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(54) Title: HIGH PRESSURE FLUID SPRAY NOZZLE INCORPORATING A FLOW CONTROLLED SWITCHING VALVE

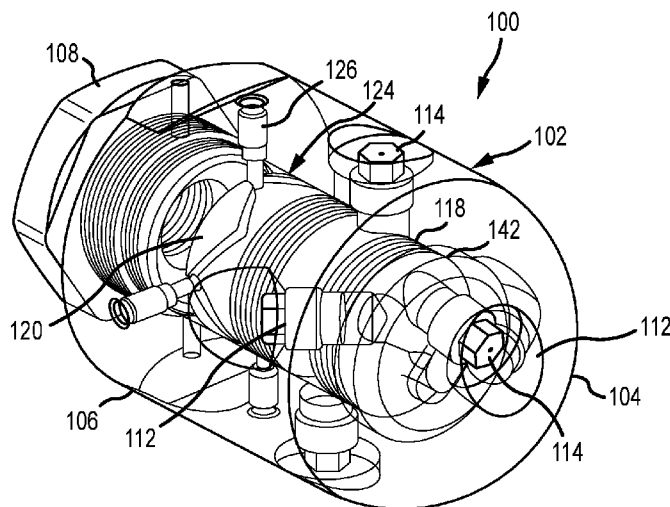


FIG. 1

(57) Abstract: A nozzle assembly comprises a hollow nozzle body having a central bore and a plurality of ports extending through the body from the central bore; and a switching valve assembly disposed in the central bore that directs fluid flow to ports upon application of fluid flow above a predetermined threshold to the inlet and direct fluid flow to different ports upon fluid flow having subsequently dropped below the predetermined threshold and then exceeding the predetermined threshold. The assembly comprises a cylindrical poppet slidably disposed within the central bore, a guide between the nozzle body and the poppet, and a biasing member within the cartridge case between the front portion of the nozzle body and the poppet urging the poppet away from the front portion of the cartridge case.

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# HIGH PRESSURE FLUID SPRAY NOZZLE INCORPORATING A FLOW CONTROLLED SWITCHING VALVE

## BACKGROUND OF THE DISCLOSURE

**[0001]** Traction nozzles are used in sewer pipe lines and other piping systems to assist in pulling high pressure hose into the pipe to reach obstructions requiring removal. These traction nozzles have jet tips oriented at an angle rearward in order to generate thrust in the nozzle within the pipe to assist in pulling the hose through and along long stretches of pipe and around pipe bends. These nozzles have forward directed jet tips and may also have laterally directed tips to ablate the obstructions encountered. However, the forward directed jet tips produce a force counter to the forward travel of the nozzle through the pipe. This counterforce hinders effective deployment of the high pressure hose and reduces the net pulling force produced by the traction nozzle on the high pressure hose. Thus there is a need for a switching mechanism that does not generate a counterforce during traction operation, yet facilitates operation of an effective fluid jet nozzle during actual cleaning operations. Furthermore, there is a need for a nozzle assembly incorporating a switching valve assembly that is replaceable and has a minimum number of component parts in order to simplify design and maintenance of such a nozzle assembly.

## SUMMARY OF THE DISCLOSURE

**[0002]** An exemplary embodiment of a nozzle assembly in accordance with the present disclosure includes a hollow nozzle head body having a central bore containing a switching valve assembly captured in the body by an inlet nut fastened to the nozzle head body. The valve assembly includes a movable poppet disposed in the central bore, a guide member in the bore, and a bias member in the bore between the nozzle head body and the poppet resiliently biasing the poppet toward the inlet nut at a rear end of the central bore.

**[0003]** This nozzle assembly more particularly includes a hollow nozzle body having a front portion and a rear portion, a central bore through the rear portion, and a plurality of ports extending out of the nozzle body through the front portion of the body from the central bore. A switching valve assembly is disposed in the central

bore. This assembly is operable to direct fluid flow from an inlet to the rear portion to at least one of the plurality of ports upon application of fluid flow above a predetermined threshold to the inlet and direct fluid flow from the inlet to at least a different one of the plurality of ports upon fluid flow having subsequently dropped below the predetermined threshold and then exceeding the predetermined threshold.

**[0004]** One embodiment of the switching valve assembly includes a cylindrical poppet slidably disposed within the central bore, a guide member in the central bore engaging the poppet, and a biasing member in the central bore between the front portion of the nozzle body and the poppet. This biasing member is preferably a coil spring. The spring urges the poppet away from the front portion of the nozzle body.

**[0005]** The assembly preferably includes a plurality of guide members engaging the poppet to alternately align the poppet with the at least one of the plurality of ports and the different at least one of the plurality of ports each time the poppet abuts one of the front portion of the nozzle body or a flow diverter positioned in the central bore. The guide members are preferably pins through a side wall of the nozzle body each projecting radially inward from the nozzle body into the central bore engaging a corresponding feature on the poppet.

**[0006]** The poppet has at least one through bore to permit fluid flow therethrough and has the corresponding feature engaging the guide member. This feature preferably is a peripheral zig-zag groove in the outer side wall of the poppet. Each transition below the predetermined threshold causes the poppet to rotate about its axis to permit fluid flow to alternate between the first and second set of ports. The poppet also has at least one other through bore that carries a floating valve pin. This floating pin has a stem in the bore and large plug end that engages and closes one of the plurality of ports through the front portion of the nozzle body when the poppet abuts against either the front portion of the nozzle body or the flow diverter in the central bore.

**[0007]** Alternatively the corresponding feature engaging the guide member may include one or more guide pins protruding from the outer side wall of the poppet into a peripheral zig-zag groove formed in a side wall of the central bore.

**[0008]** The front portion of the nozzle body has at least one bore therethrough leading to the first set of ports and at least one other bore therethrough leading to the second set of ports. The poppet has a front face and at least one of the valve pins

protruding from the front face forms a plug which is configured for selectively closing the at least one bore through the front portion of the nozzle body or the flow diverter.

**[0009]** An embodiment of a nozzle assembly in accordance with the present disclosure may be viewed as including a hollow nozzle body connectable to a high pressure fluid supply. This nozzle body has a front portion and a rear portion and a central bore through at least the rear portion, a first plurality of ports extending out of the body from one end of the central bore and a second plurality of ports extending out of the body from the central bore. A switching valve assembly disposed in the central bore is operable to direct fluid flow from an inlet to one or more of the first plurality of ports upon application of fluid flow above a predetermined threshold to the inlet and direct fluid flow from the inlet to one or more of the second plurality of ports upon fluid flow dropping below the predetermined threshold and then exceeding the predetermined threshold. One embodiment of the switching valve assembly includes a cylindrical poppet slidably disposed in the central bore.

**[0010]** The poppet has a plurality of axially extending bores therethrough. A biasing member is positioned between the front portion and the poppet biasing the poppet away from the front portion of the nozzle body. A guide member between the rear portion of the nozzle body and the poppet engages a corresponding feature on the poppet to rotate the poppet as it slides within the rear portion of the cartridge case. The poppet has one or more valve pins each disposed in one of the poppet bores for closing one of the first plurality of ports when aligned with that one of the first plurality of ports when exceeding the predetermined threshold. The poppet in this embodiment has a front face and at least one of the valve pin forms a lug shape protruding from the front face closing one of the ports and at the same time closing the poppet bore carrying the valve pin when the poppet abuts against one of the ports.

**[0011]** Further features, advantages and characteristics of the embodiments of this disclosure will be apparent from reading the following detailed description when taken in conjunction with the drawing figures.

**DESCRIPTION OF THE DRAWINGS**

**[0012]** FIG. 1 is perspective view of a switching nozzle head assembly in accordance with a first embodiment of the present disclosure with outer portions transparent to show the inner structure.

**[0013]** FIG. 2 is an axial cross sectional view of an assembled switching nozzle head assembly shown in FIG. 1.

**[0014]** FIG. 3 is an exploded view of a switching nozzle head assembly in accordance with a second embodiment of the present disclosure.

**[0015]** FIG. 4 is an axial cross sectional view through the nozzle head assembly shown in FIG. 3 in a pressurized condition showing flow plugged to tractor ports.

