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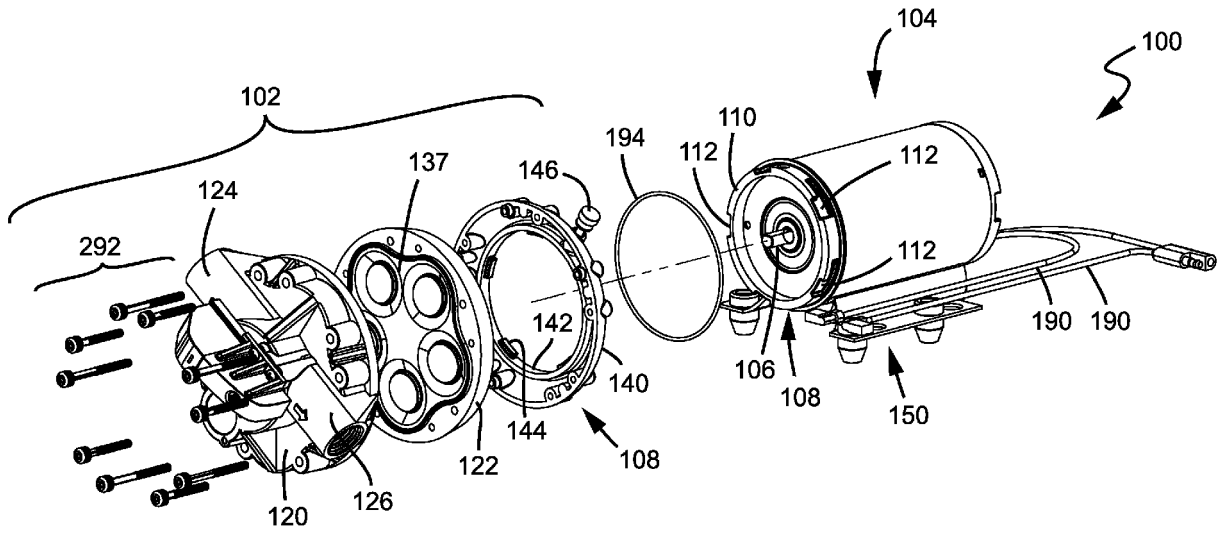
(54) PUMP WITH QUICK CONNECT PUMP HEAD AND PUMP MONITORING AND CONTROL SYSTEMS

(57) A pump includes a pump head and a motor assembly including a motor. The motor engages the pump head and actuates the pump head. The pump includes a hand actuatable quick disconnect assembly coupling the pump head to the motor assembly without the need for tools. A pump monitoring system acquires data and information to detect problems and provide information for pump maintenance.

FIG. 2



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Description

Background of the Invention

Field of the Invention

[0001] The present invention is directed to an improved pump and pump connection system, and in particular to a pump having a quick connect coupling between the pump head and the pump motor providing quick mounting and release of the pump to a mounting surface, and is also directed to a pump a controller and performance monitoring including sensors for detecting problems and possible failure.

Description of the Prior Art

[0002] Positive displacement pumps and in particular diaphragm pumps are used for various applications. Depending upon the type of application, the pumps may need to be maintained or have components replaced. Many smaller diaphragm pumps include a pump head assembly that mounts to the motor. Rather than replacing the entire pump should the pump fail, during maintenance, it may be possible to simply replace the motor or the pump head.

[0003] Such maintenance of smaller displacement pumps is critical. Failure of such pumps may cause the system to which the pump is connected to be down while repairs or maintenance are performed. It can be appreciated that conventional mounting of the head to the motor includes multiple bolts that must be individually screwed and unscrewed to attach and remove a pump head from the pump motor. Such removal is time consuming and requires the use of tools in the field. Moreover, when multiple retaining bolts or other hardware are utilized, the components might be easily lost in the field, further extending repair and down time. The pump may be mounted in cramped spaces where access is difficult and accessing hardware with tools provides challenges. In many agricultural applications, the pump is in a remote location that may be difficult to access should replacement mounting hardware be needed.

[0004] In addition to connecting the pump head to the pump motor, it may also be necessary to remove the entire pump from a mounting surface or other system components. Bolted brackets or other retainers typically need to be removed in order to allow the pump to be accessed and have repairs or maintenance be performed. Again, the need for tools and removal of multiple hardware components increases the time required and may complicate maintenance and chances of components being misplaced.

[0005] Conventional small diaphragm pumps do not include mechanisms for monitoring the operational status of the pump head for problems or malfunction. Pump head failures often occur when the flexible membrane ruptures. The malfunction resulting from this failure will cause fluid, potentially carrying corrosive media, to come in contact with the electric motor. Motor failure will follow imminently if the pump head failure goes unnoticed and the entire pumping system will need to be replaced. In many applications, the equipment operator will not check on the diaphragm pump for extended periods of time, which significantly increases the likelihood that a pump head failure will not be recognized in time to prevent motor failure.

[0006] Such pumps may therefore fail without any warning to operators. It is also possible for inexperienced users to unknowingly operate the pumps in potentially damaging ways. Small diaphragm pumps are often used by turf/sprayer equipment operators, high end recreational vehicle owners, in agriculture, and construction equipment operators. These pumps are typically used outdoors and deal with a variety of working fluids including water, bleach, pesticides, and fertilizers. As downtime is critical, delays in determining when a pump fails can be very damaging and costly. When in a remote environment away from service technicians to replace the pumps or diagnose the issue, inexperienced users may conduct maintenance incorrectly and put the pump in to damaging operating conditions without knowing.

[0007] It can therefore be appreciated that there exists a need for a quick connect system for connecting a pump head to a pump motor assembly. Such a connection should provide for a quick engagement as well as quick decoupling of the components. Such a system should also eliminate the need for tools and loose retaining hardware. Furthermore, the connection and disconnection of the pump head to the pump motor is further improved if workers may simply use their hands to manually connect and disconnect the component assemblies. A quick connect mounting assembly of the pump to a surface without the need for tools or loose mounting hardware would further speed maintenance and provide for easier inspection and repair. Such mounting of the pump to a surface should be quickly and easily performed by a worker without the need for tools. Such a pump should further be configured so that the quick connect between the pump head and the motor and a quick release system for mounting the pump do not interfere with one another and may be actuated separately and independently. In addition, such pumps should provide for continuously monitoring performance and/or failure and providing information to operators to prevent pump failure. Such a system should be capable of sensing failure events, predicting the likelihood of failure events, monitoring the state of the pump head, and taking action to interrupt operation when a failure event occurs and indicate to the operator the status of the pumping system. In this way the operator can take appropriate action and conduct maintenance or repair activities before total system failure occurs. The present invention addresses these as well as other problems associated with pumps, coupling of pump components, and mounting of the pumps, as well as monitoring pump head operations, sensing failure events and react-

ing to such events to protect the pump from further damage.

Summary of the Invention

[0008] The present invention is directed to a pump with a quick connect coupling assembly for fast tool free inspection and maintenance. The present invention is also directed to a pump with a performance monitoring module. The pump may be a diaphragm pump with a head and a motor assembly including a motor with a drive shaft engaging and driving pumping components in the pump head. The pump head is coupled to the motor assembly by a hand actuatable quick disconnect assembly.

[0009] In one embodiment, the quick disconnect assembly is a bayonet type connector assembly including an adapter-type flange mounted to the pump head and a complementary to the motor assembly. The flange includes spaced apart radial engagement elements, and the receiver includes complementary L-shaped receiving slots configured to receive and retain the engagement elements. In one embodiment, the motor assembly has a cylindrical housing and pump head has a complementary profile. The flange is circular with the engagement elements projecting radially inward and the receiver is configured as a collar and includes of complementary annularly extending L-shaped receiving slots configured to receive and retain the engagement elements upon relative rotation between the flange and the receiver. The quick connect assembly may include a locking pin for retaining the engagement elements in the receiving slots and therefore retaining the flange in engagement with the receiver.

[0010] In an embodiment, the pump further has a second quick connect assembly. The second quick connect assembly is a hand actuatable quick connect motor mounting assembly for mounting the pump to a mounting surface. The motor mounting assembly includes a cradle for receiving the motor assembly and a sliding retainer. The motor assembly has retaining screws extending radially outward with each of the retaining screws having a base and a screw head, and the sliding retainer engages the screw heads to secure the motor assembly to the quick connect motor mounting assembly. The pump is configured with the motor mounting assembly and the quick disconnect assembly positioned in an axially non-overlapping configuration so that the first and second quick connect assemblies do not interfere with one another.

[0011] The advantageous mounting of the pump of the present invention provides for a method of maintaining a pump. When a triggering event occurs, the pump is inspected. The triggering event may be scheduled maintenance or a problem. Moreover, the pump may include sensors that provide performance data and/or provide a signal or alarm that may trigger inspection. To inspect the pump, the head is removed from the motor assembly by manually decoupling the first quick disconnect assembly free of tools. The pump may be removed from the mounting surface, if needed, by manually decoupling the second quick disconnect. The quick connect assemblies are decoupled manually without the need for any tools. When decoupled, the motor and/or the pump head are inspected. Following inspection and any needed maintenance, the motor is remounted if it passes inspection. If the motor fails inspection, the motor may be replaced with a different motor. In addition, if the pump head passes inspection, the pump head may be recoupled to the motor assembly. If the pump head fails inspection, the pump head may be replaced with a different pump head. It is also possible that an entirely different pump may be needed, and the new pump is quickly mounted to the mounting surface without the need for tools.

[0012] In one embodiment, the pump includes a pump monitoring system that mounts to the pump and has a complementary shape with a surface configured to fit around the exterior of the generally cylindrical housing of the motor. The pump provides operational signals to an integrated control module that can monitor one or more parameters and trigger a predetermined response in the event a parameter enters a specific state or exceeds an acceptable operating range, as determined by the controller's programming. In the one embodiment, the monitoring system has a modular configuration that is self-contained and can therefore be easily adapted to fit onto standard models of pumps. The monitor housing may include radially and longitudinally extending cooling fins.

