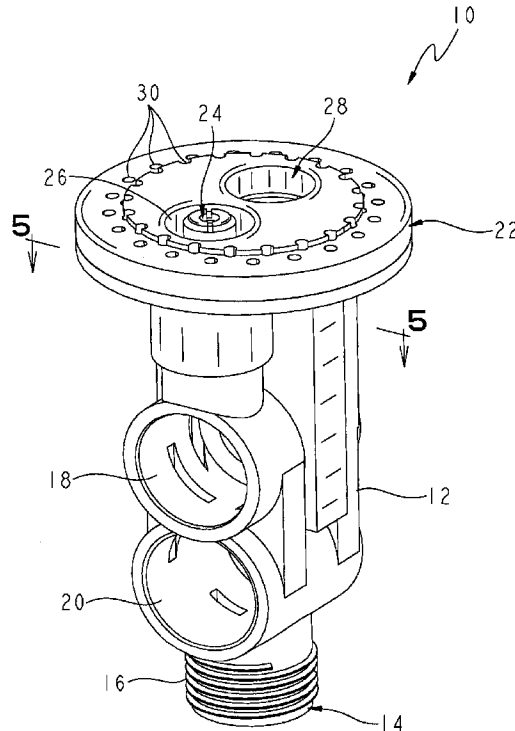




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A spray head for a power sprayer configured to generate a continuous sheet- like water shield around a center stream of water. A water delivery device for use with a sink may produce a stream of water surrounded by a continuous shield of water.

ABSTRACT

A spray head for a power sprayer configured to generate a continuous sheet-like water shield around a center stream of water. A water delivery device for use with a sink may produce a stream of water surrounded by a continuous shield of water.

POWER SPRAYER**BACKGROUND AND SUMMARY OF THE INVENTION**

[0001] The present invention relates to a water delivery device and, more particularly, to a water delivery device for use with a sink and configured to generate a continuous sheet-like water shield around a stream of water.

[0002] According to illustrative embodiment of the present disclosure, a spray head includes a body, and a cartridge assembly received within the body. The cartridge assembly includes an inlet, a first outlet in fluid communication with the inlet and configured to produce a water stream, and a second outlet in fluid communication with the inlet and configured to produce a continuous shield of water extending outwardly in a sheet-like layer around the water stream, the water stream having a substantially laminar flow.

[0003] According to a further illustrative embodiment of the present disclosure, a spray head includes a body having a fluid port, and a mount removably received within the body. The spray head further includes a flow straightening member operably coupled to the mount and in fluid communication with the fluid port. The flow straightening member is configured to assist in removing turbulence from the water. A nozzle is operably coupled to the straightening member and includes an outlet orifice configured to produce a center water stream. A whirl member is operably coupled to the mount and is configured to impart rotational movement to the water, thereby producing a continuous shield of water extending around the center water stream.

[0004] According to yet another illustrative embodiment of the present disclosure, a method of generating a water pattern includes the steps of producing a center water stream having a substantially laminar flow from a first outlet, and producing an outer continuous shield of water extending outwardly in a sheet-like layer around the center water stream.

[0005] According to still a further illustrative embodiment of the present disclosure, a method of generating a water pattern with a water delivery device includes the steps of dividing a supply of water provided to the water delivery device into at least a first portion and a second portion and supplying from the water delivery device a stream of water based on the first portion

and a continuous shield of water based on the second portion. The stream of water has a substantially laminar flow and the continuous shield of water surrounds the stream of water.

[0006] According to still another illustrative embodiment of the present disclosure, a water deliver system for connection to at least one source of water and for mounting to a sink deck is provided. The water delivery system comprises at least one valve adapted to be in communication with the at least one source of water and an output device coupled to the sink deck. The output device includes an internal waterway and a spray head. The internal waterway is in fluid communication with the valve and with the spray head. The spray head includes a first outlet producing a stream of water and a second outlet producing a continuous shield of water surrounding the stream of water.

[0007] Additional features and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of the illustrative embodiment exemplifying the best mode of carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a front perspective view of an illustrative embodiment spray head of the present disclosure;

[0009] Fig. 2 is a rear perspective view of the spray head of Fig. 1;

[0010] Fig. 3 is an exploded perspective view of the spray head of Fig. 1;

[0011] Fig. 4 is an exploded perspective view of the cartridge assembly and outlet member of the spray head of Fig. 1;

[0012] Fig. 5 is a cross-sectional view taken along line 5-5 of Fig. 1;

[0013] Fig. 6 is a top plan view of the whirl member of the cartridge assembly of Fig. 4;

[0014] Fig. 7 is a cross-sectional view of the spray head of Fig. 1;

[0015] Fig. 8 is a detailed cross-sectional view of the cartridge assembly of Fig. 4;

[0016] Fig. 9 is an end perspective view of the spray head of Fig. 1, with a partial cut-away thereof;

- [0017] Fig. 10 is an exploded perspective view of a further illustrative embodiment cartridge assembly of the present disclosure;
- [0018] Fig. 11 is a cross-sectional view of the cartridge assembly of Fig. 10;
- [0019] Fig. 12 is a perspective view with a cut-away thereof of the cartridge assembly of Fig. 10;
- [0020] Fig. 13A is a cross-sectional view of an illustrative flow straightener;
- [0021] Fig. 13B is a perspective view with a cutaway thereof of the flow straightener of Fig. 13A;
- [0022] Fig. 14 is a perspective view of a further illustrative embodiment cartridge assembly;
- [0023] Fig. 15 is a cross-sectional view of the cartridge assembly of Fig. 14;
- [0024] Fig. 16 is an exploded perspective view of the cartridge assembly of Fig. 14;
- [0025] Fig. 17 is a representative view of a further embodiment nozzle;
- [0026] Fig. 18 is a side, schematic view showing an illustrative velocity circle formed by a substantially laminar stream;
- [0027] Fig. 19 is a top, schematic view showing an illustrative velocity circle formed by a substantially laminar stream;
- [0028] Fig. 20 is an exploded perspective view of a further embodiment cartridge assembly;
- [0029] Fig. 21 is a cross-sectional view of the cartridge assembly of Fig. 20;
- [0030] Fig. 22 is a perspective view of an inlet member of the cartridge assembly of Fig. 20;
- [0031] Fig. 23 is a diagrammatic view of an exemplary water delivery system;
- [0032] Fig. 24 is a perspective view of an illustrative embodiment spray head including a further illustrative embodiment cartridge assembly;
- [0033] Fig. 25 is a cross-sectional view taken along line 25-25 of Fig. 24;
- [0034] Fig. 26 is a partially exploded perspective view, with a partial cut-away, of the spray head of Fig. 24;
- [0035] Fig. 27 is a detailed cross-sectional view of Fig. 25;

[0036] Fig. 28 is an exploded perspective view of the cartridge assembly of Fig. 24, with the holder shown in partial cross-section;

[0037] Fig. 29 is a cross-sectional view taken along line 29-29 of Fig. 24;

[0038] Fig. 30 is a cross-sectional view taken along line 30-30 of Fig. 24;

[0039] Fig. 31 is a cross-sectional view of a further illustrative embodiment cartridge assembly; and

[0040] Fig. 32 is a cross-sectional view of a further illustrative embodiment cartridge assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

[0041] Referring initially to Figs. 1-3, a spray head 10 according to an illustrative embodiment of the present invention is shown as including a valve body 12 including an inlet fluid port 14 having a plurality of external threads 16 for coupling with a conventional water supply line (not shown). A valve body 12 includes first and second bores 18 and 20 configured to receive conventional valve control members (not shown) for controlling the flow of water from the inlet fluid port 14 to an outlet member 22. More particularly, the valve control members are configured to direct water from the inlet fluid port 14 to different fluid passageways formed within the valve body 12, which are in fluid communication with a cartridge assembly 24 received within a first opening 26 of the outlet member 22, and aerator nozzle (not shown) received within a second opening 28 of the outlet plate 22, and a plurality of circumferentially disposed openings 30 positioned around the first and second openings 26 and 28.

[0042] Referring now to Figs. 3 and 4, the cartridge assembly 24 includes a holder 32, a whirl member 34, a back reflector 36, a flow straightener 38 and a flow nozzle 40. The holder 32 includes an inner first end having a plurality of external threads 42 to be received within the opening 26 of the valve body 12 and to threadably engage a plurality of internal threads 44 formed therein (Fig. 8). An outer end of the holder 32 includes a plurality of internal threads 46 which threadably engage a plurality of external threads 48 formed on an inner end of the flow straightener 38 (Fig. 8).

[0043] As shown in Fig. 8, the whirl member 34 and back reflector 36 are captured intermediate the flow straightener 38 and holder 32. Referring to Fig. 5, the flow straightener 38 includes a plurality of parallel, longitudinally aligned bores 50 configured to receive fluid from an inlet 52. The bores 50 are configured to assist in removing turbulence from water flowing therethrough, and provide a more linear flow to the water. Flow nozzle 40 includes an inner end having a plurality of internal threads 54 which threadably engage a plurality of internal threads 56 formed within the outer end of the flow straightener 38. Flow nozzle 40 includes a cylindrical outer wall 58 and a substantially planar end wall 60. An outlet orifice 62 is formed within the end wall 60 such that water passing therethrough forms a center water stream 63 (Fig. 7). The orifice 62 includes sharp entry corners 64 (see Fig. 9) to assist in providing a substantially laminar flow. Additionally, the diameter of the orifice 62 is illustratively at least as great as the thickness of the adjacent planar end wall 60 to further assist in providing a substantially laminar flow to the center water stream. A counter bore 66 is formed in the outer surface of the end wall 60 and a diametrically disposed slot 68 is likewise formed in the outer surface. The slot 68 is configured to receive a tool such as a screw driver to assist in inserting and securing the cartridge assembly 24 within the valve body 12. The counter bore 66 provides a recess to prevent potential damaging contact between the tool and the outlet orifice 62.

[0044] A plurality of passageways 70 are formed within the holder 32 and are in fluid communication with the whirl member 34. As shown in Figs. 5 and 6, the whirl member 34 includes an annular body 72 defining a central opening 74 and a plurality of outwardly extending slots 76 which are configured to impart rotational movement to water passing through the annular passageways 70, through the opening 74 intermediate the body 72 and the flow straightener 38, and out through the slot 76. Once the rotational movement is imparted to the water, it passes outwardly due to centrifugal force and contacts an outer cylindrical wall 78 of the back reflector 36. An end wall 79 of the back reflector 36 directs water in a rearward direction through a second annular passageway 80. An end wall 81 formed by the holder and the valve body then redirects the water back in a forward direction and toward a second outlet 82. In other words, the rotating water supplied from the whirl member 34 enters a serpentine passageway that reverses its direction twice as it travels toward the second outlet 82. This redirection of the water in rearward and forward directions assists in making the layer of water substantially uniform. As the water exits the second outlet 82, centrifugal force causes it to define a substantially continuous shield of water 84 having a

sheet-like appearance (Fig. 7). In order to reduce turbulence and assist in providing a continuous sheet of water within the shield 84, the surfaces contacted by the rotating water should be substantially smooth. The shield 84 will typically have a conical or bulb-like shape.

[0045] Turning now to Figs. 10-12, a further illustrative embodiment of the valve cartridge assembly 124 of the present invention is illustrated. The valve cartridge assembly 124 includes a base 126 which threadably receives a shroud 128. Similarly, a shroud shaper 130 threadably receives the shroud 128. A nozzle mount 132 is operably coupled to the base 126 through a conventional fastener, such as a screw 134. A flow straightener 136 is concentrically received within the nozzle mount 132. The flow straightener 136 is secured in position by means of a nozzle body 138 which is threadably received within an outer end of the nozzle mount 132. A nozzle 140 is threadably received within an outer end of the nozzle body 138.

[0046] The nozzle mount 132 and the flow straightener 136 cooperate to assist in removing turbulence from water flowing therethrough. More particularly, the flow straightener 136 includes a plurality of parallel bores 142 (see Fig. 11) configured to cause a substantially linear flow of water therethrough. The nozzle 140 is of a design similar to nozzle 40 detailed herein.

[0047] Referring to Figs. 13A and 13B, an alternative embodiment flow straightener 136' includes an inwardly facing conical surface 143a and an outwardly facing conical surface 143b. The flow straightener 136' may be substituted for flow straightener 136 to facilitate the removal of turbulence from water passing therethrough.

[0048] A whirl member 144 is retained within the base 126 by the nozzle mount 132. The whirl member 144 may be of a design similar to whirl member 34 as detailed herein. As noted above, the whirl member 144 is configured to impart rotational movement to water passing therethrough, wherein the water then extends into an annular passageway 146 and into the shroud shaper 130. Because the water adheres to the inner surface of the outer wall of the shroud shaper 130 it generates a conical or bulb-like continuous shield of water as it exits through outlet 150. As detailed above, the outlet orifice 62 of the nozzle 140 generates a center stream of water disposed within the shield of water.

[0049] Figs. 14-16 show another illustrative embodiment cartridge assembly 224 of the present invention. Cartridge assembly 224 includes a base 226 having an inlet 228. Inlet 228 is illustrated as a separate component coupled to base 226. However, inlet 228 may be integrally

formed as a part of base 226. A nozzle 230 is threadably received within the base 226 and includes a center first outlet 232 and an annular second outlet 234 disposed concentrically around the first outlet 232. A conical member 236 is supported concentrically around the center first outlet and provides a Coanda effect surface 238. More particularly, water passing through the inlet 228 to the center first outlet 232 generates a water stream which is illustrated as centrally located. Water passing through passageways 233 in nozzle 230 and onto the annular second outlet 234 contacts the Coanda effect surface 238 of the conical member 236. A Coanda effect results in adhesion of the water to the surface 238 by surface tension, such that the water passing beyond the conical member 236 produces a substantially continuous shield of water in a sheet-like manner around the center water stream.

[0050] Fig. 17 illustrates an alternative embodiment for producing a substantially laminar flow through the outlet orifice 62 of a nozzle 40'. In this embodiment, instead of a substantially planar end wall 60, the end wall 60' includes a conical surface directing water to the outlet orifice 62.

[0051] It should be appreciated that the substantially laminar flow of the center stream 63 reduces splashing or misting in response to water contacting a surface 280. Additionally, the water shield 84 protects against splash, mist and dislodged debris when using a power spray to clean surfaces, such as dishes, sink, etc. It is also possible to replace the continuous water shield with an aerated shield.

[0052] As discussed herein, the various illustrated embodiments provide a central flow of water having a generally laminar stream, such as stream 63 in Fig. 7, and a continuous shield of water, such as shield 83 in Fig. 7, surrounding the central flow of water. The continuous shield of water may also surround a flow of water, central or offset, having a substantially non-laminar stream.

[0053] Referring to Figs. 18 and 19, substantially laminar stream 63 is surrounded by shield 84, which essentially acts as a splash barrier. As substantially laminar stream 63 impacts surface 280 (such as a surface of a dish), fluid follows surface 280 in a direction radially outwardly from the center axis of stream 63. More particularly, the substantially laminar characteristics of stream 63 and the Coanda effect causes the fluid to generate a velocity zone 282, substantially circular, which extends outwardly to mix with fluid from shield 84 impacting surface 280. When

substantially laminar stream 63 contacts surface 280, it creates a substantially circular zone 282 (illustratively about 1 inch in diameter) that is of a high pressure and flows parallel to surface 280. Water flow within zone 282 thus tends to strip particles from surface 280 to facilitate cleaning, similar to a mechanical scraping. Further, fluid from stream 63 and from shield 84 combine to form a turbulent flow which also facilitates cleaning of surface 280.

[0054] Referring to Figs. 20-22 a further embodiment cartridge assembly 316 is shown. Cartridge assembly 316 may be received in valve body 12 and includes a holder 318, an inlet member 320, a flow straightener 322, and an outlet member 324. As explained herein outlet member 324 provides a substantially laminar flow of water. Surface 304 of holder 318 cooperate with valve body 12 to couple cartridge assembly 316 to valve body 12. In one embodiment, a coupler, such as a fastener, is received in opening 308 to couple holder 318 to valve body 12. In one embodiment, surface 304 is threaded and is threadably engaged with valve body 12 to permit removal of valve cartridge 316 from valve body 12. A seal (not shown) is carried in a recess 302 of holder to provide a fluid tight seal between valve body 12 and a periphery of holder 318.