**[0016]** FIG. 5 is an axial cross sectional view through the nozzle head assembly rotated 90 degrees from that shown in FIG. 4, showing the passages through the poppet directing flow to cleaning ports.

**[0017]** FIG. 6 is an exploded view of a switching nozzle head assembly in accordance with a third embodiment of the present disclosure.

**[0018]** FIG. 7 is an axial cross sectional view through the nozzle assembly as in FIG. 6, showing the poppet directing flow to the tractor ports.

**[0019]** FIG. 8 is an axial cross sectional view through the nozzle assembly as in FIG. 7 but rotated 90 degrees, showing the poppet plugging the passages to the cleaning ports.

**[0020]** FIG. 9 is an exploded view of a switching nozzle assembly in accordance with a fourth embodiment of the present disclosure.

**[0021]** FIG. 10 is a longitudinal cross sectional view of the nozzle assembly shown in FIG. 9 in a pressurized condition showing the poppet plugging the traction ports.

**[0022]** FIG. 11 is a longitudinal cross sectional view, rotated 90 degrees, of the nozzle assembly shown in FIG. 10 showing the passages through the poppet permitting flow to the cleaning ports.

## DETAILED DESCRIPTION

**[0023]** An exemplary first embodiment of a nozzle assembly **100** incorporating a switching valve assembly is shown in Figures **1** and **2**. Nozzle assembly **100** has a generally cylindrical solid nozzle body **102** with a front portion **104** which typically has a rounded nose and a generally cylindrical rear portion **106** that can be threadably fastened to an inlet nut **108**, which is, in turn, preferably fastened to a distal end of a rotary shaft and, in turn, thence to a high pressure fluid hose (not shown). This nozzle body **102** has a central bore **110** through at least the rear portion **106** of the nozzle body **102** and a plurality of ports **112** drilled through the body **102** each leading from the central bore **110** to a nozzle tip **114** that is threaded into each of the ports **112**.

**[0024]** Captured in the central bore **110** between the front portion **104** and the inlet nut **108** in this embodiment is a switching valve assembly **116** and a flow diverter insert **118**. This switching valve assembly **116** includes a cylindrical poppet **120** slidably disposed in the central bore **110**, a bias member **122** compressed between the poppet **120** and the diverter **118**, and a guide **124** between the poppet **120** and the nozzle body **102**.

**[0025]** In this first embodiment of the nozzle assembly **100**, the guide **124** comprises a groove in the poppet **120** that engages a plurality of guide pins **126** threaded into the body **102** that extend into the central bore **110**. The groove **124** is a peripheral zig-zag groove formed in the outer cylindrical surface of the poppet **120**. In the embodiment shown, there are four guide pins **126** spaced at 90 degrees apart around the central bore **110**. When fluid pressure/flow is applied to the assembled nozzle **100**, the poppet **120** slides within the bore **110** forward toward the front portion **104** of the nozzle body **102**, being rotated as it moves via the guide **124** until its front end face **138** abuts against the rear face of the flow diverter **118**.

**[0026]** In this first embodiment, the flow diverter **118** is a generally cylindrical body positioned in the central bore **110** that has four axial passages **128** therethrough that direct fluid to different sets of ports **112**. At least one port **112** is forward through the front portion **104** of the body **102**. Other ports **112** are directed outward from the body **102** for cleaning and still others are directed rearward to provide a tractor effect

to the nozzle assembly **100** during use, effectively pulling the nozzle assembly **100** into a piping system being cleaned (not shown).

**[0027]** The poppet **120** is a short cylindrical body that has four axially extending bores **130** symmetrically arranged around its central axis. Two oppositely arranged bores **130** carry floating valve pins **132**. These valve pins **132** are used to close corresponding aligned passages **128** through the diverter **118**. Each valve pin **132** has a stem **134** and an enlarged plug portion **136** that extends from a front face **138** of the poppet **120** giving the valve pin an external shape like an Erlenmeyer flask. The valve pins **132** are each captured within its bore **130** via a snap ring **140** fastened to the stem **134** of the valve pin **132** such that the valve pin **132** floats within its bore through the poppet **120**. This floating configuration with an enlarged plug or lug end portion **136** accommodates for tolerance stacking of the nozzle switching valve **116** components and ensures positive sealing between the poppet **120** and the valve pin **132** when fluid pressure/flow is applied to the assembled nozzle **100**.

**[0028]** The other two bores **130** (not shown in FIG. 2) through the poppet **120** provide a flow path to the passages **128** in the flow diverter **118**. Thus when the poppet **120** is arranged as shown in FIG. 2, the passages **128** directed to the cleaning ports **112** are plugged. The passages **128** that are not shown in the sectional view of FIG. 2 are not plugged permitting fluid flow directly to the tractor and forward ports **112** through a cavity **142** in the central bore **110** in the front portion **104** of the nozzle body **102**

**[0029]** FIG. 2 shows the poppet **120** closing two axial passages **128** into the diverter **118**. A cross sectional view 90° rotated from that shown would reveal the opposite straight through bores **130** through the poppet **120** aligned with axial passages **128** in the diverter **118** that lead to the cavity **142**. The view of FIG 2 shows the nozzle **100** with the switching valve assembly **116** aligned to provide fluid flow to the front ports and tractor ports **112**. When fluid pressure/flow next drops below a threshold defined by the spring rate of spring **122**, the poppet **120** would move rearward along the zig zag path of the peripheral groove of the guide **124**. When flow next exceeds the threshold, poppet **120** would move forward and rotate to align the straight through passages with the passages **128** in the flow diverter shown in FIG. 2.

**[0030]** Although not shown, the through bores **130** through the poppet **120** that do not carry valve pins **132** may have a larger diameter than those carrying valve pins **132** or they may be similarly shaped to those shown. The valve pin plug portions **136** may extend beyond the end face **138** of the poppet **120** and may be tapered so as to fit within complementary shaped tapered entrances to the mating passages **128** in the diverter **118**. The bias member **122** preferably is a coil spring that fits within a blind bore centered within the diverter **118** and has a portion fitting within a central recess in the poppet **120**.

**[0031]** A second embodiment of a nozzle assembly **200** incorporating a switching valve assembly **216** as above described is shown in FIGS. **3**, **4** and **5**. Nozzle assembly **200** is similar to nozzle assembly **100** described above except that the flow diverter **118** has been eliminated. This functionality is incorporated into the front portion of the nozzle body. Nozzle assembly **200** has a generally cylindrical solid nozzle body **202** with a front portion **204** which typically has a rounded nose and a generally cylindrical rear portion **206** that can be threadably fastened to an inlet nut **208**, which is, in turn, fastened to a rotary shaft and thence to a high pressure fluid hose (not shown). This nozzle body **202** has a central bore **210** through at least the rear portion **206** of the nozzle body **202** and a plurality of ports **212** drilled through the body **202** each leading from the central bore **210** to a nozzle tip **214** that is threaded into each of the ports **212**.

**[0032]** Captured in the central bore **210** between the front portion **204** and the inlet nut **208** in this embodiment is a switching valve assembly **216**. This switching valve assembly **216** includes a cylindrical poppet **220** slidably disposed in the central bore **210**, a bias member **222** compressed between the poppet **220** and the front portion **204**, and a guide **224** between the poppet **220** and the nozzle body **202**.

**[0033]** In this second embodiment of the nozzle assembly **200**, the guide **224** comprises a groove in the poppet **220** that engages a plurality of guide pins **226** that are threaded into the body **202** and extend into the central bore **210**. The groove **224** is a peripheral zig-zag groove formed in the outer cylindrical surface of the poppet **220**. In the second embodiment shown, there are four guide pins **226** spaced at 90 degrees apart around the central bore **210**. When fluid flow is applied to the assembled nozzle **200**, the poppet **220** slides within the bore **210** forward toward the front portion **204** of the nozzle body **202**, being rotated as it moves via the

guide **224** until its front end face **238** abuts against the rear face of the front portion **204** at the end of the central bore **210**.

