(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 607 573 A2**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.06.2013 Bulletin 2013/26

(51) Int Cl.:
E04H 4/16 *(2006.01)*

(21) Application number: **12198112.0**

(22) Date of filing: **19.12.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **19.12.2011 IL 21709311**

(71) Applicant: **Aquatron Robotic Technology Ltd.**
18550 Afula (IL)

(72) Inventor: **Porat, Joseph**
Delray Beach, FL 33483 (US)

(74) Representative: **Pearl Cohen Zedek Latzer UK LLP**
15 Old Bailey
London EC4M 7EF (GB)

(54) Automatic pool cleaner for cleaning a pool with minimum power consumption and method thereof

(57) An automatic pool cleaner (10), comprising a pump unit (230), a control unit (280) and a sensor (60), the sensor (60) configured to detect foreign objects in the pool. The control unit (280) configured to activate the pump unit (230) at a first power level which is less then full power when a foreign object is not detected by the sensor (60), and further configured to activate the pump unit (230) at a second power level, which is greater than the first power level, in response to a signal from the sensor unit (150) indicating the detection of a foreign object.

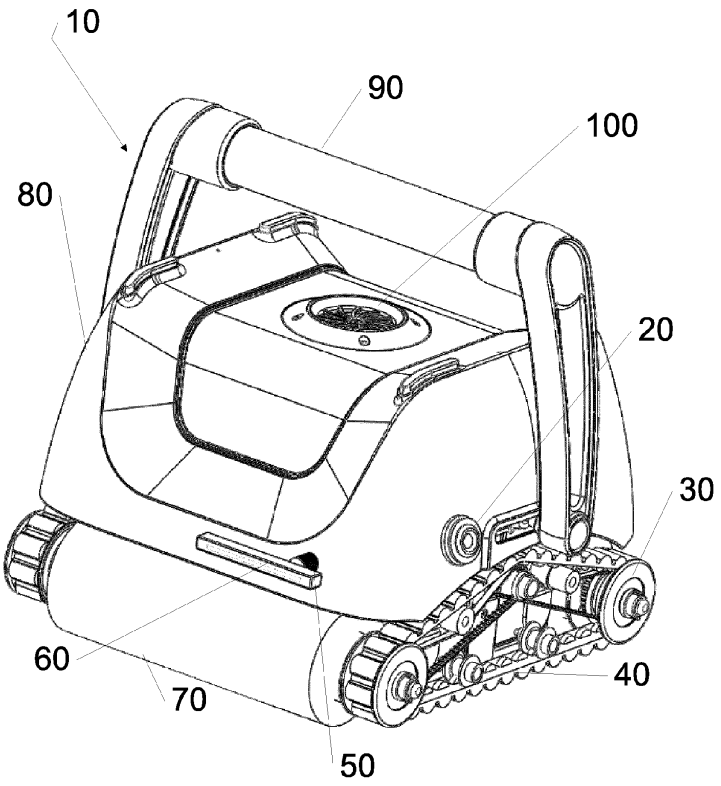

Fig.1

EP 2 607 573 A2

Description

FIELD OF THE INVENTION

[0001] The invention relates to automatic pool cleaners, in particular, the invention relates to battery operated automatic pool cleaners and their method of operation.

BACKGROUND

[0002] Automatic pool cleaners are used for cleaning surfaces, including underwater surfaces in commercial and residential pools. Some automatic pool cleaners operate independently and are battery operated to allow for flexibility in cleaning options. Automatic pool cleaners in swimming pools require a pump unit to draw water through a filter unit that traps foreign objects -including dirt or debris, but allows water to pass through the filter unit back into the pool. Typically the pump unit consumes a significant portion of the power of an automatic pool cleaner.

[0003] Many automatic pool cleaners are corded, receiving power from an external power source via a cable, necessitating a power source near the pool. Cables tend to be heavy and may tend to get tangled. Further, cables add to the overall weight of automatic pool cleaners. Cables also create a hazard outside of the pool, with the potential for people to trip over the cable. Cables further make the poolside look untidy.

[0004] Some automatic pool cleaners draw their power from onboard batteries. Typically, battery operated automatic pool cleaners require no external power cables. However, battery operated automatic pool cleaners may necessitate frequent charging due to the power consumed by the cleaning mechanisms, with the frequent charging depleting overall battery life. Further, battery life between charges is typically limited, limiting the amount of cleaning an automatic pool cleaner can do between charges.

[0005] With the pump unit consuming a significant portion of the onboard battery's energy, it may be possible to reduce power consumption to a minimum by reducing the amount of time the pump unit is operational during the standard cleaning time of an automatic pool cleaner; for example, operating the pump only when onboard sensors detect foreign objects. Automatic pool cleaners that consume less power typically need less charging, and can clean more between charges, consequentially requiring less human intervention in their daily and long-term operations, and allowing for longer battery life.

SUMMARY OF THE INVENTION

[0006] It is therefore an object of the present invention to provide an automatic pool cleaner including, a pump unit, a sensor unit comprising a sensor, the sensor configured to detect foreign object, and a control unit coupled to the sensor unit and the pump unit, the control unit configured to activate the pump unit at a first power level which is less then full power when a foreign object is not detected by the sensor, and further configured to activate the pump unit at a second power level, which is greater than the first power level, in response to a signal from the sensor unit indicating the detection of a foreign object.

[0007] Furthermore, in accordance with some embodiments of the present invention, said sensor unit is mounted so as to have a sensed region located underneath the automatic pool cleaner.

[0008] Furthermore, in accordance with some embodiments of the present invention, said sensor unit is mounted so as to have a sensed region located along a current anticipated motion path of the automatic pool cleaner.

[0009] Furthermore, in accordance with some embodiments of the present invention, said sensor unit sensor unit comprises an optical sensor.

[0010] Furthermore, in accordance with some embodiments of the present invention, said pump unit is powered by an external power source.

[0011] Furthermore, in accordance with some embodiments of the present invention, said control unit is further configured to operate the automatic pool cleaner at fixed time

[0012] There is further provided, in accordance with some embodiments of the present invention, a method for cleaning a pool with minimum power consumption, the method including configuring an automatic pool cleaner to traverse a surface while operating one or more sensors, to detect foreign objects, operating a pump unit of the automatic pool cleaner at a first power level, less then full power, when a foreign object is not detected and, operating the pump unit at a second power level, which is greater than the first power level, when a foreign object is detected.

