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(54) **Title**: ELECTRONIC CIGARETTE LIQUID DETECTION AND MEASUREMENT SYSTEMS

(57) **Abstract**: An electronic cigarette or similar vaporization devices include a liquid which is vaporized or atomized in an atomizer. An e-liquid detection system can verify that the e-liquid is acceptable for use in the device. The e-liquid detection system may detect one or more indicators, and/or physical or chemical properties of the e-liquid. The e-liquid detection system may also measure the e-liquid level in the device.

ELECTRONIC CIGARETTE LIQUID DETECTION AND MEASUREMENT SYSTEMS

BACKGROUND OF THE INVENTION

An electronic cigarette or similar vaporization device includes a liquid, referred to as e-liquid, which is vaporized or atomized in an atomizer. Using an e-liquid that is not suitable for the vaporization device may cause overheating or underheating of the e-liquid, or other improper operations. Thus, there is a need to prevent use of unsuitable e-liquids in the device.

SUMMARY OF THE INVENTION

An electronic cigarette or similar vaporization device has an e-liquid detection system which can verify that the e-liquid is acceptable for use in the device. The system may detect one or more indicators, and/or physical or chemical properties of the e-liquid. The system may also measure the e-liquid level in the device.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, the same reference number indicates the same element in each of the views.

Figure 1 shows a section view (a) and a top view (b) of an example of a liquid storage.

Figure 2 shows a section view of an example of a fluorescent e-liquid detection system.

Figure 3 shows a section view (a) and a top view (b) of another example of a fluorescent e-liquid detection system.

Figure 4 shows a section view (a) and a top view (b) of another example of a fluorescent e-liquid detection system.

Figure 5 shows a section view (a) and a top view (b) of an example of the capacitor e-liquid detection system.

Figure 6 shows a section view of an example of an electronic cigarette comprising an e-liquid detection system.

Figure 7 shows a section view (a) and a top view (b) of another example of the capacitor e-liquid detection system.

Figure 8 shows a section view (a) of another examples of the capacitor e-liquid detection system; and a section view (b) and a top view (c) of yet another examples of the capacitor e-liquid detection system.

Figure 9 shows a section view (a) and a top view (b) of another example of the capacitor e-liquid detection system.

Figure 10 shows a section view of an example of an ultrasound e-liquid detection system and the ultrasonic path.

Figure 11 provides a section view of an example of the pressure e-liquid detection system.

DETAILED DESCRIPTION

A vaporization device has an e-liquid detection system, a liquid storage element containing an e-liquid, and an atomizer. The vaporization device may be an electronic cigarette, electronic pipe, or electronic cigar, or any device that vaporizes a liquid for inhalation. The liquid storage may be at least part of an e-liquid cartridge or a so-called e-liquid cartomizer, clearomizer or tankomizer.

The-liquid detection system may verify that the e-liquid in the vaporization device is suitable for use in the device and prevent unauthorized refilling and/or modifications of the e-liquid by the user. The atomizer may be configured to shut down if the e-liquid detection

system does not provide a signal of acceptance. In certain embodiments, the e-liquid detection system may also determine the e-liquid level in the liquid storage.

The liquid storage element stores a majority amount (e.g., about 95% to about 99.9%, or about 95% to about 99%) of the e-liquid contained in the device. Thus, measuring the e-liquid level in the liquid storage is substantially equivalent to measuring the e-liquid level in the device. As used herein, the term "about" followed by a numeral means a range of the numeral ± 5% or 10% of the numeral.

The liquid storage element may take any shape as desired. For example, the liquid storage element may be a tube, tank, bottle or container containing the e-liquid. The liquid storage element may contain an absorbent or porous filler material..

Figure 1 shows a section view (a) and a top view (b) of an example of a liquid storage element 10 having a through hole 30 extending along the direction of the air flow 5. In certain embodiments, the liquid storage 10 has a first wall 15 and a second wall 25, with the through hole 30 in the first wall 15. The first and second walls 15 and 25 together form a compartment 35 that holds the e-liquid. In certain embodiments, the liquid storage element may have an absorbent material, optionally forming the through hole 30, confined by the second wall 25, with no first wall 15 needed. In other embodiments, the liquid storage element is hollow or open, and contains no solid materials.

The entire inner wall of the liquid storage element, or one or more parts of it may be polished, or coated with a layer (e.g. film, coating, etc.) reflective to light and/or sonic signals. For example, the sidewall and the bottom of the liquid storage element may be polished or coated with a reflective layer.

Fluorescent e-liquid detection system

One aspect of the invention relates to a vaporization device comprising a liquid storage element storing an e-liquid, a fluorescent e-liquid detection system, and an atomizer. The fluorescent e-liquid detection system has a light source and a light detector. The e-liquid contains at least one product indicator. The light source provides a first light that is absorbed by the product indicator, with the product indicator emitting a second light that is detected by the light detector. For a known product indicator, the wavelengths of the first and the second lights are also known. The absence of the second light of the second pre-determined wavelength indicates the absence of the pre-determined product indicator. Thus, the atomizer may be configured to shut down when the light detector does not receive the second light of the second pre-determined wavelength.

Examples of product indicators are fluorophores that emit light of longer wavelengths (fluorescent light) than the light absorbed (absorbent light). Preferred product indicators only emit fluorescent light when being exposed to the absorbent lights. Examples of fluorophores are, compounds having a conjugated system (e.g. single bond-double bond conjugate system(s), aromatic system(s) further conjugated with double bond(s) and/or other aromatic system(s)). Quinine may be used as a product indicator . Quinine is inexpensive, highly sensitive, and safe for human consumption. It is included in the World Health Organization's list of essential medicines, a list of the most important medications needed in a basic health system. Other examples of fluorophores suitable for product indicators include Alexa Fluor dyes (e.g. Alexa Fluor 488 and 514), BODIPY dyes (e.g. BODIPY FL, BODIPY R6G, 8-phenyl BODIPY), cyanine dyes (e.g. Cy 5.5, and Cy 7), cypate, fluorescein, indocyanine green (ICG), Oregon green dyes (e.g.,

Oregon green 488, Oregon green 514), rhodamine dyes (e.g. rhodamine 110, rhodamine 6G, and rhodamine X), rhodol, TAMRA (5-(and-6)-carboxytetramethylrhodamine), Texas red, and xanthene derivatives (e.g. Tokyo green).