**[0034]** The poppet **220** is a short cylindrical body that has four axially extending bores **230** symmetrically arranged around its central axis. Two oppositely arranged bores **230** carry floating valve pins **232**. These valve pins **232** are used to close corresponding aligned passages **228** through the front portion **204** of the nozzle body **202**. Each valve pin **232** has a stem **234** and an enlarged plug portion **236** extend from a front face **238** of the poppet **220** giving the valve pin an external shape like an Erlenmeyer flask. The valve pins **232** are each captured within its bore **230** via a snap ring **240** fastened to the stem **234** of the valve pin **232** such that the valve pin **232** floats within its bore through the poppet **220**. This floating configuration with an enlarged plug or lug end portion **236** accommodates for tolerance stacking of the nozzle switching valve **216** components. Further, an O-ring seal (not shown) may be installed between the chamfer of the enlarged plug portion **236** and the front portion **204** of the nozzle body **202** to provide a positive seal.

**[0035]** The other two bores **230** (shown in FIG. **5**) through the poppet **220** provide a flow path to the passages **228** in the front portion **204** of the nozzle body **202**. Thus when the poppet **220** is arranged as shown in FIG. **4**, the passages **228** directed to the cleaning ports **212** are plugged. The passages **228** that are shown in the sectional view of FIG. **5** are not plugged permitting fluid flow directly to the tractor and forward ports **212** through the front portion **204** of the nozzle body **202**.

**[0036]** FIG. **4** shows the poppet **220** closing two axial passages **228** into the front portion **204** of the nozzle body **202**. A cross sectional view 90° rotated from that shown is shown in FIG. **5** showing the opposite straight through bores **230** through the poppet **220** aligned with axial passages **228** in the front portion **204**. The view of FIGS **4** and **5** shows the nozzle **200** with the switching valve assembly **216** aligned to provide fluid flow to the lateral cleaning ports **212**. When fluid flow next drops below a threshold flow defined by the spring rate of spring **222**, the poppet **220** would move rearward along the zig zag path of the peripheral groove of the guide **224**. When flow next exceeds the threshold, poppet **220** would move forward and rotate to align the straight through passages with the other pair of passages **228** to the tractor and forward ports **212**.

**[0037]** Another switching valve nozzle assembly in accordance with the present disclosure is shown in FIGS. **6**, **7** and **8**. This nozzle assembly **300** includes a hollow nozzle body **302** that has a round nose front portion **304** and a generally cylindrical rear portion **306**. The nozzle body **302** has a central blind bore **310** that receives a removable valve cartridge **312**. The blind bore **310** has a block shaped front portion **314** and a circular cylindrical rear portion **316**. This removable cartridge **312** is shaped complementary to the central blind bore **310** and is captured within the blind bore **310** by a nozzle inlet nut **308** fastened to the nozzle body **302** and which, in turn, connects to a rotatable shaft and thence to a high pressure fluid hose (not shown).

**[0038]** The removable cartridge **312** includes a case **318** externally shaped complementary to the blind bore **310** with a front block portion **320** that acts as a flow diverter having a plurality of passages therethrough each configured to align with a port drilled through the nozzle body **302** into the front portion **314** of the blind bore **310**. The case **318** has a hollow circular cylindrical rear portion **322** that carries within it a switching valve assembly **324**.

**[0039]** This switching valve assembly **324** is similar to the switching valve assemblies **116** and **216** described above. This switching valve assembly **324** includes a cylindrical poppet **326** slidably disposed in the cylindrical rear portion **322** of the case **318**, a bias member **328** compressed between the poppet **326** and the front portion **320** of the case **318**, and a guide **330** operating between the poppet **326** and the rear portion **322** of the case **318**.

**[0040]** The guide **330** comprises a groove **332** in the poppet **326** that engages a plurality of guide pins **334** that are threaded into the case **318** and extend into the rear portion **322** of the case **318**. The groove **332** is a peripheral zig-zag groove formed in the outer cylindrical surface of the poppet **326**. In this third embodiment shown, there are four guide pins **334** spaced at 90 degrees apart around the case **318**. When fluid pressure is applied to the assembled nozzle **300**, the poppet **326** slides within the case **318** forward toward the front portion **320** of the case **318**, being rotated as it moves via the guide **330** until its front end face **336** abuts against the rear face of the front portion **320** of the case **318**.

**[0041]** The poppet **326** is a short cylindrical body that has four axially extending bores **338**, shown in FIG. **6**, symmetrically arranged 90° apart around its central axis. Two oppositely arranged bores **338** carry floating valve pins **340**. These valve pins **340** are used to close corresponding aligned passages **342** through the front portion **320** of the cartridge case **318**. Each valve pin **340** has a stem **344** and an enlarged plug portion **346** that extends from a front face **336** of the poppet **326** giving the valve pin **340** an external shape like an Erlenmeyer flask. The valve pins **340** are each captured within its bore **338** via a snap ring **348** fastened to the stem **344** of the valve pin **340** such that the valve pin **340** floats within its bore **338** through the poppet **326**. This floating configuration with an enlarged plug or lug end portion **346** accommodates for tolerance stacking of the nozzle switching valve **326** components. Further, an O-ring seal (not shown) may be installed between the chamfer of the enlarged plug portion **346** and each passage **342** in the front portion **320** of the cartridge case **318** to provide a positive seal.

**[0042]** The other two bores **338** (shown in FIG. **7**) through the poppet **326** provide a flow path to the passages **342** in the front portion **320** of the cartridge case **318**. Thus when the poppet **326** is arranged as shown in FIG. **8**, the passages **338** directed to the cleaning ports **350** are plugged. The passages **338** that are shown in the sectional view of FIG. **7** are not plugged permitting fluid flow directly to the tractor and forward ports **350** through the front portion **320** of the case **318** and thence through the front portion **304** of the nozzle body **302**.

**[0043]** FIG. **8** shows the poppet **326** closing two axial passages **342** into the front portion **320** of the cartridge case **318**. FIG. **8** is a cross sectional view 90° rotated from that shown in FIG. **7** showing the opposite straight through bores **338** through the poppet **326** aligned with axial passages **342** in the front portion **320**. The views in both FIGS **7** and **8** show the nozzle **300** with the switching valve assembly **324** aligned to provide fluid flow to the tractor and forward ports **350**. When fluid flow next drops below a threshold defined by the spring rate of spring bias member **328**, the poppet **326** would move rearward along the zig zag path of the peripheral groove of the guide **330**. When flow next exceeds the threshold pressure, poppet **326** would move forward and rotates to align the straight through passages with the other pair of passages **342** to the lateral cleaning ports **350**. Each port **350** receives a threaded nozzle tip **214** as in the embodiments previously described.

**[0044]** The front block portion **320** of the case **318** in this embodiment **300** has four axially straight side faces **352** and a flat end face **354**. Each of these faces **352** has a circular groove **356** carrying an O-ring **357** and a plastic face seal **358** around an opening to its corresponding port **350** in the front portion **304** of the nozzle head body **302**. The circular groove **356** may optionally also carry an annular metal anti-extrusion ring **360** to prevent extrusion of the plastic face seal **358** when the nozzle **300** is under pressure. The plastic face seal **358** bridges the gap between the case **318** and the nozzle body **302**. The extrusion ring **360** also keeps the plastic face seal **358** in proper position during insertion and removal of the case **318** in the central bore **310** of the nozzle body **302**.

**[0045]** This cartridge case **318** may be made of a metal or thermoplastic material such as a high molecular weight polyethylene and may be injection molded. One preferable material is ultra-high molecular weight polyethylene. Similarly, the poppet **326** itself may be made of a plastic rather than metal. Other than the coil spring **328** and the valve pins, the valve assembly **324** may be made of plastic as it does not have to withstand the high fluid stresses encountered during nozzle operation. The nozzle head body **302** and inlet nut **308** provide the strength required for high pressure operation.

**[0046]** Another alternative embodiment of a nozzle head incorporating a switching valve in accordance with the present disclosure is shown in FIGS. **9** through **11**. This nozzle assembly **400** includes a hollow nozzle body **402** that has a round nose front portion **404** and a generally cylindrical rear portion **406**. The nozzle body **402** has a central blind bore **410** that receives a removable valve cartridge **412**. The blind bore **410** has a truncated conical tapered front portion **414** and a circular cylindrical rear portion **416**. This removable cartridge **412** is captured within the blind bore **410** by a nozzle inlet nut **408** fastened to the nozzle body **402** and which, in turn, connects to a high pressure hose or to a rotary shaft (not shown).

