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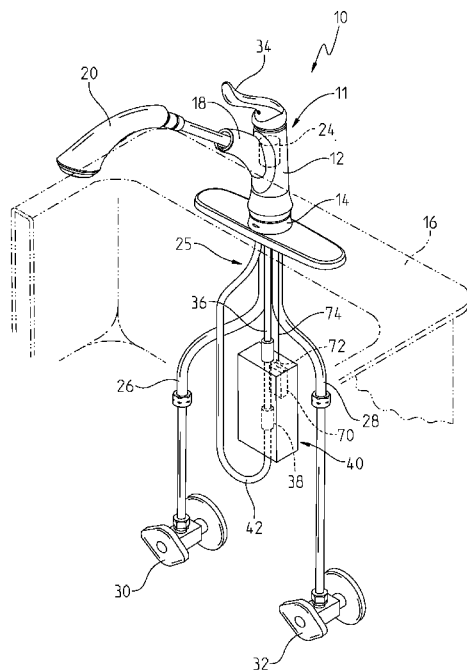


Fig. 2

(57) Abstract: An electronic faucet including a spout hub and a pullout wand removably coupled to the spout hub. The pullout wand is touch sensitive when docked to the spout hub, and is not touch sensitive when undocked from the spout hub. The present invention relates generally to electronic faucets. More particularly, the present invention relates to capacitive sensing systems and methods for operating a faucet. It is known to provide faucets with pullout sprayheads or wands fluidly connected to flexible water supply tubes and releasably coupled to a delivery spout. Such pullout wands often provide multiple delivery modes including a spray mode and a stream mode.

FAUCET INCLUDING A PULLOUT WAND WITH CAPACITIVE SENSINGCross-Reference to Related Application

The present application claims priority to U.S. provisional patent application Serial No. 61/636,373, filed April 20, 2012, the disclosure of which is expressly incorporated by reference herein.

Background and Summary of the Invention

[0001] The present invention relates generally to electronic faucets. More particularly, the present invention relates to capacitive sensing systems and methods for operating a faucet.

[0002] It is known to provide faucets with pullout sprayheads or wands fluidly connected to flexible water supply tubes and releasably coupled to a delivery spout. Such pullout wands often provide multiple delivery modes including a spray mode and a stream mode. In the spray mode, water is discharged from a plurality of outlets in a spray pattern. In the stream mode, water is discharged in a single, relatively concentrated stream.

[0003] It is also known to provide electronic faucets to control water flow. Some electronic faucets provide capacitive sensing to control water flow where a capacitive sensor is coupled to the delivery spout and/or a manual valve handle. For example, an illustrative capacitive sensing faucet permits a user to turn water flow on and off by merely tapping the spout. The faucet may distinguish between a tap on the spout to turn the water flow on and off, and a longer grasping or grab of the spout, for example, to swing it from one basin of a sink to another. Such a faucet may also utilize the manual valve handle for touch control, which illustratively distinguishes between a grasping or grab of the handle to adjust water flow rate and/or temperature, and merely tapping the handle to toggle water flow off or on. Such an illustrative faucet is detailed in U.S. Patent Application Publication No. 2010/0170570, the disclosure of which is expressly incorporated by reference herein.

[0004] According to an illustrative embodiment of the present disclosure, an electronic faucet includes a spout hub, a manual valve handle operably coupled to the spout hub, and a pullout wand removably supported by the spout hub. A passageway conducts water through the hub to the pullout wand. An electrically operable valve is fluidly coupled to the passageway,

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and a manual valve is fluidly coupled to the passageway in series with the electrically operable valve, wherein the manual valve handle controls the manual valve. A controller controls operation of the electrically operable valve and is electrically coupled to the manual valve handle of the faucet. The spout hub is capacitively coupled to the manual valve handle, and the pullout wand is capacitively coupled to the spout hub when docked with the spout hub. As such, the pullout wand is touch sensitive when docked with the spout hub.

[0005] According to another illustrative embodiment of the present disclosure, an electronic faucet includes a spout hub and a pullout wand removably supported by the spout hub. The pullout wand is movable from a docked position coupled with the spout hub and an undocked position removed from the spout hub. A manual valve includes a handle and is operably coupled to the spout hub. An electrically operable valve is in fluid communication with the manual valve. A tube is slidably received within the spout hub and fluidly couples the pullout wand to the electrically operable valve. A capacitive sensor is in electrical communication with the pullout wand when in the docked position. A controller is in electrical communication with the capacitive sensor. The pullout wand is touch sensitive when in the docked position and is not touch sensitive when in the undocked position.

[0006] According to a further illustrative embodiment of the present disclosure, an electronic faucet comprises a delivery spout including a receiver. A pullout wand is movable from a docked position coupled with the receiver of the delivery spout and an undocked position removed from the receiver of the delivery spout. A wand capacitive coupling is provided between the pullout wand and the delivery spout when the pullout wand is in the docked position. A capacitive sensor is in electrical communication with the pullout wand through the wand capacitive coupling.

[0007] According to another illustrative embodiment of the present disclosure, an electronic faucet includes a delivery spout including a receiver. A pullout wand is movable from a docked position coupled with the receiver of the delivery spout and an undocked position removed from the receiver of the delivery spout. A capacitive sensor is operably coupled to the pullout wand. The output from the capacitive sensor provides an indication of at least one of touching the pullout wand when in the docked position, and a change between the docked

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position and the undocked position of the pullout wand. Water flow through the pullout wand is controlled based upon the output from the capacitive sensor.

[0008] Additional features and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of the illustrative embodiment exemplifying the best mode of carrying out the invention as presently perceived.

Brief Description of the Drawings

[0009] The detailed description of the drawings particularly refers to the accompanying figures in which:

[0010] Fig. 1 is a perspective view of a faucet of the present disclosure supported by a sink deck, the faucet including a pullout wand shown in a docked position;

[0011] Fig. 2 is a perspective view of the faucet of Fig. 1, with the pullout wand shown in a removed or undocked position relative to the delivery spout hub;

[0012] Fig. 3 is a detailed perspective view of Fig. 2, showing the pullout wand removed from the delivery spout hub;

[0013] Fig. 4 is an exploded perspective view of the faucet of Fig. 1;

[0014] Fig. 5 is an exploded perspective view of the couplings of the handle and the delivery spout hub;

[0015] Fig. 6 is a partial cross-sectional view of the faucet of Fig. 1;

[0016] Fig. 7 is a perspective view of the sense wire support of the faucet of Fig. 1;

[0017] Fig. 8 is a partially exploded perspective view of the pullout wand of the faucet of Fig. 1;

[0018] Fig. 9 is a side elevational view in partial cross-section of the pullout wand of Fig. 8, showing the capacitive coupling of the wand;

[0019] Fig. 10 is an operation state diagram illustrating control of fluid flow based on an output signal from the capacitive sensor;

[0020] Fig. 11 illustrates an exemplary capacitive sensor output signal plot in response to a user grabbing a control lever or handle;

[0021] Fig. 12 illustrates an exemplary capacitive sensor output signal plot in response to a user tapping the control lever or handle;

[0022] Fig. 13 illustrates an exemplary capacitive sensor output signal plot in response to a user grabbing a pullout wand;

[0023] Fig. 14 illustrates an exemplary capacitive sensor output signal plot in response to a user tapping the pullout wand;

[0024] Fig. 15 illustrates an exemplary capacitive sensor output signal plot in response to a user undocking the pullout wand; and

[0025] Fig. 16 illustrates an exemplary capacitive sensor output signal plot in response to a user docking the pullout wand.

Detailed Description of the Drawings

[0026] The embodiments of the invention described herein are not intended to be exhaustive or to limit the invention to precise forms disclosed. Rather, the embodiments selected for description have been chosen to enable one skilled in the art to practice the invention.

[0027] Referring initially to Figs. 1 and 2, an illustrative faucet 10 is shown as including a delivery spout 11 having a hub 12 rotatably supported above a pedestal 14 coupled to a sink deck 16. The delivery spout hub 12 includes an outlet or receiver 18 removably receiving a pullout wand 20. A manual valve, illustratively a mixing valve 24, is supported by the delivery spout hub 12. A waterway assembly 25 is fluidly coupled to the mixing valve 24 and includes a hot water inlet conduit 26 and a cold water inlet conduit 28 coupled to a base 29 (Fig. 4). The hot water inlet conduit 26 is fluidly coupled to a hot water supply 30, illustratively a hot water stop, and the cold water inlet conduit 28 is fluidly coupled to a cold water supply 32, illustratively a cold water stop. Additional details of an illustrative waterway assembly 25 are provided in U.S. Patent No. 7,766,043, the disclosure of which is expressly incorporated by reference herein. The mixing valve 24 may be controlled by a user interface, such as a manual valve handle 34, to control the flow rate and temperature of water supplied by the hot and cold water inlet conduits 26 and 28 to an outlet conduit 36. Additional details of an illustrative

mixing valve 24 are provided in U.S. Patent No. 7,753,074, the disclosure of which is expressly incorporated by reference herein.

[0028] An outlet conduit 36 is illustratively coupled to the base 29 of the waterway assembly 25 and is fluidly coupled to an actuator driven, illustratively electrically operable valve 38, positioned within a control unit 40 positioned below the sink deck 16. A flexible inlet tube 42 fluidly couples the pullout wand 20 to the actuator driven valve 38. The flexible inlet tube 42 defines a water passageway for delivering water through the spout hub 12 to the pullout wand 20. Further, the flexible inlet tube 42 is slidably received within the spout hub 12 to permit movement of the pullout wand 20 from a docked position (Fig. 1) to an undocked position (Figs. 2 and 3). In the docked position, the pullout wand 20 is supported within the receiver 18 of the spout hub 12. In the undocked position, the pullout wand 20 is in spaced relation to the receiver 18 of the spout hub 12.

[0029] While the following description details a pullout wand 20 removably coupled to a delivery spout 11 for illustrative purposes, it should be appreciated that the present invention may find equal applicability with other fluid delivery devices, including with side sprayers typically used with kitchen faucets having delivery spouts mounted separately on the sink deck 16.

[0030] With reference to Figs. 4, 8 and 9, the pullout wand 20 illustratively includes a shell 44 receiving a waterway 46. The waterway 46 is illustratively formed of a polymer and includes an inlet or connector 48 fluidly coupled to the inlet tube 42. Fasteners, such as screws (not shown), may couple the waterway 46 to the shell 44. The inlet 48 may include internal threads configured to be fluidly coupled with an outlet coupling (not shown), such as external threads, of the inlet tube 42. An aerator 50 may be supported at an outlet end of the waterway 46. The shell 44 has an electrically conductive outer surface, and may be formed of a metal plated polymer.

[0031] The pullout wand 20 may include a user interface defined by a first input portion 54 proximate a first end of a rocker switch 56, and a second input portion 58 proximate a second end of the rocker switch 56. Depressing the first input portion 54 causes the pullout wand 20 to dispense an aerated stream of water. Depressing the second input portion 58 causes the pullout

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wand 20 to dispense a spray of water. The user interface is further defined by a third input portion 62 at a button 64. Depressing the third input portion 62 at button 64 provides an increased flow rate of water to be dispensed from the pullout wand 20.

