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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 September 2017 (28.09.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/163046 A1

(51) International Patent Classification:
A61M 15/06 (2006.01) *A61M 11/04* (2006.01) *A24F 47/00* (2006.01)

(21) International Application Number: PCT/GB2017/050783

(22) International Filing Date: 21 March 2017 (21.03.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1605105.4 24 March 2016 (24.03.2016) GB

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

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

Published:
— *with international search report (Art. 21(3))*

(54) Title: VAPOUR PROVISION APPARATUS

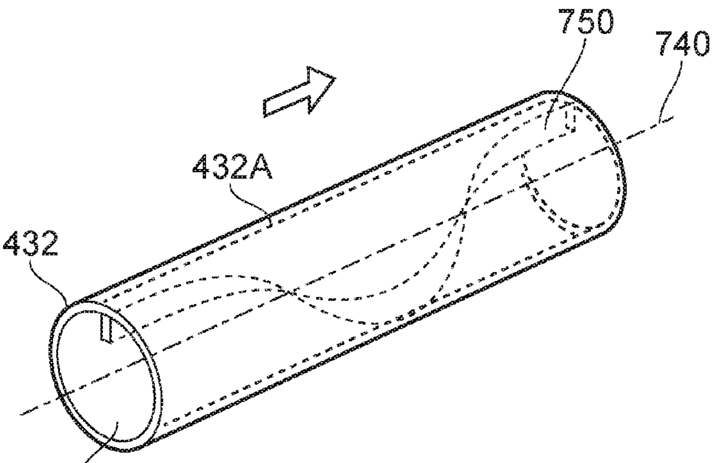

FIG. 11A

(57) Abstract: A vapour provision apparatus comprising: a vapour generation chamber containing a vaporiser for generating vapour from a vapour precursor material; and an air channel wall defining an air channel between the vapour generation chamber and a vapour outlet at a mouthpiece end of the vapour provision apparatus through which a user can inhale vapour during use; wherein an inner surface of the air channel wall is provided with at least one protrusion extending into the air channel to modify (redirect) a flow of air in the air channel during use. For example, the at least one protrusion may be arranged to define one or moreportions of a helical wall extending into the air channel so as to impart a degree of rotation about an axis of extent of the air channel to air flowing in the air channel during use.

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VAPOUR PROVISION APPARATUS

Field

The present disclosure relates to vapour provision systems such as nicotine delivery systems (e.g. electronic cigarettes and the like), and detachable cartridges / cartomisers for use in such systems, and more particularly to airflows in vapour provision systems.

Background

Electronic vapour provision systems such as electronic cigarettes (e-cigarettes) generally contain a vapour precursor material, such as a reservoir of a source liquid containing a formulation, typically including nicotine, or a solid material such a tobacco-based product, from which a vapour is generated for inhalation by a user, for example through heat vaporisation. Thus, a vapour provision system will typically comprise a vapour generation chamber containing a vaporiser, e.g. a heating element, arranged to vaporise a portion of precursor material to generate a vapour in the vapour generation chamber. As a user inhales on the device and electrical power is supplied to the vaporiser, air is drawn into the device through inlet holes and into the vapour generation chamber where the air mixes with the vaporised precursor material. There is a flow path connecting between the vapour generation chamber and an opening in the mouthpiece so the incoming air drawn through the vapour generation chamber continues along the flow path to the mouthpiece opening, carrying some of the vapour with it, and out through the mouthpiece opening for inhalation by the user.

User experiences with electronic vapour provision systems are continually improving as such systems become more refined in respect of the nature of the vapour they provide for user inhalation, for example in terms of deep lung delivery, mouth feel and consistency in performance. Nonetheless, approaches for improving further still on these aspects of electronic vapour provision systems remain of interest.

Summary

According to a first aspect of certain embodiments there is provided a vapour provision apparatus comprising: a vapour generation chamber containing a vaporiser for generating vapour from a vapour precursor material; and an air channel wall defining an air channel between the vapour generation chamber and a vapour outlet at a mouthpiece end of the vapour provision apparatus through which a user can inhale vapour during use; wherein an inner surface of the air channel wall is provided with at least one protrusion extending into the air channel to modify a flow of air in the air channel during use.

According to another aspect there is provided vapour provision means comprising: vapour generation chamber means containing vapour generation means for generating a vapour from vapour precursor material means; and air channel wall means defining air channel means fluidly connecting between the vapour generation chamber means and vapour outlet means at a mouthpiece end of the vapour provision means through which a user can inhale vapour during use; wherein an inner surface of the air channel wall means is provided with protrusion means extending into the air channel means for modifying a flow of air in the air channel means during use.

These and further aspects of certain embodiments are set out in the appended independent and dependent claims. It will be appreciated that features of the dependent claims may be combined with each other and features of the independent claims in combinations other than those explicitly set out in the claims. Furthermore, the approaches described herein are not restricted to specific embodiments such as the examples set out below, but include and contemplate any appropriate combinations of features presented herein. For example, a vapour provision system may be provided in accordance with approaches described herein which includes any one or more of the various features described below as appropriate.

Brief Description of the Drawings

Figure 1 is a cross-section through an e-cigarette comprising a cartomiser and a control unit in accordance with some embodiments of the disclosure.

Figure 2 is an isometric external view of the cartomiser of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure.

Figure 3 is a collection of five external views of the cartomiser of Figure 2 in accordance with some embodiments of the disclosure. In particular, the bottom view shows the cartomiser from underneath, the top view shows the cartomiser from above, the central view shows a face view of the cartomiser (from front or back), and on either side of the central view are respective side views of the cartomiser.

Figure 4 is an exploded view of the cartomiser of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure.

Figures 5A, 5B and 5C illustrate the wick/heater assembly being fitted into the cartomiser plug in accordance with some embodiments of the disclosure.

Figures 6A and 6B illustrate the inner frame and the vent seal being fitted into the cartomiser plug in accordance with some embodiments of the disclosure.

Figures 7A and 7B illustrate the combination of the inner frame, wick/heater assembly, and primary seal being fitted into the shell and the reservoir then being filled with e-liquid in accordance with some embodiments of the disclosure.

Figures 8A and 8B illustrate the PCB and end cap being fitted to the other components to complete the formation of the cartomiser in accordance with some embodiments of the disclosure.

Figure 9 is a top view looking down onto the control unit of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure.

Figures 10A and 10B are cross-sections respectively (a) from side to side, and (b) from front to back, showing the airflow through the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure.

Figures 11 to 14 are schematic views of various aspects of air channels in accordance with some embodiments of the disclosure.

Detailed Description

Aspects and features of certain examples and embodiments are discussed / described herein. Some aspects and features of certain examples and embodiments may be implemented conventionally and these are not discussed / described in detail in the interests of brevity. It will thus be appreciated that aspects and features of apparatus and methods discussed herein which are not described in detail may be implemented in accordance with any conventional techniques for implementing such aspects and features.

The present disclosure relates to aerosol provision systems, also referred to as vapour provision systems, such as e-cigarettes. Throughout the following description the term “e-cigarette” or “electronic cigarette” may sometimes be used; however, it will be appreciated this term may be used interchangeably with aerosol (vapour) provision system and electronic aerosol (vapour) provision system.

Figure 1 is a cross-sectional view through an example e-cigarette 100 (i.e. an example of a vapour provision system) in accordance with some embodiments of the disclosure. The e-cigarette 100 comprises two main components which are separable from one another, namely a cartomiser 200 and a control unit 300.

As discussed in more detail below, cartomiser includes a chamber 270 containing a reservoir of liquid, a heater to act as an atomiser or vaporiser, and a mouthpiece. The liquid in the reservoir (sometimes referred to as the e-liquid) typically includes nicotine in an appropriate solvent, and may include further constituents, for example, to aid aerosol formation, and / or for additional flavouring. The cartomiser 200 further includes a wick / heater assembly 500, which includes a wick or similar facility to transport a small amount of liquid from the reservoir to a heating location on or adjacent the heater. The control unit 300 includes a re-chargeable cell or battery 350 to provide power to the e-cigarette 100, a printed circuit board (PCB) for generally controlling the e-cigarette (not shown in Figure 1), and a microphone 345 for detecting a user inhalation (via a pressure drop). When the heater receives power from the battery, as controlled by the PCB in response to the microphone 345 detecting a user puff on the e-cigarette 100, the heater vaporises the liquid from the wick and this vapour is then inhaled by a user through the mouthpiece.

For ease of reference, x- and y-axes are marked in Figure 1. The x-axis will be referred to herein as the width of the device (from side to side as shown in Figure 1), while the y-axis (from bottom to top as shown in Figure 1) will be referred to herein as the height axis, where the cartomiser 200 represents an upper portion of the e-cigarette 100 and the control unit 300 represents a lower portion of the e-cigarette. Note that this orientation reflects how a user might hold the e-cigarette 100 during normal operation of the device, for example between puffs, given that the wick is located in the lower part of the reservoir in the cartomiser 200. Therefore holding the e-cigarette 100 in this orientation can help ensure the wick is in contact with liquid at the bottom of the liquid reservoir 270.

We further assume a z-axis (not shown in Figure 1) is perpendicular to the x- and y-axes shown in Figure 1. The z-axis will be referred to herein as the depth axis. The depth of the e-cigarette 100 in this example is significantly less than the width of the e-cigarette, thereby resulting in a generally flat or planar configuration (in the x-y plane). Accordingly, the z-axis can be considered as extending from face to face of the e-cigarette 100, where one face may be regarded (arbitrarily) as the front face of the e-cigarette and the opposing face as the back face of the e-cigarette 100. However, it will be appreciated the principles described herein may also be applied to electronic cigarettes having generally different shapes and sizes.

The cartomiser 200 and the control unit 300 are detachable from one another by separating in a direction parallel to the y-axis, but are joined together when the device 100 is in use so as to provide mechanical and electrical connectivity between the cartomiser 200 and the control unit 300. When the e-liquid in the cartomiser reservoir has been depleted, or the user wishes to switch to a different cartomiser, for example containing a different flavour vapour precursor material, the cartomiser 200 is removed and a new cartomiser is attached to the control unit 300. Accordingly, the cartomiser 200 may sometimes be referred to as a disposable portion of the e-cigarette 100, while the control unit 300 represents a re-usable portion. Alternatively, the cartomiser may be configured to be refillable with e-liquid, and may in some cases require detachment from the control unit for access to a filling port.

Figure 2 is an isometric external view of the cartomiser of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure. The orientation relative to the view of Figure 1 is apparent from the representation of the xyz-axes. This external view demonstrates the depth of the cartomiser 200 (as for the e-cigarette 100 as a whole) measured parallel to the z-axis, is somewhat less than the width of the cartomiser 200 (and the e-cigarette 100 as a whole) measured parallel to the x-axis in this specific example. However, as already noted above, the principles described herein are equally applicable for other sizes and shapes of vapour provision systems, for example including vapour provision systems of more conventional shapes, such as generally cylindrical systems or box-based systems.

The cartomiser 200 may, at least from an external viewpoint, be considered to comprise two main portions . In particular, there is a lower or base portion 210 and an upper portion 220 (the terms upper and lower are used here with reference to the orientation shown in Figure 1). When the cartomiser 200 is assembled with the control unit 300, the base portion 210 of the cartomiser sits within the control unit 300, and hence is not externally visible, whereas the upper portion 220 of the cartomiser protrudes above the control unit 300, and hence is externally visible. Accordingly, the depth and width of the base portion 210 are smaller than the depth and width of the upper portion 220, to allow the base portion to fit within the control unit 300. The increase in depth and width of the upper portion 220 compared with the base portion 210 is provided by a lip or rim 240. When the cartomiser 200 is inserted into the control unit 300, this lip or rim 240 abuts against the top of the control unit.

As shown in Figure 2, the side wall of base portion 210 includes a notch or indentation 260 for receiving a corresponding latching member from the control unit 300. The opposite side wall of the base portion 210 is provided with a similar notch or indentation to likewise receive a corresponding latching member from the control unit 300. It will be appreciated that this pair of notches 260 on the base portion 200 (and the corresponding latching members of the control unit) provide a latch or snap fit connection for securely retaining the cartomiser 200 within the control unit 300 during operation of the device. Adjacent to the notch 260 is a further notch or indentation 261, which is utilised in the formation of the cartomiser 200.

As also shown in Figure 2, the bottom wall 211 of the base portion 210 includes two larger holes 212A, 212B on either side of a smaller hole 214 for air inlet. The larger holes 212A and 212B are used to provide positive and negative electrical connections from the control unit 300 to the cartomiser 200. Thus when a user inhales through the mouthpiece 250 and the device 100 is activated, airflows into the cartomiser 200 through the air inlet hole 214. This incoming airflows past the heater (not visible in Figure 2), which receives electrical power from the battery in the control unit 300 so as to vaporise liquid from the reservoir (and more especially from the wick). This vaporised liquid is then incorporated or entrained into the airflow through the cartomiser, and hence is drawn out of the cartomiser 200 through mouthpiece 250 for inhalation by the user.

Figure 3 is a collection of five external views of the cartomiser 200 of Figure 2 in accordance with some embodiments of the disclosure. In particular, the bottom view shows the cartomiser from underneath (with reference to the orientation of Figure 1), the top view shows the cartomiser from above, the central view shows a face view of the cartomiser (from front or back), and on either side of the central view are respective side views of the cartomiser. Note that since the cartomiser is symmetric front / back (i.e. with respect to the z-axis), the front face of the cartomiser and the back face of the cartomiser both correspond to the central view of Figure 3. In addition, the cartomiser is also symmetric in the width direction (i.e. with respect to the x-axis), hence the two side views to the left and right of the central view appear the same.

Figure 3 illustrates the various features of the cartomiser already discussed above with respect to Figure 2. For example, the central view clearly shows the top portion 220 and the bottom portion 210 of the cartomiser. The lower view shows the bottom wall of the base portion 211, including the two larger holes 212A and 212B, which are used to provide positive and negative electrical connections from the control unit 300 to the cartomiser 200, plus the smaller hole 214 for air inlet into the cartomiser. In addition, the two side views show the two notches in each side wall, an upper notch 261A, 261B, and a lower notch 260A, 260B, the latter being used to fasten the cartomiser 200 to the control unit 300.

