(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 December 2024 (12.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/254468 A2

(51) International Patent Classification:
Not classified

(21) International Application Number:
PCT/US2024/033034

(22) International Filing Date:
07 June 2024 (07.06.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/471,832 08 June 2023 (08.06.2023) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

(54) Title: MULTI-FUNCTION FAUCET ASSEMBLY

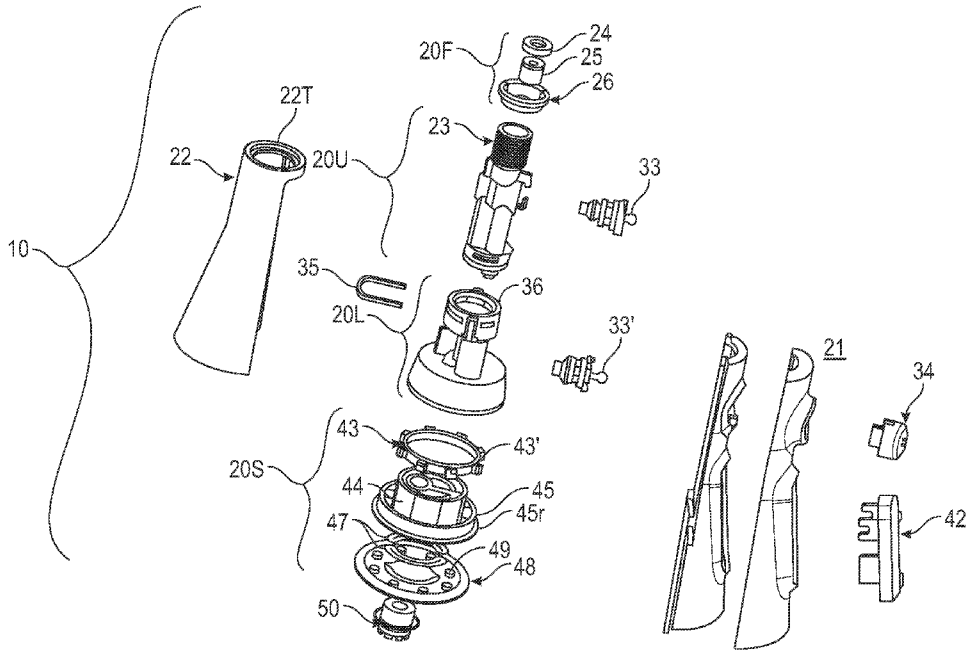

FIG. 1

(57) Abstract: A multi-function faucet assembly is provided. The multi-function faucet assembly includes a faucet body; a faucet spout; and a faucet spray head comprising a spray head face. The spray head face comprises: an aerated spray outlet positioned at a central axis or off-axis of the faucet spray head and configured to deliver the aerated spray, two or more jet spray outlets positioned around a perimeter of the aerated spray outlet and configured to deliver the jet spray, and a plurality of mist spray nozzles positioned around a perimeter of the jet spray outlets and configured to deliver the mist spray.

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[Continued on next page]

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

MULTI-FUNCTION FAUCET ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of U.S. Provisional Application No. 63/471,832, filed June 8, 2023, the entire contents of which are hereby incorporated by reference.

FIELD

[0002] The present disclosure relates to a multi-function faucet assembly, for example a faucet assembly which provides three function spray modes, e.g., an aerated spray mode, a jet spray mode, and a mist spray mode.

BACKGROUND

[0003] Conventional kitchen faucet spray heads usually offer only two functions, a shower mode and an aerator mode. These two modes are generally switched by a lever mechanism or a pull down diverter. The aerator flow is gentle and often used for rinsing dishes and filling pots. The shower flow is more powerful and is typically used for cleaning dirty dishes and the sink but generates a lot of splashes.

SUMMARY

[0004] There is a need in the art to continue to improve the functionality and features of kitchen faucets to render them more useful and user-friendly to consumers.

[0005] Accordingly, disclosed is a spray head for faucets configured to provide three different spray modes, e.g., aerated, mist, and jet. An aerated spray may be similar to a conventional aerated function. A mist spray is softer and covers a larger area, making it ideal for rinsing delicate fruits and vegetables. A jet spray is powerful and generates less splash due to its small outlet holes created by, for example, etching technology, which makes it ideal for effectively cleaning dishes and sinks.

[0006] In some embodiments, disclosed is a multi-function faucet or faucet assembly, which includes jet spray and mist spray functions while still providing a standard aerated spray function.

[0007] In some embodiments, a multi-function faucet assembly may include a faucet body, a faucet spout, and a faucet spray head. A faucet spray head may comprise a spray head face configured to deliver three types of sprays: an aerated spray, a mist spray, and a jet spray.

[0008] In some embodiments, a spray head face may include an aerated spray outlet. An aerated spray outlet may be positioned either at a central axis or off-center axis of a faucet spray head. An aerated spray outlet is configured to deliver an aerated spray. A spray head face may include two or more jet spray outlets. Two or more jet spray outlets may be positioned around a perimeter of an aerated spray outlet. For example, a semi-circular shape of jet spray outlets may be formed around a perimeter of an aerated spray outlet. Two or more jet spray outlets are configured to deliver a jet spray. A spray head face may include a plurality of mist spray nozzles. A plurality of mist spray nozzles may be positioned about a perimeter of jet spray outlets. A plurality of mist spray nozzles are configured to deliver a mist spray. A jet spray may be configured to rinse a dish or a sink. A mist spray may be configured to wash fruits and vegetables.

[0009] In some embodiments, a spray head face comprises two or more arcuate jet spray outlets positioned about a perimeter of an aerated spray outlet. Each of two or more arcuate jet spray outlets may comprise a plurality of openings configured to deliver a jet spray. Jet spray outlets may be arranged in a symmetrical manner so as to deliver a uniform jet spray.

[0010] Two or more arcuate jet spray outlets may comprise a metal plate on which a plurality of openings are positioned to deliver a jet spray. A metal plate may include stainless steel, brass, bronze, copper, aluminum, nickel, titanium, zinc, iron, silver, gold, or alloys or combinations thereof. A plurality of openings may be created by drilling, punching, water jet cutting, electrical discharge machining (EDM), chemical etching, laser etching, plasma cutting, or milling in the metal plate.

[0011] In some embodiments, the jet spray outlets, for example, the arcuate jet spray outlets, may include openings having a diameter ranging from about 0.20 mm to about 0.60 mm.

[0012] In some embodiments, each of two or more arcuate jet spray outlets may comprise a plurality of openings configured to produce a spray angle ranging from about 10° to about 45. Two or more arcuate jet spray outlets may spray water at a force in a range of about 0.5 newtons (N) to about 1.2 newtons (N).

[0013] In some embodiments, a spray head face may include 3 to 12 mist spray nozzles positioned about a perimeter of jet spray outlets. Mist spray nozzles may include stainless steel, brass, bronze, copper, aluminum, nickel, titanium, zinc, iron, silver, gold, or alloys or combinations thereof. Mist spray nozzles may be configured such that a first mist spray delivered from a first nozzle will not impede or overlap with a second mist spray delivered from a second nozzle within a distance ranging from about 1 inch to about 6 inches from the

spray head face. Further, mist spray nozzles may be configured to produce a spray with a trajectory that is predominantly straight.

[0014] In some embodiments, mist spray nozzles may spray water at a force in a range of about 0.2 N to about 0.6 N. A jet spray and a mist spray may have a spray force ratio of about 1.5:1 to about 5:1.

[0015] In some embodiments, an aerated spray outlet may spray water at a force in a range of about 0.2 N to about 0.5 N. An aerated spray outlets may be configured to produce a spray with a trajectory that is predominantly straight (about perpendicular to a spray head face).

[0016] In an embodiment, a spray head may include one or more actuators configured to be operated to select an aerated spray, a mist spray, or a jet spray.

[0017] In some embodiments, actuators may include one or more manual buttons. Actuators may include a circular button for activating a jet spray and a toggle button for selecting either an aerated spray or a mist spray. A circular button and a toggle button may be arranged in a same direction.

[0018] In some embodiments, actuators may include a polymeric material. Polymeric materials may include polyamide (PA), acrylonitrile butadiene styrene (ABS), polyoxymethylene (POM), polyphenylene sulfide (PPS), polyphenylene oxide (PPO), or copolymers or combinations thereof.

[0019] In some embodiments, a faucet spray head may comprise an internal waterway. A waterway may be configured to provide separate aerated spray, mist spray, and jet spray in response to an actuator.

[0020] In some embodiments, depressing a circular button may open a jet spray waterway. Depressing a toggle button downward may open a mist spray waterway, while releasing the toggle button upwards may open an aerated spray waterway. In some embodiments, the waterway may be configured to provide the separate aerated spray, mist spray, and jet spray in response to the actuators and may be configured to establish a spray force ratio between the jet spray and the mist spray of about 1.5:1 to about 5:1.

[0021] In an embodiment, a spray head face may include a silicone-overmolded substrate. A substrate may comprise a metal or a polymeric material. In an embodiment, a spray head may comprise an outer body shell. An outer body shell may include a front body shell and a rear body shell. A front body shell may have one or more openings for housing one or more actuators. A front body shell may include a non-conductive surface with or without a silicone-overmolded substrate. A rear body shell may include an electroplated surface or a non-conductive surface with or without a silicone-overmolded substrate. A front body shell

or a rear body shell may include a polymeric material with or without a silicone-overmolded substrate. Polymeric materials may include polyamide (PA), acrylonitrile butadiene styrene (ABS), polyoxymethylene (POM), polyphenylene sulfide (PPS), polyphenylene oxide (PPO), or copolymers or combinations thereof.

[0022] A rear body shell may include a surface that has been electroplated with a metal layer. A metal layer may include stainless steel, brass, bronze, copper, aluminum, nickel, chrome, titanium, palladium, zinc, iron, silver, tin, gold, or alloys or combinations thereof.

[0023] The multi-function faucet assembly may be applied to various applications, including not only kitchens but also lavatories or industrial sinks, without departing from the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The disclosure described herein is illustrated by way of example and not by way of limitation in the accompanying figures. For simplicity and clarity of illustration, features illustrated in the figures are not necessarily drawn to scale. For example, the dimensions of some features may be exaggerated relative to other features for clarity. Further, where considered appropriate, reference labels have been repeated among the figures to indicate corresponding or analogous elements.

[0025] FIG. 1 provides an exploded view of a multi-function spray head, according to some embodiments.

[0026] FIG. 2, FIG. 2A, and FIG. 2B show views of a multi-function spray head, according to some embodiments.

[0027] FIG. 2C is a top view of the multi-function spray head of FIG. 2, FIG. 2D is a bottom view of the multi-function spray head of FIG. 2, and FIG. 2D' shows a section of FIG. 2D, according to some embodiments.

[0028] FIG. 3 is a longitudinal section view of the multi-function spray head of FIG. 2, according to some embodiments.

[0029] FIG. 4 is a perspective view of an upper flow body of the multi-function spray head; and FIG. 4A is a longitudinal section view of FIG. 4, according to some embodiments.

[0030] FIG. 5 is a perspective view of a lower flow body of the multi-function spray head; FIG. 5A is a top view of the lower flow body of FIG. 5; and FIG. 5B is a bottom view of the lower flow body of FIG. 5, according to some embodiments.

[0031] FIG. 6A is a longitudinal section view showing an internal waterway for an aerated spray; FIG. 6B is a longitudinal section view showing an internal waterway for a mist spray;

and FIG. 6C is a longitudinal section view showing an internal waterway for a jet spray, according to some embodiments.

[0032] FIGS. 7 and 7A show a multi-function faucet assembly for a kitchen, according to some embodiments.

[0033] FIGS. 8 and 8A show a multi-function faucet assembly for a kitchen, according to some embodiments.

[0034] FIG. 9A shows an aerated spray mode of the multi-function faucet assembly; FIG. 9B shows a jet spray mode of the multi-function faucet assembly; and FIG. 9C shows a mist spray mode of the multi-function faucet assembly, according to some embodiments.

[0035] FIG. 10A shows performance testing results of a spray head with a jet spray mode in a vertical spray pattern, according to some embodiments.

[0036] FIG. 10B shows performance testing results of a spray head with a jet spray mode in a horizontal spray pattern, according to some embodiments.

[0037] FIG. 10C shows performance testing results of a spray head with a mist spray mode, according to some embodiments.

[0038] Other objects, features, and advantages of the present disclosure will become more apparent upon reading the following detailed description of the preferred embodiments and certain modifications thereof.

