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(54) Title: FLAVOR VORTEX DEVICE

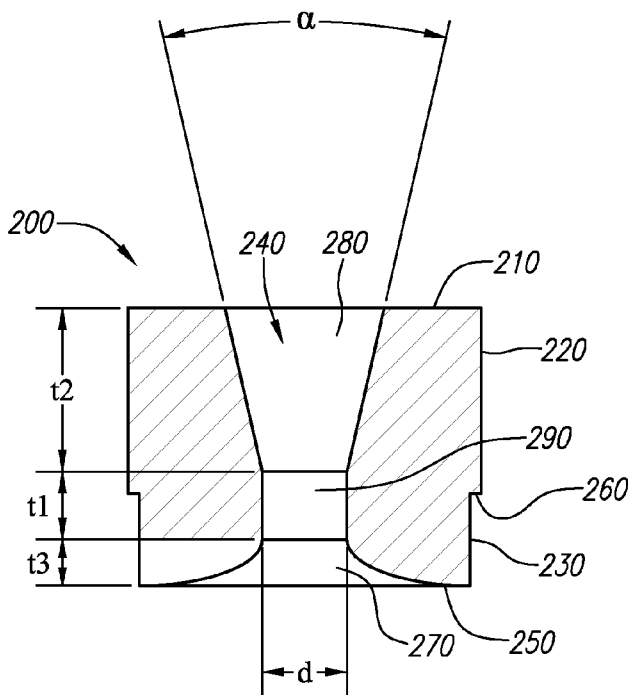


FIG. 2B

(57) Abstract: The present disclosure relates to devices and methods for controlling particle size, flow direction, and flow rate of an aerosol in an electronic smoking device. A flow discharge device 100 for an electronic smoking device 800 comprises a body and a through-hole 140. The body is configured for assembly with a housing 810 of an electronic smoking device 800, and has a first surface 110 and a second surface 130. The through-hole 140 extends from the first surface 110 to the second surface 130, and is shaped to adjust characteristics of flow between the first surface 110 and the second surface 130. In one particular embodiment, the through-hole 140 is shaped as a nozzle having a throat region 190 and a diverging region 180 downstream of the throat region 190.

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FLAVOR VORTEX DEVICE

BACKGROUND OF THE DISCLOSURE

a. Field

[0001] The present disclosure relates to a device and a method for controlling particle size in aerosol and for controlling the flow direction and flow rate of aerosol.

b. Background Art

[0002] An aerosol is defined as a suspension of solid or liquid particles in a gas. In the case of electronic cigarettes, nebulizers, personal vaporizers, and the like, aerosol includes both the particles and the suspending gas, such as air. Particle size may be described either in terms of the diameter of the particle or the particle size distribution for a given sample.

[0003] Electronic cigarettes, also known as e-cigarettes (eCigs), are electronic inhalers that vaporize or atomize a liquid solution into an aerosol mist that may then be delivered to a user. A typical eCig has a mouthpiece, a battery, a liquid storing area, an atomizer, and a liquid solution. The mouthpiece in conventional eCigs tends to be a cylindrical structure with a pin-hole opening in the center to deliver aerosol from the eCig to the user. The pin-hole opening tends to be an ineffective and inefficient delivery mechanism, since a significant portion of the aerosol delivered to the user is delivered at a rate and a particle size that results in a significant portion of the aerosol being directed and applied to the user's throat, thereby resulting in waste and an increased need to deliver larger amounts of aerosol to the user.

BRIEF SUMMARY

[0004] The present disclosure relates to a device and a method for effectively and efficiently controlling particle size in an aerosol. The present disclosure also relates to a device and a method for effectively and efficiently controlling flow direction and flow rate of an aerosol to enhance flavor, throat-effect, and delivery of the aerosol to a user.

[0005] In one embodiment, a flow discharge device for an electronic smoking device comprises a body and a through-hole. The body is configured for assembly with a housing of an electronic smoking device, and has a first surface and a second surface. The through-hole extends from the first surface to the second surface, and is shaped to adjust characteristics of flow between the first surface and the second surface.

[0006] In another embodiment, an electronic cigarette comprises an elongate cylindrical housing, a battery and a liquid storing area disposed in the housing, an atomizer and a mouthpiece. The atomizer is powered by the battery and configured to receive a liquid from the liquid storing area in order to generate an aerosol. The mouthpiece is connected to an end of the elongate cylindrical housing and has a nozzle disposed to receive aerosol drawn from the atomizer. The nozzle has a throat region and a diverging region downstream of the throat region.

[0007] In another embodiment, a method for controlling aerosol discharge in an electronic smoking device comprises drawing air into an electronic smoking device, generating an aerosol using the air and an atomizer disposed within the electronic smoking device, drawing the aerosol into a shaped passage through a mouthpiece of the electronic smoking device, and adjusting characteristics of the aerosol with the shaped passage as the aerosol passes through the mouthpiece.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1A shows an isometric view of an example of a nozzle device that is constructed according to the principles of the disclosure.

[0009] FIGS. 1B and 1C show cross-sectional and side views, respectively, of the nozzle device in FIG. 1A.

[0010] FIG. 2A and 2B show an isometric view and a cross-sectional view, respectively, of another example of a nozzle device that is constructed according to the principles of the disclosure.

[0011] FIGS. 3, 4 and 5 show cross-sectional views of additional examples of nozzle devices that are constructed according to the principles of the disclosure.

[0012] FIG. 6 shows a model of aerosol flowing through an example of a nozzle that is constructed according to principles of the disclosure.

[0013] FIG. 7 shows another model of aerosol flowing through another example of a nozzle that is constructed according to principles of the disclosure.

[0014] FIGS. 8A and 8B show a fragmentary, side-isometric view and a fragmentary cross-sectional view, respectively, of an example of an electronic cigarette (eCig) that includes a nozzle according to the principles of the disclosure.

[0015] FIGS. 8C and 8D show exploded schematic and side-isometric views, respectively, of the example eCig of FIGS. 8A and 8B illustrating components of the eCig, such as a heater subassembly, batting, and a sensor.

[0016] FIG. 9 depicts a pair of spectral density versus particle size diagrams that comparatively illustrate the performance of an existing eCig as compared to the same eCig with a nozzle that is constructed according to the principles of the disclosure.

[0017] FIGS. 10A - 17B illustrate various examples of patterns that may be provided on a surface of a nozzle that is constructed according to the principles of the disclosure.

[0018] FIGS. 18A and 18B illustrate a top view and a side cross-sectional view, respectively, of another example of a nozzle device that is constructed according to the principles of the disclosure.

[0019] FIG. 18C illustrates an alternative embodiment of the nozzle device of FIG. 18B.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0020] FIG. 1A shows an isometric view of nozzle device 100, which is an example of a nozzle device that is constructed according to the principles of the disclosure. Nozzle device 100 includes first substantially planar surface 110, second substantially planar surface 130, and through-hole 140. Nozzle device 100 may include a plurality of ribs 120. Nozzle device 100 comprises a generally cylindrical body that is configured to slide, or otherwise fit, into a cylindrical housing of an electronic smoking device, such as an electronic cigarette (eCig). Nozzle device 100 comprises a mouthpiece through which aerosol from the eCig is configured to be drawn en route to a user.

[0021] FIGS. 1B and 1C show cross-sectional and side views, respectively, of nozzle device 100. As shown in FIG. 1C, nozzle device 100 comprises inlet disk 150 configured to be disposed inside an eCig housing, and exit disk 160 configured to be disposed outside of an eCig housing. Specifically, inlet disk 150 is configured to fit tightly within the eCig housing to connect nozzle device 100 to the housing, while exit disk 160 is sized to have the same diameter as the eCig housing. As such, inlet disk 150 has a slightly smaller diameter than that of exit disk 160. Ribs 120 extend between inlet disk 150 and exit disk 160 to support nozzle device 100 and through-hole 140 extending therebetween. Ribs 120 may be provided to enable injection molding and to make nozzle device 100 lighter. In the illustrated embodiment, four ribs 120 are spaced equally around through-hole 140.

[0022] Referring to FIG. 1B, through-hole 140 of nozzle device 100 may include an hourglass-like shape. In the illustrated embodiment, through-hole 140 includes inlet region 170, exit region 180, and throat region 190. The diameter of the opening for through-hole 140 in first planar surface 110 may be substantially smaller than the diameter of the opening for through-hole 140 in second planar surface 130, as seen in FIG. 1B. Through-hole 140 extends through nozzle device 100 from inlet disk 150 to exit disk 160 so as to allow aerosol from within the eCig housing to pass therethrough. In the various embodiments described, the through-hole is shaped or contoured to influence characteristics of the flow of aerosol (e.g. velocity, direction and particle size) through the nozzle so as to adjust consumer experience of the aerosol, as will be discussed in greater detail later.

[0023] FIGS. 2A and 2B show an isometric view and a cross-sectional view, respectively, of nozzle device 200, which is another example of a nozzle device that is constructed according to the principles of the disclosure. In the embodiment of FIGS. 2A and 2B, nozzle device 200 comprises a stepped cylindrical body rather than the ribbed cylindrical body of FIGS. 1A - 1C.

[0024] Referring to FIG. 2A, nozzle device 200 includes first substantially planar surface 210, first annular portion 220, second annular portion 230, second substantially planar surface 250, and through-hole 240. The diameter of first annular portion 220 may be greater than the diameter of second annular portion 230. The diameter of first annular portion 220 may be constructed so as to be substantially the same as an outer diameter of an electronic cigarette housing, such as eCig 800 shown in FIGS. 8A - 8D, so as to provide a substantially flush and seamless outer housing of the eCig. The diameter of the second annular portion 230 may be substantially the same as an inner diameter of the eCig housing, so as to permit for a snug and secure fit when nozzle device 200 is mated to the eCig housing (as shown, e.g., in FIG. 8B). As such, first annular portion 220 and second annular portion 230 form step 260 in the diameter of nozzle device 200.

[0025] As seen in FIG. 2B, through-hole 240 may have an hourglass-like shape, which may include three separate regions, including inlet region 270, throat region 290, and exit region 280. The geometries (e.g., the diameter, length and shape) of inlet region 270, throat region 290 and exit region 280 can be adjusted in concert with each other to influence the formation and flow of particles within the suspending gas of the aerosol. Studies have shown that aerosol ingested by users of electronic smoking devices incorporating the nozzle devices of the present disclosure have superior user experiences, including, depending on the

nozzle device design, improved mouth feel, impact, draw characteristics, and perceived flavor.

[0026] Through-hole 240 may have a smaller diameter at an exit end of exit region 280 (i.e., in first planar surface 210) than at an inlet end of inlet region 270 (i.e., in second planar surface 250) of nozzle device 200. Exit region 280 may have a height t_2 that is greater than the height t_1 of throat region 290, which in turn may be greater than the height t_3 of inlet region 270. The walls of inlet region 270 may be curved or shaped, such as in the shape of a tangential curve or another specific curve-type. The phrase "tangential curve" as used throughout this description is referring to a pair of tangential curves that are slid apart to form a nozzle - or a pair of opposing curves that if slid together would be tangent. In one embodiment, the diameter (inlet region inlet diameter) of the inlet opening in the surface 250 may be in the range of 70% to 95% of the diameter of annular portion 230. It is noted that the inlet diameter may be close to (or at) 100% of the diameter of annular portion 230, or less than 70% of the diameter of annular portion 230. The diameter of the outlet of inlet region 270 (inlet region outlet diameter) may be equivalent to the diameter of the inlet of throat region 290 (throat region inlet diameter).

[0027] The walls of throat region 290 may form a substantially cylindrical shape, wherein the throat region inlet diameter d may be substantially the same as the diameter of the outlet of throat region 290 (throat region outlet diameter). The throat region outlet diameter d may be substantially the same as the diameter of the inlet of exit region 280 (exit region inlet diameter). The walls of exit region 280 may be formed in a substantially cone-like (or funnel-like) shape, with the diameter of the outlet of exit region 280 (outer region outlet diameter) being significantly greater than the exit region inlet diameter. For example, the walls of exit region 280 may form an exit region angle a of about $30^\circ \pm 10^\circ$. In other embodiments of a nozzle device, the inlet region may have cone-like straight walls, and the exit region may have curved walls.

[0028] According to an aspect of the disclosure, the nozzle device may have the following ranges of dimensions:

- t_1 : from about 0.75 to about 3.0 mm;
- t_2 : from about 1.0 to about 4.0 mm;
- t_3 : from about 0.75 to about 2.0 mm; and
- d : from about 1.0 to about 3.0 mm.

[0029] According to one aspect of the disclosure, it was found that the nozzle device improved performance at about $t_2 = 1.5$ mm.

[0030] In one example, the nozzle dimension may be expressed by the following equations:

$t_2/d \geq 0.5$, where the nozzle may begin to work well at $t_2/d =$ about 0.75; and $t_1/d \geq 0.325$, where about 0.75 seems to work well.

[0031] As will be discussed with reference to FIGS. 6, 7 and 9, the flow characteristics of the aerosol generated by the shape of the through-hole can be adjusted, such as to increase or decrease speed and direction of the aerosol through the mouthpiece. Studies have shown that the speed of the aerosol influences the modality and distribution of the particle size in the suspending gas. The through-hole shape can also influence the trajectory of the aerosol leaving the mouthpiece and entering the mouth of the user. Thus, by changing the geometry of the through-hole, the total user experience, as determined by the collective influence of the fluid mechanics and particle modality, can be tuned to provide a desired user experience per nozzle design.

[0032] FIGS. 3, 4 and 5 show cross-sectional views of additional examples of nozzle devices constructed according to the principles of the disclosure. As seen in FIGS. 3 and 4, nozzle devices 300 and 400 may have dimensions that differ significantly in ratios from the dimensions of nozzle devices 100 and 200 (shown in FIGS. 1B and 2B, respectively). As seen in FIG. 5, nozzle device 500 may have different regions than those of nozzle devices 100, 200, 300 and 400. Through manipulation of the dimensions of the regions in the through-holes, aerosol flowing through (as well entering into and exiting from) the through-holes may be controlled so as to adjust speed and direction of particles flowing in each of the regions of the respective nozzle device (as shown in FIGS. 6 and 7), as well as the form (e.g., modality), speed and direction that the aerosol takes as it exits from the nozzle device (as shown in FIG. 9).

[0033] FIG. 3 shows nozzle device 300 comprising first substantially planar surface 310, second substantially planar surface 330, and through-hole 340. In the illustrated embodiment, through-hole 340 includes inlet region 370, exit region 380, and throat region 390. Through-hole 340 is similar to through-hole 140 of FIG. 1B, but the diameter of the opening for through-hole 340 in first planar surface 310 may be smaller than the diameter of the opening for through-hole 140 in first planar surface 110 in FIG. 1B. Exit region 380 is therefore more cylindrical and less conical than exit region 180. Through-hole 340 will

influence the speed and atomization of the aerosol differently than through-hole 140. For example, because the exit of through-hole 340 is narrower than the exit of through-hole 140, a more concentrated or narrow flow of aerosol may be provided. Such a narrowing of the exit may provide, among other things, a more direct sensation of particles hitting the throat or soft palate.