[0013] The pump monitoring system includes a relay unit and a controller/processor gathering operational and performance information of the pump and providing output to operators. The controller/processor may be integrated on the pump to capture information that can be used to determine the life and performance of the pump and/or to determine whether maintenance should be performed. The boundary conditions that dictate when the control module reacts to an event correspond to the type of input signal and can be binary in nature (i.e. open/closed) or a continuous range (0 < value < 5). Different control actions may be used to respond to different sensing and triggering events. These actions can be classified in two distinct categories; 1) alarm actions that are intended to protect the pumping system such as termination of operation, and 2) warning actions to notify the operator important information that may impact the pumping system negatively but is not currently causing malfunction. In order to perform control and monitoring actions the control module measures input signals, compares the measurements to defined boundary conditions, and sends signals to additional components to execute control actions and store values in memory to create event history logs. The pump monitoring system protects the pump from further damage if failure begins and provides warnings for problems that are experienced in operation. The processor/controller is also able to establish operational settings at the factory and modify settings in

the field after being placed in use. The relay unit connects to the controller/processor, a power source, such as AC, a solar energy panel or a battery, and to the pump. A moisture sensor includes a connector for mounting to the motor side of the pump for detecting fluid leaks to the motor. The connector and the sensor are preferably attached with a quick disconnect so that the elements may be easily switched or interchanged should a new motor or monitoring system be needed. In one embodiment, the relay unit will disconnect the pump in case of moisture detected by the moisture sensor.

[0014] The controller/processor receives data and information from various sensors and/or inputs. The controller/processor also includes a data port and a wireless communication device. The data port and wireless communication device provide for outputting information to a central control system, to a PC or other mobile device. The inputs and sensors can be various types of sensors including flow meters, heat sensors, moisture sensors, timer, electrical sensors measuring current, resistance, and related electrical system variables, as well as other meters and sensors that measure parameters that indicate performance of the pump. The sensing signals include, but are not limited to, physical measurements such as temperature, current, voltage and operating time or discreet values such as on/off, open/closed, and high/low voltage. The pump monitoring system is configured to acquire data including, but not limited to outlet/system pressure, motor temperature, fluid temperature, diaphragm cavity temperature, flow rate, motor RPM, motor current, motor voltage, runtime, and vibration.

[0015] The pump monitor system utilizes the information received by the processor and have the capability to control the pump and provide performance operation to operators. The pump monitoring is configurable to provide a variety of information, including, but not limited to:

- Alert a user when the pump has failed due to a damaged diaphragm from a fluid leak accumulating between lower and motor housing or a dead motor from no power is detected to the motor and/or zero rpm
- Prevent further damage by disabling the operation of the pump motor
- Alerting a user when the pump has reduced performance such as lower flow at pressures indicating a valve failure and/or a stretched or worn diaphragm stretched
- Record runtime
- Estimate remaining life
- Adjust life prediction based on the application data from runtime record
- Identify when new pump head is installed
- Communicate to the operator in the field of use
- Communicate to equipment controllers with a standard interface
- Detecting cycling
- Sending data to the manufacturer for review
- Controlling pump on/off based on external input
- Controlling pump on/off based on user configurable timer/duty cycle
- Detecting a pressure switch/relay failure
- Output speed control signal to reduce or increase speed.

[0016] In one embodiment, the controller/processor includes an exterior user interface that provides a display with an indication of the status of the pump's operations. The user interface includes status indicators to display a mode or current operational status of the pump. In one embodiment, the user interface includes LED indicator lights such as a run light to indicate that the pump is in a normal operating condition, a service light to indicate that the pump requires maintenance and/or repairs, a failure light to indicate that the pump has failed and is not operating, and/or a diagnostic light to indicate that the pump is in a diagnostic mode. In one embodiment, the indicator lights have different colors to provide a quick visual indication of the operational status of the pump.

[0017] In operation, the interface provides for diagnosing problems and setting up operation of the pump. In one embodiment, a small magnet is used to enter diagnostic mode and to reset the device, although a switch or other actuation could also be used depending on the application and site where the pump is operating. The magnet is held on the interface over the failure light. One or more of the lights or combinations of the light may blink and/or show solid to indicate start of reset and to indicate that the reset is complete.

[0018] These features of novelty and various other advantages that characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings that form a further part hereof, and to the accompanying descriptive matter, in which there is illustrated and described a preferred embodiment of the invention.

Brief Description of the Drawings

[0019] Referring now to the drawings, wherein like reference numerals and letters indicate corresponding structure throughout the several views:

Figure 1 is a perspective view of a pump according to the principles of the present invention;

Figure 2 is a partially exploded perspective view of the pump in Figure 1;

Figure 3 is a partially exploded side view of the pump shown in Figure 1;

Figure 4 is a partially exploded perspective view of the motor and quick connect assembly for the pump shown in Figure 1;

Figure 5 is a perspective view of the pump head with a flange for the pump shown in Figure 1;

Figure 6 is an end view of the pump head shown in Figure 5;

Figure 7 is a side view of the pump head shown in Figure 5;

Figure 8 is an end view of the motor, receiver and flange for the pump shown in Figure 1 with the quick connect components in a pump head locked position;

Figure 9 is an end view of the motor, receiver and flange for the pump shown in Figure 1 with the quick connect components in a pump head unlocked position;

Figure 10 is an end view of the motor, receiver and flange for the pump shown in Figure 1 with the quick connect components in a pump head decoupled position;

Figure 11 is a detail view of the receiver;

Figure 12 is a detail view of the flange;

Figure 13 is a detail view of a locking mechanism for the quick connect assembly with a locking pin engaged and the quick connect assembly locked;

Figure 14 is a detail view of the locking mechanism shown in Figure 13 with the locking pin disengaged and the quick connect assembly unlocked;

Figure 15 is a detail view of the locking mechanism shown in Figure 13 with the locking pin locked out and the quick connect assembly unlocked;

Figure 16 is a perspective view of the motor with a quick connect pump mounting assembly with portions broken away for clarity;

Figure 17 is an end view of the motor with a quick connect pump mounting assembly shown in Figure 16 with the motor attached;

Figure 18 is an end view of the motor with a quick connect pump mounting assembly shown in Figure 16 with the motor detached;

Figure 19 is a side view of the motor with a quick connect pump mounting assembly shown in Figure 16 with the retainer locked;

Figure 20 is a side view of the motor with a quick connect pump mounting assembly shown in Figure 16 with the retainer unlocked;

Figure 21 is a perspective view of a modular monitoring system for the pump shown in Figure 1;

Figure 22 is a diagrammatic view of the modular monitoring system shown in Figure 21;

Figure 23 is a front elevational view of a processor/controller for the modular monitoring system shown in Figure 21; and

Figure 24 is a diagrammatic view of the processor/controller shown in Figure 23.

Detailed Description of the Preferred Embodiment

[0020] Referring now to the drawings and in particular to Figures 1-3, there is shown a pump, generally designated (100). In the embodiment shown, the pump (100) is a diaphragm pump and includes a motor assembly (104) and a pump head (102). It can be appreciated that other types of pumps having a pump head connecting to a motor and driven by a motor are also foreseen according to the present invention. The motor assembly (104) includes an outer generally cylindrical housing, and the motor is typically an electrical motor and includes a cord or wiring (190). A drive shaft (106) extends from the motor and is driven by the electric motor (104) to engage and drive the pumping elements of the pump head (102). According to the present invention, a first quick connect assembly (108) allows for simple and quick connection and disconnection of the pump head (102) to the motor assembly (104) without the use of any tools, as explained hereinafter. The ability for a worker to manually remove and mount the motor (104) and the pump head (102) to one another by hand without the need for tools provides for simple and quick maintenance. The ability to mount and remove without tools also allows for mounting in positions and locations that might be difficult to access if tools are needed to engage mounting hardware. Moreover, during maintenance, the motor assembly (104) and the pump head assembly (102) may be quickly inspected and interchanged if there are problems so that down time for maintenance and repairs is substantially reduced with the quick connect assembly (108). The pump (100) also includes a second quick connect assembly (150) for mounting the pump to a mounting surface.

[0021] The pump head (102) includes a pump head upper housing assembly (120) and a pump head lower housing assembly (122). The pump head upper housing assembly (120) generally retains the various valves and flow components. In the embodiment shown, the pump (100) is a wobble plate type diaphragm pump including five chambers. It can be appreciated that other types of pumps or diaphragm pumps might be utilized. Moreover, such wobble plate type pumps may have a different number of chambers, such as three chambers. A molded

diaphragm (130) mounts to the lower housing assembly (122) and includes five distinct portions that are engaged by valves in the head (102) as the wobble plate rotates, as is well known in the art. The pump head's major components are generally connected by a plurality of bolts (192). The upper housing assembly (120) of the pump head assembly (102) also includes a fluid inlet port (124) and a fluid outlet port (126). The inlet port (124) and the outlet port (126) may include mounting portions, such as threaded connections or other types of connections or adapters to mount to incoming and outgoing fluid lines. It can be appreciated that the pump (100) of the present invention completely contains the fluid to be pumped within the pump head (102) and fluid is kept out of the motor assembly (104). As shown in Figures 5 and 8-10, a receiving slot (132) receives the drive shaft (106) and provides for driving the valves and wobble plate and other components of the pump head to produce a pumping action.