DETAILED DESCRIPTION

[0039] A multi-function faucet assembly of the present disclosure may provide a jet spray and a mist spray, in addition to an aerated spray. A mist spray herein may be softer and cover a larger area that can be effective for rinsing delicate fruits and vegetables. A jet spray can be powerful but may generate less splash due to its small outlet holes, which may also be effective for cleaning dishes and sinks.

[0040] In the following description of the various embodiments, it is to be understood that the singular forms "a," "an," and "the" used in the following description are intended to include the plural forms as well, unless the context clearly indicates otherwise. It is also to be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It is further to be understood that the terms "includes, "including," "comprises," and/or "comprising," when used herein, specify the presence of stated features, integers, steps, operations, elements, components, and/or units but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, units, and/or groups thereof.

[0041] FIG. 1 provides an exploded view of spray head 10, according to some embodiments. Spray head 10 may comprise an outer body shell having front body shell 21 and rear body shell 22. An outer body shell may be formed from a variety of decorative materials, such as a metallic cast finish, a plastic molded design color or metallic appearance, or the like. Front body shell 21 and rear body shell 22 as well as a spray head face (described herein later) may be a molded metallic or polymeric structure, or a molded polymeric material with or without a cast metallic finish. In some embodiments, an outer body shell or spray head face may comprise an electroplated surface and/or a non-conductive surface, e.g., either a surface that has been plated with electricity or a surface that doesn't conduct electricity.

[0042] An outer body shell or a spray head face may include polymeric materials, which may be unfilled or a filler polymeric or composite material having a powder type or fibrous reinforcing material therein. Examples of polymeric materials include, but are not limited to, polyamides (PA), polyphenylene sulfides (PPS), or a polyphenylene oxide (PPO), polystyrene-butadiene-styrenes (SBS), polyacrylonitrile-butadiene-styrene (ABS), polyimides (PI), polyarylenes (polyetherether ketone (PEEK), polyether ketone (PEK), polyether ketone (PEKK), etc.), polyethylene sulfones (PES), polyetherimides (PEI), polytetrafluoroethylene (PTFE), fluoroplastics (FEP and PFA), polyethylenes (PE), polypropylenes (PP), polyvinylchloride (PVC), polyoxyalkylenes (e.g., polyacetals such as polyoxymethylene (POM), polyoxyethylenes (POE), polyoxybutylenes (POB), etc.), and styrene-maleic-anhydrides (SMA).

[0043] An outer body shell may also be formed of alloys, blends and/or copolymers or combinations of these polymeric materials, provided the materials provide adequate strength, impact resistance, chemical resistance, heat resistance, and moldability required for carrying out their functions as an outer body shell as they come into contact with water and various cleaning substances. Composite materials may include a combination of polymeric materials as noted above with fibrous and/or particulate materials such as glass fibers, carbon fibers, aramid fibers, Kevlar®, mica, carbon powder, and other fillers known in the art. Materials include PA, ABS, POM, PPS and PPO and copolymers, combinations and functionalized polymers of these materials.

[0044] FIG. 1 and FIG. 2, show spray head 10. An outer body shell may comprise front body shell 21 and rear body shell 22. An exterior of front body shell 21 and rear body shell 22 may conform to a contour of interior parts. Front body shell 21 and spray head face 48 may comprise a non-conductive surface, which may be a plastic molded design, a silicone-overmolded design, or a design with color. Rear body shell 22 may comprise an

electroplated surface or a metallic cast finish. Other embodiments include a non-conductive surface, which may be a plastic molded design, a silicone-overmolded design, or a design with color.

[0045] Front body shell 21 may contain openings arranged in a same longitudinal direction to receive actuators 34 and 42. Actuators 34 and 42 may be configured to apply force from a higher position or a lower position to depress or release first diverter 33 and second diverter 33'. Circular button actuator 34 may be configured to actuate a jet spray and a toggle button actuator 42 is configured to select an aerated spray or a mist spray. Circular button 34 and toggle button 42 may be arranged in a same longitudinal direction. Actuators 34 and 42 may include a polymeric material as described herein above.

[0046] FIG. 2A and FIG. 2B show tactile or iconic features 51, 52 and 53, which may be positioned on actuators 34 and 42. Tactile or iconic features 51, 52 and 53 may be positioned (e.g.) aligned to correspond to each spray function, for example, 51 for selecting a jet spray mode, 52 for selecting a mist spray mode, and 53 for selecting an aerated spray mode.

[0047] Referring back to FIGS. 1 and 2, front body shell 21 may be seated so as to fit over a mating edge of rear body shell 22. An inner space of outer body shell 21, 22 may be configured to house interior parts of faucet spray head 10. Upper end 22T of shell 22 may comprise attachment fitting 20F. Attachment fitting 20F may comprise locking ring 26 for retaining check valve 25 and washer 24 for sealing upper end 22T for connection to a faucet. Check valve 25, which only permits fluid to flow in one direction, may be installed downstream of washer 24 (e.g., closer to the spray head face) to prevent backflow into the faucet. Locking ring 26, typically a threaded or snap-fit component, may be used to secure washer 24 and check valve 25 remain in place.

[0048] In some embodiments, an upper flow body 20U may be embedded into the outer body shell 21, 22. The upper flow body 20U can extend through the attachment fitting 20F and connectable at the upper end through screw threads 23 or other suitable connecting features to a faucet neck. As shown in FIGS. 1 and 4, the upper flow body 20U can extend within the outer body shell 21, 22. The upper flow body 20U can comprise a primary water passing chamber 61. The primary water passing chamber can have a stationary post 67 at its inner bottom.

[0049] The primary water passing chamber 61 can receive a first diverter 33 to provide an alternate jet spray waterway passing through an off-axis protruded cylindrical body 63 instead of a misting/aerated spray waterway 64. As shown in FIG. 3, the first diverter 33 may

be seated and fitted in the primary water passing chamber 61 and may be firmly secured through the stationary post 67 with the help of a male and female connection with a shuttle valve 33V and a piston spring 33S of the first diverter 33. As such, the first diverter 33 adopts a piston mechanism that can be operated by a piston spring 33S configured to move between a depressed/closed position and a released/open position. The piston spring 33S can provide tension and can facilitate the return of the diverter to its original position. Depressing the circular button 34 or the first diverter 33, can close the primary water passing chamber and can open a jet spray waterway and activate a jet spray stream (*see* FIGS. 6C and 9B). Once the first diverter 33 is released from the depressed position, it can return to its original position and can stay in the released state. The released state can allow fluid to be supplied to a misting/aerated spray waterway. This arrangement may advantageously configure the circular button 34 as a momentary switch.

[0050] As shown in FIGS. 1 and 4A, the spray head can include an upper flow body 20U**.** The upper flow body 20U can include an off-axis protruded cylindrical body 63 at its planar bottom end 65. A jet spray stream diverted by the first diverter 33 can pass through the off-axis protruded cylindrical body 63. Meanwhile, a misting/aerated spray waterway outlet 64 exists at the planar bottom end 65. The upper flow body 20U may be a single, integrated component.

[0051] In some embodiments, as shown in FIGS. 3 and 5, a lower flow body 20L is also embedded in the outer body shell 21, 22, while connected with and configured to seat the bottom features 63 and 65 of the upper flow body 20U. The lower flow body 20L can comprise a recessed circular head 72 configured to seat the bottom features 63 and 65 of the upper flow body 20U. As shown in FIG. 5, the head 72 can be formed to have an interior surface that is primarily smooth but can have recesses 78 built in a manner that the bottom features 63 and 65 of the upper flow body 20U can be seated and fitted on the interior surface of the lower flow body 20L. As shown herein, there may be locking members to secure 20U to 20L. The locking members may include snaps to lock with mating snap features 36 and 78. Further, the lower flow body 20L and the upper flow body 20U can be designed with through-holes therearound to accommodate a clip ring 35, as shown in FIG. 1. Clip ring 35 can fit onto both the lower flow body and the upper flow body, such that it can firmly secure the two bodies, can keep the two bodies aligned and can prevent any leaks or water loss of the spray head 10 during use. The clip ring 35 can be easily installed or removed, allowing for convenient assembly or disassembly of the spray head for maintenance or replacement

purposes. The clip ring 35 can be a metallic or plastic circular ring, but not particularly limited thereto.

[0052] Further, the lower flow body 20L can comprise a cylindrical body having a secondary water passing chamber 71 configured to seat a second diverter 33'. Further, the lower flow body 20L can comprise a water bypassing chamber 73 configured for a jet spray stream to bypass the secondary water passing chamber 71. Further, the lower flow body 20L can comprise a truncated cone-shaped bottom 76 configured to seat a spray head face unit 20S, which is shown in FIG. 1. The truncated cone-shaped bottom 76 can have a diameter sufficient for a spray head face unit 20S to be seated. As used herein before and after, the terms "spray head face unit" and "spray head face" are used interchangeably. The spray head face is positioned and/or designed in such a way that it can be easily seen or observed, likely due to its location or construction, while the spray head face unit may include additional internal components that may not be visible from an exterior view of the spray head.

[0053] The lower flow body 20L may be a single, integrated component. In some embodiments, the lower flow body 20L can include a secondary water passing chamber 74. The secondary water passing chamber 74 can have a stationary post 67' within its bottom, as shown in FIG. 3. The secondary water passing chamber 74 can receive a second diverter 33' to provide a mist spray waterway 79 and an aerated spray waterway 77. The second diverter 33' can be seated and fitted in the secondary water passing chamber 71 and can be firmly secured through the stationary post 67' and a male and female connection with a shuttle valve 33V' and a piston spring 33S' of the second diverter 33'. As such, the second diverter 33' can adopt a piston mechanism that can be operated by a piston spring 33S' configured to move between a depressed/closed position and a released/open position. The piston spring 33S' can provide tension and facilitate the return of the diverter to its open position by releasing the toggle button 42 upward.

[0054] In some embodiments, for example, as shown in FIGS. 6A and 6B, depressing the toggle button 42 or the second diverter 33' downward, while at the same time keeping the primary water passing chamber open, can enable the opening of a mist spray waterway 79 and can activate a mist spray stream (*see* FIGS. 6B and 9C). On the other hand, releasing the toggle button 42 or the second diverter 33' upward while the primary water passing chamber stays open can enable the opening of an aerated spray waterway 77 and can activate an aerated spray stream (*see* FIGS. 6A and 9A).

[0055] Referring back to FIG. 1, a spray head face unit 20S can be joined to the lower flow body within the shell. The spray head face unit 20S can be connected to the lower flow body

20L, for example, using a watertight welding technique, such as an ultrasonic welding, but not limited thereto. The spray head face unit 20S can comprise a circular faceplate 45 with a rim 45r and a raised portion 44 receiving an aerated spray stream, a jet spray stream, and a mist spray stream, to and around which an aerator 50, a jet sprayer 47, and an atomizer 43 can be attached.

[0056] Thus, as shown in FIGS. 1, 6A, 6B, and 6C, the spray head face unit 20S may include an aerator 50, a jet sprayer 47, and an atomizer 43, such that it can provide a separate internal waterway. The waterway can be configured to provide the separated aerated spray, mist spray, and jet spray in response to the actuators or the diverters. For example, depressing the circular button 34 or the first diverter 33, while at the same time closing the primary water passing chamber can enable the opening of a jet spray waterway and can activate a jet spray stream (*see* FIGS. 6C and 9B). Further, depressing the toggle button 42 or the second diverter 33' downward, while at the same time keeping the primary water passing chamber open, can enable the opening of a mist spray waterway 79 and can activate a mist spray stream (*see* FIGS. 6B and 9C). Further, releasing the toggle button 42 or the second diverter 33' upward, while at the same time keeping the primary water passing chamber open can enable the opening of an aerated spray waterway 77 and can activate an aerated spray stream (*see* FIGS. 6A and 9A).

[0057] In some embodiments, as shown in FIGS. 1 and 2D, the spray head face unit 20S may include an aerator 50, which can have small mesh-like aerated spray outlets. The aerated spray outlets can be positioned at a central axis A or off-axis of the faucet spray head 10. The aerated spray outlets can be configured to produce a spray with a trajectory that is predominantly straight. As used herein, the term "straight" indicates a spray pattern that is primarily directed in a straight line from the outlet without significant dispersion or divergence. For example, the aerated spray has a central axis parallel with a spray head face central longitudinal axis, such that the spray delivered or emitted from the aerated spray outlets has minimal bending or curving and maintains a more focused and linear flow pattern.