[0034] FIG. 4 shows nozzle device 400 comprising first substantially planar surface 410, second substantially planar surface 430, and through-hole 440. In the illustrated embodiment, through-hole 440 includes inlet region 470, exit region 480, and throat region 490. Through-hole 440 is similar to through-hole 340 of FIG. 3, but the length of inlet region 470 is shorter than the length of inlet region 370. Likewise, throat region 490 is longer than throat region 390. The longer throat region drives higher speed through nozzle device 400, which generally correlates to smaller particle size. Generally speaking, longer, tighter throat regions generate more velocity and shear, which produces smaller particles. Additionally, the exit angle and length of the exit region, such as exit region 480, generally slows down flow, which allows a plume of aerosol to stall within the mouth of a user. The combination of throat geometry and exit speed geometry first speeds up flow and then slows down flow to achieve desired effects. Changing the proportions of the throat and exit allows for tailoring of the effects.

[0035] FIG. 5 shows nozzle device 500 comprising first substantially planar surface 510, second substantially planar surface 530, and through-hole 540. In the illustrated embodiment, through-hole 540 includes exit region 580 and throat region 590. Nozzle device 500 differs from nozzle devices 100, 200, 300 and 400 in that a specific inlet region is omitted. In other embodiments, nozzle device 500 can be supplemented with a separate device (not shown) that conditions, e.g., steers, flow of aerosol into throat region 590. The geometries of exit region 580 and throat region 590 can be set to any geometry, including those described with reference to FIGS. 1A - 4. Through-hole 540 will influence the speed and atomization of the aerosol differently than will the other through-holes described, depending on the selected geometry. Additionally, nozzle device 500 provides other benefits, such as being more compact and lighter than nozzle devices having lengthier through-holes.

[0036] FIG. 6 shows a model of aerosol flowing through an example of a nozzle that is constructed according to principles of the disclosure. Nozzle device 600 is shown having inlet region 670, exit region 680, and throat region 690, which are shaped similarly to those of FIG. 3. Flow is indicated in FIG. 6 by shading of regions that each have a different color

(shown in cross-hatching in FIG. 6), which represents a simplification of individually colored streamlines generated by the actual modeling. Each color (or hatching) indicates a different velocity, as indicated by legend 602. The aerosol includes fast flow region 610, decelerating flow region 620, and accelerating flow region 630. By manipulating the speed of the flow, the shear forces acting on the characteristics of the aerosol can be controlled. Higher shear forces tend to produce smaller particles, while lower shear force may result in larger ones. Resulting shear forces depend on the nature of the incoming aerosol. Lower shear force areas may leave inflowing aerosol unchanged, depending on characteristics of inflow. Appropriately controlling both high shear and low shear forces simultaneously in the nozzle at characteristic flow rates commensurate with product use produces desirable particle size and consumer experience.

[0037] Slow moving flow is modeled with lighter hatched regions, while fast moving flow is modeled with heavier hatched regions. Specifically, as shown in FIG. 6 with lighter hatched regions, aerosol may move slower at the beginning of inlet region 670 and the ending of exit region 680. In such slow moving regions, the aerosol may experience reduced friction and less shear forces, which may not act to change particle size. The aerosol may be accelerated by the curved walls of inlet region 670 to a maximum speed that may occur in throat region 690, as shown with a lighter hatched region. In such a fast moving region, the aerosol may experience increased friction and more shear forces, which may be conducive to smaller particle sizes. At the outlet of throat region 690, the aerosol may be significantly decelerated by the outwardly funnel-shaped walls of the exit region. Decelerating the flow reduces the exit velocity of the aerosol, allowing for more effective delivery of aerosol to the user and less hitting back of the throat or a soft palate. Furthermore, cone-shaped exit regions also spread the cloud of aerosol leaving the nozzle device. It has been found that slowing of the particle velocity with an exit cone may reduce speed without an associated effect on particle size. Generally, any opening of the exit region slows the particle speed. However, if the exit region is opened too much, it is possible that undesirable effects will be generated, such as vacuum or boundary layer effects that will cause turbulence or change the particle size. For example, at too slow of speeds, the particles may join together, increasing the particle size. It has been found that an exit angle α (FIG. 2) of thirty degrees slows the particles in a fashion to achieve desirable user experiences. Similar desirable effects are achieved at other angles, such as at fifteen degrees.

[0038] FIG. 7 shows another model of aerosol flowing through another example of a nozzle that is constructed according to principles of the disclosure. Nozzle device 700 is shown having inlet region 770, exit region 780, and throat region 790, which are shaped similarly to those of FIG. 4. The aerosol includes fast flow region 710, decelerating flow region 720, and accelerating flow region 730, as indicated with different colored (shown in grayscale in FIG. 7) regions indicated by legend 702.

[0039] FIG. 7 shows similar regions of acceleration, fast flow, and deceleration as is shown in FIG. 6. However, in FIG. 7, inlet region 770 is shorter in length than inlet region 670 of FIG. 6, and exit region 780 is longer than exit region 680 of FIG. 6. Thus, accelerating flow region 730 is much more compact, resulting in more uneven velocity distribution in fast flow region 710. Also, due to the uneven velocity distribution in throat region 790 and the shape of exit region 720, deceleration flow region 720 does not reduce the velocity as much or as uniformly as compared to exit region 620 of FIG. 6. The configuration of nozzle device 700 as compared to nozzle device 600 might provide a user with a more forceful draw experience. As mentioned previously, the resulting user experiences generated by the nozzles of FIGS. 6 and 7 represent only two specific user experiences, and the resulting user experience can be adjusted, almost infinitely, by adjusting the number of flow regions provided and the geometry of each flow region.

[0040] FIGS. 8A and 8B show a fragmentary, side-isometric view and a fragmentary, cross-sectional view, respectively, of electronic smoking device 800, which is an example of an eCig that may include a nozzle device according to the principles of the disclosure, such as nozzle device 100. FIGS. 8C and 8D show exploded schematic and isometric views, respectively, of the example eCig of FIGS. 8A and 8B illustrating components of the eCig, such as heater subassembly 802, batting 804A and 804B, battery 806, sensor and processor subassembly 808, and housing 810. FIGS. 8A - 8D show only one example embodiment of an electronic smoking device that may be used with the nozzle devices of the present disclosure. The nozzle devices of the present disclosure may be used with nearly any type of electronic smoking device, such as those using other types of vaporizers.

[0041] Liquid area separator 812 and spacer 814 facilitate organizing of other components in device 800. Heater tube 816 is mounted on liquid area separator 812. Heater wick 818 is fluidly connected to batting 804A and 804B through heater tube 816 and connected to heater subassembly 802. Inner batting 804A is wrapped around heater tube 816, heater subassembly 802 and heater wick 818. Outer batting 804B is wrapped around inner

bating 804A and is itself wrapped in tube 820. Spacer 814 separates battery 806 to be brought into engagement with liquid area separator 812 and sensor and processor subassembly 808. Lens 822 is mounted to housing 810 adjacent sensor and processor subassembly 808. Inlet 824 allows air to enter housing 810.

[0042] As seen in FIGS. 8A and 8B, the inlet end of the nozzle device 100 may be inserted into opening 826 of housing 810, where the outer diameter of the inlet portion of the nozzle device 100 is substantially equal (but less than) the diameter of opening 826 so as to provide a snug and secure fit when nozzle device 100 is mated to device 800.

[0043] With specific reference to FIGS. 8C and 8D, liquid area separator 812 provides separation of the liquid area while allowing heater subassembly 802 to pass through and align heater tube 816 within device 800, which extends along a central axis. Liquid area separator 812 includes a larger diameter portion that is secured against the interior of housing 810 to immobilize the components therein. A smaller diameter portion of liquid area separator 812 provides for alignment of heater tube 816. Heater tube 816 comprises a sleeve of woven material, such as non-permeable fiberglass, that separates the liquid area from the airflow path. Heater wick 818 also comprises a woven material, such as fiberglass, that draws fluid from inner batting 804A and outer batting 804B to heater subassembly 802 for vaporization. Inner batting 804A and outer batting 804B additionally help to prevent leakage. Tube 820 holds batting 804A and 804B in contact with heater tube 816 within housing 810 and may also hold the vaporizing liquid or provide an evaporation barrier.

[0044] Heater subassembly 802 includes a coil that is wrapped around heater wick 818 and electrically coupled to battery 806 via sensor and processor subassembly 808, which may comprise, for example, a processor, transistor, and sensor. As such, wires (not shown) form a circuit between battery 806 and heater subassembly 302, which is controlled by sensor and processor subassembly 808. Sensor and processor subassembly 808 includes a visual indicator, such as a light emitting diode (LED), that is activated when sensor and processor subassembly 808 is tripped or otherwise activated. Lens 822 is at least partially translucent and is positioned next to the indicator to allow a user of device 800 to see when sensor and processor subassembly 808 and, hence, heater subassembly 802 is active. In one embodiment, sensor and processor subassembly 808 may comprise a pressure activated sensor that detects the presence of flow of air into housing 810.

[0045] Liquid area separator 812 includes an interior axial passageway to allow airflow from one side of support 812 to the other along the axis of device 800. Spacer 814

also includes an interior axial passageway that allows airflow from one side of spacer 814 to the other along the axis of device 800. Spacer 814 further includes side radial porting to allow airflow from the circumference of spacer 814 into the interior, such as air from inlet 824 (FIG. 8B). Secondly, air may be allowed to enter device 800 between lens 822 and housing 810, with each component including porting as appropriate. Air is drawn out of device 800 at nozzle device 100 via a user action.

[0046] In action, a user of device 800 inhales at nozzle device 100, which causes air to be drawn into inlet 824. This produces a pressure drop at sensor and processor subassembly 808. Airflow from inlet 824 flows radially into spacer 814, axially through liquid area separator 812 and then into heater tube 816 and past heater subassembly 802. All of, or substantially all of, the air that enters device 800 exits at nozzle device 100.

[0047] Flow of air detected by sensor and processor subassembly 808 causes the indicator and heater subassembly 802 to activate. Activation of heater subassembly 802 causes the coil to heat up, thereby causing liquid in contact with the coil at heater wick 818 to vaporize into the flow of air from inlet 824. Vaporized liquid and airflow form an aerosol that travels through the through-hole of nozzle device 100 where it is influenced to provide a desired user experience, as described throughout the present disclosure and particularly with reference to FIG. 9.

[0048] FIG. 9 depicts a pair of spectral density versus particle size diagrams that comparatively illustrate the performance of an existing eCig with standard pinhole (left diagram) as compared to the same eCig with a nozzle device that is constructed according to the principles of the disclosure (right diagram). The horizontal axis indicates particle sizes and is shown in the same scale for both diagrams. The vertical axis indicates particle size frequency and is shown in different scales for each diagram, with the left diagram showing higher frequencies. As seen in the diagrams, the novel eCig device delivers greater amounts of aerosol with an improved control over modality.

[0049] The left diagram shows plot 910, which includes peak regions 912 and 914. The right diagram shows plot 916, which includes peak region 918. Each of plots 910 and 916 refer to a plurality of overlapping curves, respectively, that illustrate multiple data sets. The base of plot 910 is approximately as wide as the base of plot 916, indicating that the particle size has approximately the same range in each diagram. Also, peak 912 and peak 918 are located around the same particle size, indicating that each plot includes a majority of particles having the same diameter. However, peak 912 is much greater in magnitude than

peak 918 of plot 910 (diagrams are not drawn to same scale), indicating that plot 910 includes many more particles at the same particle size. Additionally, peak 914 of plot 910 is much greater in magnitude at that particular particle size as compared to plot 916.

[0050] FIG. 9 illustrates that it is possible to adjust the modality of the particle size to achieve different aerosol characteristics that influence the user experience of the electronic smoking device. The particles generated by the different nozzles of the left and right diagrams have a much different modality than each other, as indicated by the shape of plots 910 and 916. Modality can generally include some or all of factors such as the distribution, particle frequencies, peaks and range of a particular plot. Differing modality may provide a differing user experiences, including variations of mouth feel, flavor, impact, draw characteristics, and exhale characteristics. Along with the velocity tailoring that can be achieved with the various nozzle devices described herein, a wide variety of user experiences can be provided by varying the geometry of the through-holes within a nozzle device.

[0051] FIGS. 10A - 17B illustrate various examples of patterns that may be provided on a surface of a nozzle device that is constructed according to the principles of the disclosure. A purpose of such patterns may include an indication of the function of the internal design of the nozzle through-hole. Additionally, each pattern may provide a tactile feel of the nozzle device to a user of an electronic smoking device. The tactile feel may be for various purposes, such as an identifier of the function of the internal design of the nozzle, or simply a pleasant or desirable sensation. FIGS. 10A - 17B illustrate examples of patterns that may be provided on the surface of the nozzle device, or the outlet end of the nozzle device so as to be visible when assembled with a housing, as are described with reference to an example nozzle device connected to an example electronic smoking device.

[0052] FIGS. 10A and 10B show a "twisted" pattern on the outlet end of nozzle device 1001. Electronic smoking device 1000 includes housing 1002, to which nozzle device 1001 is connected. Nozzle device 1001 includes first substantially planar surface 1003, inlet disk 1016, and through-hole 1014, which penetrates first substantially planar surface 1003 at inlet 1005. Portions of nozzle device 1001, such as an exit disk similar to exit disk 150 of FIG. 1C, are disposed within housing 1002 such that inlet disk 1016 is pressed against housing 1002 in order to retain nozzle device 1001 with device 1000.

[0053] The pattern in first substantially planar surface 1003 comprises depressed portions (e.g., trenches) 1004 and raised portions (e.g., protrusions) 1006. Depressed portions 1004 are recessed into substantially planar surface 1003 a small amount such that the

pattern is perceptible from both a visual and tactile perspective. Specifically, depressed portions 1004 have a depth giving rise to a three-dimensional pattern that can be felt with a finger of a user. Additionally, raised portions 1006 can be felt with the tongue of a user when electronic smoking device 1000 and nozzle device 1001 are brought to the mouth of a user.

[0054] With specific reference to FIG. 10B, trenches 1004 comprise spiral portion 1008 that is interweaved with vortex ray portions 1010A - 1010F. Spiral portion 1008 begins at inlet 1005 and extends in a helical fashion to the outer diameter of first substantially planar surface 1010. Each of vortex ray portions 1010A - 1010F extends from inlet 1005 to the outer diameter of first substantially planar surface 1003 in an arcuate manner. In the embodiment of FIGS. 10A and 10B, portion 1008 and portions 1010A - 1010F have the same depth, but need not in other embodiments. The visual pattern represented by spiral portion 1008 and vortex ray portions 1010A - 1010F can be uniquely associated with the geometry of, and hence the user experience associated with, through-hole 1014, such as any of the geometries described and shown in FIGS. 1B, 2B, 3, 4 or 5, or any other through-hole geometry.

