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(54) **PUMP SYSTEM WITH DYNAMIC LEVEL CONTROL**

(57) A pump having a motor, an inlet port, a discharge port, a fluid sensor, and a controller is provided. The fluid sensor is configured to detect whether a fluid level has risen above a threshold fluid level. The controller is configured to activate the pump in response to the fluid sensor detecting that the fluid level has risen above the threshold fluid level, initiate a shutoff delay timer in response to the fluid sensor detecting that the fluid level has receded below the threshold fluid level, the shutoff delay timer having a shutoff delay time, increase the shutoff delay time if the fluid sensor detects that the fluid level has risen above the threshold fluid level again before the shutoff delay time elapsed, and maintain the shutoff delay time if the fluid sensor detects that the fluid level stayed below the threshold fluid level until the shutoff delay time elapsed.

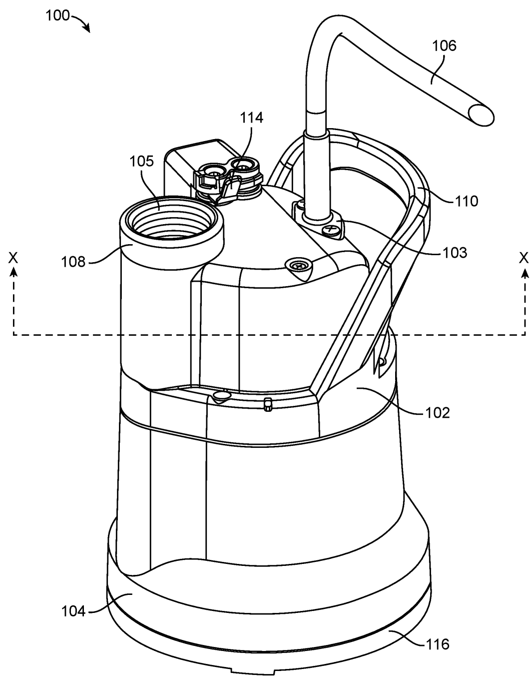

FIG. 1

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Description

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 63/606,458, filed on December 5, 2023, the entire disclosure of which is incorporated herein by reference.

TECHNOLOGY FIELD

[0002] This disclosure generally relates to fluid transfer. More specifically, the disclosure relates to a pump with a fluid level control system.

BACKGROUND

[0003] Electrically powered pumps are often used to move fluids from one location to another. While the pump may readily move a volume of fluid from a source location, fluid may repeatedly fill the source location, causing the pump to turn on and shut off repeatedly.

[0004] Repeated turn-on and shut-off cycles may result in premature wear of the internal components of the pump (e.g., bearings, rotor, stator, windings, etc.) and further result in eventual pump failure. Also, pump failure may in turn result in damage to the source location from where the pump is intended to remove fluid.

[0005] Electrically powered pumps may use a level sensor as a switch that turns on the pump when the level sensor contacts a fluid and shuts off the pump when the level sensor is no longer in contact with the fluid. However, an undesirably high frequency of starts and stops due to intermittent contact with the fluid may damage the pump, cause inconsistent fluid pumping, and other undesirable effects. Further, many conventional drainage pumps are designed to work only at high water levels and prove to be less effective at transferring fluid away from large, flat surfaces such as roofs, terraces, tennis courts, construction pits, and basements.

[0006] As such, there is a need for an improved pump that is designed to mitigate rapid cycling starts and stops, in particular when used to transfer fluid away from large, flat surfaces.

SUMMARY

[0007] Some embodiments provide a pump having a motor, an inlet port, a discharge port, a fluid sensor, and a controller. The fluid sensor is configured to detect whether a fluid level has risen above a threshold fluid level. The controller is configured to activate the pump in response to the fluid sensor detecting that the fluid level has risen above the threshold fluid level, initiate a shutoff delay timer in response to the fluid sensor detecting that the fluid level has receded below the threshold fluid level, the shutoff delay timer having a shutoff delay time, increase the shutoff delay time if the fluid sensor detects that the fluid level has risen above the threshold fluid level again before the shutoff delay time has elapsed, and maintain the shutoff delay time if the fluid sensor detects that the fluid level stayed below the threshold fluid level until the shutoff delay time has elapsed.

[0008] In some embodiments, the shutoff delay timer has a maximum shutoff delay time. The controller can be configured to maintain the shutoff delay time when the shutoff delay time is equal to the maximum shutoff delay time, even if the fluid sensor detects that fluid has risen above the threshold fluid level before the shutoff delay time has elapsed. The controller can be configured to shut down the pump if the fluid sensor detects that the fluid level remains below the threshold fluid level until the shutoff delay time has elapsed. The controller can be configured to initiate a reset timer after shutting down the pump, the reset timer having a reset time. The controller can be configured to reset the shutoff delay time to a default shutoff delay time if the fluid level remains below the threshold fluid level until the reset time has elapsed. The default delay time can be 15 seconds. The reset time can be reset to a default reset time each time the shutoff delay time is reset to the default shutoff delay time. The reset time can be increased each time the shutoff delay time is increased. The reset time can be increased in proportion to the shutoff delay time each time the shutoff delay time is increased.

[0009] Some embodiments provide a pump having an inlet port, a discharge port, a fluid sensor configured to detect a fluid, and a controller. The controller is configured to activate the pump in response to the fluid sensor detecting the fluid, after activating the pump, initiate a shutoff delay timer having a shutoff delay time when the fluid sensor no longer detects the fluid, increase the shutoff delay time if the fluid sensor detects the fluid before the shutoff delay time has elapsed, and maintain the shutoff delay time if the fluid sensor does not detect the fluid before the shutoff delay time has elapsed.

[0010] In some embodiments, the fluid sensor is a provided in the form of a plurality of electrodes. Each of the plurality of electrodes can have a bottom end and a strainer covering the inlet port can have a bottom-most portion, and a distance between the bottom end of each of the plurality of electrodes and the bottom-most portion of the strainer can be about 7mm. The plurality of electrodes can be provided as only two electrodes. The controller can be configured to initiate a startup delay timer having a startup delay time when the fluid sensor detects the fluid and delay activation of the pump until after the startup delay time has elapsed. The controller can be configured to shut down the pump if the fluid sensor does not detect the fluid before the shutoff delay time has elapsed.

[0011] Some embodiments provide a method of controlling a level of fluid with a pump having a motor, an inlet port, a discharge port, and a fluid sensor configured to detect a fluid. The method includes activating the pump in response to the fluid sensor detecting the fluid, initiating a shutoff delay timer when the fluid sensor no longer detects the fluid, the shutoff delay timer having a shutoff delay time, increasing the shutoff delay time if the fluid sensor detects the fluid before the shutoff delay time has elapsed, and maintaining the shutoff delay time if the fluid sensor does not detect the fluid before the shutoff delay time has elapsed.

[0012] In some embodiments, the method can further include shutting down the pump if the fluid sensor does not detect the fluid before the shutoff delay time has elapsed. In some embodiments, the method can further include initiating a reset timer after shutting down the pump, the reset timer having a reset time. In some embodiments, the method can further include resetting the shutoff delay time to a default shutoff delay time if the fluid sensor does not detect the fluid before the reset time has elapsed. In some embodiments, the method can further include initiating a startup delay timer having a startup delay time when the fluid sensor detects the fluid after the shutoff delay time is reset. In some embodiments, the method can further include delaying activation of the pump until after the startup delay time has elapsed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a front and left side isometric view of a pump according to an embodiment;
FIG. 2 is a rear and right side isometric view of the pump of FIG. 1;
FIG. 3 is a partial bottom isometric view of the pump of FIG. 1;
FIG. 4 is a cutaway isometric view of the pump of FIG. 1;
FIG. 5 is a partial top isometric view of the pump of FIG. 1 with an upper housing of the pump shown in phantom;
FIG. 6 is a partial cross-sectional isometric view of the upper housing of FIG. 5 taken along line X-X of FIG. 1;
FIG. 7 is a block diagram of various electronic components of the pump of FIG. 1; and
FIG. 8 is a flowchart representing a method of controlling a level of fluid with the pump of FIG. 1.