[0058] The aerated spray outlets may spray water at a force, for example, in the range of approximately 20 gram-force (about 0.2 newtons (N)) to approximately 50 gram-force (about 0.5 N), creating a spray that is softer and more efficient for various tasks such as washing dishes or rinsing fruits and vegetables. The water force in an aerated spray can be adjusted by manipulating a flow restrictor inside (not shown) or the aerator itself. By removing or modifying the flow restrictor, the water force can be increased. In some embodiments, the aerated spray outlets may spray water at a force of greater than or equal to 0.15, 0.2, 0.25,

0.3, 0.35, 0.4, or 0.45 N. In some embodiments, the aerated spray outlets may spray water at a force of less than or equal to 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, or 0.5N.

[0059] In some embodiments, the spray head face unit 20S or the spray head face 48 may include a jet sprayer with two or more arcuate jet spray outlets 47, 47' positioned around a perimeter of the aerated spray outlet. For example, as shown in FIGS. 2, 2D, 7A and 8A, the arcuate jet spray outlets are arranged in a semi-circular shape around a perimeter of the aerated spray outlet, which can result in improved washing performance or increased coverage compared to using a straight stream.

[0060] The two or more jet spray outlets may have two or more arcuate slots (*see* FIG. 2D). As shown in partly expanded FIG. 2D', the two or more arcuate jet spray outlets may include a plurality of openings configured to deliver or emit a jet spray. The plurality of openings may be arranged in a symmetrical manner to deliver a uniform jet spray. The plurality of openings can be positioned on each of two or more metal plates. The metal plate may include, but is not limited to, stainless steel, brass, bronze, copper, aluminum, nickel, titanium, zinc, iron, silver, gold, or alloys or combinations thereof. In this embodiment, the openings on each of the two or more metal plates may be created by drilling, punching, water jet cutting, electrical discharge machining (EDM), chemical etching, laser etching, plasma cutting, or milling, but not limited thereto. In an embodiment, the jet spray outlets may include openings with a diameter ranging from about 0.20 mm to about 0.60 mm, for example, about 0.20 mm or more, about 0.25 mm or more, about 0.30 mm or more, about 0.35 mm or more, about 0.40 mm or more, about 0.45 mm or more, about 0.50 mm or more, about 0.55 mm or more, or about 0.60 mm or more, and about 0.60 mm or less, about 0.55 mm or less, about 0.50 mm or less, about 0.45 mm or less, about 0.40 mm or less, about 0.35 mm or less, about 0.30 mm or less, about 0.25 mm or less, or about 0.20 mm or less. As a result, the jet spray is powerful, but it generates less splash due to its small outlet holes created by such methods. This makes it ideal for effectively cleaning dishes and sinks.

[0061] In some embodiments, the plurality of openings can be configured or adjusted to produce a range of jet spray angles from approximately 10° to approximately 45° between the opposite sprays. For instance, the opposite sprays can be adjusted to achieve angles ranging from approximately 15° to 30° or 30° to 50°, including specific angles such as about 15°, about 20°, about 25°, about 30°, about 35°, or about 40°, or even greater. In some embodiments, the jet spray angles may be less than or equal to 15°, 20°, 25°, 30°, 35°, 40°, 45°, or 50°. In some embodiments, the jet spray angles may be greater than or equal to 10°, 15°, 20°, 25°, 30°, 35°, 40°, or 45°.

[0062] This can create a cone-shaped spray pattern aligned with the central axis of the spray head. The two or more arcuate jet spray outlets can spray water at a force in the range of approximately 50 gram-force (about 0.5 N) to approximately 120 gram-force (about 1.2 N), depending on the water pressure from a supply water source, such as between about 40 psi and about 80 psi, particularly about 50 psi. In some embodiments, the two or more arcuate jet spray outlets may spray water at a force of greater than or equal to 0.5 N, 0.6 N, 0.7 N, 0.8 N, 0.9 N, 1.0 N, 1.1 N, or 1.2 N. In some embodiments, the two or more arcuate jet spray outlets may spray water at a force of less than or equal to 0.6 N, 0.7 N, 0.8 N, 0.9 N, 1.0 N, 1.1 N, 1.2 N, or 1.3 N.

[0063] In some embodiments, when considering a spray surface area of about 12.4 in^2 (about 79.8 cm^2) at a distance of about 4" from the spray head, a 0.5 N - 1.2 N spray force can be achieved with a water pressure of about 20 psi from the supply water source. In some embodiments, when considering a spray surface area of about 13.3 in^2 (about 85.8 cm^2) at a distance of about 4" from the spray head, a 0.5N-1.2N spray force can be achieved with a water pressure of about 40 psi from the supply water source. In some embodiments, when considering a spray surface area such as about 17.4 in^2 (about 112.4 cm^2) at a distance of about 4" from the spray head, a 0.5 N - 1.2 N spray force can be achieved with a water pressure of about 80 psi from the supply water source. In some embodiments, the water pressure from the supply water source may be less than or equal to 20, 30, 40, 50, 60, 70, 80, or 90 psi. In some embodiments, the water pressure from the supply water source may be greater than or equal to 10, 20, 30, 40, 50, 60, 70, or 80 psi.

[0064] In some embodiments, as shown in FIG. 1, the spray head face unit 20S may include a plurality of mist spray nozzles 43' positioned along the perimeter of the jet spray outlets 50. The plurality of mist spray nozzles 43' are in fluid communication with corresponding mist spray holes 49 arranged in a spray head face 48 to deliver or emit the mist spray. In some embodiments, there are 3 to 12 mist spray nozzles distributed around the spray head face. These mist spray nozzles can be configured such that a first mist spray delivered or emitted from a first nozzle may not impede or overlap with a second mist spray delivered or emitted from a second nozzle at a spray area within a distance ranging from about 1 inch to about 6 inches from the spray head face. This arrangement can allow for a consistent and even distribution of mist spray over the desired area. This can help to avoid concentration of mist in certain spots and can ensure that the mist is evenly distributed across the target area. Having multiple mist spray nozzles arranged in this manner can provide a more effective and

uniform misting effect. However, the configuration of mist spray nozzles may vary depending on its particular spray head and faucet applications.

[0065] In some embodiments, the mist spray nozzles are configured to produce a spray with a trajectory that is predominantly straight. As used herein, the term "straight" indicates a spray pattern that is primarily directed in a straight line from the nozzles without significant dispersion or divergence. For example, the mist spray may have a central axis parallel with a spray head face central longitudinal axis, such that the spray delivered or emitted from the mist spray nozzles can have minimal bending or curving, maintaining a more focused and linear flow pattern.

[0066] In some embodiments, the mist spray nozzles may spray mist at a force in the range of approximately 20 gram-force (about 0.2 N) to approximately 60 gram-force (about 0.6 N). Higher water forces may require more water and energy, potentially leading to wastage. The above range can ensure gentle rinsing of delicate fruits and vegetables while minimizing water and energy consumption. The selected water force range can be also influenced by the intended application of the mist spray nozzles. Different applications may require varying levels of misting force. In some embodiments, the mist spray nozzles may have a spray force of less than or equal to 0.2 N, 0.3 N, 0.4 N, 0.5 N, or 0.6 N. In some embodiments, the mist spray nozzles may have a spray force of greater than or equal to 0.1 N, 0.2 N, 0.3 N, 0.4 N, or 0.5 N.

[0067] In some embodiments, the jet spray and the mist spray may have a spray force ratio of approximately 1.5:1 to approximately 5:1, for example, around 1.5:1 to around 3:1, depending on the water pressure from a supply water source, such as between about 40 psi and about 80 psi, particularly around 50 psi. In some embodiments, the spray head face 48 may include a silicone-overmolded substrate for additional protection, shock absorption, improve grip, and the like. The substrate may be a metal or a polymeric material as described herein above. In another embodiment, the spray head face 48 may be overmolded with thermoplastic elastomers (TPE), liquid silicone rubber (LSR), polyurethane (PU), ethylene propylene diene monomer (EPDM) rubber, silicone coatings, or the like.

[0068] In some embodiments, as shown in FIG. 2, the spray head face 48 may further include a rib circle 48R that can protrude around the aerator 50, which can provide an enhanced grip and stability when handling or adjusting the aerator, additional protection or safeguard to the aerator, and overall aesthetic appeal of the spray head face.

[0069] FIGS. 7 and 8 show exemplary embodiments of a multi-function faucet assembly according to the present disclosure. The exemplary embodiments show two types of faucets,

e.g., a pull-down faucet (FIG. 7) and a semi-pro faucet with a magnetic support (FIG. 8). In these embodiments, the front body shell or the spray head face may include ABS or silicone-overmolded ABS, while the rear body shell may include an electroplated surface.

[0070] FIGS. 9A shows an aerated spray mode of the multi-function faucet assembly according to an embodiment of the present disclosure. FIGS. 9B shows a jet spray mode of the multi-function faucet assembly according to an embodiment of the present disclosure. FIG. 9C shows a mist spray mode of the multi-function faucet assembly according to an embodiment of the present disclosure.

Example

[0071] A performance study was conducted on a kitchen faucet spray head having a jet spray mode and a mist spray mode, in addition to an aerated spray mode, as described herein. Using a custom designed and build test stand, a low load robot was programed to follow a repeatable motion to hold and use the spray head in a human-like manner. The spray head was positioned 9 inches away and held perpendicular to the plate holder. The plate was set to an angle of 60°. The incoming 70°F cold water pressure was set to 45 psi. Each plate was evenly coated with a 3mm layer of peanut butter. The robot used a vertical zig zag spray pattern and a horizontal zig zag spray pattern, each with a total of 11 passes across the plate. This testing path took 10 seconds to complete and a total of 3 cycles were completed on each plate for each spray mode and spray pattern.

[0072] The results of the performance testing are shown in FIGS. 10A-10C. FIG. 10A shows the removal of peanut butter from a plate after three testing cycles using a jet spray mode in a vertical spray pattern. FIG. 10B shows the removal of peanut butter from a plate after three testing cycles using a jet spray mode in a horizontal spray pattern. FIG. 10C shows the removal of peanut butter from a plate after three testing cycles using a mist spray mode.

[0073] As shown in FIGS. 10A and 10B, the jet spray mode was powerful in removing about one third to one half of the peanut butter from the plate after 3 testing cycles. However, as also shown in FIGS. 10A-10B, the jet spray mode created small outlet holes in the peanut butter, which is indicative of a reduced amount of splashing off of the plate. Accordingly, FIGS. 10A-10B suggest that the jet spray modes of the embodiments described herein can provide a balance between powerful cleaning and minimizing splash.

[0074] As shown in FIG. 10C, the mist spray mode created tiny, uniform outlet holes in the peanut butter after 3 testing cycles. This suggests that the mist spray modes of the embodiments described herein may provide a mist spray with minimal overlap between

individual mist spray streams, may help to avoid concentration of mist in certain spots, and may ensure that the mist is evenly distributed across the target area.

[0075] The term “flow communication” or “fluid communication” means, for example, configured for liquid or gas flow therethrough and may be synonymous with “fluidly coupled”. The terms “upstream” and “downstream” indicate a direction of gas or fluid flow, that is, gas or fluid will flow from upstream to downstream.

[0076] Likewise, “electrical communication” may mean “electrically coupled”. Electrical communication may be via wired connection or may be wireless.

[0077] The terms “coupled” or “connected” may mean that an element is “attached to” or “associated with” another element. Coupled or connected may mean directly coupled or coupled through one or more other elements. An element may be coupled to an element through two or more other elements in a sequential manner or a non-sequential manner. The term “via” in reference to “via an element” may mean “through” or “by” an element. Coupled or connected or “associated with” may also mean elements not directly or indirectly attached, but that they “go together” in that one may function together with the other.

[0078] The term “towards” in reference to a of point of attachment, may mean at exactly that location or point or, alternatively, may mean closer to that point than to another distinct point, for example, “towards a center” means closer to a center than to an edge.

[0079] The term “like” means similar and not necessarily exactly like. For instance “ring-like” means generally shaped like a ring, but not necessarily perfectly circular.

[0080] Any ranges cited herein are inclusive. The term "about" used throughout is used to describe and account for small fluctuations. For instance, "about" may mean the numeric value may be modified by ±0.05%, ±0.1%, ±0.2%, ±0.3%, ±0.4%, ±0.5%, ±1%, ±2%, ±3%, ±4%, ±5%, ±6%, ±7%, ±8%, ±9%, or ±10%. All numeric values are modified by the term "about" whether or not explicitly indicated. Numeric values modified by the term "about" include the specific identified value. For example, "about 5.0" includes 5.0.

[0081] The term “substantially” is similar to “about” in that the defined term may vary from, for example, by ±0.05%, ±0.1%, ±0.2%, ±0.3%, ±0.4%, ±0.5%, ±1%, ±2%, ±3%, ±4%, ±5%, ±6%, ±7%, ±8%, ±9%, or ±10% of the definition; for example, the term “substantially perpendicular” may mean the 90° perpendicular angle may mean “about 90°”. The term “generally” may be equivalent to “substantially”.