[0055] FIGS. 11A and 11B show an "after math" pattern on the outlet end of nozzle device 1101. Smoking device 1100 includes housing 1102 to which nozzle device 1101 is connected. Nozzle device 1101 includes first planar surface 1103, inlet disk 1116, and through-hole 1114. FIGS. 11A and 11B include the same pattern as FIGS. 10A and 10B, but the depth of spiral portion 1108, formed from depressed portions 1104 in raised portions 1106, is different from the depth of vortex ray portions 1010A - 1010F. In the particular embodiment shown, spiral portion 1108 is deeper than vortex ray portions 1110A - 1110F.

[0056] FIGS. 12A and 12B show a "spiral" pattern on the outlet end of nozzle device 1201. Smoking device 1200 includes housing 1202 to which nozzle device 1201 is connected. Nozzle device 1201 includes first planar surface 1203, inlet disk 1216, and through-hole 1214. FIGS. 12A and 12B are similar to the pattern of FIGS. 10A - 10B, but vortex ray portions 1810A - 1810F are omitted, so that depressed portions 1204 only comprise spiral portion 1208 in raised portions 1206.

[0057] FIGS. 13A and 13B show a "hurricane" pattern on the outlet end of nozzle device 1301. Smoking device 1300 includes housing 1302 to which nozzle device 1301 is connected. Nozzle device 1301 includes first planar surface 1303, inlet disk 1316, and through-hole 1314. Depressed portions 1304 and raised portions 1306 form the "hurricane"

pattern. As shown in FIG. 13B, depressed portions 1304 comprise a single contiguous blade shape 1312 resembling disjointed overlapping portions of a ying-yang shape.

[0058] FIGS. 14A and 14B show a "tornado" pattern on the outlet end of nozzle device 1401. Smoking device 1400 includes housing 1402 to which nozzle device 1401 is connected. Nozzle device 1401 includes first planar surface 1403, inlet disk 1416, and through-hole 1414. Depressed portions 1404 and raised portions 1406 form the "tornado" pattern. As shown in FIG. 14B, depressed portions 1404 comprise a pair of Fibonacci spirals 1415 emanating from through-hole 1414.

[0059] FIGS. 15A and 15B show a "Vortex" pattern on the outlet end of nozzle device 1501. Smoking device 1500 includes housing 1502 to which nozzle device 1501 is connected. Nozzle device 1501 includes first planar surface 1503, inlet disk 1516, and through-hole 1514. Depressed portions 1504 and raised portions 1506 form the "vortex" pattern. As shown in FIG. 15B, depressed portions 1504 comprise a plurality of identical curve lengths or arcs 1517 emanating from through-hole 1504. In the illustrated embodiment, there are eight arcs 1517 equally spaced around through-hole 1514.

[0060] FIGS. 16A and 16B show a "twister" pattern on the outlet end of nozzle device 1601. Smoking device 1600 includes housing 1602 to which nozzle device 1601 is connected. Nozzle device 1601 includes first planar surface 1603, inlet disk 1616, and through-hole 1614. Depressed portions 1604 form vortex ray portions 1610A - 1610F in raised portions 1606. FIGS. 16A and 16B are similar to the pattern of FIGS. 10A - 10B, but spiral portion 1808 is omitted, so that depressed portions 1604 only comprise vortex ray portions 1610A - 1610F.

[0061] FIGS. 17A and 17B show an "impeller" pattern on the outlet end of nozzle device 1701. Smoking device 1700 includes housing 1702 to which nozzle device 1701 is connected. Nozzle device 1701 includes first planar surface 1703, inlet disk 1716, and through-hole 1714. Depressed portions 1704 form vortex ray portions 1718A - 1718F in raised portions 1706. FIGS. 17A and 17B are similar to the pattern of FIGS. 16A and 16B, but instead of there being six vortex ray portions 1610A - 1610F, there are four vortex ray portions 1718A - 1718D. Vortex ray portions 1718A - 1718D are equally spaced around through-hole 1714 and are wider than vortex ray portions 1610A - 1610F.

[0062] Any of the patterns of FIGS. 10A - 17B may be used to uniquely represent a design of a nozzle device and the particular through-hole provided therein. As such, users can select a nozzle device that provides them with an enhanced or different user experience

based on external indicia. FIGS. 10A - 17B provide only a select few patterns that may be used. Other embodiments may any type of pattern that provides a visual and/or tactile indication of an internal feature of the nozzle device.

[0063] FIGS. 18A and 18B illustrate a top view and a side cross-sectional view, respectively, of nozzle device 1800, which comprises another example of a nozzle device that is constructed according to the principles of the disclosure. Nozzle device 1800 may include a plurality of through-holes 1810. As shown in FIG. 18B, one or more (or all) of through-holes 1810 may include a substantially hourglass shape, similar to through-hole 240 (shown in FIG. 2B). Nozzle device 1800 may further include optional protrusion 1820, which may be configured and positioned to assist in directing the flow direction of aerosol entering (or exiting) nozzle device 1800. For example, in the illustrated embodiment, protrusion 1820 is centrally positioned on an inlet surface of nozzle device 1800 to facilitate flow of air into through-holes 1810.

[0064] The plurality of through-holes 1810, while not providing the same sheer force control of the hourglass-like shape, have the benefit of controlling the flow rate by virtue of their increased wall surface area relative to the surface area the holes create on planar surface 1830. This increased surface area creates a boundary layer effect, thus limiting the speed of the flow.

[0065] FIG. 18C illustrates an alternative embodiment of the nozzle device of FIG. 18B. In FIG. 18C, nozzle device 1800' includes a plurality through-holes 1810', each of which has an hourglass-like shape.

[0066] The disclosure and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments and examples that are described and/or illustrated in the accompanying drawings and detailed in the description. It should be noted that the features illustrated in the drawings are not necessarily drawn to scale, and features of one embodiment may be employed with other embodiments as the skilled artisan would recognize, even if not explicitly stated herein. Descriptions of well-known components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments of the disclosure. The examples used herein are intended merely to facilitate an understanding of ways in which the disclosure may be practiced and to further enable those of skill in the art to practice the embodiments of the disclosure. Accordingly, the examples and embodiments herein should not be construed as limiting the scope of the disclosure.

Moreover, it is noted that like reference numerals represent similar parts throughout the several views of the drawings.

[0067] The terms "including," "comprising" and variations thereof, as used in this disclosure, mean "including, but not limited to," unless expressly specified otherwise.

[0068] The terms "a," "an," and "the," as used in this disclosure, means "one or more," unless expressly specified otherwise.

[0069] Devices that are in communication with each other need not be in continuous communication with each other, unless expressly specified otherwise. In addition, devices that are in communication with each other may communicate directly or indirectly through one or more intermediaries.

[0070] Although process steps, method steps, algorithms, or the like, may be described in a sequential order, such processes, methods and algorithms may be configured to work in alternate orders. In other words, any sequence or order of steps that may be described does not necessarily indicate a requirement that the steps be performed in that order. The steps of the processes, methods or algorithms described herein may be performed in any order practical. Further, some steps may be performed simultaneously.

[0071] When a single device or article is described herein, it will be readily apparent that more than one device or article may be used in place of a single device or article. Similarly, where more than one device or article is described herein, it will be readily apparent that a single device or article may be used in place of the more than one device or article. The functionality or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality or features.

CLAIMS

What is claimed is:

1. A flow discharge device for an electronic smoking device, the flow discharge device comprising the following:
 - a body configured for assembly with a housing of an electronic smoking device, the body having a first surface and a second surface; and
 - a through-hole extending from the first surface to the second surface, the through-hole being shaped to adjust characteristics of flow between the first surface and the second surface.
2. The flow discharge device of claim 1, wherein the body comprises a mouthpiece of an electronic cigarette.
3. The flow discharge device of claim 1, wherein the through-hole comprises the following:
 - an exit located in the first surface;
 - an inlet located in the second surface, wherein the second surface is positioned on the body for insertion into the electronic smoking device; and
 - a throat positioned between the exit and inlet.
4. The flow discharge device of claim 3, wherein the through-hole has an hourglass-like shape.
5. The flow discharge device of claim 4, wherein the inlet has a larger diameter than that of the exit, and the throat has a smaller diameter than those of the exit and inlet.
6. The flow discharge device of claim 5, wherein the throat has a diameter in the range of about 1.0 mm to about 3.0 mm.
7. The flow discharge device of claim 4, wherein:
 - an inlet region of the through-hole between the inlet and the throat has a curved shape;

- an exit region of the through-hole between the throat and the exit has a cone shape; and
a throat region between the inlet and exit regions has a cylindrical shape.
8. The flow discharge device of claim 4, wherein:
an inlet region of the through-hole between the inlet and the throat has a first length;
an exit region of the through-hole between the throat and the exit has a second length; and
a throat region between the inlet and exit regions has a third length;
wherein the second length is longer than the third length, and the third length is longer than the first length.
9. The flow discharge device of claim 8, wherein:
the first length is in the range from about 0.75 mm to about 2.0 mm;
the second length is in the range from about 1.0 mm to about 4.0 mm; and
the third length is in a range from about 0.75 mm to about 3.0 mm.
10. The flow discharge device of claim 4, wherein:
an inlet region of the through-hole between the inlet and the throat is shaped to accelerate flow velocity; and
an exit region of the through-hole between the throat and the exit is shaped to decelerate flow velocity.
11. The flow discharge device of claim 3, wherein the through-hole comprises a cylindrical throat region and a diverging exit region.
12. The flow discharge device of claim 11, wherein the diverging exit region comprises a conical section having an exit angle of fifteen degrees or thirty degrees.
13. The flow discharge device of claim 1, wherein the first surface includes a pattern indicative of the through-hole shape.

14. The flow discharge device of claim 13, wherein the pattern has a depth into the first surface.
15. The flow discharge device of claim 1, wherein the body further includes a plurality of ribs extending from the first surface to the second surface along a length of the through-hole.
16. The flow discharge device of claim 1, wherein the body includes a cylindrically-shaped wall between the first and second surfaces.
17. The flow discharge device of claim 1, further comprising a plurality of through-holes extending from the first surface to the second surface, the plurality of through-holes collectively being shaped to adjust characteristics of flow between the first surface and the second surface.
18. The flow discharge device of claim 17, wherein the body further includes a protrusion positioned to direct flow toward at least one of the plurality of through-holes.
19. An electronic cigarette comprising the following:
 - an elongate cylindrical housing;
 - a battery disposed in the housing;
 - a liquid storing area disposed in the housing;
 - an atomizer powered by the battery and configured to receive a liquid from the liquid storing area in order to generate an aerosol; and
 - a mouthpiece connected to an end of the elongate cylindrical housing and having a nozzle disposed to receive aerosol drawn from the atomizer, the nozzle having a throat region and a diverging region downstream of the throat region.
20. The electronic cigarette of claim 19, wherein the nozzle includes an inlet opening located within the housing, and an exit opening located outside of the housing.

21. The electronic cigarette of claim 19, wherein the nozzle includes a converging inlet section.
22. The electronic cigarette of claim 19, wherein the mouthpiece includes a three-dimensional pattern visible from outside of the electronic cigarette when assembled with the elongate cylindrical housing.
23. The electronic cigarette of claim 19, wherein the mouthpiece includes a plurality of through-holes.
24. The electronic cigarette of claim 19, wherein the nozzle has a conical exit region with an exit angle of fifteen degrees or thirty degrees.
25. A method for controlling aerosol discharge in an electronic smoking device, the method comprising the following:
drawing air into an electronic smoking device;
generating an aerosol using the air and an atomizer disposed within the electronic smoking device;
drawing the aerosol into a shaped passage through a mouthpiece of the electronic smoking device; and
adjusting characteristics of the aerosol with the shaped passage as the aerosol passes through the mouthpiece.
26. The method of claim 25, wherein adjusting characteristics of the aerosol comprises controlling flow velocity of the aerosol.
27. The method of claim 25, wherein adjusting characteristics of the aerosol comprises controlling flow direction of the aerosol.
28. The method of claim 25, wherein adjusting characteristics of the aerosol comprises controlling uniformity in particle size of the aerosol.

29. The method of claim 25, wherein adjusting characteristics of the aerosol comprises the following:
accelerating flow of the aerosol in an inlet region of the shaped; and
decelerating the flow of the aerosol in an exit region of the shaped passage.
30. The method of claim 29, wherein adjusting characteristics of the aerosol comprises passing the aerosol through a shaped passage having an hourglass-like shape.
31. The method of claim 25, wherein adjusting characteristics of the aerosol comprises decelerating the flow of the aerosol in an exit region of the shaped passage.