[0032] Additional details of an illustrative pullout wand 20 are provided in US Patent Application Publication No. 2011/0088784, the disclosure of which is expressly incorporated by reference herein.

[0033] As noted above, the hot water supply 30 and the cold water supply 32 may be fluidly connected directly to the actuator driven valve 38 positioned below the sink deck 16. The actuator driven valve 38 is illustratively controlled electronically by a controller 70, also positioned within the control unit 40 below the sink deck 16. As such, the flow of water through the faucet 10 may be controlled using an output from a capacitive sensor 72.

[0034] The output signal from capacitive sensor 72 may be provided to the controller 70 for controlling the actuator driven valve 38, which thereby controls flow of water to the pullout wand 20 from the hot and cold water supplies 30 and 32. By sensing capacitance changes with capacitive sensor 72, the controller 70 can make logical decisions to control different modes of operation of faucet 10, such as described in U.S. Patent No. 7,537,023; U.S. Patent No. 7,690,395; U.S. Patent No. 7,150,293; U.S. Patent No. 7,997,301; and PCT International Application Serial Nos. PCT/US08/01288 and PCT/US08/13598, the disclosures of which are all expressly incorporated herein by reference.

[0035] With reference to Figs. 4 and 5, a sense wire or cable 74 is in electrical communication with the capacitive sensor 72, and with the manual valve handle 34 at a handle electrical coupling 76. More particularly, the sense wire 74 is electrically conductive and includes a first end connected to the controller 70, and a second end supporting a wireform 78, illustratively formed of stainless steel. The wireform 78 is in electrical communication a cap 80 supported by a waterway holder 82. The waterway holder 82 supports the waterway assembly 25 and is secured to the cap 80 by fasteners 84. As shown in Fig. 7, the wireform 78 includes a J-hook 86 that is received within a recess 88 in the holder 82 such that the wireform 78 is in electrical contact with the cap 80.

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[0036] The manual valve 24 is supported by the base 29 of the waterway assembly 25 and is in fluid communication with the hot and cold water inlet conduits 26 and 28. A brass bonnet nut or sleeve 83 couples to the mixing valve 24 and includes a lower end threadably coupled to the cap 80. A contact assembly 85 extends above the mixing valve 24 and is in electrical communication with the handle 34. A bonnet cap 87 is threadably supported by an upper end of the bonnet nut 83 below the handle 34 and secures the mixing valve 24 to the bonnet nut 83. The contact assembly 85 provides electrical communication between the handle 34 and the bonnet nut 83 through the bonnet cap 87.

[0037] With reference to Fig. 6, the handle 34 is in electrical communication with the spout hub 12 at a hub capacitive coupling 89. More particularly, the bonnet nut 83 is concentrically received within the hub 12, such that an outer surface 90 of the bonnet nut 83 is in close proximity to an inner surface 91 of the spout hub 12. An annular seal 92 is supported by a ledge 94 on the bonnet nut 83 to provide a seal between the surfaces 90 and 91, while accommodating rotation of the hub 12 relative to the bonnet nut 83. The capacitive coupling 89 occurs over a gap 96 (illustratively around 0.012 inches) between the bonnet nut 83 and the hub 12.

[0038] With reference to Figs. 3, 6, 8 and 9, the pullout wand 20 may be removably docked or nested within the receiver 18 of the spout hub 12. A metal sleeve 98, illustratively formed from a stamped stainless steel, is concentrically received over the inlet 48 of the waterway 46 and includes a tab 100 that contacts the outer shell 44 of the wand 20. The shell 44 is illustratively plated with a metallic coating and is in electrical communication with the sleeve 98 through the tab 100. A plastic cylindrical liner 102 is received within the spout receiver 18 intermediate an outer surface of the sleeve 98 and an inner surface of the hub 12. As such, the wand 20 is not in direct electrical contact with the hub 12 but is capacitively coupled to the hub 12 through a wand capacitive coupling 104. O-rings 106 may be supported by the inlet 48 to help secure and stabilize the wand 20 within the receiver 18.

[0039] As further detailed herein, the controller 70 in connection with the capacitive sensor 72 and associated software causes the wand 20 to be touch sensitive when docked with the hub 12. In an illustrative embodiment, when a user taps the outer shell 44 of the wand 20

when docked to the hub 12 (Fig. 1), the actuator driven valve 38 is actuated (e.g., toggled between on and off) by the controller 70. When a user grabs the outer shell 44 of the wand 20 when the wand 20 is docked to the hub 12, for example to rotate the spout hub 12 about the bonnet nut 83, the controller 70 does not alter the position or state of the actuator driven valve 38. When the wand 20 is removed or undocked from the hub 12 by a user, the controller 70 may cause the actuator driven valve 38 to open and thereby initiate water flow. In this undocked position, the wand 20 is not touch sensitive. When the wand 20 is subsequently replaced or docked within the hub 12 by the user, the controller 70 may keep the actuator driven valve 38 in its current state (e.g., open). Alternatively, the controller 70 may cause the actuator driven valve 38 to change its state (e.g., close) and thereby terminate water flow, when replaced within the hub 12.

[0040] In one illustrated embodiment, the capacitive sensor 72 is a CapSense capacitive sensor available from Cypress Semiconductor Corporation. In this illustrated embodiment, the capacitive sensor 72 converts capacitance into a count value. The unprocessed count value is referred to as a raw count. Processing the raw count signal determines whether the handle 34, hub 12 or pullout wand 20 have been touched and whether the pullout wand 20 is docked or undocked as discussed below. It is understood that other suitable capacitive sensors 72 may be used.

[0041] Fig. 10 is an operation state diagram illustrating control of fluid flow based on the output signal from the capacitive sensor 72. The controller 70 processes the output signal from the capacitive sensor 72 to determine whether a user grabs the control handle or lever 34 of the faucet which is referred to as a "strong grab". The controller 70 also determines whether the user has grabbed the pullout wand 20 of the faucet which is referred to herein as a "weak grab". In addition, the controller 70 determines whether the handle 34, the hub 12, or the pullout wand 20 has been tapped by the user. Taps have a shorter time duration than grabs and control operation differently.

[0042] In an illustrated embodiment, a tap of any of the components (e.g., the handle 34, the hub 12, or the pullout wand 20) by the user will change the state of fluid flow. A weak grab where the user grabs onto the pullout wand 20 will not change the fluid flow state. Referring

now to Fig. 10, if the water is off as illustrated at block 500, the controller 70 will take no action if a weak grab of the pullout wand 20 is detected with the wand 20 in a docked position. When the water is off block 500, the controller 70 will change the state and turn the water on if a tap of any faucet component (e.g., the handle 34, the hub 12, or the pullout wand 20) is detected, if a strong grab of the handle 34 is detected, or if undocking of the pullout wand 20 is detected.

[0043] Once the water is on as illustrated at block 502, the controller 70 takes no action and keeps the water on if it detects either a weak grab of the pullout wand 20, a strong grab of the control handle 34, or that the wand 20 is undocked. The controller 70 will change the water flow state and turn the water off upon detecting a tap of any of the faucet components including the handle 34, the hub 12, or the pullout wand 20. The controller 70 will also turn the water off upon detecting that the pullout wand 20 is docked indicating that the user has replaced the pullout wand 20 into the receiver 18.

[0044] Figs. 11-16 show exemplary output signal plots from the capacitive sensor 72. Controller 70 establishes an upper "grab" threshold level and a lower "tap" threshold level above a signal baseline level 510 as illustrated in Figs. 11-16. The tap threshold 512 is set as low as possible in order to avoid false activations due to noise, interference, etc. The grab threshold 514 varies depending upon the particular faucet and sink components. Therefore, the grab threshold 514 is determined by an analysis of each faucet model. The controller 70 distinguishes between a "tap" and a "grab" of the handle 34 or pullout wand 20 based on the amplitude of the capacitive signal and an amount of time between the positive and negative slopes of the capacitive signal. Illustratively, a "grab" is a touch lasting longer than 0.3 seconds in one embodiment.

[0045] Figs. 11 illustrates an output signal from the capacitive sensor 72 when the control lever or handle 34 of the faucet is grabbed by the user. The capacitive signal has an initial baseline level 510. When the handle 34 is grabbed by the user, a large positive slope of the capacitive signal occurs at location 516. The signal during the handle 34 grab is above the grab threshold level 514 as illustrated at location 518. Once the handle 34 is released, a large negative slope 520 occurs and the signal returns to a baseline level 522 which is illustratively the same as original baseline level 510 in Fig. 11. As discussed above, the controller 70 determines

that the handle 34 has been grabbed when the length of time that the signal exceeds the grab threshold 514 exceeds a preselected time period. Illustratively, if the signal exceeds the grab threshold 514 for more than 0.3 seconds, then a grab of handle 34 is detected.

[0046] Fig. 12 illustrates an output signal from the capacitive sensor when a tap of the control lever or handle 34 is detected. In Fig. 12, the tap causes a large positive slope to occur at location 524 and a large negative slope occurs at location 526 less than 0.3 seconds after the positive slope 524. The signal exceeds the grab threshold 514 at location 525 indicating that the handle 34 has been tapped by a user.

[0047] In an illustrated embodiment, the controller 70 also determines whether a hub 12 of the faucet has been grabbed or tapped. Plots for the hub 12 being grabbed or tapped are similar to Figs. 11 and 12, respectfully, and with a reduction in the capacitance value of about 10% during the grab or tap time periods.

[0048] Fig. 13 illustrates an output signal from the capacitive sensor 72 when the pullout wand 20 of the faucet is docked and grabbed by the user. The capacitive signal has an initial baseline level 510. After an initial positive slope portion 530, the capacitive signal during the pullout wand 20 grab is above the tap threshold level 512 but below the grab threshold level 514 as illustrated at location 532. Once the pullout wand 20 is released, a large negative slope 534 occurs and the signal returns to a baseline level 522 which is illustratively the same as baseline level 510 in Fig. 13. As discussed above, the controller 70 determines that the pullout wand 20 has been grabbed when the length of time that the signal exceeds the tap threshold 512 exceeds a preselected time period. Illustratively, if the signal exceeds the tap threshold 512 for more than 0.3 seconds, then a pullout wand 20 grab is detected.

[0049] Fig. 14 illustrates an output signal block from the capacitive sensor 72 when a tap of the docked pullout wand 20 is detected. In Fig. 14, the tap occurs when the large positive slope occurs at location 536 and a large negative slope occurs at location 540 less than 0.3 seconds after the positive slope 536. The signal exceeds the tap threshold 512 at location 538, but is less than the grab threshold 514, indicating that the pullout wand 20 was tapped by a user.