[0013] Furthermore, in accordance with some embodiments of the present invention, said automatic pool cleaner is configured to operate the pump to maintain a straight course in the face of asymmetry.

[0014] Furthermore, in accordance with some embodiments of the present invention, said one or more sensors are configured to provide a sensed region along a current anticipated motion path of the automatic pool cleaner.

[0015] Furthermore, in accordance with some embodiments of the present invention, said one or more sensors are configured to provide a sensed region located underneath the automatic pool cleaner.

[0016] Furthermore, in accordance with some embodiments of the present invention, said one or more sensors comprise one or more optical sensors.

[0017] Furthermore, in accordance with some of the embodiments of the present invention, said method includes activating the automatic pool cleaner at a regular fixed time interval to traverse the surface.

BRIEF DESCRIPTION OF THE DRAWING

[0018] In order to better understand the present inven-

tion, and appreciate its practical applications, the following Figures are provided and referenced hereafter. It should be noted that the Figures are given as embodiments only and in no way limit the scope of the invention. Like components are denoted by like reference numerals.

[0019] Fig. 1 is a schematic illustration of an automatic pool cleaner according to some embodiments of the current invention;

[0020] Fig. 2A is a schematic illustration of an automatic pool cleaner according to some embodiments of the current invention;

[0021] Fig. 2B is a schematic illustration of an underside of an automatic pool cleaner according to some embodiments of the current invention;

[0022] Fig. 3A is a schematic illustration of a sensor unit according to some embodiments of the current invention;

[0023] Fig. 3B is a schematic illustration of a sensor unit according to an embodiment of the current invention;

[0024] Fig. 4 is a flow chart of a method of operating the automatic pool cleaner, according to an embodiment of the current invention; and,

[0025] Fig. 5 is a flow chart of a method for operating automatic pool cleaner, according to an embodiment of the invention.

[0026] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0027] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the methods and apparatus. However, it will be understood by those skilled in the art that the present methods and apparatus may be practiced without these specific details. In other instances, well-known methods, procedures, and components have not been described in detail so as not to obscure the present methods and apparatus.

[0028] Although the embodiments disclosed and discussed herein are not limited in this regard, the terms "plurality" and "a plurality" as used herein may include, for example, "multiple" or "two or more". The terms "plurality" or "a plurality" may be used throughout the specification to describe two or more components, devices, elements, units, parameters, or the like. Unless explicitly stated, the method embodiments described herein are not constrained to a particular order or sequence. Additionally, some of the described method embodiments or elements thereof can occur or be performed at the same point in time.

[0029] Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that throughout the specification, discussions utilizing terms such as "adding", "associating" "selecting," "evaluating," "processing," "computing," "calculating," "determining," "designating," "allocating" or the like, refer to the actions and/or processes of a computer, computer processor or computing system, or similar electronic computing device, that manipulate, execute and/or transform data represented as physical, such as electronic, quantities within the computing system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices.

[0030] Fig. 1 is a schematic illustration of an automatic pool cleaner 10 according to some embodiments of the current invention. Automatic pool cleaner 10 typically comprises a housing 80, a connection for battery charging 20, a battery, inside housing 80, the battery described below with reference to Fig. 2A, drive wheels 30 and track 40 for moving automatic pool cleaner 10, one or more sensor mountings 50, one or more sensors 60, a brush 70 for uses known in the art, a handle 90 for uses known in the art, and a pump outlet 100 for a pump unit, the pump unit described below with reference to Fig. 2A.

[0031] In some embodiments, the pump outlet may be configured to eject water drawn up into the automatic pool cleaner through an intake, the intake described below with reference to Fig. 2B.

[0032] Typically water enters the automatic pool cleaner through the intake. Water may then pass through a filter unit, the filter unit described with reference to Fig. 2A. Water may then pass through the pump unit, and out pump outlet 100, while trapping foreign objects -including dirt or debris, in the filter unit.

[0033] Housing 80, sensor mounting 50 and connection for battery charging 20 may be watertight.

[0034] Control unit, as described, for example, below with reference to Fig. 2A, may be configured to activate automatic pool cleaner 10 at set intervals. In some embodiments of the current invention, automatic pool cleaner 10 may be configured to be activated by the control unit at a regular or fixed time intervals, for example, between 2 and 10 times per week, e.g., once every 24 hours.

[0035] Sufficient light is typically required for some types of sensors 60 to operate, typically image sensors. When the pool is in darkness or low light, automatic pool cleaner 10 may be configured to cease all operations. In some embodiments of the current invention, automatic pool cleaner 10 may have an additional sensor, described below, to determine ambient light.

[0036] When activated at a regular or fixed time interval, automatic pool cleaner 10 may be typically programmed to run a cleaning cycle for a set fixed time interval. In some embodiments of the current invention, automatic pool cleaner 10 may be programmed to run for 30 minutes to 120 minutes, e.g., 45 minutes to 90

minutes. The automatic pool cleaner may be typically configured to transverse the surfaces of the pool during a cleaning cycle autonomously. Numerous algorithms for autonomous operation of pool cleaners are known in the art.

[0037] Automatic pool cleaner 10 may operate continuously during cleaning cycles. Typically, when automatic pool cleaner 10 is employing an image sensor, automatic pool cleaner 10 may continue on a straight path until automatic pool cleaner 10 reaches a wall. In some examples, automatic pool cleaner 10 changes direction, and or turns, if it encounters an obstacle.

[0038] In some examples, the automatic pool cleaner executes turns according to a preprogrammed algorithm as are known in the art, such as, for example, the algorithm, described in US Patent 6,815,918.

[0039] In some examples the control unit will activate the pump after each turn that the robot makes, if foreign objects are sensed by the image sensor. In other examples, the control unit would activate the pump in another manner, if no foreign objects are within the field of view of the sensor.

[0040] In some embodiments of the current invention, the control unit may also modify the operation of drive wheels 30 of automatic pool cleaner 10, for example, moving the wheels more slowly, or backing up over a foreign object discovered by sensor 60.

[0041] Sensor 60 may be typically a component of sensor unit 150, described in reference to Figs. 3a and 3b. Automatic pool cleaner 10 may have one or more sensor units 150 connected to the control unit. Sensor 60 may be coupled to control unit as described below in reference to Fig. 2A.

[0042] Sensor 60 may have a sensed region, the sensed region being a field of view of sensor 60, when sensor 60 is an optical sensor, or the extent of the observable area over which information can be extracted at any given moment by sensor 60, when sensor 60 is any other kind of sensor known in the art.