**[0047]** The removable cartridge **412** includes a case **418** externally shaped complementary to the blind bore **410** with a front tapered portion **420** that acts as a flow diverter having a plurality of passages therethrough each configured to align with a port **450** drilled through the nozzle body **402** into the front portion **414** of the blind bore **410**. The case **418** has a hollow circular cylindrical rear portion **422** that carries within it a portion of a switching valve assembly **424**.

[0048] This switching valve assembly **424** functions similar to the switching valve assemblies **116**, **216** and **324** described above. This switching valve assembly **424** includes a cylindrical poppet **426** slidably disposed partially in the cylindrical rear portion **422** of the case **418** and partially in the front portion **420** of the case **418**, a bias member **428** compressed between the poppet **426** and the front portion **420** of the case **418**, to the front portion **404** of the nozzle body **402** and a guide **430** operating between the poppet **426** and the rear portion **422** of the case **418**.

[0049] The guide in this embodiment **400** comprises a stationary tubular sleeve **430** set into the rear portion **422** of the case **418** that has an internal zig-zag groove **432**. The poppet **426** includes a plurality of radially protruding pins **434** each engaging the groove **432** in the sleeve **430** set into the rear portion **422** of the case **418**. The pins **434** are threaded through a rear portion of the poppet **426** and extend radially outward so as to ride in the groove **432** as the poppet **426** moves back and forth in the case **418**. In this fourth embodiment shown, there are two guide pins **434** spaced at 180 degrees apart around the case **418**. When fluid flow is applied to the assembled nozzle **400**, the poppet **426** slides within the case **418** forward toward the front portion **420** of the case **418**, being rotated as it moves via the guide **430** until its front end face **436** abuts against the front portion **420** of the case **418**.

[0050] The poppet **426** is a short cylindrical body that has a common rear opening that diverges to four bores **438** symmetrically arranged 90° apart around its central axis. Two are biased forward, and two are biased rearward. Two oppositely arranged bores **438** are radially directed and carry floating valve plugs **440**. In this embodiment, the floating valve plugs **440** free float in their radial bores **438**. These valve plugs **440** close corresponding aligned passages **442** through the side of the front portion **420** of the cartridge case **418** as shown in FIG. 10.

[0051] The other two bores **438** (shown in FIG. 11) through the poppet **426** provide a flow path to the passages **442** through the side of the front portion **420** of the cartridge case **418**. Thus when the poppet **426** is arranged as shown in FIG. 10, the passages **438** directed to the tractor and front or forward ports **450** are plugged. The passages **438** that are shown in the sectional view of FIG. 11 are not plugged permitting fluid flow directly to the cleaning ports **450** through the front portion **420** of the case **418**.

**[0052]** FIGS. 10 and 11 both show the same configuration, with the cleaning ports open and the forward and tractor ports plugged. FIG. 10 shows the poppet 426 closing two axial passages 442 into the front portion 420 of the cartridge case 418. A cross sectional view 90° rotated from that shown is shown in FIG. 11 showing the opposite through bores 438 through the poppet 426 aligned with axial passages 442 in the front portion 420. The view of FIGS 10 and 11 shows the nozzle 400 with the switching valve assembly 424 aligned to provide fluid flow to the cleaning ports 450. When fluid pressure next drops below a threshold flow defined by the spring rate of spring bias member 428, the poppet 426 would move rearward along the zig zag path of the peripheral groove of the guide 430. When flow next exceeds the threshold pressure, poppet 426 would move forward and rotates to align the poppet passages with the other pair of passages 442 to the tractor and forward ports 450.

**[0053]** The front tapered portion 420 of the case 418 in this embodiment 400 has a single circular conical side face 452 and an open end face 454. Because of the tapered conical side face 452, there is no need for an O ring seal around each of the four port openings 450 as in embodiment 300, as the taper itself provides the seal. In this embodiment 400, the end of the poppet 426 provides a seat that seals the end face 454 of the case 418 when the poppet is aligned with the cleaning ports as shown in FIGS. 9-11. When the poppet is aligned to provide flow to the tractor ports, the poppet 426 is displaced from the end face 454 of the case 418 to permit flow through passages 438 to the forward ports 450. This cartridge case 418 may be made of a metal or thermoplastic material and may be injection molded. One preferable material is ultra-high density polyethylene. Similarly, the poppet 426 itself may be made of a plastic rather than metal. Other than the coil spring 422, the components of the valve assembly 424 may be made of plastic. However, the valve pins do see full pressure and therefore may be made of metal or a different high strength plastic. The nozzle head body 402 and inlet nut 408 primarily provide the strength required for containment of the cartridge 412 during high pressure operation. Each of the ports 450 preferably carries a removable threaded nozzle tip 214 just as in the previously described embodiments.

**[0054]** Many changes may be made to the embodiments described above. For example, the guide pins 434 may be threaded through the wall of the poppet 426 or may be press fit. The poppet 426 may have a peripheral groove as in the first three

embodiments described above and the cartridge case **418** provided with the guide pins.

**[0055]** All such changes, alternatives and equivalents in accordance with the features and benefits described herein, are within the scope of the present disclosure. Such changes and alternatives may be introduced without departing from the spirit and broad scope of my invention as defined by the claims below and their equivalents.

## CLAIMS

What is claimed is:

1. A nozzle comprising:
  - an inlet nut fastenable to a distal end of one of a rotatable nozzle shaft or a high pressure hose;
  - a hollow nozzle body having a front portion, a rear inlet portion configured to engage the inlet nut, a central bore through at least the rear portion of the nozzle body, and a plurality of ports extending through the body from the central bore; and
  - a switching valve assembly disposed in the central bore operable to direct fluid flow from the inlet portion to at least one set of the plurality of ports upon application of fluid flow above a predetermined threshold to the inlet and direct fluid flow from the inlet to at least a different set of the plurality of ports upon fluid flow having subsequently dropped below the predetermined flow threshold and then exceeding the predetermined threshold, the switching valve assembly comprising:
    - a cylindrical poppet disposed in the central bore, the poppet having at least one axially extending through bore to permit fluid flow therethrough slidably disposed in the central bore and another bore containing a valve pin protruding therefrom for closing at least one of the ports;
    - a guide cooperating with the poppet to rotate the poppet in one direction to alternate fluid flow between the ports; and
    - a biasing member between the front portion of the nozzle body and the poppet urging the poppet away from the front portion of the nozzle body.
2. The nozzle assembly according to claim 1 wherein the guide includes one or more guide members engaging the poppet to alternately rotatably align the poppet with the at least one set of the plurality of ports and the different set of the plurality of ports each time the poppet abuts the front portion of the nozzle body.
3. The nozzle assembly according to claim 1 wherein the guide member comprises pins projecting inward from the rear portion of the nozzle body into the central bore engaging the poppet.
4. The nozzle assembly according to claim 2 wherein the poppet has a peripheral groove engaging the one or more guide members.

5. The nozzle assembly according to claim 4 wherein each transition below the predetermined threshold causes the poppet to rotate to a different angular position to permit fluid flow to alternate between the first and second set of ports.

6. The nozzle assembly according to claim 1 wherein the switching valve assembly includes a removable tubular case within the bore carrying the poppet and the guide therein, wherein the case has a front portion and a rear portion, the rear portion carrying the poppet and guide therein, and the biasing member is within the front portion of the tubular case.

7. The nozzle assembly according to claim 6 wherein the front portion of the case has at least one bore therethrough leading to the first set of ports and at least one other bore therethrough leading to the second set of ports.

8. The nozzle assembly according to claim 7 wherein the poppet has a front face and at least one valve pin disposed in a through bore and protruding from the front face for selectively closing the at least one bore through the front portion of the tubular case.

9. The nozzle assembly according to claim 7 wherein the poppet is a circular cylindrical body having a plurality of through bores and at least one of the through bores carries a valve pin therein having a lug shaped end portion protruding from a front face of the poppet for selectively closing the at least one bore through the front portion of the tubular case.

10. The nozzle assembly according to claim 1 wherein the guide rotates the poppet a predetermined amount each time the poppet moves toward or away from the front portion of the nozzle body.