The top view further shows a hole 280 in the mouthpiece 250 which represents the air / vapour outlet from the cartomiser 200. Thus in operation, when a user inhales, air enters the cartomiser at the bottom through inlet 214, flows through the atomiser, including past the heater, where it acquires vapour, and then travels up the centre of the cartomiser to exit through air outlet 280.

For the sake of providing a concrete example, Figure 3 provides exemplary dimensions for the cartomiser 200, showing a largest height (in the y- direction) of around 31.3mm, a largest width (in the x- direction) of around 35.2mm, and a largest depth of around 14.3 mm (parallel to the z- direction). Note that these largest width and depth measurements relate to the upper portion 220 of the cartomiser; the width and depth of the base portion 210 are somewhat smaller, in order to allow the base portion to be received into the control unit 300. The difference in width and depth between the upper portion 220 and the base portion 210 is accommodated by the rim or flange 240, as described above.

Figure 3 also gives an indication of the size and shape of the mouthpiece 250. In contrast to many e-cigarettes, which provide a circular mouthpiece akin to a straw or conventional cigarette, the mouthpiece 250 in this example has a different overall shape. In particular, the mouthpiece comprises a pair of large, relatively flat, opposing faces. One of these mouthpiece faces is denoted as face 251 in the central view of Figure 3, and there is a corresponding, opposing face to the rear of the device. (Note that the labelling of front and back for the cartomiser is arbitrary, since it is symmetric with respect to the z-axis, and can be fitted either way around onto the control unit 300). Nonetheless, as already mentioned the principles described herein can be implemented in devices of different overall shape and size.

As can be seen in Figure 3, the front and back faces 251 do not converge completely at the top of the mouthpiece, but rather overhang to provide a small valley 284 which extends in the x-direction of the device. The opening 280, which allows air and vapour to exit from the cartomiser 200, is formed in the centre of this valley 284. Having this small overhang, so that the mouthpiece opening 280 is located in the groove or valley 284, helps to protect the mouthpiece opening from physical contact, and hence from potential damage and dirt.

Figure 4 is an exploded view of the cartomiser 200 of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure. The cartomiser includes a shell 410, a vent seal 420, an inner frame 430, a heating coil 450 located on a wick 440, a primary seal 460 (also referred to as the cartomiser plug), a printed circuit board (PCB) 470 and an end cap 480. The view of Figure 4 shows the above components exploded along the longitudinal (height or y) axis of the cartomiser 200.

The cap 480 is formed from substantially rigid plastic such as polypropylene and provides the base portion 210 of the cartomiser. The cap is provided with two holes 260, 261 on each side (only one side is visible in Figure 4, but the side which is not visible is the same as the side that is visible). The lower hole 260 is for latching the cartomiser 200 to the control unit 300, while the upper hole 261 is for latching the end cap 480 to the shell 410. As described in more detail below, latching the cap 480 and the shell 410 in effect completes the assembly of the cartomiser, and retains the various components shown in Figure 4 in the correct position.

Above the end cap is located the PCB 470, which includes a central air hole 471 to allow air to flow through the PCB into the atomiser (the end cap 480 is likewise provided with a central air hole, not visible in Figure 4, but apparent in Figure 2) to support this airflow into the atomiser. In accordance with some embodiments, the PCB does not contain any active electrical components, but rather provides a circuit or conductive path between the control unit 300 and the heater 450.

Above the PCB 470 is located the primary seal (cartomiser plug) 460, which has two main portions, an upper portion which defines (in part) an atomizer chamber (vapour generation chamber) 465, and a lower portion 462 which acts as an end seal for the reservoir 270. Note that in the assembled cartomiser 200, the reservoir of e-liquid is located around the outside of the atomizer chamber, and the e-liquid is prevented from leaving the cartomiser (at least in part) by the lower portion 462 of the cartomiser plug 460. The cartomiser plug is made from a material that is slightly deformable. This allows the lower portion 462 to be compressed a little when inserted into the shell 410, and hence provide a good seal to retain the e-liquid in reservoir 270.

Two opposing side walls of the atomiser chamber 465 are provided with respective slots 569 into which the wick 440 is inserted. This configuration thereby helps to ensure the heater (vaporiser) 450, which is positioned on the wick, is located near the bottom of the atomiser chamber to vaporise liquid introduced into the atomiser chamber 465 by wick 440. In some embodiments, the wick 440 is made of glass fibre rope (i.e. filaments or strands of glass fibre twisted together), and the heater coil 450 is made of nichrome (an alloy of nickel and chromium) wire wound about the wick. However, various other types of wick and heater are known and could be used in the cartomiser 200, such as a wick made out of porous ceramic, and / or some form of planar heater (rather than a coil). Note that although Figure 4 suggests that the heater coil 450 has a loop of wire dropping down from the wick at each end, in practice there is just a single lead at each end.

The cartomiser plug 460 and the wick / heater assembly are surmounted by the inner frame 430, which has three main sections. The inner frame is substantially rigid, and may be made of a material such as polybutylene terephthalate. The lowermost section 436 of the inner frame 430 covers the lower portion 462 of the cartomiser plug 460, while the middle section 434 completes the atomiser chamber 465 of the cartomiser plug. In particular, the inner frame provides the top wall of the atomiser chamber, and also two side walls that overlap with the two side walls of the atomising chamber 465 of the cartomiser plug. The final section of the inner frame comprises an air channel wall / airflow tube 432 that defines an interior air channel that leads upwards from the top wall of the atomising chamber (part of the middle section 434) and couples with the mouthpiece hole 280. In other words, tube (air channel wall) 432 provides a passage (air channel) for vapour produced in the atomising chamber (vapour generation chamber) 465 to be drawn along to exit the e-cigarette 100 for user inhalation through mouthpiece exit hole (vapour outlet) 280 in the mouthpiece end 250 of the vapour provision system / apparatus 100.

Since the inner frame is substantially rigid, the vent seal 420 is provided at (inserted around) the top of the airflow tube 432 to help ensure a suitable seal between the inner frame and the interior of the shell 410 around the mouthpiece exit hole 280. The vent seal 420 is made of a suitably deformable and resilient material such as silicone. Lastly, the shell 410 provides the external surface of the upper portion 220 of the cartomiser 200, including the mouthpiece 250, and also the lip or flange 240. The shell 410, like the end cap, is formed of a substantially rigid material, such as polypropylene. The lower section 412 of the shell 410 (i.e. below the lip 240) sits inside the end cap 480 when the cartomiser has been assembled. The shell is provided with a latch tab 413 on each side to engage with hole 261 on each side of the end cap 480, thereby retaining the cartomiser 200 in its assembled condition.

An airflow pathway through the cartomiser enters a central hole 214 in the cap 480 (not visible in Figure 4 but apparent in Figure 2) and then passes through a hole 471 in the PCB. The airflow next passes up into the atomiser chamber 465, which is formed, at least in part, as part of the cartomiser plug 460, flows around the wick and heater assembly 500 and along the air channel defined by the tube (air channel wall) 432 of the inner frame 430 (and through vent seal 420), and finally exits through the hole 280 in the mouthpiece 250.

The reservoir 270 of e-liquid is contained in the space between this airflow pathway through the cartomiser 200 and the outer surface of the cartomiser 200. Thus shell 410 provides the outer walls (and top) of the housing for the reservoir 270, while the lower section 436 of the inner frame in conjunction with the base portion 462 of the primary seal 460 and end cap 480 provide the bottom or floor of the housing for the reservoir of e-liquid. The inner walls of this housing are provided by the atomising (vapour generation) chamber 465 of the primary seal 460, in cooperation with the middle section 434 of the inner frame, and also the airflow tube 432 of the inner frame 430 and the vent seal 420. In other words, the e-liquid is stored in the reservoir space between the outer walls and the inner walls. Ideally, the e-liquid should not penetrate inside the inner walls, into the airflow passage, except via wick 440, otherwise there is a risk that liquid would leak out of the mouthpiece hole 280.

The capacity of this space is typically of the order of 2ml in accordance with some embodiments, although it will be appreciated that this capacity will vary according to the particular features of any given design. Note that unlike for some e-cigarettes, the e-liquid reservoir 270 in this example is not provided with any absorbent material (such as cotton, sponge, foam, etc.) for holding the e-liquid. Rather, the reservoir chamber only contains the liquid, so that the liquid can move freely around the reservoir 270. However, it will be appreciated this is not in itself significant to the principles described herein regarding the aspects of aerosol provision system relating to the air channel extending between the vaporising chamber and the vapour outlet.

Figure 5A, 5B and 5C illustrate the wick / heater assembly being fitted into the cartomiser plug in accordance with some embodiments of the disclosure. The wick / heater assembly 500 is formed from the heater wire 450 and the wick 440. As noted above, the wick in this example comprises glass fibres formed into a generally cylindrical or rod shape. The heater / vaporiser 450 comprises a coil of wire 551 wound around the wick. At each end of the coil there is a contact wire 552A, 552B, which together act as the positive and negative terminals to allow the coil to receive electrical power.

As visible in Figure 5A, the primary seal 460 includes the base portion 462 and the atomising chamber 465. The base portion is provided with two outwardly directed ribs. When the shell 410 is fitted over the base portion, these ribs are compressed slightly in order to fit inside the shell 410. This compression and the resulting slight resilient deformation of the ribs helps to ensure a good seal for the e-liquid at the base of the cartomiser reservoir.

Also visible in Figure 5A, the vapour generation chamber 465 comprises four walls in a substantially rectangular arrangement, a pair of opposing side walls 568, and a pair of opposing front and back walls 567. Each of the opposing side walls 568 includes a slot 569 which has an open end at the top (and in the centre) of the side wall, and a closed end 564 relatively near the bottom of the atomising chamber 465 – i.e. the two slots 569 extend more than halfway down their respective side walls 568.

Referring now to Figure 5B, this shows the wick / heater assembly 500 now fitted into the atomising chamber 465 of the cartomiser plug. In particular, the wick / heater assembly is positioned so that it extends between, and protrudes out of, the two opposing slots 569A, 569B. The wick is then lowered until it reaches the closed end 564 of each slot. Note that in this position, the coil 551 is located entirely in the atomizing chamber 465 – it is only the wick itself 440 that extends out of the slots into the reservoir area 270. It will be appreciated that this arrangement allows the wick to draw e-liquid from the reservoir 270 into the atomizing chamber 465 for vaporisation by the wire heater coil 551. Having the wick located near the bottom of the atomizing chamber, and more particularly also near the bottom of the reservoir 270, helps to ensure that the wick retains access to liquid in the reservoir even as the e-liquid is consumed, and hence the level of the e-liquid in the reservoir drops. Figure 5B also shows the heater contact wires 552A, 552B extending below the primary seal 460.

Figure 5C illustrates the underside of the base portion 462 of the primary seal 460. This view shows that the base portion includes two holes 582A, 582B, which are used for filing the reservoir 270 with e-liquid, as described in more detail below. The underside further includes a rectangular indentation / recess 584 for receiving the PCB 470. A central hole 583 is provided in this indentation 584 to provide an air passage from underneath (and outside) the cartomiser into the atomisation (vaporisation) chamber 465. It will be appreciated that after assembly, this central hole 583 in the cartomiser plug is aligned with the corresponding central hole 471 in the PCB.

There are also two smaller holes 587A, 587B formed in the rectangular indentation 584 of the lower portion of the cartomiser plug 460, one on either side of the central hole 583. The contact wires 552A and 552B extend downwards from the heater 450 and pass respectively through these two holes, 587A, 587B, in order to exit the vaporising chamber 465.

A slit 590A, 590B is formed in each of the front and back walls of the rectangular indentation 584. After extending through the two holes 587A, 587B, each contact wire from the heater is bent flat onto the underside of the cartomiser plug, and then leaves the rectangular indentation via the respective slits 590A, 590B. Thus contact wire 552A passes out of the atomising chamber 465 through hole 587A, and then exits the rectangular indentation 584 via slot 590A; likewise, contact wire 552B passes out of the atomising chamber 465 through hole 587B, and then exits the rectangular indentation 584 via slot 590B. The remaining portion of each wire 552A, 552B is then bent upwards towards the atomising chamber 465 in order to sit within a respective groove 597 in the cartomiser plug 460 (see Figure 5B).

Figures 6A and 6B illustrate the inner frame and the vent seal being fitted into the cartomiser plug in accordance with some embodiments of the disclosure. Thus as previously described, the inner frame 430 comprises a base section 436, a middle section 434 and an upper section providing an air channel wall 432 defining an air channel providing fluid communication between the vapour generation chamber 465 and the vapour outlet to 80 when the cartomiser 200 is assembled for use.

The base section of the inner frame contains two slots 671A, 671B extending in a horizontal sideways direction (parallel to the x-axis). As the base section 436 of the inner frame is lowered down past the atomizing chamber 465, the portions of the wick 440 that extend out from each side of the atomizing chamber 465 pass through these slots 671A, 671B, thereby allowing the base section of the inner frame to be lowered further until it is received in the lower portion 462 of the cartomiser plug.

As noted above, the middle section 434 of the inner frame complements and completes the vapour generation / atomising chamber 465 of the cartomiser plug 460. In particular, the middle section provides two opposing side walls 668 and a top wall or roof 660. The latter closes the top of the atomizing chamber 465, except in respect of the air tube 432 which extends up from the atomizing chamber 465 to the exit hole 280 of the mouthpiece 250.