[0082] Features described in connection with one embodiment of the disclosure may be used in conjunction with other embodiments, even if not explicitly stated.

[0083] Embodiments of the disclosure include any and all parts and/or portions of the embodiments, claims, description and figures. Embodiments of the disclosure also include any and all combinations and/or sub-combinations of embodiments.

[0084] Therefore, it should be understood that while three types of spray functions (e.g., jet spray, aerated spray, and mist spray) are described in the preferred embodiments, it is within the scope of the disclosure to change or add further spray functions if desired by modifying outlets and/or adding additional valves, diverters and/or further waterways or paths and openings therein, alternate flow diversion conduits within the shell of the spray heads described herein.

CLAIMS

1. A multi-function faucet assembly, comprising:
   a faucet body;
   a faucet spout; and
   a faucet spray head comprising a spray head face, wherein the spray head face comprises:
      an aerated spray outlet positioned at a central axis or off-axis of the faucet spray head and configured to deliver the aerated spray,
      two or more jet spray outlets positioned around a perimeter of the aerated spray outlet and configured to deliver the jet spray, and
      a plurality of mist spray nozzles positioned around a perimeter of the jet spray outlets and configured to deliver the mist spray.

2. The multi-function faucet assembly of claim 1, wherein the spray head face comprises two or more arcuate jet spray outlets positioned around a perimeter of the aerated spray outlet.

3. The multi-function faucet assembly of claim 2, wherein each of the two or more arcuate jet spray outlets comprises a plurality of openings configured to deliver the jet spray.

4. The multi-function faucet assembly of claim 3, wherein each of the two or more arcuate jet spray outlets comprises a metal plate on which a plurality of openings are positioned to deliver the jet spray.

5. The multi-function faucet assembly of claim 4, wherein the metal plate comprises stainless steel, brass, bronze, copper, aluminum, nickel, titanium, zinc, iron, silver, gold, or alloys or combinations thereof.

6. The multi-function faucet assembly of claim 5, wherein each of the two or more arcuate jet spray outlets comprises a plurality of openings configured to produce a spray angle ranging from about 10° to about 45°.

7. The multi-function faucet assembly of claim 2, wherein the two or more arcuate jet spray outlets comprise openings with a diameter ranging from about 0.20 mm to about 0.60 mm.

8. The multi-function faucet assembly of claim 2, wherein the two or more arcuate jet spray outlets are configured to spray water at a force of about 0.5 newtons (N) to about 1.2 newtons (N).

9. The multi-function faucet assembly of claim 2, wherein the arcuate jet spray outlets are arranged in a semi-circular shape around a perimeter of the aerated spray outlet.

10. The multi-function faucet assembly of claim 1, wherein the spray head face comprises 3 to 12 mist spray nozzles positioned around a perimeter of the jet spray outlets.

11. The multi-function faucet assembly of claim 10, wherein the mist spray nozzles are configured such that a first mist spray delivered from a first nozzle will not impede or overlap with a second mist spray delivered from a second nozzle within a distance ranging from about 1 inch to about 6 inches from the spray head face.

12. The multi-function faucet assembly of claim 10, wherein the mist spray nozzles comprise stainless steel, brass, bronze, copper, aluminum, nickel, titanium, zinc, iron, silver, gold, or alloys or combinations thereof.

13. The multi-function faucet assembly of claim 10, wherein the mist spray nozzles are configured to spray water at a force of about 0.2 N to about 0.6 N.

14. The multi-function faucet assembly of claim 1, wherein the jet spray and the mist spray have a spray force ratio of about 1.5:1 to about 5:1.

15. The multi-function faucet assembly of claim 1, wherein the aerated spray outlets are configured to spray water at a force of about 0.2 N to about 0.5 N.

16. The multi-function faucet assembly of claim 1, wherein the spray head comprises one or more actuators configured to be operated to select the aerated spray, the mist spray, or the jet spray.

17. The multi-function faucet assembly of claim 16, wherein the faucet spray head comprises an internal waterway, wherein the waterway is configured to provide the separate aerated spray, mist spray, and jet spray in response to the actuators and configured to establish a spray force ratio between the jet spray and the mist spray of about 1.5:1 to about 5:1.

18. The multi-function faucet assembly of claim 1, wherein the spray head face comprises a silicone-overmolded substrate.

19. The multi-function faucet assembly of claim 16, wherein the spray head comprises an outer body shell, wherein the outer body shell comprises a front body shell and a rear body shell, the front body shell having one or more openings for housing the one or more actuators, and wherein the front body shell comprises a non-conductive surface with or without a silicone-overmolded substrate, and the rear body shell comprises an electroplated surface or a non-conductive surface with or without a silicone-overmolded substrate.

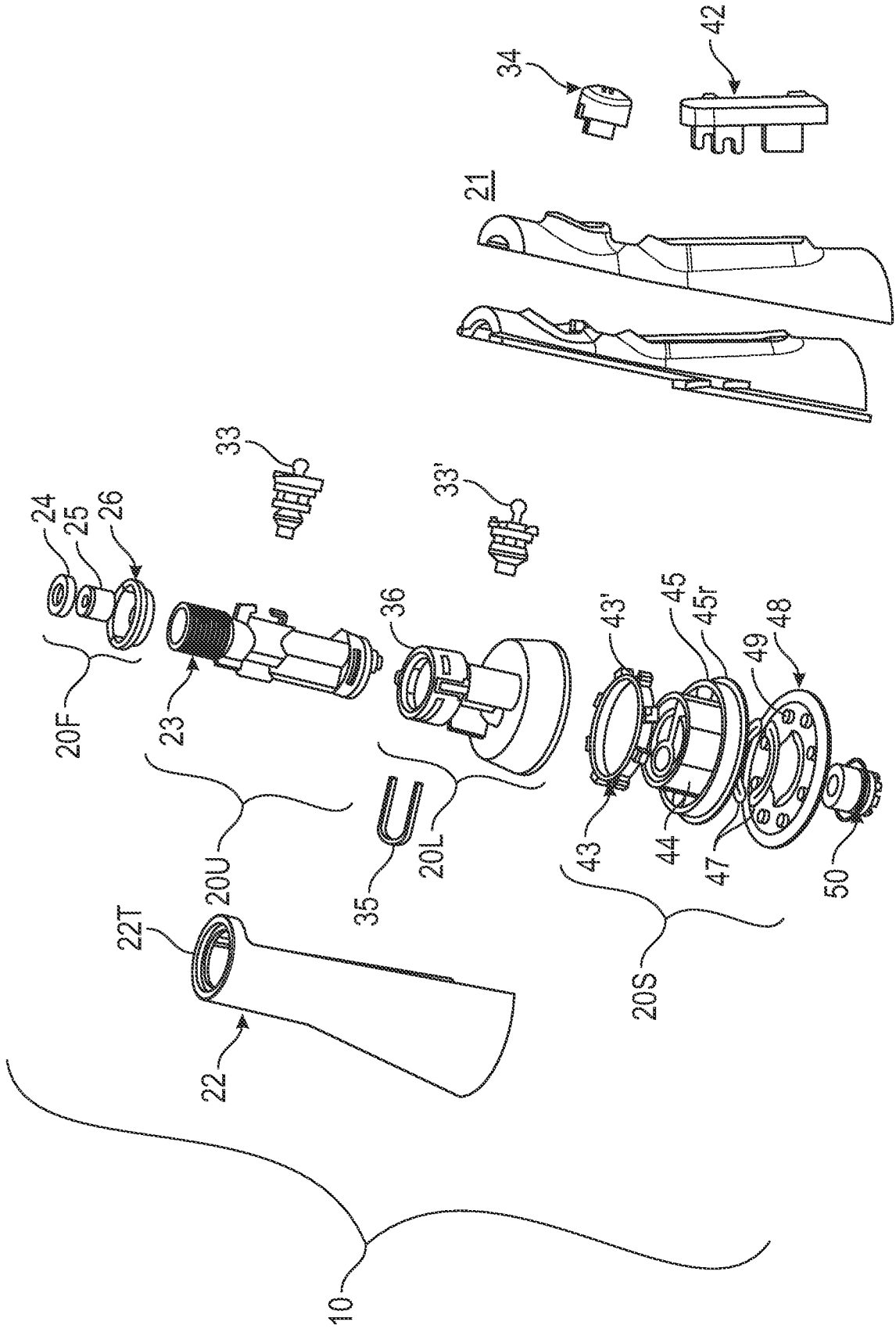
34
42
21
33
33'
24
25
26
36
43'
45
45r
48
49
20F
23
20U
20L
35
43
44
47
50
22T
22
20S
10