[0022] Referring now to Figure 4 as well as other figures, the quick connect assembly (108) includes a quick connect receiver (110) that couples to a flange (140). The receiver, or collar, (110) mounts to an end of the motor assembly (104) against the outer housing of the motor assembly. The quick connect receiver (110) of the motor assembly (104) couples to the complementary quick connect flange (140) of the head (102) to removably couple the head (102) and the motor assembly (104). As shown in Figures 2 and 4, an O-ring type gasket (194) provides for a seal between the receiver (110) and the flange (140). The receiver (110) and the flange (140) are connected by a bayonet type engagement system. However, it can be appreciated that other quick connect systems that do not require tools, such as a threaded assembly or of cam assemblies, might also be utilized. The quick connect flange (140) includes a generally circular outer flange frame (142). Extending radially inward from the frame (142) are male engagement elements (144), as shown in greater detail in Figure 12. The male engagement elements are shown as substantially rectangular and radially inward protruding raised portions, but other shapes are also foreseen. The quick connect frame (142) includes a pin receiving hole (148A). The hole (148A) receives a quick connect pin or other element that locks the flange (140) to the receiver (110), as explained hereinafter. In the embodiment shown, the flange includes five engagement elements (144) spaced apart and protruding inward to engage five complementary slots of the receiver (110). However, a lesser number or greater number of engagement elements and complementary slots may also be utilized.

[0023] The quick connect receiver (110) is configured to mount to the motor assembly (104) and is complementary to the flange (140). The receiver (110) includes L-shaped slots (112) spaced apart around a periphery of the receiver and configured to receive the complementary male engagement elements (144). As shown in Figure 11, the slots (112) are L-shaped slots, including a widened slot first arm portion (114) and a slot second arm portion (116) extending annularly from the first portion (114). The slots (112) and engagement elements (144) are complementary shaped and configured so that the engagement element (144) slides into the first arm portion (114) of the corresponding slot (114). The pump head (102) and motor assembly (104) are then rotated relative to one another, thereby also rotating the flange (140) relative to the receiver (110). This rotation moves the engagement elements (144) into the second arm portion (116) of the L-shaped slot (112). The engagement elements (144) and the second slot arm portion (116) have complementary angled surfaces, chamfered surfaces or other complementary portions that engage so that the receiver (110) and the flange (140) cannot be pulled axially apart.

[0024] To maintain the rotational position of the flange (140) relative to the receiver (110), a locking pin (146) is utilized. The locking pin (146) may be spring-loaded or may be a threaded member, such as a thumbscrew type element. The locking pin extends through the hole (148A) of the flange (140) and into the hole (148B) of the receiver (110). When lowered as shown in Figure 13, the pin (146) is engaged in a fully locked position. Depending on the configuration of the pin, it may be lifted upward, or if threaded, the pin (146) is rotated to raise the pin (146). In the position shown in Figure 14, the pin (146) is raised, which unlocks the flange (140) and the receiver (110). Moreover, as shown in Figure 15, the pin (146) may be moved to a locked out position and unlocked so that the pin (146) cannot accidentally re-engage. Therefore, when in such a position, the flange (140) and the receiver (110) may be easily rotated relative to one another and then separated.

[0025] The locking, unlocking, and decoupling and their relative positions are shown in Figures 8-10. As shown in Figure 8, the pin (146) is lowered to engage both the hole (148A) and extend into the hole (148B). This engagement by the pin (146) prevents relative rotation between the flange (140) and the receiver (110). When the pin (146) is lifted, as indicated by the arrow in Figure 9, the flange (140) and the receiver (110) are unlocked and may be rotated relative to one another. Once the pin (146) has been raised, the flange (140) may be rotated clockwise as shown in Figure 10, relative to the receiver (110), thereby moving the engagement elements (144) along the slot (112) to the first arm portion (114) of the L-shaped slot (112). When the engagement elements (144) are in the first arm portion (114) of the L-shaped slot (112), the flange (140) may be freely pulled away from the receiver (110). Remounting of the flange (140) to the receiver (110) is easily done by simply reversing the steps so that the engagement elements (144) are moved into the second slot portion (116) of the L-shaped slot (112) and engaged and the pin (146) is lowered to extend into hole (148B) of the receiver (110).

[0026] As shown in Figures 16-20, the pump mounting assembly (150) is also a quick connect assembly that

allows for easily removing the entire pump (100) from a mounting surface or to other components in a fluid system. The pump mounting assembly (150) includes a cradle (152) with lateral mounting portions (154) extending laterally outward from the cradle (152). The lateral mounting portions may include mounting holes for receiving hardware and mounting the cradle (152) to a surface. The cradle (152) has an arcing surface complementary to the outer cylindrical surface of the pump assembly (104). Retaining screws (118) include a head portion that extends into complementary keyhole shaped orifices (162) of the mounting assembly (150). The pump mounting assembly (150) also includes a sliding retainer (156) actuated by a retainer handle (158). A spring return mechanism (160) provides for maintaining the position of the sliding member (156) relative to the cradle in a locked position. The sliding retainer (156) includes a handle (158) at one end. It can be appreciated that the retainer handle (158) slides with the retainer (156) between a retaining position engaging the heads of the screws (118) and a free position in which the screws (118) are disengaged and may be freely lifted from the mounting assembly (150). The biasing force of the return mechanism (160) is overcome by pulling the handle (158) outward to a free position.

[0027] To mount the motor assembly (104) to the pump mounting assembly (150), the sliding retainer (156) is pulled outward by the handle (158) to the position shown in Figure 20. The motor assembly (104) is then placed against the cradle (152) with the mounting screws (118) extending through orifices in the cradle and an enlarged portion of the keyhole shaped orifices (162) in the sliding retainer (156). When the motor assembly (150) is correctly positioned, the handle (158) is released, and the return mechanism (160) pulls the sliding retainer inward to the locked position shown in Figure 19. This motion slides the retainer (156) so that the small portion of the key shaped orifices (162) engage the shaft of the mounting screws and are beneath the head of the screws (118) and therefore retaining the motor assembly (104). To release the motor assembly (104), the handle (158) is pulled outward to move the retainer (156) back to the position of Figure 20, as indicated by the arrow in Figure 20.

[0028] It can be appreciated that the quick connect mounting assembly (150) and the quick connect assembly (108) between the pump head (102) and the motor assembly (104) are configured so that they do not interfere with one another. Moreover, it can be appreciated that both mounting mechanisms can be engaged and disengaged manually by hand without the need for any tools. Furthermore, there are no loose screws, bolts, clips, or other retaining hardware that might be lost.

[0029] The present invention also provides for a method of inspecting and maintaining pumps and easily interchanging or replacing the motor (104) and/or the pump head (102) without the need for tools. It can be appreciated that the pump head (102) and/or the motor assembly (104) may incorporate sensors that monitor the performance of the pump (100). Therefore, if problems are indicated, such sensors may detect a general problem with the pump (100) or might detect a problem with the pump head (102) or a problem with the pump motor (104). The sensor may generate a signal or alarm to indicate a performance problem and the need for inspection and possible maintenance. The pumps (100) might also be inspected regularly under a maintenance schedule.

[0030] Referring now to Figures 21-24, in one embodiment, the pump includes a pump monitoring system, generally designated (200). As shown in Figure 21, the pump monitoring system (200) includes a housing (202). The pump monitor housing (202) mounts to the pump (100) and has a complementary shape with an arcing surface (204) configured to fit around the exterior of the substantially cylindrical housing of the motor (104). In the one embodiment, the monitoring system (200) has a modular configuration that is self-contained and can therefore be easily adapted to fit onto standard models of pumps. The monitor housing (202) includes radially and longitudinally extending cooling fins (216).

[0031] As shown in Figures 21 and 22, the pump monitoring system (200) includes a relay unit (210). The monitoring system (200) also includes a controller/processor (220) gathering operational and performance information of the pump (100) and providing output to operators. The controller/processor (220) is integrated on the pump (100) to capture information that can be used to determine the life and performance of the pump (100) and create a log and history. The controller/processor (220) protects the pump (100) from further damage if failure begins and provides warnings for performance issues that are experienced in operation, as explained hereinafter. The processor/controller (220) is also able to establish operational settings at the factory and modify the settings after being placed in use. The relay unit (210) connects to the controller/processor (220) through relay signal lines (208). The relay unit (210) also connects to a power source (300), such as the electrical grid, a solar energy panel or a battery through line (214). The relay unit (210) connect the pump (100) by a wiring line (212). The controller/processor (220) connects to the power source (300) by wiring (222) and associated ground (224). Sensors, such as a moisture sensor (206) includes a connector (226) for mounting to the motor side (104) of the pump (100) for detecting fluid leaks to the motor (104). The connector (226) and the sensor (206) are preferably coupled by a quick disconnect so that the elements may be easily switched or interchanged should a new motor (104) or monitoring system (200) be needed. In one embodiment, the relay unit (210) will disconnect the pump (100) should moisture be detected by the moisture sensor (206).

[0032] Referring now to Figure 23, the controller/processor (220) receives data and information from various sensors and/or inputs (206, 240, 242, 244, 246, 248). The controller/processor (220) also includes a data port

(232) and a wireless communication device (230). The wireless communication device (230) may be configured to use various types of wireless communication including, but not limited to, Wi-Fi, Bluetooth, CANNUD, and RF. The data port (232) and wireless communication device (230) provide for outputting information to a central control system, to a PC or other mobile device. The inputs and sensors (206, 240, 242, 244, 246, 248) can be various types of sensors including flow meters, heat sensors, moisture sensors, timer, electrical sensors measuring current, resistance, and related electrical system variables, as well as other meters and sensors that measure parameters that indicate performance of the pump (100). The pump monitoring system (200) is configured to acquire data for the following measurements:

- o Outlet/System Pressure
- o Motor Temperature
- o Fluid Temperature
- o Diaphragm Cavity Temperature
- o Flow rate
- o Motor RPM
- o Motor Current
- o Motor Voltage
- o Runtime
- o Vibration

Although sensors (206, 240, 242, 244, 246, 248) are shown by way of example, fewer or additional sensors and inputs may be utilized as needed.