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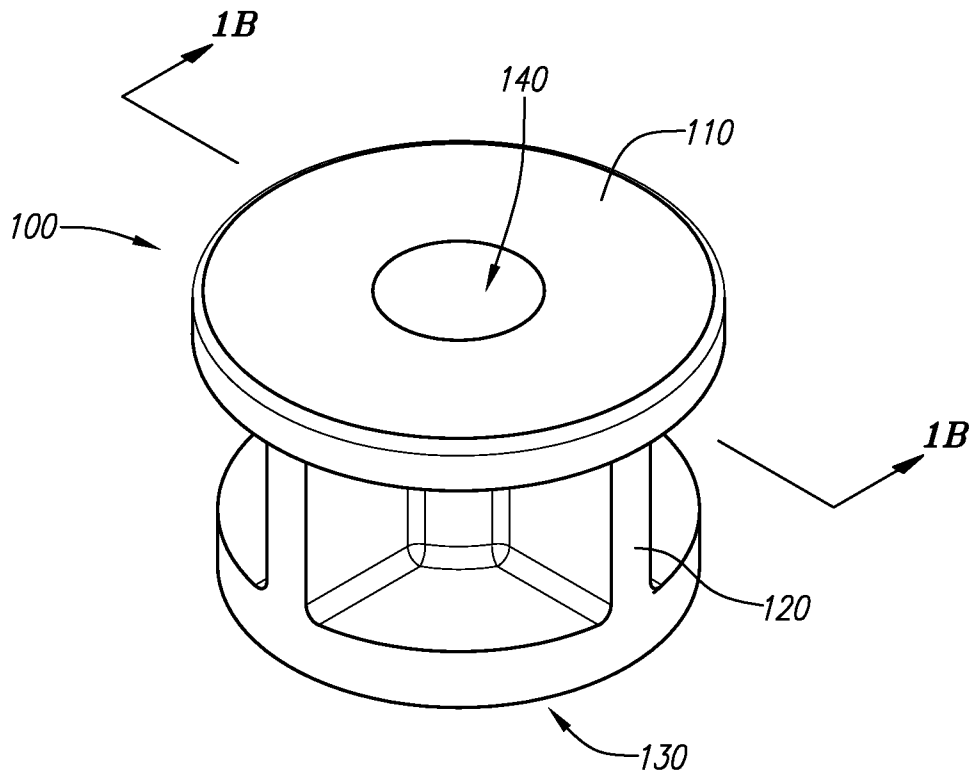