FIG. 1

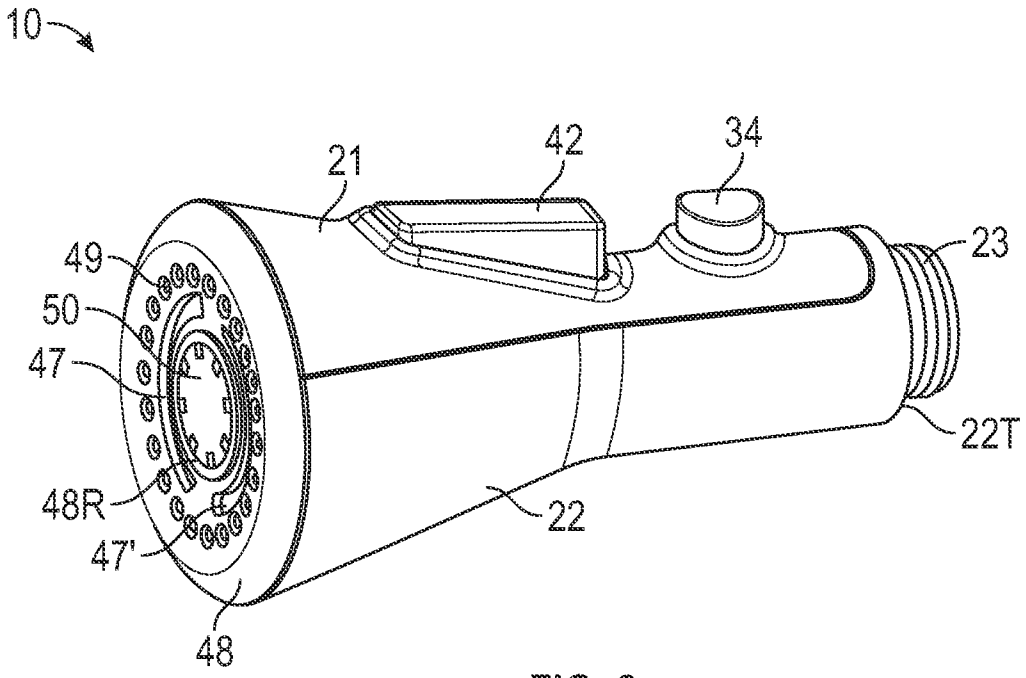

FIG. 2

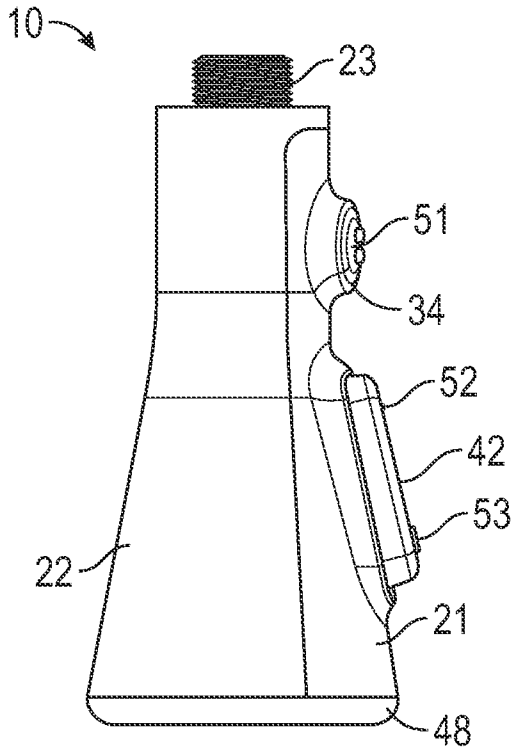

FIG. 2A

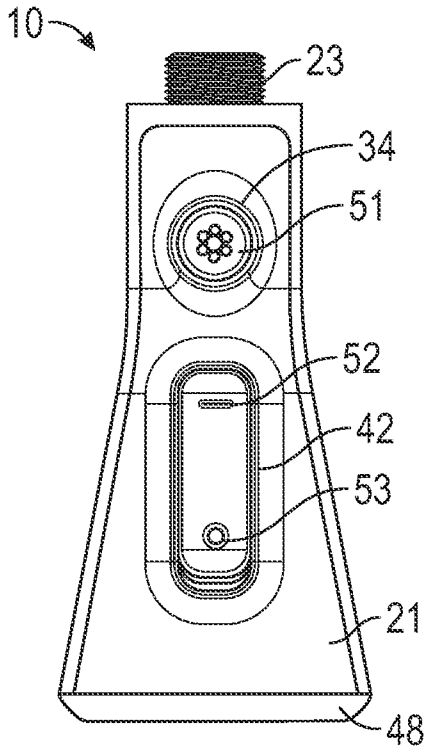

FIG. 2B

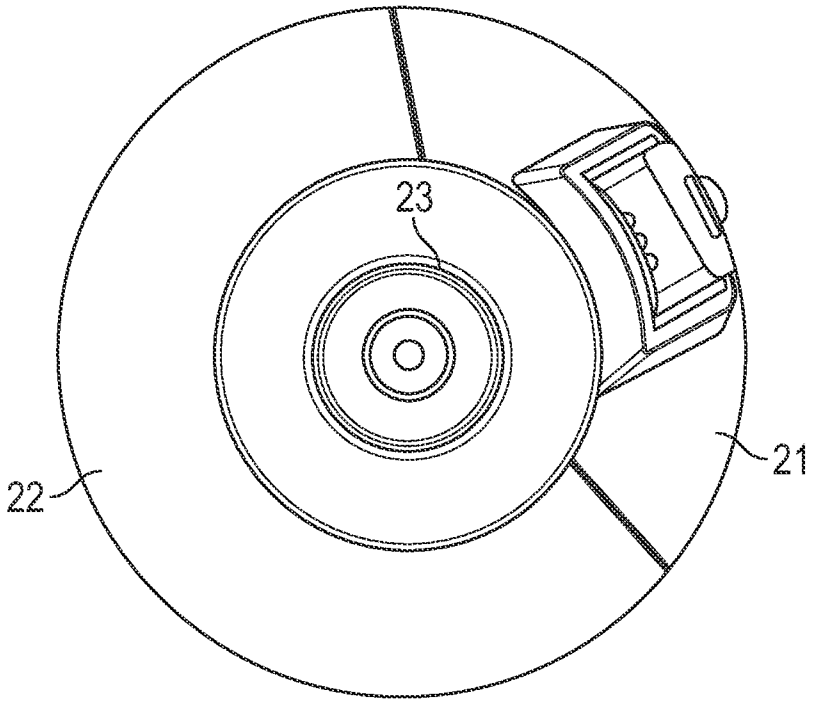

FIG. 2C

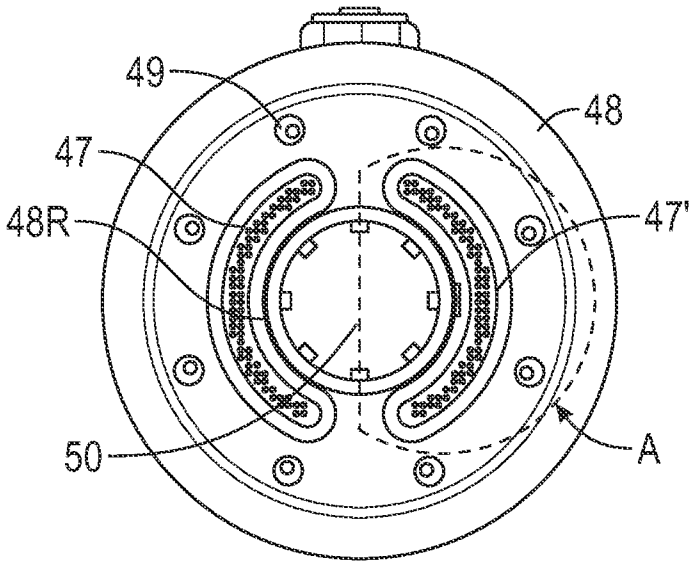

FIG. 2D

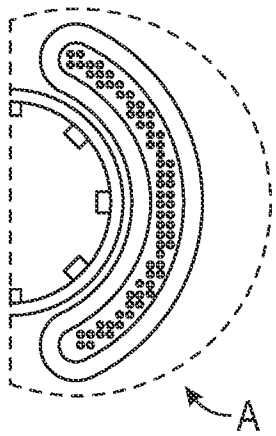

FIG. 2D'