The concentration of the product indicator(s) in a suitable e-liquid is advantageously as low as possible. In e-liquids suitable for use in an electronic cigarette, the concentration of product indicator may be at or close to the threshold of detection. The e-liquid will then be suitable or useable as is, but become non-suitable if diluted, thereby preventing use of unapproved e-liquid mixtures. Most of the fluorophores may be used at a very lower concentration without recognizable toxic effect.

Examples of light sources are UV LED, or any light source that provides the suitable absorbent light. As used herein, the wavelength specified for an absorbent light for a fluorophore is the wavelength at the maximum absorption. The fluorophore may be properly excited by lights in a wavelength range of the maximum absorption ± 10 nm, ± 20 nm, ± 50 nm, ± 100 nm, or ± 200 nm. For example, the maximum absorption wavelength for quinine is about 560 nm. A light source in the wavelength of 550 nm to 570 nm, 5400 nm to 580 nm, or 510 nm to 610 nm will be suitable to excite quinine. The maximum absorption wavelength of some other fluorophore examples is about 346 nm to about 782 nm for the Alexa Fluor dyes (e.g. about 495 nm for Alexa Fluor 488, about 517 nm for Alexa Fluor 514), about 500 nm to about 646 nm for BODIPY dyes (e.g. about 503 for BODIPY FL, about 528 for BODIPY R6G, and about 524 for 8-phenyl BODIPY), about 489 nm to about 743 nm for cyanine dyes (e.g. about 675 nm for Cy 5.5, and about 743 nm for Cy 7), about 494 nm for fluorescein, about 600 nm to about 900 nm for ICG (e.g., about 800 nm), about 490 nm to about 515 nm for Oregon green dyes

(e.g., about 496 nm for Oregon green 488, about 511 nm for Oregon green 514), about 528 nm to about 586 nm for rhodamine dyes (e.g. about 498 nm for rhodamine 110, about 530 nm for rhodamine 6G, and about 585 nm for rhodamine X), about 492 nm for rhodol, about 557 nm for TAMRA, about 589 nm for Texas red, and about 491 nm for xanthene derivatives such as Tokyo green.

Examples of light detectors are photodetectors having a color filter to filter only the indicator fluorescent light to the detector (e.g., green (about 460 nm) for quinine; about 442 nm to about 805 nm for the Alexa Fluor dyes (e.g. about 519 nm for Alexa Fluor 488, about 542 nm for Alexa Fluor 514); about 506 nm to about 660 nm for BODIPY dyes (e.g. about 512 for BODIPY FL, about 550 for BODIPY R6G, and about 540 for 8-phenyl BODIPY); about 506 nm to about 767 nm for cyanine dyes (e.g. about 694 nm for Cy 5.5, and about 767 nm for Cy 7); about 524 nm for fluorescein; about 750 to about 950 nm for ICG (e.g., about 810 nm and about 830 nm); about 520 nm to about 535 nm for Oregon green dyes (e.g., about 524 nm for Oregon green 488, about 530 nm for Oregon green 514); about 553 nm to about 605 nm for rhodamine dyes (e.g. about 520 nm for rhodamine 110, about 566 nm for rhodamine 6G, and about 597 nm for rhodamine X); about 516 nm for rhodol; about 583 nm for TAMRA; about 615 nm for Texas red; and about 510 nm for xanthene derivatives such as Tokyo green.

The light source may be configured to flash at a first puff to verify the e-liquid as a suitable e-liquid. If the e-liquid does not fluoresce, the vaporization device may shut down.

The light source may be programmed to flash at programmed intervals to determine the e-liquid level according to the intensity of fluorescent light the light detector detects, and the refractive index of the e-liquid. A table or plot of the parameter (e.g. refractive index) detected

v. remaining e-liquid level may be obtained for a specific type of e-liquid and e-liquid detection system. Then, the table or plot may be used to determine the corresponding e-liquid level for a measured parameter.

The results may be displayed on the vaporization device to indicate the e-liquid level. For example, an LED showing different colors may be used to indicate the e-liquid level (e.g. red: empty; green: full; amber: medium); or a digital display may be used to show the e-liquid level.

Figure 2 shows a section view of an example of a fluorescent e-liquid detection system for a liquid storage 10. A prism 110 is placed on one end of the liquid storage 10. Alternatively, the prism 110 may be omitted if the inner surface of said end of the liquid storage 10 reflects light sufficiently well. A light source (e.g. a LED) 130 and a light detector 140 are placed in proximity to the other end of the liquid storage 10. The e-liquid in the liquid storage 10 comprises a product indicator. The product indicator absorbs the light provided by the light source 130 and emits a fluorescent light received by the light detector 140, as shown by the light path 120 in Figure 2.

Figure 3 shows a section view (a) and a top view (b) of another example of a fluorescent e-liquid detection system. The inside of the liquid storage 10 is polished and may reflect light as shown by the light path 120 in the top view of the fluorescent e-liquid detection system (Figure 3b). The light source (e.g. a LED) 130 and the light detector 140 are placed on the inside wall of the liquid storage 10, such that the light detector 140 receives the fluorescent light the product indicator emits upon absorbance of the light provided by the light source 130.

Figure 4 shows a section view (a) and a top view (b) of another example of a fluorescent e-liquid detection system for a liquid storage 10, wherein the liquid storage 10 has a through

hole 30 as described supra (see Figure 1). The inside of the liquid storage 10 is polished and may reflect light as shown by the light path 120 in the top view of the fluorescent e-liquid detection system (Figure 4b). The light source (e.g. a LED) 130 and the light detector 140 are placed on the inside wall of the liquid storage 10, such that the light detector 140 receives the fluorescent light the product indicator emits upon absorbance of the light provided by the light source 130.

The light source 130 and the light detector 140 are shown to be on about the opposite side of the liquid storage 10 in Figures 3 and 4. However, the light detector may be placed at any position (e.g., other positions shown in Figure 5) in the liquid storage 10 as long as it can receive the fluorescent light.

Figure 6 shows a section view of an electronic cigarette 1 having a tubular housing 100, with a liquid storage element 10, an e-liquid detection system 50, and an atomizer 60 in the housing 100. The e-liquid detection system 50 includes a light source 130 positioned to emit light into the liquid storage element 10 and a light detector 140 positioned to detect light emitted from the light source 130 into the liquid storage element 10. A controller 70 in the housing 100 electrically is connected to the e-liquid detection system 50 and to the atomizer 60, with the controller 70 allowing activation of the atomizer 60 based on a signal from the liquid detection system 50.