11. The nozzle assembly according to claim 6 wherein the case has two or more axial bores through the front portion equally spaced about a central axis through the case and two or more angled bores through the front portion extending through a side of the case.

12. The nozzle assembly according to claim 11 wherein the front portion of the case has straight rectangular side wall portions.

13. The nozzle assembly according to claim 11 wherein the front portion of the case is tapered.

14. The nozzle assembly according to claim 12 wherein the rear portion of the case has a right circular cylindrical shape.

15. The nozzle assembly according to claim 1 wherein the switching valve assembly includes a removable tubular case within the bore carrying the poppet and the guide therein, wherein the case has a front tapered portion and a rear portion, the rear portion carrying the poppet and guide therein, and the biasing member is within the front portion of the tubular case.

16. The nozzle assembly according to claim 15 wherein the switching valve assembly further includes a tubular guide sleeve disposed within the rear portion of the case and the poppet include movable plugs disposed in radial bores for closing ports in the nozzle body.

17. The nozzle assembly according to claim 16 wherein the poppet has guide pins protruding radially outward engaging grooves formed in the guide sleeve to rotate the poppet.

18. The nozzle assembly according to claim 15 wherein the guide sleeve is a polymer with internal grooves.

19. A nozzle assembly comprising:  
a hollow nozzle body connectable to one of a high pressure rotatable shaft or a distal end of a high pressure hose, the body having a front portion and a rear portion and a central bore through at least the rear portion, a first plurality of ports extending out of the body from one end of the central bore and a second plurality of ports extending out of the body from the central bore; and

a switching valve assembly disposed in the central bore operable to direct fluid flow from an inlet to one or more of the first plurality of ports upon application of fluid flow above a predetermined threshold to the inlet and direct fluid flow from the inlet to one or more of the second plurality of ports upon fluid flow dropping below the predetermined threshold and then exceeding the predetermined threshold, wherein the switching valve assembly comprises:

a cylindrical poppet slidably disposed in the central bore, the poppet having a plurality of axially extending bores therethrough;

a biasing member between the front portion and the poppet biasing the poppet away from the front portion of the nozzle body; and

a guide member between the rear portion of the nozzle body and the poppet engaging a corresponding feature on the poppet to rotate the poppet as it slides within the rear portion of the cartridge case, wherein the poppet has a one or more valve pins each disposed in one of the poppet bores for closing one of the first plurality of ports when aligned with that one of the first plurality of ports when exceeding the predetermined threshold.

20. The nozzle assembly according to claim 19 wherein the poppet has a front face and at the valve pin forms a lug protruding from the front face closing one of the ports and at the same time closing the poppet bore carrying the valve pin when the poppet abuts against another one of the ports.

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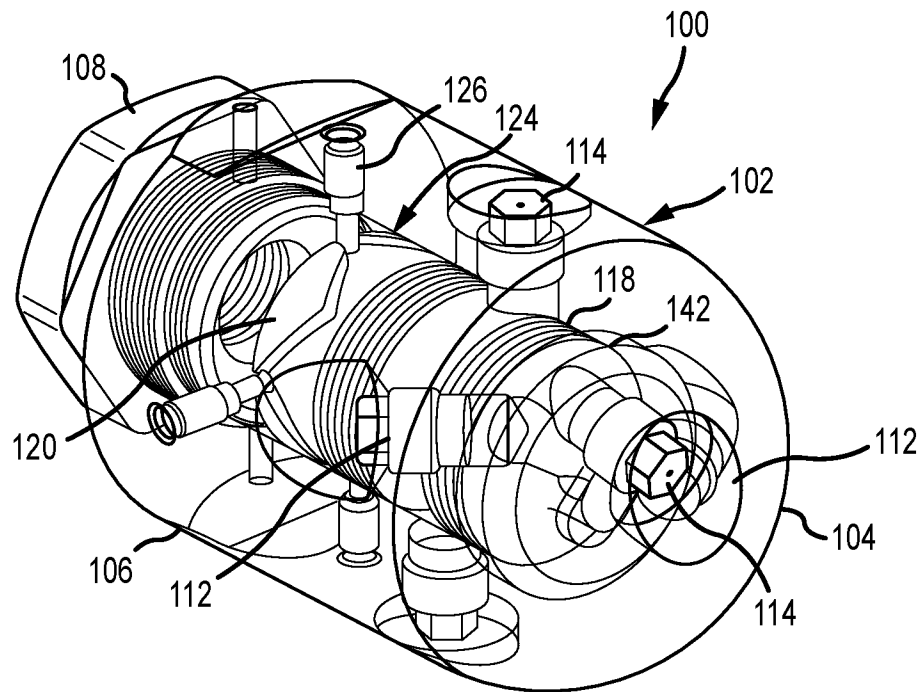