[0055] Holder 318 includes an inlet 306 which is in fluid communication with the internal fluid passageways of valve body 12. Illustratively inlet 306 includes three elongated orifices 310A-C. Inlet 306 may have fewer or more orifices. Referring to Fig. 21, orifices 310A-C (310A illustrated) are generally aligned with passageways 330A-C formed by the cooperation of inlet member 320 and flow straightener 322. Orifices 310A-C are in fluid communication with a region 312 in holder 318 between holder 318 and inlet member 320.

[0056] Inlet member 320 is coupled to holder 318. In one embodiment surface 332 of inlet member 320 and surface 334 of holder 318 are each threaded. In one embodiment, surfaces 332 and 334 are sized such that holder 318 and inlet member 320 may be sonically welded together. An angled surface 336 of inlet member 320 and an angled surface 338 of holder 318 cooperate to assist in sealing the periphery of inlet member 320 relative to holder 318.

[0057] Surfaces 348 (illustratively three surfaces) of flow straightener 322 and surfaces 348 (illustratively three surfaces) of inlet member 320 are sized such that flow straightener 322 may be sonically welded to inlet member 320. In one embodiment, flow straightener 322 is coupled to inlet member 320 by other suitable means, such as threads.

[0058] Referring to Fig. 22, inlet member 320 includes a plurality of slot 340 are in fluid communication with passageways 330 and which impart a rotational movement to the water to assist in the formation of the continuous shield of water, as explained below. The central portion of inlet member 320 receives a body portion 321 of flow straightener 322. A lower portion 342 of inlet member 320 which contains slots 340 is received within an opening 344 of flow straightener 322 between body portion 321 and a deflector portion 374 of flow straightener 322.

[0059] Outlet member 324 includes a recess 350 which is in fluid communication with fluid passages 352 in flow straightener 322. Recess 350 terminates in an outlet orifice 354. Outlet member 324 includes a raised portion 356 which cooperates with a surface 358 of flow straightener 322 to permit outlet member 324 to be sonically welded to flow straightener 322. In one embodiment, flow straightener 322 is coupled to outlet member 324 by other suitable means, such as threads.

[0060] In operation, water enters valve cartridge 316 through orifices 310A-C. As explained herein, a first portion of the water entering valve cartridge 316 exits as a stream of water, similar to stream 63, and a second portion of the water entering valve cartridge 316 exits as a continuous shield of water, similar to shield 84.

[0061] Body portion 321 of flow straightener 322 includes a plurality of passageways 352. Illustratively passageways 352 are a plurality of parallel, longitudinally aligned bores (see 352A in Fig. 21) which are configured to assist in removing turbulence from fluid flowing there through, and provide a more linear flow to the fluid. Water passing through passageways 352 is communicated to an internal waterway 360 in flow straightener 322 and onto recess 350 in outlet member 324. Recess 350 includes a cylindrical outer wall 362 and a tapered or conical inner wall 364. Conical inner wall 364 abuts a substantially planar end wall 366 defining outlet orifice 354, such that water passing there through forms a center water stream similar to stream 63. Orifice 354 includes sharp entry corners 368 to assist in providing a substantially laminar flow to the outlet stream. In one embodiment, the outlet stream has a substantially laminar flow.

[0062] A continuous shield of water is formed by water that enters passageways 330A-C formed by inlet member 320 and flow straightener 322. Passageways 330A-C are in fluid communication with slots 340 positioned at a lower end of inlet member 320. Slots 340 and a lower surface 370 of flow straightener 322 change the direction of flow of the water and impart

rotational movement to the water passing there through. Once the rotational movement is imparted to the water, it moves outwardly to a side wall 372 of deflector member 374 of flow straightener 322 and is directed backwards in direction 376. The water continues generally in direction 376 until it is redirected forward again in direction 378 by surface 380 of inlet member 320. The water travels generally in direction 378 toward a shield outlet 382.

[0063] As the fluid moves toward shield outlet 382, centrifugal force causes it to follow an inner surface 384 of holder 318. Due to the well-known Coanda effect, where fluid flowing along a solid surface which is curved slightly from the stream tends to follow the surface, the fluid defines a substantially continuous shield of fluid, generally similar to shield 84 having a sheet-like appearance. As shown in Fig. 21, inner surface 384 illustratively includes a flared or angled portion extending toward shield outlet 382. In order to reduce turbulence and to assist in providing a continuous sheet of water within the shield, inner surface 384 contacted by the rotating fluid should be substantially smooth.

[0064] The flared portion of surface 384 assists in shaping the appearance of the continuous sheet of water. The flared portion causes the appearance of the continuous sheet of water to be more conical and less spherical.

[0065] As illustrated in Fig. 23, the spray heads and valve cartridges discussed herein may be used as part of a water delivery system 400 for use with a sink 402 having a drain 401 or other device, residential or commercial, associated with a drain. Sink 402 is shown being coupled to a countertop 404. The countertop 404 and a top portion of the sink 402 are collectively referred to as the sink deck. Water delivery system 400 is coupled to a source of hot water 406 and a source of cold water 408. Water from the source of hot water 406 and source of cold water 408 are provided to one or more valves 410 which may be adjusted to regulate the flow of water there through.

[0066] In one embodiment, the source of hot water 406 and the source of cold water 408 are both in fluid communication with a single mixing valve which regulates the flow rate of water from each source 406, 408 which is to be provided to an output device 412, if any depending on the water characteristics desired. For instance, only hot water may be desired so the valve would only pass water from the source of hot water 406. In another embodiment, the source of hot water 406 and the source of cold water 408 are each in fluid communication with a respective

valve; each valve regulating the flow of water to be provided to the output device 412 from the respective source of water in fluid communication with the valve. Valve 410 may be positioned above the sink deck or below the sink deck.

[0067] The control of valve 410 is through one or more input devices 414. Exemplary input devices 414 include both mechanical input devices, such as handles, and electronic input devices, such as a touch sensor or an infrared sensor, which provide an indication to a controller of the water characteristics desired. In one example, the controller adjusts valve 410 through a motor coupled to valve.

[0068] Exemplary output devices 412 include a spout having a spray head coupled thereto. The spout may be rigid or may have a flexible portion. In one embodiment, spray head is a swivel head attached to the end of a spout base member. In one embodiment, spray head is a pull out wand which is attached to a spout base member. The pull out wand having a first position generally coupled to spout base member and a second position wherein the wand is spaced apart from the spout base member and connected thereto through a waterway connecting the two. Another exemplary output device is a side spray. In one embodiment, spray head is incorporated into a side spray which may be coupled to the sink deck and is in fluid communication with valve 410. In one example side spray is in fluid communication with valve 410 independent of a spout. In one embodiment, spray head may be used with any type of water delivery device which is coupled to a sink deck and used in combination with a sink 402.

[0069] In one embodiment, water delivery system 400 is associated with a bathtub, a shower, or other receptacle having an associated drain, such as drain 401 associated with sink 402 in Fig. 23. As such, the spray heads and/or valve cartridges disclosed herein may be used to provide a continuous shield surrounding a stream of water as part of a tub filler, a showerhead, and/or a body spray.

[0070] In one example, using the continuous shield and stream combination may reduce the amount of steam produced in a shower setting. In effect, a portion of air may be trapped between the stream and the continuous shield. As such, steam generated from the stream is generally trapped inside the shield thereby limiting the humidity in the bathroom.

[0071] In one embodiment, the spray heads and/or valve cartridges disclosed herein may be configured to include multiple streams of water surrounded by the continuous stream. Each

stream may have a substantially laminar flow or a non-laminar flow. In one embodiment, the spray heads and/or valve cartridges disclosed herein may be configured to include multiple continuous shields of water. In one embodiment, the spray heads and/or valve cartridges disclosed herein may be configured to include one or more streams of the water, each stream having one of a substantially laminar flow or a non-laminar flow, and one or more continuous shields of water surrounding the one or more streams of water.

[0072] In one embodiment, the inlet to the water passage to generate the stream of water and the inlet to the water passage to generate the shield of water are independent of each other, such that water may be presented to only the water passage to generate the stream of water, to only the water passage to generate the shield of water, or to both the water passage to generate the shield of water and the water passage to generate the stream of water. The water delivery system 400 may include separate water conduits from valve 410 connecting to the water passage to generate the stream of water and the water passage to generate the shield of water. As such, a user may select with input device 414 to generate a stream of water only, to generate a shield of water only, or to generate a combination of a stream of water and a continuous shield of water. In one example, the water shield only mode may be used for a rinsing application.

[0073] In one embodiment, the continuous shield of water has a generally football shaped appearance. In one embodiment, the shape of the continuous shield of water is influenced by the pressure of the water. At standard pressures for residential applications, the shape of the continuous shield is generally a half of a football or generally conical. At lower pressures the shape of the continuous shield is generally football shaped. As such, the pressure related to the water in the continuous shield may be chosen to select an aesthetically pleasing appearance. In one example, the pressure is chosen such that the appearance of the water shield provides a bubble around a stream of water. The shape of the continuous shield may also be influenced by the temperature of the water.

[0074] With reference now to Figs. 24-27, an illustrative embodiment spray head 510 is shown as including a further illustrative spray cartridge assembly 524. In the following description, many components are similar to those identified above in connection with other illustrative embodiment spray heads. As such, similar components will be identified with like reference numbers.

[0075] Illustratively, the spray head 510 includes a valve body 512 supporting a fluid inlet port 514 for coupling to a conventional water supply line (not shown). The valve body 512 may be received within an outer shell 516 and may also support a user interface 518 to control water flow through the water inlet port 514 to a plurality of different water outlet openings 526, 528, 530. For example, the user interface 518 may include a push button 532 configured to cause water to flow from the inlet port 514 through the valve cartridge assembly 524 received within the outlet opening 526, in a manner further detailed herein. The illustrative user interface 518 may further include a toggle switch 534 configured to cause water to flow from the inlet port 514 alternatively between spray nozzles 536 received within the outlet openings 528, and a conventional aerator 538 received within the outlet opening 530.

[0076] With reference now to Figs. 25-28, illustrative valve cartridge assembly 524 is supported by the body 512 and includes a holder 540, an inlet member or retainer 542, a flow straightener or nozzle 544, an outlet member or housing 546 and an o-ring 548. The nozzle 544 is received within the outlet housing 546 and retained therein by the inlet retainer 542. More particularly, the outlet housing 546 couples with the inlet retainer 542 which, in turn, couples with the holder 540.

[0077] As shown in FIGS. 27 and 28, the holder 540 illustratively includes a body 550 defining outlet openings 526, 528 and 530 supporting valve cartridge assembly 524, spray nozzles 536 and aerator 538, respectively. Retaining tabs 552 are illustratively supported by the body 550 within the outlet opening 526 and couple with the inlet retainer 542. More particularly, the inlet retainer 542 includes a first or inlet coupler 554 including a pair of openings 556 configured to receive a pair of retaining tabs 552 supported by the holder 540 within the outlet opening 526. A second or outlet coupler 558 of the inlet retainer 542 is configured to couple with a coupler 560 of the outlet housing 546. The second coupler 558 illustratively comprises external threads 562 supported by a cylindrical sidewall 564 defining a fluid passageway 566 (FIG. 27). The coupler 560 of the outlet housing 546 illustratively comprises internal threads 568 supported by a cylindrical sidewall 570 of the outlet housing 546.

[0078] The sidewall 570 of the outlet housing 546 defines a receiving passageway or cavity 572 receiving the nozzle 544 defining a fluid passageway 574 in fluid communication with the fluid passageway 566 of the inlet retainer 542. The external threads 562 of the inlet retainer 542

threadably engage with the internal threads 568 of the outlet housing 546 to retain the nozzle 544 within the passageway 572.

[0079] An inlet, illustratively a plurality of inlet openings 576 are defined by the inlet coupler 554 of the inlet retainer 542 and are in fluid communication with the fluid passageway 566. A rearwardly extending post 578 is configured to engage a valve, such as a flow restrictor 580, to prevent axial movement thereof in response to water pressure (FIG. 25). As further detailed herein, the flow restrictor 580 is configured to maintain consistent performance of the valve cartridge assembly 524 despite varying water pressure (e.g., 20 psi to 60 psi).

[0080] With reference to FIGS. 26-30, a whirl member 582 is illustratively supported by the holder 540 and is in fluid communication with the inlet retainer 542. The whirl member 582 includes a cylindrical sidewall 584 having a plurality of angled slots 586. As shown in FIG. 29, the angled slots 586 are generally tangential to an inner surface of the sidewall 584 for imparting a rotational movement to the water and thereby assisting in the formation of the continuous shield of water, as further detailed herein.

[0081] With reference to FIGS. 27, 28 and 30, the nozzle 544 includes a cylindrical sidewall 588 extending between an inlet end 590 and an outlet end 592. The sidewall 588 includes an inner surface 594 and an outer surface 596. An end tip 598 is defined at the outlet end 592 and includes a recessed portion 600 configured to receive the o-ring 548. The o-ring 548 is received between the outer surface 596 of the nozzle 544 and an inner surface 602 of the outlet housing 546, thereby preventing water from leaking and disrupting a laminar stream 63 at the outlet end 592. The fluid passageway 574 is defined by the inner surface 594 of the sidewall 588 and extends from the inlet end 590 to the outlet end 592. The inner surface 594 illustratively includes a stair-step geometry such that the passageway 574 tapers inwardly as it extends from the inlet end 590 toward the outlet end 592, thereby promoting laminar water flow. More particularly, the inner surface 594 includes a plurality of stepped portions 604a, 604b, 604c, 604d of decreasing inner diameters (FIG. 27).

[0082] With reference to FIGS. 26, 27 and 30, the end tip 598 of the outlet end 592 of the nozzle 544 includes an end wall 606 including sharp edges or corners 608 to define a first outlet 610. The first outlet 610 is configured to produce a central water stream 63. While a single first outlet 610 is illustrated, it should be appreciated that a plurality of first outlets 610 may be

provided to produce a plurality of separate central water streams 63. Each water stream 63 includes a velocity circle, wherein multiple water streams 63 should be separated to prevent colliding of the velocity circles of the water streams 63 and potential splashing. A plurality of ribs 612 are supported at the inlet end 590 of the nozzle 544 and are configured to facilitate a press fit or friction fit with the inner surface 602 of the outlet housing 546.

[0083] As shown in FIGS. 27, 28 and 30, the cylindrical sidewall 570 of the outlet housing 546 illustratively extends from an inlet end 616 to an outlet end 618. An end wall 620 is formed at the outlet end 618 wherein the end tip 598 of the nozzle 544 is configured to engage or abut the end wall 620. The first outlet 610 is recessed axially toward the inlet end 616 of the outlet housing 546, thereby protecting the corners 608 of the nozzle end tip 598 from damage (for example, by dropping the spray head 510 into the sink or by aggressive cleaning).

[0084] The illustrative outlet housing 546 includes an annular flange 622 supported by the sidewall 570 by a connecting wall 624, thereby defining an annular groove 625. The annular groove 625 concentrically receives the sidewall 584 of the whirl member 582 to define a serpentine flow path 626 as water flows out of the slots 586 and downstream to a second outlet 628. More particularly, the outlet opening 526 of the holder 540 includes a radially inwardly facing fluid contact surface 630 defining the second outlet 628, which surrounds the first outlet 610. The fluid contact surface 630 is flared radially outwardly as it extends axially downstream (i.e., in a direction from the inlet end 616 toward the outlet end 618).