FIG. 1A

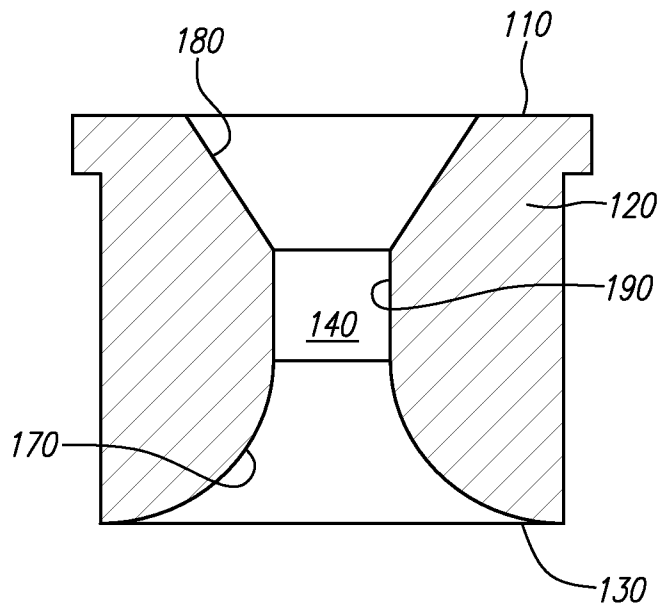


FIG. 1B

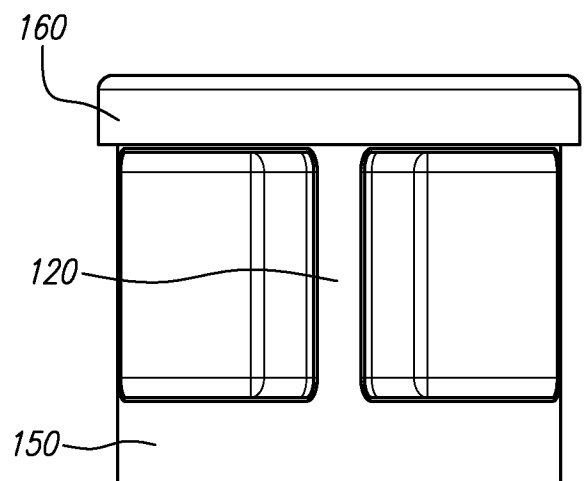


FIG. 1C

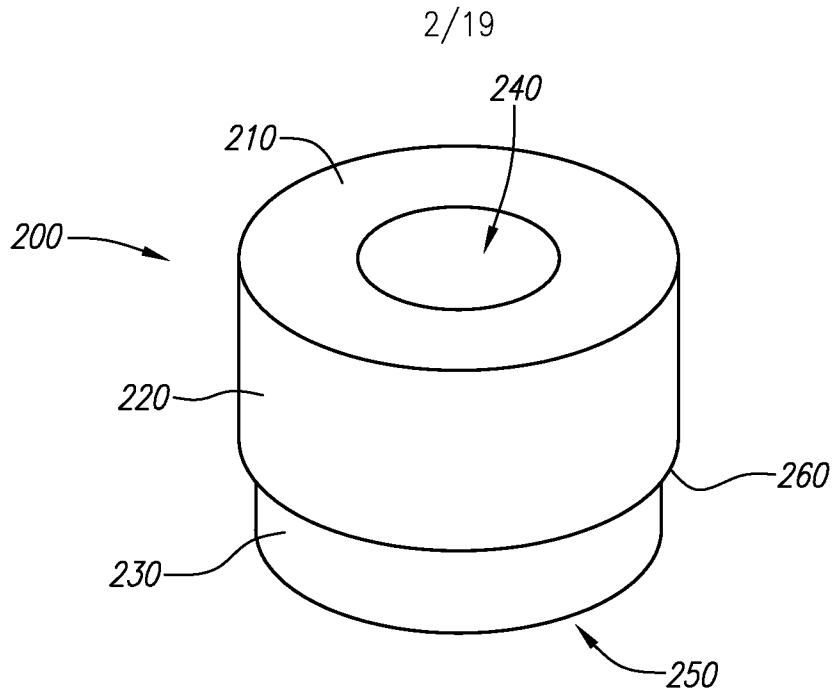


FIG. 2A

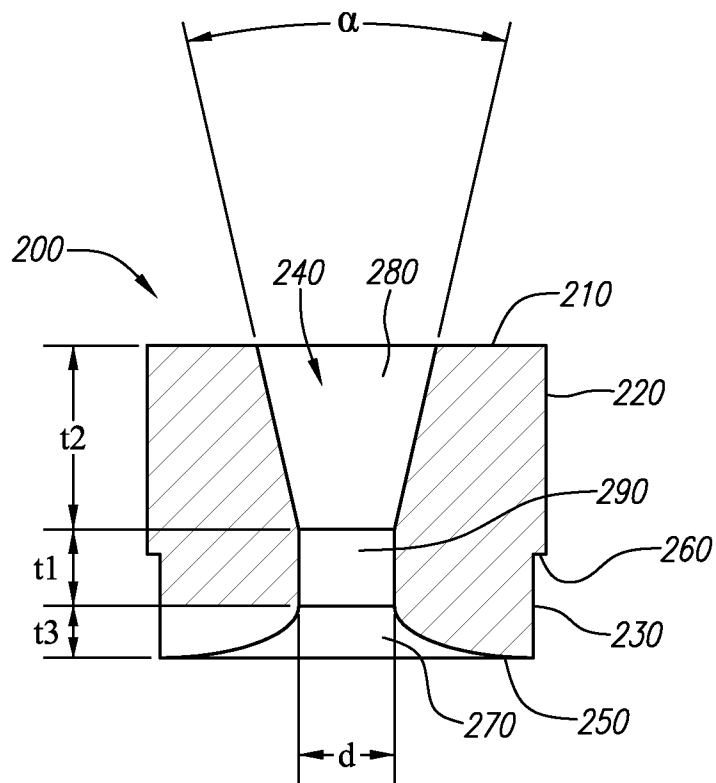


FIG. 2B

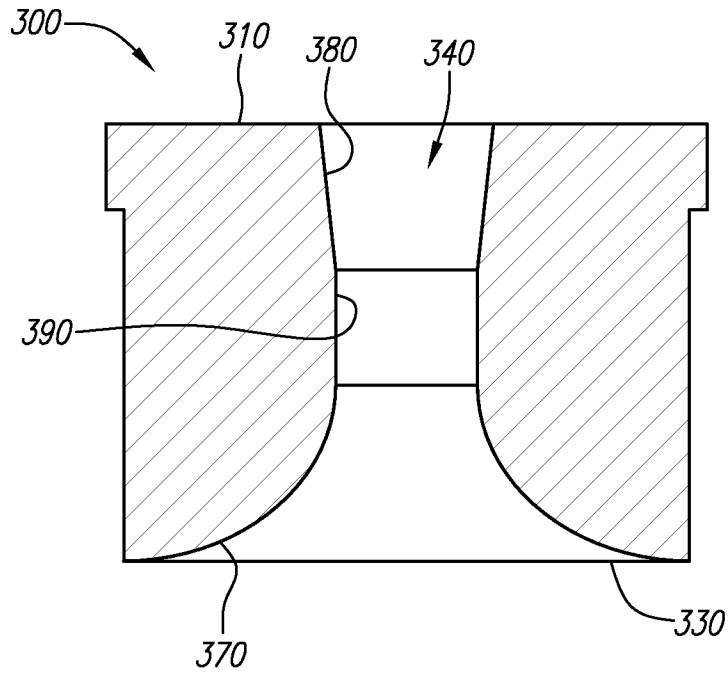


FIG. 3

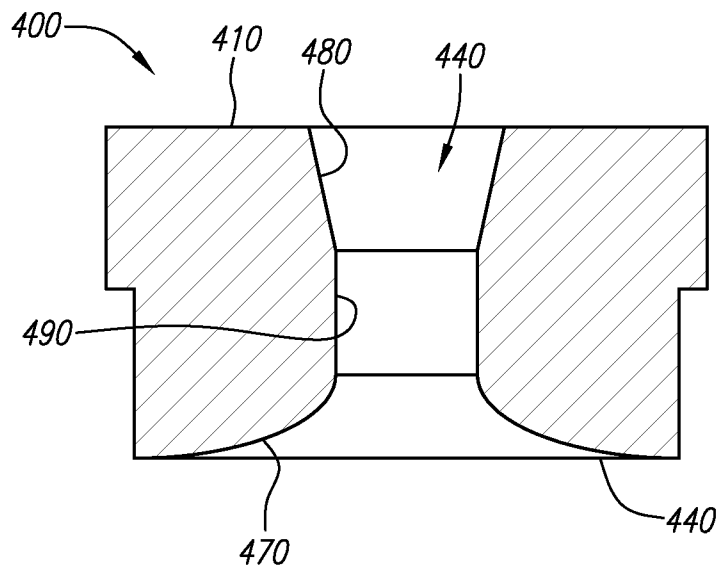


FIG. 4

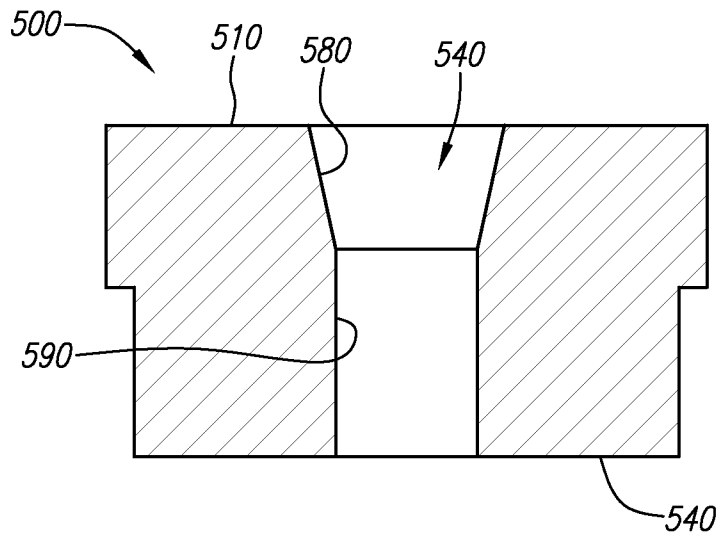


FIG. 5

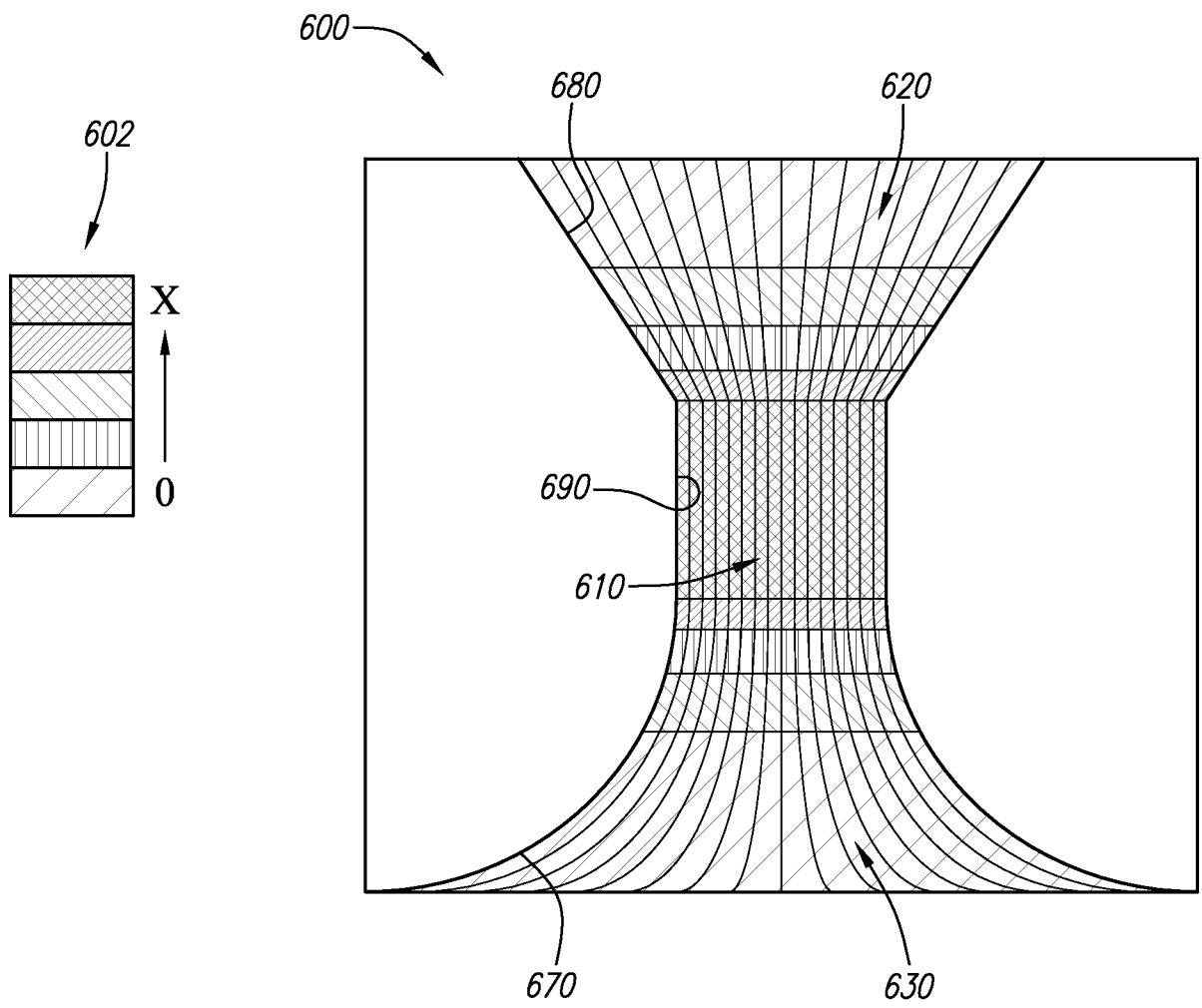


FIG. 6

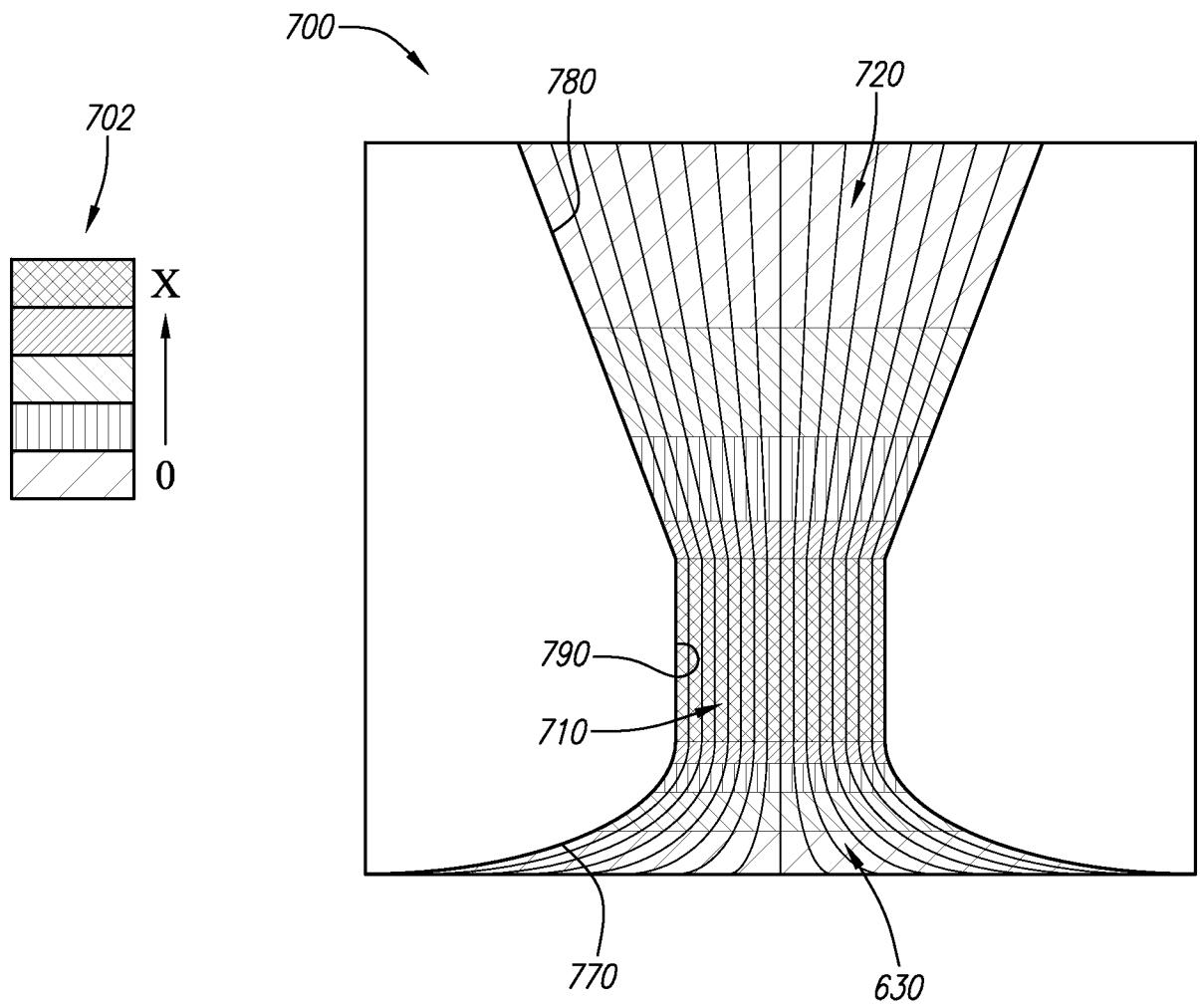


FIG. 7

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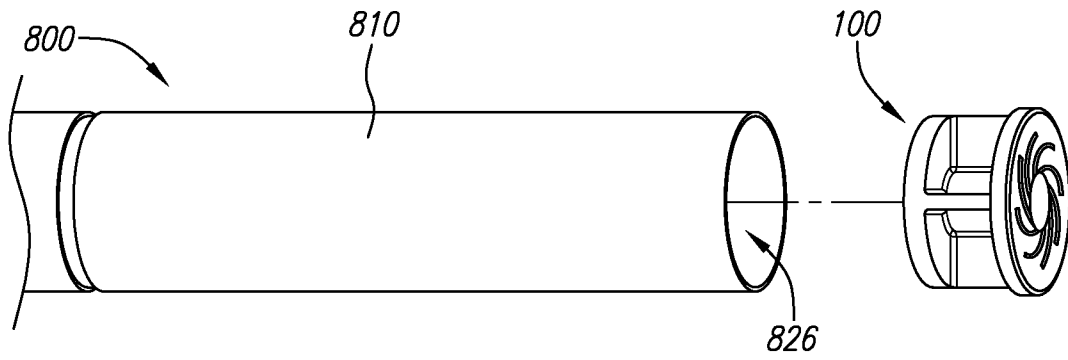