[0050] Fig. 15 illustrates the output of the capacitive sensor 72 when the pullout wand 20 is undocked from the receiver 18 of hub 12. In the illustrated embodiment, the initial baseline

level 510 of the capacitive signal changes to a lower baseline level 522 after the pullout wand 20 is touched by the user and removed or undocked at location 550. The drop in the baseline level of the capacitive signal as illustrated by dimension 552 is detected by the controller 70 to determine that the pullout wand 20 has been undocked from the receiver 18 of hub 12.

[0051] Fig. 16 illustrates the output signal from the capacitive sensor 72 when the pullout wand 20 is moved from an undocked position to a docked position within the receiver 18 of hub 12. In this instance, the initial baseline signal level 510 increases to a higher baseline level 522 after the user replaces or docks the pullout wand 20 at location 560. The increase of the baseline level illustrated by dimension 562 in Fig. 16 is detected by the controller 70 to determine that the wand 20 has been docked.

[0052] Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the spirit and scope of the invention as described and defined in the following claims.

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CLAIMS:

1. An electronic faucet comprising:
 - a spout hub;
 - a pullout wand removably supported by the spout hub, the pullout wand being movable from a docked position coupled with the spout hub and an undocked position removed from the spout hub;
 - a manual valve including a handle operably coupled to the spout hub;
 - an electrically operable valve in fluid communication with the manual valve;
 - a tube slidably received within spout hub and fluidly coupling the pullout wand to the electrically operable valve;
 - a capacitive sensor in electrical communication with the pullout wand when in the docked position; and
 - a controller in electrical communication with the capacitive sensor, wherein the pullout wand is touch sensitive when in the docked position and is not touch sensitive when in the undocked position.
2. The electronic faucet of claim 1, wherein the pullout wand is capacitively coupled to the spout hub through a wand capacitive coupling.
3. The electronic faucet of claim 2, wherein the wand capacitive coupling includes a metal sleeve supported by the pullout wand and a plastic cylindrical liner supported by the spout hub.
4. The electronic faucet of claim 2, further comprising a handle electrical coupling between the capacitive sensor and the handle of the manual valve.
5. The electronic faucet of claim 2, further comprising a hub capacitive coupling between the capacitive sensor and the spout hub.
6. The electronic faucet of claim 1, wherein the controller distinguishes between a tap of the pullout wand when in the docked position, and a grab of the pullout wand when in the docked position.

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7. The electronic faucet of claim 1, wherein the controller controls operation of the electrically operable valve based upon a touching of the pullout wand when in the docked position.

8. An electronic faucet comprising:
a delivery spout including a receiver;
a pullout wand movable from a docked position coupled with the receiver of the delivery spout and an undocked position removed from the receiver of the delivery spout;
a wand capacitive coupling between the pullout wand and the delivery spout when the pullout wand is in the docked position; and
a capacitive sensor in electrical communication with the pullout wand through the wand capacitive coupling.

9. The electronic faucet of claim 8, further comprising a controller in electrical communication with the capacitive sensor, wherein the pullout wand is touch sensitive when in the docked position and is not touch sensitive when in the undocked position.

10. The electronic faucet of claim 9, wherein the controller distinguishes between a tap of the pullout wand when docked and a grab of the pullout wand when docked.

11. The electronic faucet of claim 8, further comprising an electrically operable valve, and a tube slidably received within the delivery spout and fluidly coupling the pullout wand to the electrically operable valve.

12. The electronic faucet of claim 11, further comprising a manual valve including a handle operably coupled to the delivery spout and in fluid communication with the electrically operable valve.

13. The electronic faucet of claim 12, further comprising a handle electrical coupling between the capacitive sensor and the handle of the manual valve.

14. The electronic faucet of claim 11, wherein operation of the electrically operable valve is controlled based upon at least one of a touching of the pullout wand when in the docked position, and a change between the docked position and the undocked position of the pullout wand.

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15. The electronic faucet of claim 8, wherein the wand capacitive coupling includes a metal sleeve supported by the pullout wand and a plastic cylindrical liner supported by the receiver of the delivery spout.

16. The electronic faucet of claim 8, further comprising a hub capacitive coupling between the capacitive sensor and the delivery spout.

17. An electronic faucet comprising:
a delivery spout including a receiver;
a pullout wand movable from a docked position coupled with the receiver of the delivery spout and an undocked position removed from the receiver of the delivery spout; and
a capacitive sensor operably coupled to the pullout wand;
wherein output from the capacitive sensor provides an indication of at least one of touching the pullout wand when in the docked position, and a change between the docked position and the undocked position of the pullout wand, and wherein water flow through the pullout wand is controlled based upon the output from the capacitive sensor.

18. The electronic faucet of claim 17, wherein the pullout wand is capacitively coupled to the delivery spout through a wand capacitive coupling.

19. The electronic faucet of claim 18, wherein the wand capacitive coupling includes a metal sleeve supported by the pullout wand and a plastic cylindrical liner supported by the receiver of the delivery spout.

20. The electronic faucet of claim 17, further comprising a controller in electrical communication with the capacitive sensor, wherein the pullout wand is touch sensitive when in the docked position and is not touch sensitive when in the undocked position.

21. The electronic faucet of claim 17, further comprising an electrically operable valve and a tube slidably received within the delivery spout and fluidly coupling the pullout wand to the electrically operable valve.

22. The electronic faucet of claim 21, wherein the electrically operable valve changes state if at least one of the pullout wand is touched while in the docked position, and if the pullout wand is moved between the docked position and undocked position.

23. The electronic faucet of claim 22, wherein the controller moves the electrically operable valve from a closed position to an open position in response to at least one of a user tap of the pullout wand when in the docked position, and undocking of the pullout wand from the docked position to the undocked position.

24. The electronic faucet of claim 22, wherein the controller moves the electrically operable valve from an open position to a closed position in response to at least one of a user tap of the pullout wand when in the docked position, and docking of the pullout wand from the undocked position to the docked position.