[0085] As further detailed herein, as the water (represented by arrows 632 in FIG. 30) exits the whirl member 582, it moves radially outwardly and axially toward the outlet end 618, reverses course axially back toward the inlet end 616, and reverses course axially again toward the outlet end 618. This serpentine path is configured to decrease turbulence in the water moving toward the second outlet 628 and provide a substantially laminar water flow to the fluid contact surface 630. Water from the whirl member 582 is configured to be directed toward the fluid contact surface 630 due to centrifugal force, and produce from the second outlet 628 a continuous shield of water 84 extending outwardly from the spray head 510 in a sheet-like layer around the central water stream 63 discharged from the first outlet 610 of the nozzle 544 and spaced apart therefrom (FIG. 30). As noted above, a plurality of spaced apart central water

streams 63 may be generated by a plurality of first outlets 610 and surrounded by the continuous shield of water 84 generated by the second outlet 628.

[0086] As noted above, the flow restrictor 580 is configured to maintain consistent performance of the valve cartridge assembly 524 with varying water pressure. More particularly, the flow restrictor 580 allows the central water stream from the first outlet 610 and the continuous water shield from the second outlet 628 to remain relatively the same through the duration of different water pressures (e.g., 20 psi to 60 psi). In other words, the force of the central water stream 63 and the size of the continuous water shield 84 do not significantly change through the range of water pressures.

[0087] In this illustrative embodiment, the nozzle 544 is positioned inside the outlet housing 546 to protect the sharp edges 608 of the end tip 598 from being damaged. If the edges 608 of the nozzle 544 are damaged, the central water stream 63 discharged from the first outlet 610 may not be laminar. The arrangement of the nozzle 544 and outlet housing 546 also facilitates manufacturing independently from the rest of the valve cartridge assembly 524 (moldability, material selection, accuracy of edges, etc.), and facilitates replacement through a threaded connection between the inlet retainer 542 and the outlet housing 546. The stair-step geometry inside the nozzle 544 facilitates stream straightening to provide for laminar flow of the stream 63 discharged out of the first outlet(s) 610 of the nozzle 544.

[0088] FIG. 31 is a cross-sectional view of a further illustrative cartridge assembly 224' for generating a continuous water shield 84'' around center water 63. Cartridge assembly 224' is illustratively substantially similar to cartridge assembly 224 as detailed above in connection with FIGS. 14-16. More particularly, cartridge assembly 224' includes nozzle 230 having center first outlet 232 and annular second outlet 234 disposed concentrically around the first outlet 232 and defined by an outer wall 634 of holder 540'. Conical member 236 is supported concentrically around the center first outlet 232 and provides Coanda effect surface 238. Water passing through the center first outlet 232 generates water stream 63 which is illustrated as being centrally located. Water passing into the annular second outlet 234 contacts the Coanda effect surface 238 of the conical member 236. A Coanda effect results in adhesion of the water to the surface 238 by surface tension, such that the water passing beyond the conical member 236 produces a

substantially continuous shield of water 84' in a sheet-like manner around the center water stream 63.

[0089] FIG. 32 is a cross-sectional view of a further illustrative cartridge assembly 224'' for generating a continuous water shield 84'' around the center water stream 63. Cartridge assembly 224'' includes nozzle 244' including first outlet 610 and annular second outlet 526' disposed concentrically around the first outlet 610 and defined by outer wall 634 of holder 540'. The nozzle 244' is illustratively received within outlet housing 546'. A deflector 636 includes an outwardly flared portion 638 that illustratively defines a Coanda effect surface 640. Water passing beyond the flared portion 638 produces a substantially continuous shield of water 84'' in a sheet-like manner around the center water stream 63. In the illustrated embodiment, the deflector 636 is defined by an intermediate wall positioned between the nozzle 244' and the outer wall 634. Alternatively, the deflector 636, including flared portion 638, may be formed integral with the outlet housing 546'.

[0090] Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope of the invention as described and defined in the following claims.

CLAIMS:

1. A spray head for use with a water delivery system comprising:
a body including a fluid inlet port configured to be coupled to a water supply; and
a cartridge received within the body, the cartridge including:
an inlet in fluid communication with the fluid inlet port;
a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the inlet and configured to produce from the spray head a water stream, the first outlet positioned downstream from the inlet;
a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the inlet, the second outlet positioned downstream from the inlet;
an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle, the end wall defining an opening co-axially aligned with the first outlet; wherein water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;
wherein the second outlet has a flared surface which shapes the continuous shield of water to be conical; and wherein the second outlet is continuous and surrounds the first outlet.
2. The spray head of claim 1, wherein the water stream produced by the first outlet has a substantially laminar flow.
3. The spray head of claim 1, wherein: the first outlet defines a longitudinal axis; and the fluid contact surface faces inwardly toward the longitudinal axis.
4. The spray head of claim 1, wherein the first outlet of the nozzle is fixed relative to the end wall of the outlet housing.

5. A spray head for use with a water delivery system comprising:
 - a body including a fluid inlet port configured to be coupled to a water supply; and
 - a cartridge received within the body, the cartridge including:
 - an inlet in fluid communication with the fluid inlet port;
 - a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the inlet and configured to produce from the spray head a water stream, the first outlet positioned downstream from the inlet;
 - a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the inlet, the second outlet positioned downstream from the inlet; and
 - an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle;
 - wherein water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;
 - a whirl member configured to impart rotational movement to water passing from the inlet to the second outlet, the cartridge being configured to decrease turbulence in water moving toward the second outlet and provide a substantially uniform water flow to the fluid contact surface;
 - wherein the whirl member includes an annular body having a plurality of slots formed therein to rotate water outwardly about a longitudinal axis of the first outlet;
 - wherein the outlet housing includes a cylindrical flange concentrically positioned radially outwardly from the side wall, and a rearwardly facing annular groove receiving the whirl member to define a serpentine water flow path.
6. The spray head of claim 5, wherein the second outlet has a flared surface which shapes the continuous shield of water to be conical.
 7. The spray head of claim 6, wherein the second outlet is continuous and surrounds the first outlet.

8. A spray head for use with a water delivery system comprising:
 - a body including a fluid inlet port configured to be coupled to a water supply; and
 - a cartridge received within the body, the cartridge including:
 - an inlet in fluid communication with the fluid inlet port;
 - a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the inlet and configured to produce from the spray head a water stream, the first outlet positioned downstream from the inlet;
 - a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the inlet, the second outlet positioned downstream from the inlet; and
 - an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle; wherein water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;
 - wherein the end tip of the nozzle abuts the end wall of the outlet housing;
 - wherein the end tip includes a recess and an o-ring is received within the recess to provide a seal between the nozzle and the outlet housing.
9. The spray head of claim 8, further comprising a retainer defining the inlet and securing the nozzle within the housing.
10. The spray head of claim 9, further comprising a holder received within the body and defining the cavity.
11. The spray head of claim 9, further comprising a support post extending rearwardly from the retainer and configured to engage a valve.

12. A spray head for use with a water delivery system comprising:
a body including a fluid inlet port configured to be coupled to a water supply; and
a cartridge received within the body, the cartridge including:
an inlet in fluid communication with the fluid inlet port;
a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the inlet and configured to produce from the spray head a water stream, the first outlet positioned downstream from the inlet;
a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the inlet, the second outlet positioned downstream from the inlet; and
an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle;
wherein water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;
wherein the end tip of the nozzle abuts the end wall of the outlet housing;
wherein the nozzle includes a plurality of circumferentially spaced ribs supported on the side wall, and configured to frictionally engage an inner surface of the outlet housing.

13. A spray head for use with a water delivery system comprising:
a body including a fluid inlet port configured to be coupled to a water supply; and
a cartridge received within the body, the cartridge including:
an inlet in fluid communication with the fluid inlet port;
a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the inlet, the first outlet positioned downstream from the inlet;
a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the inlet, the second outlet positioned downstream from the inlet; and an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream

from the first outlet of the nozzle, the end wall defining an opening co-axially aligned with the first outlet;

wherein the end tip of the nozzle abuts the end wall of the outlet housing; and the first outlet of the nozzle is fixed relative to the end wall of the outlet housing, and has a diameter less than a diameter of the opening defined by the end wall;

wherein the first outlet is configured to produce from the spray head a water stream; wherein water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream; and

a whirl member configured to impart rotational movement to water passing from the inlet to the second outlet, the cartridge being configured to decrease turbulence in water moving toward the second outlet and provide a substantially uniform water flow to the fluid contact surface.

14. The spray head of claim 13, wherein the whirl member includes an annular body having a plurality of slots formed therein to rotate water outwardly about a longitudinal axis of the first outlet.

15. The spray head of claim 14, wherein the outlet housing includes a cylindrical flange concentrically positioned radially outwardly from the side wall, and a rearwardly facing annular groove receiving the whirl member to define a serpentine water flow path.

16. The spray head of claim 13, further comprising a retainer defining the inlet and securing the nozzle within the housing.

17. The spray head of claim 16, further comprising a holder received within the body and defining the cavity.

18. A spray head comprising:
a water inlet;

a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the water inlet and configured to produce a water stream;

a holder defining a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the water inlet, wherein the water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;

an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle, wherein the end tip of the nozzle abuts the end wall of the housing; and

a retainer defining the inlet and securing the nozzle within the housing.

19. The spray head of claim 18, further comprising a whirl member configured to impart rotational movement to water passing from the inlet to the second outlet, the whirl member configured to decrease turbulence in water moving toward the second outlet and provide a substantially uniform water flow to the fluid contact surface.

20. The spray head of claim 19, wherein the whirl member includes an annular body having a plurality of slots formed therein to rotate water outwardly about a longitudinal axis of the first outlet.

21. The spray head of claim 18, wherein the water stream produced by the first outlet has a substantially laminar flow.

22. The spray head of claim 18, wherein the second outlet has a flared surface which shapes the continuous shield of water to be conical.

23. The spray head of claim 18, wherein the second outlet is continuous and surrounds the first outlet.

24. The spray head of claim 18, wherein the outlet housing includes a cylindrical flange concentrically positioned radially outwardly from the side wall, and a rearwardly facing annular groove receiving the whirl member to define a serpentine water flow path.

25. The spray head of claim 18, wherein the end tip includes a recess and an o-ring is received within the recess to provide a seal between the nozzle and the outlet housing.

26. A spray head comprising:
a water inlet;
a nozzle having a side wall and an end tip defining a first outlet in fluid communication with the water inlet and configured to produce a water stream;
a holder defining a cavity receiving the nozzle and having a second outlet with a fluid contact surface and in fluid communication with the water inlet, wherein the water from the second outlet is configured to produce a continuous shield of water extending outwardly from the spray head in a sheet-like layer around the water stream and spaced apart from the water stream;
an outlet housing including a side wall positioned radially intermediate the nozzle and the fluid contact surface, and an end wall positioned downstream from the first outlet of the nozzle, wherein the end tip of the nozzle abuts the end wall of the housing; and
wherein the fluid contact surface is flared outwardly, is continuous and surrounds the first outlet.

27. The spray head of claim 26, further comprising a retainer defining the inlet and securing the nozzle within the housing.

28. The spray head of claim 26, further comprising a whirl member configured to impart rotational movement to water passing from the inlet to the second outlet, the whirl member configured to decrease turbulence in water moving toward the second outlet and provide a substantially uniform water flow to the fluid contact surface.

29. The spray head of claim 28, wherein the whirl member includes an annular body having a plurality of slots formed therein to rotate water outwardly about a longitudinal axis of the first outlet.

30. The spray head of claim 26, wherein the outlet housing includes a cylindrical flange concentrically positioned radially outwardly from the side wall, and a rearwardly facing annular groove receiving the whirl member to define a serpentine water flow path.

31. The spray head of claim 26, wherein the end tip includes a recess and an o-ring is received within the recess to provide a seal between the nozzle and the outlet housing.