Each of the opposing side walls 668 includes a slot 669A, 669B which extends upwards (parallel to the y-axis) from the bottom of the side wall to the closed end of the respective slot. Accordingly, as the base section 436 of the inner frame is lowered down past the atomizing chamber 465, the portions of the wick 440 that extend out from each side of the atomizing chamber 465 pass through these slots 669A, 669B (in addition to slots 671A, 671B). This therefore allows the side walls 668 of the inner frame 430 to overlap the side walls 568 of the cartomiser plug. Further downward movement of the inner frame 430 is prevented once the closed end of slots 669A, 669B contacts the wick 440, which coincides with the base section 4436 of the inner frame being received into the lower portion 462 of the cartomiser plug. At this stage, the combination of cartomiser plug 460, heater / wick assembly 500, and inner frame 430, as shown in Figure 6B has been formed, and the vent seal 420 can now be fitted onto the air tube (pipe / air channel wall) 432 of the inner frame 430.

Figure 7A illustrates the combination of the inner frame 430, wick / heater assembly 500, and primary seal 460 being fitted into the shell 410. As this insertion occurs, the slot 415 in each of the front and back faces of the lower portion 412 of the shell 410 accommodates a portion of wire 552 that has passed through slot 590 and has been wrapped back up around the outside of the cartomiser plug 460 and into groove 597. Furthermore, the deformable ribs 563 around the lower portion 462 of the primary seal are slightly compressed by the inside wall of the lower portion 412 of the shell 410 during the insertion, and thereby form a seal to retain the e-liquid in the resulting reservoir 270. Accordingly, as illustrated in Figure 7B, the cartomiser 200 is now ready for filling with the e-liquid. This filling is performed, as indicated by arrows 701A, 701B, through holes 582A and 582B in the primary seal 460, and through slots 671A, 671B in the inner frame (not visible in Figure 7B).

Figure 8A illustrates the PCB 470 being fitted into the rectangular indentation 584 in the underside of the primary seal 460. This fitting aligns the central hole 471 in the PCB with the central hole 583 in the primary seal 460 in order to provide the main airflow channel into the cartomiser 200.

As previously described, the rectangular indentation 584 is provided with a pair of holes 587, located on either side of the central hole 583. Each hole allows egress of a respective contact wire 552A, 552B from the vaporiser chamber 465. The contact wires 552A, 552B are bent flat against the floor of the rectangular indentation 584, and then exit the rectangular indentation 584 via respective slots 590A, 590B in the front and back walls of the rectangular indentation. The final portion of each heater contact wire 552A, 552B, is then bent upwards, back towards the top of the cartomiser and mouthpiece 250, and located in a corresponding groove or channel 597 formed in the cartomiser plug. In addition, the base portion of the shell also includes a slot 415 on each of the front and back faces to accommodate a respective heater contact wire 552A, 552B.

In accordance with some embodiments, the PCB 470 does not contain any active components, but rather provides two large contact pads 810A, 810B on either side of the central hole 471. These contact pads are visible in Figure 8A on the lower face of the PCB, i.e. the side facing the control unit 300 after assembly. The opposite face of the PCB, i.e. the upper side which is received into the rectangular indentation 584 and faces the heater 450, is provided with a similar, corresponding configuration of contact pads (not visible in Figure 8A). The heater contact wires 552A, 552B are in physical, and hence electrical, contact with a respective contact pad on the upper side of the PCB.

The opposing pairs of contact pads on either side of the PCB 470 are connected by respective sets of one or more vias 820A, 820B. In other words, vias 820A provide a conductive path between one contact pad on the lower face of the PCB and a corresponding contact pad on the upper face of the PCB, and vias 820B provide a conductive path between the other contact pad on the lower face of the PCB and its corresponding contact pad on the upper face of the PCB. Accordingly, when the control unit is connected to the cartomiser, pins from the control unit touch the contact pads on the lower side of the PCB 470, and electrical current flows to / from the heater 450 through the respective vias, contact pads on the upper side of the PCB 470, and respective heater contact wires 552A, 552B.

Figure 8B illustrates the end cap 480 being fitted to the cartomiser 200 in accordance with some embodiments of the disclosure. In particular, the end cap 480 is fitted over the end of the cartomiser plug 460 and the lower section 412 of the shell 410, and is retained in this position by the protruding member 413 provided on each side of the lower section 412 of the shell engaging into the corresponding hole or slot 261 on each side of the end cap. In this fully assembled state (see Figure 2), the end cap 480 covers and therefore closes the holes 582A, 582B in the cartomiser plug that were used for filling the liquid reservoir 270. Indeed, as can be seen in Figure 10A, the end cap 480 is provided with two upwardly directed plugs 870A and 870B that respectively penetrate and close the filling holes 582A, 582B. Accordingly, the reservoir 270 is now fully sealed, apart from the opening on each side of the atomising chamber 465 through which the wick 440 passes into the atomising chamber 465.

As previously discussed, the end cap includes three holes, a central hole 214 and two holes 212A, 212B located on either side of this central hole. The fitting of the end cap 480 aligns the central hole 214 of the end cap with the central hole 471 in the PCB and with the central hole 583 in the primary seal 460 in order to provide the main airflow channel into the cartomiser 200. The two side holes 212A, 212B allow pins from the control unit 300, acting as positive and negative terminals, to pass through the end cap 480 and make contact with respective contact pads 810A, 810B on the lower side of the PCB, thereby enabling the battery 350 in the control unit 300 to supply power to the heater 450.

In accordance with some embodiments, the primary seal 460, which as noted above is made of a resilient deformable material such as silicone, is held in a compressed state between the inner frame 430 and the end cap 480. In other words, the end cap is pushed onto the cartomiser 200 and compresses the primary seal 460 slightly before the latch components 413 and 261 engage with one another. Consequently, the primary seal remains in this slightly compressed state after the end cap 480 and shell 410 are latched together. One advantage of this compression is that the end cap acts to push the PCB 470 onto the heater contact wires 552A, 550B, thereby helping to ensure a good electrical connection without the use of solder.

Figure 9 is a top view looking down onto the control unit 300 of the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure. The control unit includes external walls 315 that rise above the rest of the control unit (as best seen in Figure 1) to define a cavity for accommodating the lower portion 210 of the cartomiser. Each side of these walls 315 is provided with a spring clip 931A, 931B that engages with the hole or slot 260 on each side of the cartomiser 200 (see Figure 2), thereby retaining the cartomiser in engagement with the control unit 300 to form the assembled e-cigarette 100.

At the bottom of the cavity formed by the upper portion of control unit walls 315 (but otherwise at the top of the main body of the control unit 300) is a battery seal 910 (see also Figure 1). The battery seal 910 is formed from a resilient (and compressible) material such as silicone. The battery seal 910 helps to mitigate one potential risk with an e-cigarette 100, which is that e-liquid leaks from the reservoir 270 into the main air passage through the device (this risk is greater where there is free liquid in the reservoir, rather than the liquid being held by a foam or other such material). In particular, if e-liquid were able to leak into the portion of the control unit containing the battery 350 and control electronics, then this might short circuit or corrode such components. Furthermore, there is also a risk that the e-liquid itself would then become contaminated before returning into the cartomiser 200 and then exiting through the mouthpiece hole 280. Accordingly, if any e-liquid does leak into the central air passage of the cartomiser, the battery seal 910 helps to prevent such leakage progressing into the portion of the control unit that contains the battery 350 and control electronics. (The small holes 908 in the battery seal 910 do provide very limited fluid communication with the microphone 345 or other sensor device, but the microphone 345 itself can then act as a barrier against any such leakage progressing further into the control unit.

As shown in Figure 9, there is a small groove or spacing 921 around the perimeter between the top of the battery seal 910 and the inside of the walls 315 of the control unit; this is primarily formed by the rounded corner of the battery seal 910. The battery seal is further provided with a central groove 922 from front to back, which connects at both ends (front and back) with the perimeter groove 921 to support airflow into the cartomiser, as described in more detail below. Immediately adjacent to central groove 922 are two holes 908A, 908B, one on either side of the groove 922. These air holes extend down to the microphone 345. Thus when a user inhales, this causes a drop in pressure within the central air passage through the cartomiser 200, as defined by air tube 432, the central hole 583 in the primary seal 460, etc., and also within the central groove 922, which lies at the end of this central air passage. The drop in pressure further extends through holes 908A, 908B to the microphone 345, which detects the drop in pressure, and this detection is then used to trigger activation of the heater 450.

Also shown in Figure 9 are two contact pins, 912A, 912B, which are linked to the positive and negative terminals of the battery 350. These contact pins 912A, 912B pass through respective holes in the battery seal 910 and extend through holes 212A, 212B of the end cap to make contact with contact pads 810A, 810B respectively on the PCB. Accordingly, this then provides an electrical circuit for supplying electrical power to the heater 450. The contact pins may be resiliently mounted within the battery seal (sometimes referred to as “pogo pins”), such that the mounting is under compression when the cartomiser 200 is latched to the control unit 300. This compression causes the mounting to press the contact pins against the PCB contact pads 810A, 810B, thereby helping to ensure good electrical connectivity.

The battery seal 910, which as noted above is made of a resilient deformable material such as silicone, is held in a compressed state between the cartomiser 200 and the control unit 300. In other words, inserting the cartomiser into the cavity formed by walls 315 causes the end cap 480 of the cartomiser to compress the battery seal 910 slightly before the spring clips 931A, 931B of the control unit engage with the corresponding holes 260A, 260B in the lower portion 210 of the cartomiser. Consequently, the battery seal 910 remains in this slightly compressed state after the cartomiser 200 and the control unit 300 are latched together, which helps to provide protection against any leakage of e-liquid, as discussed above.

Figures 10A and 10B are cross-sections respectively (a) from side to side, and (b) from front to back, showing the airflow through the e-cigarette of Figure 1 in accordance with some embodiments of the disclosure. The airflow is denoted in Figures 10A and 10B by the heavy black, dashed arrows. (Note that Figure 10A only shows airflow on one side of the device, but there is an analogous airflow on the other side as well – having multiple such air inlets reduces the risk that a user will accidentally block the air inlets with their fingers while holding the device).

The airflow enters through a gap at the sides of the e-cigarette 100, in between the top of the walls 315 of the control unit, and the flange or rim 240 of the cartomiser shell 410. The airflow then passes down a slight spacing between the inside of the walls 315 and the outside of the lower portion 210 of the cartomiser 200, past the spring clips 931, and hence into perimeter groove 921 (as shown in Figure 9). The airflow is then drawn around the perimeter groove 921, and hence out of the plane of Figures 10A and 10B (so that this portion of the airflow path is therefore not visible in these two diagrams). Note that there is typically some space above the groove 921 between the inside of the control unit walls and the outside of the cartomiser end cap, so the airflow is not necessarily constrained to the groove 921 per se.

After travelling an angle of approximately 90 degrees around the perimeter groove 921, the airflow passes into the central groove 922, from where it travels to and through the central hole 583 of the end cap 480 and hence into the central air passage of the cartomiser upstream of the vapour generation chamber 465 (i.e. further from the vapour outlet 280 than the vapour generation chamber 465). Note that Figure 10B shows this airflow along the central groove 922 into the central air passage, and then the flow of air up through the central air passage is shown in both Figures 10A and 10B. In contrast to groove 921, the space above groove 922 is not open, but rather the battery seal 910 is compressed against the end cap 480 of the cartomiser 200. This configuration results in the end cap covering the groove to form a closed channel having a confined space. This confined channel can be utilised to help control the draw resistance of the e-cigarette 100.

After entering the cartomiser through the air inlet holes 214, the airflow passes into the vapour generation chamber 465 where it mixes with vapour generated by the vaporiser. The vapour is then carried by the air along the air channel 33 defined by the air channel wall 432 (provided by the inner frame component of the cartomiser as discussed above).

Thus, the cartomiser 200 comprises a vapour provision apparatus which, when coupled to the control unit 300, forms a vapour provision system in which the cartomiser comprises a vapour generation chamber 465 containing a vaporiser (e.g. electric heater) 450 for generating vapour from a vapour precursor material / e-liquid. The cartomiser further comprises an air channel wall 432 defining an air channel 433 between the vapour generation chamber and a vapour outlet 280 through which vapour exits the device when in use. In accordance with certain embodiments of the disclosure, and as discussed further below, an inner surface of the air channel wall is provided with at least one protrusion which extends into the air channel to modify / redirect / disrupt a flow of air in the air channel during use. This approach can help to improve the nature of the aerosol delivered received by users. For example, and without being bound by theory, approaches in accordance with the principles described herein may be considered to enhance an intermixing of the air drawn into the cartomiser 200 from the environment through the air inlet 214 and the vapour generated in the vapour generation chamber 465 by the vaporiser 450 to provide a more uniform / consistent vapour

Figures 11A to 11C are highly schematic views of the air channel wall 432 defining the air channel 433 extending along an axis of extent 740 in accordance with certain embodiments of the disclosure. Figure 11A schematically represents a perspective view of the air channel wall 432 with elements hidden behind the outer surface of the air channel wall 432 shown in dashed line. Figure 11B schematically represents an end view of the air channel wall 432, in this example the left-hand end of the representation of Figure 11A (i.e. a view parallel to the y-axis represented in Figure 1). Figure 11C schematically represents a side view of the air channel wall 432 (i.e. a view parallel to the x-axis represented in Figure 1). The direction of normal airflow when the cartomiser is in use is indicated in Figures 11A and 11C by an arrow. For ease of representation, the air channel wall 432 represented in Figures 11A to 11C is shown as comprising a generally cylindrical shape with structural features associated with the coupling of the air channel 433 to the vapour generation chamber 465 and the vapour outlet 280 (via the outlet seal 420) not being shown for simplicity.

Also represented in Figures 11A to 11C is an inner wall 432A of the air channel wall 432 which defines an outer surface of the air channel 433 through which airflows when the vapour provision system is use. As also schematically represented in these figures, the air channel wall 432 includes a protrusion 750 extending into the air channel 433 from a part of the inner wall 432A. In this example the protrusion is in the form of a protrusion wall running the length of the portion of the air channel represented in Figure 11 along a generally helical path, completing around one turn.