[0043] Typically, sensor 60 may be an optical sensor that is known in the art. Examples of sensors include, but are not limited to, color sensors, reflectivity sensors, and image sensors. Sensor 60 may be configured to scan a surface of the pool for foreign objects, i.e., traversing a surface while operating one or more sensors to detect foreign objects, and send data to the control unit regarding the results of the scan, the scan not limited to optical scans but may include scans made by other non-optical sensors known in the art. In some embodiments, the sensor may be another type of sensor capable of determining whether there may be a foreign object in the path of automatic pool cleaner 10, or in the surroundings of automatic pool cleaner 10.

[0044] Typically, automatic pool cleaner 10 does not have an absolute front or back; it travels both forward and backwards. Automatic pool cleaner may have a relative front and a relative back, wherein the relative front is facing the current anticipated motion path of the automatic pool cleaner and the relative back relative is facing the opposite direction of the current anticipated motion path of the automatic pool cleaner. Typically sensor 60 is mounted to automatic pool cleaner such that the sensor provides a sensed region directed at the area in front of the relative front of automatic pool cleaner 10, i.e., facing the current anticipated motion path of automatic pool cleaner. In some applications, a second sensor 60 is mounted to the automatic pool cleaner such that sensor 60 provides a sensed region directed at the area behind the automatic pool cleaner in the opposite direction of the current anticipated motion path of the automatic pool cleaner, i.e., the sensor may be mounted on the relative back of automatic pool cleaner 10. The sensed region of sensor 60 may not be limited to fields of view of optical sensors, but may include other fields of view of other non-optical sensors known in the art.

[0045] Automatic pool cleaner 10 may have at least one motor, as described below with reference to Fig. 2A. Typically, automatic pool cleaner 10 may have two motors, described below in reference to Fig. 2A. At least one of the motors may be configured to be connected to the control unit and further connected to drive wheels 30.

[0046] In some embodiments, a motor may be configured to be coupled to pump unit 230, described below in reference to Fig. 2A. Control unit, in response to a signal from sensor 60, indicating the presence of foreign objects, may send a signal to the motor to power pump unit 230. Typically, the pump unit may include an axial type pump powered by a brush or brushless DC motor. Other types of pumps and motors known in the art may also be used.

[0047] Typically, a measure of hysteresis may be included in the activation of the pump unit so as to prevent frequent start/stop operation when dirt, debris and foreign objects in the pool are patchy or unevenly distributed.

[0048] Fig.2a is a schematic illustration that includes internal components of the automatic pool cleaner. Typically, automatic pool cleaner 10 has an intake, as described below with reference to Fig. 2B, on an underside of the automatic pool cleaner, configured to draw water into a filter unit 220. In some embodiments of the current invention, filter unit 220 may include a filter bag or a filter cartridge. Typically, filter unit 220 may be configured to be removed periodically and emptied of foreign objects. In some embodiments, filter unit 220 may be periodically disposed of and replaced.

[0049] Typically, water and foreign objects may be drawn through intake and into filter unit 220 via vacuum suction created by pump unit 230. Pump unit 230 may be typically powered by motor 240. In some embodiments of the current invention, motor 250 may power wheels 30. Motors 240 and 250 are typically connected to control unit 280. Control unit 280 typically contains a micro-controller.

[0050] Motor 240, and in some embodiments, motor 240 which may power the pump unit and motor 250 which may power wheels 30, may be powered by one or more

batteries 260. In some embodiments of the current invention, batteries 260 are rechargeable. Typically, batteries 260 may be nickel metal hydride (NiMH), lithium ion (Li-ion), Lithium-iron-phosphate ($LiFePO_4$), or lithium ion polymer (Li-ion polymer), or other batteries known in the art. In some embodiments, motor 240 and or more motor 250 are powered by an external power source.

[0051] In some embodiments of the current invention, motor 240 powers pump unit 230. Motor 240 may be powered down completely unless motor 240 receives a signal from control unit 280 to power up pump unit 230. In some embodiments, pump unit may be powered up to a first power level to maintain a straight course in the face of asymmetry. Typically, uneven pool surfaces or uneven wear on the cleaners tracks or wheels create instances of asymmetry for automatic pool cleaner 10. Other forms of asymmetry known in the art may also require a powered up pump unit to maintain a straight course for automatic pool cleaner. In some applications, the pump unit may be powered up to maintain any course known in the art for automatic pool cleaners. When partially powered up, pump unit 230 uses between 0% and 50% of power, e.g., 30% of power.

[0052] In some embodiments, pump unit 230 may be powered up to a second power level, the second power level may be equal to full power, in response to control unit 280 sending a signal to power up pump unit 230 when foreign objects are detected by sensor 60. In other embodiments, when powered at a second power level, the pump may be only partially powered up, the level of power depending on factors relevant to cleaning the surfaces of the pool.

[0053] In some applications of the current invention, automatic pool cleaner 10 may have a sensor 305 to determine ambient light conditions. Sensor 305 may send a signal to control unit 280 to either stop to delay operation until there is sufficient light for sensor 60 to be effective. In some applications, sensor 305 may send a signal to control unit 280 to operate a light source 300. Light source 300 may be a high brightness light emitting diode (LED) or a number of LEDs, or other forms of illumination. Light source 300 may provide sufficient ambient light for sensor 60 to operate even when ambient light outside the pool is too low for sensor 60 to operate.

[0054] Fig. 2B is a schematic illustration of an underside of automatic pool cleaner 10. Underside 400 may be positioned to be sufficiently close to a pool surface such that robot cleaner 10 can vacuum up foreign objects via pump unit 230 as describe, e.g., herein.

[0055] In some embodiments of the current invention, automatic pool cleaner 10 may have wheels 30 and track 40, and at least one intake 410 on the underside of automatic pool cleaner 10. Typically intake 410 is configured to be far enough from sensor 60 such that pump unit 230 has sufficient time to power-up and vacuum up foreign objects in response to the foreign object being sensed by sensor 60.

[0056] In some embodiments the sensed region of sensor 60 is directed toward the current anticipated direction of motion of automatic pool cleaner 10. In some embodiments of the current invention, automatic pool cleaner 10 may have at least one sensor 60 connected to underside 400. In other embodiments, the sensed region of sensor 60 may be beneath automatic pool cleaner 10, and may be wider, narrower, or equal to the width of automatic pool cleaner 10. In some embodiments, other non-optical sensors known in the art may also be used.