[0014] Before explaining the disclosed embodiments of the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the particular arrangements shown since the invention is capable of other embodiments. Exemplary embodiments are illustrated in referenced figures of the drawings. It is intended that the embodiments and figures disclosed herein are to be considered illustrative rather than limiting. Also, the terminology used herein is for the purpose of description and not of limitation.

DETAILED DESCRIPTION

[0015] The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus, embodiments of the invention are not intended to be limited to embodiments shown but are to be accorded the widest scope consistent with the principles and features disclosed herein.

[0016] The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives and fall within the scope of embodiments of the invention. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. For example, the use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

[0017] As used herein, unless otherwise specified or limited, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, unless otherwise specified or limited, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings, but can also refer to communicative, electrical, or fluidic couplings.

[0018] As used herein, unless otherwise specified or limited, "at least one of A, B, and C," and similar other phrases, are meant to indicate A, or B, or C, or any combination of A, B, and/or C. As such, this phrase, and similar other phrases can include single or multiple instances of A, B, and/or C, and, in the case that any of A, B, and/or C indicates a category of elements, single or multiple instances of any of the elements of the categories A, B, and/or C.

[0019] FIGS. 1-6 illustrate a pump 100 in accordance with the teachings of this disclosure. As best seen in FIGS. 1 and 2, the pump 100 is provided in the form of an upper housing 102, a lower housing 104, an electrical cord 106, a reinforcement ring 108, and various internal components discussed in more detail below. The upper housing 102 also optionally includes a handle 110 by which the pump 100 may be grasped, stored, and/or transported. The upper housing 102 is removably fastened to the lower housing 104 such that the internal components of the pump 100 are accessible for maintenance, service, lubrication, etc. when the pump 100 is not in use. Further, the internal electrical components of the pump 100 are substantially isolated and sealed from outside fluids. Thus, the pump 100 is submersible and may be lowered into a volume of fluid via a rope (not shown) tied to the handle 110 or via other methods.

[0020] In some embodiments, the upper housing 102 is formed of a polymer material (e.g., polyethylene, nylon, acrylonitrile butadiene styrene (ABS), etc.). In some embodiments, the lower housing 104 is formed of a metallic material (e.g., steel, aluminum, brass, etc.). In one specific embodiment, the upper housing 102 is formed of a glass reinforced plastic and the lower housing 104 is formed of solid aluminum.

[0021] Here, the upper housing 102 is sealably engaged with the lower housing 104 and with the electrical cord 106. The electrical cord 106 protrudes upwardly and outwardly from a top surface of the upper housing 102 and includes an electrical plug (not shown) at a distal end thereof. The electrical cord 106 may be fastened or otherwise joined to the upper housing 102 via screws or other waterproof fastening mechanisms. A stiffening plate 103 (see FIG. 2) may be provided around the electrical cord 106 to impart additional stability and strength. The electrical cord 106 provides electrical energy to the internal electrical components of the pump 100 when the electrical plug is engaged to or in communication with a power source.

[0022] Further, the reinforcement ring 108 is provided in the form of an annular metallic body. In some forms, with respect to the electrical cord 106, the reinforcement ring 108 can be disposed on an opposite side of the upper housing 102. Further, the upper housing 102 forms a fluid discharge pathway and includes a series of threads 105 that circumscribe an interior surface thereof. The threads 105 of the upper housing 102 are designed to engage with a discharge hose (not shown). In some instances, the reinforcement ring 108 may aid in preventing damage to the threads 105 caused by incorrect hose assembly. A check valve 111 (see FIGS. 2 and 4-6) is disposed within the orifice defined by the upper housing 102 and the annular body of the reinforcement ring 108. In some instances, the check valve 111 may be positioned upstream of and adjacent to the threads 105.

[0023] Referring to FIGS. 2 and 3, the pump 100 further includes a fluid level sensor 112, a manual override switch 114, and a strainer 116, which covers an inlet port of the pump 100. The upper housing 102 further includes an arm 117 that extends downwardly along the lower housing 104. The level sensor 112 can be disposed in the arm 117, adjacent to a bottom of the pump 100, and is provided in the form of a first electrode 118 and a second electrode 120. In some forms, the level sensor 112 may instead be provided in the form of float switch or a capacitive level sensor that is integrated with or selectively removable from the pump 100. The arm 117 includes slots that receive, support, and guide the first electrode 118 and the second electrode 120. The first electrode 118 and the second electrode 120 extend from the arm 117 along a portion of an outer rim 122 of the strainer 116 circumscribing the lower housing 104.

[0024] In operation, when the first electrode 118 and the second electrode 120 contact an electrically conductive fluid (e.g., water with at least trace dissolved ionic minerals), the first electrode 118 and the second electrode 120 are put into electrical communication with one another via the electrically conductive fluid. Thus, the level sensor 112 is configured to detect electrically conductive fluids. In some embodiments, the minimum level (height) of fluid detectable by the level sensor 112 is any possible range where fluid contacts the first electrode 118 and the second electrode 120. In some forms, the distance between the bottom-most ends of the first electrode 118 and the second electrode 120 and the bottom-most portion of the strainer 116 is between about 1 mm to about 10 mm, about 3 mm to about 7 mm, about 1 mm to about 5 mm, etc. For example, the distance between the bottom-most ends of the first electrode 118 and the second electrode 120 and the bottom-most portion of the strainer 116 can be 5mm. Accordingly, with the pump 100 resting on a flat surface, the level sensor 112 would be able to detect a fluid level between about 1 mm to about 10 mm, about 3 mm to about 7 mm, about 1 mm to about 5 mm, etc.

[0025] Further, the manual override switch 114 is supported by the arm 117 and is in electrical communication with the level sensor 112. In operation, the manual override switch 114 is selectively actuatable between an automatic position and a manual position. In some embodiments, the manual override switch 114 includes a slot such that it can be selectively actuated with a tool (e.g., a screwdriver, a coin, a key, etc.) to prevent accidental engagement. In the manual position, the first electrode 118 and the second electrode 120 are placed in electrical communication with one another via the manual override switch 114. In the automatic position, the first electrode 118 and the second electrode 120 are electrically separated from one another unless they are in contact with the electrically conductive fluid.

[0026] In operation, when the electrical cord 106 is plugged into an external power grid (not shown) and the manual override switch 114 is oriented in the manual position, the pump 100 turns on. Additionally, when the electrical cord 106 is plugged into the external power grid and the manual override switch 114 is oriented in the automatic position, the pump remains off until the first electrode 118 and the second electrode 120 contact the electrically conductive fluid, in which case the pump 100 turns on. Due to the configuration of the level sensor 112 (i.e., adjacent the bottom of the pump 100, and more specifically, coextensive with the arm 117 and a portion of the outer rim 122) and the strainer 116, the pump 100 may start when the fluid is at a depth of about 5 mm (or 5 mm) and may remove or draw down fluid to a depth of about 2 mm (or 2 mm).

[0027] Referring to FIG. 3, the strainer 116 is removably engaged with the lower housing 104. The strainer 116 is provided in the form of a circular disc that includes a plurality of slots 124 through which fluid may flow. The slots 124 extend radially around the strainer 116 and may vary in size and/or shape. In operation, the strainer 116 prevents debris from contacting one or more of the internal components of the pump 100.

[0028] Turning to FIG. 4, various internal components of the pump 100 are depicted. In particular, the pump 100 further includes a motor 126, a motor cooling jacket 128, a shaft 130, and an impeller 132. The motor 126 and the motor cooling jacket 128 are supported by the lower housing 104 and the impeller 132 is connected to and driven by the motor 126 via the shaft 130. In some instances, the motor 126 is an air-filled submersible pump motor. A fluid flow path 134 is defined by the flow path of the fluid as it enters the pump 100 via the strainer 116, travels upwardly through an exterior portion of the lower housing 104 into an exterior portion of the upper housing 102, and is ejected from the pump 100 via a discharge port 135 defined by the upper housing 102 and into the discharge hose (not shown).