FIG.1

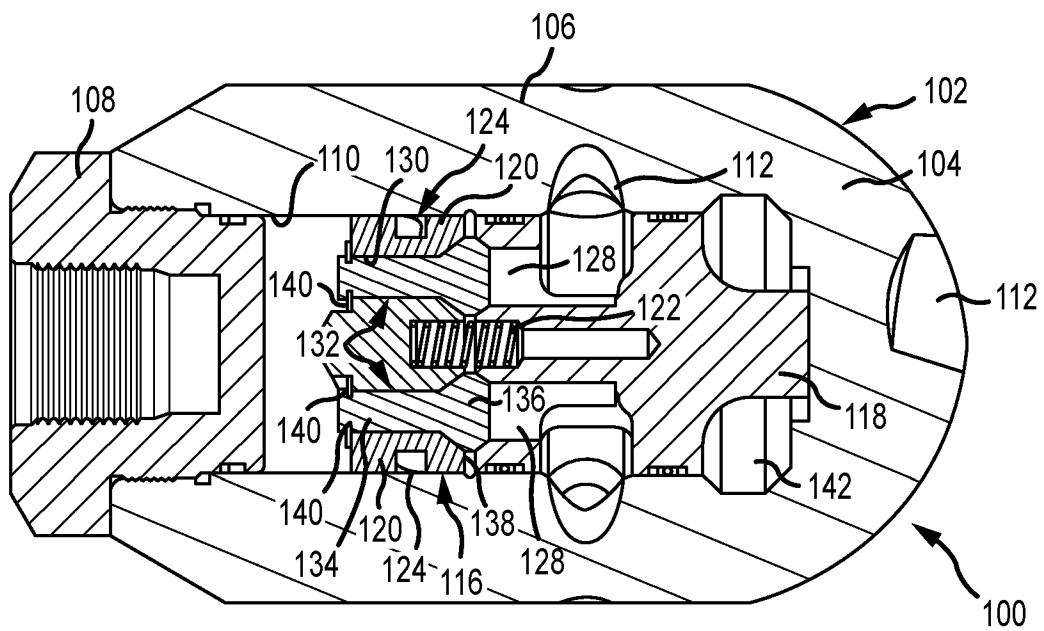


FIG.2

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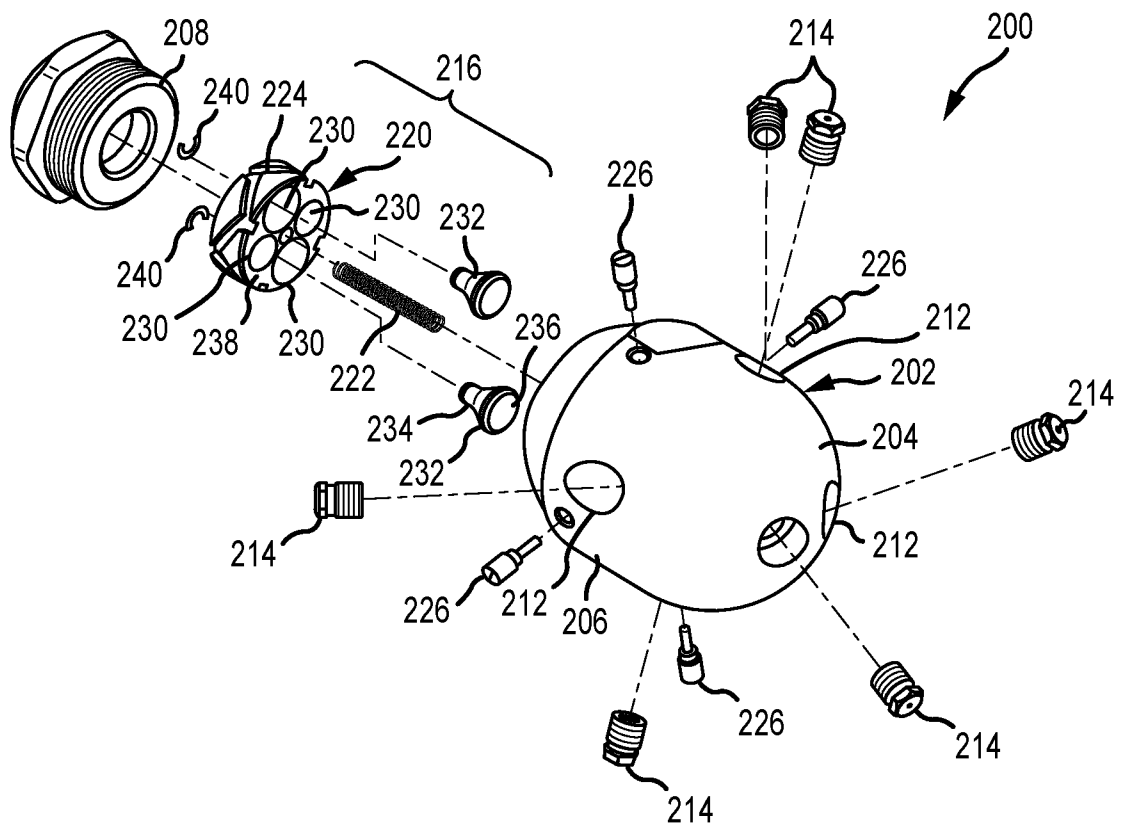


FIG.3

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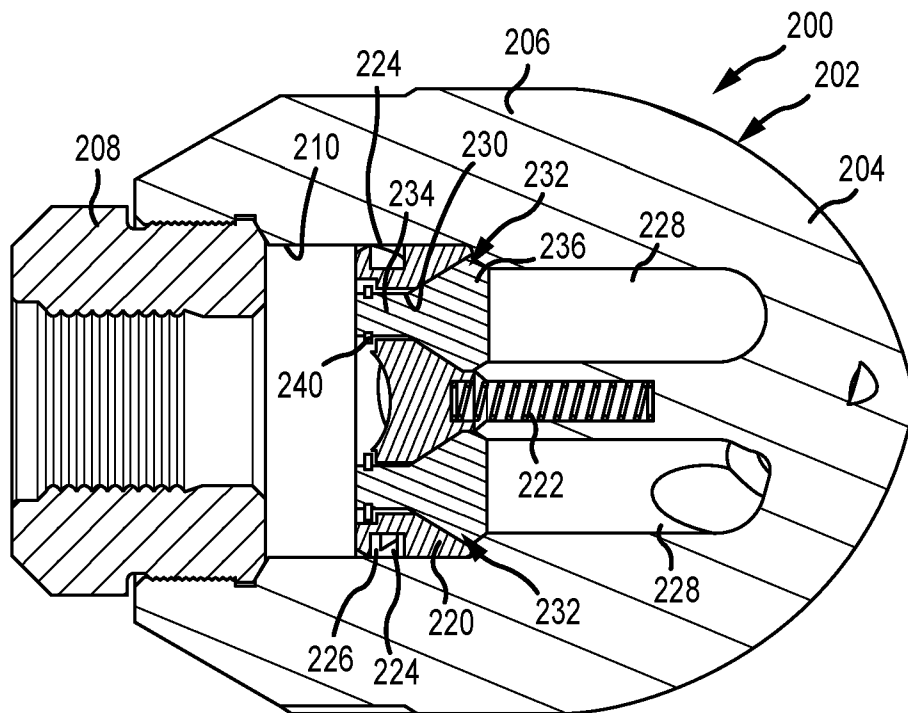


FIG. 4

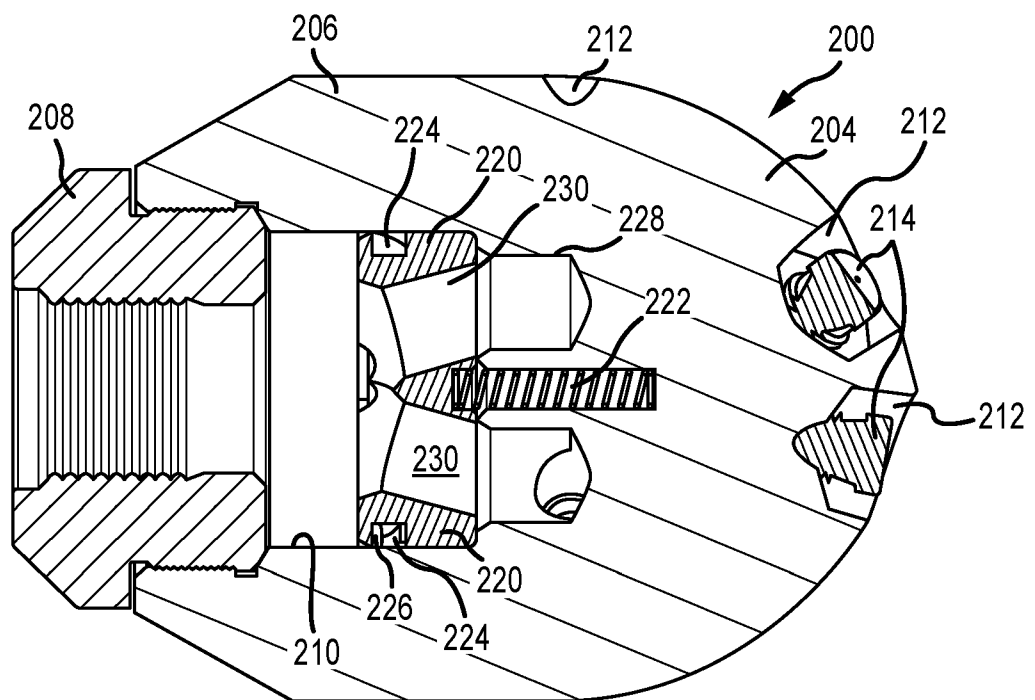
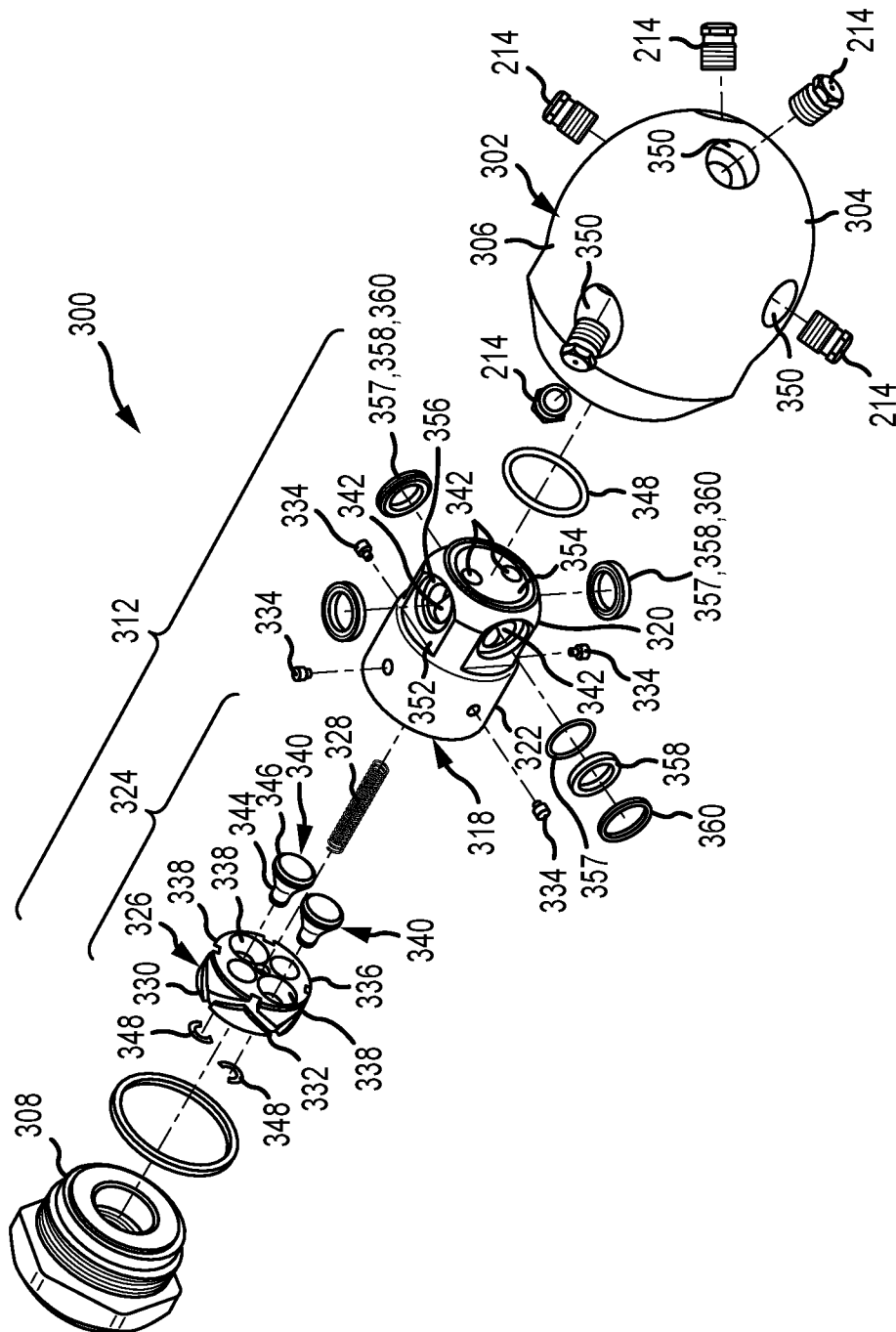