The light detector 140 in the electronic cigarette 1 is positioned to detect light reflected off of a surface of the liquid storage element 10 (e.g., as shown in Figures 3b and 4b).

The light detector 140 in the electronic cigarette 1 is positioned to detect light passing through the liquid storage element 10 (e.g., as shown in Figures 3b and 4b).

Capacitor e-liquid detection system

Another aspect of the invention relates to a vaporization device comprising a liquid storage storing an e-liquid, a capacitor e-liquid detection system, and an atomizer.

The capacitor e-liquid detection system comprises a first conductor and a second conductor. The first and second conductors are at least partially parallel to each other, and configured to form a capacitor circuit having a capacitance. The first and second conductors extend from one end of the liquid storage substantially to the other end thereof through the longitude direction thereof. The first and second conductors are configured such that a substantial amount (e.g., about 90% to about 99.9%, about 95% to about 99.9%, about 90% to about 95%, or about 95% to about 99%) of the e-liquid in the liquid storage is between the first and second conductors. Thus, the permittivity of the capacitor relates to a substantial amount (e.g., about 90% to about 99.9%, about 95% to about 99.9%, about 90% to about 95%, about 95% to about 99%) of the e-liquid remained in the liquid storage.

The liquid storage 10 may be a tube as shown in Figure 7. Figure 7 shows a section view (a) and a top view (b) of an example of the capacitor e-liquid detection system. The first conductor 210 and the second conductor 220 may be conductive plates (e.g. metal plates). The first and second conductors 210 and 220 are configured to be as close to the outside wall 45 of the liquid storage 10 as possible to maximize the amount of e-liquid positioned between the first and the second conductors 210 and 220. The first and the second conductors 210 and 220 are at least partially parallel to each other, e.g., about 80% to about 99.9%, about 90% to about 99.9%, about 95% to about 99.9% of the area of the first conductor 210 is parallel to the second conductor 220. The first and the second conductors 210 and 220 are configured to form a

capacitor circuit having a capacitance. One end of the first and the second conductors 210 and 220 are electronically connected to the PCB 20 (outside of the liquid storage 10) via a first lead 215 and a second lead 225, respectively. The other end of the first and the second conductors 210 and 220 are not electronically connected.

Figure 8(a) shows a section view of another example of the capacitor e-liquid detection system disclosed herein. At least a portion of the outside wall 45 of the liquid storage 10 is conductive (e.g. metal) and at least partially parallel to the first conductor 210. Thus, the portion of the outside wall 45 may serve as the second conductor 220. One end of the first and the second conductors 210 and 220 may be electrically connected to the PCB 20 (outside of the liquid storage 10) via a first lead 215 and a second lead 225, respectively. The other end of the first and the second conductors 210 and 220 are not electrically connected.

Figure 8(b) shows a section view and Figure 8(c) shows a top view of another example of the capacitor e-liquid detection system disclosed herein. Two separate conductive (e.g. metal) portions of the outside wall 45 of the liquid storage 10 that are insulate from each other, are at least partially parallel to each other. Thus, the two separate conductive portions of the outside wall 45 may serve as the first and the second conductors 210 and 220, respectively. The first and the second conductors 210 and 220 are configured to form a capacitor circuit having a capacitance, as described supra. One end of the first and the second conductors 210 and 220 may be electronically connected to the PCB 20 (outside of the liquid storage 10) via a first lead 215 and a second lead 225, respectively. The other end of the first and the second conductors 210 and 220 are not electronically connected.

The first and/or the second conductors may adopt various widths. The parallel portion of the first and second conductors 210 and 220 may be narrow or broad. The first and/or second conductors 210 and 220 may be relatively broad and extend along partial of or substantially (e.g., about) the whole circumference of the wall(s) of the liquid storage 10 (e.g., see Figure 9 for conductors surrounding the circumference of the walls of the liquid storage 10).

The liquid storage may comprise a through hole 30 as described supra (Figure 1). The liquid storage 10 comprises a first wall 15 and a second wall 25.

Figure 9 shows a section view (a) and a top view (b) of an example of the capacitor e-liquid detection system disclosed herein. The first and the second conductors 210 and 220 are conductive plates surrounding the first wall 15 and the second wall 25 of the liquid storage 10, respectively. Alternatively, the first and the second conductors 210 and 220 may only extend along part of the circumferences of the first and the second walls 15 and 25, respectively, as long as the conductors 210 and 220 are at least partially parallel to each other. The first and the second conductors 210 and 220 are configured to form a capacitor circuit having a capacitance, as described supra. One end of the first and the second conductors 210 and 220 may be electrically connected to the PCB 20 (outside of the liquid storage 10) via a first lead 215 and a second lead 225, respectively. The other end of the first and the second conductors 210 and 220 are not electrically connected.

In another embodiment, the first wall 15 is conductive (e.g., metal) and may serve as the first conductor 210. In another embodiment, the second wall 25 is conductive (e.g., metal) and may serve as the second conductor 220. In another embodiment, both of the first and the

second walls 15 and 25 are conductive (e.g., metal) and serve as the first and the second conductors 210 and 220, respectively.

For a capacitor having a media (e.g., e-liquid) between the first and second conductors thereof, the permittivity of the capacitor depends on the amount and the composition of the liquid. The more sensitive the permittivity changes over the liquid amount, the more accurate the capacitor e-liquid detection system may determine whether the e-liquid is a suitable product, and/or the remaining e-liquid level. Substances having higher permittivity may increase the sensitivity of permittivity changes to change of the liquid amount. Preferred examples include, without limitation, glycerol.

An e-liquid comprising compatible high permittivity substances may be used to identify suitable product and determine the remaining e-liquid level.

A table or plot of the parameter (e.g. permittivity) detected v. remaining e-liquid level may be obtained for a specific type of e-liquid and e-liquid detection system. Then the table or plot may be used to determine the corresponding e-liquid level for a measured parameter.

In certain embodiments, the capacitor e-liquid detection system may be configured to measure the permittivity at programmed intervals to determine the permittivity change pattern of the e-liquid. The vaporization device may shut down if the permittivity change pattern measured is significantly different (e.g. smaller) from what is expected from using a suitable product. The results of remaining e-liquid level may be displayed on the surface of the vaporization device as described supra.