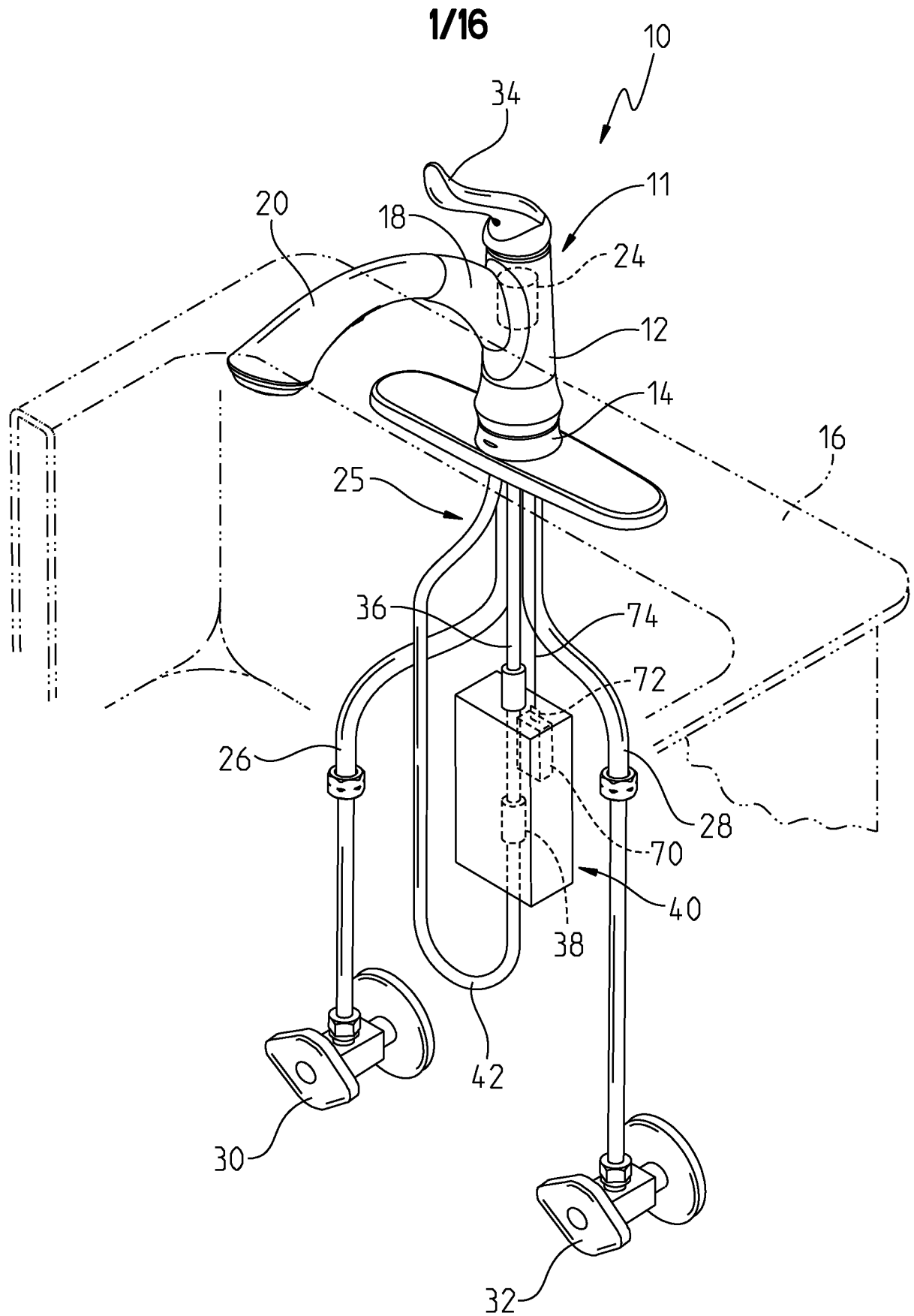


Fig. 1

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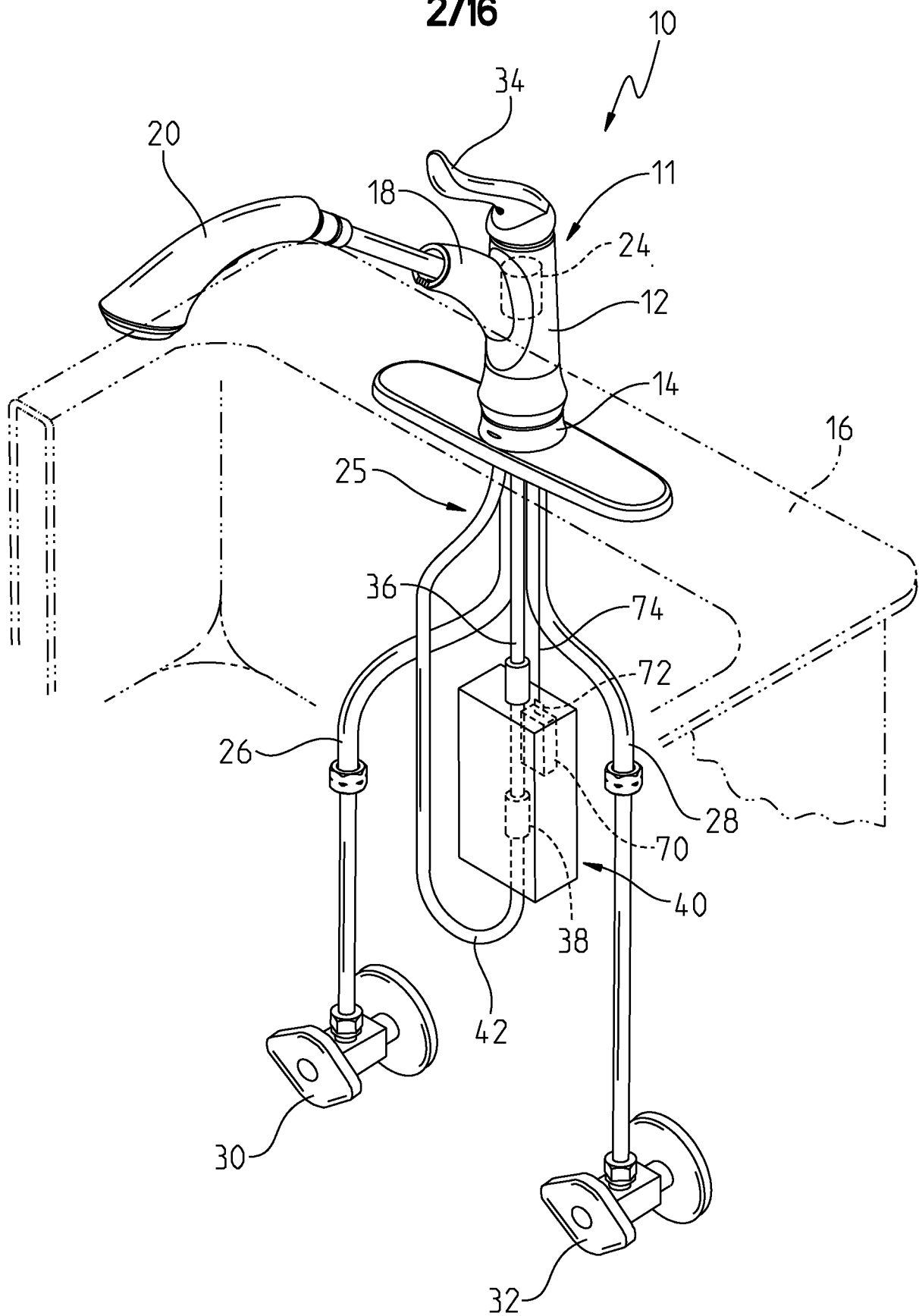


Fig. 2

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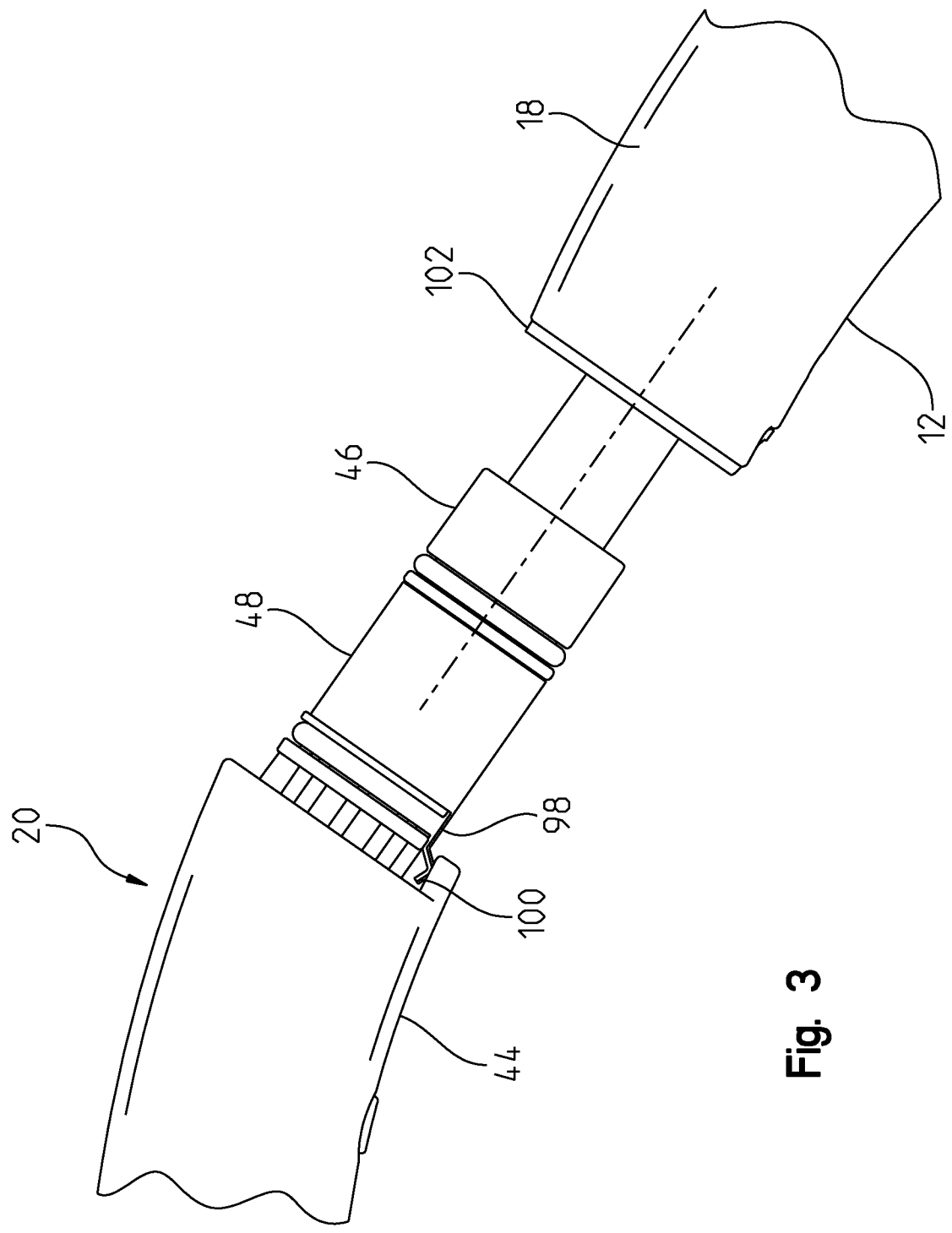


Fig. 3

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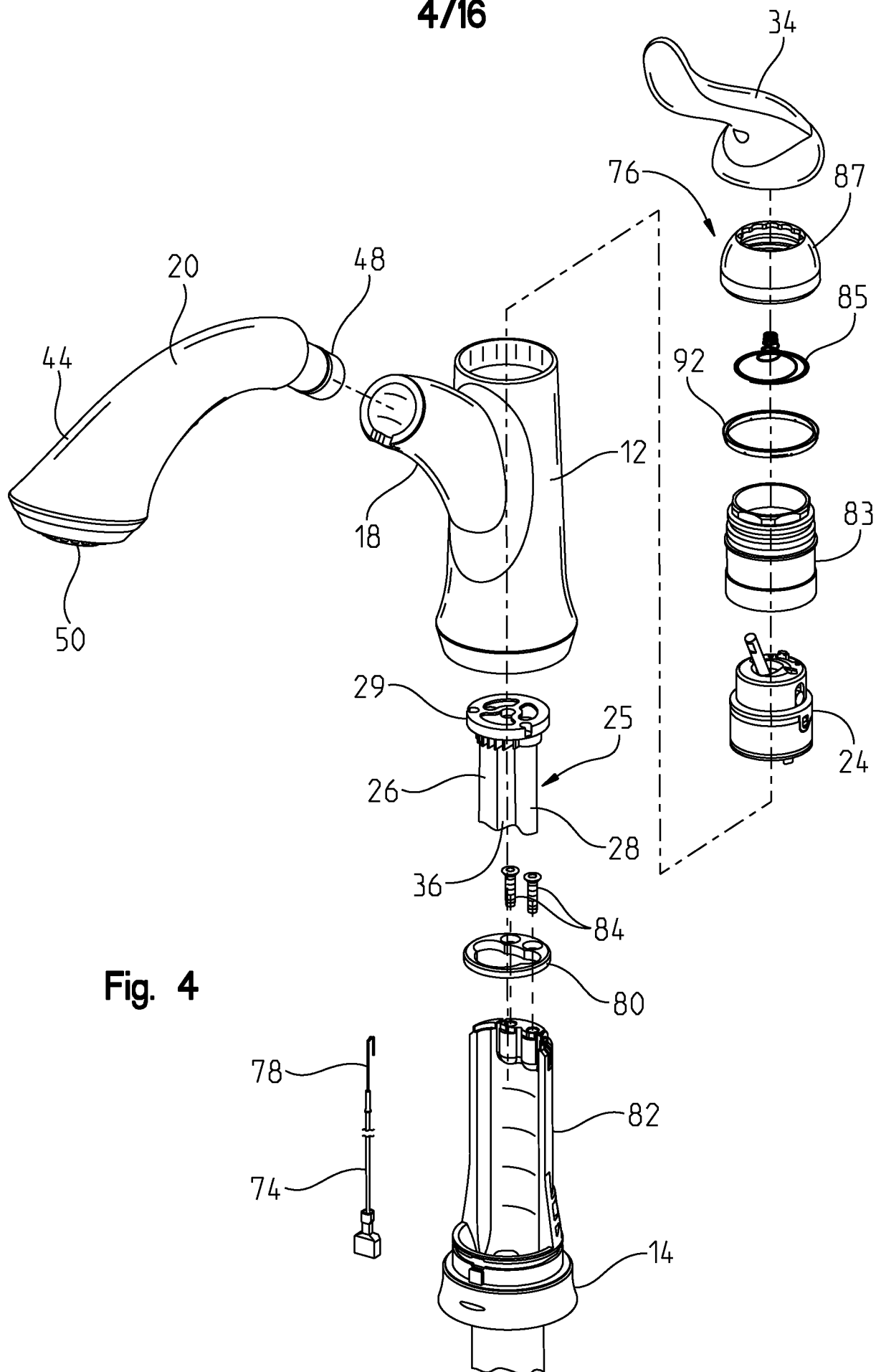