[0029] Referring to FIGS. 5 and 6, the pump 100 further includes a controller 136 designed to effectuate the operation of the pump 100. The controller 136 is disposed in the upper housing 102 and is isolated from the fluid flow path 134 and other water or fluid incursion by the sealing engagement of the upper housing 102 with the lower housing 104 and the seal around the electrical cord 106. The controller 136 receives electrical power from the external power grid via the electrical cord 106 and includes various control components mounted to a circuit board 142. The control components are in electrical communication with one another and configured to dynamically control the motor 126 (shown in FIG. 4), as will be explained in further detail below. In some embodiments, the controller 136 may be located externally to the pump 100 and in communication with the pump 100 via a wired and/or wireless connection.

[0030] FIG. 7 illustrates a block diagram of various electronic components of the pump 100 in more detail that are used to control the pump 100 of FIGS. 1-5. Various electronic components of the pump 100 are in communication with each other and include the controller 136, the motor 126, the level sensor 112, and a temperature sensor 202. The controller 136 includes a processor 204, a memory 206, a thermostat 208, and a fluid level control module 210. The controller 136 is in electrical communication with the motor 126, the level sensor 112, and the temperature sensor 202 such that the controller 136 can send and receive signals to and from the motor 126, the level sensor 112, and the temperature sensor 202.

[0031] The memory 206, the thermostat 208, and the fluid level control module 210 can be provided in the form of tangible computer-readable media on which one or more sets of non-transitory, computer readable instructions, such as the software or firmware for operating the methods of the present disclosure, can be embedded. The embedded instructions may embody one or more of the methods or logic as described herein. In a particular embodiment, the embedded instructions may reside completely, or at least partially, within any one or more of the memory 206, the thermostat 208, or the fluid level control module 210.

[0032] The memory 206, the thermostat 208, and the fluid level control module 210, may be provided in the form of one or more of volatile memory (e.g., RAM, which may include magnetic RAM, ferroelectric RAM, and any other suitable forms); non-volatile memory (e.g., disk memory, FLASH memory, EPROMs, EEPROMs, non-volatile solid-state memory, etc.), unalterable memory (e.g., EPROMs), read-only memory, and/or high-capacity storage devices (e.g., hard drives, solid state drives, etc.). In some examples, the memory 206, the thermostat 208, and the fluid level control module 210, include multiple types of memory, particularly both volatile memory and non-volatile memory.

[0033] Still referring to FIG. 7, the processor 204 may be provided in the form of one or more of any suitable processing devices or set of processing devices such as, but not limited to a microprocessor, a microcontroller-based platform, a suitable integrated circuit, one or more field programmable gate arrays (FPGAs), and/or one or more application-specific integrated circuits (ASICs). The processor 204 is configured to execute non-transitory computer readable instructions, such as those instructions stored in the memory 206, the thermostat 208, and the fluid level control module 210.

[0034] In some forms, the processor 204 may include multiple processors, the memory 206 may include multiple memories, and the controller 136 may include multiple controllers. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions described herein. In some examples, the processor 204 may be a component of a processing system, which may refer to a system (such as a series) of machines, circuitry (including, for example, one or both of processor circuitry (which may include the processor 204) and memory circuitry (which may include the memory 206)), or components, that receives or obtains inputs and processes the inputs to produce, generate, or obtain a set of outputs. The processing system may be configured to perform one or more of the functions described herein. For example, the processor 204 or a processing system including the processor 204 may be configured to, configurable to, or operable to cause the pump 100 to perform one or more of the functions described herein. Further, as described herein, being "configured to," being "configurable to," and being "operable to" may be used interchangeably and may be associated with a capability, when executing code (e.g., processor-executable code) stored in the memory 206 or otherwise, to perform one or more of the functions described herein.

[0035] The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" should be understood to include a single medium or multiple media, such as a centralized or distributed database, and/or associated caches and servers that store one or more sets of instructions. The terms "non-transitory computer-readable medium" and "tangible computer-readable medium" also include any tangible medium that can store, encode, or carry a set of instructions for execution by the processor 204 or that causes the pump 100 to perform any one or more of the methods or operations disclosed herein. As used herein, the term "tangible computer-readable medium" includes any type of computer-readable storage device and/or storage disk and excludes propagating signals. As used herein, the terms "tangible computer-readable medium" and "tangible machine-readable medium" are used interchangeably.

[0036] Turning next to the function of the thermostat 208, the thermostat 208 receives temperature signals from the temperature sensor 202 (i.e., a first temperature value at a first time period, a second temperature value at a second time period, etc.). Based on these temperature signals, the thermostat 208 determines whether a temperature of the internal components of the pump 100 (e.g., the motor 126) has exceeded a pre-defined temperature threshold value. If the temperature (e.g., first temperature value, second temperature value, etc.) of the internal components has exceeded the temperature threshold value, the thermostat 208 can turn off the motor 126. Once the temperature of the internal components of the pump 100 have cooled to a temperature that is below the temperature threshold value, the motor 126 can be turned on to initiate a pumping operation.

[0037] Referring next to the fluid level control module 210, the fluid level control module 210 includes instructions to determine whether the pump 100 has been placed into a volume of fluid based on fluid presence signals received from the level sensor 112. Based on the fluid presence signals, the fluid level control module 210 includes instructions to turn on the pump 100, retain the pump 100 in an operational and/or active state, and turn off the pump 100. The fluid level control module 210 also includes instructions to activate one or more timers, such as a startup delay timer, a shutoff delay timer, and a reset timer, which are configured to provide additional limits as to whether and when the pump 100 is turned on or off, as described in further detail below. In practice, the timers of the fluid level control module 210 prevent the motor 126 from rapidly cycling between on and off. It should be appreciated that repetitive starts and stops may damage the motor 126. Thus, the fluid level control module 210 aids in mitigating damage to the motor 126. Further, by dynamically controlling the motor 126 in accordance with the instructions of the fluid level control module 210, the pump 100 may be adapted for use in varying pumping applications (e.g., removing puddles from a flat roof, emptying swimming pools, emptying flooded basements, etc.).

[0038] FIG. 8 illustrates a method 800 corresponding to the functions implemented by the processor 204 of the controller 136 when executing the instructions provided by the fluid level control module 210. At step 802, the level sensor 112 detects the presence of a fluid and sends a detection signal to the controller 136 accordingly. In practice, at step 802, the level sensor 112 detects whether a fluid level of the fluid has risen above a threshold fluid level as determined, for example, by the distance between the bottom-most edges of the first electrode 118 and the second electrode 120 and the bottom-most portion of the strainer 116. If at step 802, the controller 136 determines that the level sensor 112 is not in contact with the fluid, the method 800 continues to monitor the fluid level/presence. However, if at step 802, the controller 136 determines that the level sensor 112 is in contact with the fluid, e.g., the fluid has risen above the threshold fluid level, the method 800 proceeds to step 804.

[0039] At step 804, the controller 136 initiates the startup delay timer, which has a startup delay time, e.g., about 0 seconds, about 1 second, about 2 seconds, less than 1 second, etc. In practice, initiating the startup delay timer includes initiating a countdown of the startup delay time, and step 804 involves waiting for the startup delay time to elapse. If the controller 136 determines that the level sensor 112 is no longer in contact with the fluid before to the startup delay time has elapsed, the method 800 will return to step 802. However, if the controller 136 determines that the level sensor 112 is still in contact with the fluid until after the startup delay time has elapsed, the method 800 proceeds to step 806. At step 806, the controller 136 turns on the pump 100. The method 800 then proceeds to step 808 with the pump 100 turned on.