Ultrasound e-liquid detection system

An ultrasound e-liquid detection system may be used. The ultrasound e-liquid detection system has an ultrasound emitter and an ultrasound detector. When an ultrasound signal is applied to a liquid, the resonant frequency received depends on the amount of the liquid in the container. When a sonar signal is applied to the liquid storage, the resonant frequency received reflects the remaining e-liquid level in the liquid storage element.

Figure 10 shows a section view of an example of an ultrasound e-liquid detection system and the ultrasonic path. The ultrasound emitter 330 and the ultrasound detector 340 are placed in proximity to one end of the liquid storage 10. The inner surface of the other end of the liquid storage 10 is reflective to sonar signals. The ultrasound detector 340 is positioned to receive the sonar signal after it travels through the liquid storage 10, via the ultrasonic path 320.

A table or plot of the parameter (e.g. sonar signals) detected v. remaining e-liquid level may be obtained for a specific type of e-liquid and e-liquid detection system. Then the table or plot may be used to determine the corresponding e-liquid level for a measured parameter. In certain embodiments, the ultrasound e-liquid detection system may be configured to measure the resonant frequency at programmed intervals to determine the resonant frequency of the e-liquid. The results of remaining e-liquid level may be displayed on the surface of the vaporization device as described supra.

Pressure e-liquid detection system

Another aspect of the invention relates to a vaporization device comprising a liquid storage storing an e-liquid, a pressure e-liquid detection system, and an atomizer. The pressure e-liquid detection system comprises a pressure sensor positioned at one end of the liquid storage that is closer to the direction of gravity. The weight of the liquid storage will change

based on the e-liquid level therein. Because the pressure measured by the pressure sensor relates to the weight of the liquid storage, measuring the pressure may determine the remaining e-liquid level in the liquid storage. Figure 11 provides a section view of an example of the pressure e-liquid detection system. The pressure sensor 410 is positioned in proximity to one end of the liquid storage 10 that is close to the PCB 20.

A table or plot of the parameter (e.g. pressure) detected v. remaining e-liquid level may be obtained for a specific type of e-liquid and e-liquid detection system. Then the table or plot may be used to determine the corresponding e-liquid level for a measured parameter. In certain embodiments, the pressure e-liquid detection system may be configured to measure the pressure at programmed intervals to determine the pressure of the e-liquid. The results of remaining e-liquid level may be displayed on the surface of the vaporization device as described supra.

Claims

1. An electronic cigarette comprising:

a tubular housing;

a liquid storage element, an e-liquid detection system, and an atomizer in the housing, with the e-liquid detection system including a light source positioned to emit light into the liquid storage element and a light detector positioned to detect light emitted from the light source into the liquid storage element;

a controller in the housing electrically connected to the e-liquid detection system and to the atomizer, with the controller allowing activation of the atomizer based on a signal from the liquid detection system.

2. The electronic cigarette of claim 1 with the light detector positioned to detect light reflected off of a surface of the liquid storage element.

3. The electronic cigarette of claim 1 or 2 with the light detector positioned to detect light passing through the liquid storage element.

4. A vaporization device comprising:

a liquid storage element containing an e-liquid;

a fluorescent e-liquid detection system comprising a light source and a light detector; and

an atomizer; wherein:

the light source provides an absorbent light of a first pre-determined wavelength to the e-liquid; and

the light detector is configured to receive a light emitted by the e-liquid during exposure to the absorbent light;

refractive indexes of the e-liquid reflect remaining e-liquid levels in the liquid storage; and/or

the atomizer is configured to shut down when the light detector does not receive the light of a second pre-determined wavelength.

5. The vaporization device of claim 4 wherein the light of the second pre-determined wavelength is a fluorescent light emitted by a pre-determined product indicator when exposed to the light of the first pre-determined wavelength.

6. The vaporization device of claim 4 or 5 wherein:

the light source is positioned in proximity to one end of the liquid storage; and

the vaporization device further comprises a prism positioned on the other end of the liquid storage.

7. The vaporization device of claim 6 wherein:

the light source is positioned in proximity to one end of the liquid storage; and

the inner surface of the other end of the liquid storage reflects light.

8. The vaporization device of claim 6 wherein:

the inner surface of the liquid storage reflects light; and

the light source is positioned on the inner surface of the liquid storage.

9. The vaporization device of claims 6 or 7 wherein the light detector comprises one or more photodetectors that can detect the light of the second pre-determined wavelength.

10. The vaporization device of claim 9 wherein the photodetector comprises a color filter to filter only the indicator fluorescent light to the detector.

11. The vaporization device of claims 4 or 5 wherein the product indicator is a fluorophore.

12. The vaporization device of claim 11 wherein the product indicator is selected from the group consisting of quinine, Alexa Fluor dyes, BODIPY dyes, cyanine dyes, cypate, fluorescein, indocyanine green (ICG), Oregon green dyes, rhodamine, rhodol, TAMRA (5-(and-6)-carboxytetramethylrhodamine), Texas red, and xanthene derivatives.

13. The vaporization device of claim 10 wherein:

the product indicator is quinine;

the light source provides a light that is about 560 nm; and

the photodetector filters a light of about 460 nm.

14. A vaporization device comprising:

a liquid storage element holding an e-liquid;

a capacitor e-liquid detection system comprising a first and a second conductors configured to form a capacitor circuit having a capacitance; and

an atomizer; wherein:

the first and the second conductors are positioned in the liquid storage to maximize the amount of e-liquid placed inbetween;

the first and the second conductors are at least partially parallel to each other;

permittivities of the capacitor reflect e-liquid levels in the liquid storage; and/or

the atomizer is configured to shut down when a permittivity change pattern measured for the e-liquid is significantly different from a pre-determined pattern.

15. The vaporization device of claim 14 wherein:

a portion of the wall of the liquid storage is conductive and serves as the first or the second conductor.

16. The vaporization device of claim 15 wherein:

the first and second conductors are two separate conductive portions of the walls of the liquid storage that are insulated from each other another.

17. A vaporization device comprising:

a liquid storage containing an e-liquid;

an ultrasound e-liquid detection system comprising an ultrasound emitter that emits a sonar signal, and an ultrasound detector that is positioned to receive the sonar signal after it travels through the e-liquid in the liquid storage; and

an atomizer; wherein

ultrasound signal strengths received by the ultrasound detector reflect remaining e-liquid levels in the liquid storage.