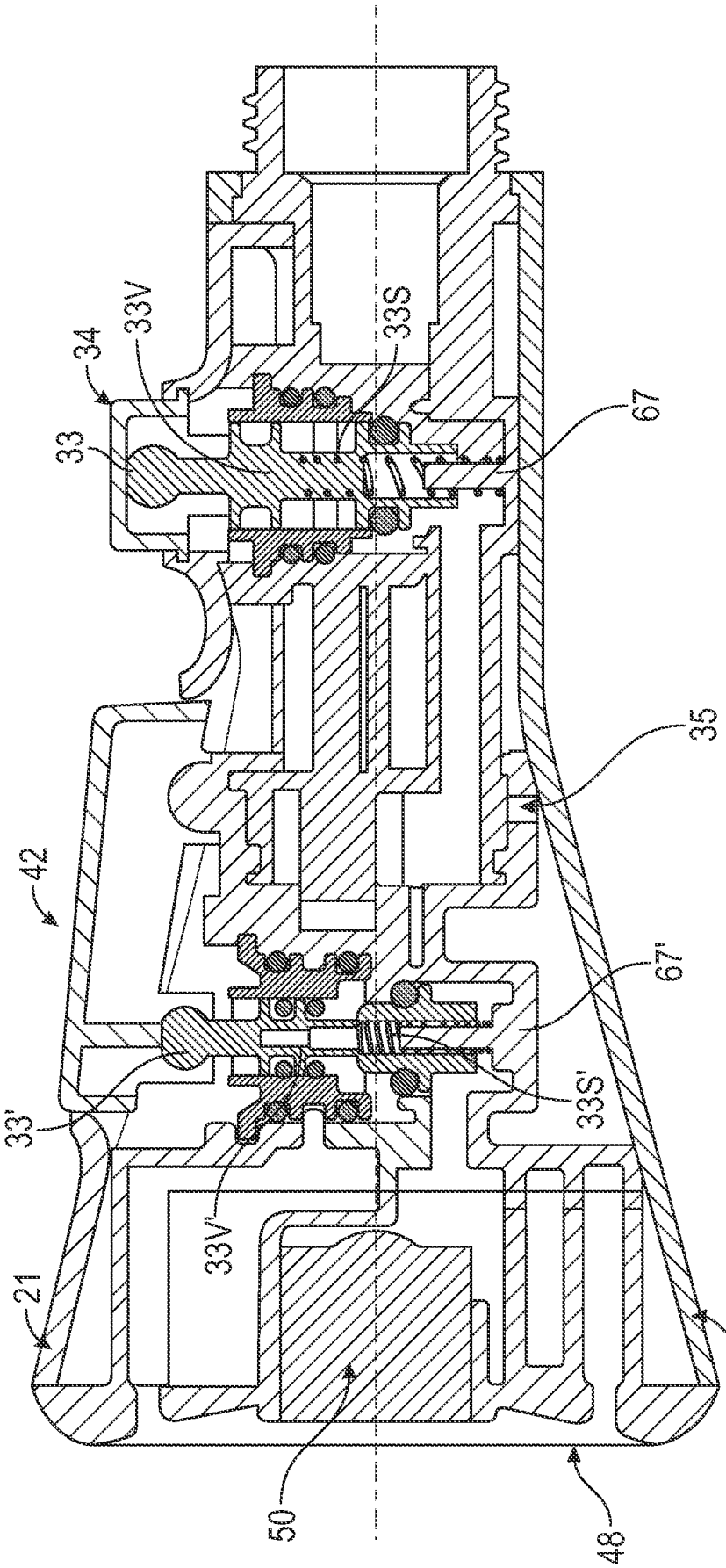

FIG. 3

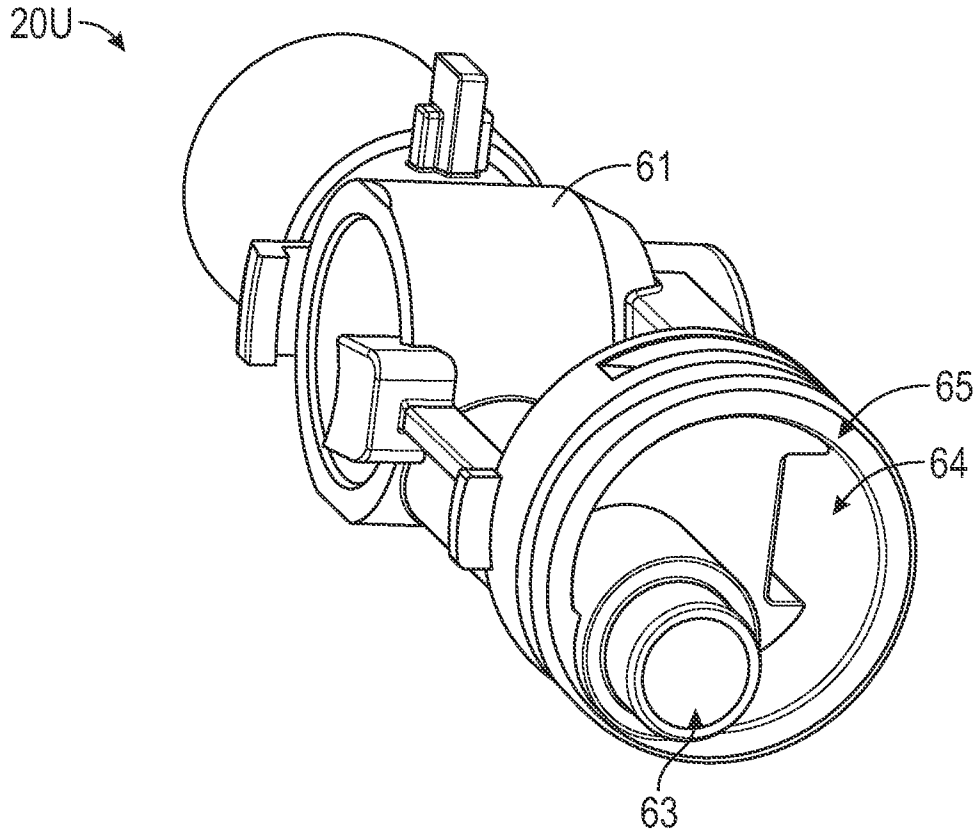

FIG. 4

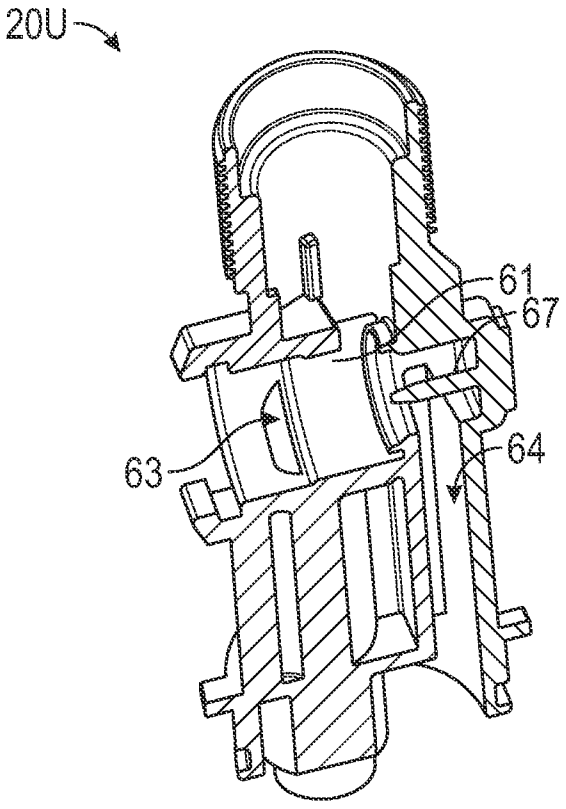

FIG. 4A

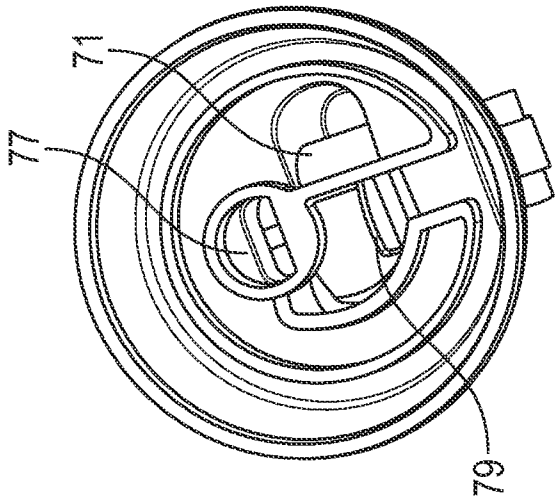

FIG. 5B

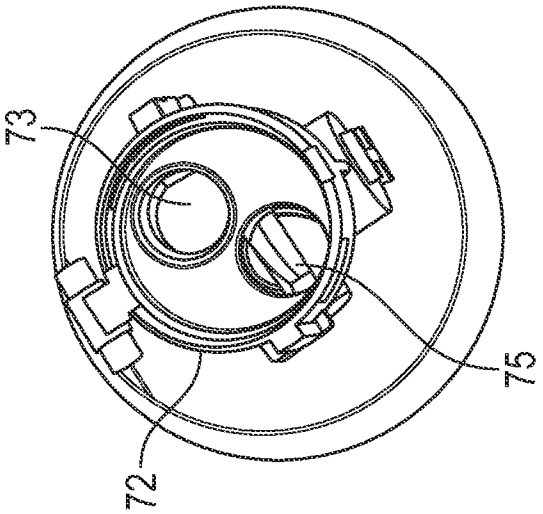

FIG. 5A

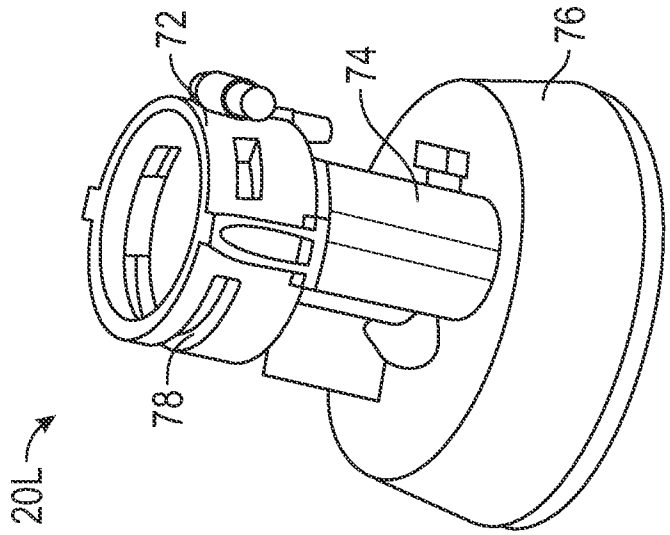

FIG. 5

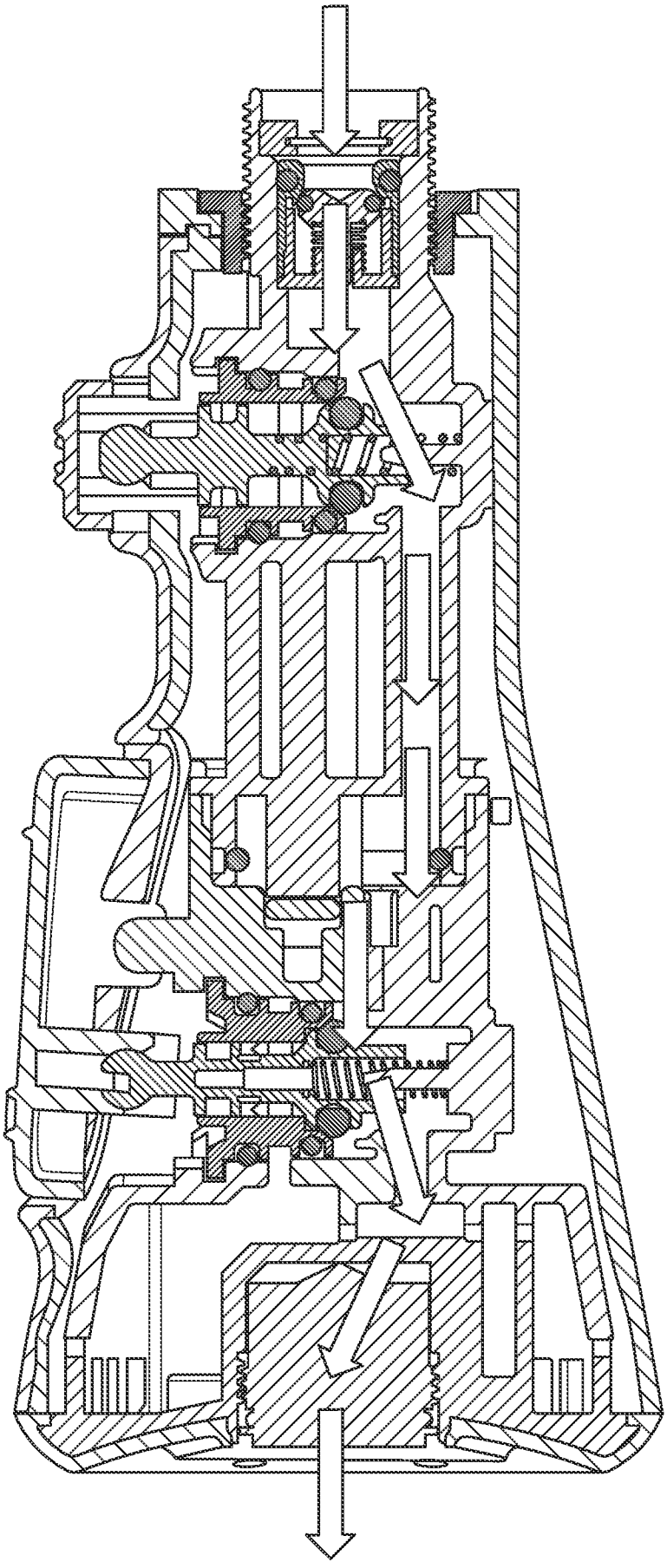

FIG. 6A

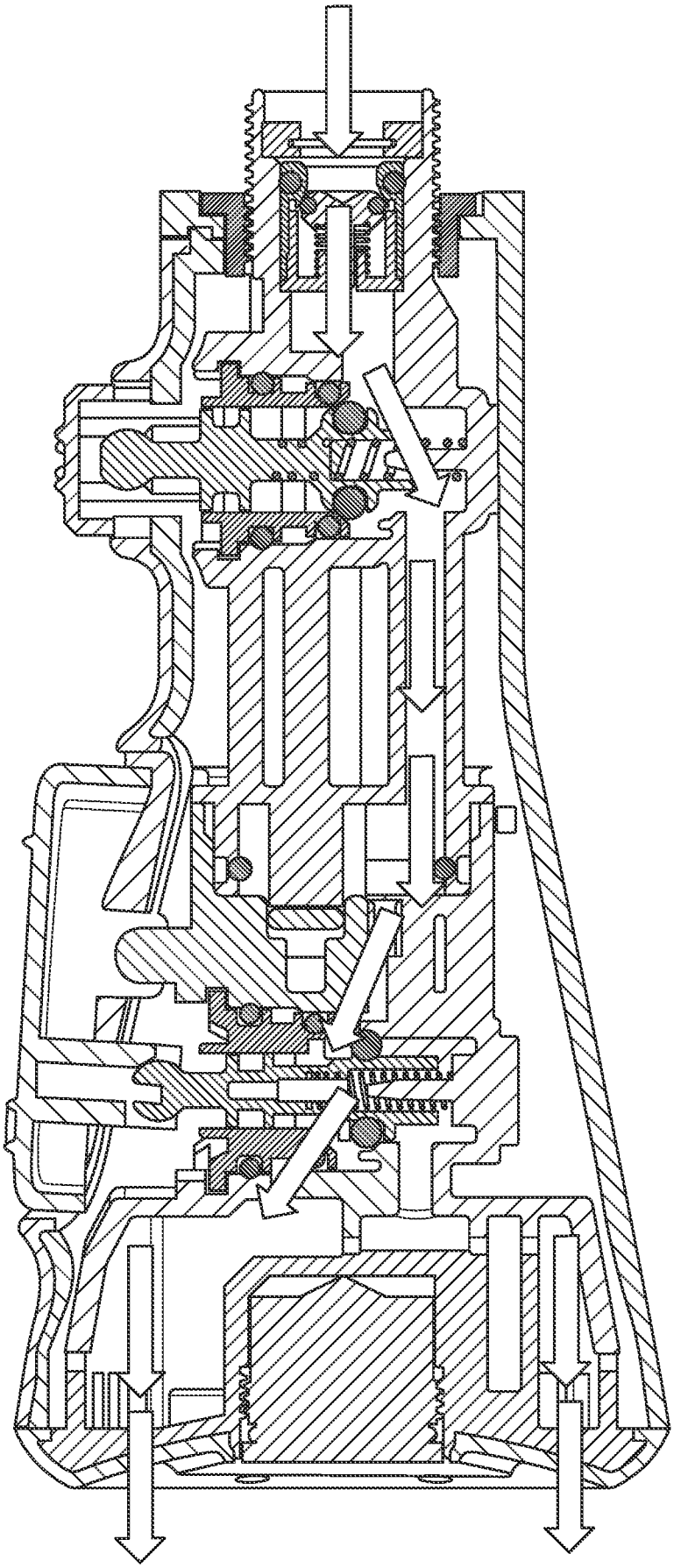