[0033] The pump monitor system (200) utilizes the information received by the processor and has the capability to control the pump (100) and provide performance operation information to operators.

[0034] The pump monitor is configured to provide a variety of information, including, but not limited to:

- Alert a user when the pump has failed due to:
  - o Damaged diaphragm from a fluid leak accumulating between lower and motor housing
  - o Dead Motor from no power is detected to the motor and/or zero rpm
- Prevent further damage by disabling the operation of the pump motor
- Alerting a user when the pump has reduced performance
  - o Lower flow at pressures indicating a valve failure and/or a stretched or worn diaphragm stretched
- Record runtime
- Estimate remaining life
- Adjust life prediction based on the application data from runtime record
- Identify when new pump head is installed
- Communicate to the operator in the field of use
- Communicate to equipment controllers with a standard interface
- Detecting cycling
  - o Enable rapid on/off cycling of the pressure switch/motor
- Sending data to the manufacturer for review
- Controlling pump on/off based on external input
- Controlling pump on/off based on user configurable timer/duty cycle
- Detecting a pressure switch/relay failure
  - o Power to the switch and zero system pressure
- Output speed control signal
  - o Reduce or increase speed.

[0035] Referring now to Figure 24, the controller/processor (220) includes an exterior user interface (250) having a display (hidden in Figure 21) that provides an indication of the status of the pump's operations. The user interface (250) includes a display with status indicators to show a mode or current operational status of the pump. In one embodiment, the user interface (250) includes LED indicator lights. A run light (252) indicates that the pump is in a normal operating condition. A service light (254) indicates that the pump requires maintenance and/or repairs. A failure light (256) indicates that the pump has failed and is not operating. The failure indicator (256) may also include an associated audible alarm. A diagnostic light (258) indicates that the pump is in a diagnostic mode. In one embodiment, the diagnostic mode is activated my placing a magnet (260) over the diagnostic light (258) that is sensed by the user interface (220). In one embodiment, the indicator lights (252, 254, 256, 258) have different colors to provide a quick visual indication of the operational status of the pump.

[0036] In operation, the interface (250) provides for diagnosing problems and setting up operation of the pump (100). In one embodiment, the failure light (256) will turn ON while the water/contamination is in contact with the moisture sensor (206). The failure light (256) changes to flashing after the detection of moisture until the controller (220) is reset. This notifies the operator a leak was previously detected but not detected currently. Only when a leak is actively detected will the pump be OFF by the relay unit (210). In the embodiment shown, the service light (254) will turn on when a predetermined time limit is exceeded, such as 400 hours.

[0037] In the embodiment shown, the magnet (260) is used to reset the device, although a switch or other actuation could also be used depending on the application and site where the pump is operating. The magnet is held on the interface (250) over the failure light (256). One or more of the lights (252, 254, 256, 258) or combinations of the light may blink and/or show solid to indicate start of reset and then change to indicate that the reset is complete.

[0038] The controller/processor (220) and interface (250) provide for a diagnostic mode, which may be indicated by the diagnostic light (258). To activate the diagnostic mode, the magnet (260) is placed proximate the user interface, such as against the diagnostic indicator

light (258) as shown in Figure 24. A combination of flashing by one or more of the lights may indicate that the controller/processor (220) is in diagnostic mode. The magnet (260) may then be removed. The failure light (256) and the service light (254) may flash in particular patterns that may indicate the number of times the pump monitor system (200) has been reset and/or to indicate the total number of hours the pump has been operating.

[0039] The pump monitoring system (200) is able to detect conditions that may require maintenance. When a triggering event such as scheduled maintenance or a problem are indicated by the monitoring system (200), the pump may be shut down by a switch, disconnecting the cord (190) or through the controller (220). The entire pump (100) may then be released from its mounting position by actuating the handle (158) of the pump mounting assembly (150) and lifting the pump (100) from the mounting assembly (150). Independently, the pump head (102) may also be simply removed by moving the locking pin (146) radially outward to disengage the hole (148B) and then rotating the pump head (102) relative to the motor (104) until the engagement elements (144) are moved to the first arm portion (114) of the L-shaped slot (112). The pump head (102) may then be simply pulled apart from the motor (104). It can also be appreciated that the drive shaft (106) is aligned with the complementary receiving slot and simply slides into and out of the slot (132) without the need for any tools or adapters. If the pump head (102) and the motor (104) are satisfactory following inspection, they may be simply be reassembled. However, if either the pump head (102) or the motor (104) needs replacement, these assemblies may be replaced and the replacement components are connected to one another, placed in the cradle (152), and mounted again to a mounting surface. Moreover, certain operational features of the controller (220) may be reset as appropriate. Reconnection of the cord (190) or actuation of a switch or the controller (220) would restart the pump (100).

[0040] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

Claims

1. A pump, comprising:

a pump head;
a motor assembly comprising a motor, wherein the motor engages the pump head and actuates the pump head;
a hand actuatable quick disconnect assembly coupling the pump head to the motor assembly.

2. The pump according to claim 1, wherein the motor comprises a drive shaft extending from the motor and engaging the pump head.

3. The pump according to claim 1, wherein the pump comprises a diaphragm pump and wherein the pump head comprises a diaphragm pump head.

4. The pump according to claim 1, further comprising a hand actuatable quick connect motor mounting assembly for mounting the pump to a mounting surface.

5. The pump according to claim 1, wherein the quick disconnect assembly comprises a bayonet type connector assembly.

6. The pump according to claim 1, wherein the quick disconnect assembly comprises a flange mounted to the pump head and a complementary receiver mounted to the motor assembly.

7. The pump according to claim 6, wherein the flange comprises a plurality of radial engagement elements and the receiver comprises a plurality of complementary L-shaped receiving slots configured to receive and retain the engagement elements.

8. The pump according to claim 7, further comprising a locking element for retaining the engagement elements in the receiving slots.

9. The pump according to claim 6, further comprising a locking pin for retaining the flange to the receiver.

10. The pump according to claim 8, further comprising a hand actuatable quick connect motor mounting assembly for mounting the pump to a mounting surface.

11. The pump according to claim 9, wherein the motor mounting assembly comprises a cradle for receiving the motor assembly and a sliding retainer.

12. The pump according to claim 10, wherein the motor assembly comprises retaining screws extending radially outward, each of the retaining screws having a base and a screw head, and wherein the sliding retainer engages the screw heads to secure the motor assembly to the quick connect motor mounting assembly.

13. The pump according to claim 11, wherein the motor mounting assembly and the quick disconnect assembly are positioned in an axially non-overlapping configuration.

14. The pump according to claim 1, wherein the motor assembly comprises a cylindrical housing and the quick disconnect assembly comprises a flange mounted to the pump head, and a complementary receiver mounted to the motor assembly; the flange comprising a plurality of radial engagement elements and the receiver comprising a plurality of complementary annularly extending L-shaped receiving slots configured to receive and retain the engagement elements upon relative rotation between the flange and the receiver.

15. The pump according to claim 1, further comprising a pump monitoring system including a controller to modify pump settings or stop the pump.

16. The pump according to claim 15, wherein the pump monitoring system comprises a display for providing an indication that the pump is running, the pump is failing, or the pump is in a diagnostic mode.

17. The pump according to claim 1, further comprising a pump monitoring system, wherein the pump monitoring system comprises a moisture sensor in communication with the controller for sensing fluid in the motor assembly.

18. The pump according to claim 1, further comprising a pump monitoring system mounted on the pump and including a user interface and display.

19. The pump according to claim 1, further comprising a pump monitoring system including a controller, and a housing having an arcing mounting surface configured to mount on an exterior of the mounted on an exterior of the motor assembly.

20. The pump according to claim 1, wherein the pump monitoring system housing comprises a plurality of cooling fins extending radially outward.

21. A method of manually maintaining a pump, the pump comprising a pump head, a motor assembly including a motor actuating the pump head, a first quick connect assembly coupling the pump head to the pump housing; a second quick disconnect assembly retaining the motor assembly to a mounting surface; the method comprising:

responding to a triggering event;
removing the pump head from the motor assembly by manually decoupling the first quick disconnect assembly free of tools, removing the motor assembly by manually decoupling the second quick disconnect assembly free of tools,
inspecting the motor and/or the pump head;
following inspection, remounting the motor if the motor passes inspection, or if the motor fails inspection, replacing the motor with a different motor;
following inspection, reconnecting the pump head if the pump head passes inspection, or if the pump head fails inspection, replacing the pump head with a different pump head.

22. The method according to claim 21, wherein the triggering event comprises scheduled maintenance.

23. The method according to claim 21, wherein the pump comprises a pump monitoring system and the triggering event comprises an indication from the pump monitoring system.