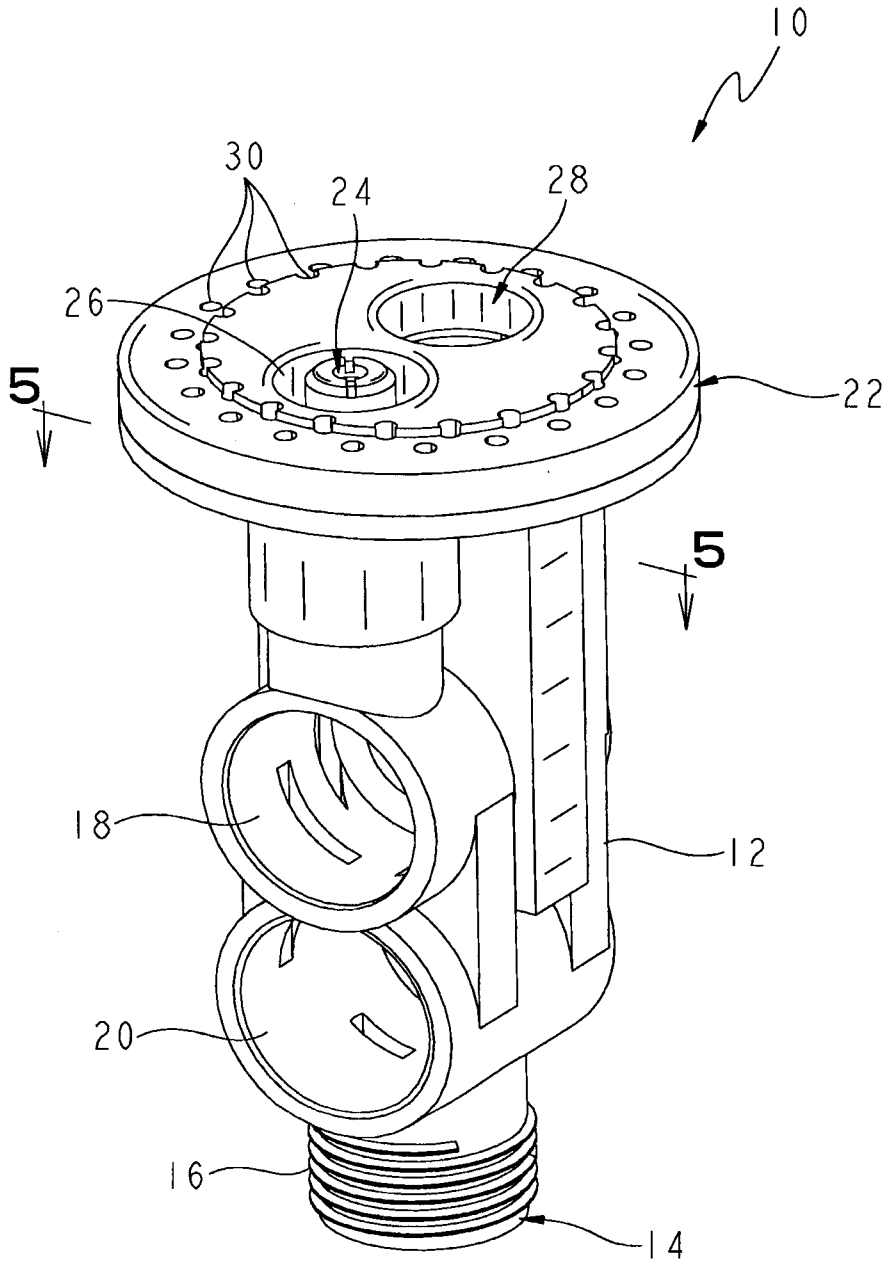


FIG. 1

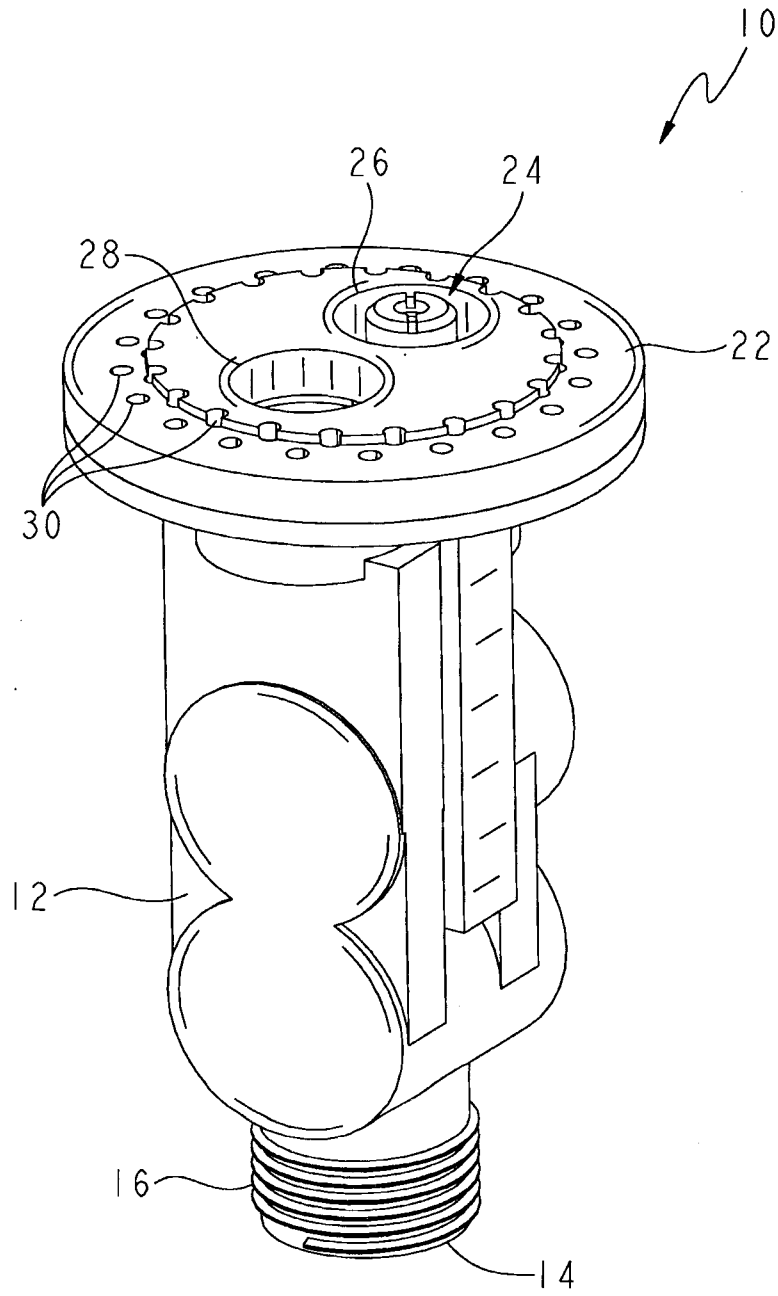


FIG. 2

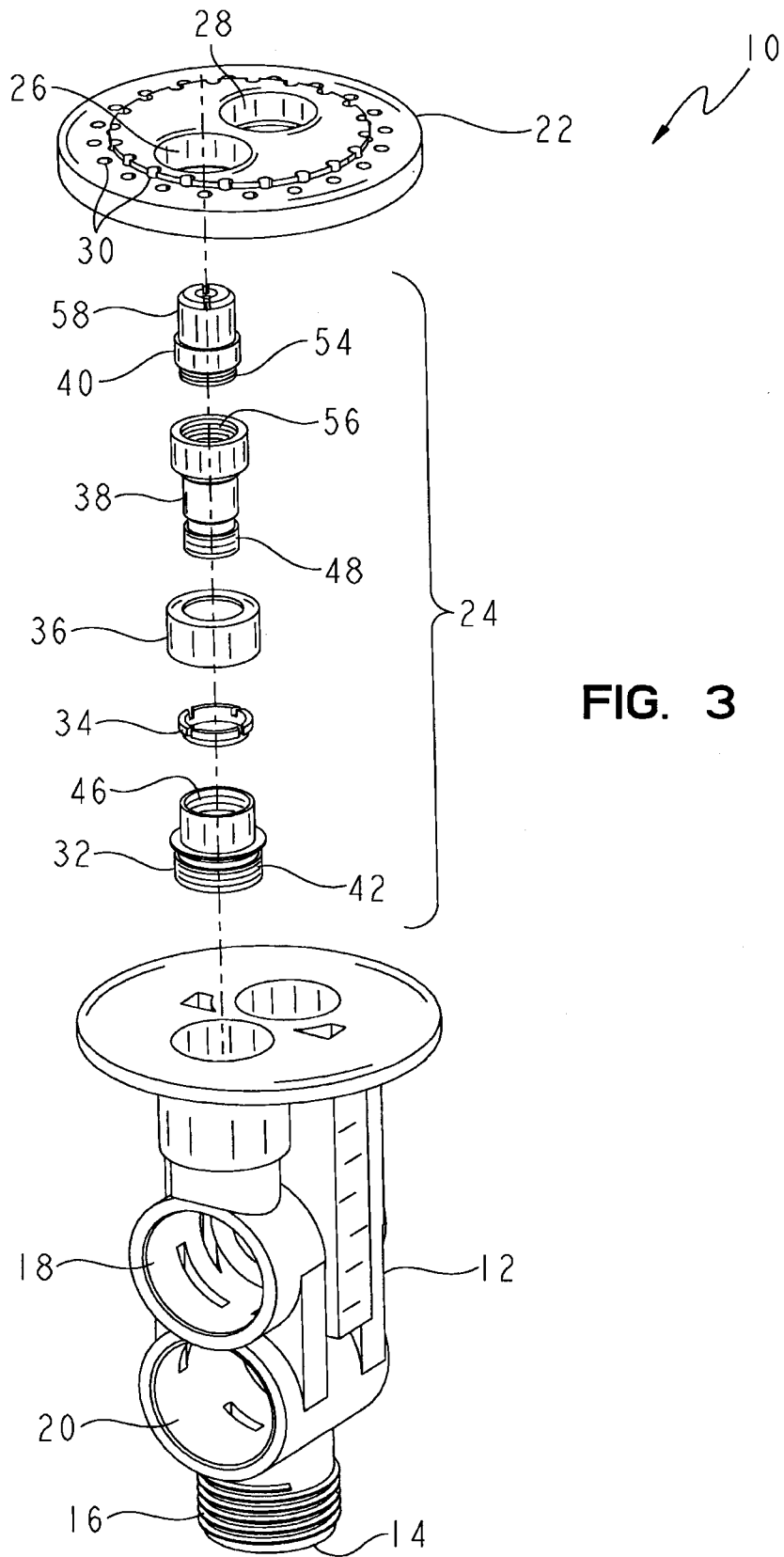


FIG. 3

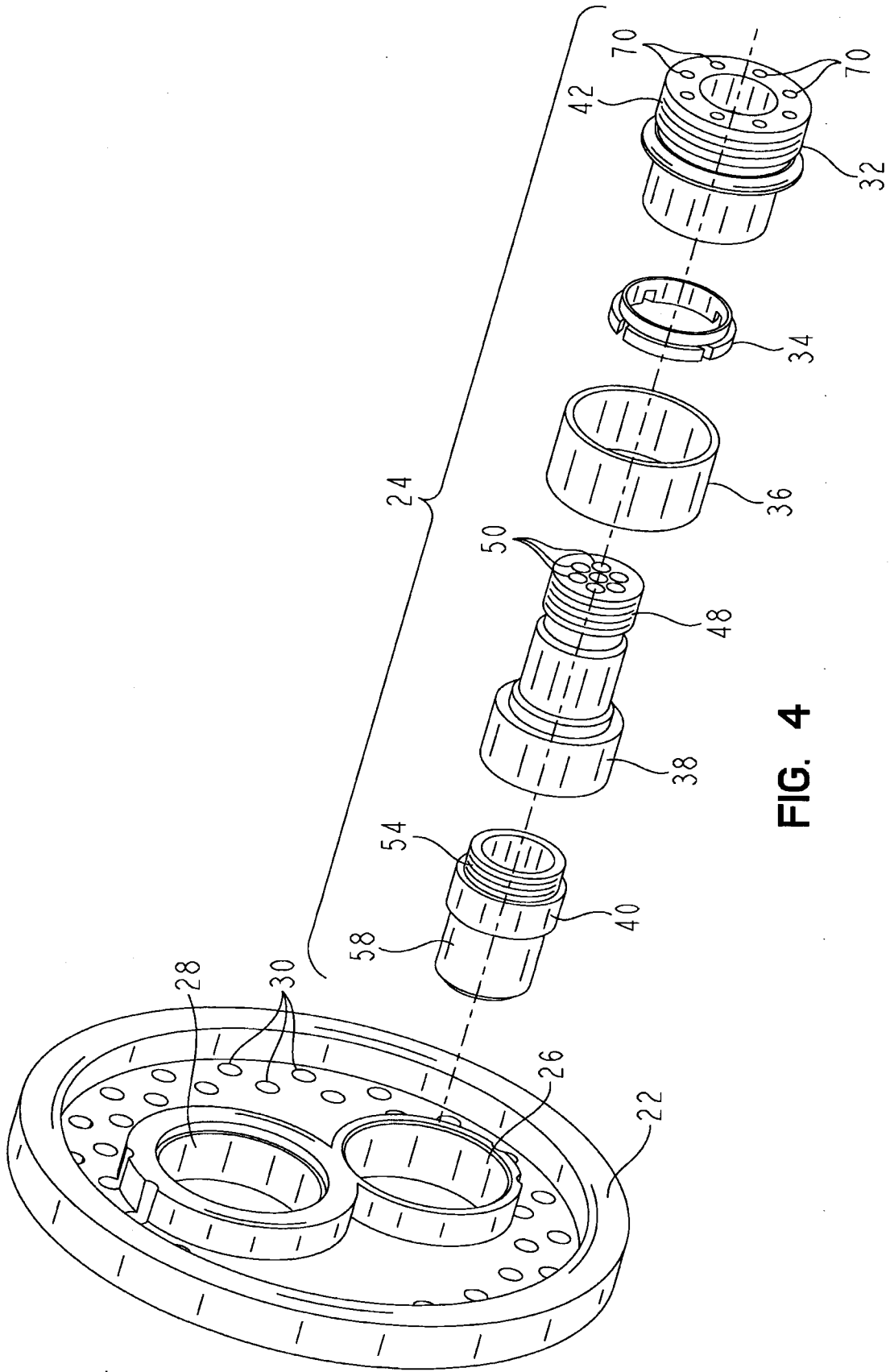


FIG. 4

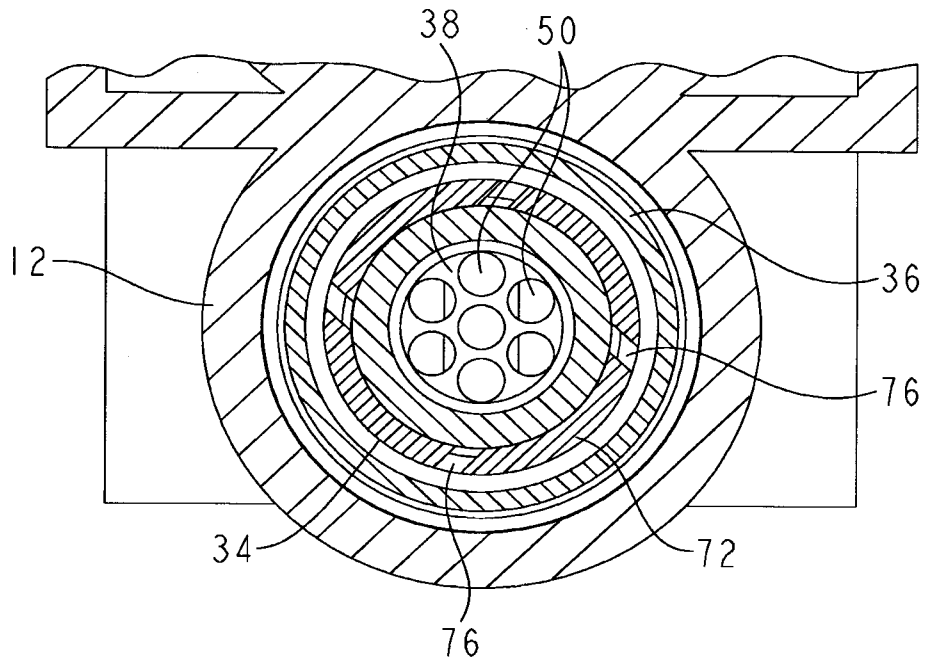


FIG. 5

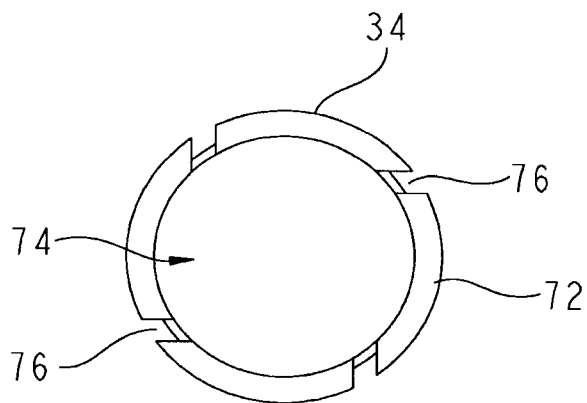


FIG. 6