Fig. 4

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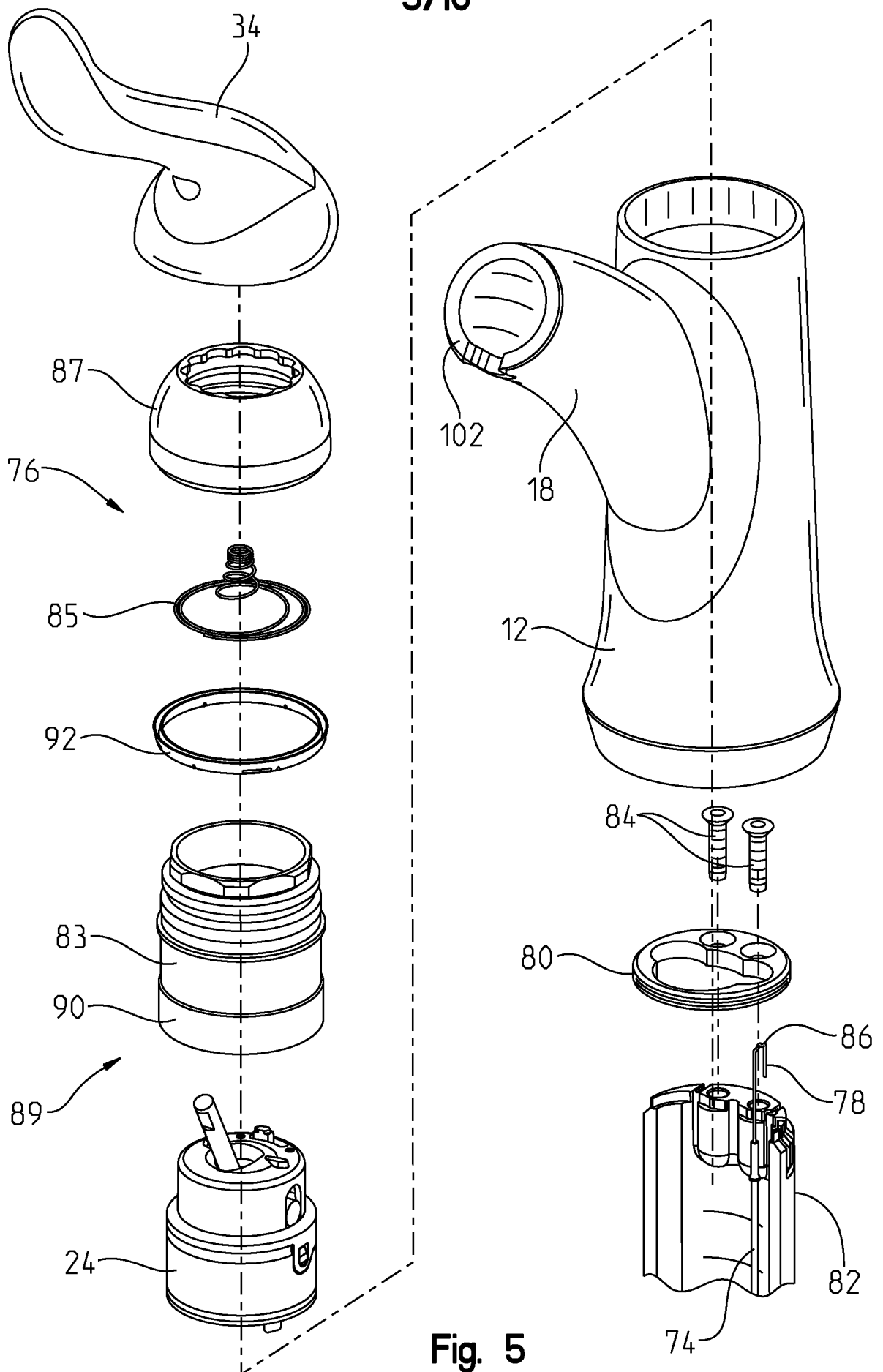


Fig. 5

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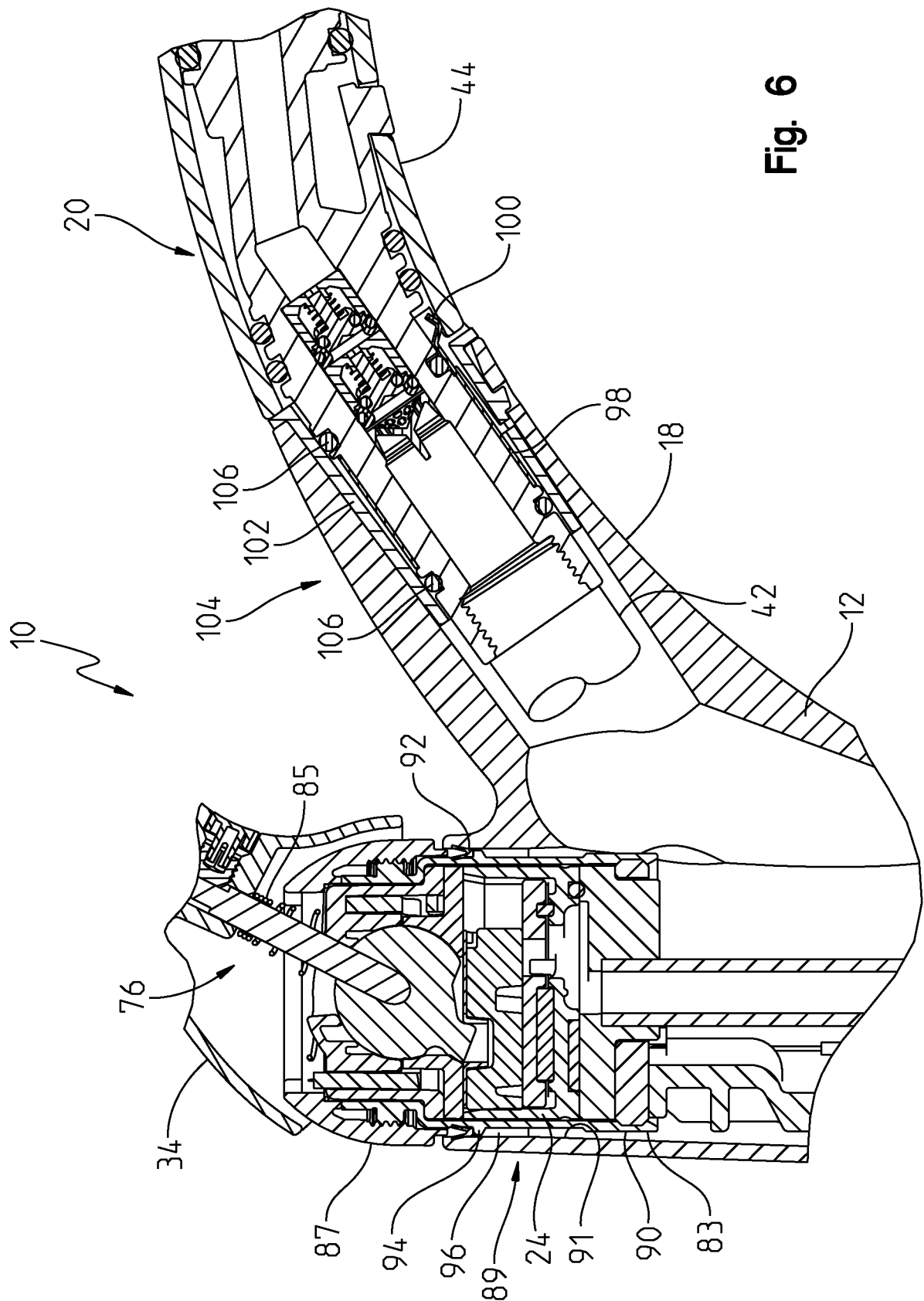


Fig. 6

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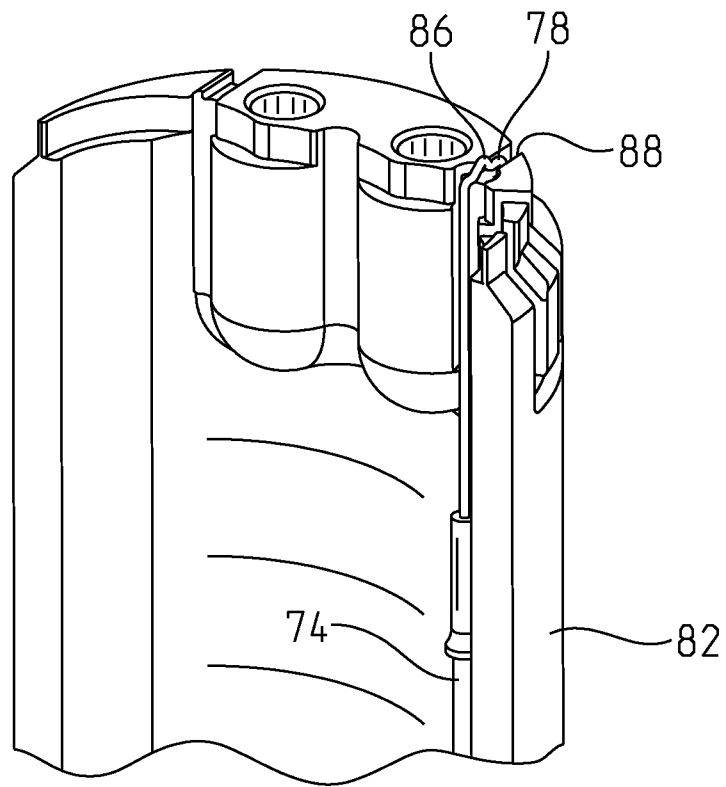


Fig. 7

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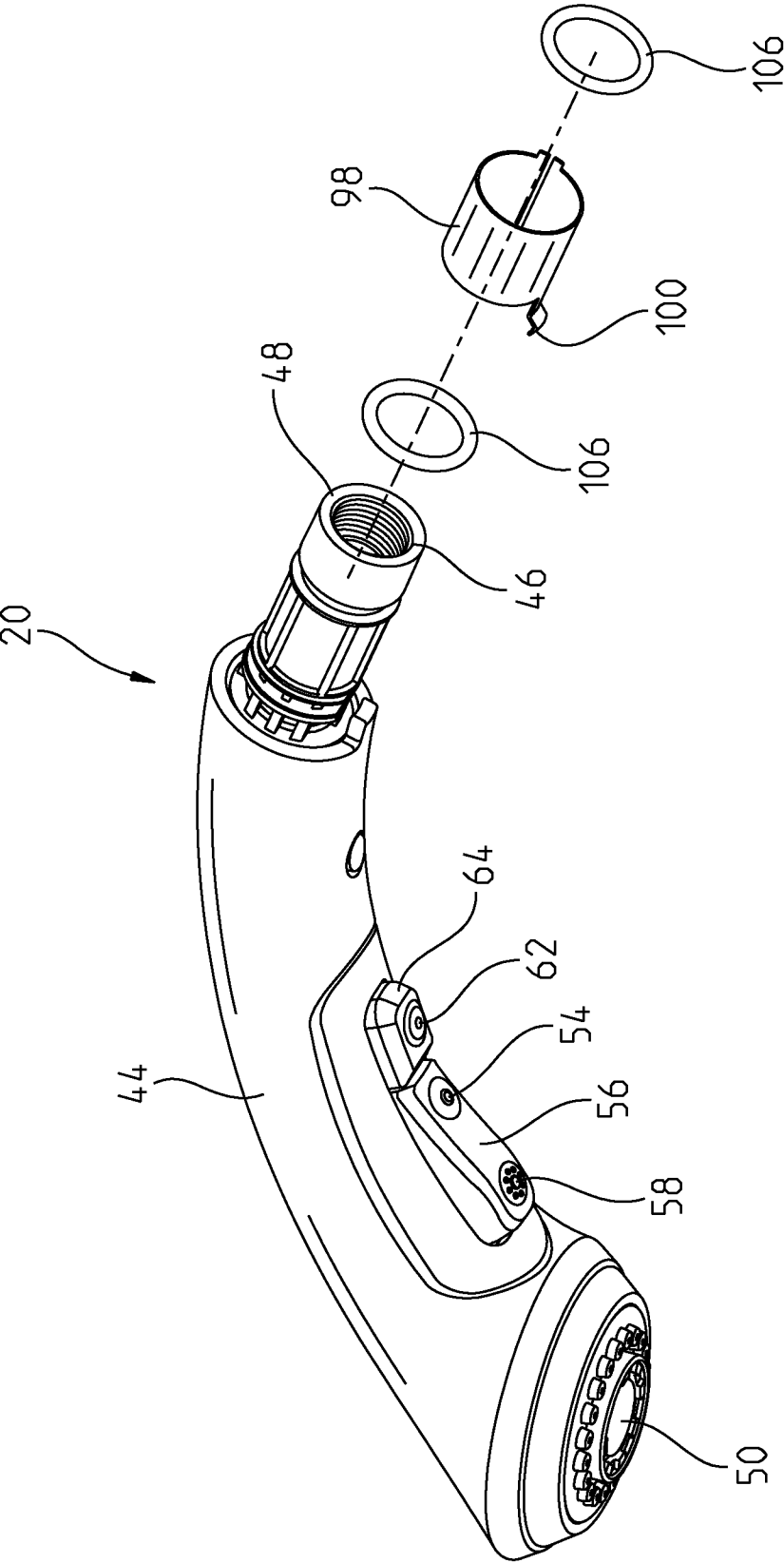


