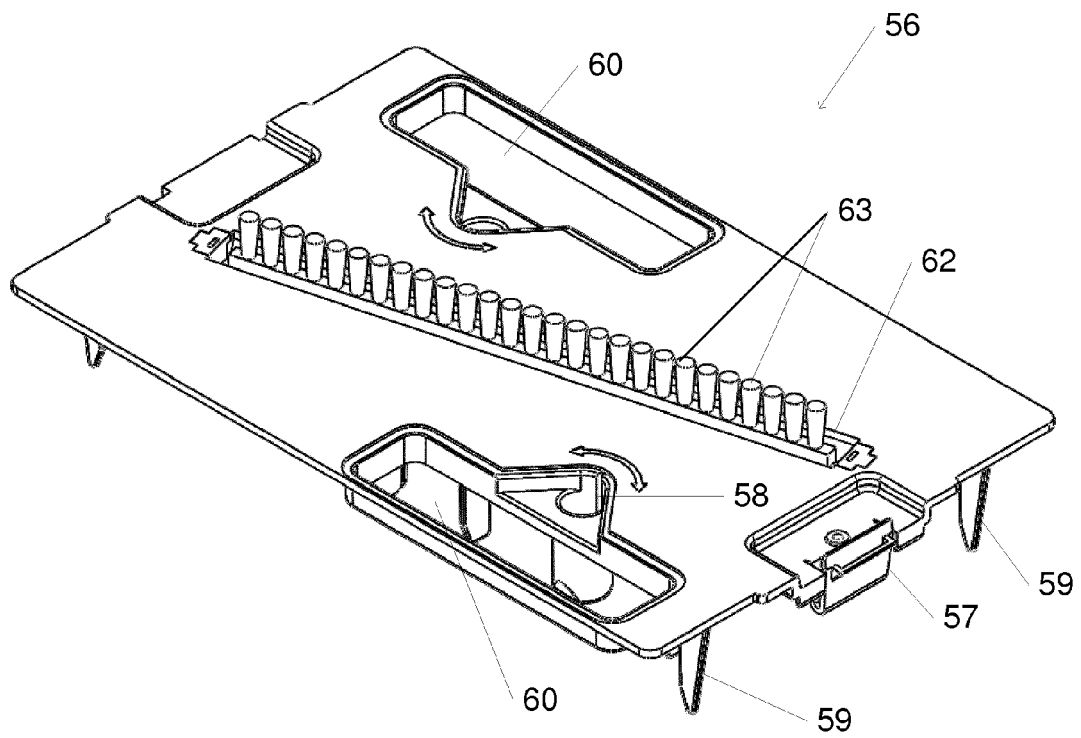


Fig. 6A

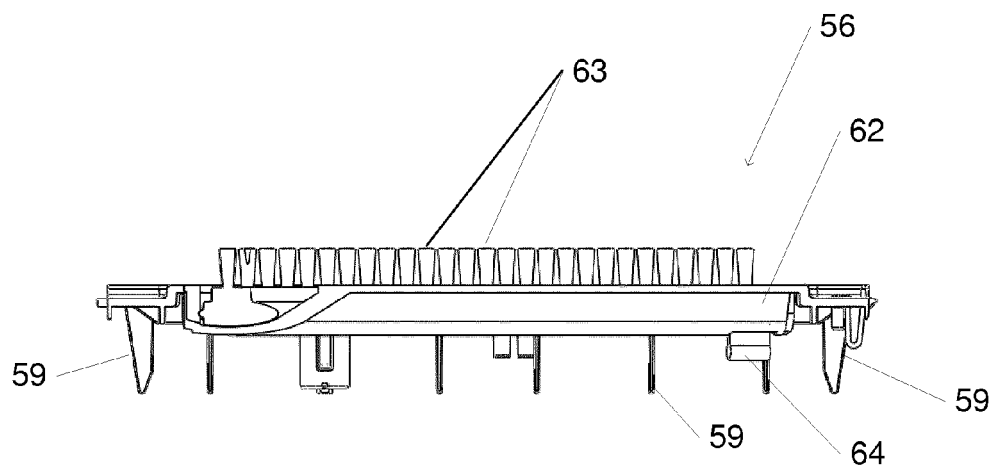


Fig. 6B