The helical / spiral path of the protrusion 750 along the length of the air channel means the protrusion provides a wall that extends into the air channel with a surface facing air drawn along the channel and inclined at a non-zero angle to the axis of extent 740 of the air channel 433 (i.e. an axis corresponding generally to the direction of airflow in use). This causes air passing along the channel 433 to be deflected about the central axis of the airflow tube (in this example in a clockwise direction as viewed from the upstream end), thereby imparting a degree of rotation about the axis of extent of the air channel to the air flowing through the air channel. Thus, the protrusion causes the flow of air in the air channel to be modified during use, in this case by introducing rotation.

The degree of rotation will depend on various factors, such as the size of the protrusion (i.e. how far it extends into the airflow channel 433 (its height), the inclination of the deflecting wall provided by the protrusion to the axis of extent 740, and the number of protrusions). In the example represented in Figures 11A to 11C, the airflow channel 433 has a diameter of around 5 mm and the protrusion extends into the airflow channel for a distance of around 2 mm. The protrusion 750 presents a relatively shallow angle to incoming air, for example around 15 degrees. Furthermore, in this example there is only one protrusion.

If a greater degree of airflow modification (i.e. more rotation) is desired, a greater number of walls, for example one or more further protrusion walls, could be added with an appropriate azimuthal offset from the protrusion wall 750 represented in Figures 11A to 11C (e.g. 180 degrees offset for one further wall, 120 degrees offset for each of two further walls, etc.). Also, the extent of the protruding wall(s) (or other protrusions / ridges) into the air channel 433 could be increased to increase the modification to the airflow. Furthermore still, a tighter spiral (i.e. more turns along the length of the air channel 433) could be used to provide an increase in the deflection angle presented to air flowing in the air channel. For example, in some examples the deflection angle may be selected from the group comprising: at least 10 degrees; at least 20 degrees; at least 30 degrees; at least 40 degrees; at least 50 degrees; at least 60 degrees; at least 70 degrees; and at least 80 degrees.

To introduce a smaller degree of rotation, the protruding wall 750 could be made smaller, or it may be broken into a number of non-continuous portions along the helical path.

More generally, it will be appreciated there are many parameters for the configuration of one or more protrusions which could be adjusted to provide a desired degree of rotation. An appropriate degree of rotation for any given implementation could be determined empirically, for example, by testing the performance of different example configurations.

In some respects the approaches of introduction of rotation into airflow along the air channel 433 may be considered to providing a rifling effect.

Figure 12A and 12B are similar to, and will be understood from, Figures 11B and 11C, but show a different protrusion configuration. In particular, rather than a single ribbon-like helical protrusion from an inner wall 432A of the air channel wall 432, in the example of Figures 12A and 12B, there are a plurality of separate protrusions extended inwardly from the inner wall 432A defining the air channel 433. These protrusions 760 provide surfaces facing the direction of airflow more or less square on (i.e. the major surfaces of the respective protrusions 760 facing the oncoming air are substantially orthogonal to the axis of extent 740 of the airflow channel 433 / direction of airflow). Accordingly, rather than introduce rotation into the airflow, this configuration introduces turbulence, as schematically indicated by the airflow arrows shown within the air channel 433. It will again be appreciated the specific arrangement of protrusions will depend on the degree of airflow modification required. For example, in Figure 12A and 12B the individual protrusions 760 extend around a relatively small azimuthal extent, whereas in other examples they may extend around a greater azimuthal extent, perhaps forming closed rings, to provide an increased degree of airflow modification / turbulence in the air channel. Similarly, a higher or lower number of protrusions may be provided along the axial extent of the airflow path to increase or decrease the degree of airflow modification in the air channel due to the protrusions.

In terms of their structure, the protrusions 750, 760 and the airflow wall 732 represented in the respective embodiments of Figures 11A to 11C and Figures 12A to 12B may in each case be integrally formed, e.g. with appropriate moulding and / or machining techniques. However, in other examples in which an inner surface of the air channel wall is provided with at least one protrusion extending into the air channel in accordance with the principles described herein, the at least one protrusion may be formed separately from the air channel wall and instead comprise a separate insert for the air channel.

Figure 13A, 13B and 13C are generally similar to, and will be understood from, Figures 11A, 11B and 11C. However, whereas in the example of Figures 11A, 11B and 11C, the airflow modification (rotation) is achieved using a protrusion comprising a helical wall integrally formed with the air channel wall 432, in the example of Figure 13A, 13B and 13C, a protrusion 770 comprising a helical spring-shaped structure is inserted into the air channel 433 which is defined by an otherwise smooth inner wall 432A. In this example the helical spring-shaped structure comprises a conventional spring having an appropriate outer diameter and thickness (gauge). In this regard, the thickness of the spring 770 providing the protrusion in Figures 13A to 13B is in this example less than the height of the wall 750 providing the protrusion in Figures 13A to 13B, but the spring 770 is arranged to present a steeper angle to incoming air (i.e. arranged on a tighter helix with more turns) and so may introduce a broadly corresponding degree of rotation to air flowing in the air channel. In any event, and as discussed above, an appropriate configuration providing a desired degree of airflow modification can be established through empirical testing, for example by assessing the performance using springs of different dimensions.

Figures 14A and 14B schematically represent portions of an air channel wall 832 defining an air channel 833 extending along an axis of extent 840 and which includes protrusions 835A and 835B for use in a cartomiser in accordance with certain embodiments of the disclosure. The direction of normal airflow when the cartomiser is in use is indicated in Figure 14A by an arrow 836. In this example the air channel wall 832 is manufactured as two parts with each part being integrally moulded, e.g. from a plastic material, with a respective one of the protrusions 835A, 835B. Thus the air channel wall 832 comprises a first part 832A and a second part 832B which are assembled to define a generally tubular air channel 833 with the protrusions 835A, 835B extending into the air channel 833 to modify airflow in accordance with the principles described herein. In both Figures 14A and 14B only a portion of the air channel wall 832 in the vicinity of the protrusions 835A, 835B is shown for simplicity, and furthermore, only the first half of the air channel wall 832A is shown in Figure 14A.

It will be appreciated these kinds of protrusion can be incorporated in an air channel regardless of the overall construction and operation of the remaining parts of the electronic cigarette and in that sense, the manner in which the air channel wall 832 is incorporated into an electronic cigarette, for example in terms of sealing and coupling to other parts of the electronic cigarette, is not significant to the principles described herein.

In terms of scale, the air channel wall 832 in this specific implementation example has an outer diameter of around 6 mm and an inner diameter of around 3 mm (i.e. wall thickness is around 1.5 mm) in the vicinity of the protrusions. The respective protrusions have a length of around 4 mm and are inclined in this example is an angle of around 40° to the air channel wall. The protrusions have a thickness of around 0.5 mm and a height of around 1.5 mm. Consequently, when the two halves of the air channel wall 832 are assembled together for use, the respective protrusions 835A, 835B are close to meeting at the centre of the air channel 833, as can be seen in Figure 14B. In that sense the protrusions are arranged to extend from the air channel wall to around the centre of the air channel so that together they span the majority, e,g. more than 50%, 60%, 70%, 80% or 90% of the air channel diameter, and in some cases the individual protrusions may extend from the wall to be on the centre of the air channel so that protrusions on one side of the air channel overlap with protrusions on the other side of the air channel. That is to say a protrusion may extends from the air channel wall towards a central axis of the air channel for a distance corresponding to at least 50%, 60%, 70%, 80%, 90% and 100% of the distance between the air channel wall and the central axis.

For arrangement discussed above in which the protrusions comprise two angled walls (vanes) extending from the air channel wall to around the centre of the air channel at around the same location along the axis of the air channel, it will be appreciated when viewed along the axis of the air channel, the protrusions cover around 50% of the cross-sectional area of the air channel. However, it will be appreciated that in other examples the protrusions may cover different amounts of the cross sectional area of the air channel, for example having regard to a desired increase in draw resistance provided by the protrusions. For example, in other cases the protrusions may cover, in projection, between 20% and 80%, between 30% and 70%, or between 40% and 60% of the cross-sectional area of the airflow channel in a plane perpendicular to its axis of extent.

It will be appreciated the specific example sizes and shapes set out above are merely for one particular implementation and other implementations may have different geometries, for example different sizes having regard to the overall structure of the cartomiser in which the air channel is provided. Furthermore it will be appreciated the specific example of an angle of inclination for the respective protrusions of of 40 degrees to the air channel wall / longitudinal axis of the air channel is again merely one particular implementation. Other angles may be used in other implementations, for example angles in the range 10 degrees to 70 degrees, 20 degrees to 60 degrees and 30 degrees to 50 degrees.

Approaches in accordance with the examples discussed above in relation to Figures 14A and 14B, i.e. consisting of two protrusions arranged to almost meet at the centre of the air channel, have been found to provide an appropriate degree of modification to airflow without generating an undesirably high increase in draw resistance and / or condensation in use.

Thus, in accordance with the principles described herein, an air channel providing fluid communication between a vapour generation chamber and a vapour outlet opening in an aerosol provision apparatus, for example a cartomiser for coupling to a control unit comprising a battery for selectively supplying power to the vaporiser in the vapour generation chamber, is provided with a means (e.g. one or more protrusions) for modifying the flow of air in the air channel, for example by imparting a degree of rotation and / or a degree of turbulence. As noted above, this can help provide a vapour / aerosol with improved characteristics in terms of user perception.

Thus, there has been described a vapour provision apparatus (e.g. a detachable cartridge for a vapour provision system) comprising: a vapour generation chamber containing a vaporiser for generating vapour from a vapour precursor material; and an air channel wall defining an air channel between the vapour generation chamber and a vapour outlet at a mouthpiece end of the vapour provision apparatus through which a user can inhale vapour during use; wherein an inner surface of the air channel wall is provided with at least one protrusion extending into the air channel to modify (redirect) a flow of air in the air channel during use. For example, the at least one protrusion may be arranged to define one or more portions of a helical wall extending into the air channel so as to impart a degree of rotation about an axis of extent of the air channel to air flowing in the air channel during use.

While some particular examples have been described above, it will be appreciated there are many modifications that could be made in accordance with other implementations.

For example, it will be appreciated some embodiments may incorporate features of different embodiments discussed above, for example a combination of turbulence inducing protrusions and rotation inducing protrusions.

It will also be appreciated the specific shape and configuration of the various elements discussed above may be modified for different implementations, for example in accordance with a desired overall size and shape of the electronic cigarette. For example, the system need not be generally flat, but could be more cylindrical, while still making use of the principles described herein in respect of airflow along an air channel connecting a vaporisation chamber to a vapour outlet.

It will further be appreciated that whereas the above-described embodiments have primarily focused on an electrical heater based vaporiser, the same principles may be adopted in accordance with vaporisers based on other technologies, for example piezoelectric vibrator based vaporisers.

It will similarly be appreciated that whereas the above-described embodiments have primarily focused on liquid-based aerosol provision systems, the same principles for manipulating the flow of air in an outlet air channel of a vapour provision system can equally be applied in respect of systems for generating vapour from a solid, or other non-liquid, precursor material, for example an aerosol provision system based on heating tobacco or a tobacco derivative could also make use of the principles described herein.

Although various embodiments have been described in detail herein, this is by way of example only, and as already noted, it will be appreciated that approaches in accordance with the principles described herein may be utilised in many different configurations. For example, these approaches might be used for a one-piece or three-piece device (rather than a two-piece device, i.e. cartomiser and control unit, as described here). Similarly, as already noted, these approaches could be utilised with electronic vapour provision systems that includes non-liquid aerosol precursor material, for example material derived from tobacco plants which is provided in another (e.g. powder, paste, shredded leaf material, etc.), and then heated to produce volatiles for inhalation by a user. The approaches described herein could also be used with various types of heater for the e-cigarette, various types of airflow configuration, various types of connection between the cartomiser and the control unit (such as screw or bayonet) etc. The skilled person will be aware of various other forms of electronic vapour provision system which might employ approaches of the kind discussed above.

More generally, it will be appreciated the various embodiments described herein are presented only to assist in understanding and teaching the claimed features. These embodiments are provided as a representative sample of embodiments only, and are not exhaustive and / or exclusive. It is to be understood that advantages, embodiments, examples, functions, features, structures, and / or other aspects described herein are not to be considered limitations on the scope of the invention as defined by the claims or limitations on equivalents to the claims, and that other embodiments may be utilised and modifications may be made without departing from the scope of the claimed invention. Various embodiments of the invention may suitably comprise, consist of, or consist essentially of, appropriate combinations of the disclosed elements, components, features, parts, steps, means, etc., other than those specifically described herein. In addition, this disclosure may include other inventions not presently claimed, but which may be claimed in future.

CLAIMS

1. A vapour provision apparatus comprising:

a vapour generation chamber containing a vaporiser for generating vapour from a vapour precursor material; and

an air channel wall defining an air channel between the vapour generation chamber and a vapour outlet at a mouthpiece end of the vapour provision apparatus through which a user can inhale vapour during use;

wherein an inner surface of the air channel wall is provided with at least one protrusion extending into the air channel to modify a flow of air in the air channel during use.

2. The vapour provision apparatus of claim 1, wherein the at least one protrusion defines at least one protrusion wall extending into the air channel and having a surface inclined at a non-zero angle to an axis of extent of the air channel.

3. The vapour provision apparatus of claim 2, wherein the non-zero angle comprises an angle selected from the group comprising: at least 10 degrees; at least 20 degrees; at least 30 degrees; at least 40 degrees; at least 50 degrees; at least 60 degrees; at least 70 degrees; and at least 80 degrees.

4. The vapour provision apparatus of claim 2 or 3, wherein the at least one protrusion wall is arranged on a helical path extending along at least a part of the air channel wall so as to impart a degree of rotation about the axis of extent of the air channel to air flowing along the air channel during use.

5. The vapour provision apparatus of any of claims 1 to 4, wherein the at least one protrusion is arranged to introduce a degree of turbulence to flowing along the air channel during use.

6. The vapour provision apparatus of any of claims 1 to 5, wherein the at least one protrusion and the air channel wall are integrally formed.

7. The vapour provision apparatus of any of claims 1 to 5, wherein the at least one protrusion is formed separately from the air channel wall and comprises an insert for the air channel.