Fig. 8

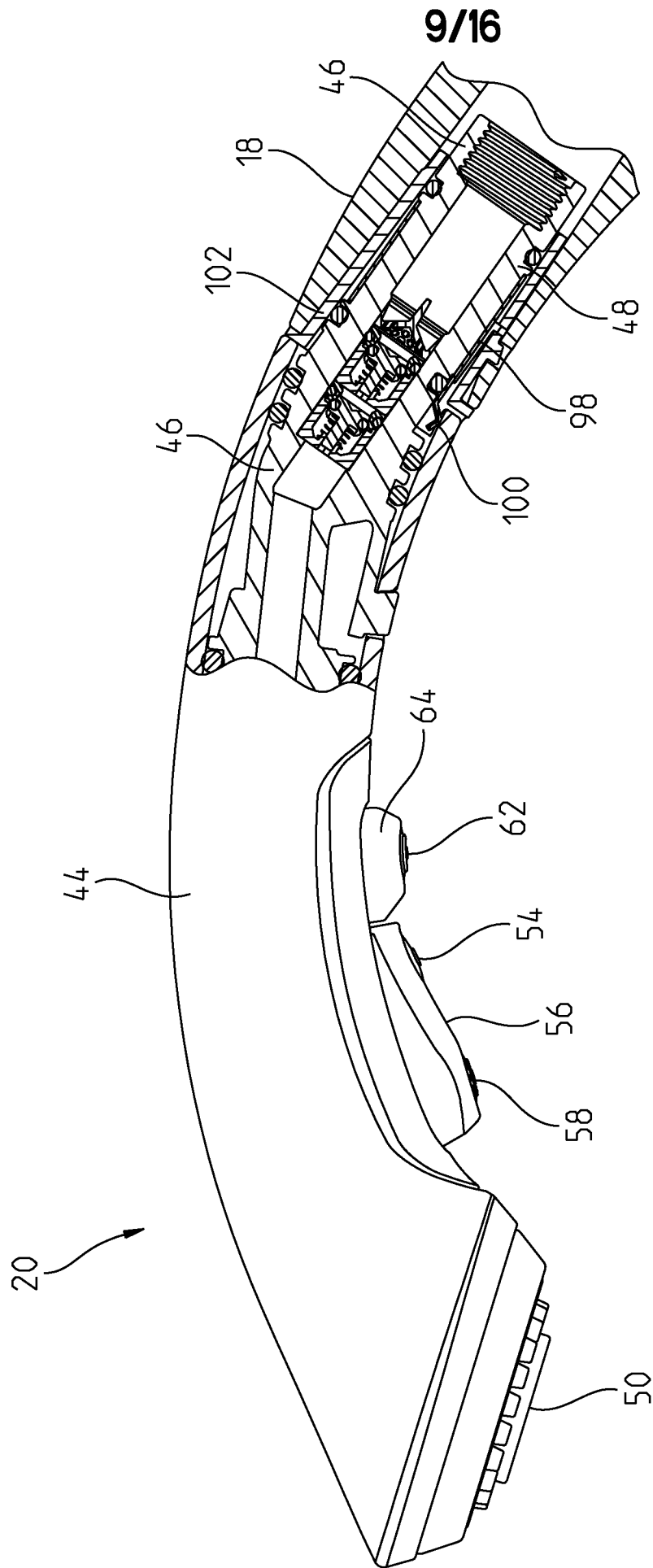
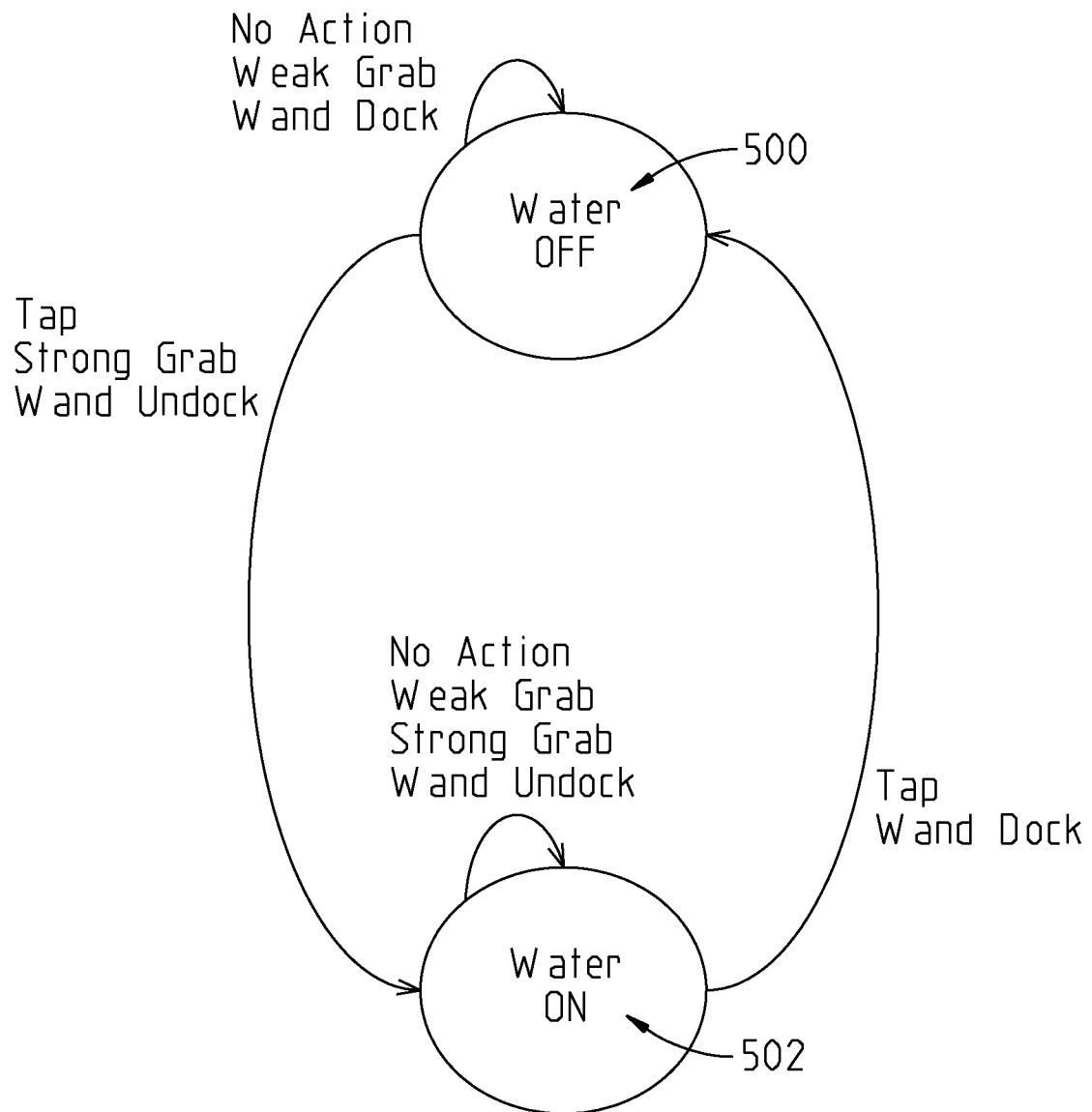


Fig. 9

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Pullout Faucet Water State Diagram