18. The vaporization device of claim 17, wherein the ultrasound emitter is placed in proximity to one end of the liquid storage; and the inner surface of the other end of the liquid storage is reflective to sonar signals.

19. A vaporization device comprising:

a liquid storage comprising an e-liquid;

a pressure e-liquid detection system comprising a pressure sensor positioned at one end of the liquid storage that is closer to the direction of gravity; and

an atomizer; wherein

pressures measured by the pressure sensor reflect remaining e-liquid levels in the liquid storage.

20. A liquid for use in an electronic cigarette or vaporization device, comprising:

at least one member selected from the group of propylene glycol (PG), glycerin (G), and polyethylene glycol 400; and

a product indicator that emits light at a second wavelength when exposed to light of a first wavelength.

21. The liquid of claim 20 with the product indicator comprising quinine.

22. The liquid of claim 20 further including an alcohol.

23. The liquid of claim 20 further including nicotine.

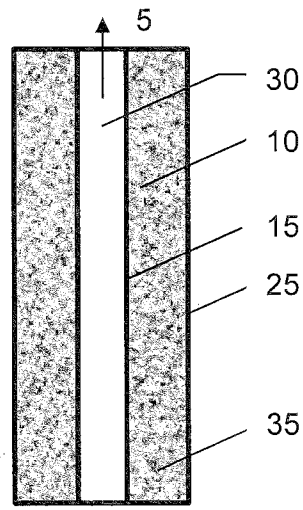
24. The liquid of claim 20 further including flavorings.

25. A liquid for use in an electronic cigarette or vaporization device, comprising:

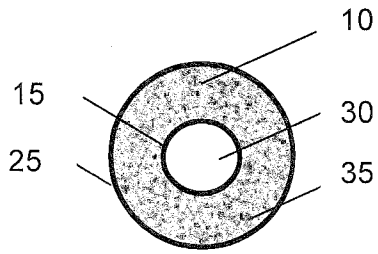
at least one member selected from the group of propylene glycol (PG), glycerin (G), and polyethylene glycol 400; and

quinine.

26. The liquid of claim 25 wherein the concentration of quinine is just sufficient to allow detection of a second wavelength of light when the liquid is exposed to a first wavelength of light.



(a)



(b)

Figure 1

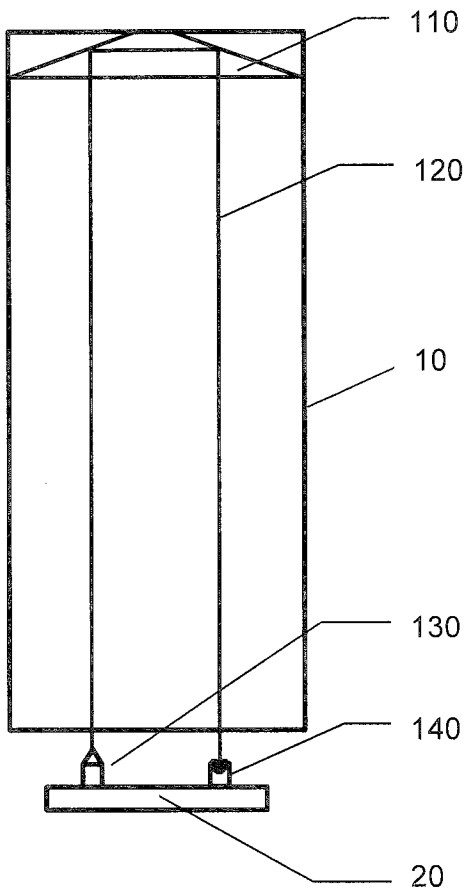
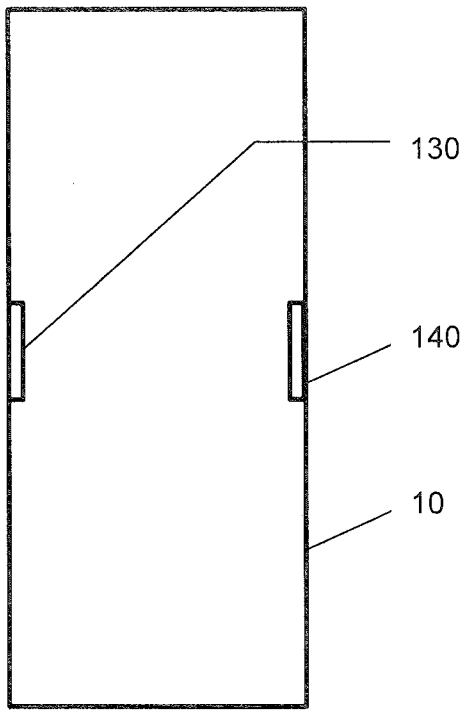
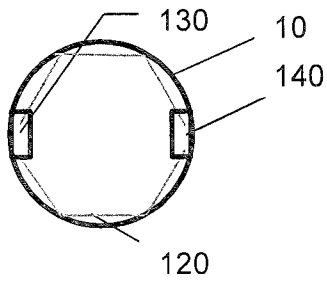


Figure 2

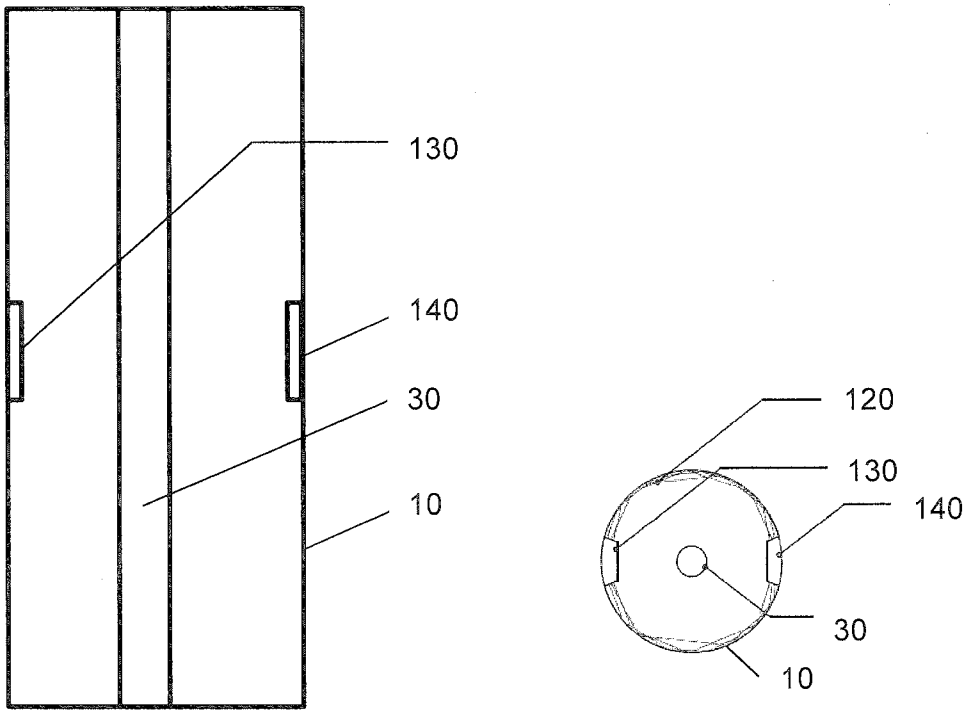


(a)