8. The vapour provision apparatus of claim 7, wherein the insert comprises a helical spring.

9. The vapour provision apparatus of any of claims 1 to 8, wherein the vapour provision apparatus is a detachable cartridge for a vapour provision system comprising the detachable cartridge and a control unit, wherein the control unit comprises a power supply for selectively supplying power to the vaporiser when the detachable cartridge is coupled to the control unit for use.

10. The vapour provision apparatus of any of claims 1 to 9, further comprising a power supply for selectively supplying power to the vaporiser.

11. The vapour provision apparatus of any of claims 1 to 10, wherein the vaporiser comprises a heater in proximity to at least a portion of the vapour precursor material.

12. The vapour provision apparatus of any of claims 1 to 11, wherein the vapour precursor material comprises a liquid.

13. The vapour provision apparatus of any of claims 1 to 12, wherein the vapour precursor material comprises a solid material.

14. The vapour provision apparatus of any of claims 1 to 13, wherein the at least one protrusion defines at least one protrusion wall extending into the air channel and having a surface inclined at a non-zero angle to an axis of extent of the air channel, wherein the non-zero angle comprises an angle within the range 10 degrees to 70 degrees; 20 degrees to 60 degrees; or 30 degrees to 50 degrees.

15. The vapour provision apparatus of any of claims 1 to 14, wherein the at least one protrusion extends from the air channel wall towards a central axis of the air channel by a distance of at least 50%, 60%, 70%, 80%, 90% and 100% of the distance between the air channel wall and the central axis.

16. The vapour provision apparatus of any of claims 1 to 15, wherein the at least one protrusion comprises two protrusions, and the air channel wall is formed of a first wall part and a second wall part, and wherein each wall part is intergrally moulded with one of the protrusions.

17. The vapour provision apparatus of any of claims 1 to 16, wherein the at least one protrusion comprises two protrusions which extending into the air channel at the same location along the axis of the air channel.

18. The vapour provision apparatus of any of claims 1 to 17, wherein the at least one protrusions covers between 20% and 80%, between 30% and 70%, or between 40% and 60% of the cross-sectional area of the airflow channel in a plane perpendicular to its axis of extent.

19. Vapour provision means comprising:

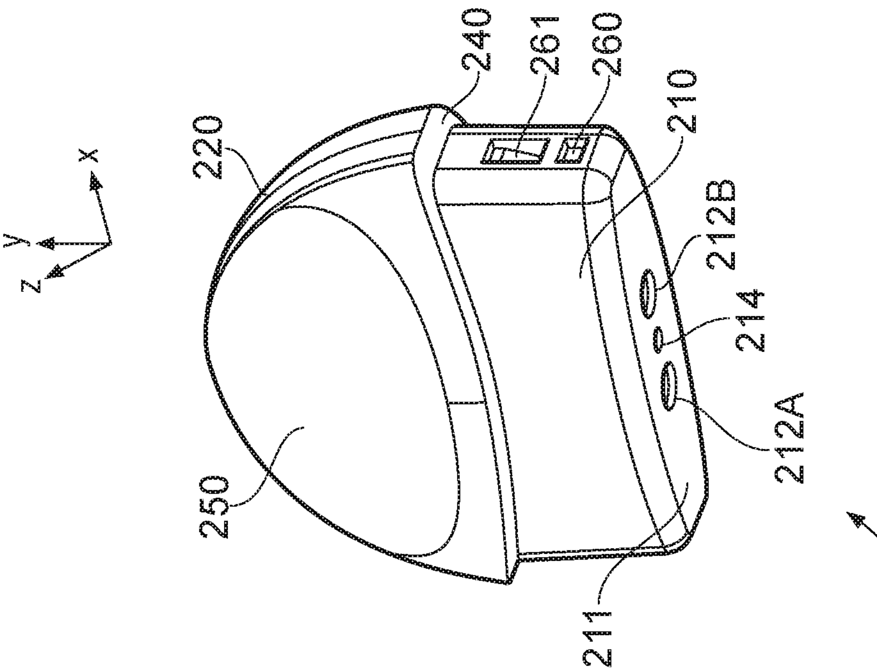
vapour generation chamber means containing vapour generation means for generating a vapour from vapour precursor material means; and

air channel wall means defining air channel means fluidly connecting between the vapour generation chamber means and vapour outlet means at a mouthpiece end of the vapour provision means through which a user can inhale vapour during use;

wherein an inner surface of the air channel wall means is provided with protrusion means extending into the air channel means for modifying a flow of air in the air channel means during use.

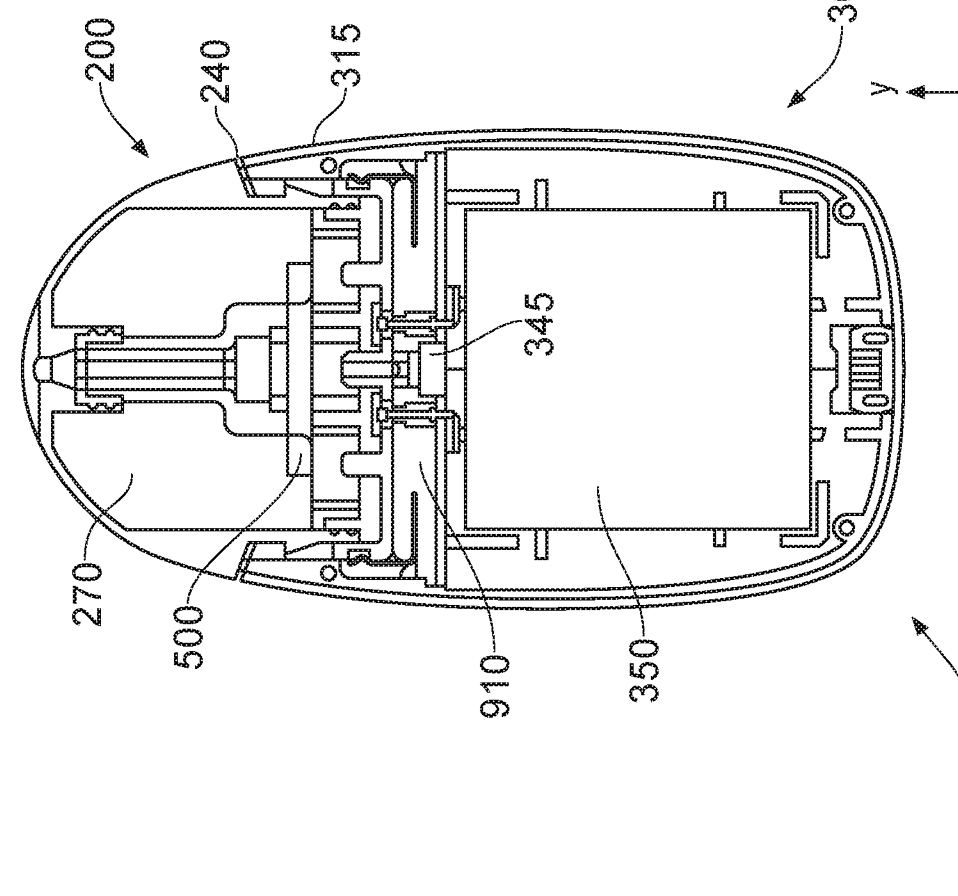
20. An aerosol provision system substantially as described hereinbefore described with reference to the accompanying drawings.

21. A method substantially as described hereinbefore described with reference to the accompanying drawings.



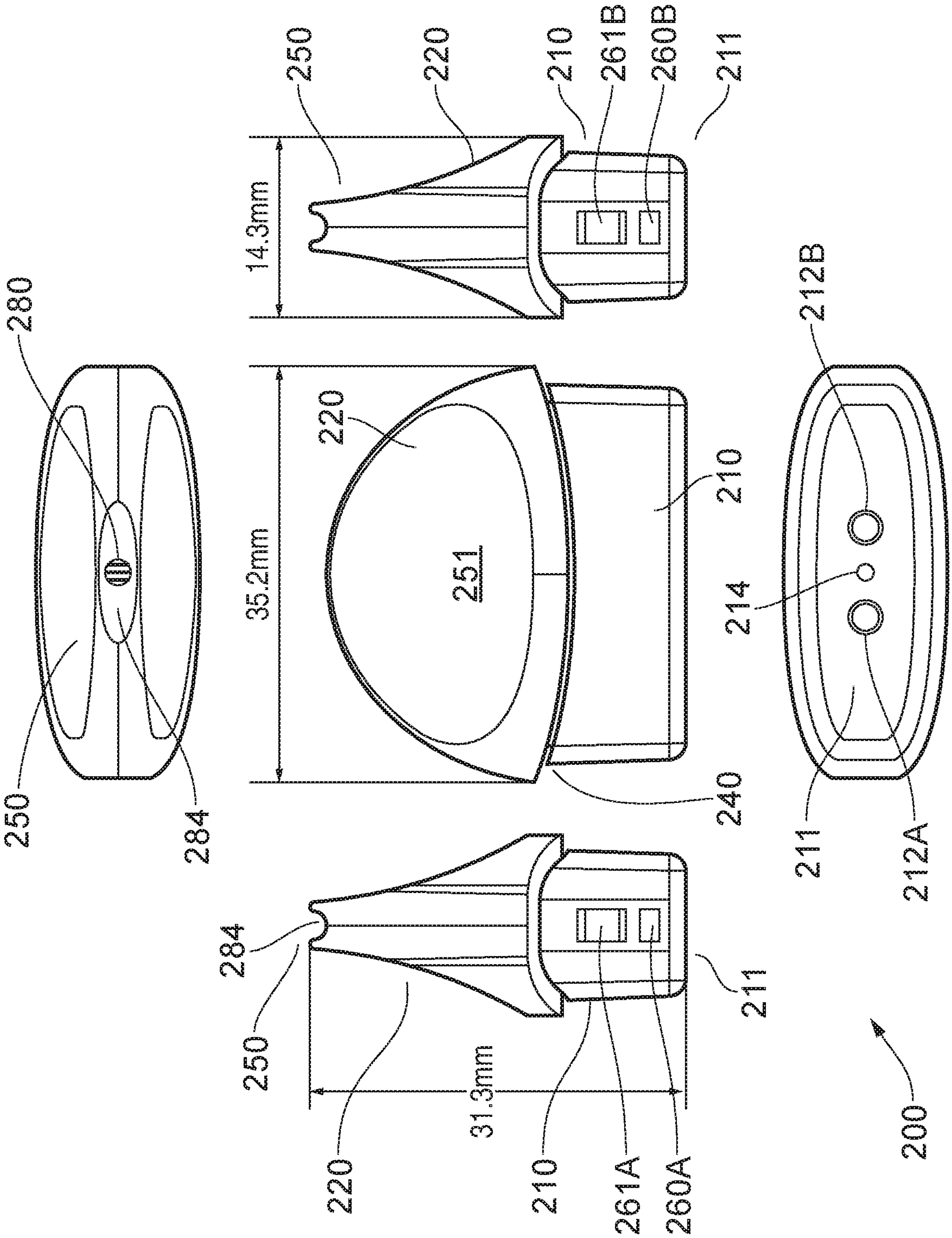
240
261
260
220
210
212B
214
212A
250
211
200
x
y
z

FIG. 2



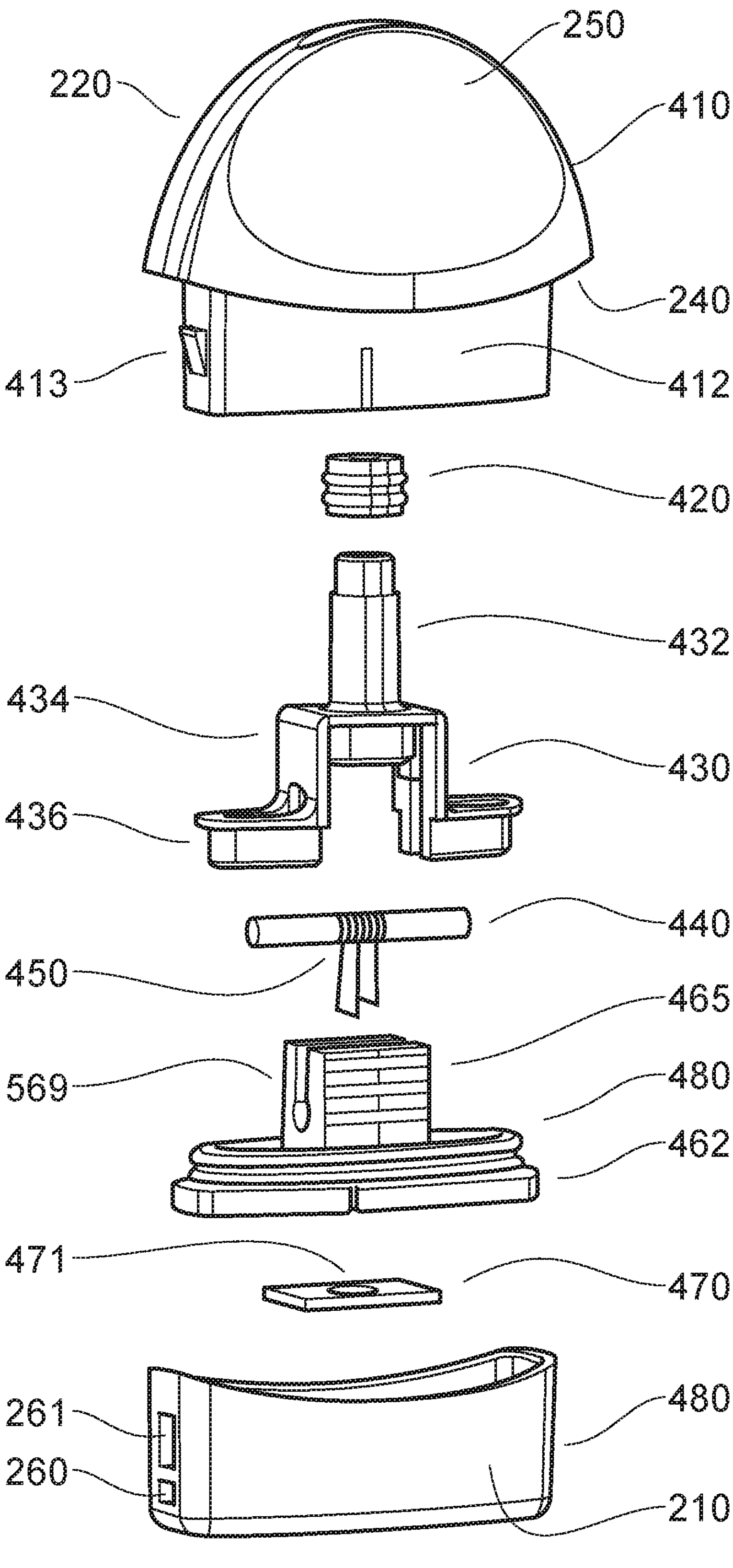
200
240
315
300
x
y
345
270
500
910
350
100