FIG. 8A

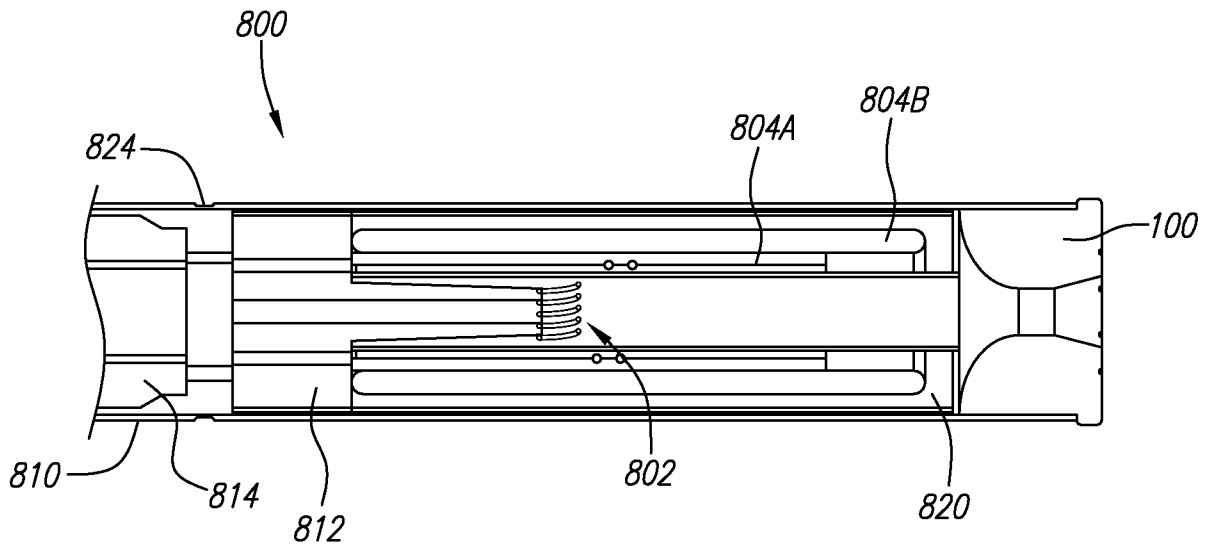


FIG. 8B

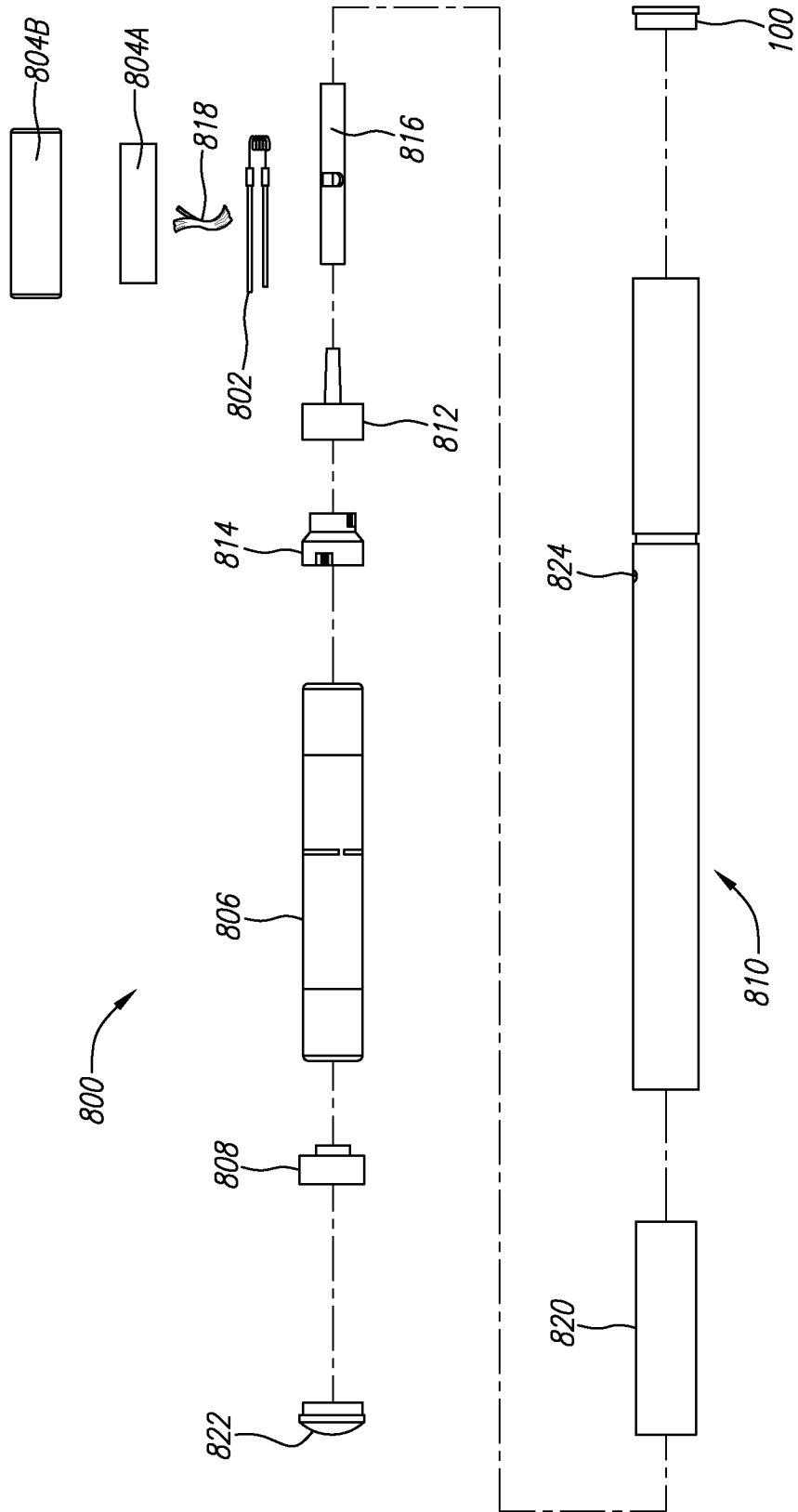


FIG. 8C

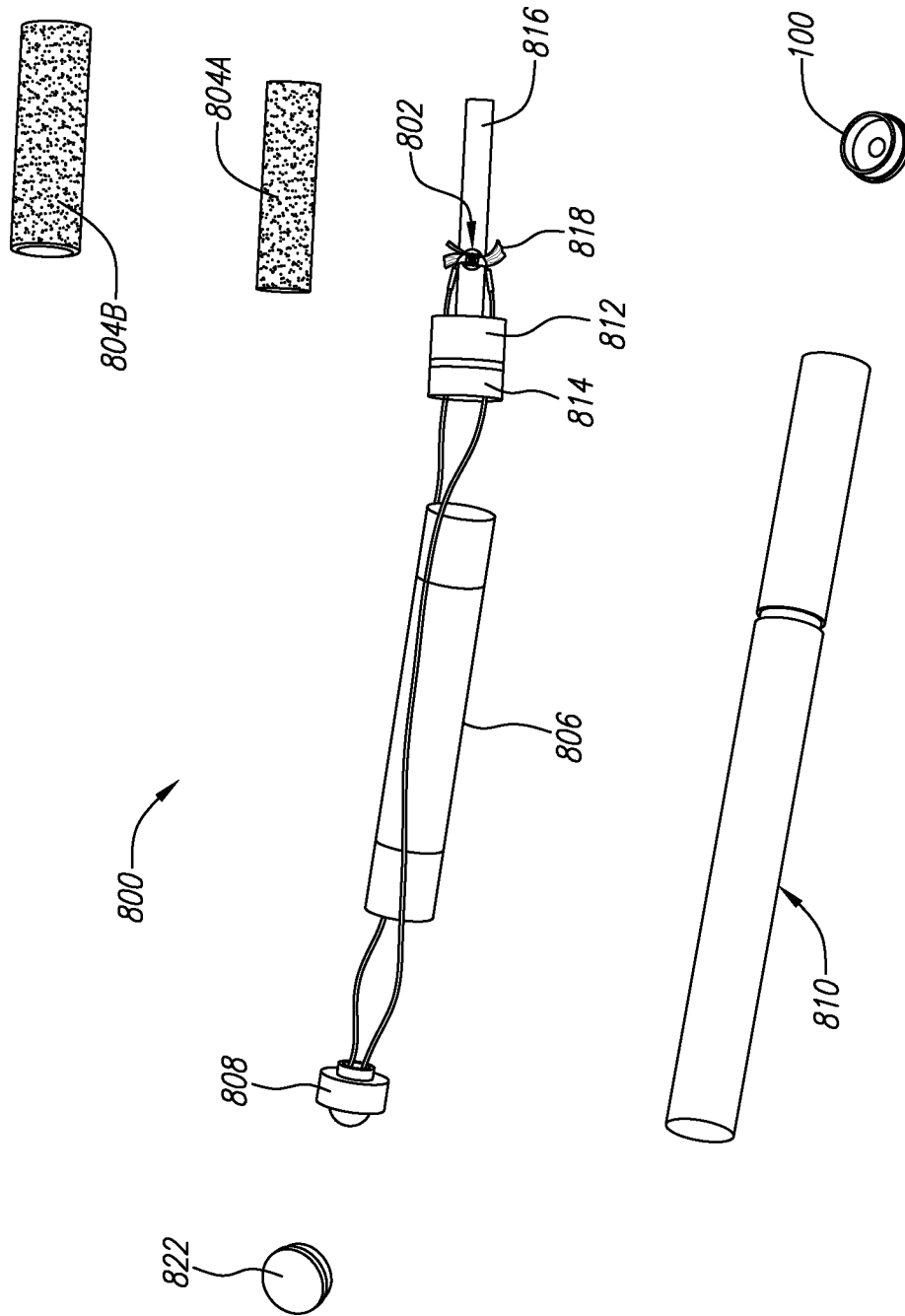


FIG. 8D

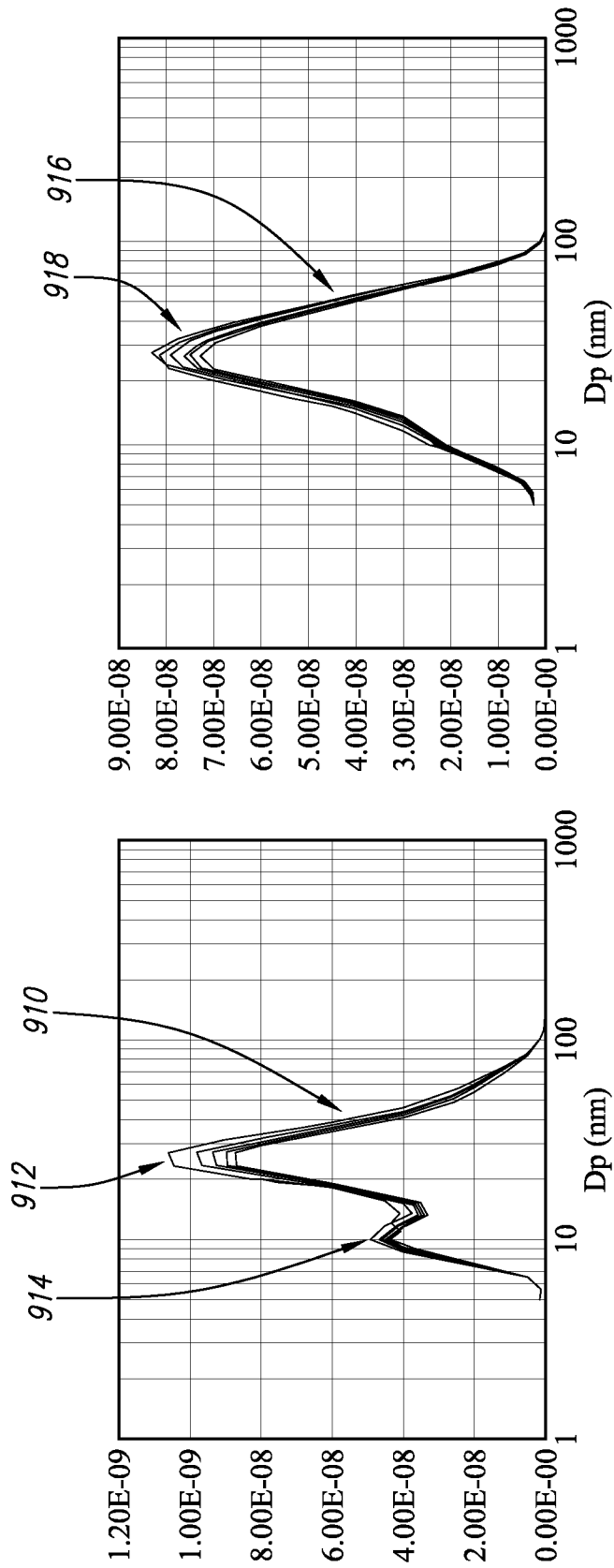


FIG. 9

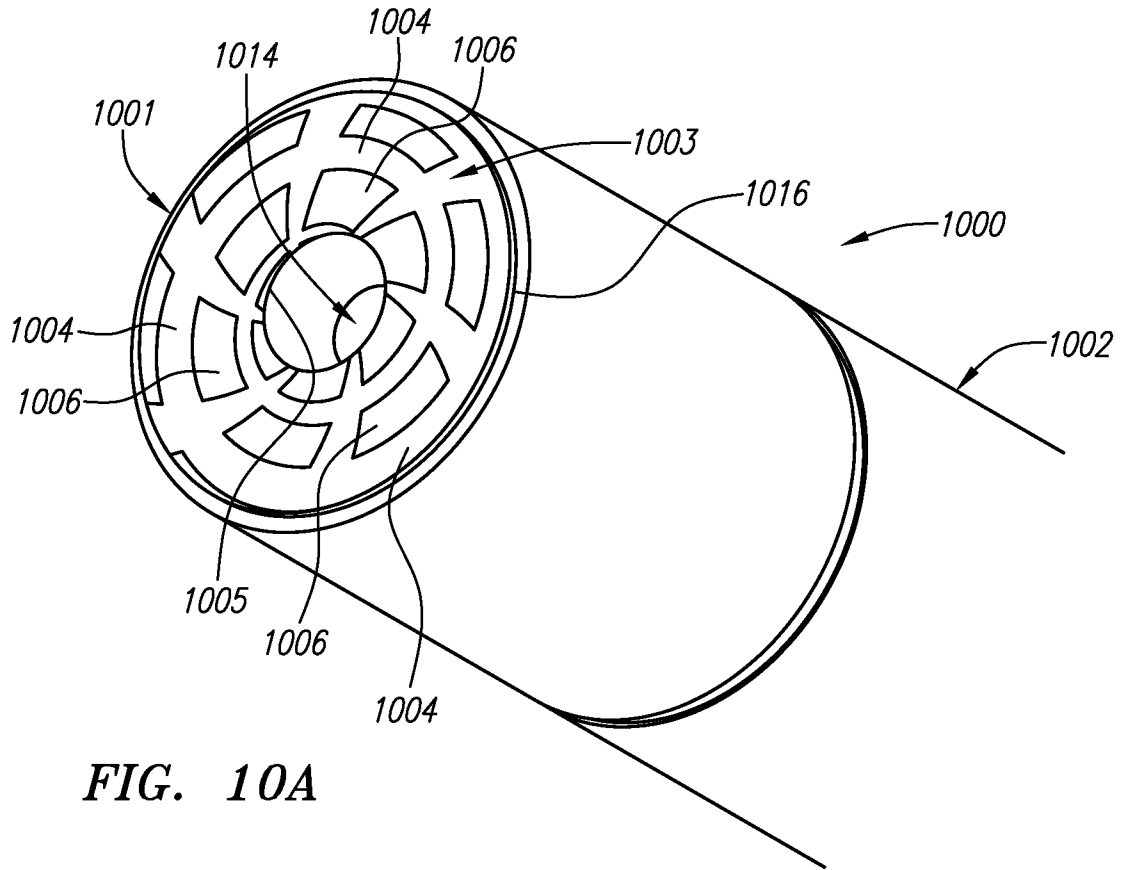


FIG. 10A

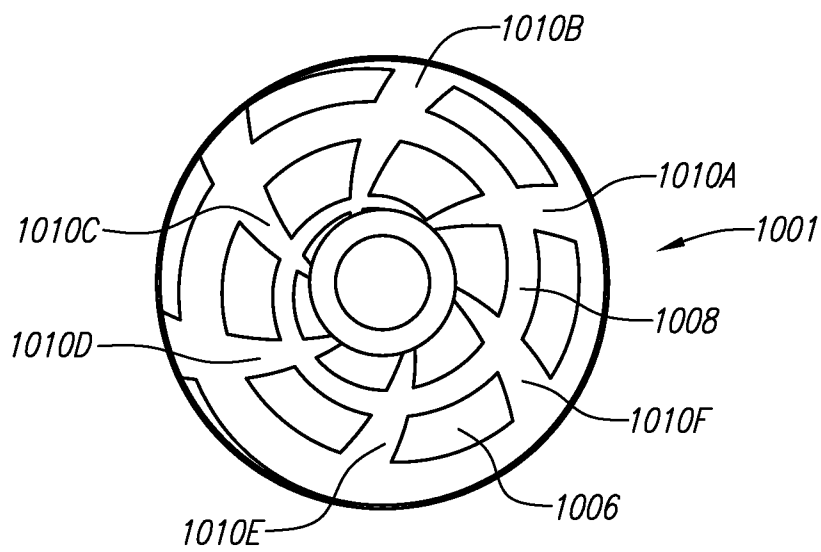
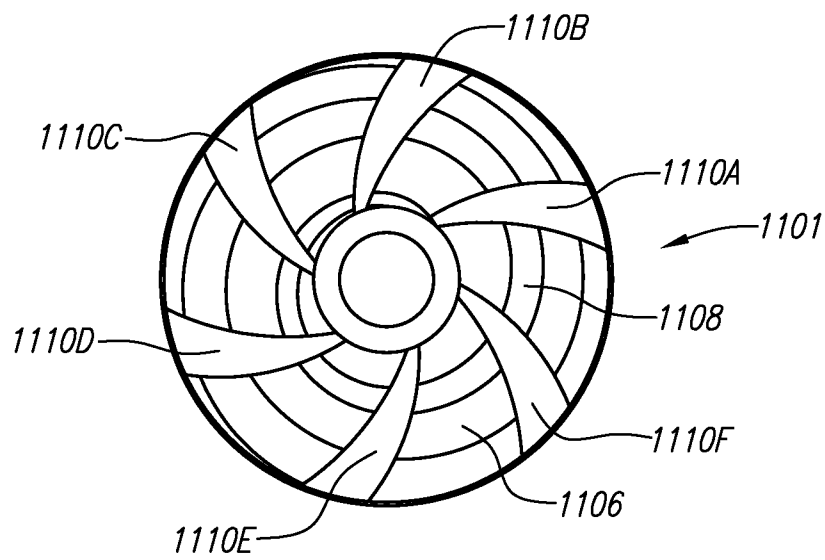
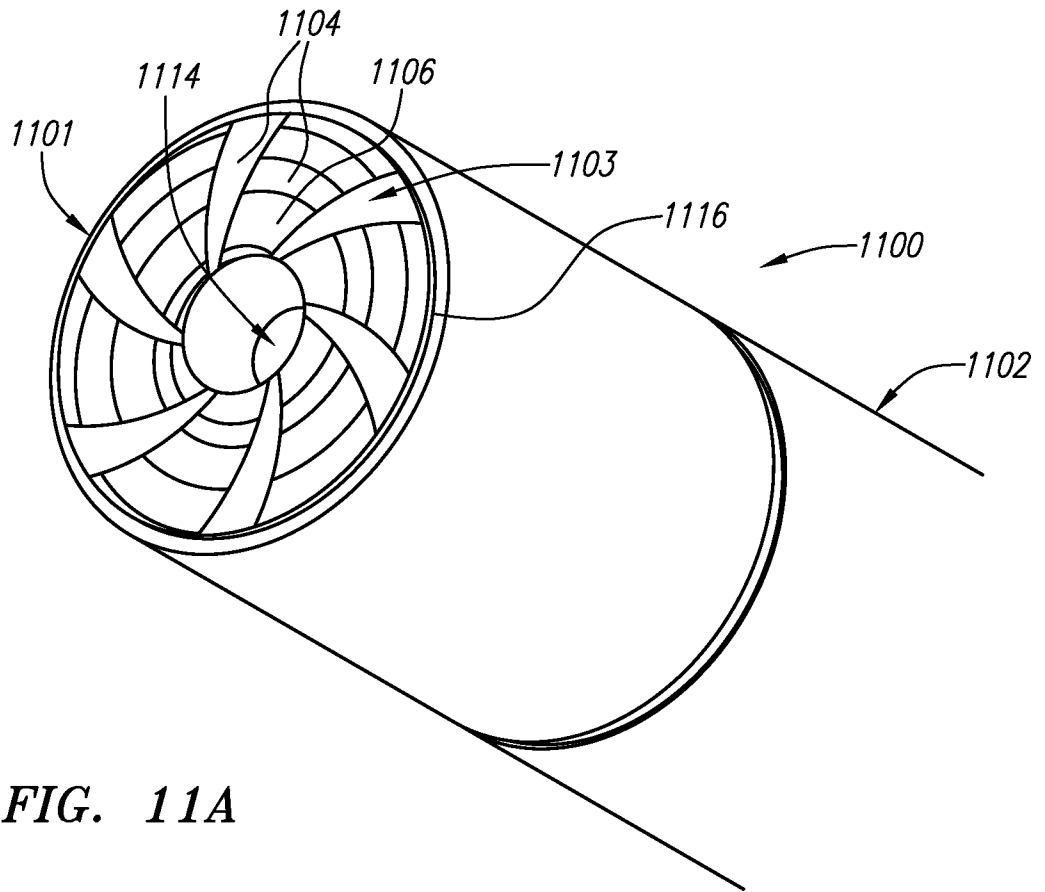