FIG. 6B

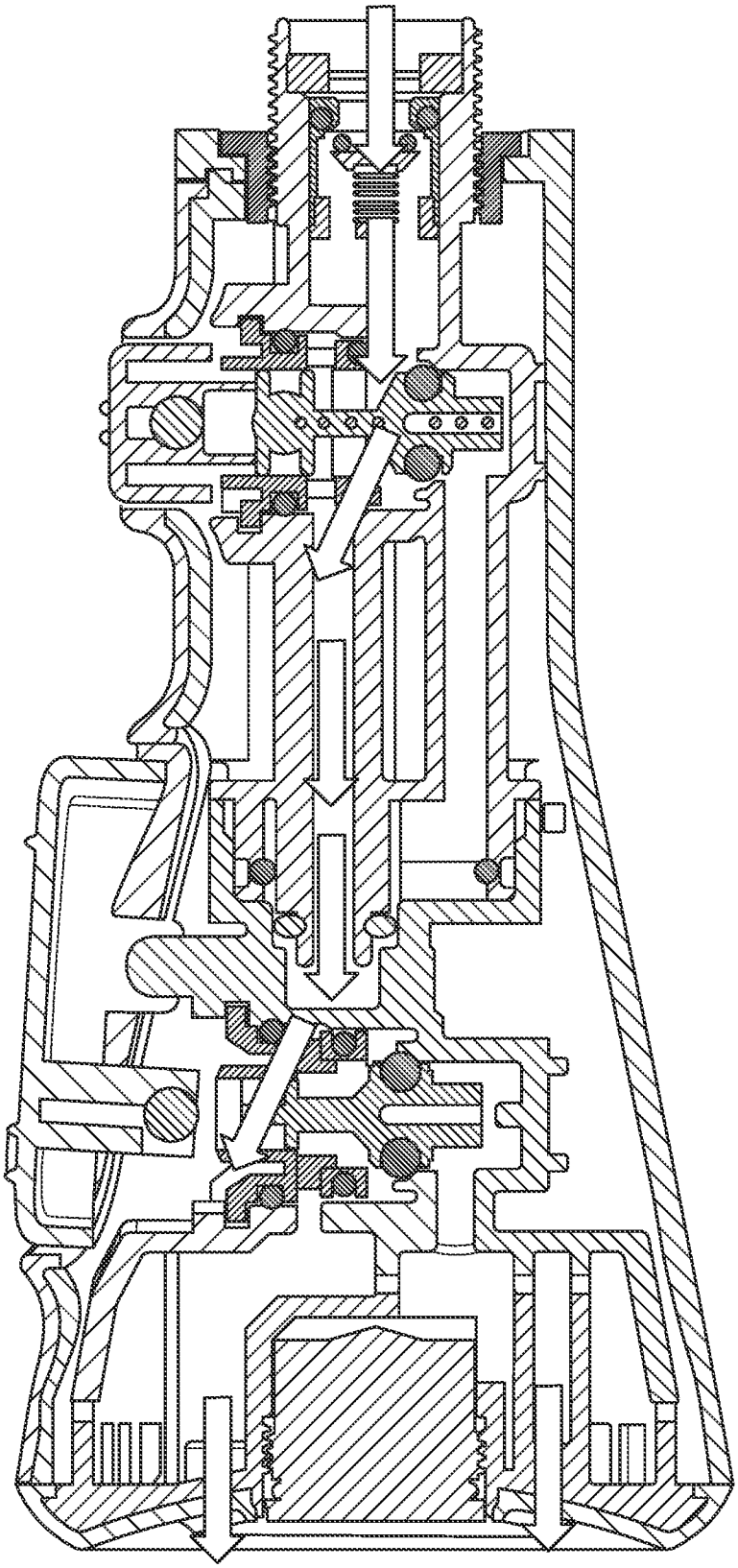

FIG. 6C

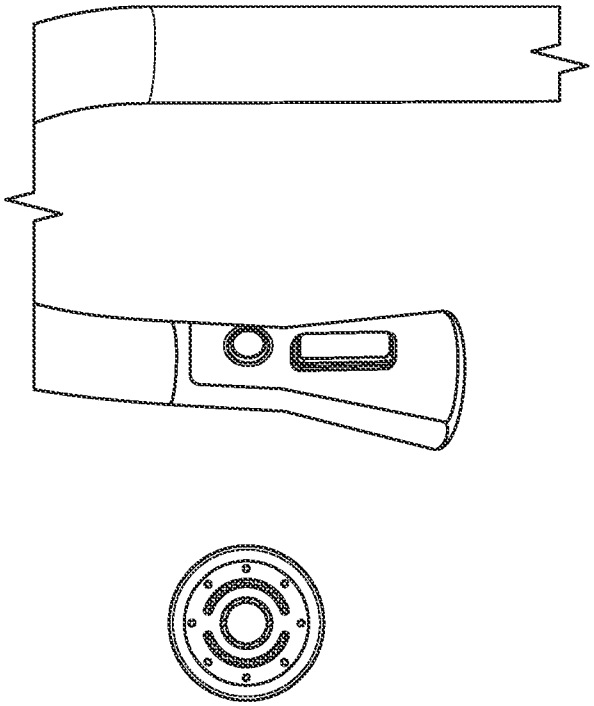

FIG. 7A

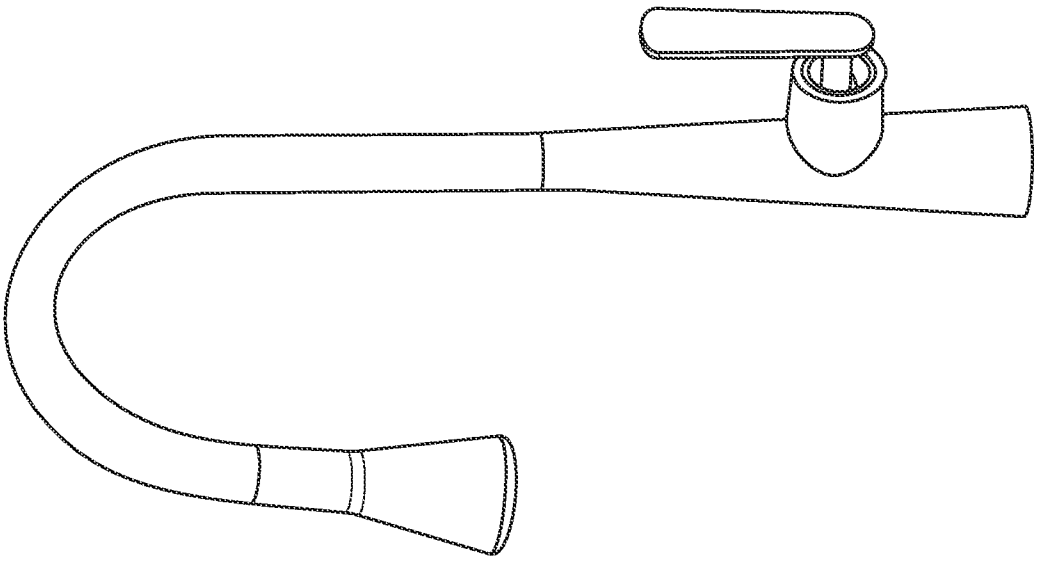

FIG. 7

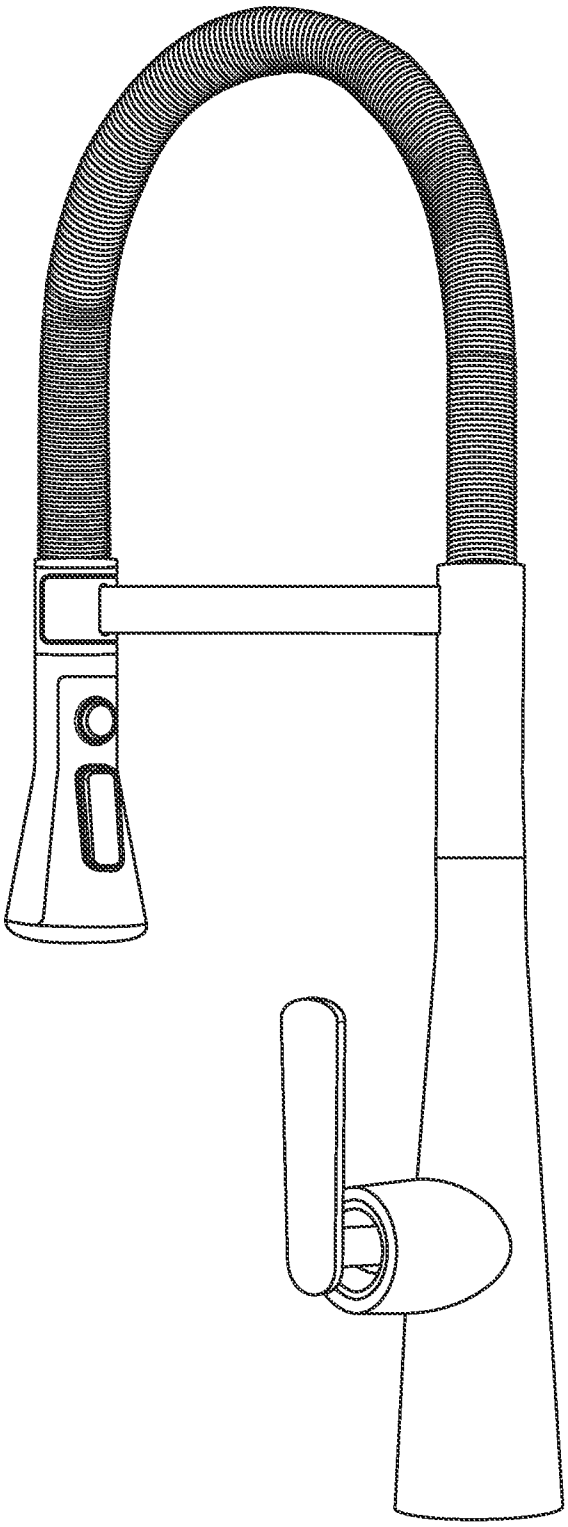

FIG. 8

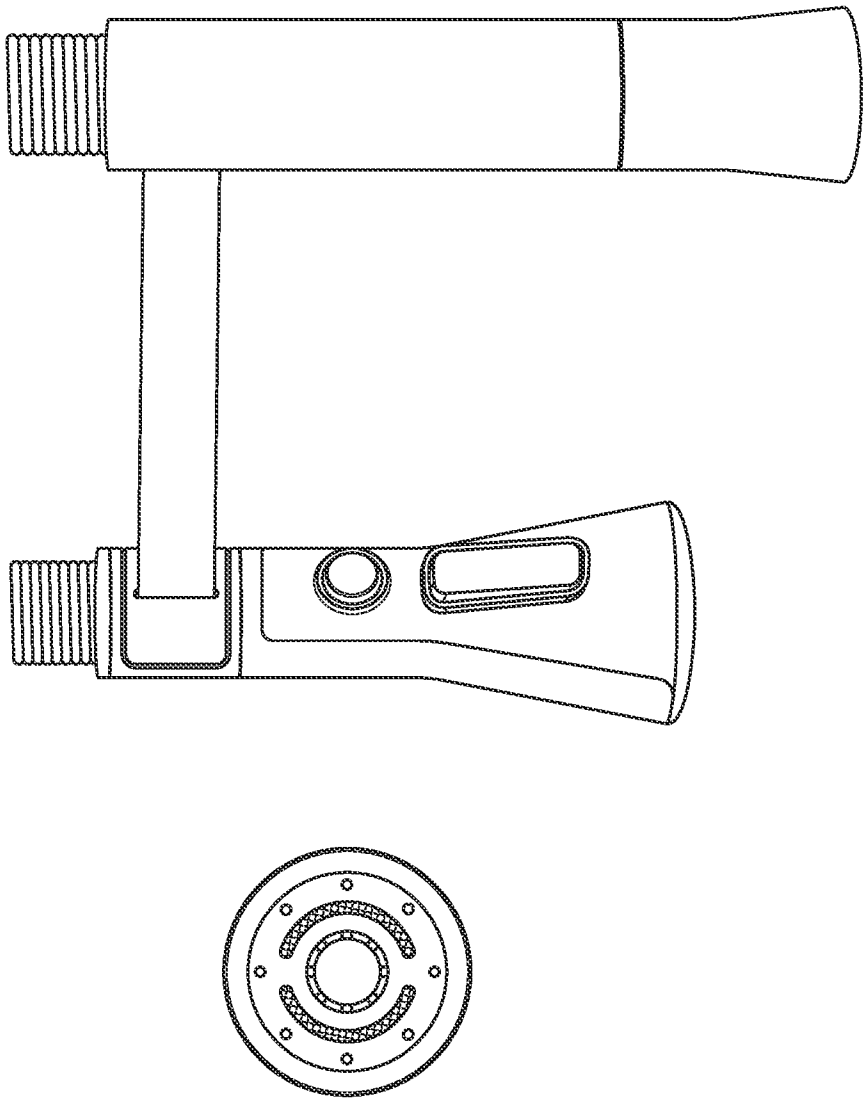

FIG. 8A

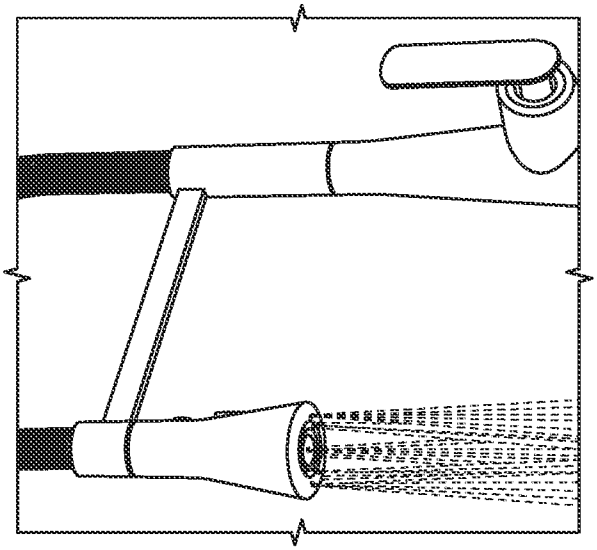

FIG. 9C

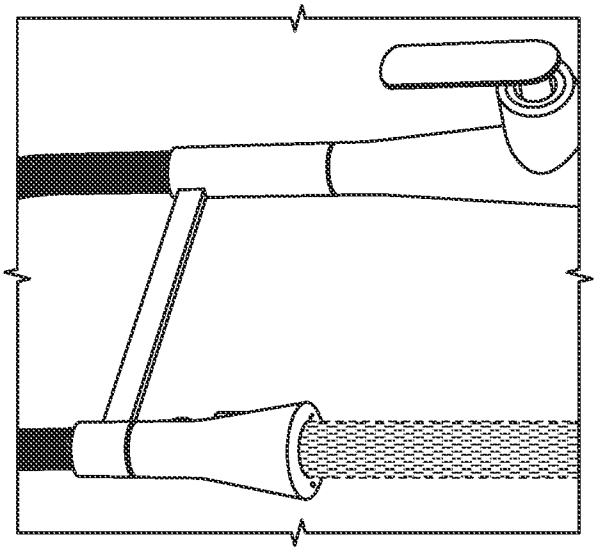

FIG. 9B