[0040] At step 808, while the pump 100 is running, the controller 136 determines whether the level sensor 112 is still in contact with the fluid based on signals from the level sensor 112, e.g., whether the fluid level is still above the threshold fluid level. If at step 808, the controller 136 determines, based on signals from the level sensor 112, that the level sensor 112 remains in contact with the fluid, the method 800 returns to step 806 to continue running the pump. However, if at step 808, the controller 136 determines, based on signals from the level sensor 112, that the level sensor 112 is no longer in contact with the electrically conductive fluid, e.g., the fluid level has receded below the threshold fluid level, the method 800 proceeds to step 810.

[0041] At step 810, while the pump 100 continues to run, the controller 136 initiates the shutoff delay timer, which has a shutoff delay time, e.g., between about 7 seconds and about 20 seconds, about 10 seconds, about 15 seconds, etc. It is to be understood that at the first instance of step 810 being implemented, the shutoff delay time can be provided as a default shutoff delay time. Once the shutoff delay timer has been initiated, the method 800 proceeds to step 812.

[0042] At step 812, while the pump 100 continues to run, the controller 136 determines, based on signals from the level sensor 112, whether the level sensor 112 has reestablished contact with the fluid before the shutoff delay time has elapsed, e.g., the fluid level has risen back above the threshold fluid level. If, at step 812, the controller 136 determines that the level sensor 112 has not reestablished contact with the fluid within the shutoff delay time, e.g., the fluid level has stayed below the threshold fluid level, the method 800 proceeds to step 814, where the controller 136 stops the pump 100. If, however, at step 812, the controller 136 determines that the level sensor 112 has reestablished contact with the fluid before the shutoff delay time has elapsed, the method 800 proceeds to step 816.

[0043] At step 816, while the pump 100 continues to run, the controller 136 determines, according to the instructions of the fluid level control module 210, whether the shutoff delay time is equal to a maximum shutoff delay time, e.g., 35 seconds, 45 seconds, 60 seconds, etc. If, at step 816, the controller 136 determines that the shutoff delay time is equal to the maximum shutoff delay time, the method 800 returns to step 806 where the pump 100 continues to run. However, if, at step 816, the controller 136 determines that the shutoff delay time has not reached the maximum shutoff delay time, the method 800 proceeds to step 818. At step 818, while the pump 100 continues to run, the controller 136 increases the delay shutoff time by a predetermined time value, e.g., by 5 seconds, 10 seconds, etc., and the method 800 returns to step 806 where the pump continues to run.

[0044] Returning to step 814, which occurs after fluid has not been re-detected and the shutoff delay time has elapsed in step 812, e.g., the fluid level is still below the threshold fluid level until at least the shutoff delay time has elapsed, the controller 136 turns off the pump 100 and the method 800 proceeds to step 820.

[0045] At step 820, while the pump 100 is stopped, the controller 136 initiates the reset timer, which has a reset time, e.g., between about 7 seconds and about 20 seconds, about 10 seconds, about 15 seconds, etc. As the reset timer is running, the controller 136 determines whether the level sensor 112 reestablishes contact with the fluid before the reset time has elapsed, e.g., the fluid level has risen back above the threshold fluid level. In some embodiments, the controller 136 also performs step 820 if the pump 100 stops because of a brief (e.g., 35 seconds or less) power supply interruption. If, at step 820, the controller 136 determines that the level sensor 112 has reestablished contact with the fluid before the reset time has elapsed, the method 800 proceeds to step 822 in which the controller 136 maintains the shutoff delay time and the method 800 returns to step 806 to run the pump 100.

[0046] However, if, at step 820, the controller 136 determines that the level sensor 112 has not reestablished contact with the fluid before the reset time has elapsed, the method 800 proceeds to step 824. At step 824, the controller 136 resets the shutoff delay time to be the default shutoff delay time and the method 800 begins anew. It should be known that in some embodiments, the shutoff delay time and the reset time are the same time value, e.g., between about 7 seconds and about 20 seconds, about 10 seconds, about 15 seconds, etc. In some embodiments, the shutoff delay time and the reset time are different time values. Further, in some embodiments, each time the shutoff delay time is increased in step 818, the reset time is increased in proportion to the increase in the shutoff delay time. For example, in some forms, each time the shutoff delay time is increased by a particular time value, the reset time is also increased by that same time value. Also, in some embodiments, each time the shutoff delay time is reset to the default shutoff delay time in step 824, the reset time can also be reset to a default reset time.

[0047] Accordingly, the pump 100 is highly adaptable to a variety of different source locations and can provide a self-adjusting working time for different applications. In particular, the pump 100 can be adapted for transferring fluid away from large, flat surfaces of different sizes or that experience different rates of fooding at different times such as tennis courts, construction pits, flat roofs, etc.

[0048] Specific embodiments of the pump described according to the present invention have been described for the purpose of illustrating the manner in which the invention can be made and used. It should be understood that the implementation of other variations and modifications of this invention and its different aspects will be apparent to one skilled in the art, and that this invention is not limited by the specific embodiments described. Features described in one embodiment can be implemented in other embodiments. The subject disclosure is understood to encompass the present invention and any and all modifications, variations, or equivalents that fall within the spirit and scope of the basic underlying principles disclosed and claimed herein.

Claims

1. A pump comprising:

a motor;
an inlet port;
a discharge port;
a fluid sensor configured to detect whether a fluid level has risen above a threshold fluid level; and
a controller configured to:

activate the pump in response to the fluid sensor detecting that the fluid level has risen above the threshold fluid level,
initiate a shutoff delay timer in response to the fluid sensor detecting that the fluid level

has receded below the threshold fluid level, the shutoff delay timer having a shutoff delay time,

increase the shutoff delay time if the fluid sensor detects that the fluid level has risen above the threshold fluid level again before the shutoff delay time has elapsed, and

maintain the shutoff delay time if the fluid sensor detects that the fluid level stayed below the threshold fluid level until the shutoff delay time has elapsed.

2. The pump of claim 1, wherein the shutoff delay timer has a maximum shutoff delay time.

3. The pump of claim 2, wherein the controller is configured to maintain the shutoff delay time when the shutoff delay time is equal to the maximum shutoff delay time, even if the fluid sensor detects that fluid has risen above the threshold fluid level again before the shutoff delay time has elapsed.

4. The pump of any one of claims 1 to 3, wherein the controller is configured to shut down the pump when the fluid sensor detects that the fluid level remains below the threshold fluid level until the shutoff delay time has elapsed.

5. The pump of claim 4, wherein the controller is configured to initiate a reset timer after shutting down the pump, the reset timer having a reset time.

6. The pump of claim 5, wherein the controller is configured to reset the shutoff delay time to a default shutoff delay time if the fluid level remains below the threshold fluid level until the reset time has elapsed.

7. The pump of claim 6, wherein the default shutoff delay time is 15 seconds.

8. The pump of claim 6, wherein the reset time is reset to a default reset time each time the shutoff delay time is reset to the default shutoff delay time.

9. The pump of claim 5, wherein the reset time is increased each time the shutoff delay time is increased.

10. The pump of claim 9, wherein the reset time is increased in proportion to the shutoff delay time each time the shutoff delay time is increased.

11. The pump of any one of claims 1 to 10, wherein the fluid sensor is a provided in the form of a plurality of electrodes.

12. The pump of claim 11, wherein each of the plurality of electrodes has a bottom end and a strainer covering the inlet port has a bottom-most portion, and a distance between the bottom end of each of the plurality of electrodes and the bottom-most portion of the strainer is about 7mm.

13. The pump of claim 11, wherein the plurality of electrodes is provided as only two electrodes.

14. The pump of any one of claims 1 to 13, wherein the controller is configured to initiate a startup delay timer having a startup delay time when the fluid sensor detects that the fluid level has risen above the threshold fluid level.

15. The pump of claim 14, wherein the controller is configured to delay activation of the pump until after the startup delay time has elapsed.