FIG. 5



**FIG. 6.**

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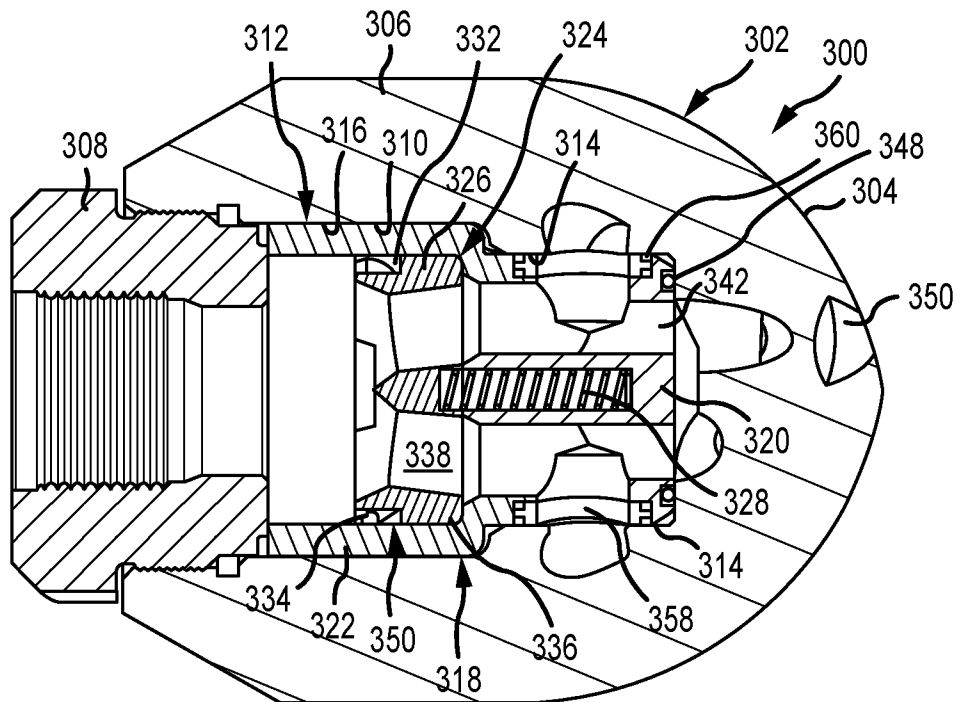