(b)

Figure 3



(a) (b)

Figure 4

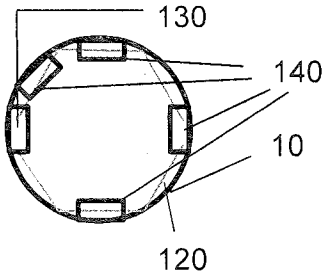


Figure 5

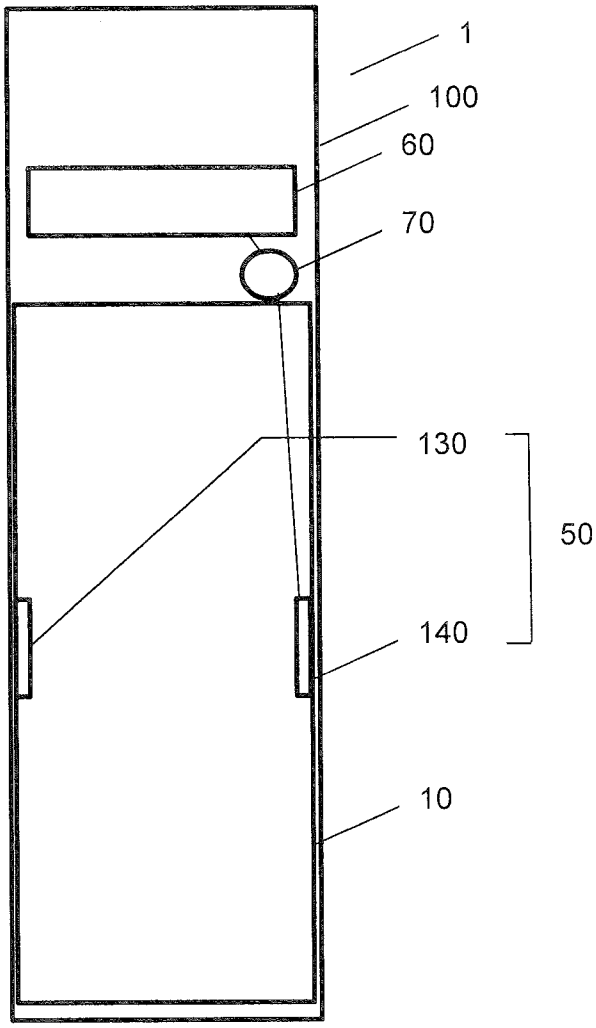


Figure 6

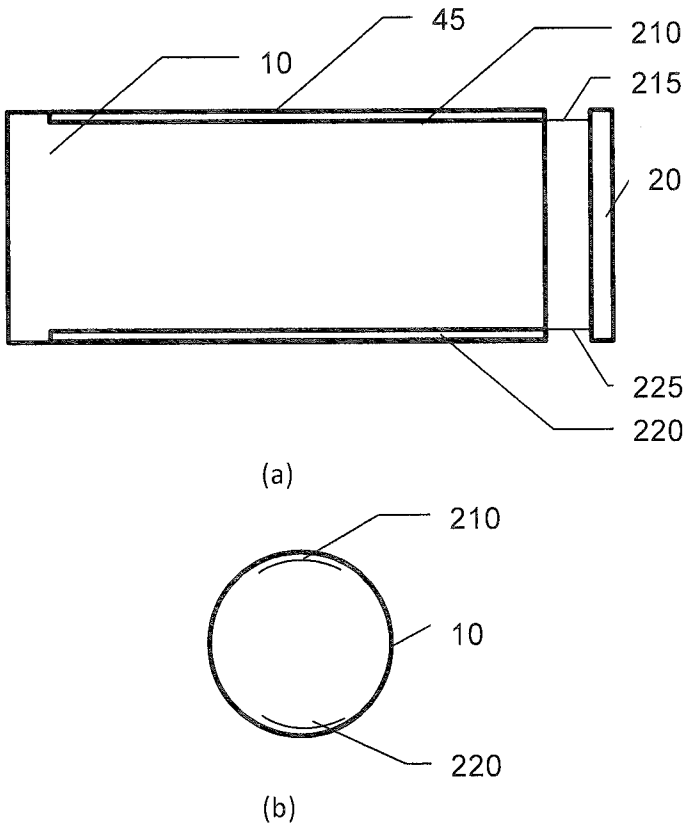
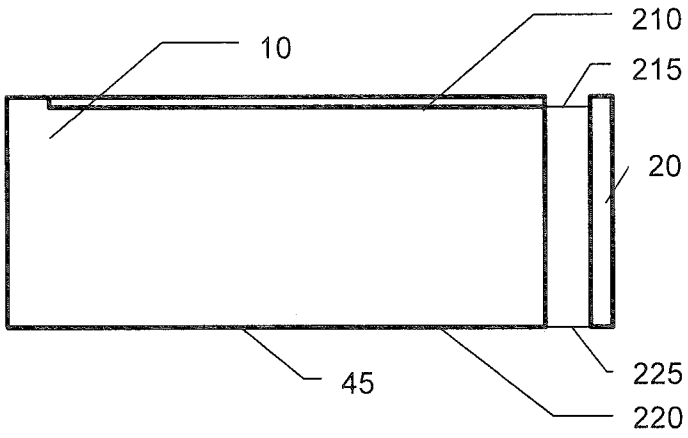
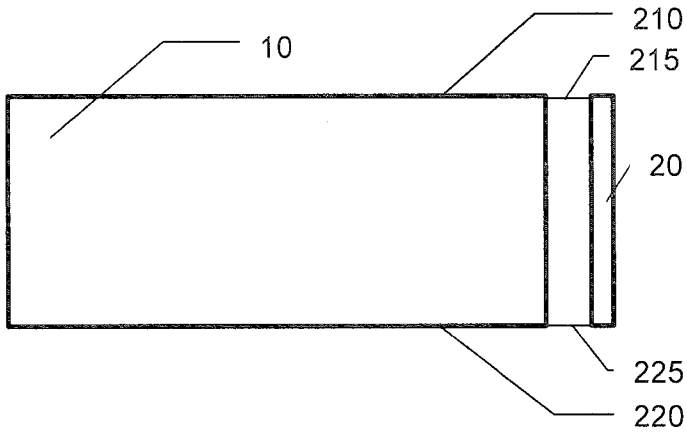