FIG. 1



250
220
210
261B
260B
211
14.3mm
280
250
284
220
251
35.2mm
210
240
212B
214
211
212A
284
250
220
31.3mm
210
261A
260A
211
200

FIG. 3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470
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480
260
210

FIG. 4

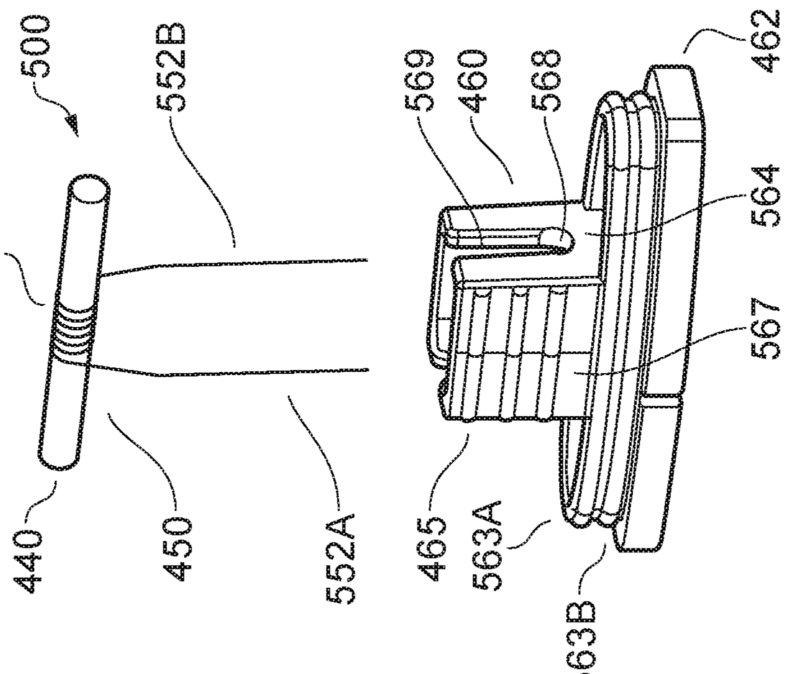


FIG. 5A

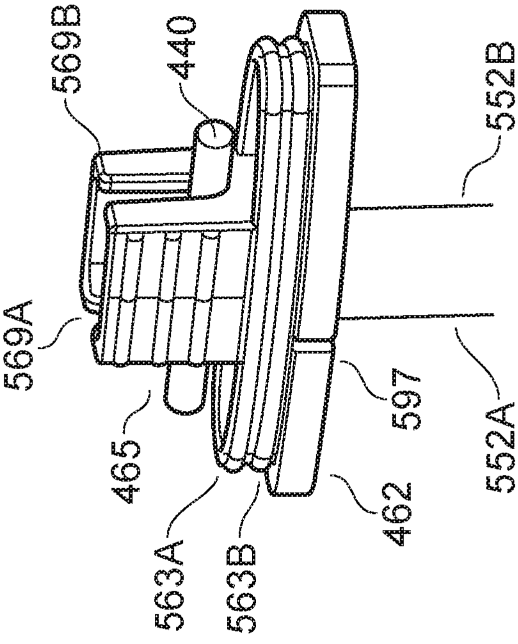


FIG. 5B

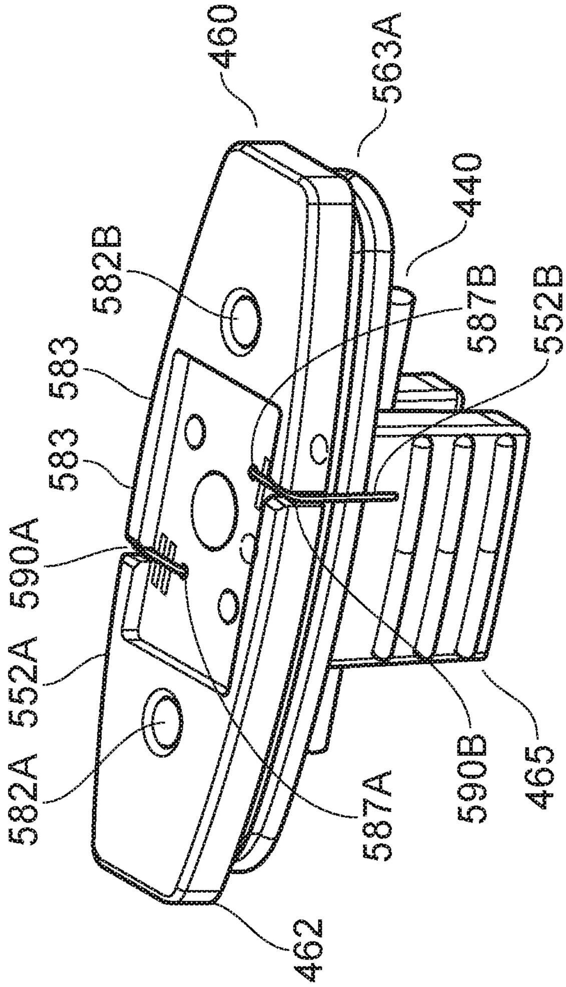
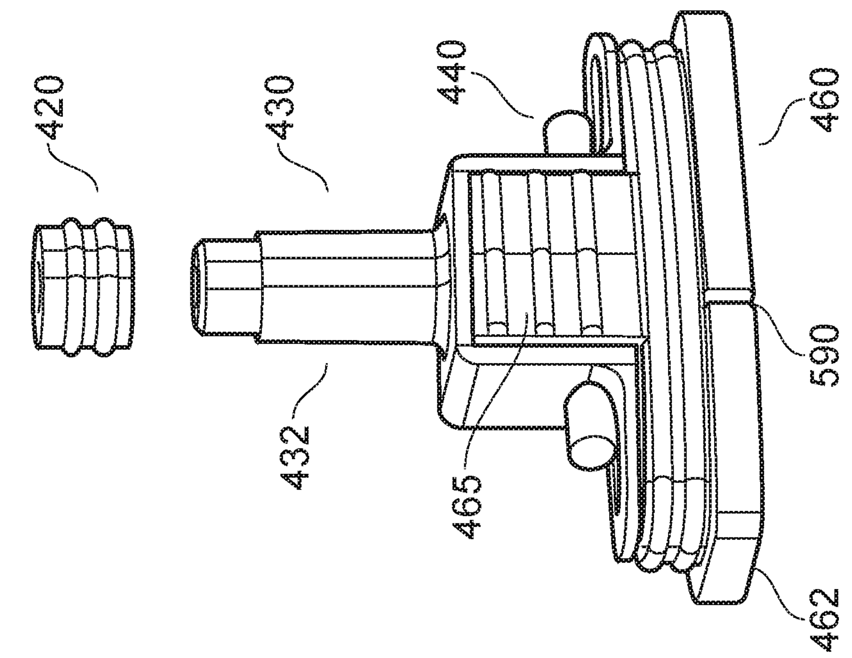


FIG. 5C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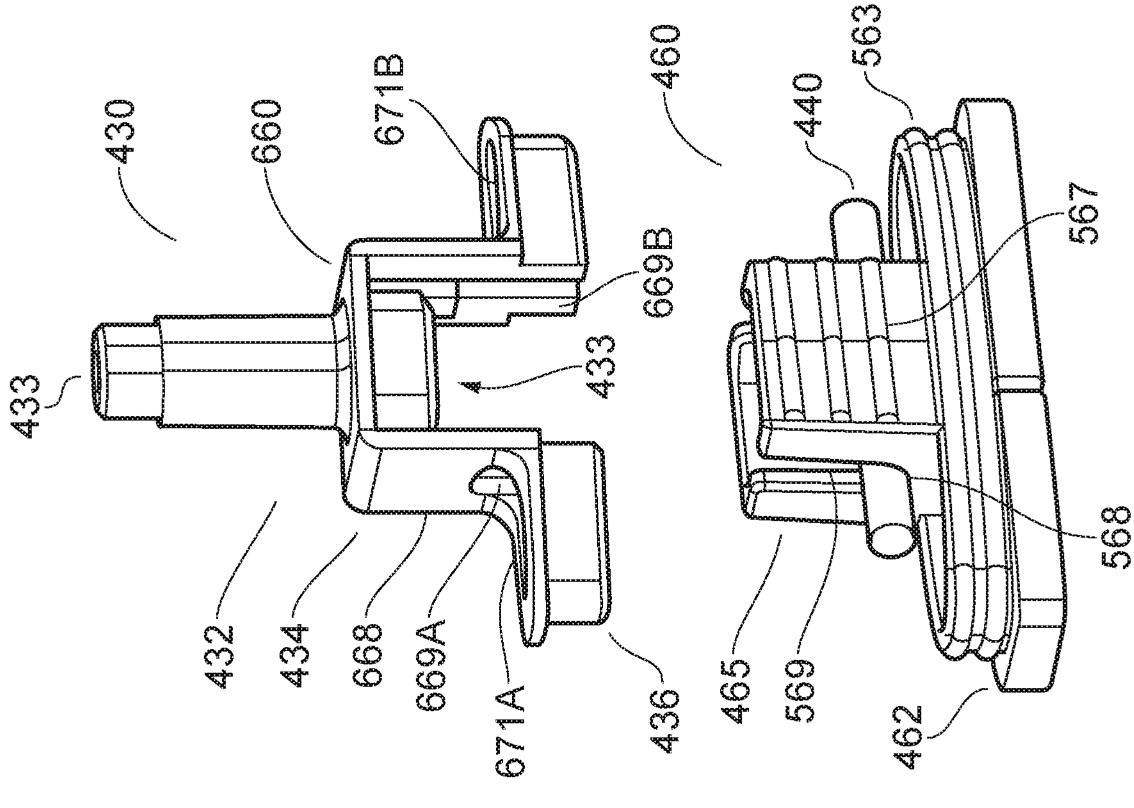
460
432
465
590
462

FIG. 6B


430
660
671B
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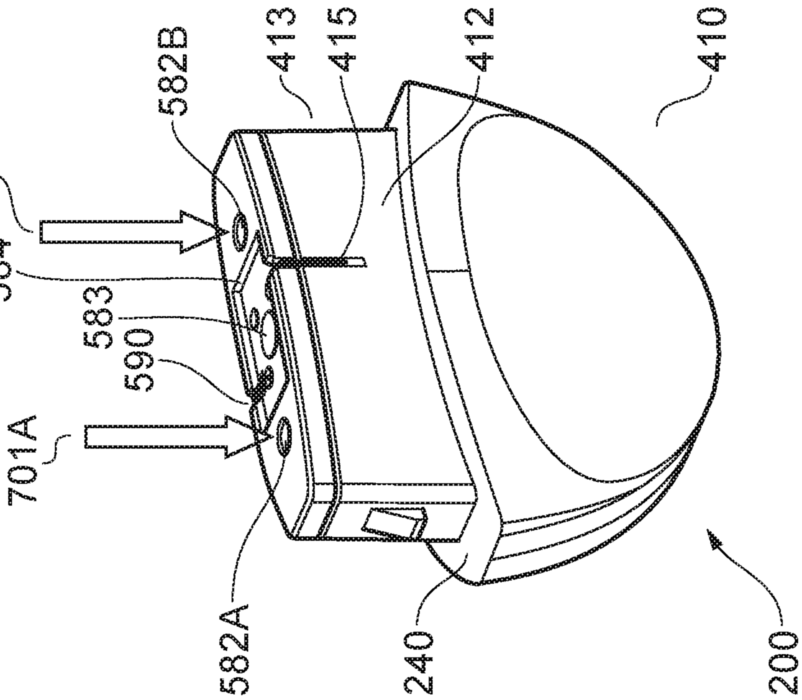
669B
433
432
434
668
669A
671A
436
460
440
563
567
568
465
569
462

FIG. 6A


701B
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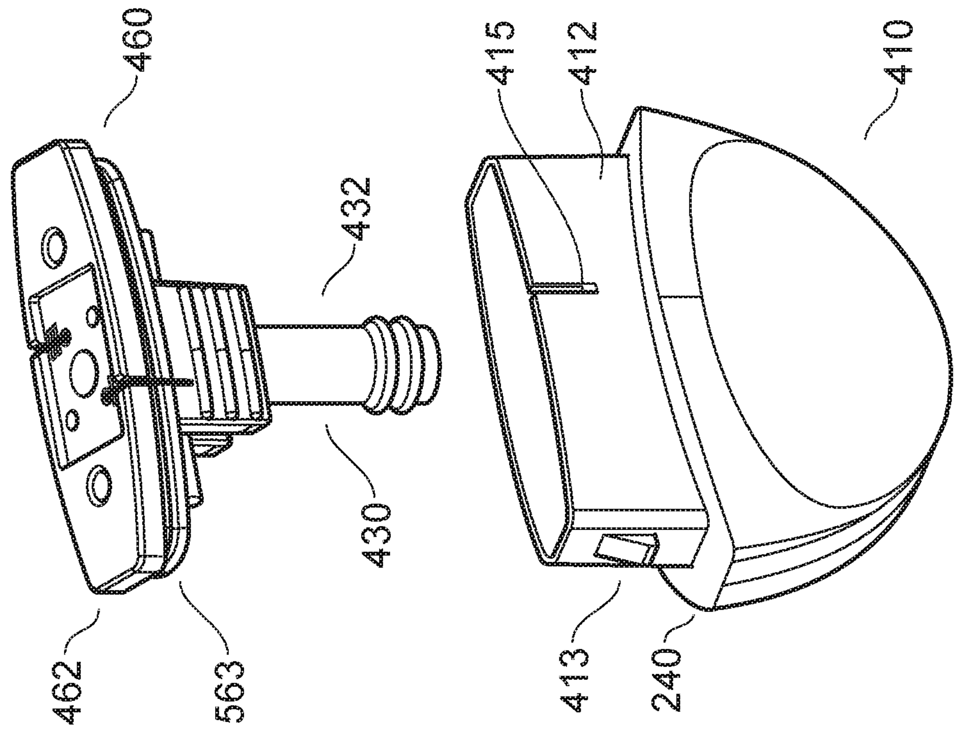
583
590
701A
582B
413
415
412
410
582A
240
200