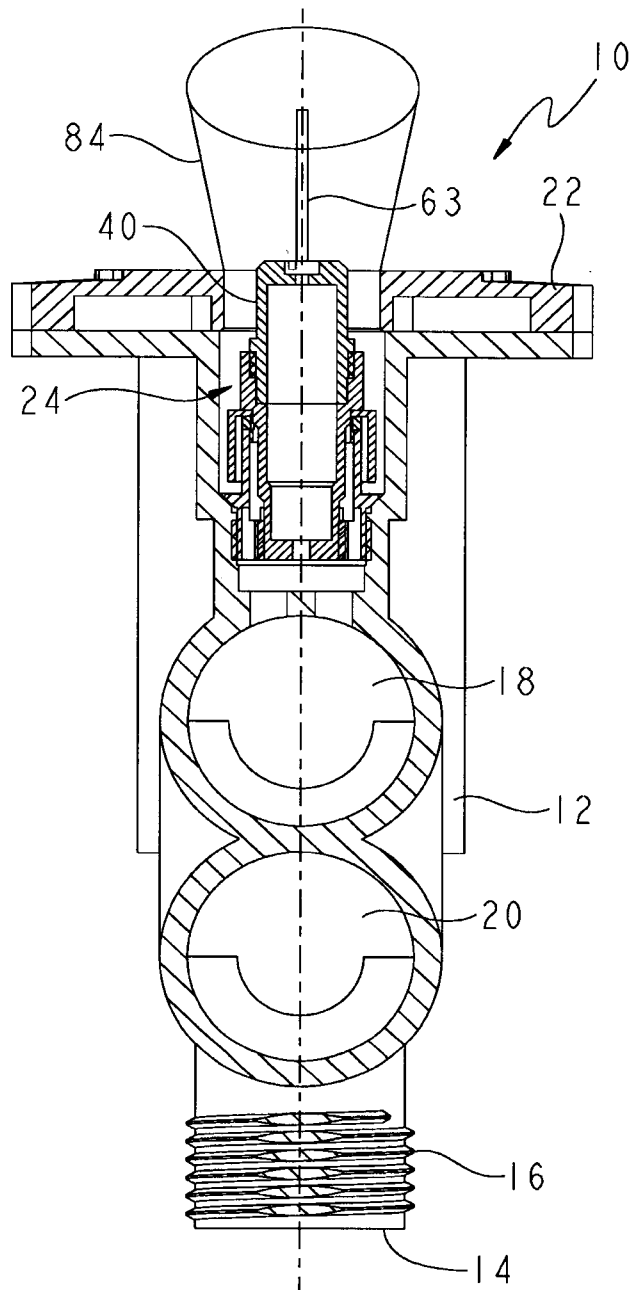


FIG. 7

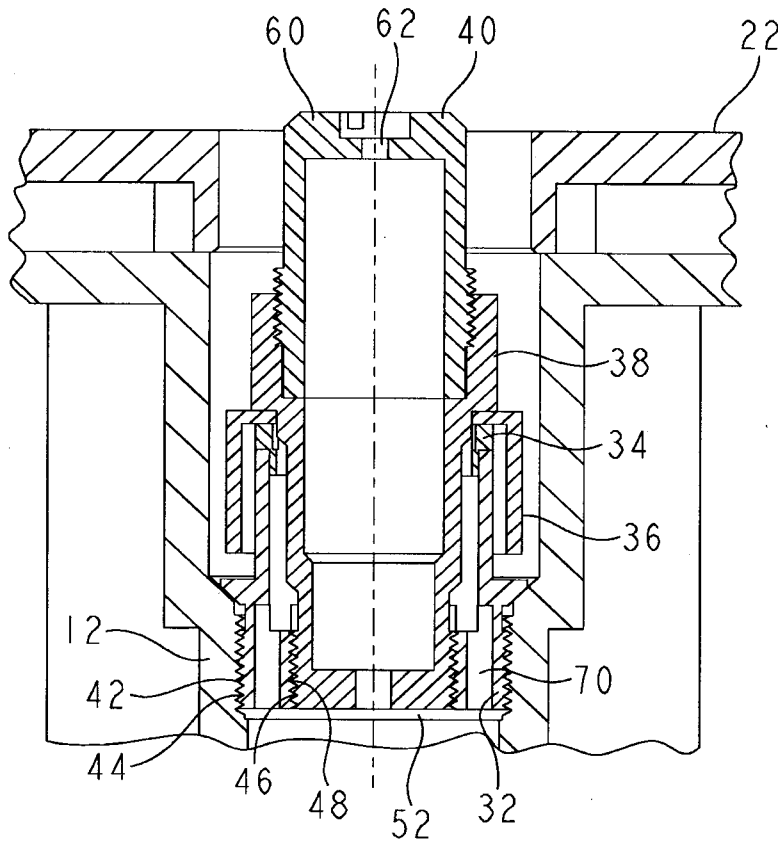


FIG. 8

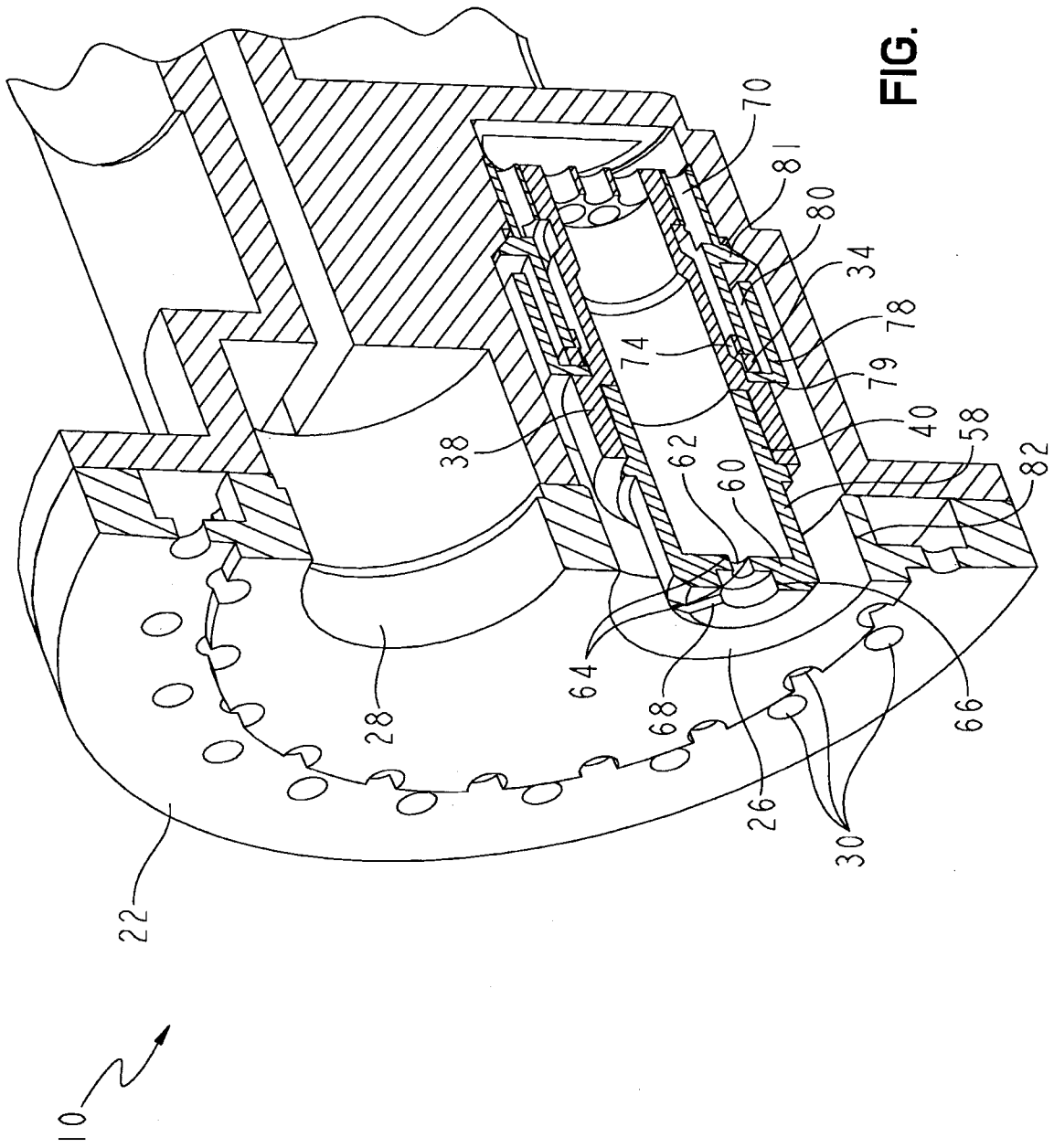


FIG. 9

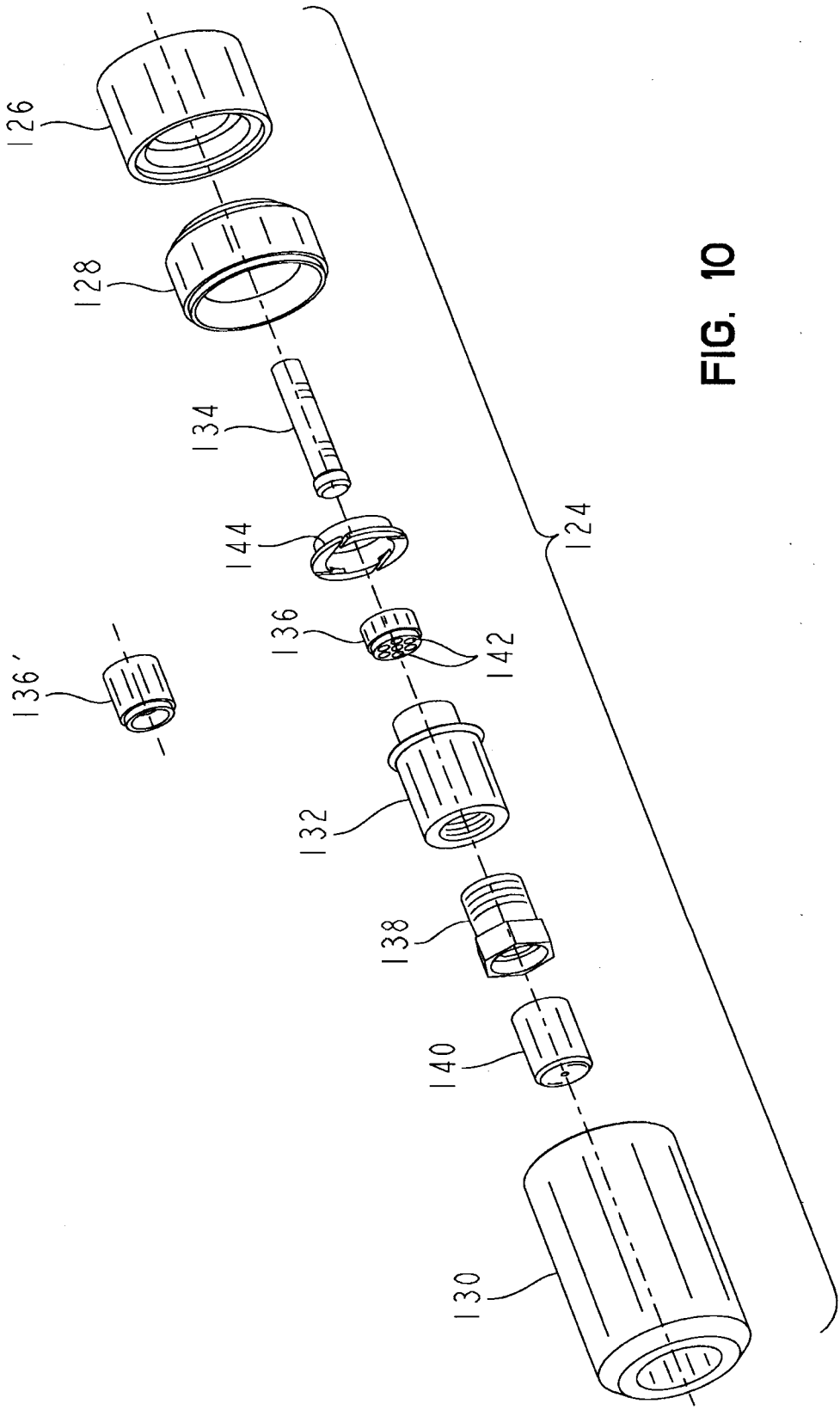


FIG. 10

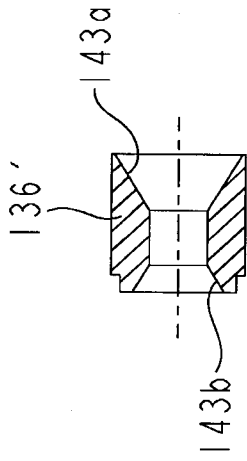


FIG. 13A

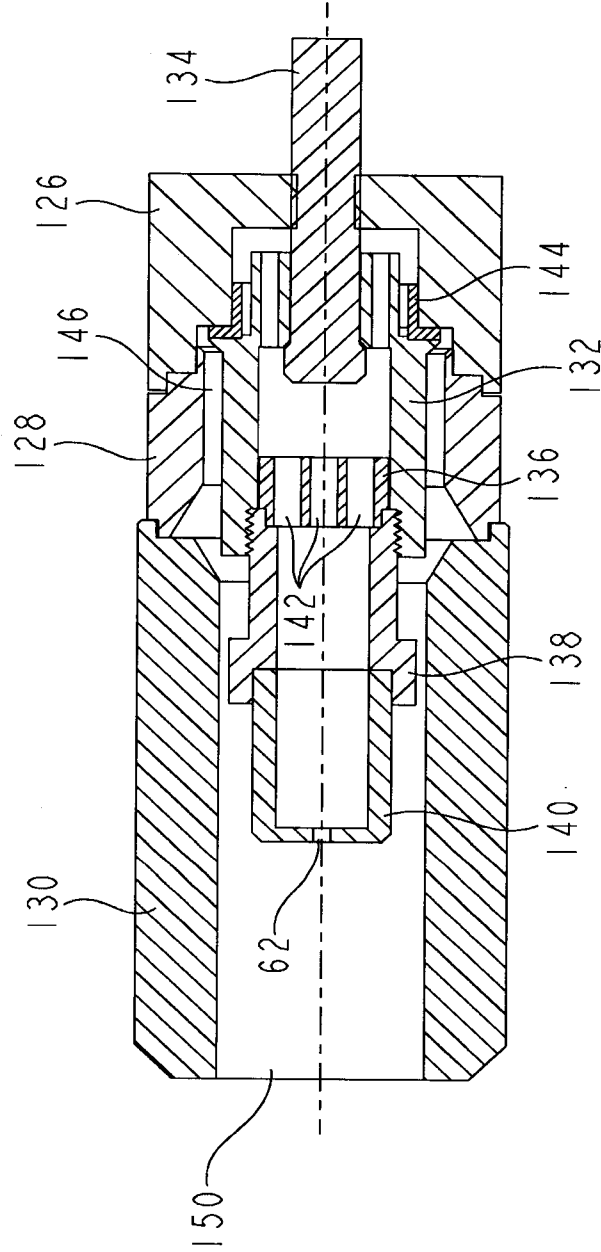


FIG. 11