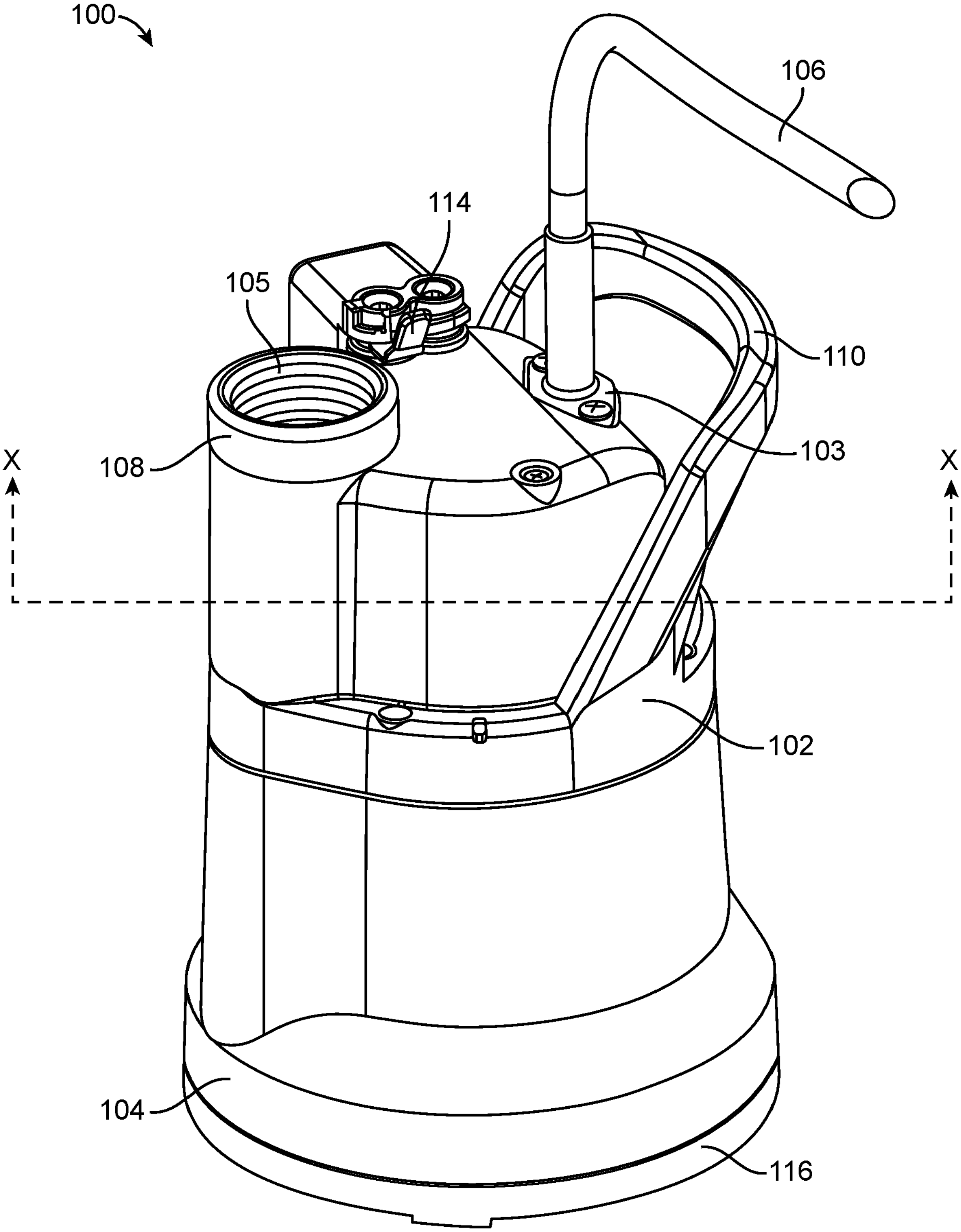

FIG. 1

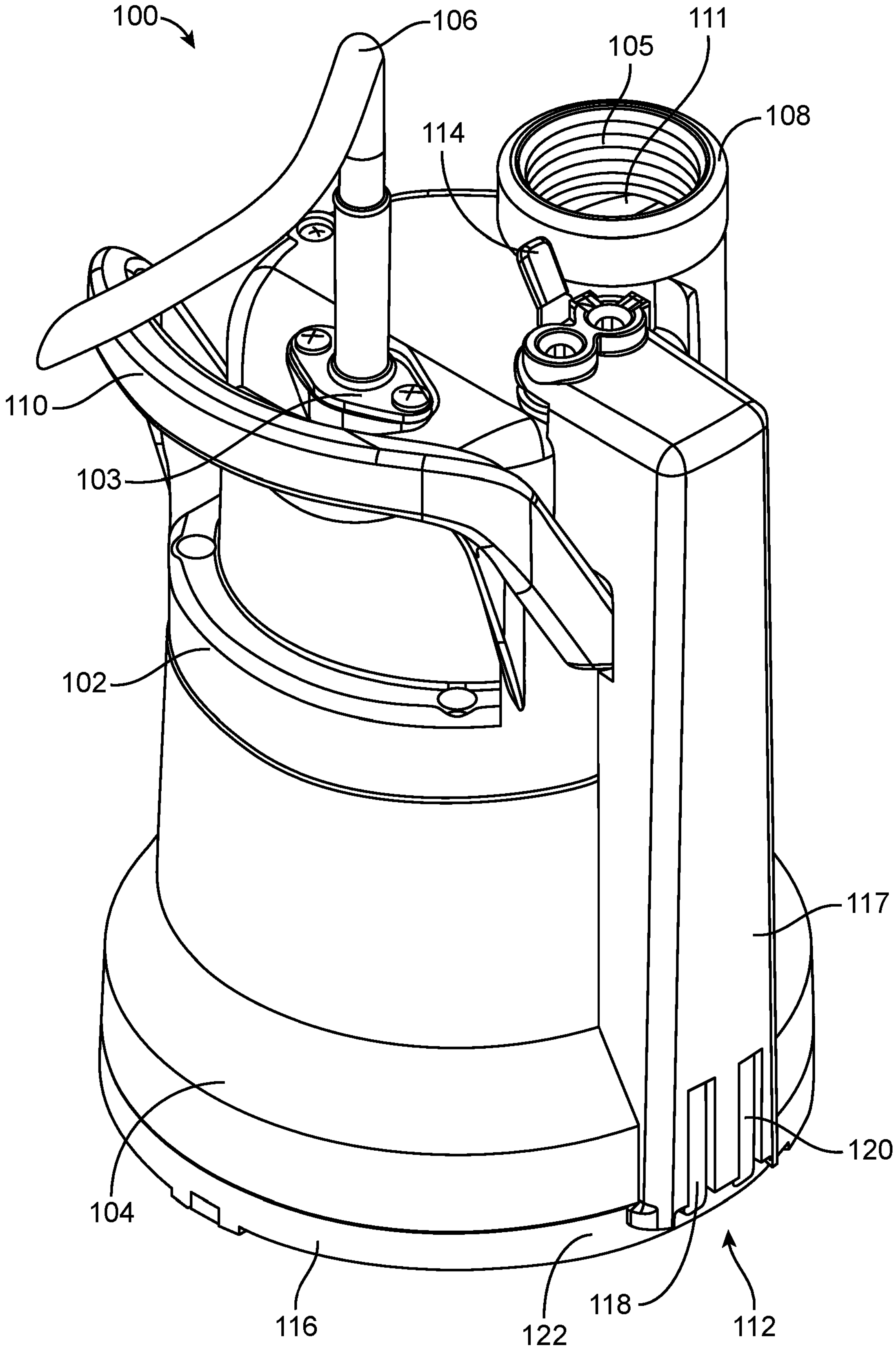

FIG. 2

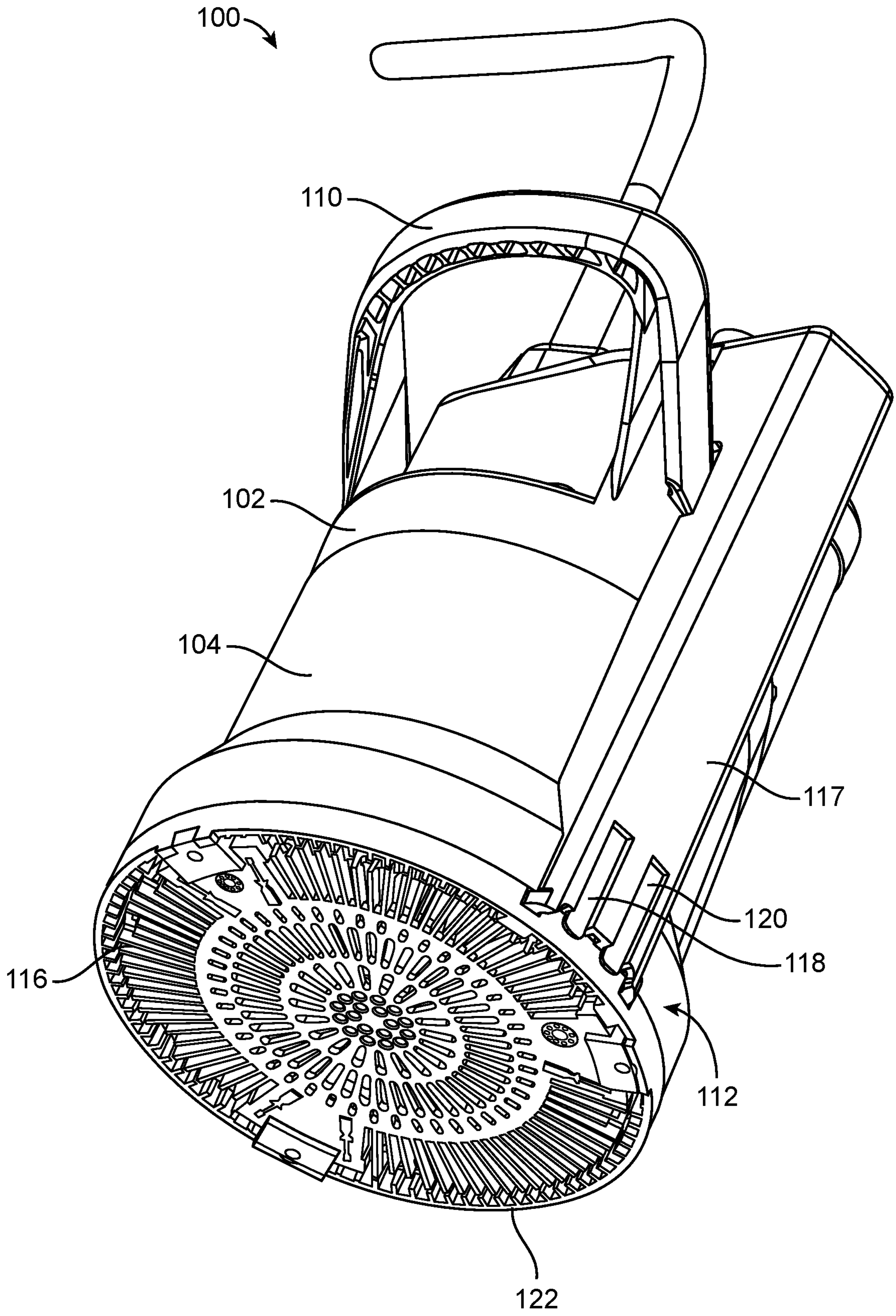