[0057] Fig. 3A is a schematic illustration of a sensor unit 150. Typically, sensor unit 150 may be configured to be removable from the automatic pool cleaner 10. In some embodiments of the current invention, sensor unit 150, or sensors 60 within sensor unit 150, may be encapsulated or in a resin filled enclosure. In some embodiments, a second sensor unit may be connected to automatic pool cleaner 10 after sensor unit 150 is removed. In some embodiments, an additional sensor unit can be connected to automatic pool cleaner 10 without removing sensor unit 150.

[0058] Sensor unit 150 may be configured to be connected to automatic pool cleaner 10 with a watertight seal. In some embodiments, sensor unit 150 may be connected to housing 80 of automatic pool cleaner 10, typically via connector 160. Sensor unit 150 typically may have a cable 170 configured to connect control unit 280, described with reference to Fig. 2A, to sensor 60. Sensor unit 150 may also include a sensor housing 180, the sensor housing configured to house sensor 60, the sensor configured to be in communication with the control unit via cable 170. Typically data may be sent to control unit 280 in automatic pool cleaner 10 from sensor unit 150 via a serial data link.

[0059] Cable 170 may also be configured to send power to sensor unit 150 from a power source in automatic pool cleaner 10. Typically batteries 260, as described with reference to Fig. 2A, provide power to sensor unit 150. Sensor unit 150 may also have a threading 180. Threading 180 may be configured to securely connect sensor unit 150 to automatic pool cleaner 10.

[0060] Sensor unit may be connected to control unit 280 via an industry standard M12 connector. Typically, this connection may be watertight. In other applications, other connectors known in the art may also be used.

[0061] Typically, sensor unit 150 may include an electronic circuit, 165. Electronic circuit 165 may include a microcontroller.

[0062] Fig. 3B is a schematic drawing of sensor unit 150 described heretofore with reference to Fig. 3A with exceptions noted. Sensor unit 150 may include a linear array optical sensor 190. In some embodiments of the current invention, linear array optical sensor 190 may be housed within sensor housing 180. Sensor housing 180 may be transparent. In some applications, sensor housing 180 may also contain an illumination source 205 (e.g. a white light source). Illumination source 205 may be similar to light source 300 described above with reference to Fig. 2A. Sensor housing 180 may also contain an elec-

tronic circuit 165, and a color sensor 155, the color sensor may include an array of detectors and color filters combined with a light source. In some embodiments, sensor housing 180 may house an array of color sensors. Electronic circuit 165, as described with reference to Fig. 3A, may be configured to decode and format the information derived from the sensors, and further configured to connect to a digital data bus to send data to control unit 280 in automatic pool cleaner 10.

[0063] In some embodiments of the current invention, sensor unit 150 includes an image sensor 185, for example an active-pixel sensor (APS), a complementary metal-oxide-semiconductor (CMOS) sensor, or a charge-coupled device (CCD) sensor. Other sensors that may be used in digital cameras, or other sensor devices that are known in the art, may also be used. The image sensor may be typically configured to determine the cleanliness state of the pool, in particular, a surface within the pool. In some embodiments, image sensor 185 may be configured to determine the patchiness of color on the pool floor, and distinguish foreign objects that result in a sensed evenness that is different from the evenness depicted in a reference image.

[0064] The image sensor may provide an image to an image processor 195, which may be configured to compare the current image with a reference image, typically with respect to color and texture. The image processor may facilitate identifying foreign objects lying on the surface of the pool. Typically, the image processor may take advantage of the uniform coloring of most residential pools, in comparing a current image with a reference image. The image processor may also not need to know the exact location of automatic pool cleaner 10 in the pool to determine whether a foreign object has been detected by a sensor, given the relative uniform coloring typically found in most residential pools.

[0065] Sensor housing 180 may also contain one or more other optical sensors; the optical sensors may include those that are known in the art. Sensor unit 150 may also include a sensor window 200 in sensor housing 180.

[0066] Fig. 4 is a flow chart of a method for operating automatic pool cleaner, according to an embodiment of the current invention.

[0067] In some embodiments of the invention, automatic pool cleaner 10 may clean a pool with minimum power consumption, wherein automatic pool cleaner 10 traverses a surface while operating one or more sensors 60, to detect foreign objects, as depicted in block 500. Automatic pool cleaner may traverse the pool at a first power level. Automatic pool cleaner 10 may employ sensors 60 while traversing the pool to search for or look for foreign objects, as depicted as diamond 505. Automatic pool cleaner 10 may not detect or find a foreign object. While traversing the pool, automatic pool cleaner 10 may operate pump unit 230 at a first power level, less then full power, when a foreign object is not detected, as depicted in block 510. Automatic pool cleaner 10 may find and/or detect a foreign object. Automatic pool cleaner may operate pump unit 230 at a second power level, which is greater than the first power level, when a foreign object is detected, as depicted in block 520.

[0068] In some embodiments of the invention, automatic pool cleaner 10 may operate at regular and/or fixed time intervals, for example, as described above. In some embodiments of the invention, automatic pool cleaner 10 may not operate at regular and/or fixed time intervals.

[0069] Fig. 5 is a flow chart of a method for operating automatic pool cleaner, according to an embodiment of the invention.

[0070] In some embodiments of the invention, a method for cleaning a pool with minimum power consumption includes activating an automatic pool cleaner for a fixed time interval to traverse a surface while operating one or more sensors to detect foreign objects, as depicted as box 600.

[0071] The method may further include configuring the automatic pool cleaner to determine if there is a foreign object on the surface by comparing a current image of the surface with a reference image obtained by said one or more sensors, as depicted as diamond 610.

[0072] When no foreign object is detected, Box 630 depicts of the portion of the method that may include configuring the automatic pool cleaner to employ a pump unit at a first power level. The first power level may be 0% power.

[0073] When a foreign object is detected, the method may include configuring the automatic pool cleaner to move toward the foreign object on the surface, as depicted as box 620. In some embodiments of the inventions, automatic pool cleaner may employ algorithms to move toward the foreign object. The algorithms may determine an optimal path to reach the foreign object. The algorithms may determine an optimal path for automatic pool cleaner 10 to advance over foreign object to vacuum up foreign object. Algorithms may be used to determine size shape, orientation and other characteristics of the foreign object in determining how automatic pool cleaner should advance toward, reach and pass over the foreign object.

[0074] Automatic pool cleaner may move toward foreign object a first power level and vacuum foreign object at a second power level. Automatic pool cleaner may move toward a suspected foreign object at a power level, and when reaching suspected foreign object, changing power levels in response to newly discovered characteristics of the foreign object, including, in some embodiments of the invention, false positives.