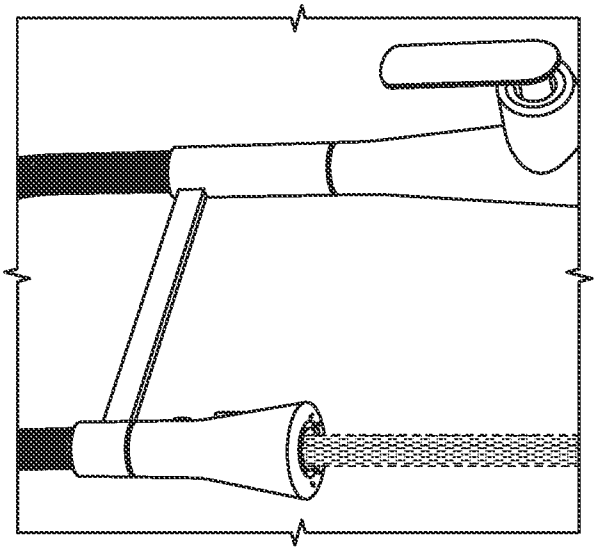

FIG. 9A

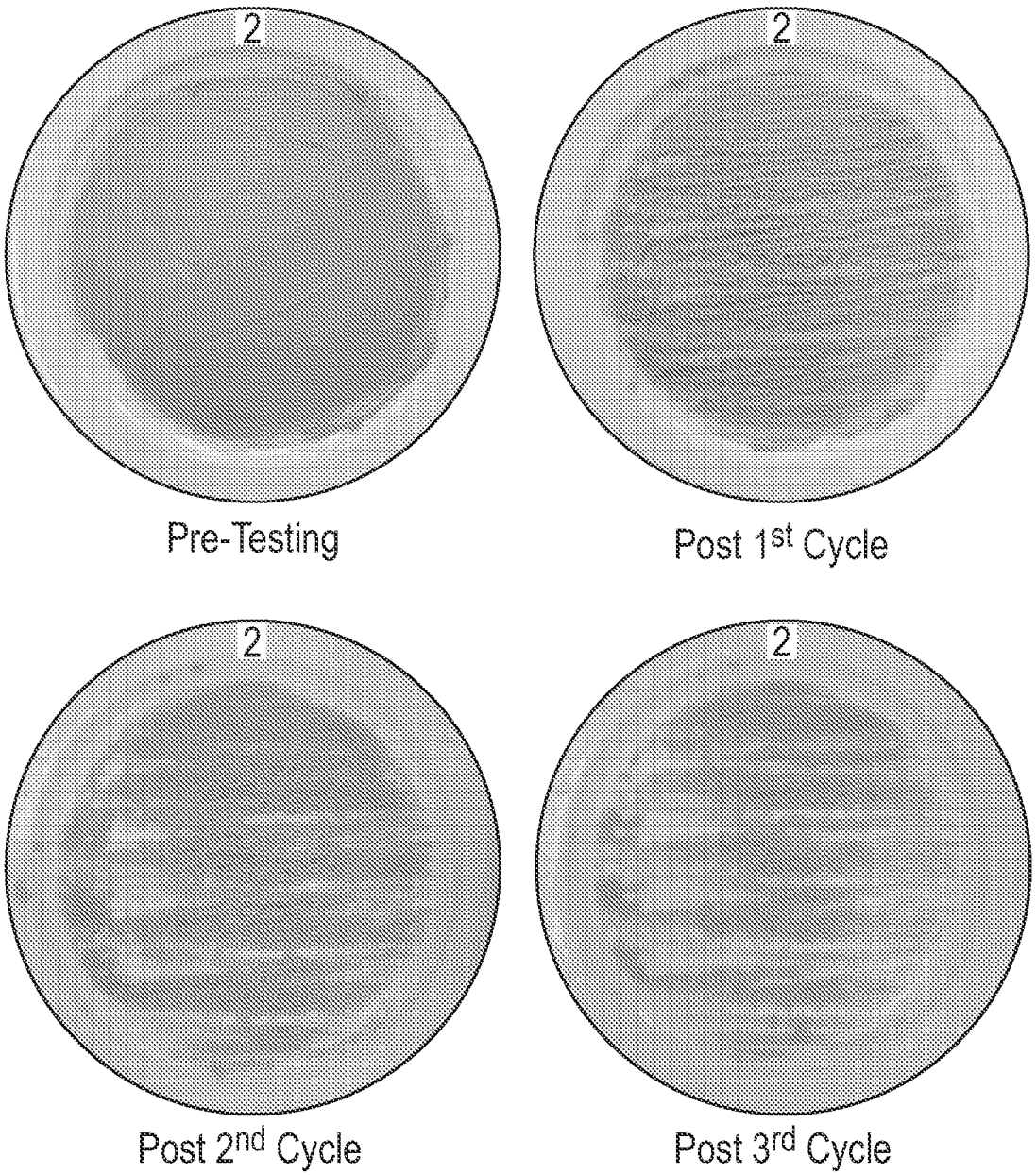
2
Pre-Testing
2
Post 1st Cycle
2
Post 2nd Cycle
2
Post 3rd Cycle

FIG. 10A

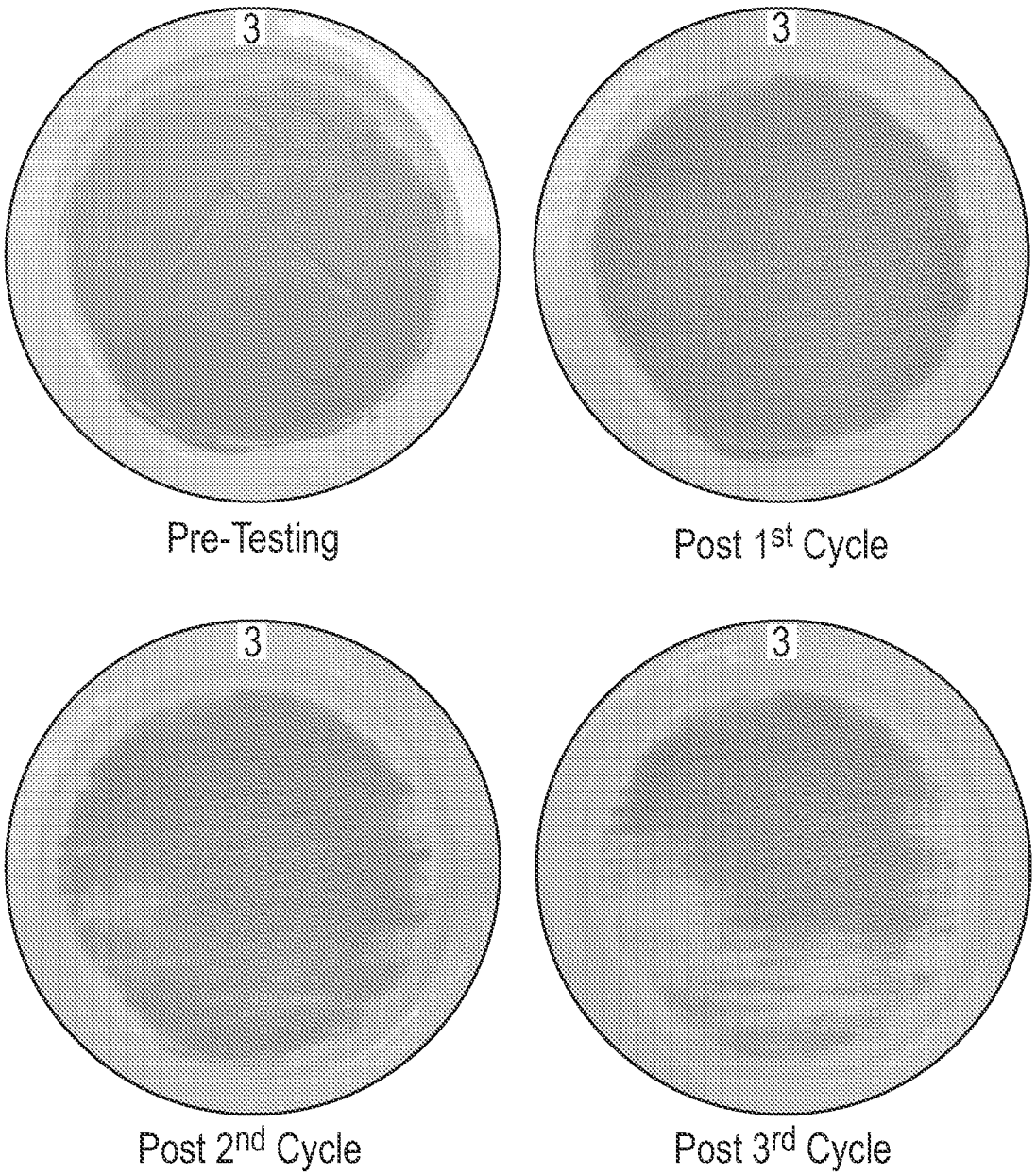
3
Pre-Testing
3
Post 1st Cycle
3
Post 2nd Cycle
3
Post 3rd Cycle

FIG. 10B

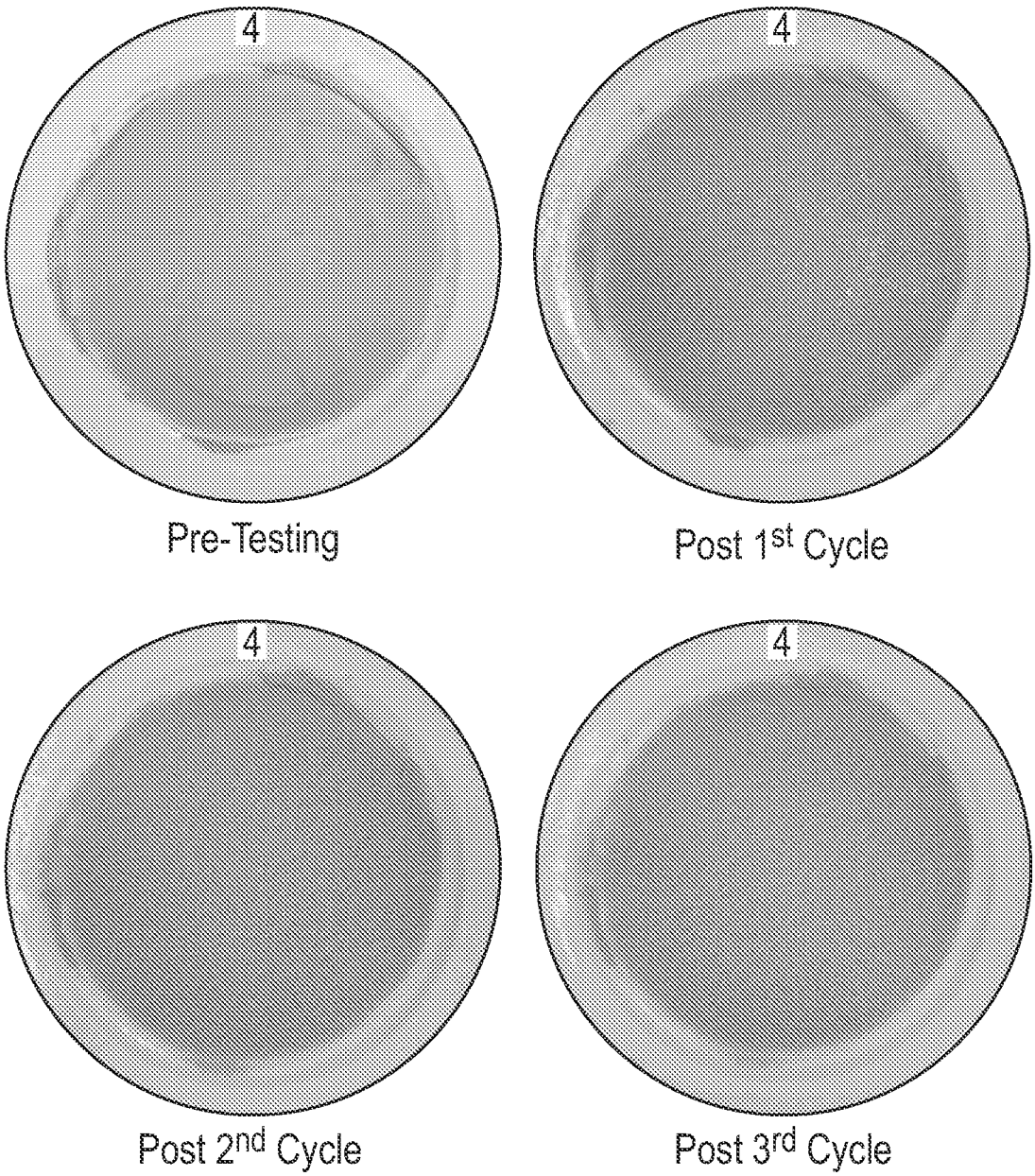
4
Pre-Testing
4
Post 1st Cycle
4
Post 2nd Cycle
4
Post 3rd Cycle

FIG. 10C