FIG. 3

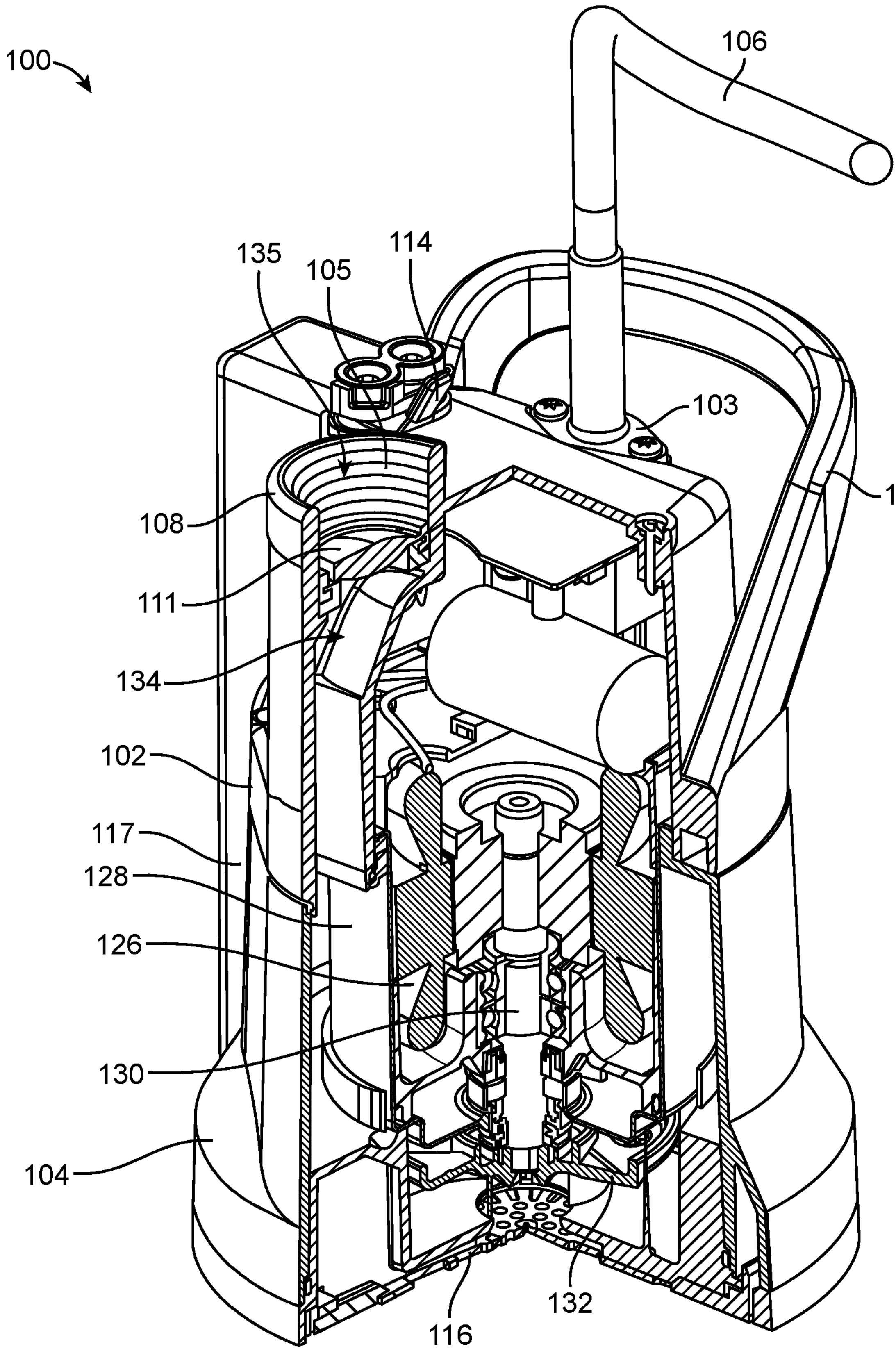
100
106
135
105
114
103
110
108
111
134
102
117
128
126
130
104
116
132