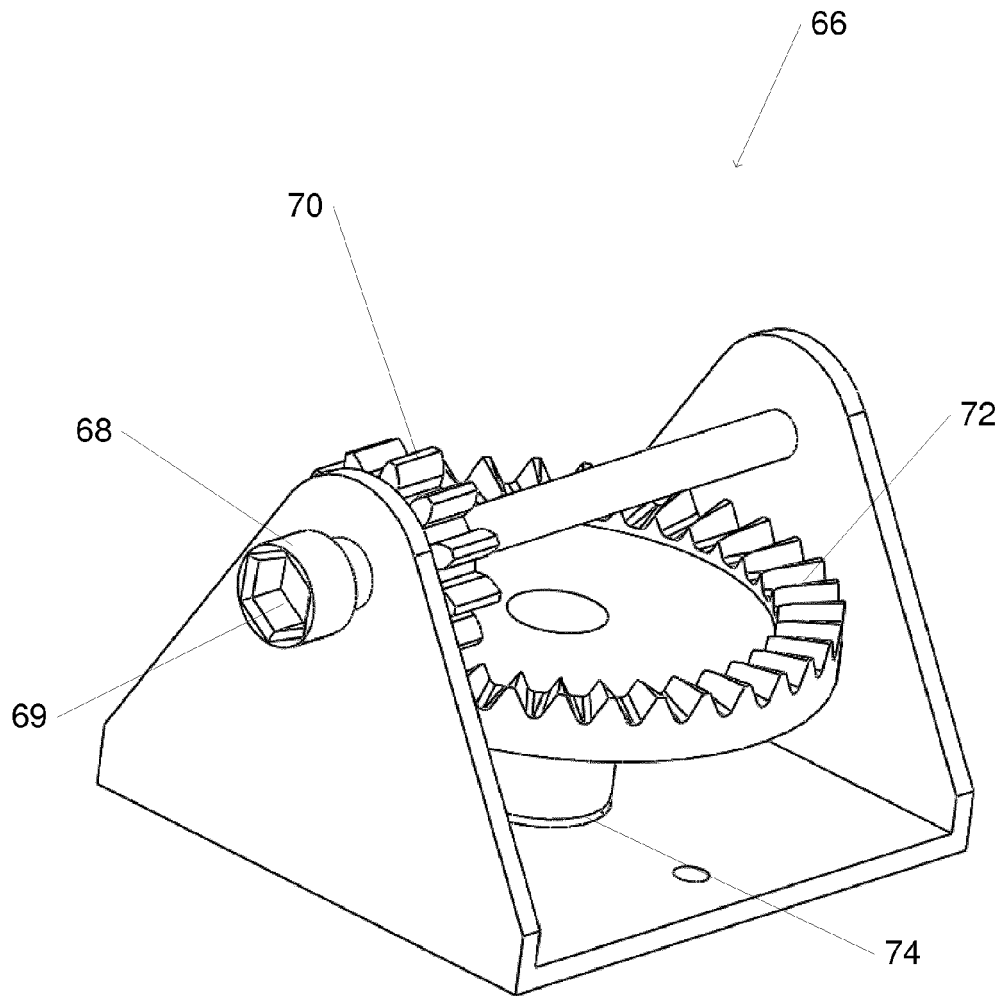


Fig. 7

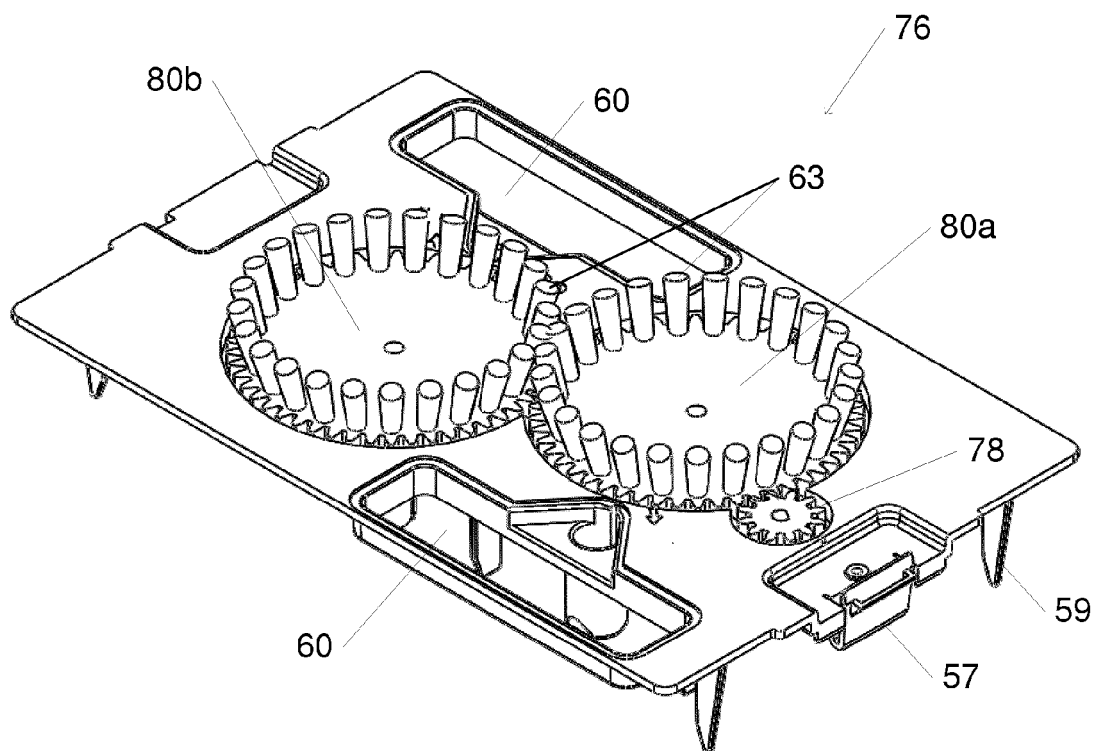


Fig. 8A

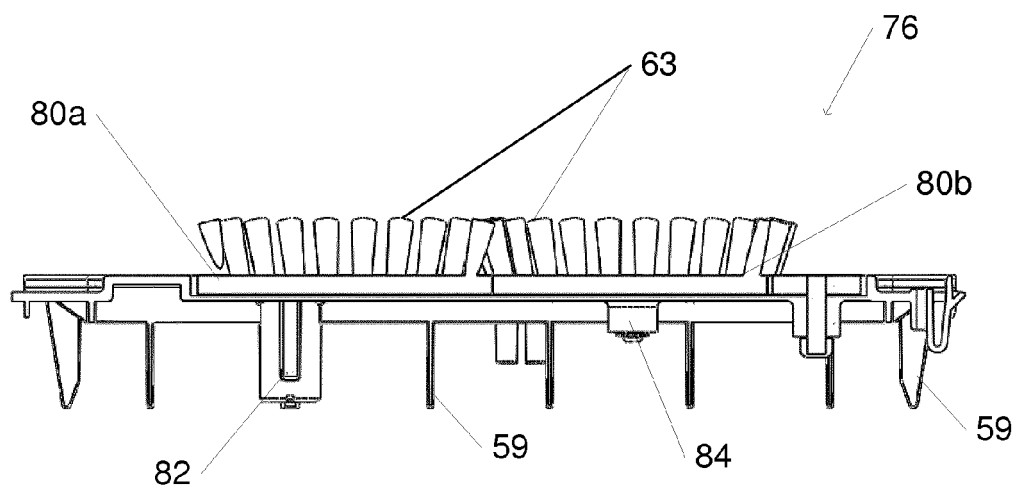


Fig. 8B

REFERENCES CITED IN THE DESCRIPTION

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