**Fig. 10**

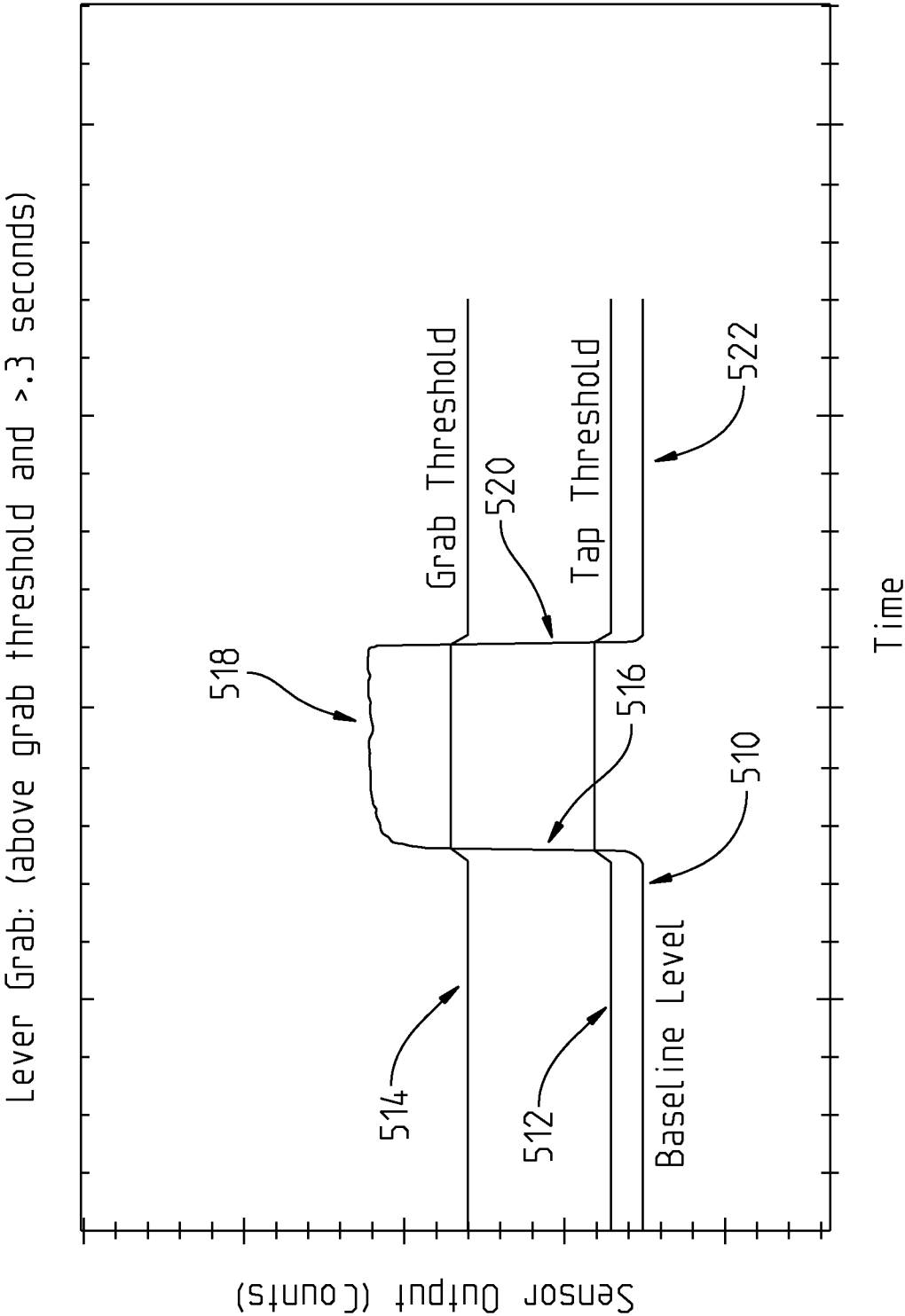


Fig. 11

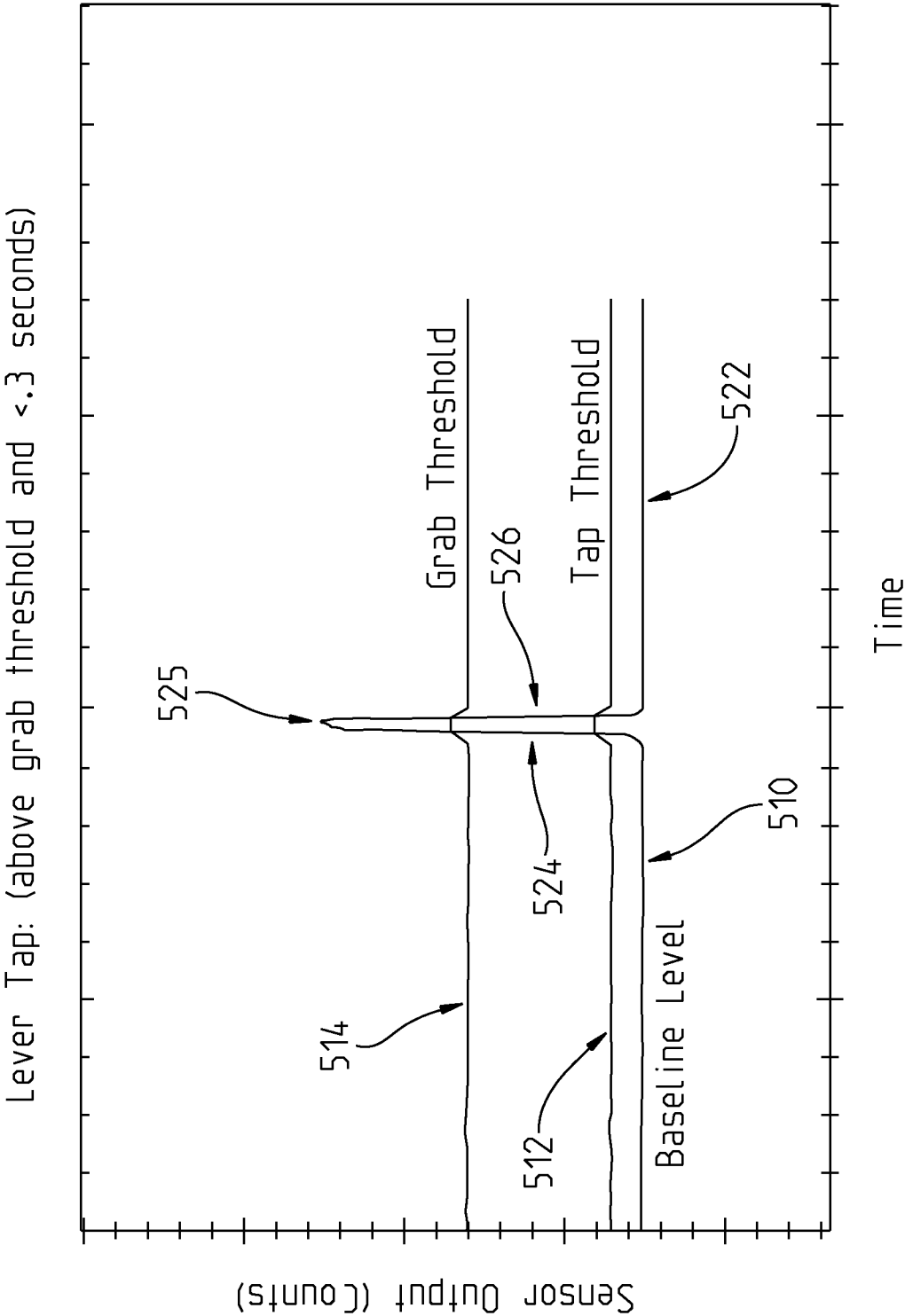


Fig. 12

Pullout Grab: (below grab threshold, above tap threshold, and >.3 seconds)

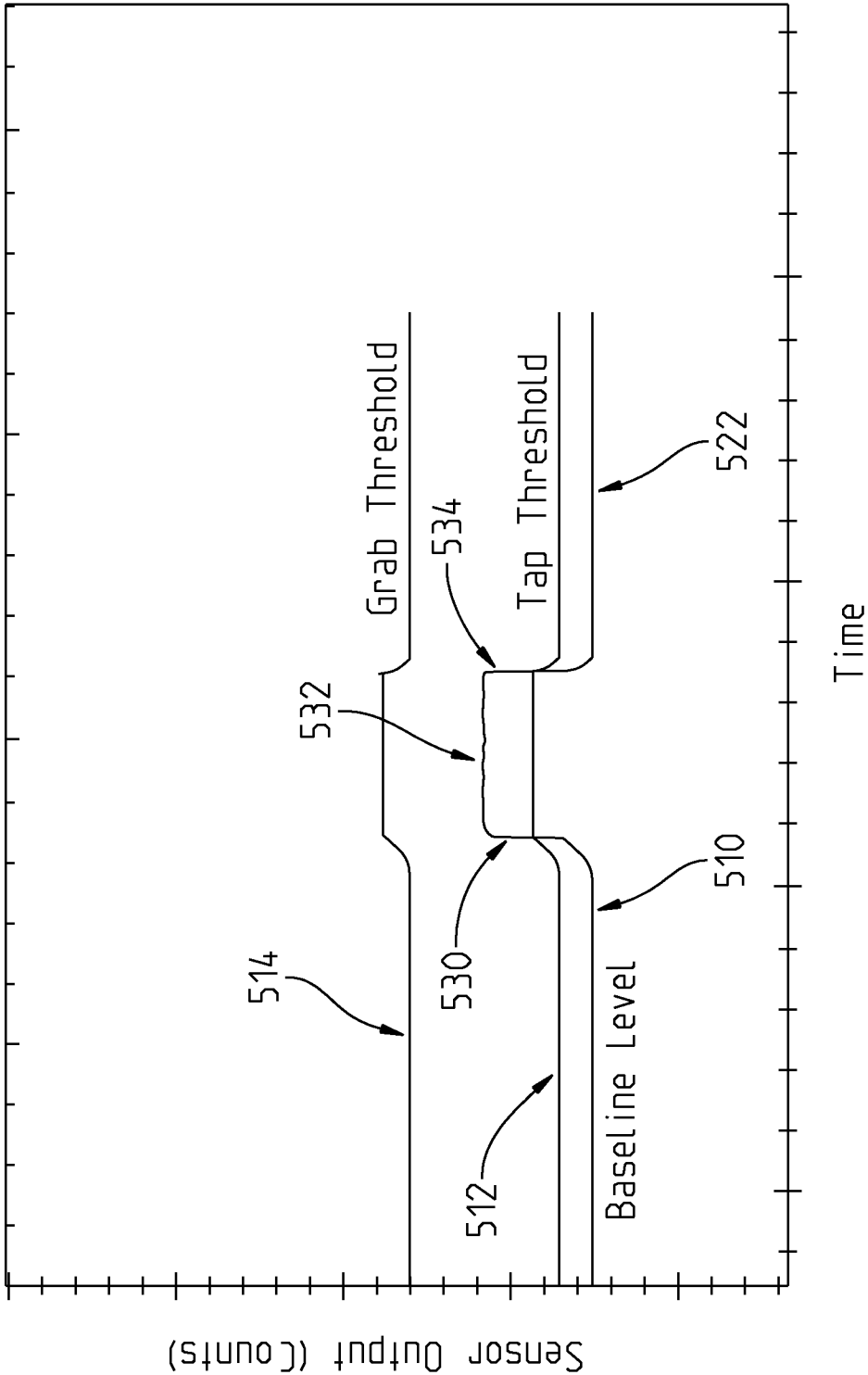


Fig. 13

Pullout Tap: (below grab threshold, above tap threshold, and <.3 seconds)