FIG. 4

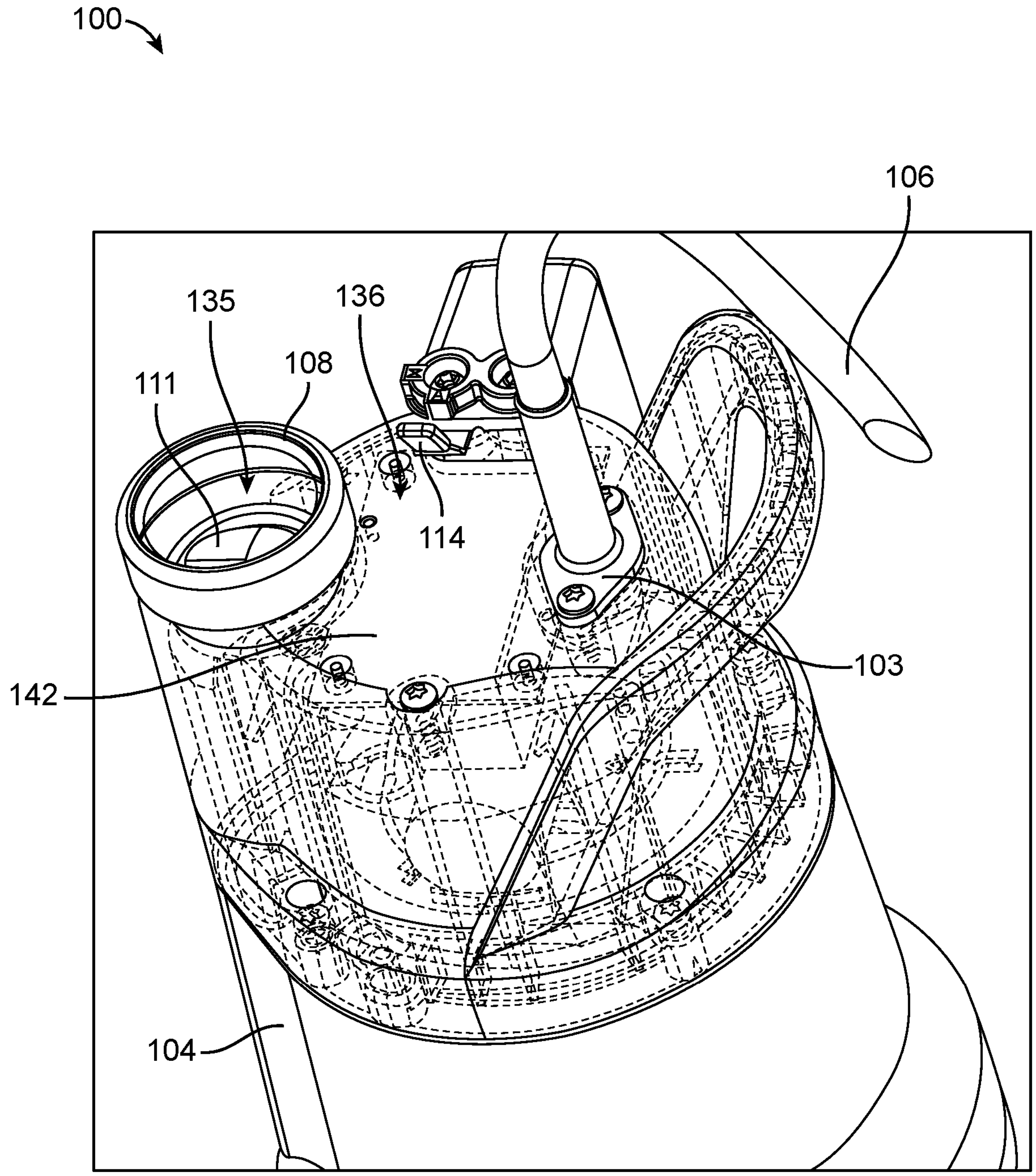

FIG. 5

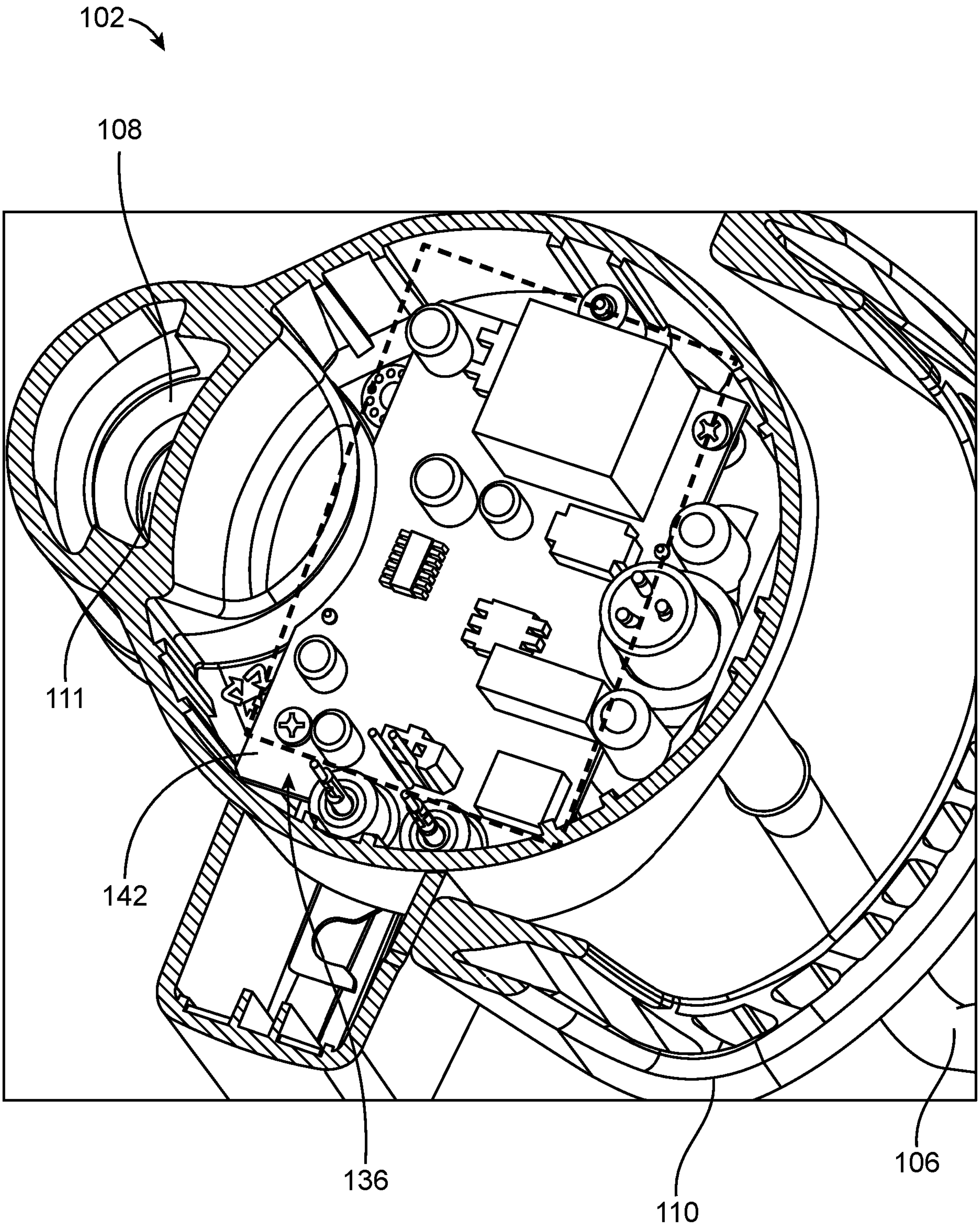

FIG. 6

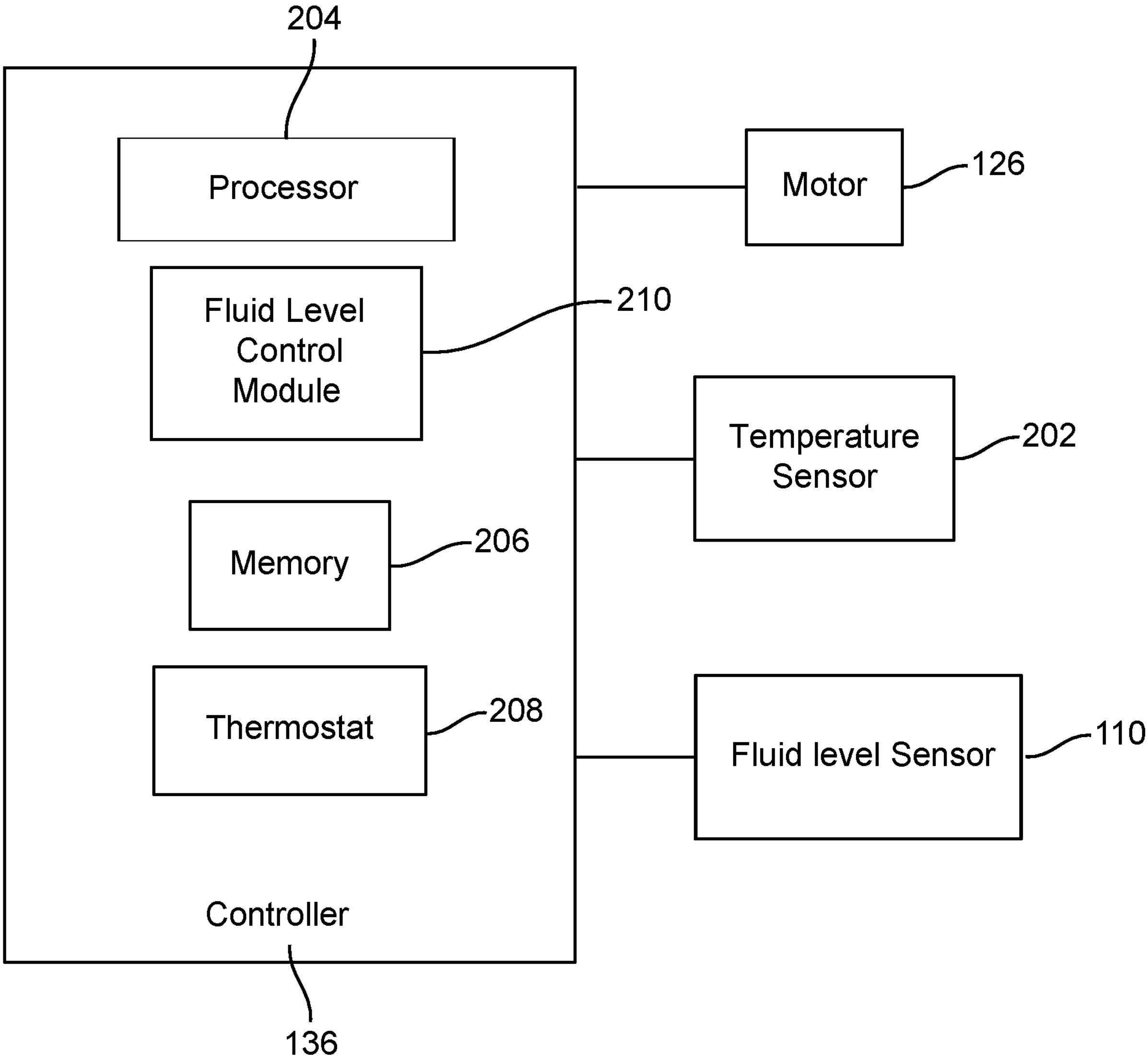
204
Processor
Fluid Level Control Module
210
Memory
206
Thermostat
208
Controller
136
Motor
126
Temperature Sensor
202
Fluid level Sensor
110

FIG. 7

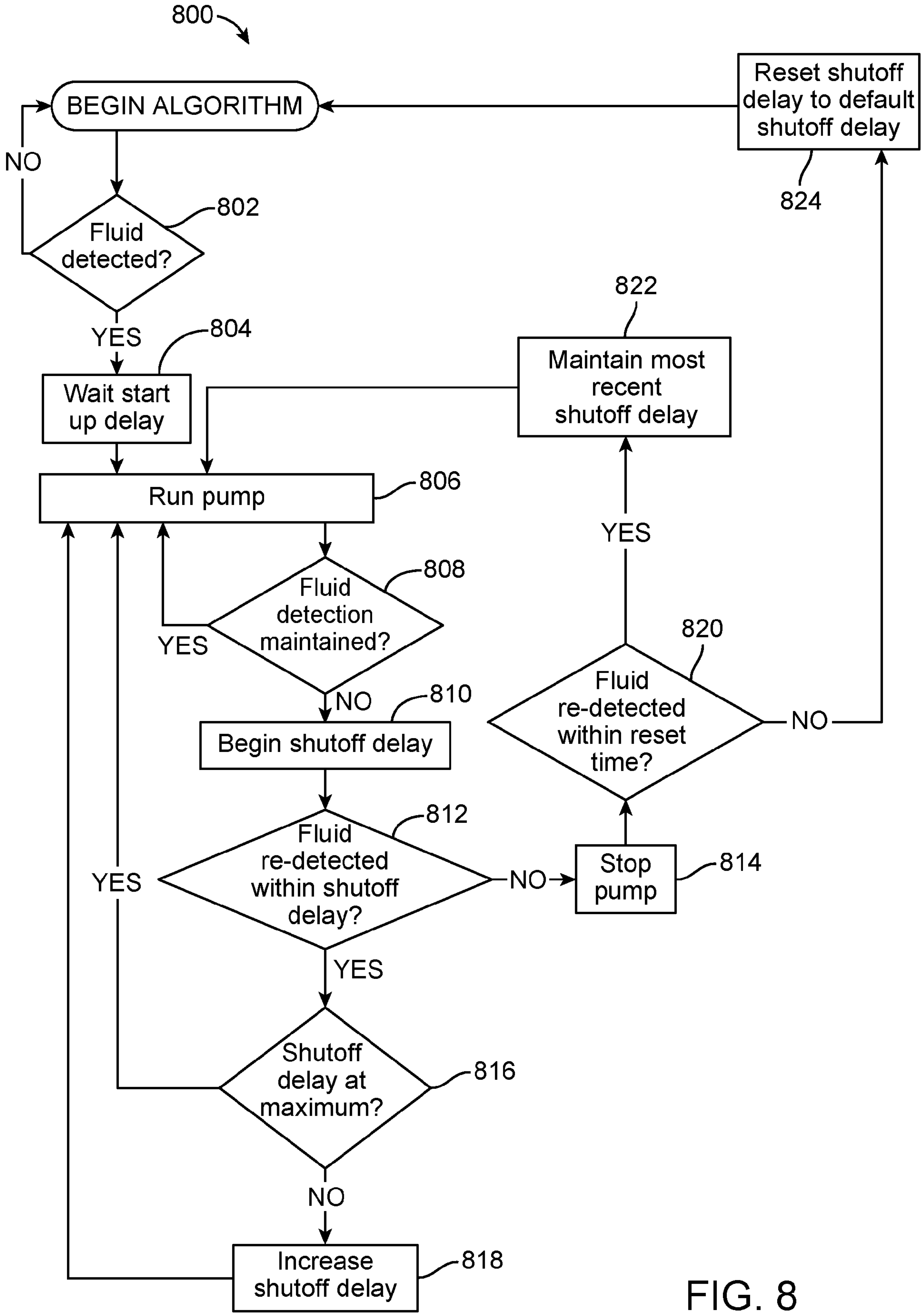
800
BEGIN ALGORITHM
NO
802
Fluid detected?
YES
804
Wait start up delay
Run pump
806
808
Fluid detection maintained?
YES
NO
810
Begin shutoff delay
812
Fluid re-detected within shutoff delay?
YES
NO
Stop pump
814
YES
816
Shutoff delay at maximum?
NO
Increase shutoff delay
818
820
Fluid re-detected within reset time?
YES
NO
822
Maintain most recent shutoff delay
Reset shutoff delay to default shutoff delay
824

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 7740

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	US 2013/022475 A1 (ATCHIA ALAIN JULIAN [US]) 24 January 2013 (2013-01-24) * paragraph [0043] * -----	5-10	
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Y	EP 1 256 724 B1 (KSB SAS [FR]) 26 July 2006 (2006-07-26) * paragraph [0006]; figures 1-3 * -----	14,15	

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F04D
F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 March 2025	Morales Gonzalez, M

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25-03-2025

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