24. The method according to claim 23, further comprising resetting the pump monitoring system.

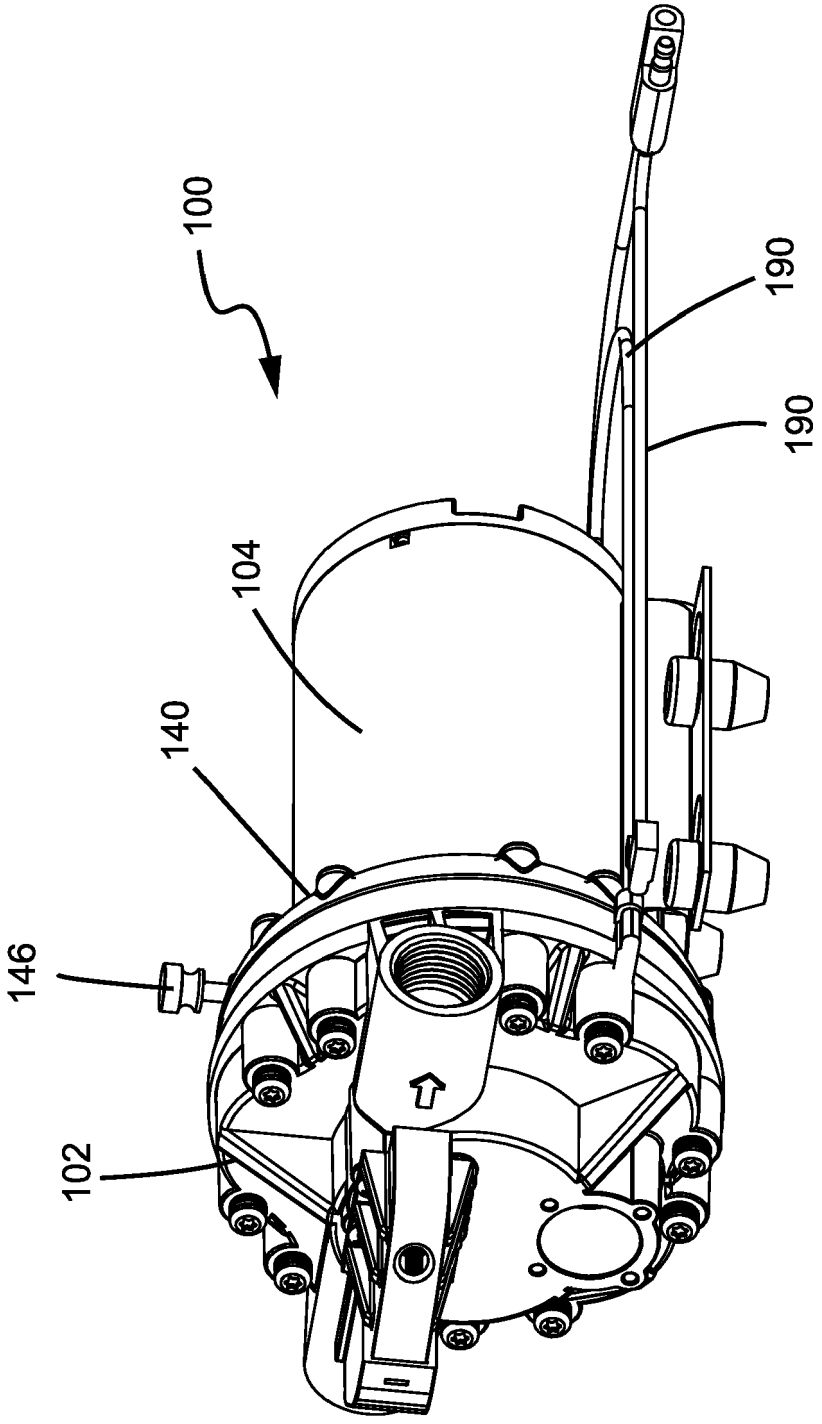
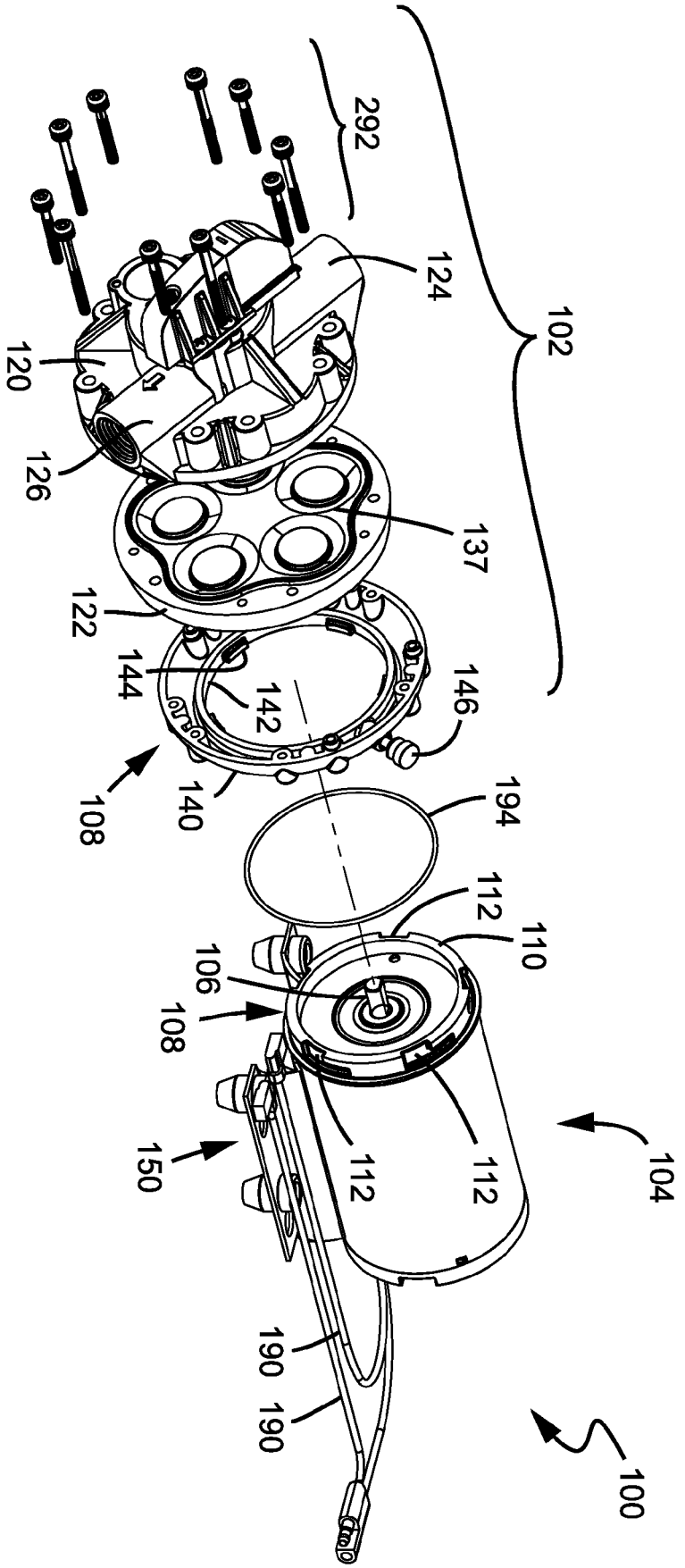