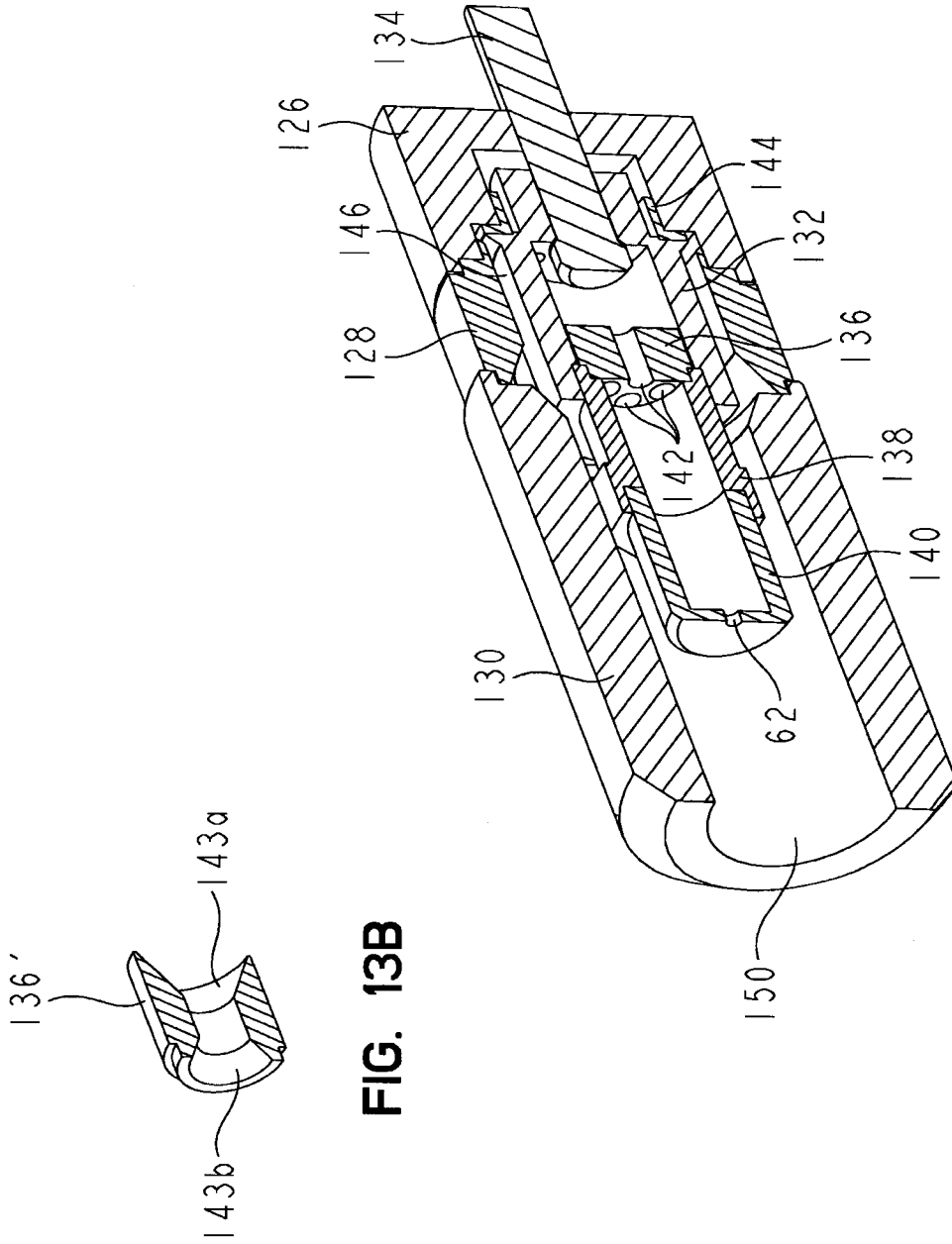


FIG. 13B

FIG. 12

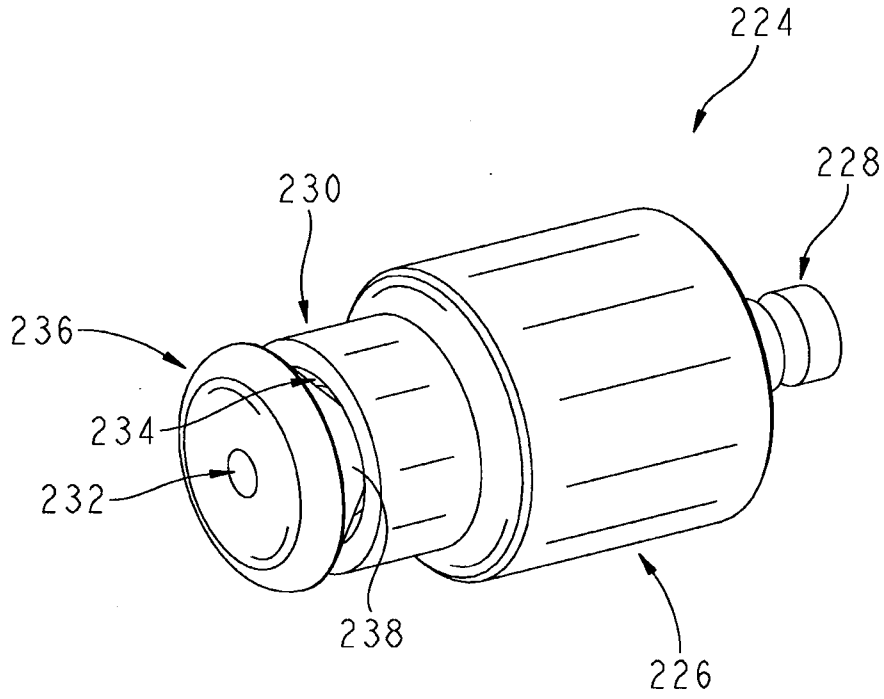


FIG. 14

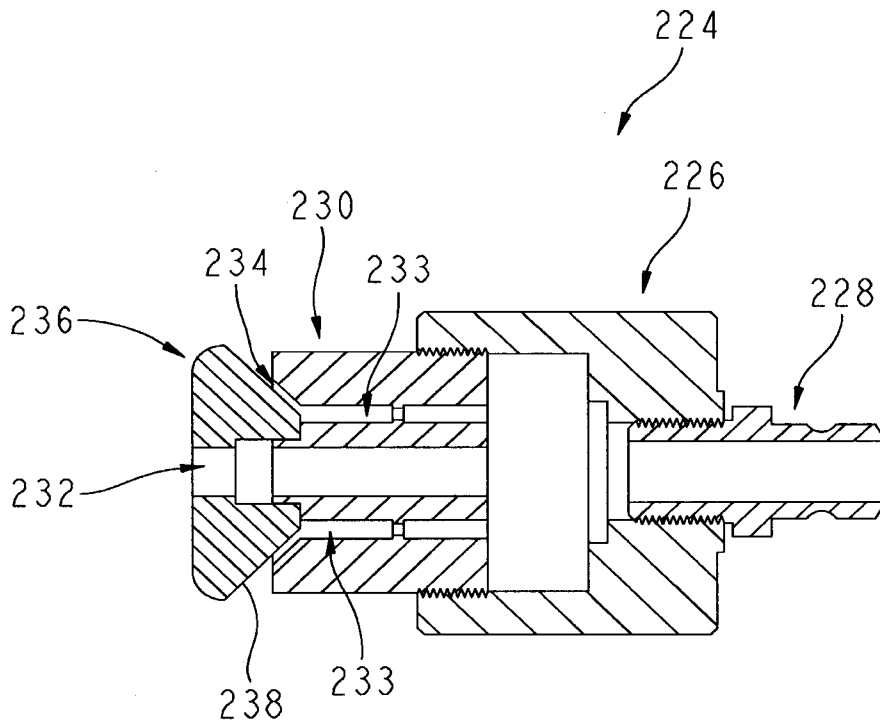


FIG. 15

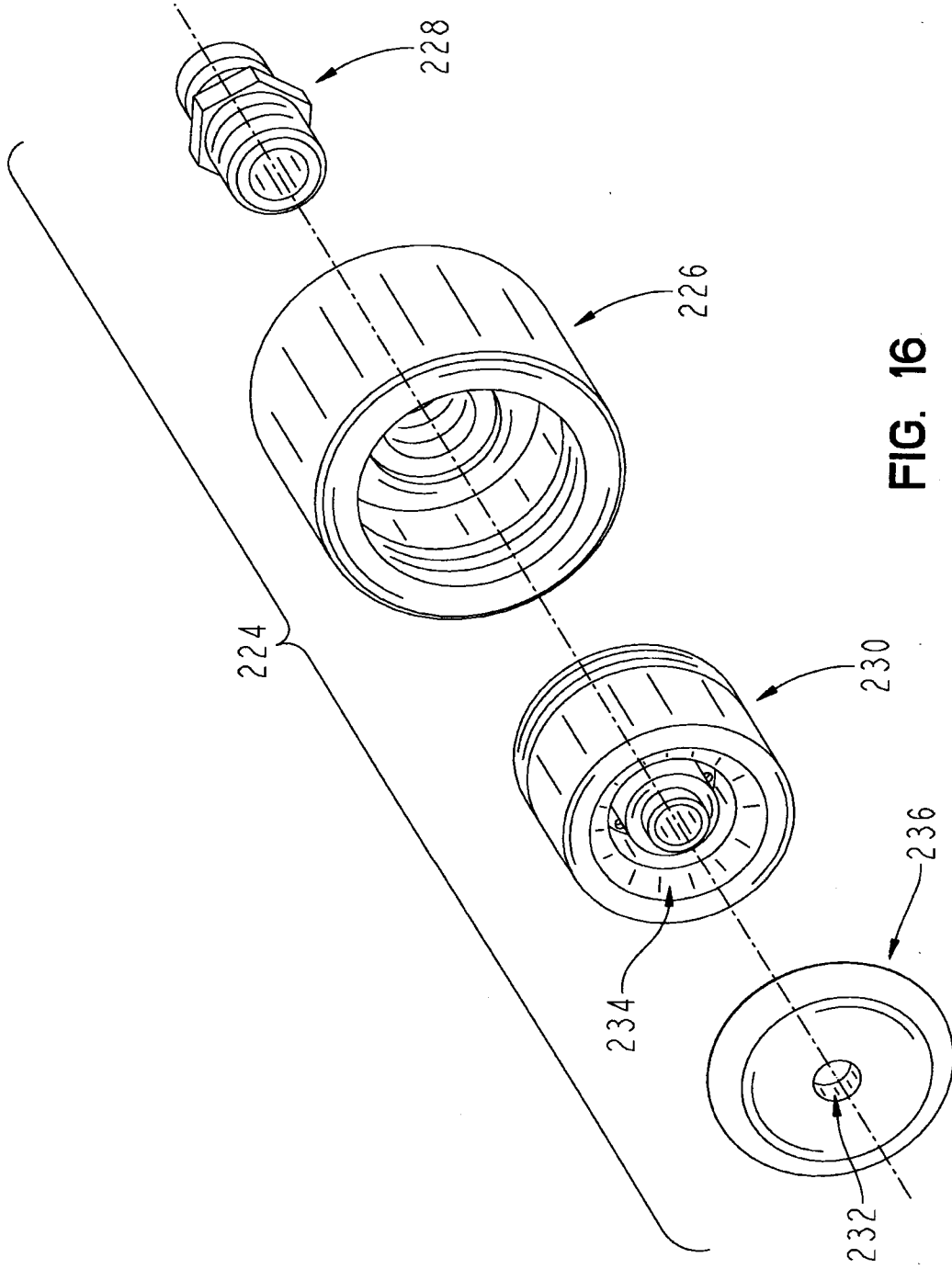


FIG. 16

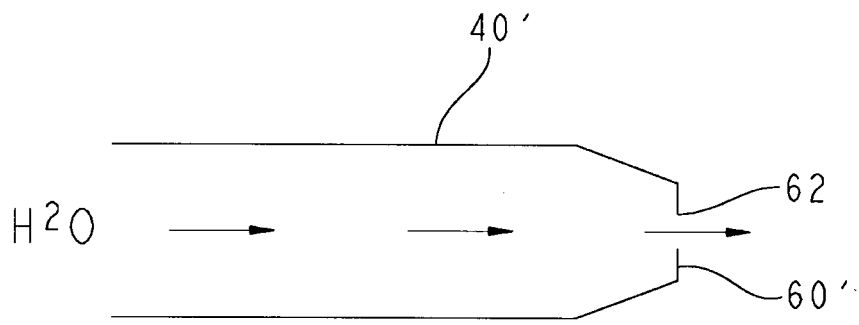


FIG. 17

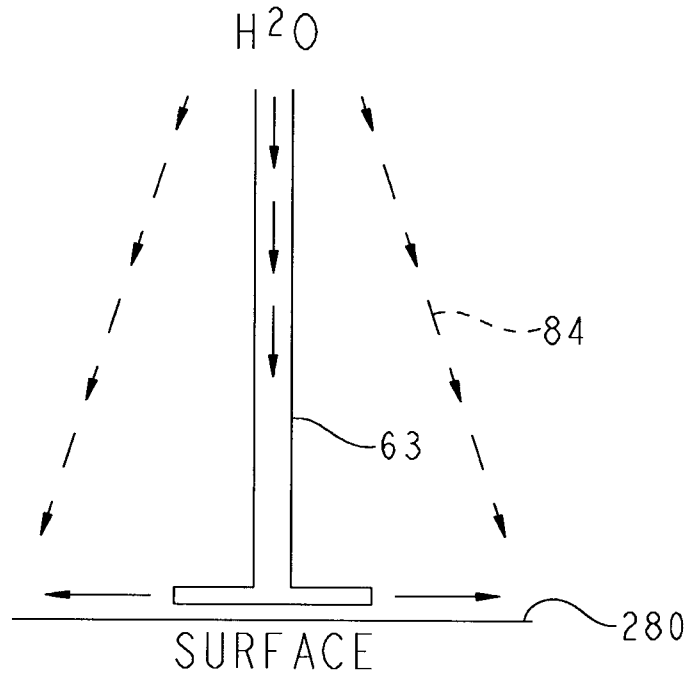


FIG. 18