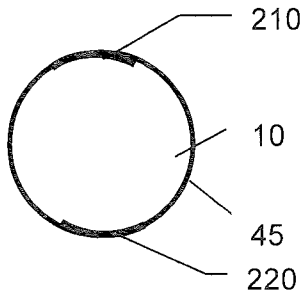
Figure 7



(a)



(b)



(c)

Figure 8

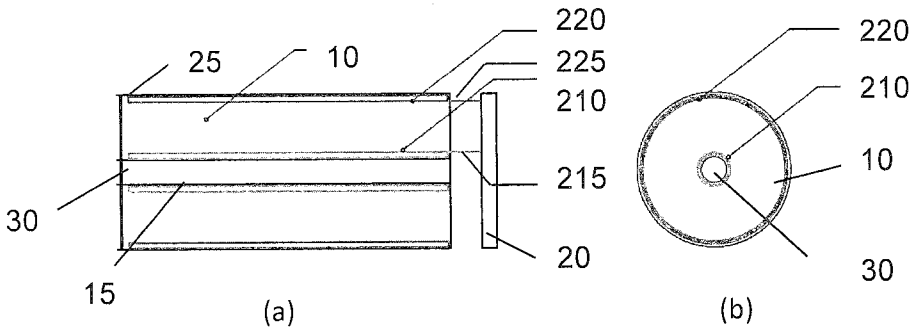


Figure 9

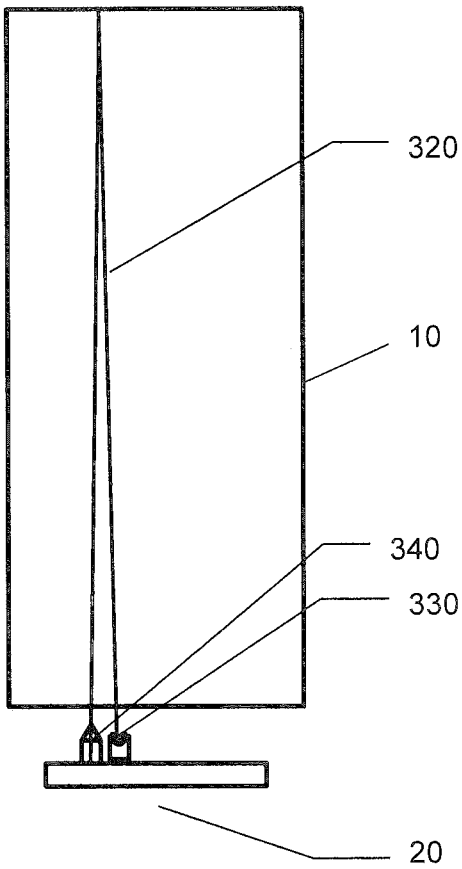


Figure 10

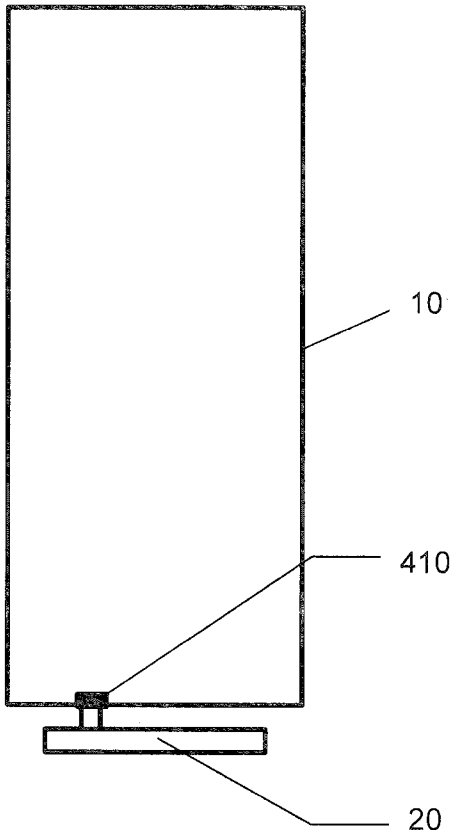


Figure 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/094908

A. CLASSIFICATION OF SUBJECT MATTER

A24F 47/00(2006.01)i; G01F 23/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A24F47; A61M15; G01F23

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)

CNABS;VEN: electronic, electrical, simulate, imitate, substitute, atomizer, cigar, cigarette, tobacco, capacitor, liquid level, ultrasound, ultrasonic, fluorescent, fluorophore, sensor, pressure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104106844 A (SHENZHEN SMOORE TECHNOLOGY LTD) 22 October 2014 (2014-10-22) see claims 1-10, description, paragraphs [0025]-[0031] and figures 1-3	14-16
Y	CN 104106844 A (SHENZHEN SMOORE TECHNOLOGY LTD) 22 October 2014 (2014-10-22) see claims 1-10, description, paragraphs [0025]-[0031] and figures 1-3	1-13,17-18
Y	CN 203981244 U (UNIV JILIANG CHINA) 03 December 2014 (2014-12-03) see claims 1-3	1-13
Y	WO 2014027561 A1 (ADEKA CORP) 20 February 2014 (2014-02-20) see claims 1-5	17-18
X	CN 203873007 U (SHENZHEN SMACO TECHNOLOGY CO LTD) 15 October 2014 (2014-10-15) see claim 1	19
X	WO 2013116558 A1 (ALTRIA CLIENT SERVICES INCET AL.) 08 August 2013 (2013-08-08) see claims 1-28	20-26

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 September 2015	**08 October 2015**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**WANG,Xiaoyuan**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62085241**