FIG. 10B



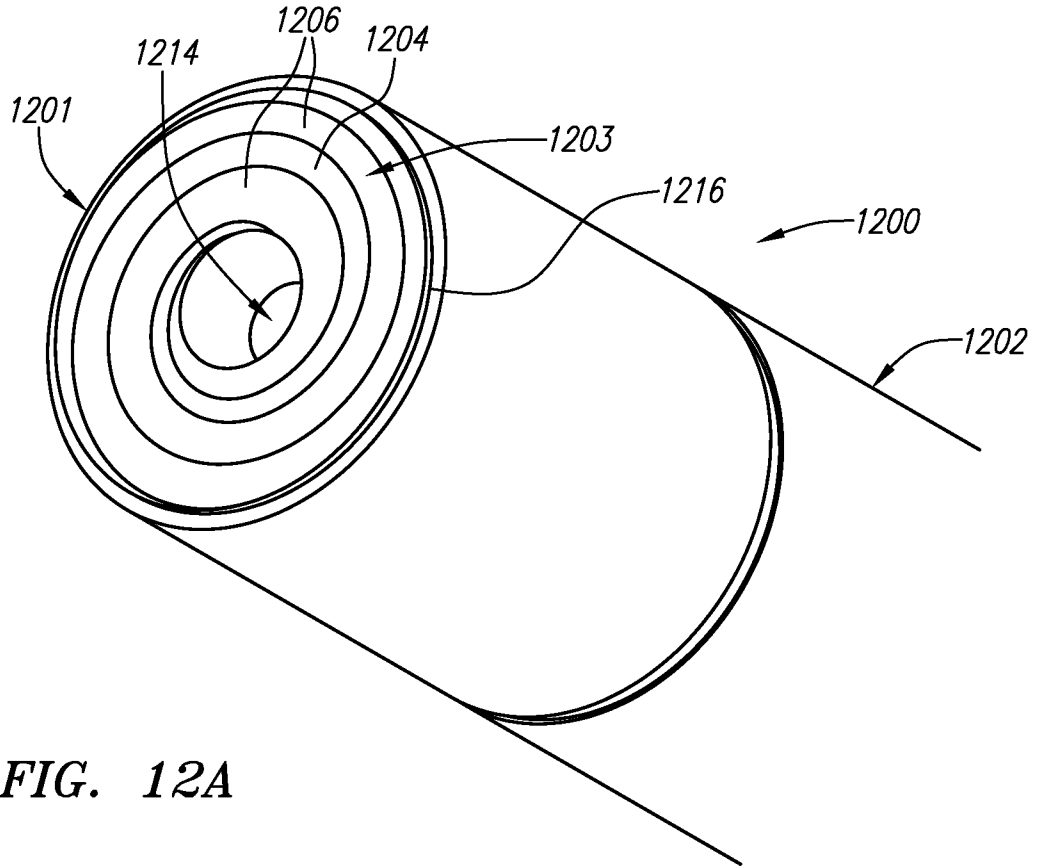


FIG. 12A

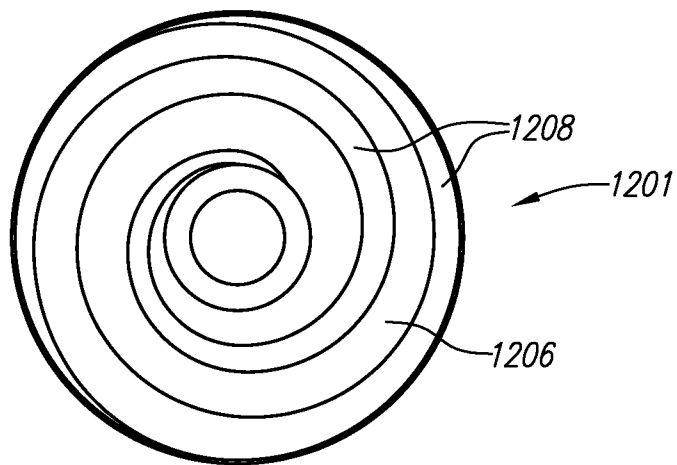


FIG. 12B

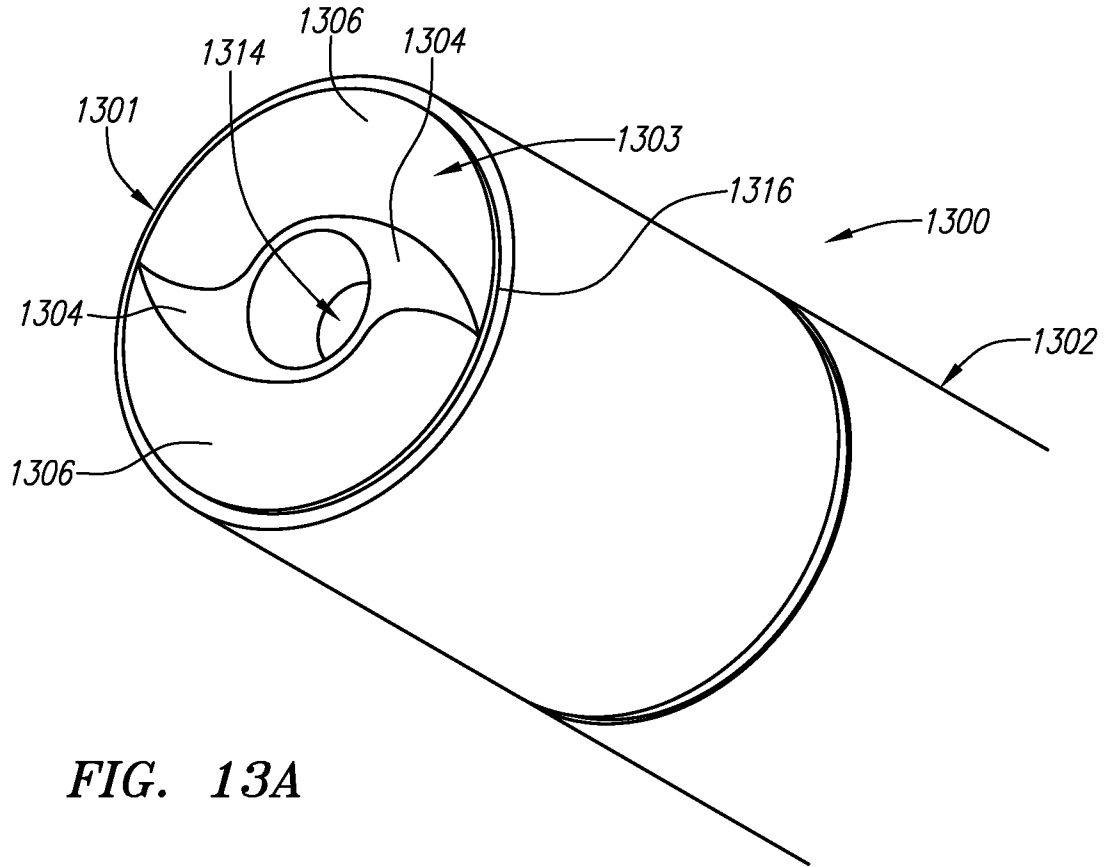


FIG. 13A

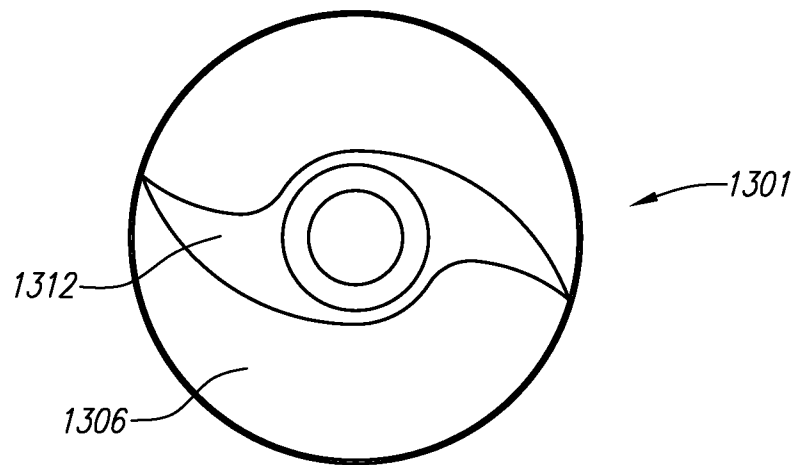


FIG. 13B

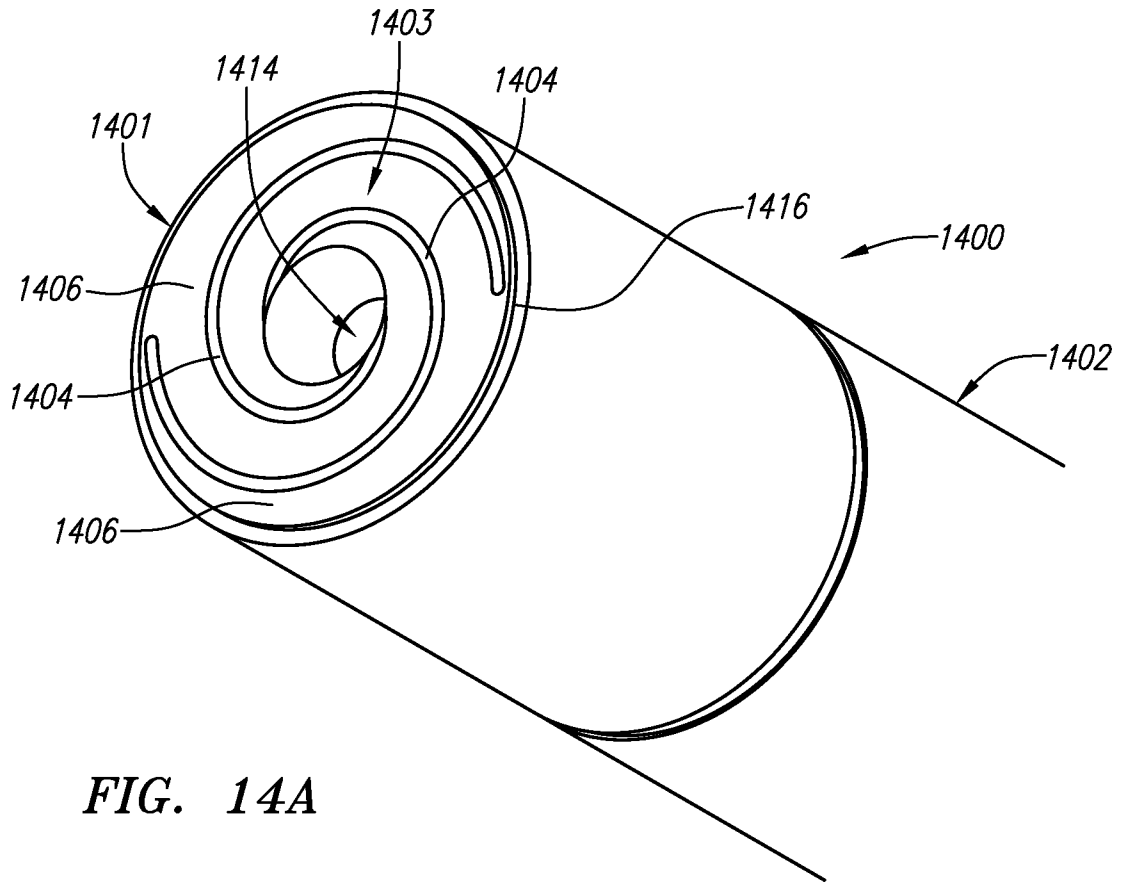


FIG. 14A

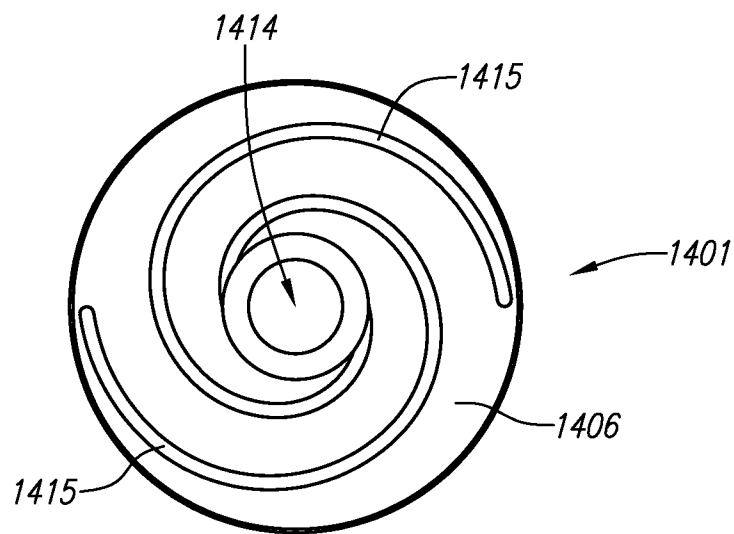


FIG. 14B

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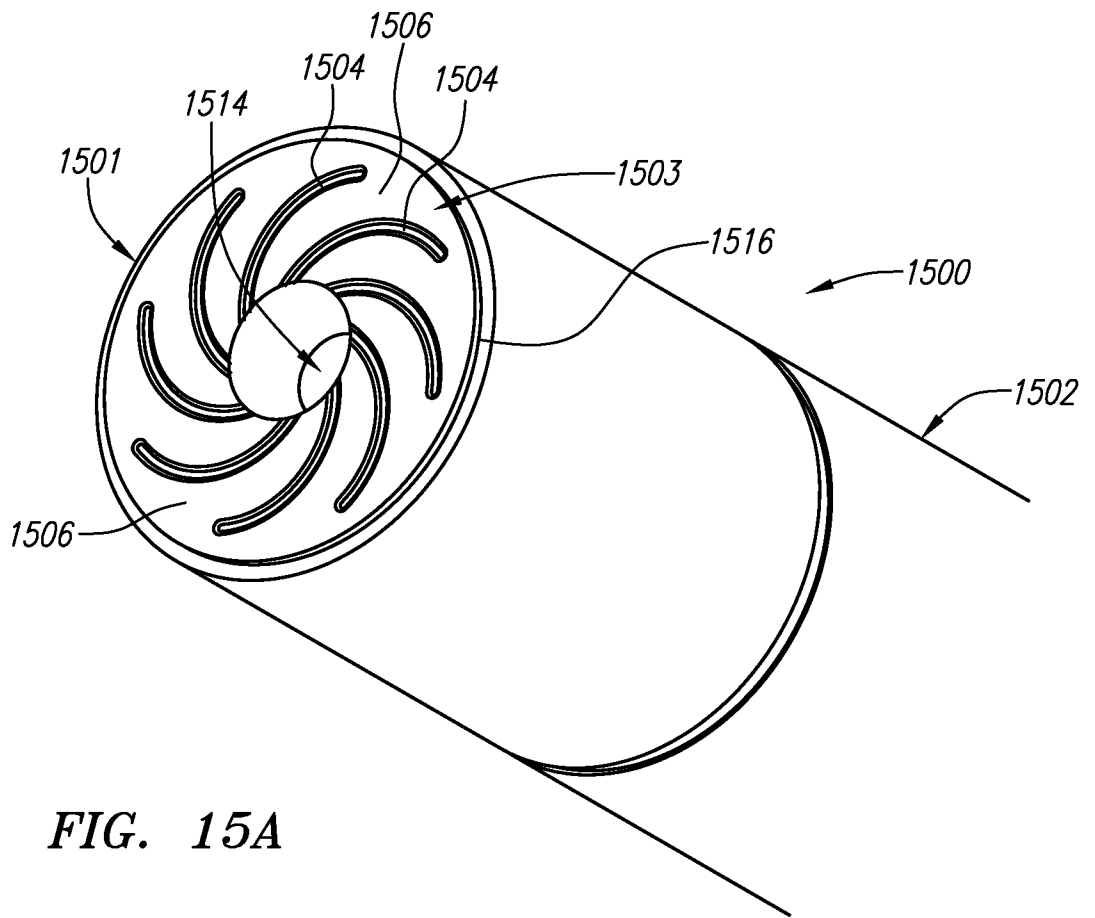