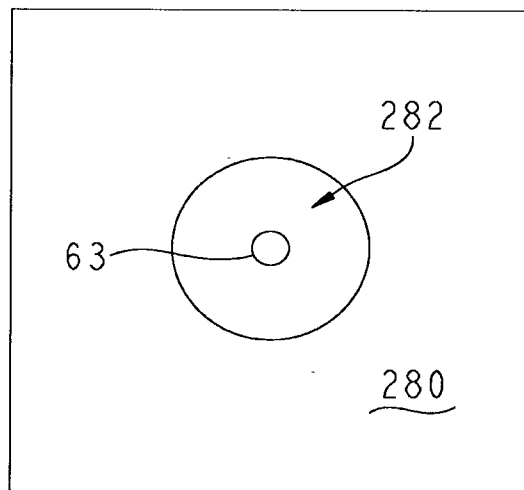


FIG. 19

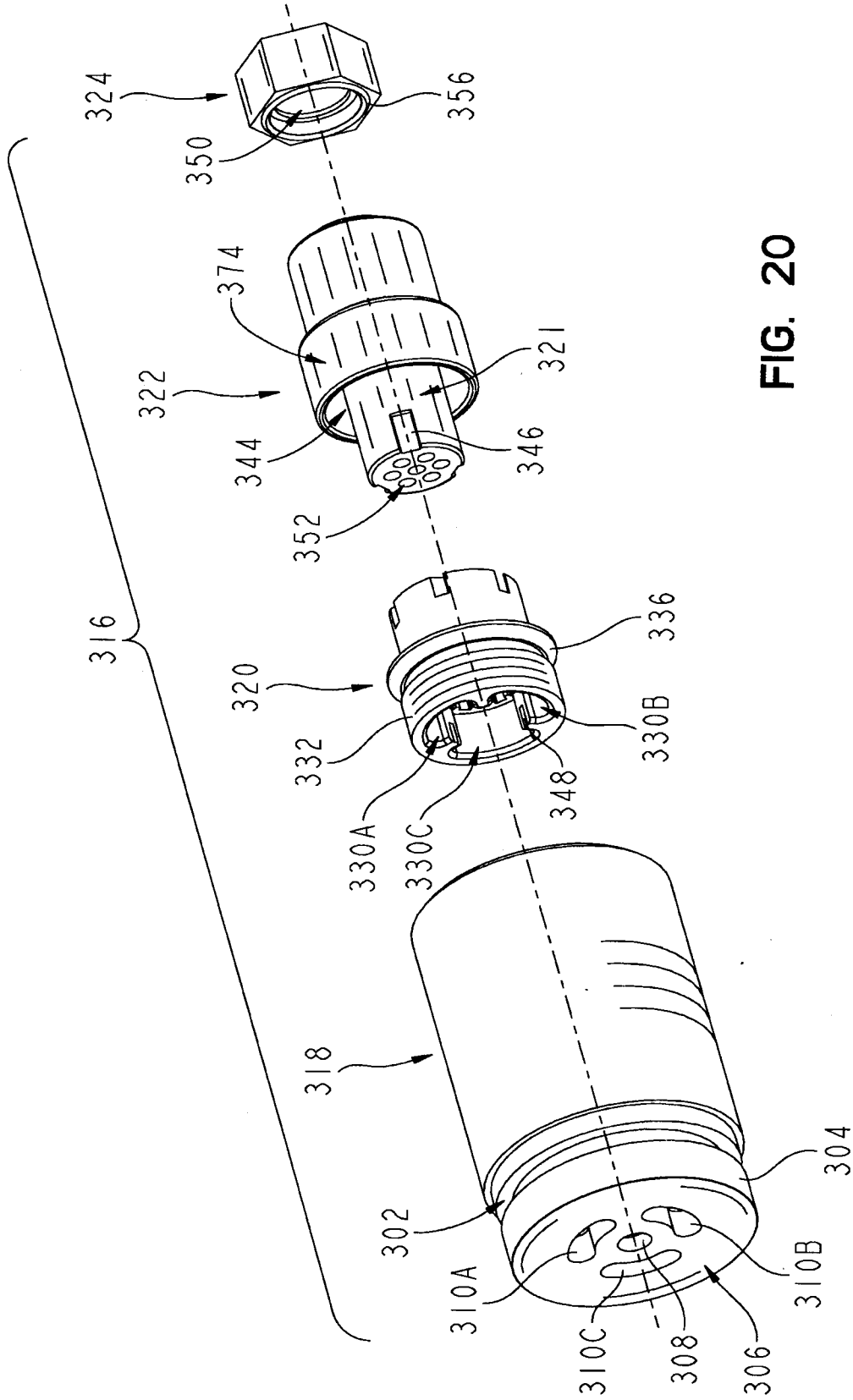


FIG. 20

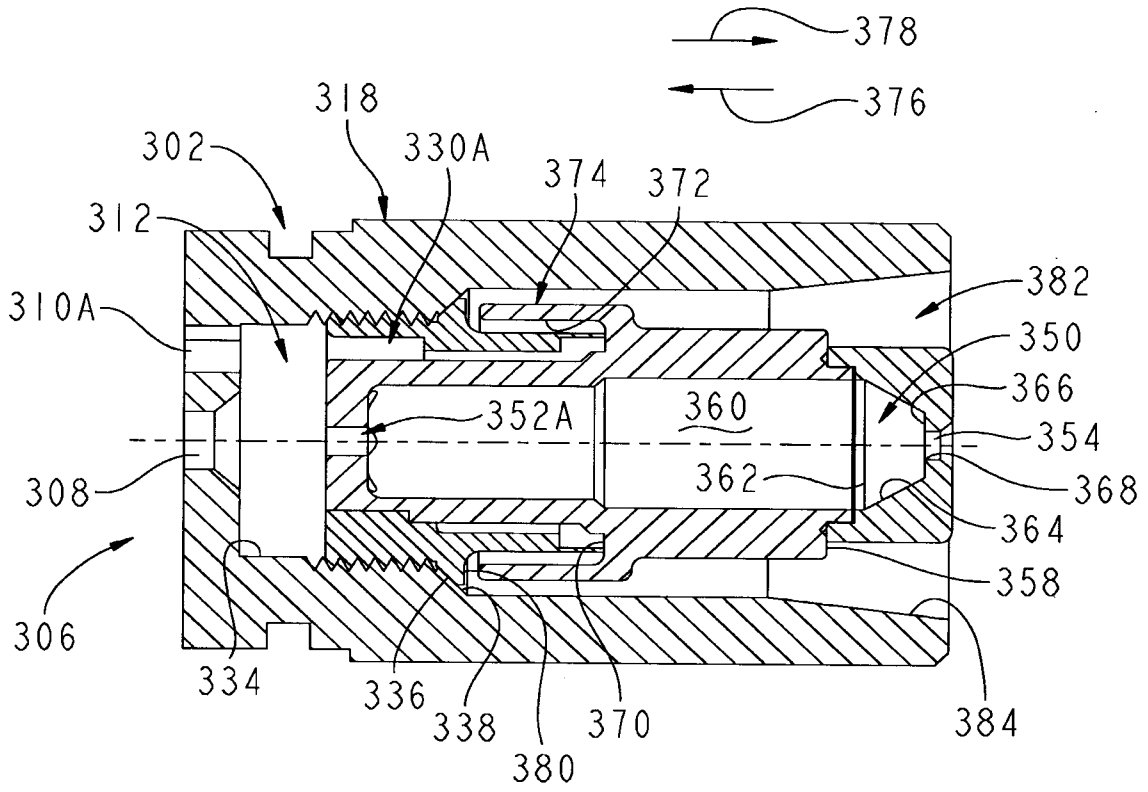


FIG. 21

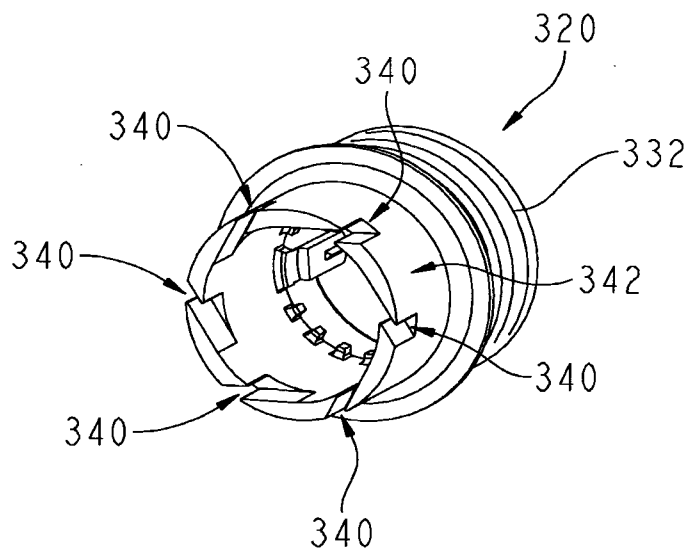


FIG. 22

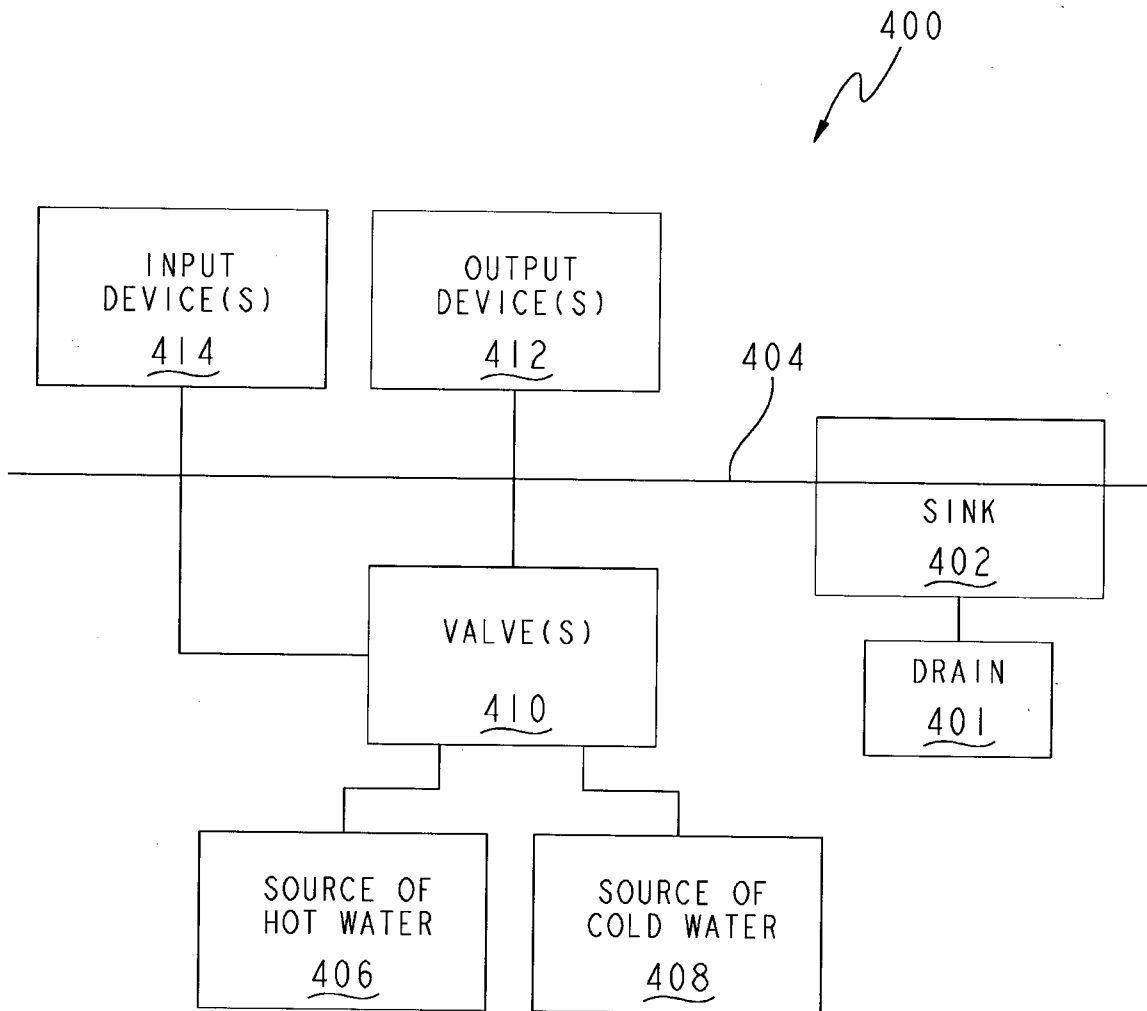


FIG. 23

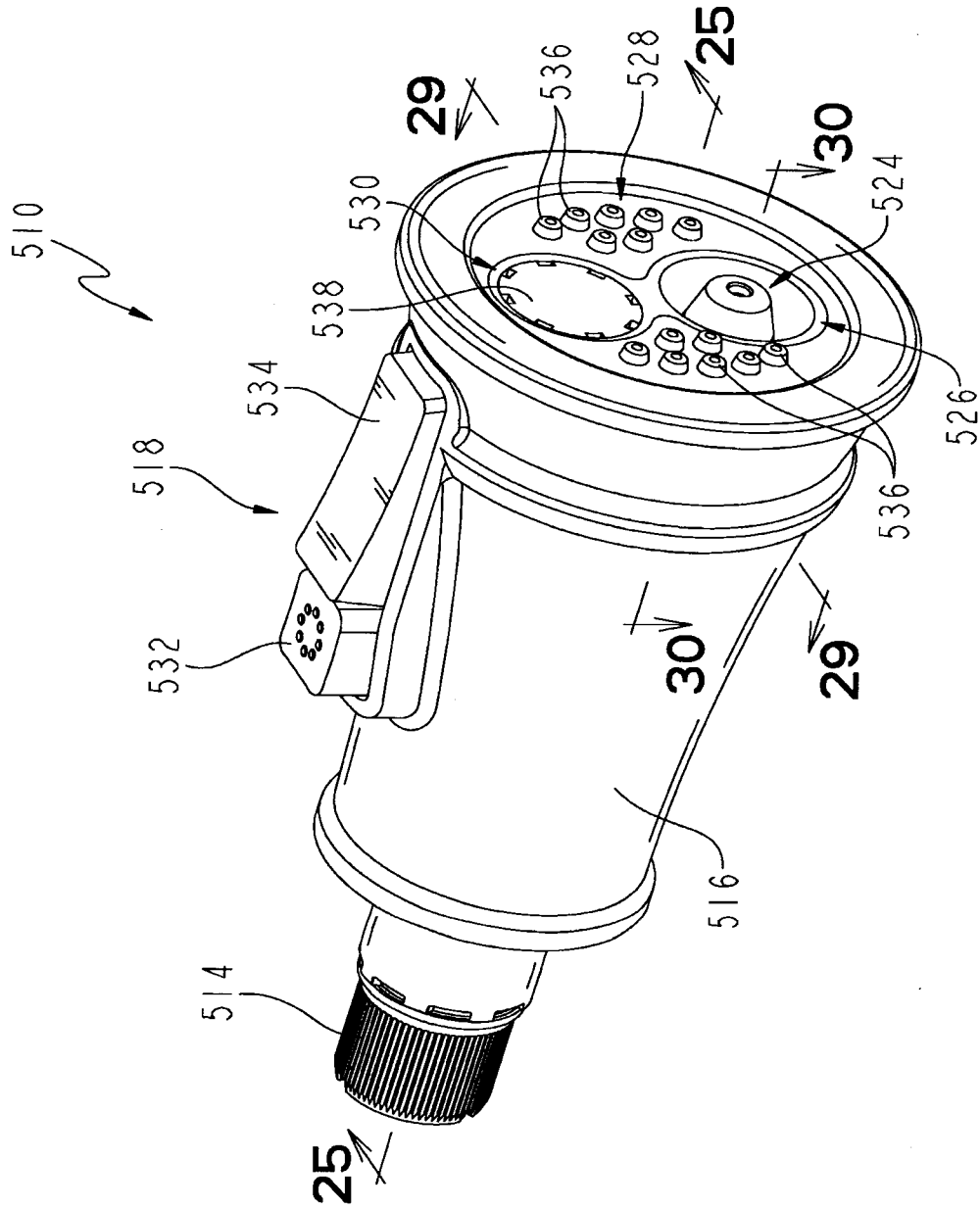


FIG. 24