FIG. 1

FIG. 2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190
100

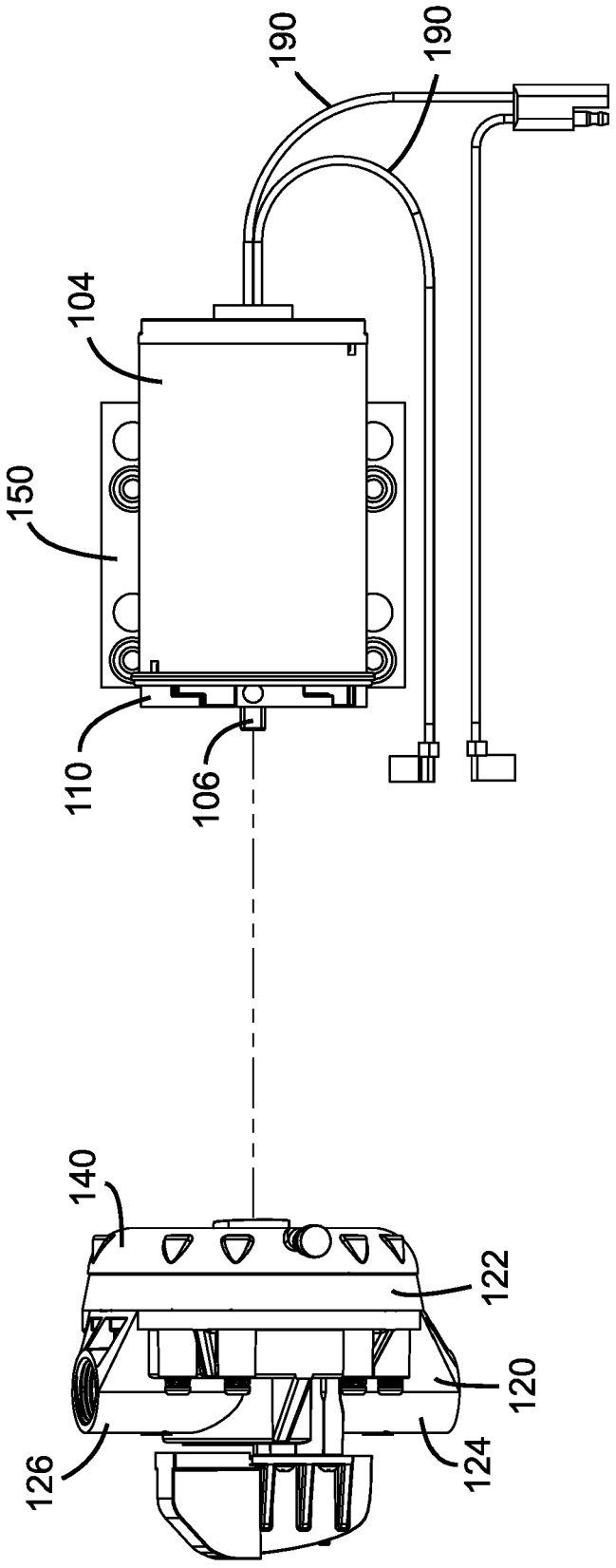
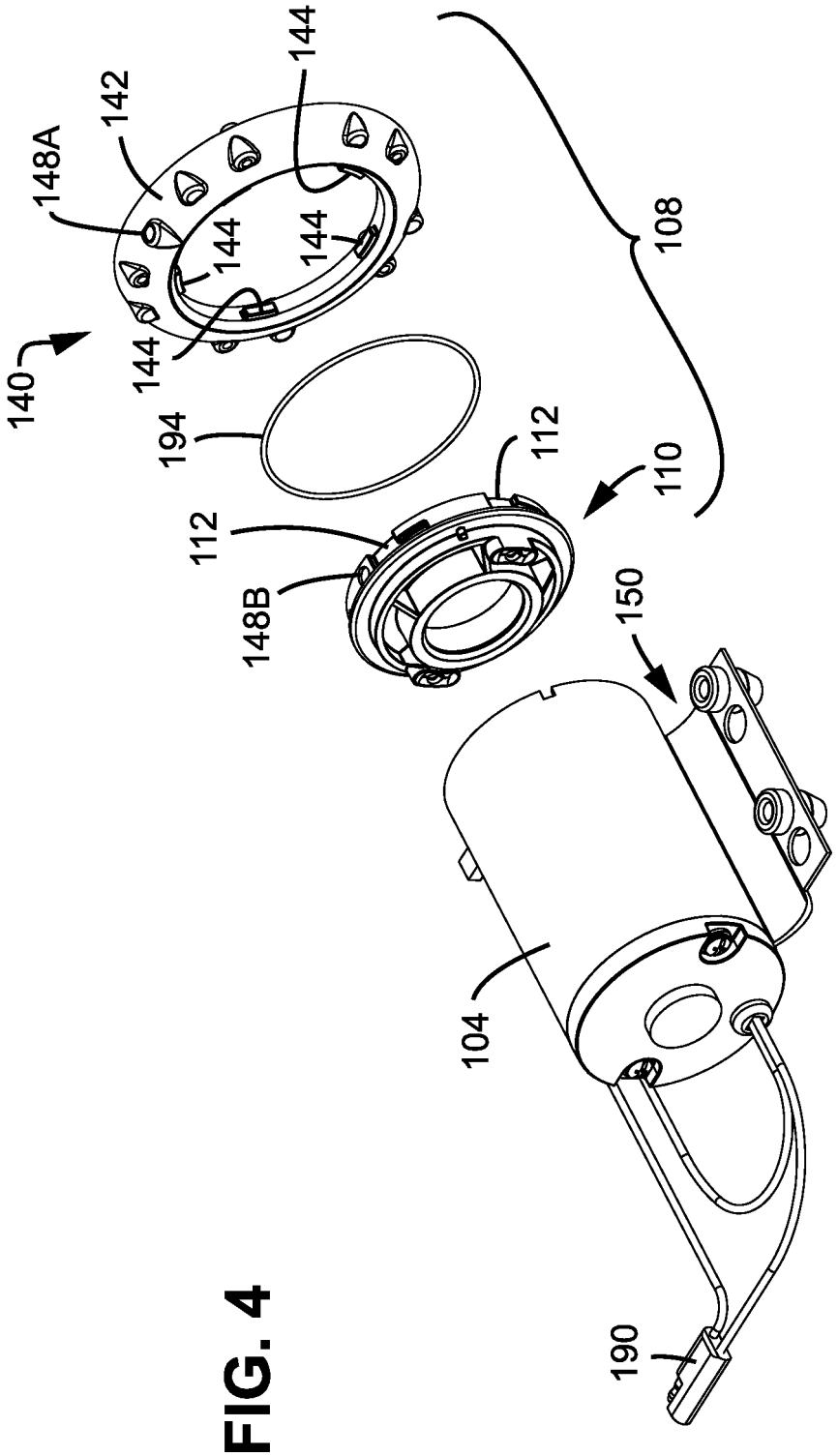


FIG. 3


140
148A
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144
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194
112
112
148B
110
108
150
104
190