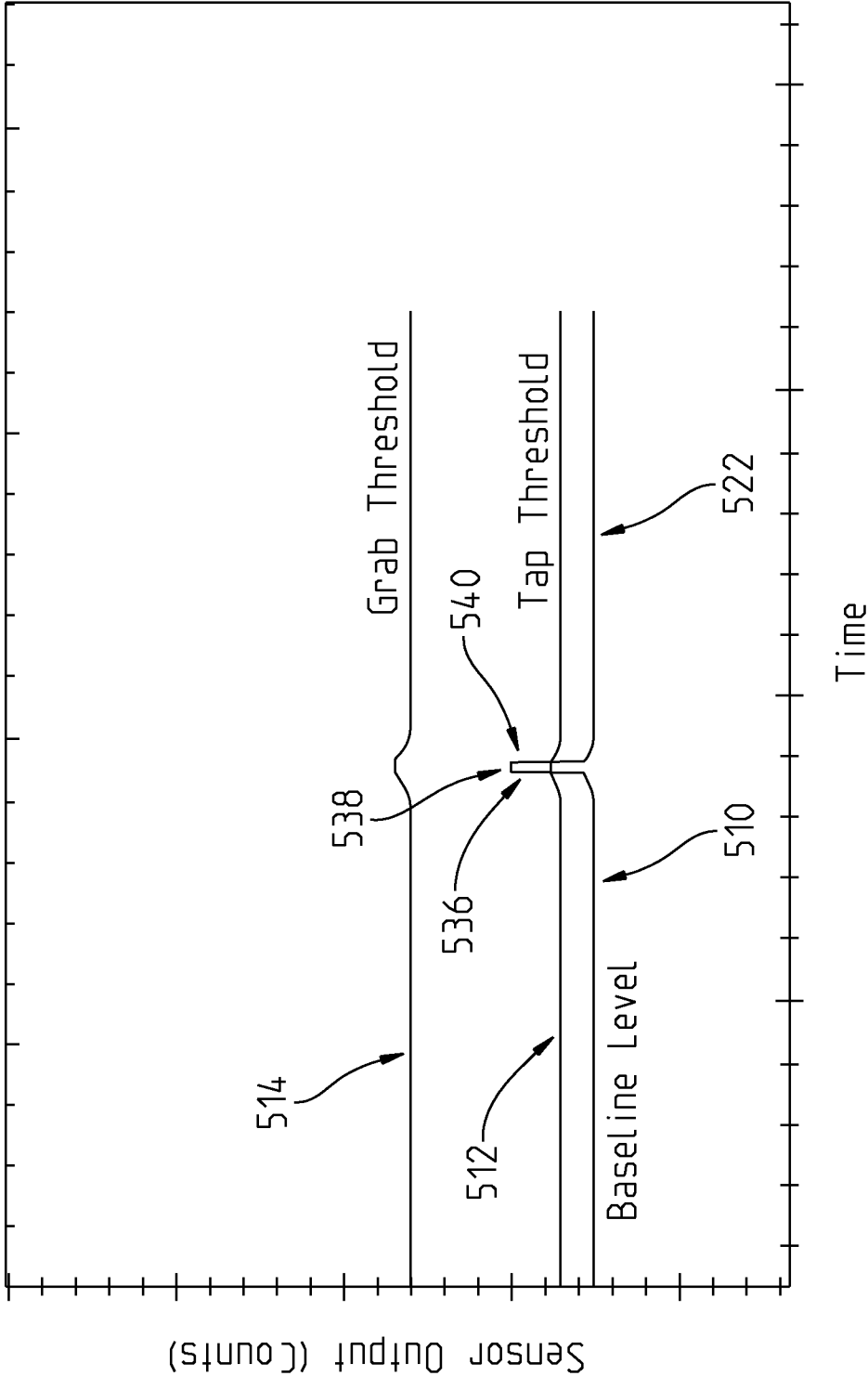


Fig. 14

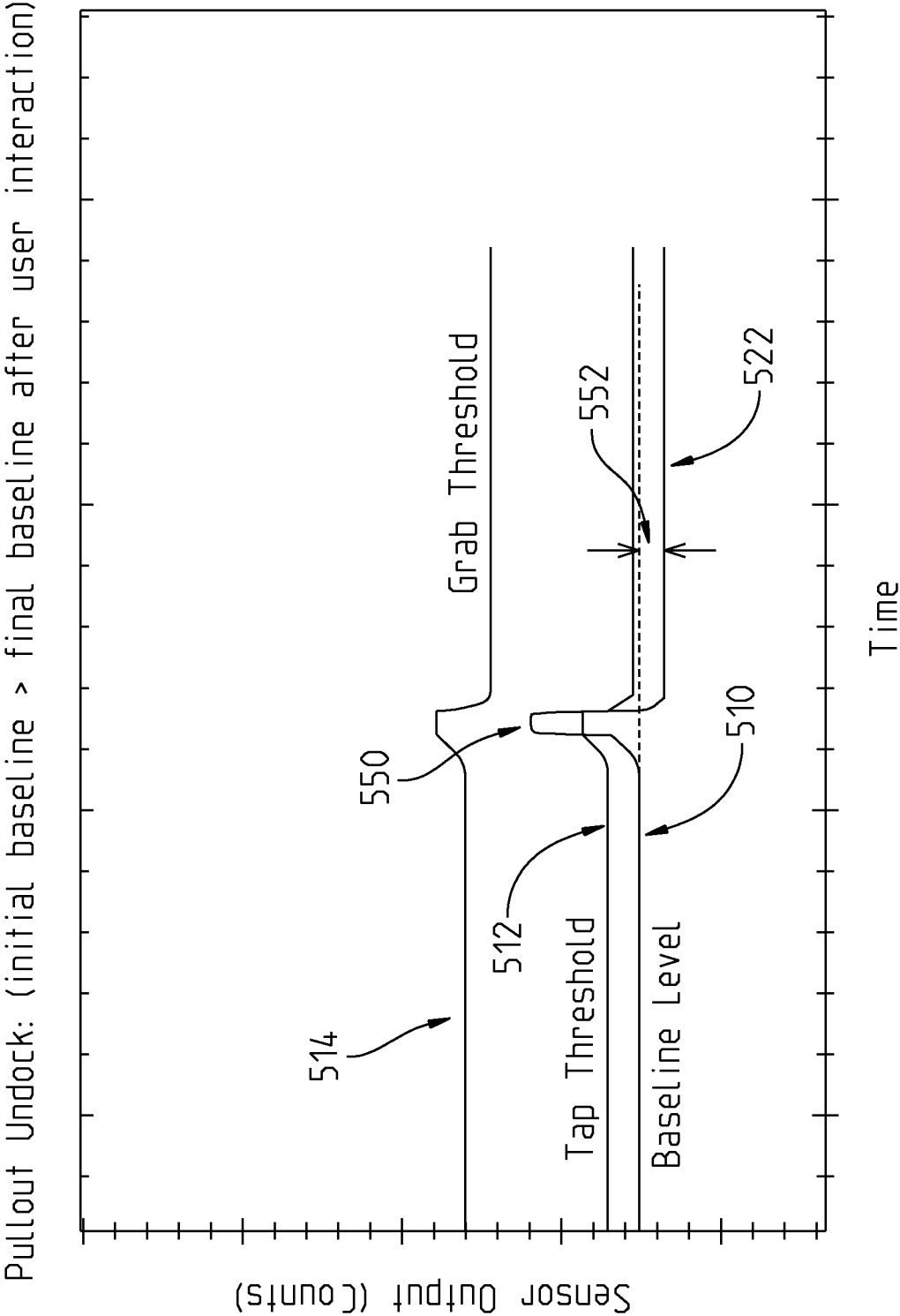


Fig. 15

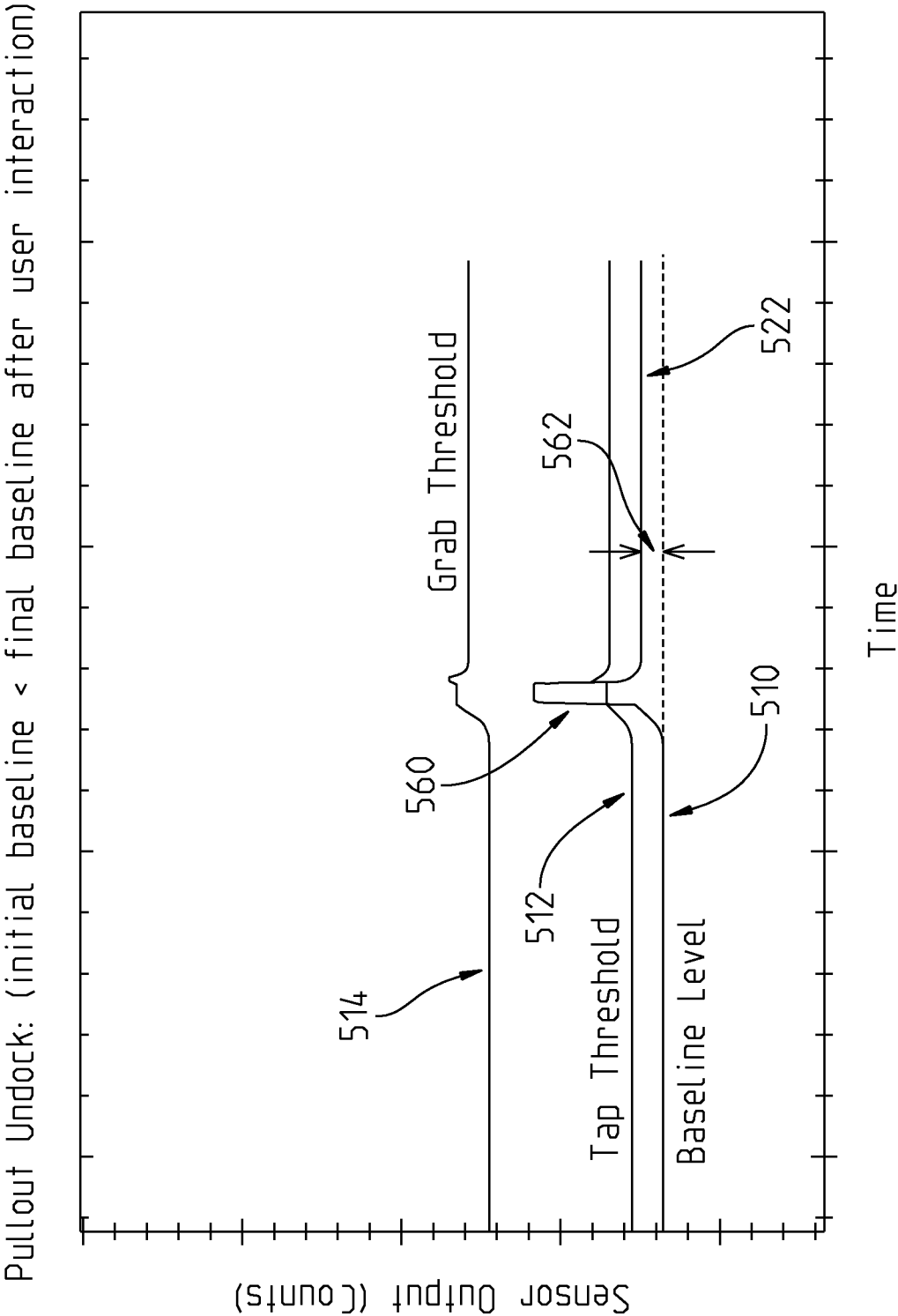


Fig. 16

INTERNATIONAL SEARCH REPORT

PCT/US2013/037384

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E03C 1/04 (2013.1)

USPC - 4/678

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - E03C 1/00, 1/01, 1/02, 1/04, F16K 31/00, 31/02, 31/04 (2013.1)

USPC - 4/675-678, 137/801, 239/281, 588

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - E03C 1/00, 1/01, 1/02, 1/04, 1/0404 (2013.1)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Orbit, Google, Google Patents, YouTube

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011/0284111 A1 (MARTY et al) 24 November 2011 (24.11.2011) entire document	1-24
A	US 2010/0170570 A1 (RODENBECK et al) 08 July 2010 (08.07.2010) entire document	1-24
A	US 6,962,168 B2 (MCDANIEL et al) 08 November 2005 (08.11.2005) entire document	1-24
A	US 2007/0246564 A1 (RODENBECK et al) 25 October 2007 (25.10.2007) entire document	1-24

☐ Further documents are listed in the continuation of Box C.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

17 July 2013

Date of mailing of the international search report

25 JUL 2013

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