FIG. 7B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432
430
462
563
415
412
410
413
240

FIG. 7A

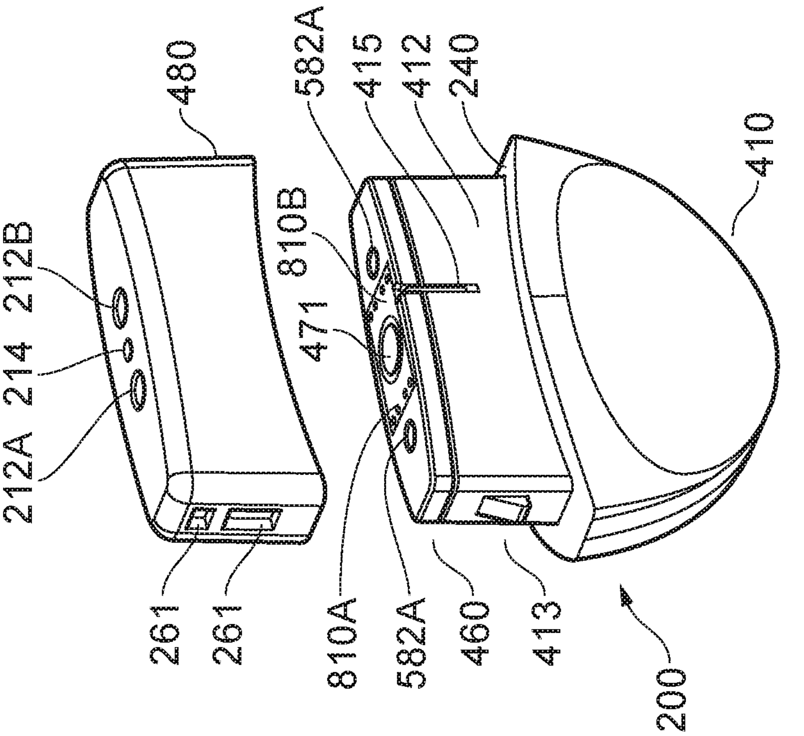

FIG. 8B

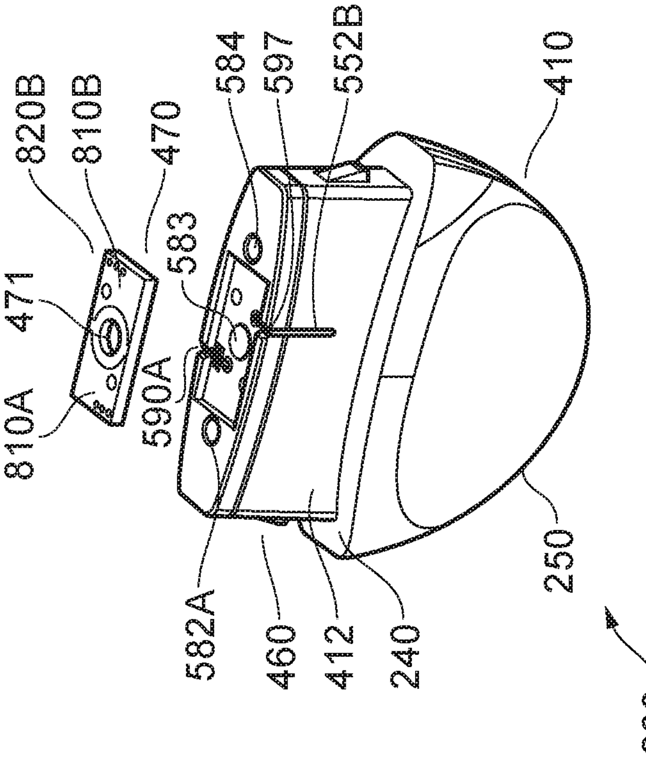

FIG. 8A

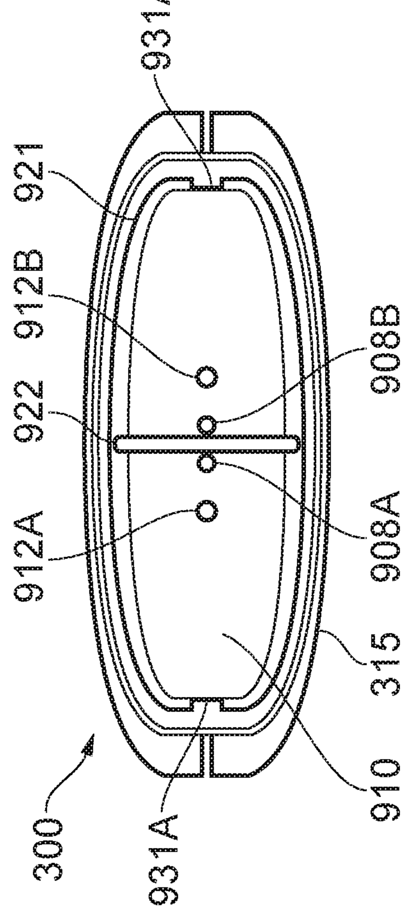

FIG. 9

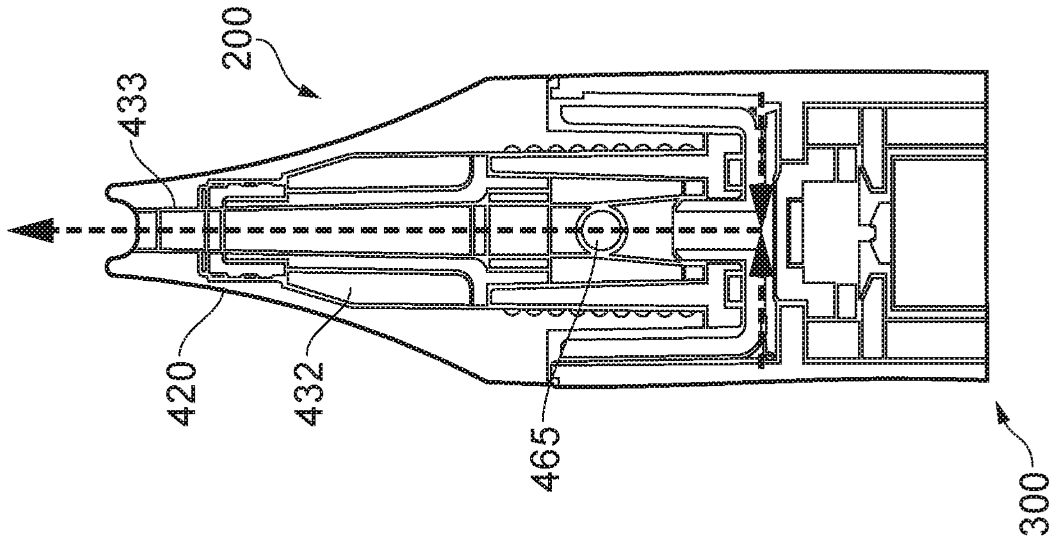

FIG. 10B

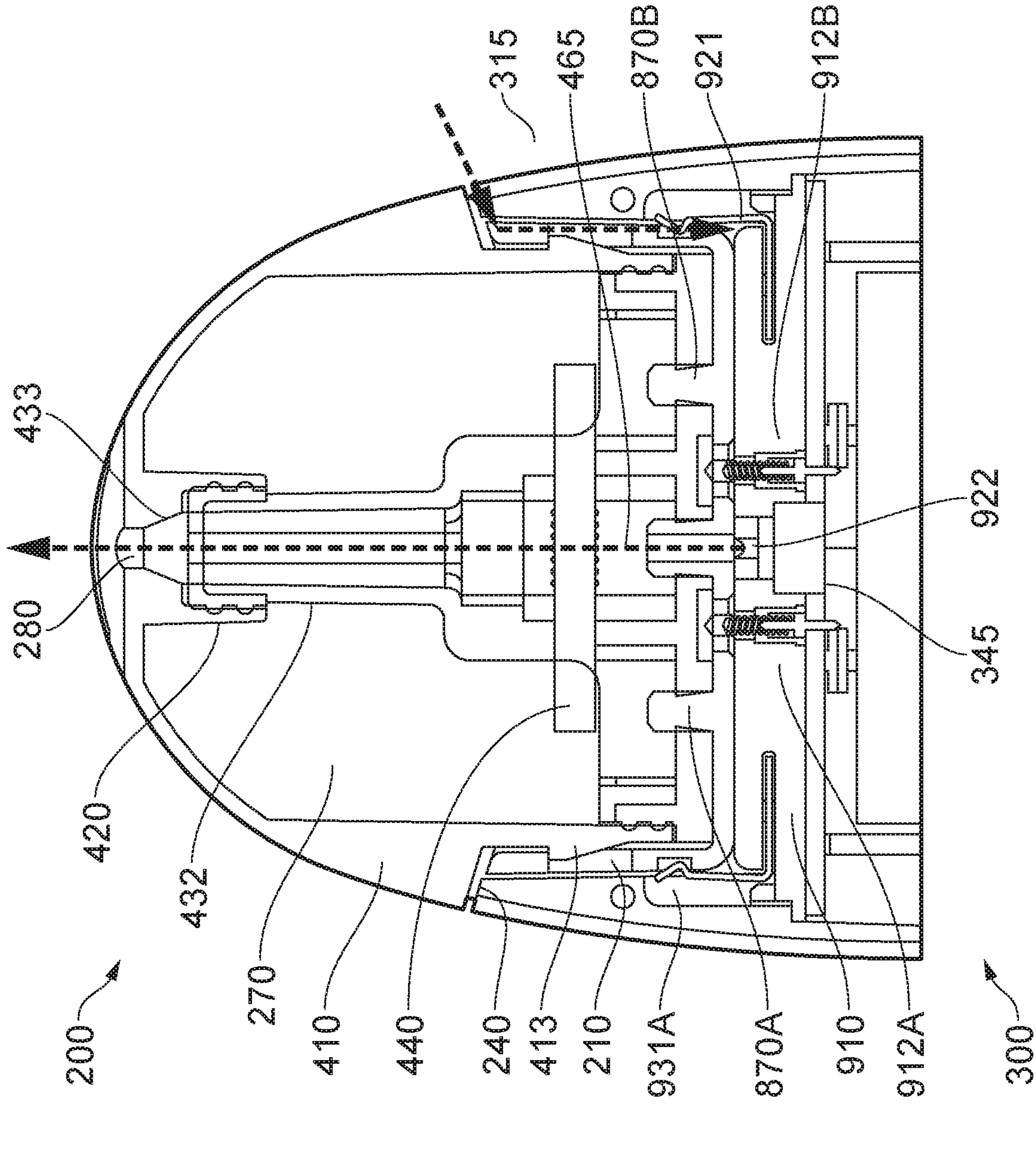

FIG. 10A

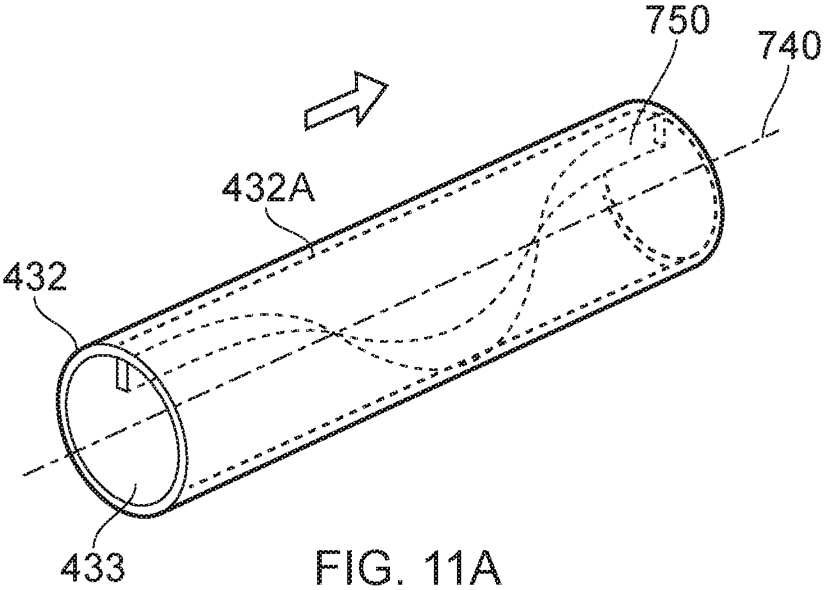

FIG. 11A

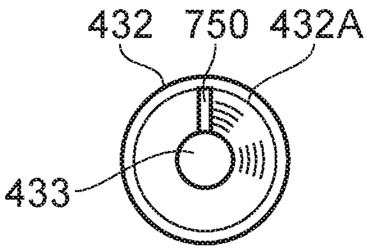

FIG. 11B

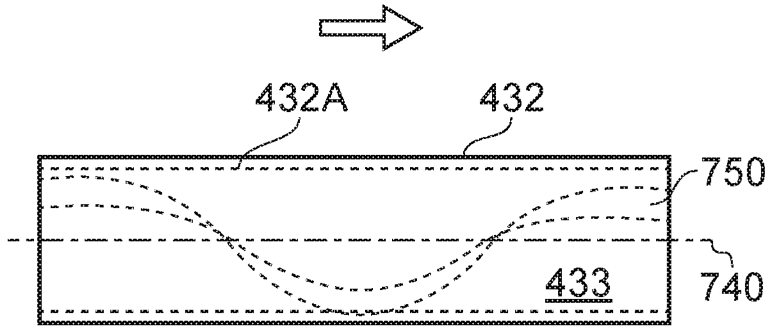

FIG. 11C

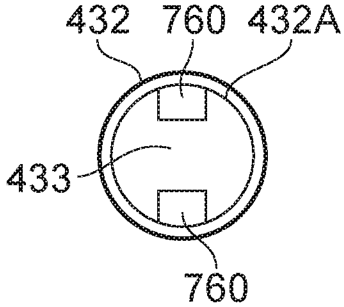

FIG. 12A

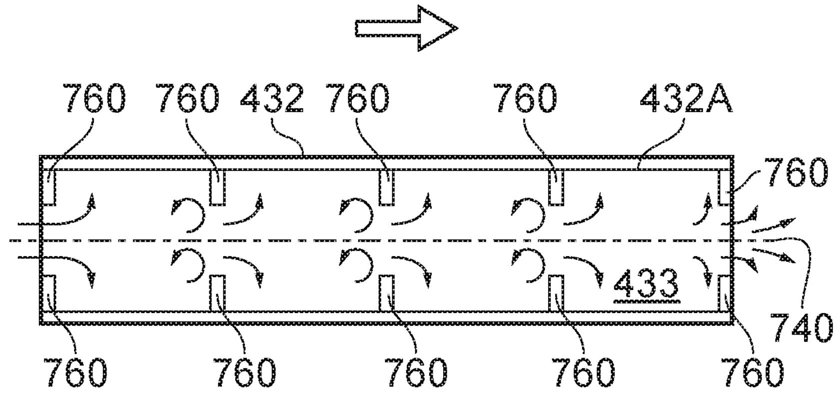

FIG. 12B

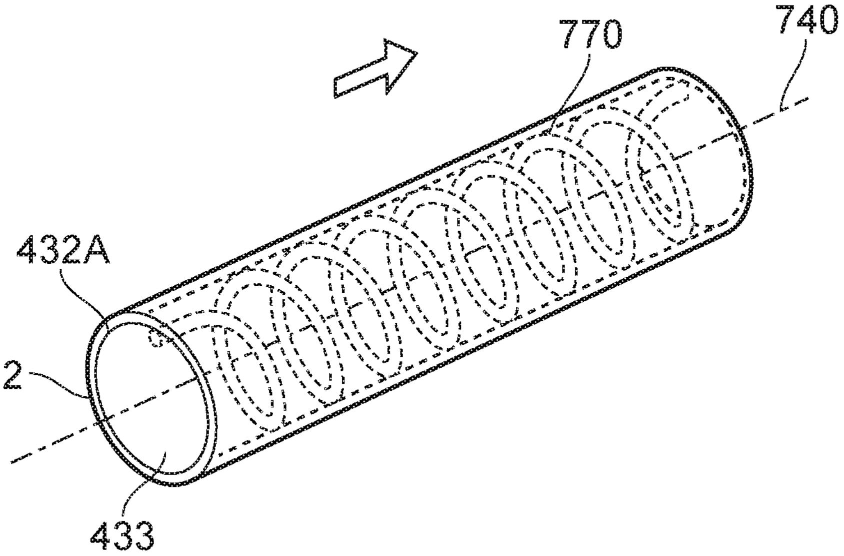

FIG. 13A

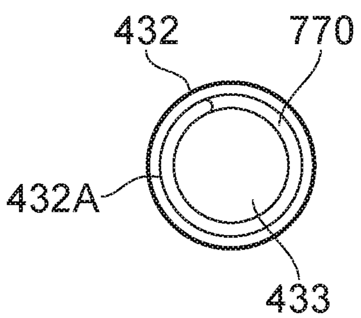

FIG. 13B

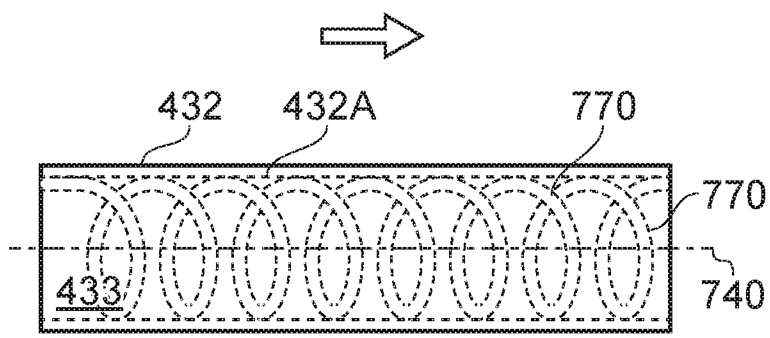

FIG. 13C

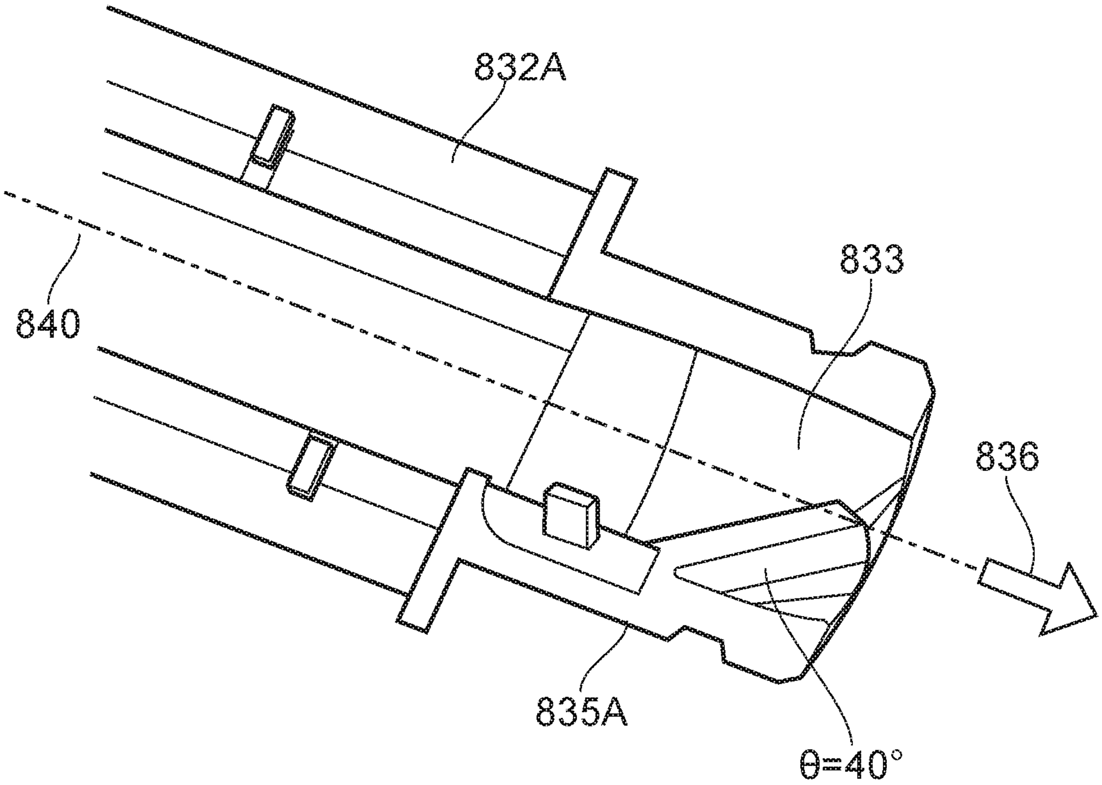

FIG. 14A

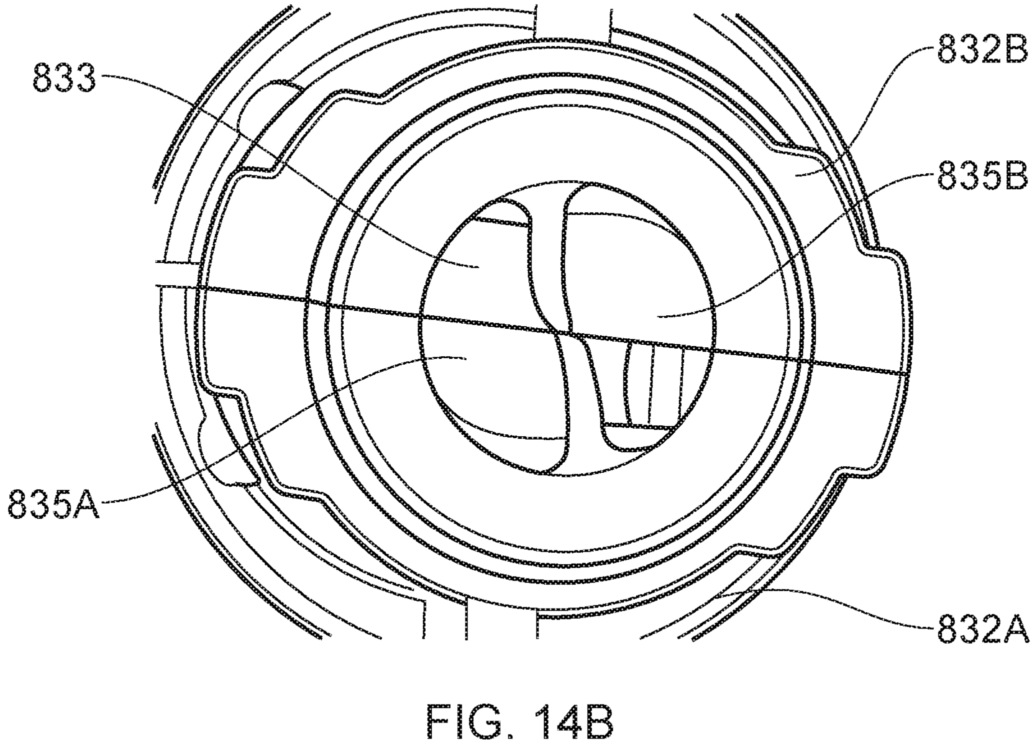

FIG. 14B

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050783

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M15/06 A24F47/00 A61M11/04
ADD.

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)
A61M A24F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 504 077 A (NICOVENTURES HOLDINGS LTD [GB]) 22 January 2014 (2014-01-22) figures 1-11 page 7, line 6 - page 11, line 10	1-19
X	US 2015/027456 A1 (JANARDHAN SRINIVASAN [US] ET AL) 29 January 2015 (2015-01-29) figures 1-12 paragraph [0064] - paragraph [0077]	1-19
X	GB 2 191 718 A (BRITISH AMERICAN TOBACCO CO) 23 December 1987 (1987-12-23) figure 1 page 1, line 5 - page 2, line 94	1-19

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"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)

"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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2017	09/06/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Liess, Helmar

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2017/050783

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 412 876 A (GASFLOW SERVICES LTD [GB]) 12 October 2005 (2005-10-12) figures 1-4 page 3, line 1 - page 4, line 6 -----	1-19
X	EP 2 319 334 A1 (PHILIP MORRIS PROD [CH]) 11 May 2011 (2011-05-11) figures 2a-c paragraph [0061] - paragraph [0065] -----	1-19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2017/050783