FIG. 4

FIG. 7

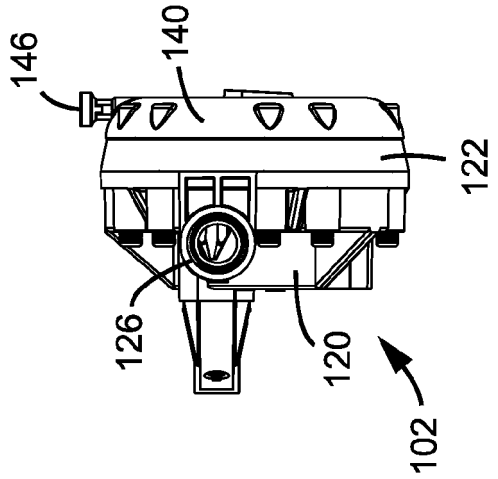


FIG. 6

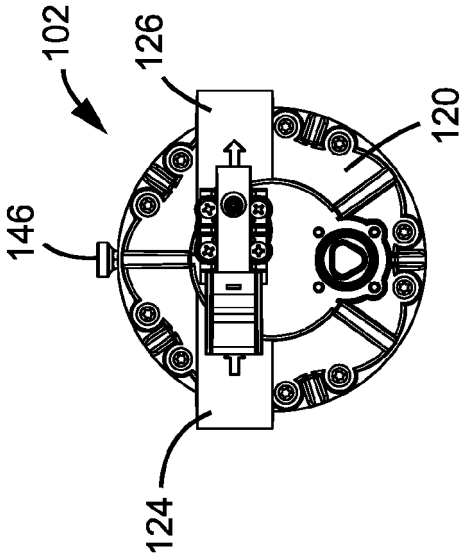


FIG. 5

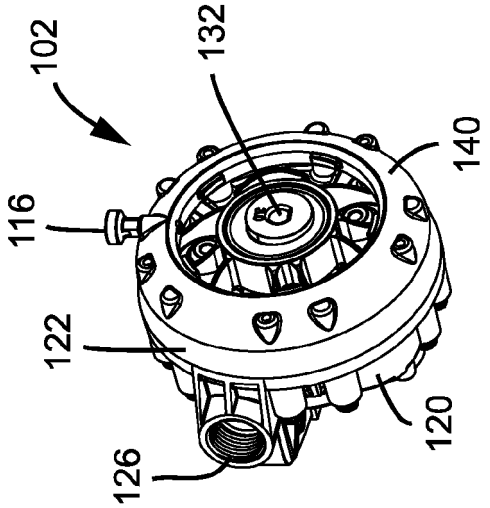


FIG. 8

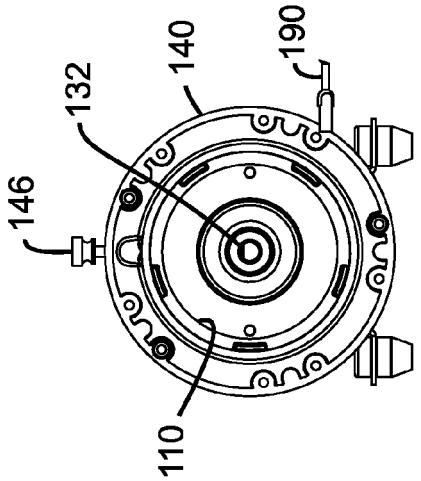


FIG. 9

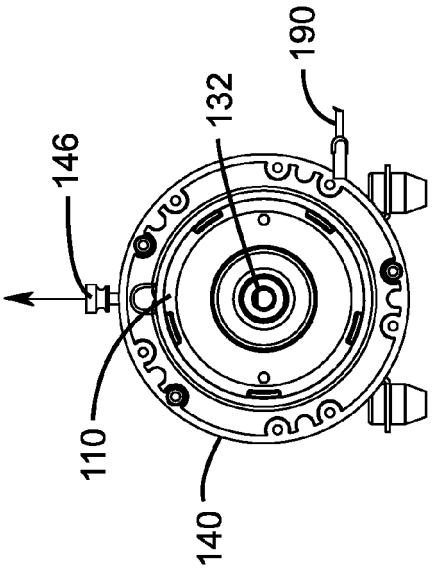


FIG. 10

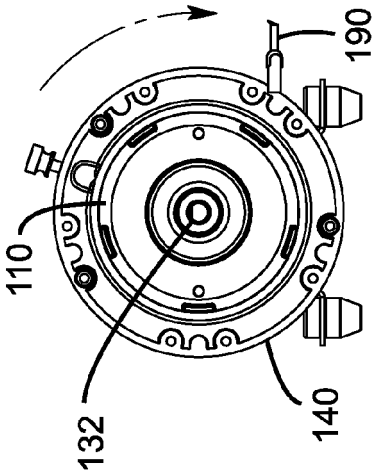


FIG. 11

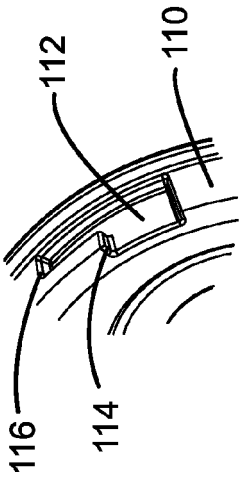


FIG. 12

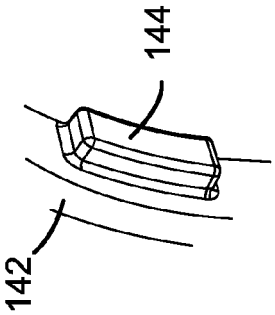


FIG. 15

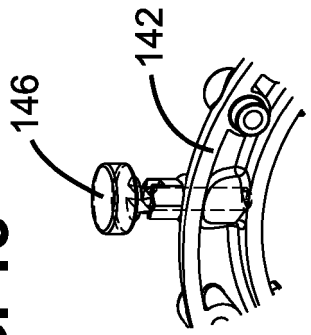


FIG. 14

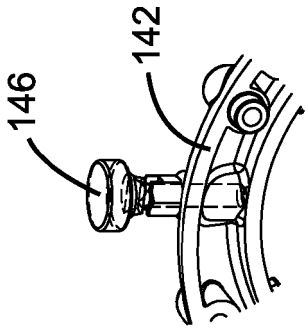


FIG. 13

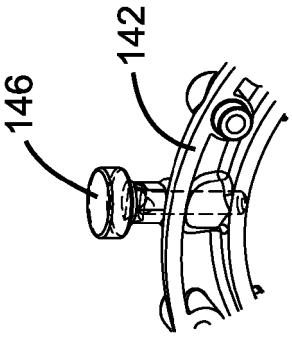


FIG. 16

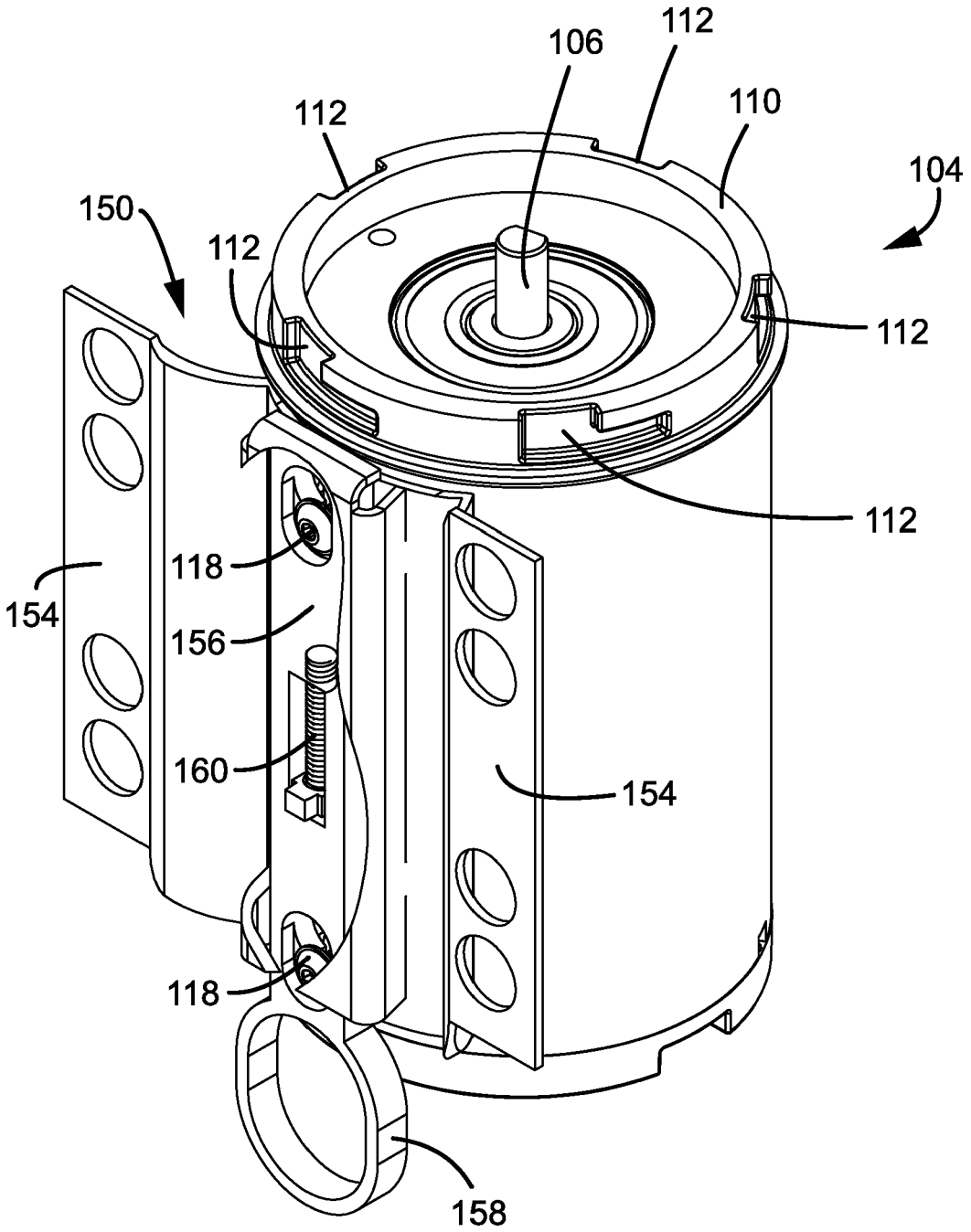


FIG. 17

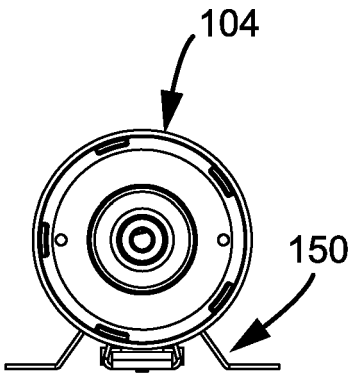


FIG. 18

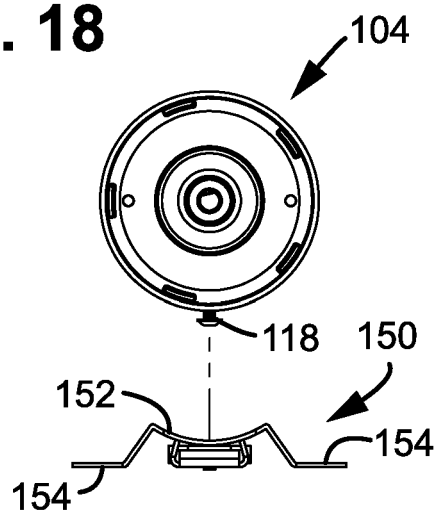


FIG. 19

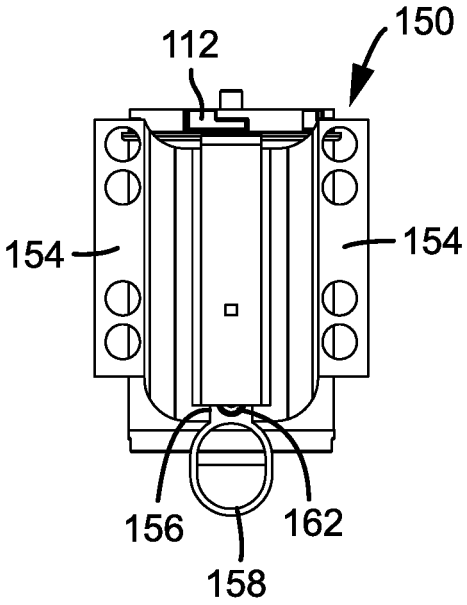
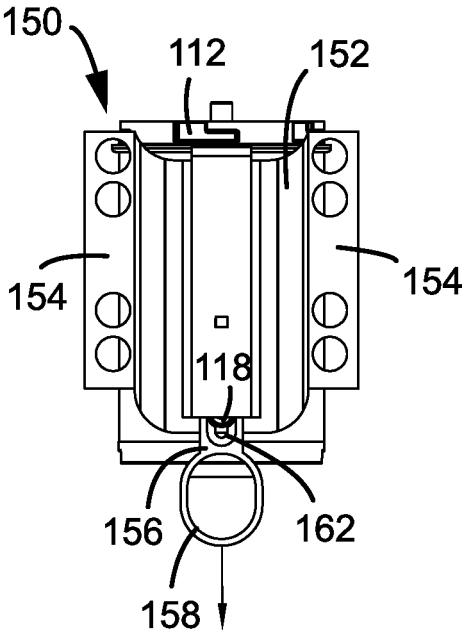