FIG. 7

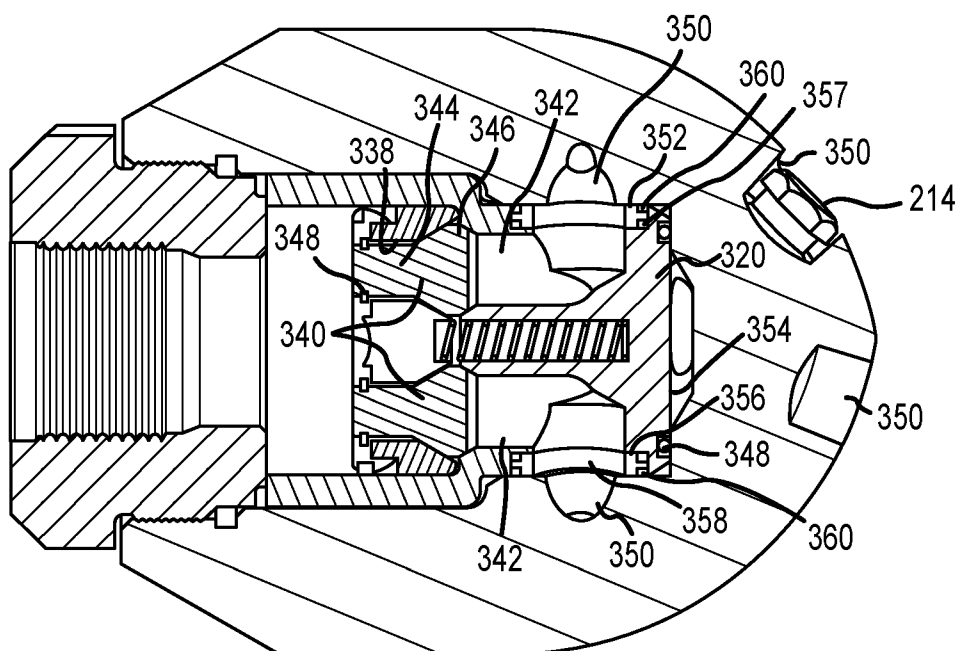


FIG. 8

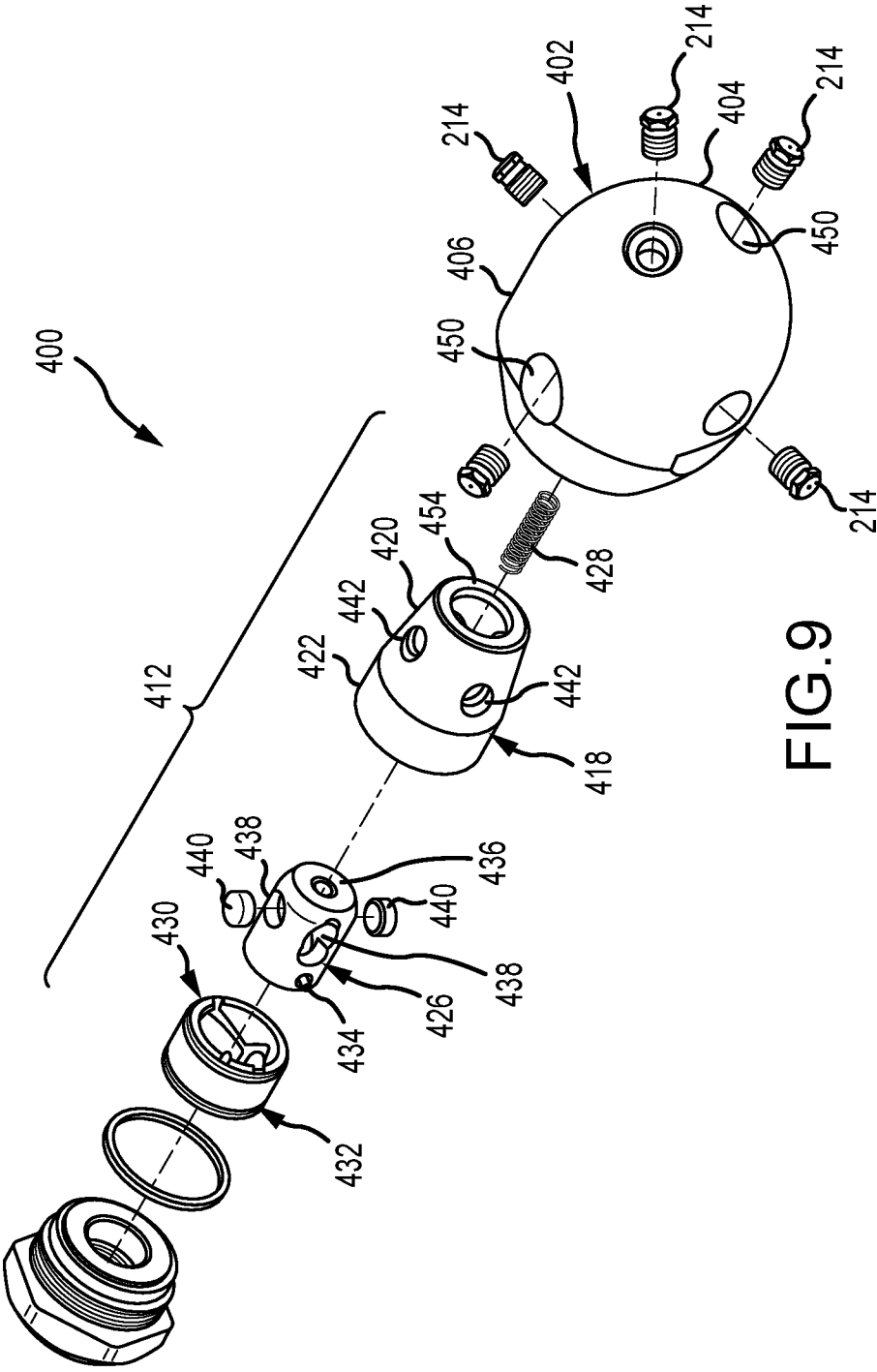


FIG.9

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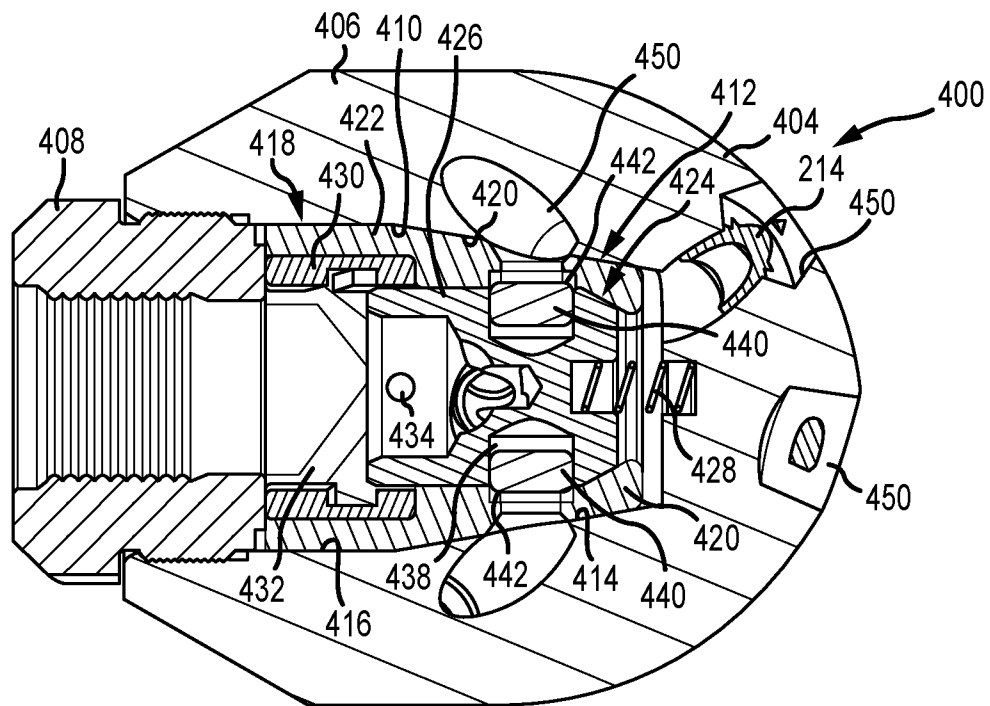


FIG.10

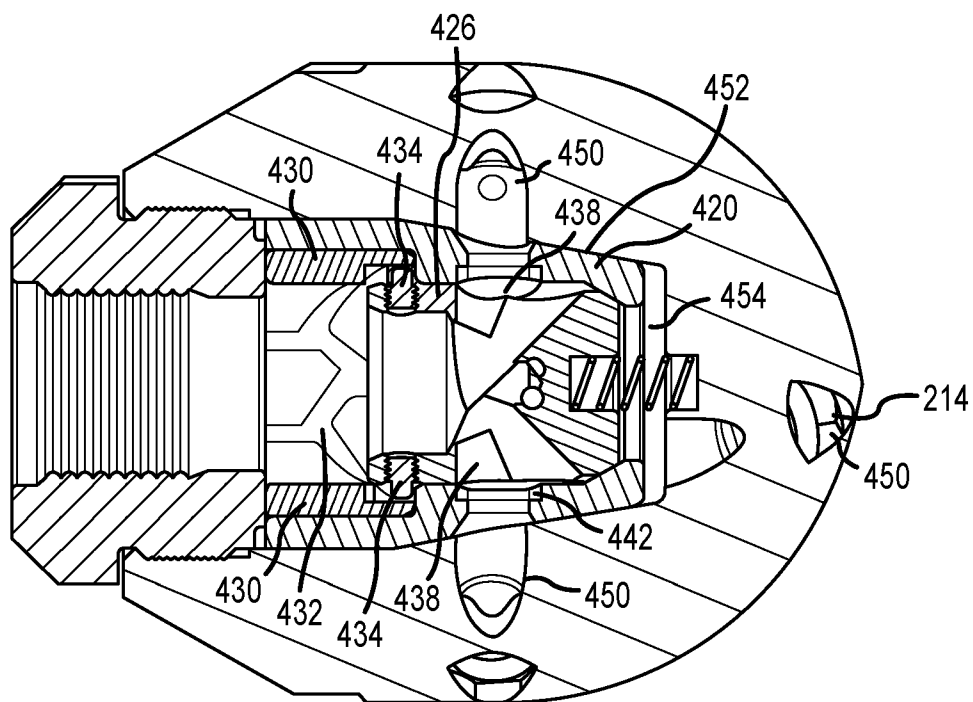


FIG.11

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2019/054112****A. CLASSIFICATION OF SUBJECT MATTER****B05B 1/16(2006.01)i, B05B 1/30(2006.01)i, B05B 13/06(2006.01)i, B08B 9/049(2006.01)i, F16K 11/04(2006.01)i, F16K 31/163(2006.01)i**

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)

B05B 1/16; B05B 1/30; B05B 3/06; B08B 009/00; B08B 5/02; B08B 9/00; B08B 9/043; E03F 9/00; B05B 13/06; B08B 9/049; F16K 11/04; F16K 31/163

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; keywords: nozzle, hollow nozzle body, switching valve assembly, cylindrical poppet, guide, biasing member

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                    | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2016-0244959 A1 (STONEAGE, INC.) 25 August 2016 paragraphs [0025]-[0040], claim 1, and figures 1-7 | 1-20                  |
| A         | US 6059202 A (ZINK et al.) 09 May 2000 column 3, line 66 - column 4, line 24 and figure 1             | 1-20                  |
| A         | US 5551458 A (FAXON, JOHAN) 03 September 1996 column 3, lines 24-60 and figures 1-5                   | 1-20                  |
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| A         | US 2004-0261822 A1 (URA, KIMASARU) 30 December 2004 claim 1 and figure 3                              | 1-20                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

17 January 2020 (17.01.2020)

Date of mailing of the international search report

**23 January 2020 (23.01.2020)**

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



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Information on patent family members

International application No.

**PCT/US2019/054112**

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Information on patent family members

International application No.

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member(s)Publication  
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