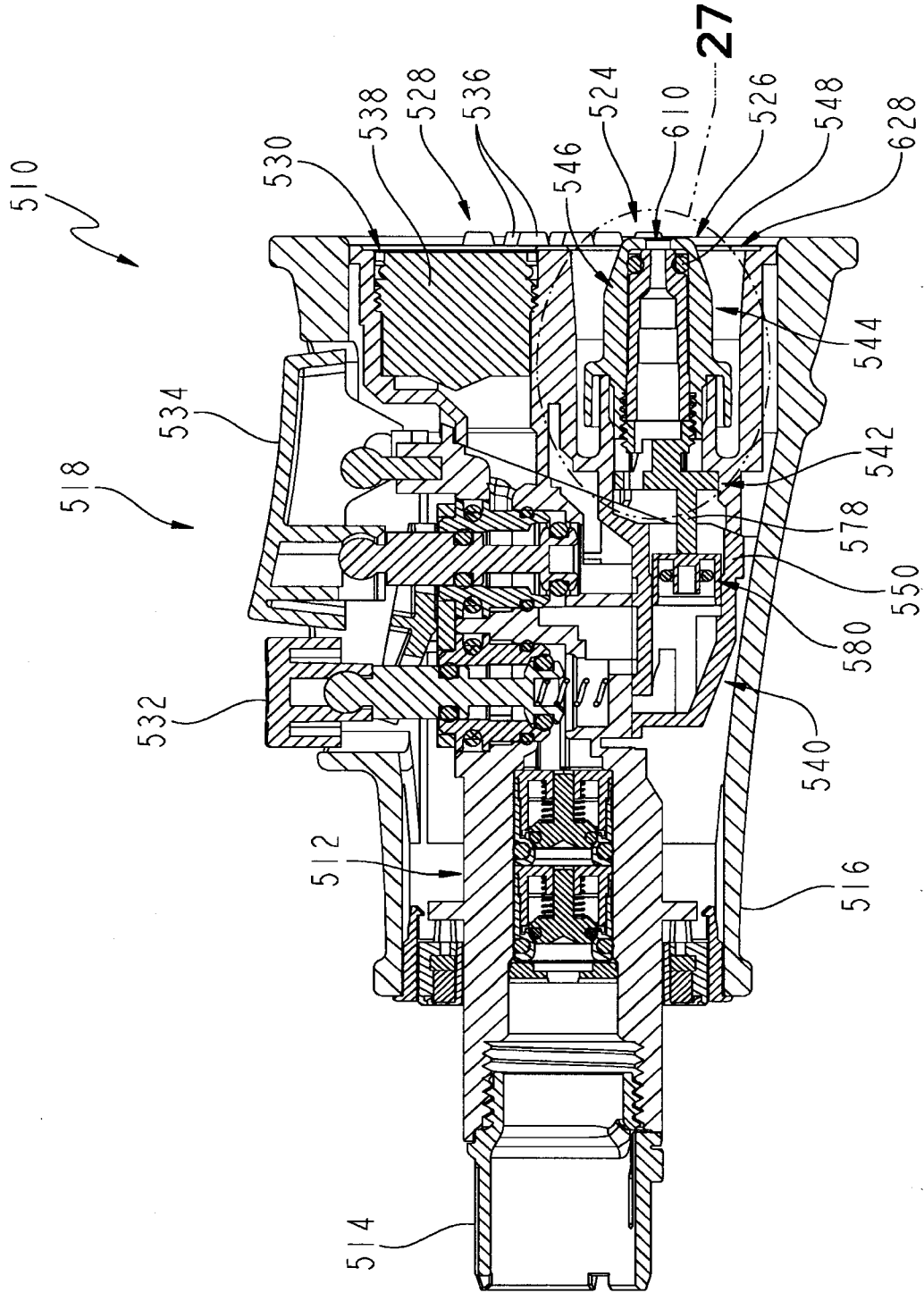


FIG. 25

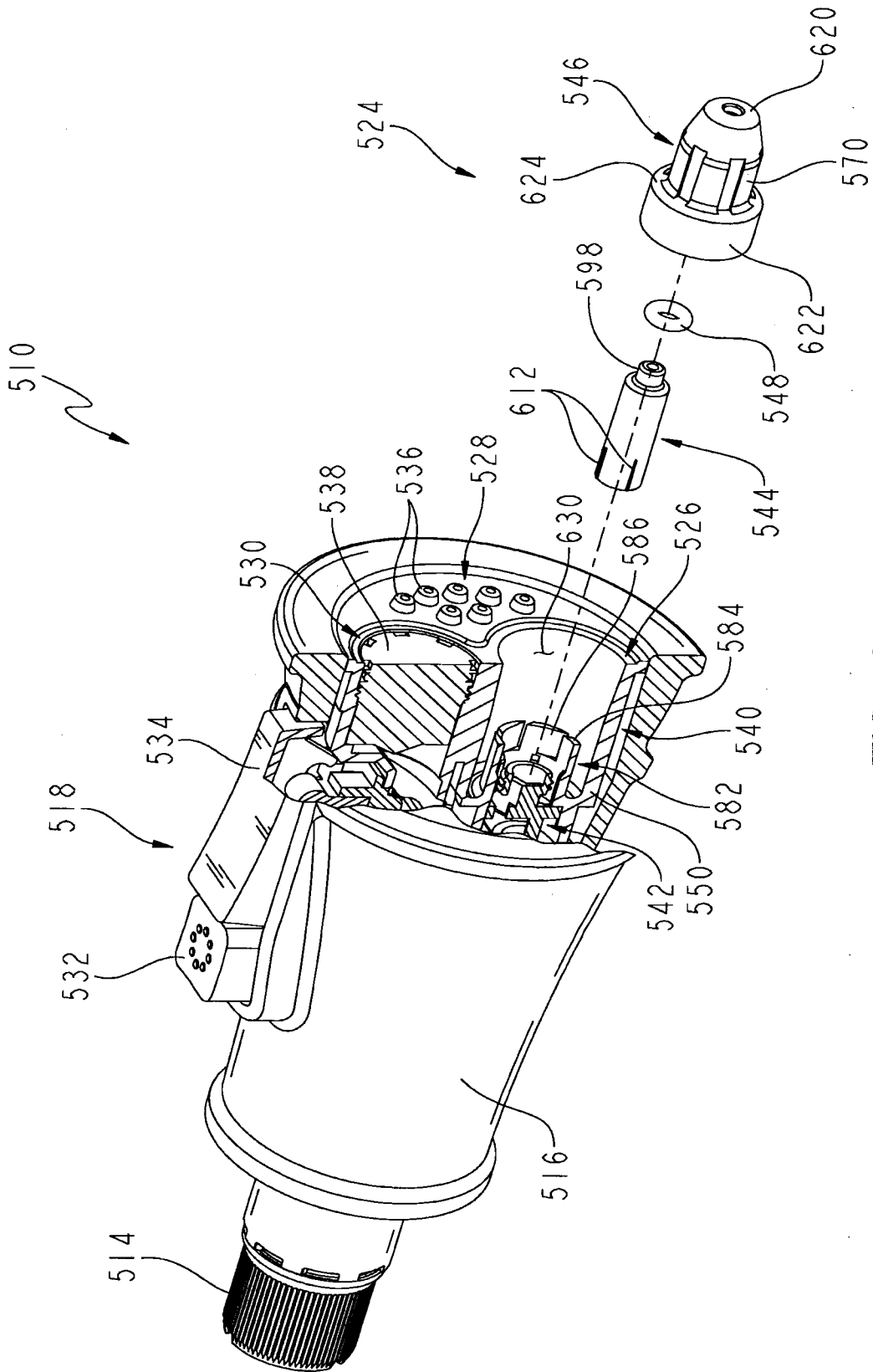


FIG. 26

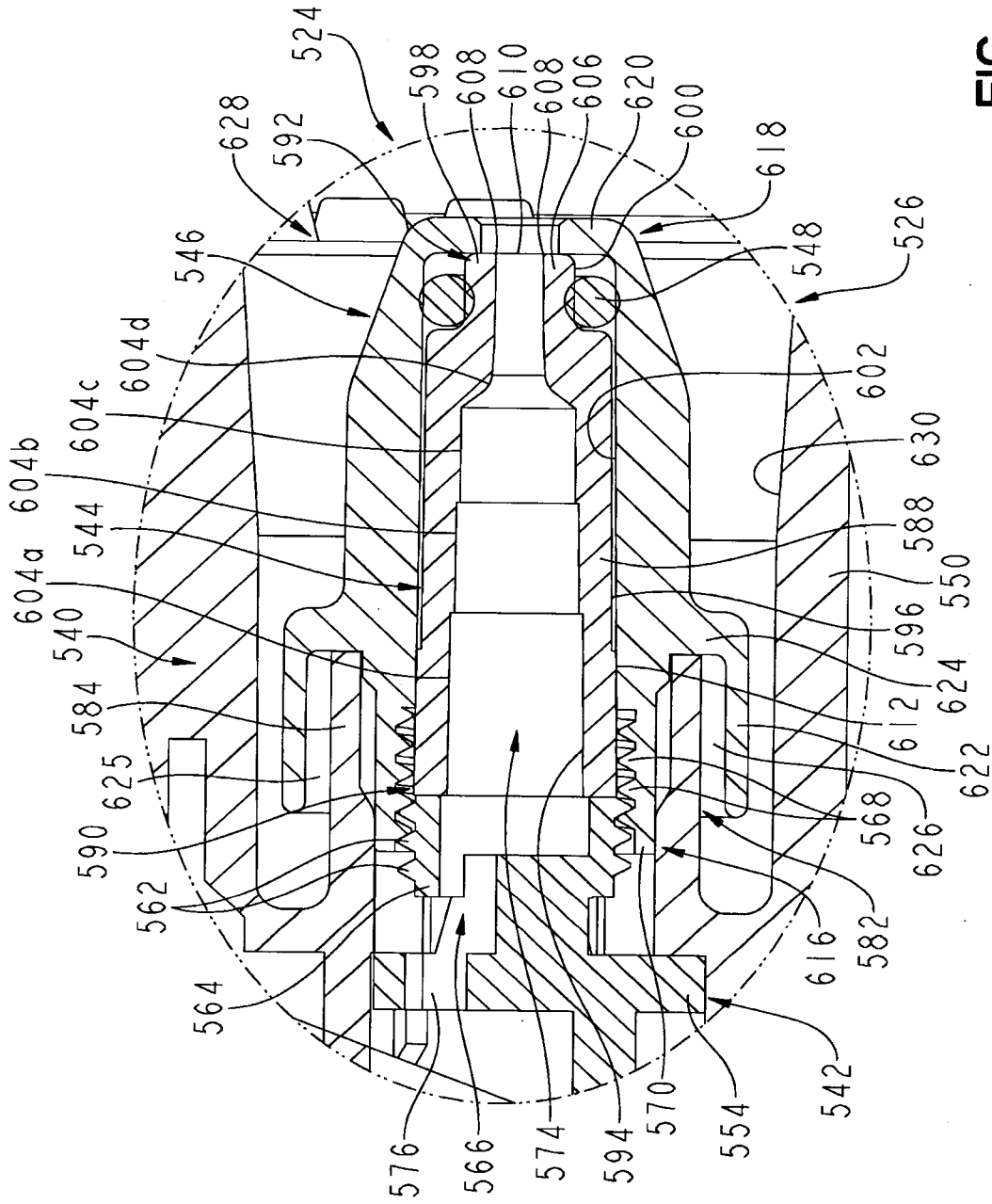


FIG. 27

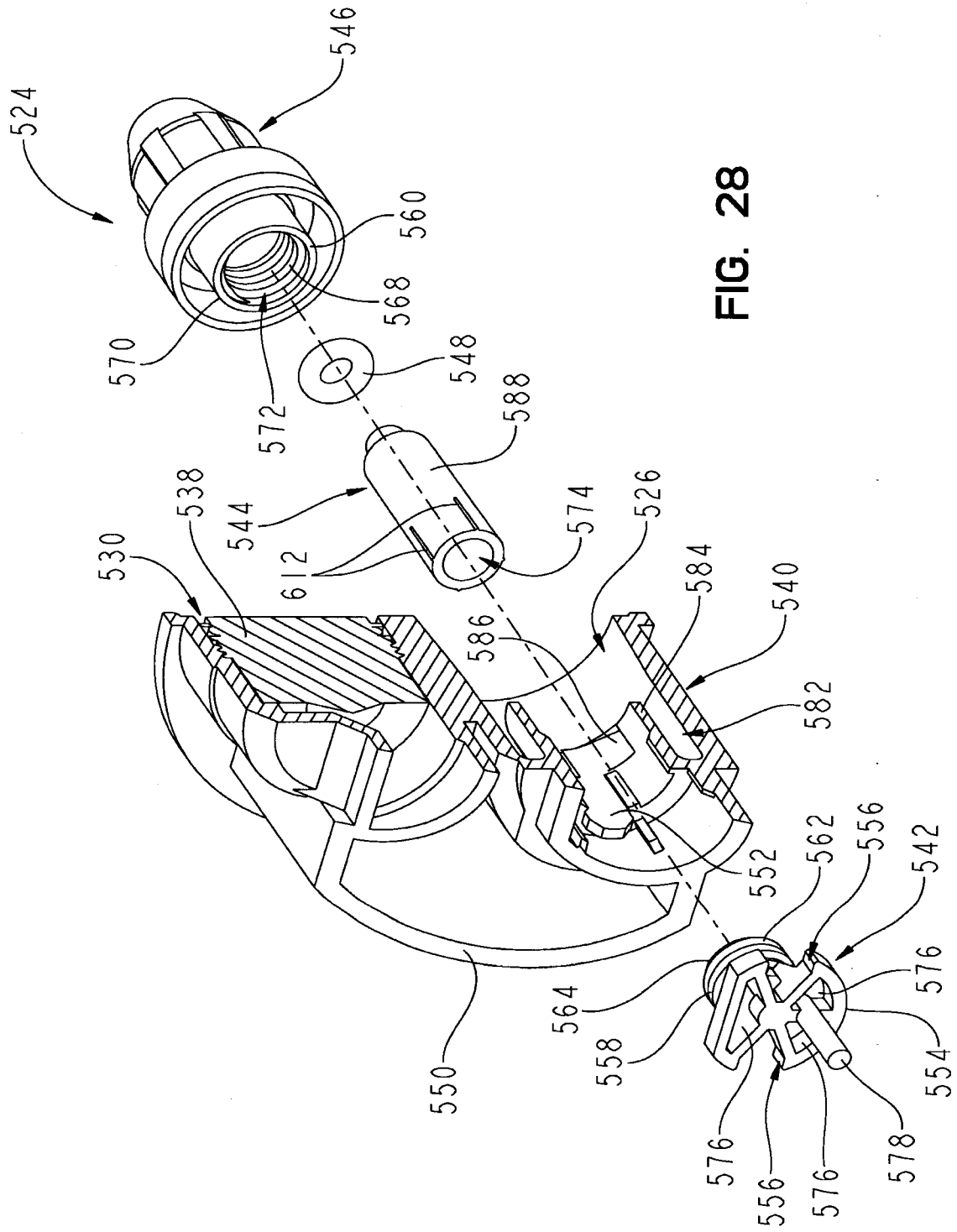


FIG. 28

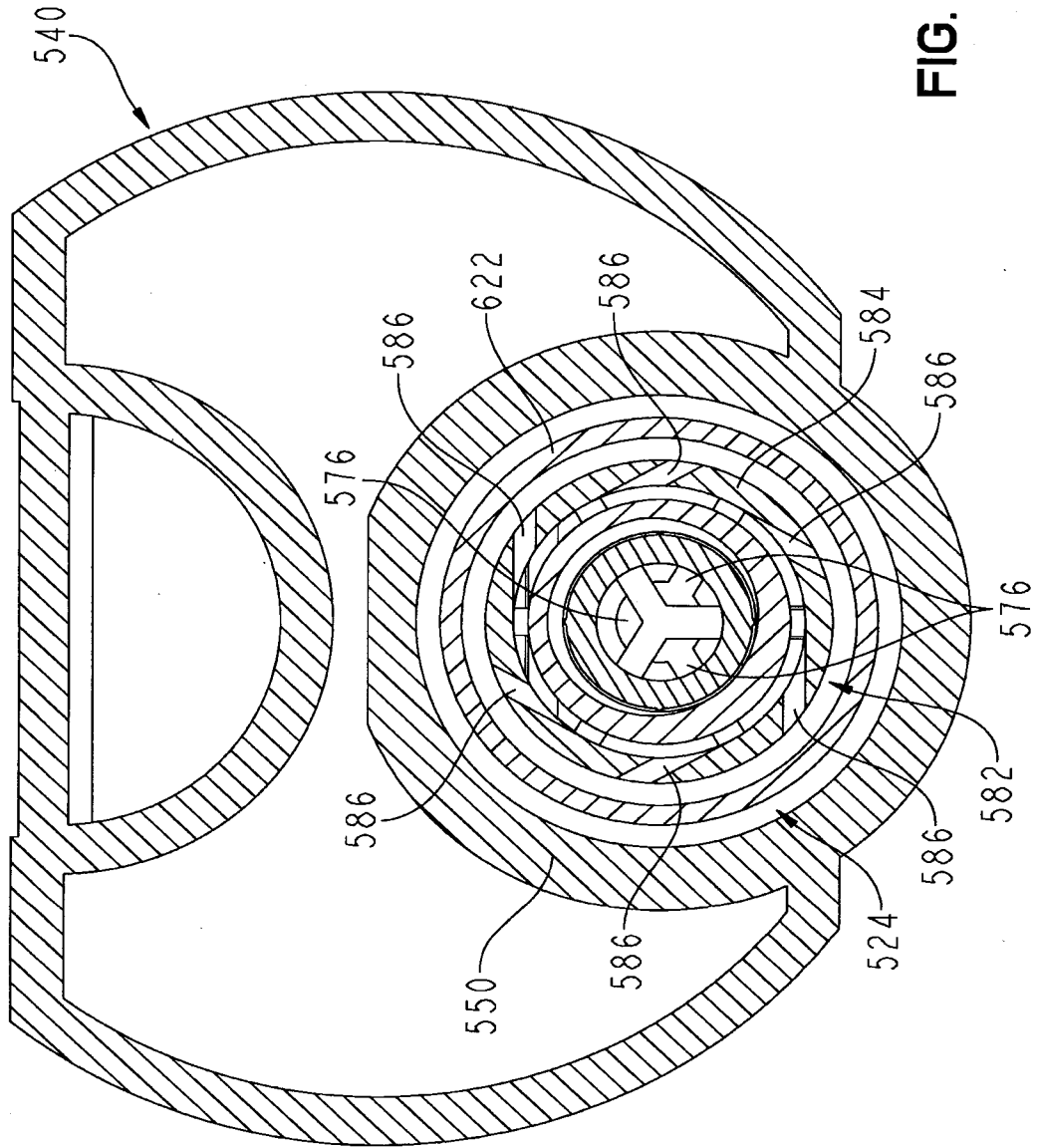


FIG. 29

FIG. 31

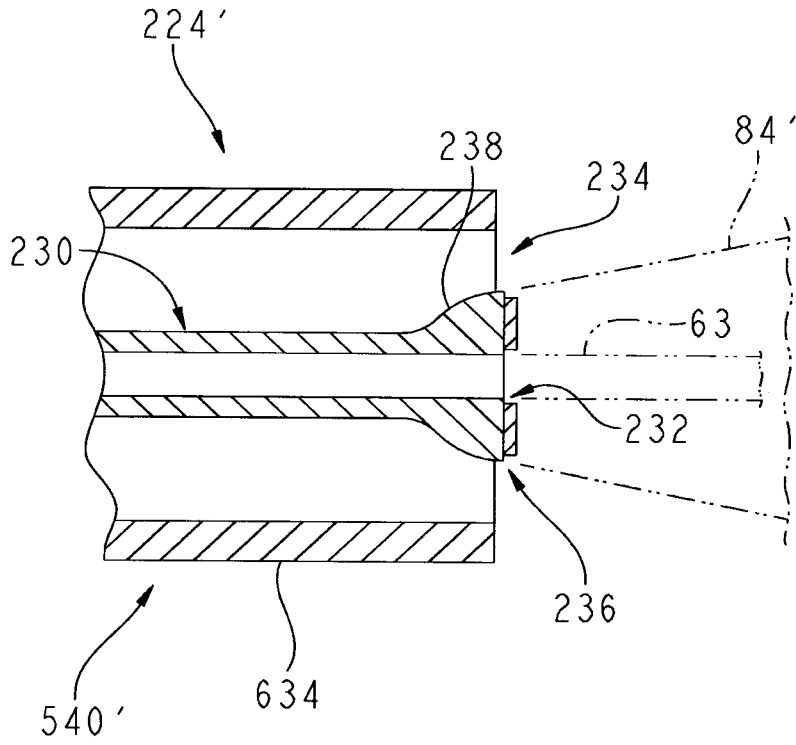


FIG. 32