FIG. 20



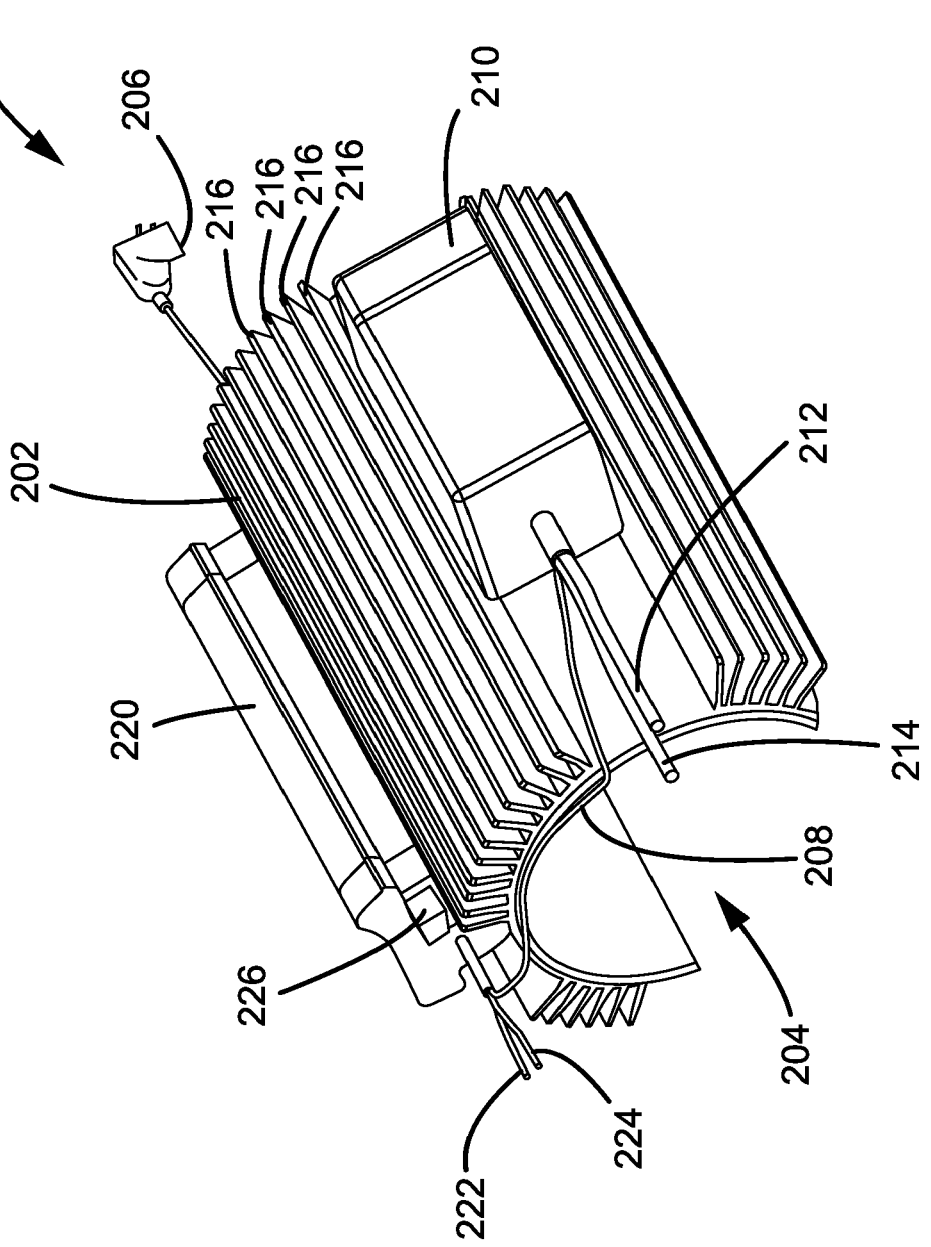
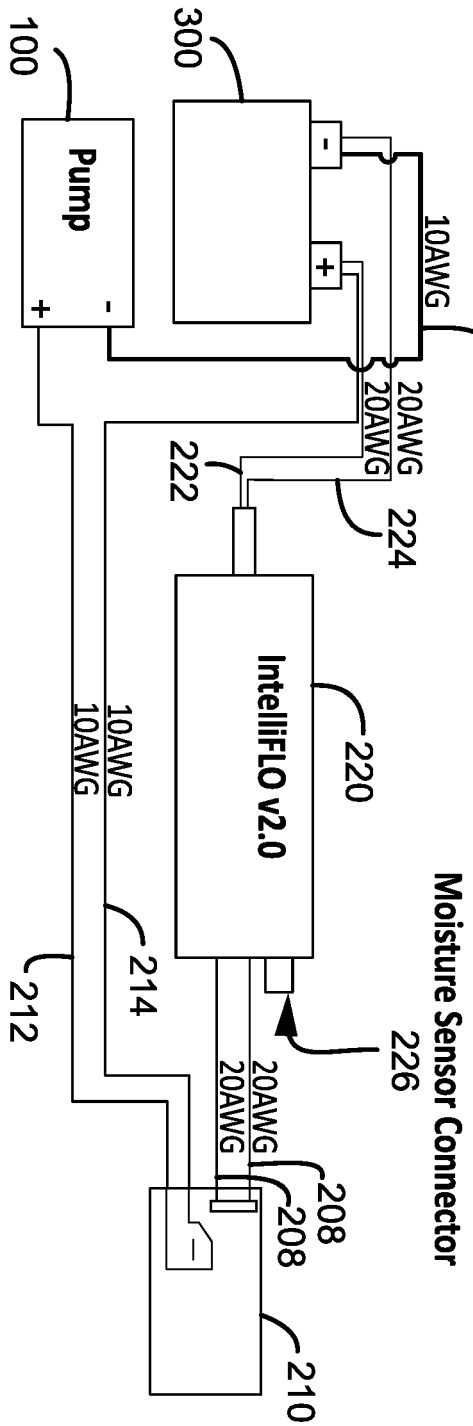


FIG. 21

FIG. 22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Pump
+
-
300
-
+
10AWG
228
20AWG
20AWG
222
224
IntelliFLO v2.0
220
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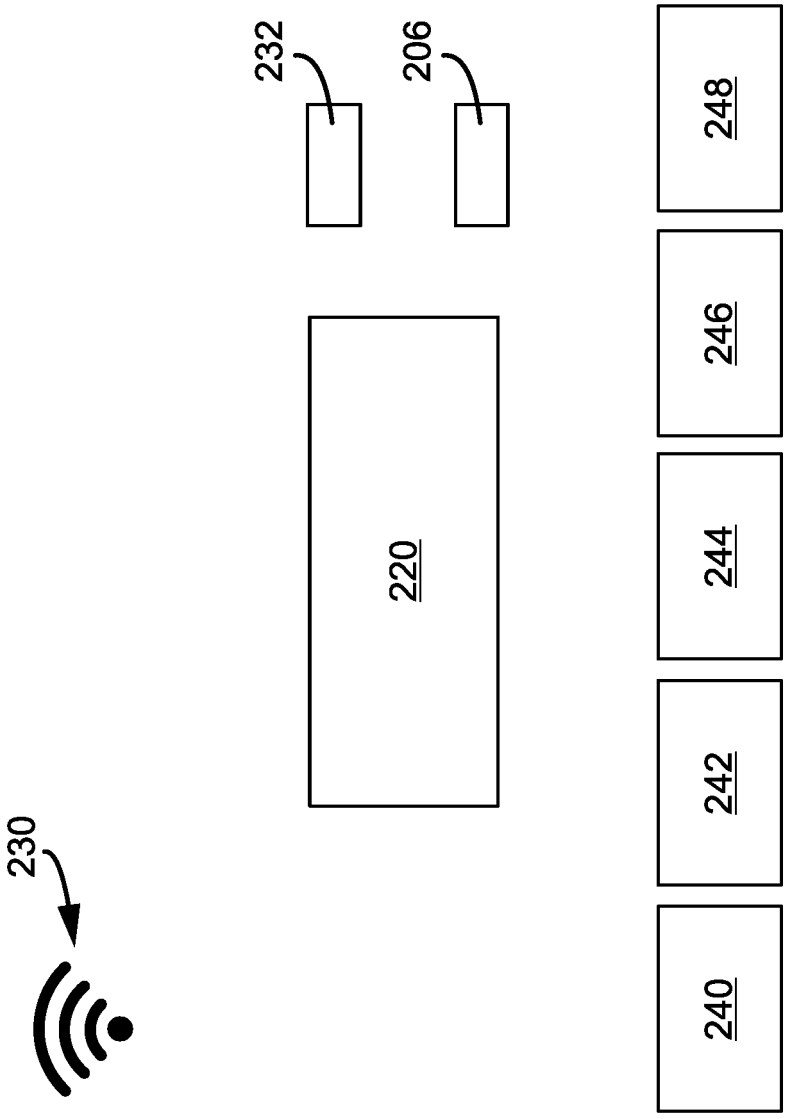
10AWG
214
212
Moisture Sensor Connector
226
20AWG
20AWG
208
208
210

FIG. 23



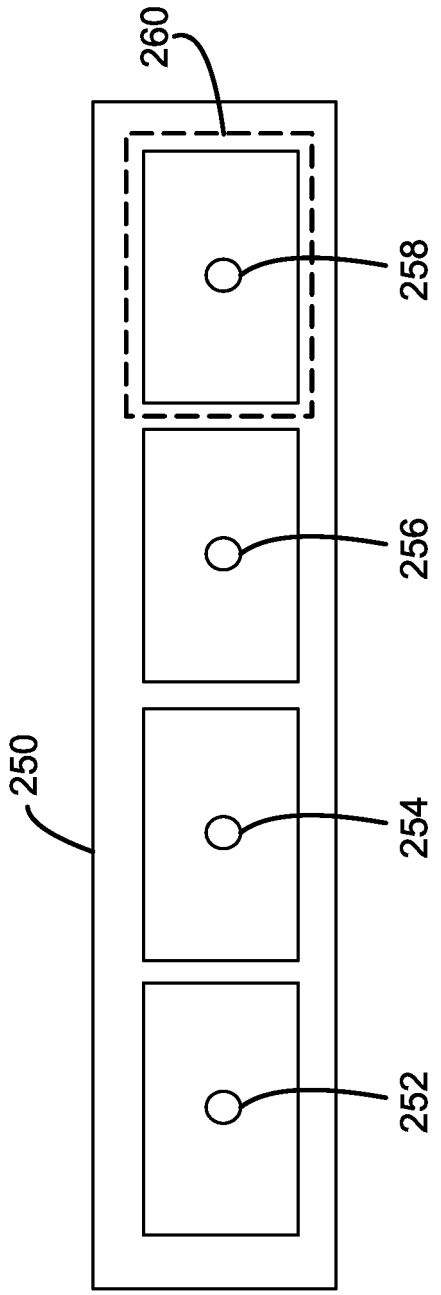


FIG. 24

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 3543

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 105 673 457 A (DONGGUAN RUIKE ELECTRONIC TECH CO LTD) 15 June 2016 (2016-06-15) * figures 1-4,6-7 *	1-24	INV. F04B39/12 F04B43/02 F04B43/04 F04B35/04
X	US 2013/129535 A1 (SCHMID GUNTHER ERICH [DE] ET AL) 23 May 2013 (2013-05-23) * abstract *paragraph 57-81; figures *	1-24	
X	EP 3 167 190 A1 (FLOW CONTROL LLC [US]) 17 May 2017 (2017-05-17) * paragraphs [0002], [0026]; claims; figures *	1-24	
X	EP 2 031 250 A1 (ITT MFG ENTERPRISES INC [US]) 4 March 2009 (2009-03-04) * abstract *; figures *	1-24	
X	CN 105 443 351 A (NANTONG XIWANG ELECTRICAL APPLIANCE CO LTD) 30 March 2016 (2016-03-30)	1	
A	* abstract *; claims; figures *	2-24	TECHNICAL FIELDS SEARCHED (IPC) F04B

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 March 2022	Pinna, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 21 3543

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