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102928048 A (GUANGDONG SHUNDE XINGYUAN ELECTRONIC IND CO LTD) 13 February 2013 (2013-02-13) see the whole document	1-26
A	US 2013192623 A1 (ALTRIA CLIENT SERVICES INCET AL.) 01 August 2013 (2013-08-01) see the whole document	1-26
A	JP 2014029278 A (USHIO ELECTRIC INC) 13 February 2014 (2014-02-13) see the whole document	1-26
A	CN 203037314 U (UNIV XI AN TECHNOLOGY) 03 July 2013 (2013-07-03) see the whole document	1-26
A	CN 102865905 A (WUXI LANHUI ULTRASONIC ELECTRONIC EQUIPMENT FACTORY) 09 January 2013 (2013-01-09) see the whole document	1-26
A	CN 103889488 A (KONINKL PHILIPS NV) 25 June 2014 (2014-06-25) see the whole document	1-26

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/094908

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 104106844 A	22 October 2014	None	
CN 203981244 U	03 December 2014	None	
WO 2014027561 A1	20 February 2014	US 2015185065 A1	02 July 2015
		JP 2014037994 A	27 February 2014
		DE 112013004042 T5	07 May 2015
		KR 20150040934 A	15 April 2015
		CN 104583736 A	29 April 2015
		TW 201425882 A	01 July 2014
CN 203873007 U	15 October 2014	None	
WO 2013116558 A1	08 August 2013	KR 20140125827 A	29 October 2014
		IL 233894 D0	30 September 2014
		WO 2013116567 A1	08 August 2013
		EP 2809185 A1	10 December 2014
		EP 2809182 A4	12 August 2015
		CN 104244750 A	24 December 2014
		JP 2015505475 A	23 February 2015
		WO 2013116571 A1	08 August 2013
		CN 104661544 A	27 May 2015
		EP 2809186 A1	10 December 2014
		EP 2809183 A4	12 August 2015
		AU 2013214997 A1	07 August 2014
		CA 2862105 A1	08 August 2013
		US 2013192615 A1	01 August 2013
		CN 104394722 A	04 March 2015
		WO 2013116572 A1	08 August 2013
		MX 2014009396 A	20 February 2015
		EP 2809187 A1	10 December 2014
		WO 2013116568 A2	08 August 2013
		EP 2809184 A4	01 July 2015
		US 2013192616 A1	01 August 2013
		JP 2015512617 A	30 April 2015
		CA 2867620 A1	08 August 2013
		CN 104284606 A	14 January 2015
		KR 20140127288 A	03 November 2014
		AU 2013214998 A1	21 August 2014
		CA 2868313 A1	08 August 2013
		KR 20150005514 A	14 January 2015
		US 9004073 B2	14 April 2015
		WO 2013116568 A3	06 November 2014
		EP 2809185 A4	05 August 2015
		AU 2013214984 A1	21 August 2014
		CN 104219973 A	17 December 2014
		US 2013192620 A1	01 August 2013
		MX 2014009398 A	20 February 2015
		KR 20150035488 A	06 April 2015
		US 2013192621 A1	01 August 2013
		KR 20140125828 A	29 October 2014
		CA 2863185 A1	08 August 2013
		CA 2862294 A1	08 August 2013
		EP 2809187 A4	01 July 2015

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/094908

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
		US 2013192619 A1	01 August 2013
		JP 2015505474 A	23 February 2015
		IL 233885 D0	30 September 2014
		US 2013192622 A1	01 August 2013
		WO 2013116561 A1	08 August 2013
		AR 091949 A1	11 March 2015
		CA 2867624 A1	08 August 2013
		IL 233851 D0	30 September 2014
CN 102928048 A	13 February 2013	None	
US 2013192623 A1	01 August 2013	CN 104661544 A	27 May 2015
		EP 2809186 A1	10 December 2014
		EP 2809183 A4	12 August 2015
		AU 2013214997 A1	07 August 2014
		CA 2862105 A1	08 August 2013
		US 2013192615 A1	01 August 2013
		CN 104394722 A	04 March 2015
		WO 2013116572 A1	08 August 2013
		MX 2014009396 A	20 February 2015
		EP 2809187 A1	10 December 2014
		WO 2013116568 A2	08 August 2013
		EP 2809184 A4	01 July 2015
		US 2013192616 A1	01 August 2013
		JP 2015512617 A	30 April 2015
		CA 2867620 A1	08 August 2013
		CN 104284606 A	14 January 2015
		KR 20140127288 A	03 November 2014
		AU 2013214998 A1	21 August 2014
		CA 2868313 A1	08 August 2013
		KR 20150005514 A	14 January 2015
		US 9004073 B2	14 April 2015
		WO 2013116568 A3	06 November 2014
		EP 2809185 A4	05 August 2015
		AU 2013214984 A1	21 August 2014
		CN 104219973 A	17 December 2014
		US 2013192620 A1	01 August 2013
		MX 2014009398 A	20 February 2015
		KR 20150035488 A	06 April 2015
		US 2013192621 A1	01 August 2013
		KR 20140125828 A	29 October 2014
		CA 2863185 A1	08 August 2013
		CA 2862294 A1	08 August 2013
		EP 2809187 A4	01 July 2015
		US 2013192619 A1	01 August 2013
		JP 2015505474 A	23 February 2015
		IL 233885 D0	30 September 2014
		US 2013192622 A1	01 August 2013
		WO 2013116561 A1	08 August 2013
		WO 2013116558 A1	08 August 2013
		AR 091949 A1	11 March 2015
		CA 2867624 A1	08 August 2013

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/094908

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
				IL	233851	D0	30 September 2014
				AU	2013214987	A1	07 August 2014
				CN	104302197	A	21 January 2015
				IL	233653	D0	31 August 2014
				EP	2809180	A1	10 December 2014
				AU	2013214991	A1	21 August 2014
				JP	2015505476	A	23 February 2015
				US	8997753	B2	07 April 2015
JP	2014029278	A	13 February 2014		None		
CN	203037314	U	03 July 2013		None		
CN	102865905	A	09 January 2013		None		
CN	103889488	A	25 June 2014	WO	2013061248	A1	02 May 2013
				MX	2014004906	A	05 June 2014
				EP	2747812	A1	02 July 2014
				JP	2014530736	A	20 November 2014
				US	2015020804	A1	22 January 2015