[0075] Box 640 depicts a portion of the method wherein automatic pool cleaner may employ the pump unit at a second power level in response to detecting and/or moving toward the foreign object. The second power level may be greater than the first power level. The second power level may be optimized given detected characteristics of the foreign object. The second power level may be one or a plurality of power levels depending on characteristics associated the foreign object, including, in

some embodiments of the invention, distance from the automatic pool cleaner.

[0076] Examples of the present invention may include apparatuses for performing the operations described herein. Such apparatuses may be specially constructed for the desired purposes, or may comprise computers or processors selectively activated or reconfigured by a computer program stored in the computers. Such computer programs may be stored in a computer-readable or processor-readable non-transitory storage medium, any type of disk including floppy disks, optical disks, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs) electrically programmable read-only memories (EPROMs), electrically erasable and programmable read only memories (EEPROMs), magnetic or optical cards, or any other type of media suitable for storing electronic instructions. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein. Examples of the invention may include an article such as a non-transitory computer or processor readable non-transitory storage medium, such as for example, a memory, a disk drive, or a USB flash memory encoding, including or storing instructions, e.g., computer-executable instructions, which when executed by a processor or controller, cause the processor or controller to carry out methods disclosed herein. The instructions may cause the processor or controller to execute processes that carry out methods disclosed herein.

[0077] Different embodiments are disclosed herein. Features of certain embodiments may be combined with features of other embodiments; thus certain embodiments may be combinations of features of multiple embodiments. The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. It should be appreciated by persons skilled in the art that many modifications, variations, substitutions, changes, and equivalents are possible in light of the above teaching. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

[0078] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents will now occur to those of ordinary skill in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

Claims

1. An automatic pool cleaner (10), comprising:

a pump unit (230);

a sensor unit (150) comprising a sensor (60), the sensor (60) configured to detect foreign objects; and,

a control unit (280) coupled to the sensor unit (150) and the pump unit (230),

wherein the control unit (280) is configured to activate the pump (230) unit at a first power level which is less than full power when a foreign object is not detected by the sensor (60), and further configured to activate the pump unit (230) at a second power level, which is greater than the first power level, in response to a signal from the sensor unit (150) indicating the detection of a foreign object.

2. An automatic pool cleaner (10) according to claim 1, wherein the sensor unit (150) is mounted so as to have a sensed region located underneath the automatic pool cleaner (10).

3. An automatic pool cleaner (10) according to claim 1 or claim 2, wherein the sensor unit (150) is mounted so as to have a sensed region located along a current anticipated motion path of the automatic pool cleaner (10).

4. An automatic pool cleaner according to any of claims 1 to 3, wherein the sensor unit (150) comprises an optical sensor.

5. An automatic pool cleaner according to any of claims 1 to 4, wherein the pump unit (230) is powered by a battery or an external power source.

6. An automatic pool cleaner according to any of claims 1 to 5, wherein the control unit (280) is further configured to operate the automatic pool cleaner (10) at fixed time intervals.

7. A method of cleaning a pool with minimum power consumption comprising:

configuring an automatic pool cleaner (10) to traverse a surface while operating one or more sensors (60), to detect foreign objects;

and

operating a pump unit (230) of the automatic pool cleaner (10) at a first power level, less than full power, when a foreign object is not detected; and,

operating the pump unit (230) at a second power level, which is greater than the first power level, when a foreign object is detected.

8. A method according to claim 7, wherein the automatic pool cleaner (10) is configured to operate the pump unit (230) to maintain a straight course in the face of asymmetry.

9. A method according to claims 7 or 8, wherein said one or more sensors (60) are configured to provide a sensed region along a current anticipated motion path of the automatic pool cleaner (10).

10. A method according to any of claims 7 to 9, wherein said one or more sensors (60) are configured to provide a sensed region located underneath the automatic pool cleaner (10).

11. A method according to any of claims 7 to 10, wherein said one or more sensors (60) comprise one or more optical sensors.

12. A method as claimed in any of claims 7 to 11 comprising: activating the automatic pool cleaner (10) at a regular fixed time interval to traverse the surface.