FIG. 15A

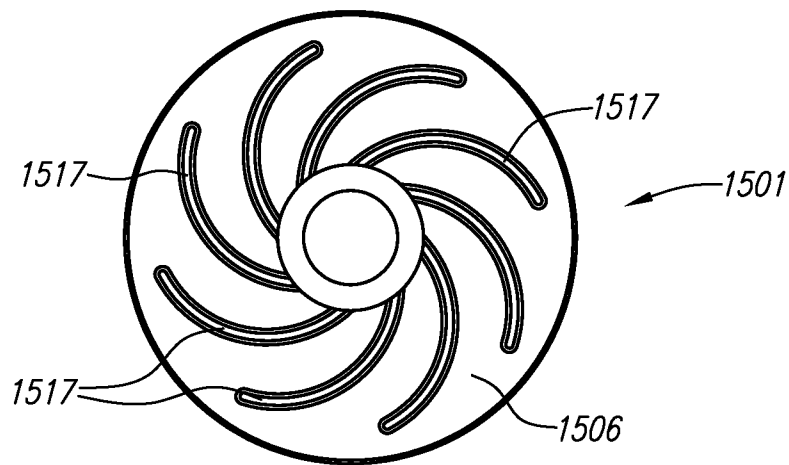
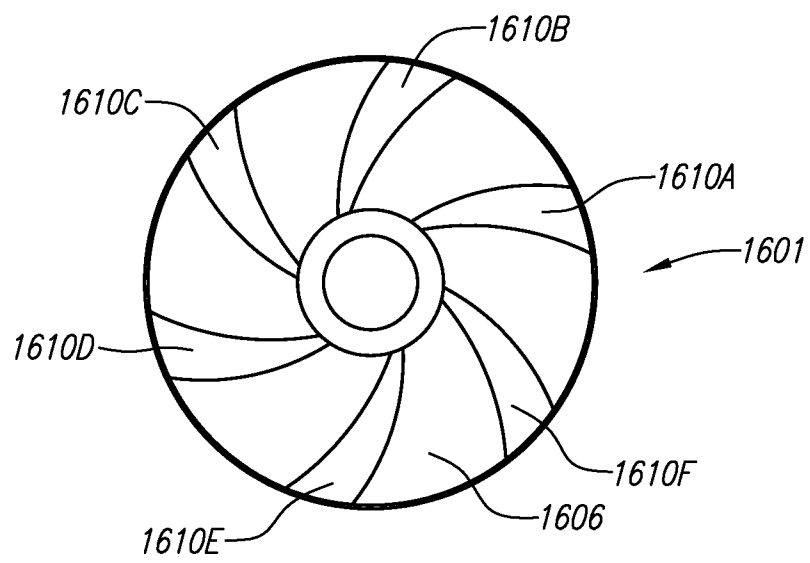
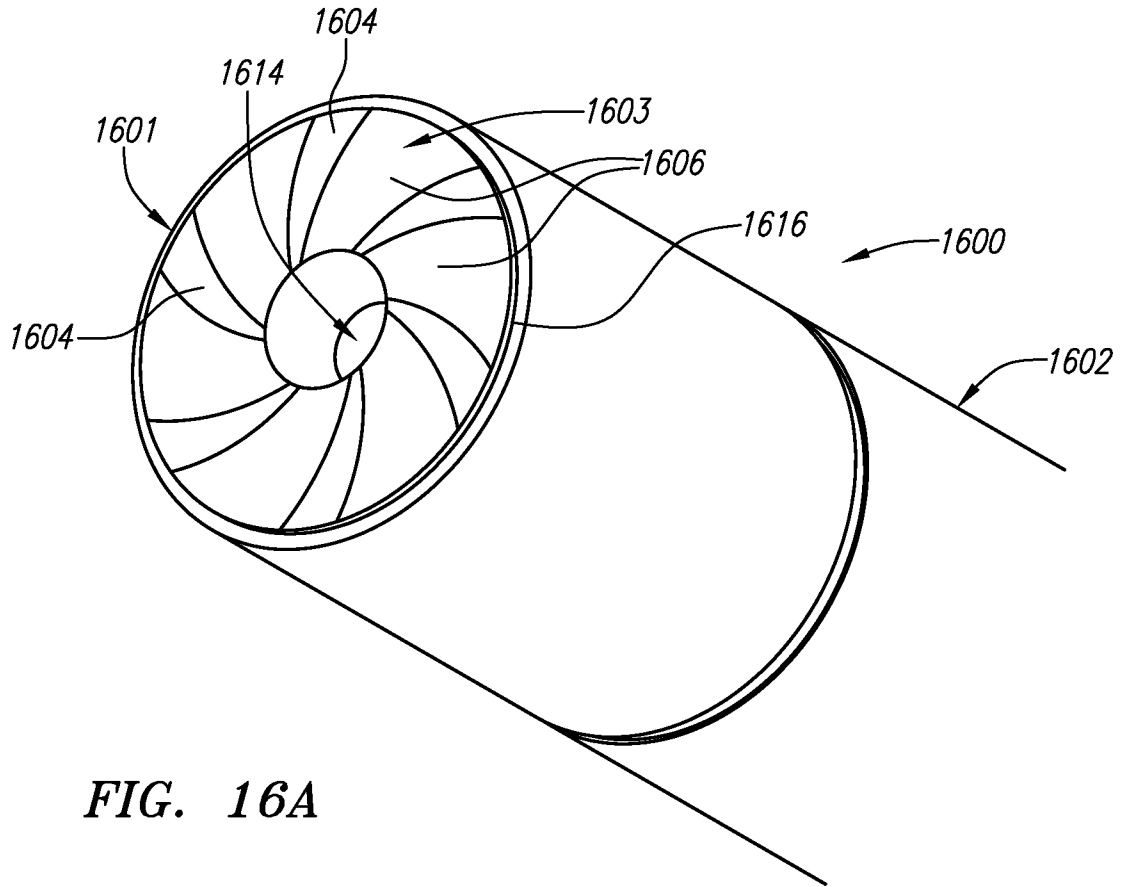


FIG. 15B



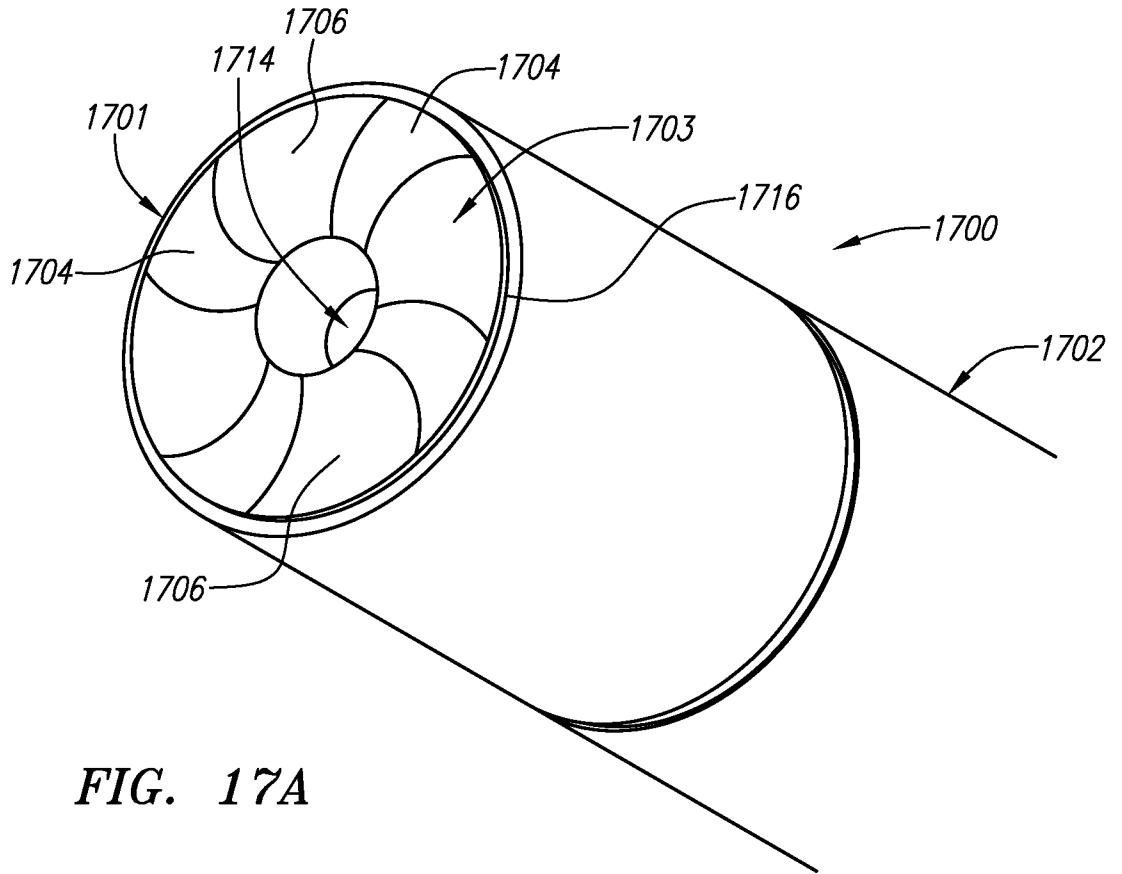


FIG. 17A

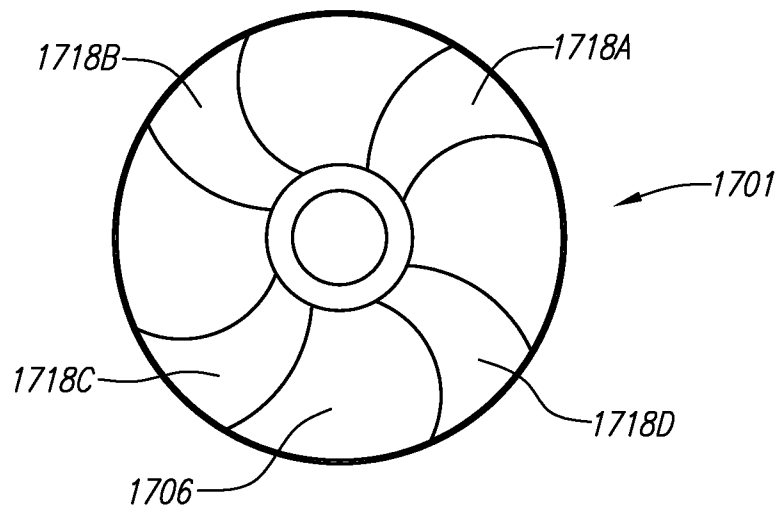


FIG. 17B

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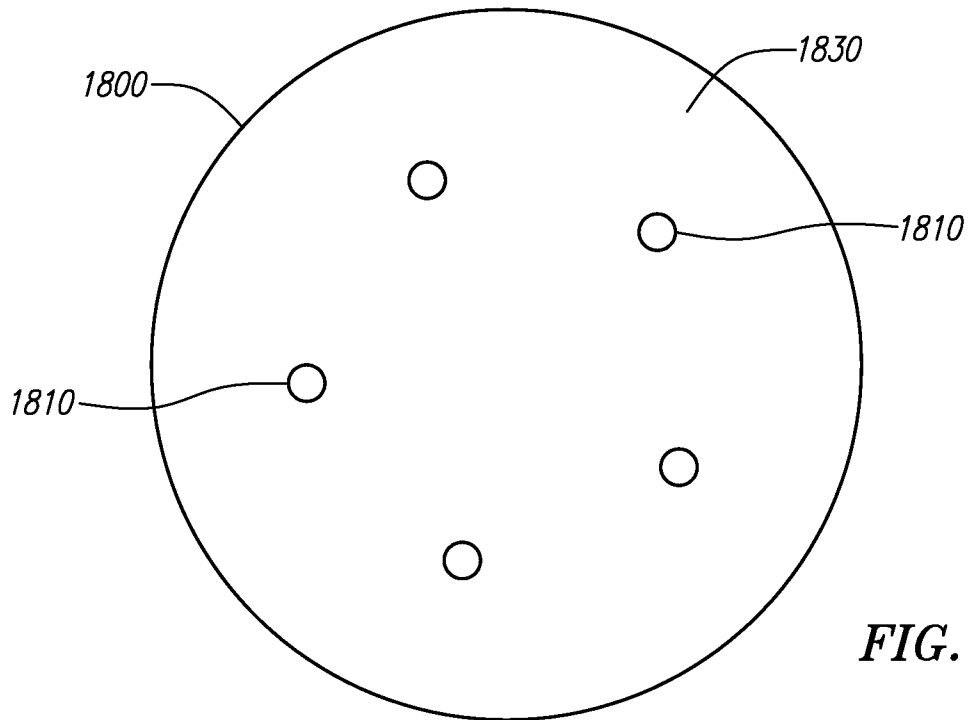


FIG. 18A

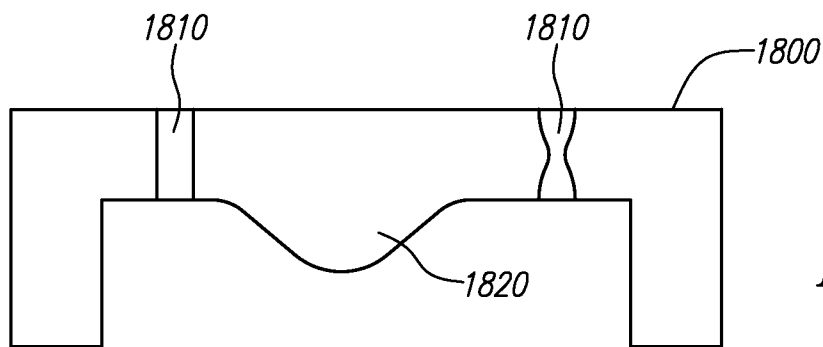


FIG. 18B

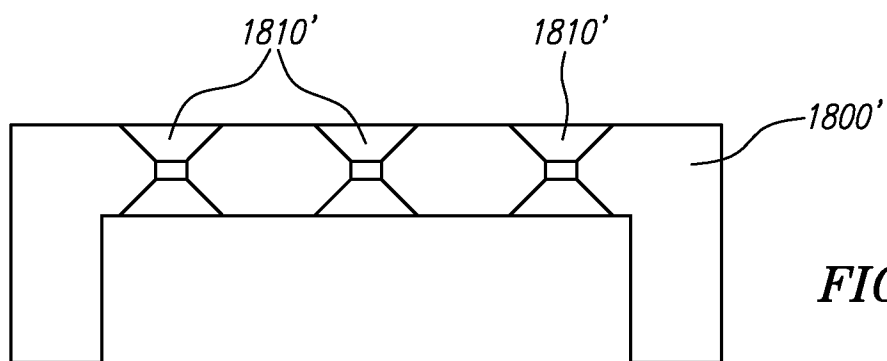


FIG. 18C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/37558

A. CLASSIFICATION OF SUBJECT MATTER

IPC (8) - A24D 3/04 (2014.01)
CPC - A24D 3/045
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC(8): A24D 3/04; A24D 1/04 (2014.01)
 CPC: A24D 3/045, A24D 1/04*, A24D 3/04*

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 IPC(8): A24D 1/*, A24D 3/* (2014.01)
 CPC: A24D 3/045, A24D 1/04*, A24D 3/04*; USPC: 131/*

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 PatBase; Google Patents; Google Web
 Keywords: cigarette, cigar, smoking, electronic, battery, flow, velocity, speed, acceleration, accelerate, vortex, battery, aerosol, atomizer, venturi, cone, conical

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category' *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 287594 A1 (TYNAN et al.) 07 May 1964 (07.05.1964), entire document	1, 3-7, 10-11, 16
Y		2, 8-9, 12-15, 17-31
Y	US 2005/0016550 A1 (KATASE) 27 January 2005 (27.01.2005), entire document	2, 19-31
Y	DE 1110070 B (GEPPERT) 29 June 1961 (29.06.1961), entire document	8-9, 12, 24
Y	GB 2021 925 A1 (GEORGIU) 24 November 1982 (24.11.1982), entire document	13-15, 17-18
A	US 2,954,778 A (LEBERT) 04 October 1960 (04.10.1960), entire document	1-31
A	US 2,686,524 A (KERSHAW et al.) 17 August 1954 (17.08.1954), entire document	1-31

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 22 August 2014 (22.08.2014)	Date of mailing of the international search report 06 OCT 2014
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272*1300 PCT OSP: 571-272-7774
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