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 20, 21
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 20, 21

Claims 20, 21 attempts to define their subject-matter by referring ambiguously to the accompanying drawings of the application rather than clearly defining the apparatus and method in terms of technical features. The intended limitations are therefore not clear from these claims, contrary to the requirements of Article 6 PCT, and therefore no meaningful search can be made.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2017/050783

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2504077 A	22-01-2014	AU 2013292107 A1	29-01-2015
		CA 2878977 A1	23-01-2014
		CN 104661545 A	27-05-2015
		EP 2871985 A1	20-05-2015
		ES 2604473 T3	07-03-2017
		GB 2504077 A	22-01-2014
		HK 1204237 A1	13-11-2015
		JP 6031192 B2	24-11-2016
		JP 2015524259 A	24-08-2015
		KR 20150036557 A	07-04-2015
		RU 2015101747 A	27-08-2016
		UA 110898 C2	25-02-2016
		US 2015201675 A1	23-07-2015
		WO 2014012907 A1	23-01-2014
US 2015027456 A1	29-01-2015	AR 097084 A1	17-02-2016
		CN 105578913 A	11-05-2016
		EP 3024342 A1	01-06-2016
		US 2015027456 A1	29-01-2015
		WO 2015013329 A1	29-01-2015
GB 2191718 A	23-12-1987	DE 3719718 A1	23-12-1987
		GB 2191718 A	23-12-1987
		US 4945929 A	07-08-1990
GB 2412876 A	12-10-2005	NONE	
EP 2319334 A1	11-05-2011	AU 2010311893 A1	07-06-2012
		BR 112012010034 A2	24-05-2016
		CA 2778786 A1	05-05-2011
		CN 102655773 A	05-09-2012
		CN 105815814 A	03-08-2016
		CO 6551748 A2	31-10-2012
		DK 2493341 T3	08-09-2013
		EA 201270596 A1	30-11-2012
		EA 201500760 A1	31-03-2016
		EP 2319334 A1	11-05-2011
		EP 2493341 A1	05-09-2012
		EP 2606756 A1	26-06-2013
		ES 2431273 T3	25-11-2013
		HK 1173346 A1	20-12-2013
		IL 219338 A	30-04-2017
		JP 5901527 B2	13-04-2016
		JP 2013507976 A	07-03-2013
		KR 20120115488 A	18-10-2012
		NZ 599821 A	30-04-2014
		PT 2493341 E	18-09-2013
		RS 52925 B	28-02-2014
		UA 106393 C2	26-08-2014
		US 2011094523 A1	28-04-2011
		US 2016198772 A1	14-07-2016
		US 2016331039 A1	17-11-2016
		WO 2011050943 A1	05-05-2011
		ZA 201202994 B	30-01-2013