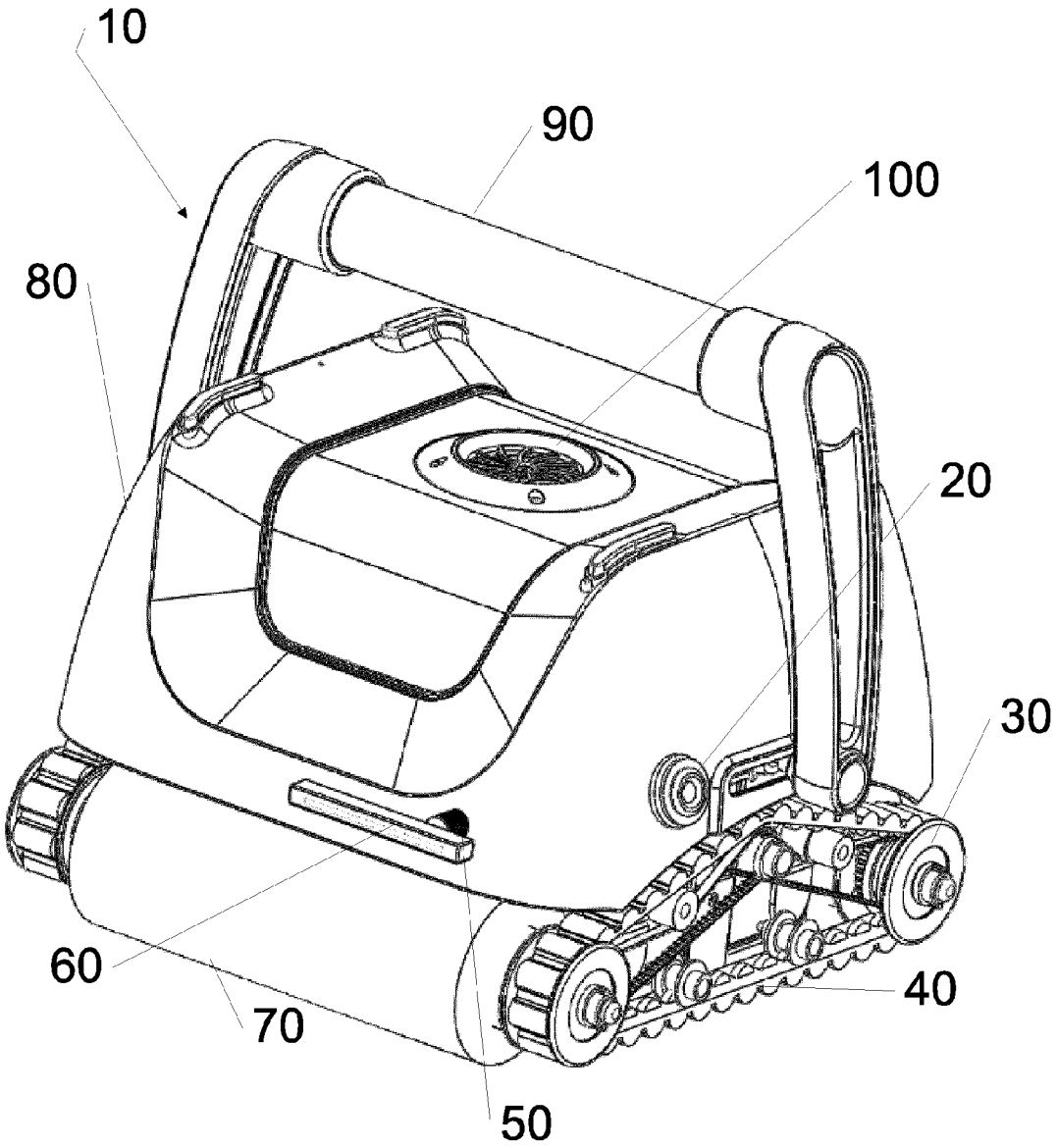

Fig.1

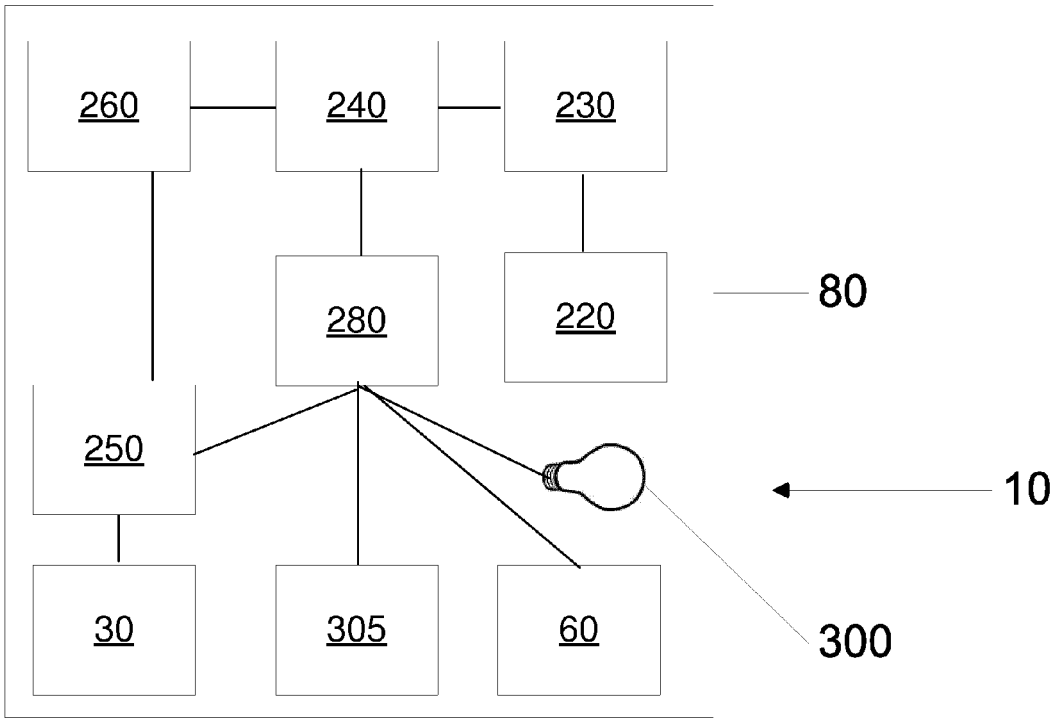

Fig. 2A

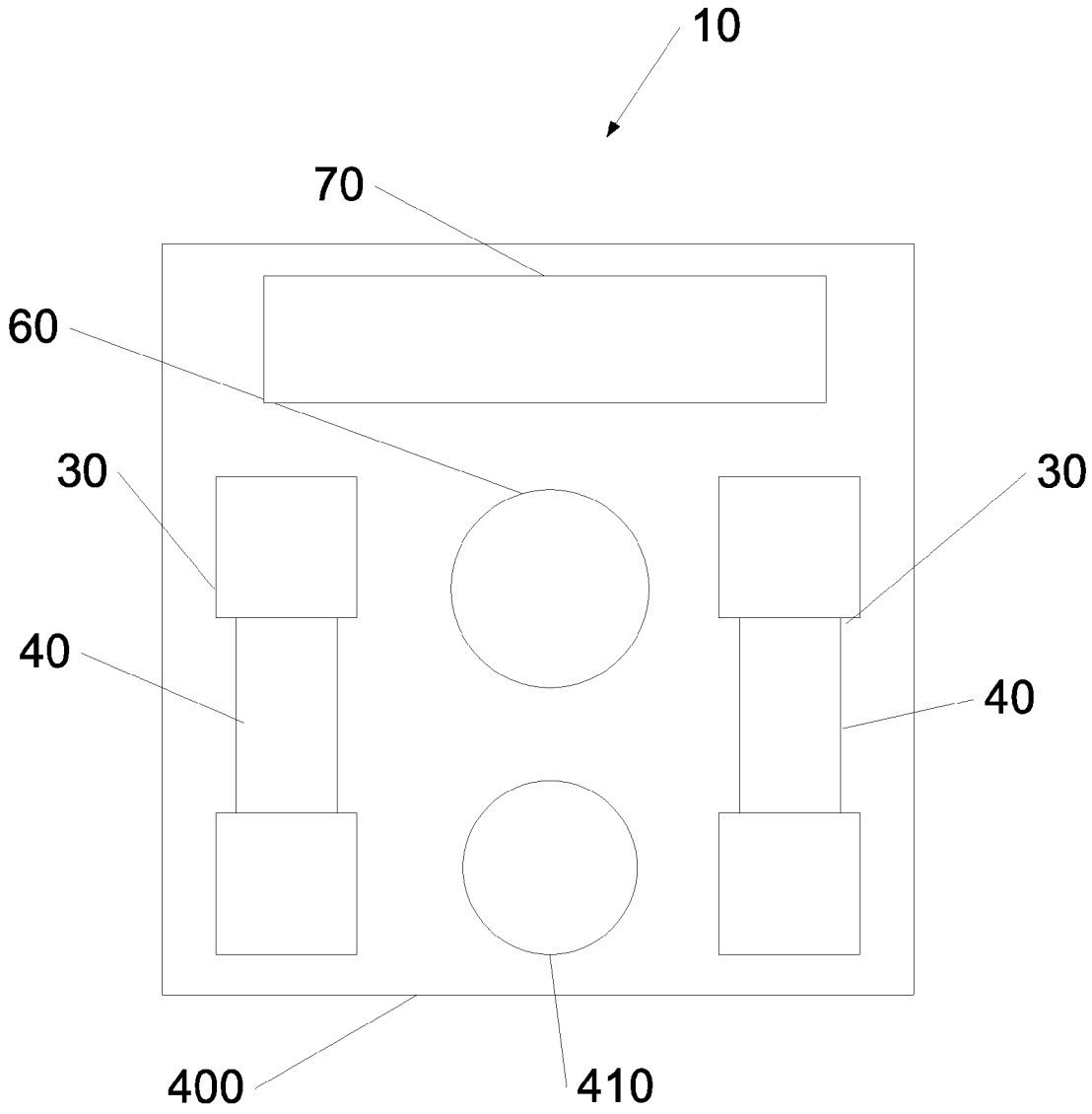

Fig 2B

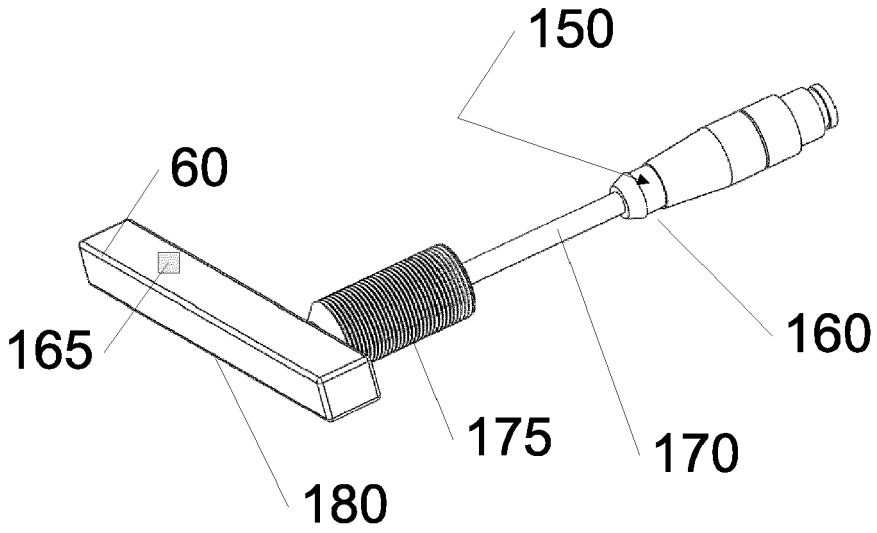

Fig. 3A

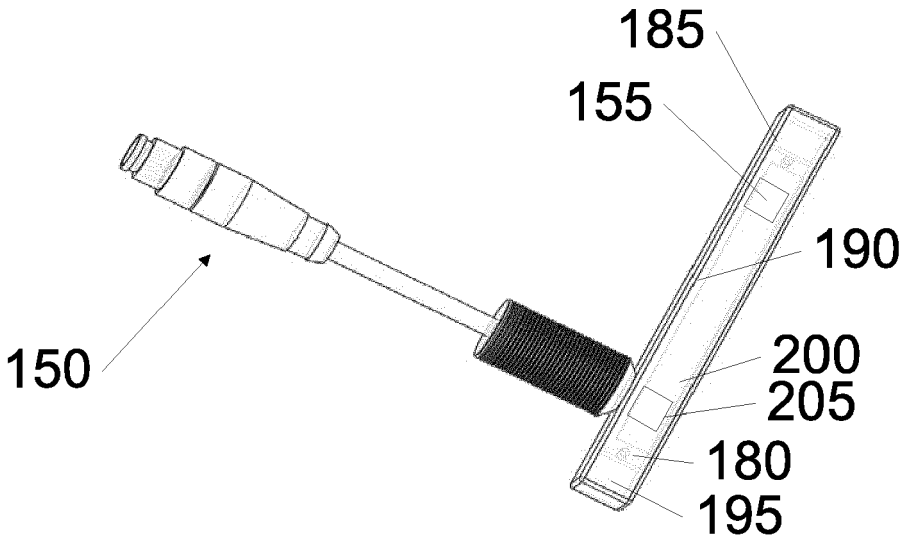

Fig. 3B

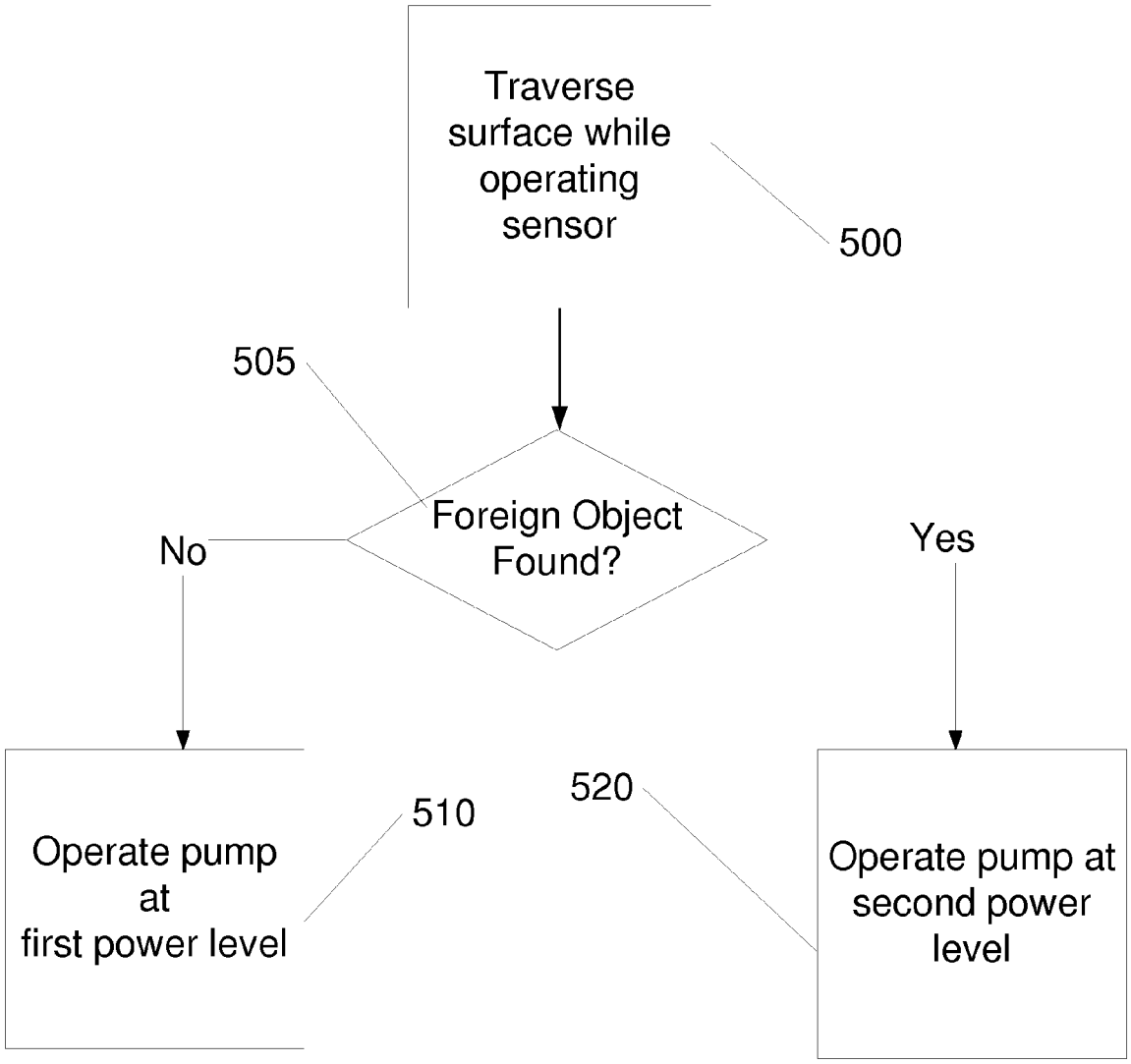
Traverse surface while operating sensor
500
505
Foreign Object Found?
No
Yes
Operate pump at first power level
510
520
Operate pump at second power level

Fig. 4

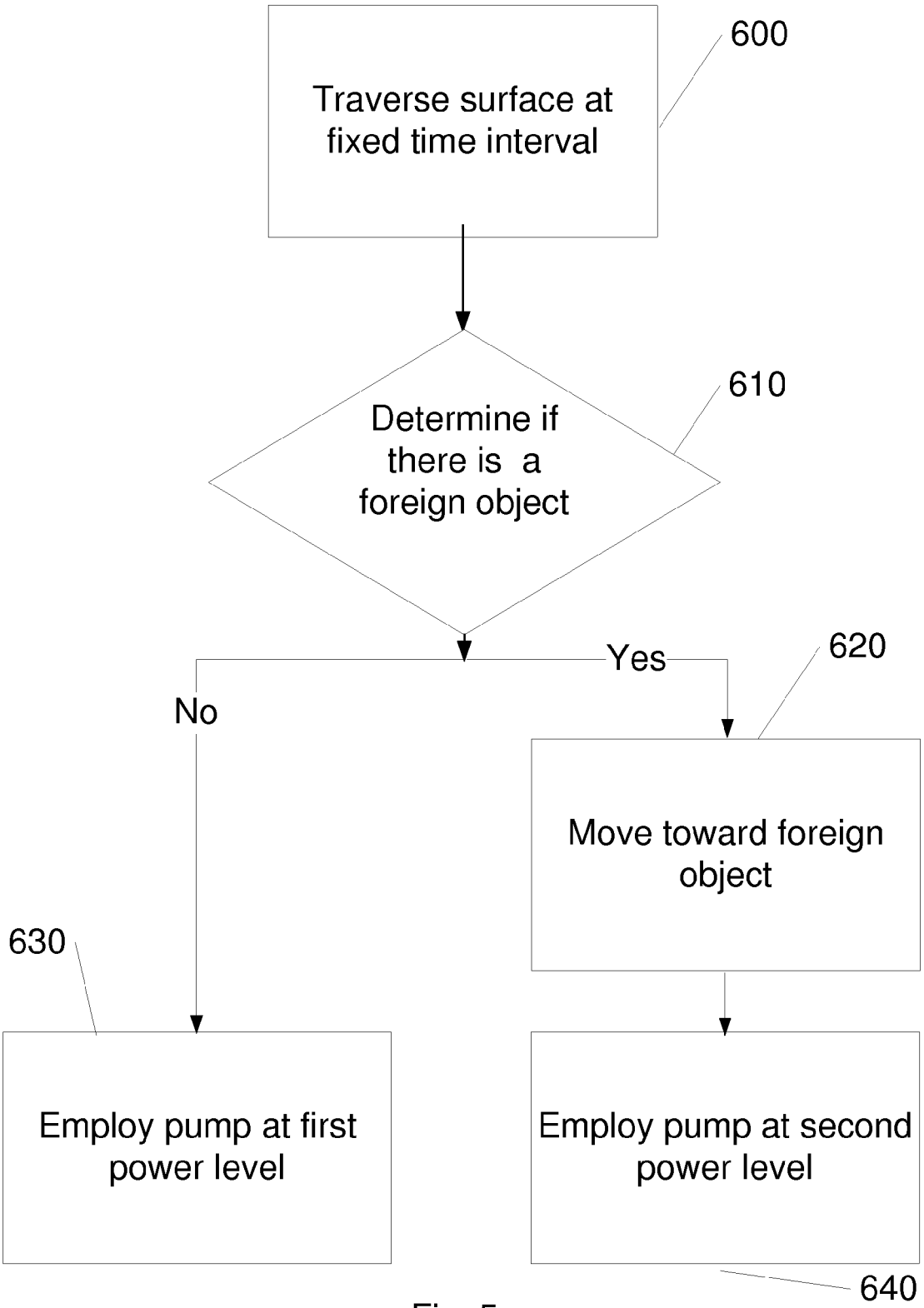
Traverse surface at fixed time interval
600
Determine if there is a foreign object
610
Yes
620
No
Move toward foreign object
630
Employ pump at first power level
Employ pump at second power level
640

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6815918 B **[0038]**