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(54) **Title:** LIQUID FORMULATION FOR E-CIGARETTES

(57) **Abstract:** The present invention provides a vaporizable liquid formulation for refilling cartridges in e-cigarettes or for using directly on atomizers or other controlled temperature vaporizers. Particularly, the liquid formulation is devoid of polyethylene glycol (PEG) and/or propylene glycol as solvent and instead comprises dipropylene glycol or other higher molecular weight linear polyesters.



## LIQUID FORMULATION FOR E-CIGARETTES

### Field of the invention

[0001] The present invention relates to a formulation, particularly a liquid formulation, for disposable cartridges or for refilling cartridges in electrical smoking systems (such as e-cigarettes) or to be used with other types of atomizers such as for example: drip atomizers, herbal vaporizers, convection vaporizers etc. More particularly, the liquid formulation is devoid of propylene glycol and synthetic polymers of ether oxides such as polyethylene glycols (PEGn like polyethylene glycol 400) and vegetable glycerin (or monoglycerol) as seen in the prior art.

### 10 Background of the invention

[0002] Combustion of organic materials such as tobacco is known to produce tar and other potentially harmful materials. Electronic cigarettes (or "e-cigarettes") have been developed as an alternative to traditional cigarettes as a means for volatilizing active components (US 6041789), such as nicotine, for inhalation without combustion, while at the same time providing the user with an oral experience similar to that of traditional cigarette smoking. US 7,832,410 describes an e-cigarette having a liquid supply bottle in communication with an atomizer for volatilizing a nicotine-containing solution. US 7,726,320 discloses a smoking article having an electrically powered aerosol-generating device which heats tobacco contained within the device to generate an aerosol which is described as being similar to tobacco smoke (US 2007/0267031). Other systems provide alternatives for controlled release flavoring (i.e. US 2005/0172976).

[0003] Currently e-cigarettes generally use a liquid containing nicotine, a toxic and addictive substance, as the sole active component (US 2012/0325228; US 25 2013/0008457), whereas others use caffeine that is also addictive (CN 101926505). It would be especially desirable to develop an alternative formulation that more effectively and safely achieves the pleasure-enhancing attributes of traditional cigarette smoking, which in turn may assist smokers in quitting traditional cigarette-smoking.

[0004] E-cigarette liquid (or e-cigarette atomizing liquid) is the most popular cigarette substitute product. The formulation usually comprises excipients such as 30

solvents, thickening agents, stabilizing agents, flavoring and/or taste regulators and optionally alkaloids such as nicotine or other pleasure-enhancing compounds. In more recent art, others disclose new formulations comprising all sorts of naturally addictive products instead of nicotine but without any improvement in delivery than the regular  
5 propylene glycol, PEG (polyethylene glycol) and vegetable glycerin (monoglycerol) solvents.

**[0005]** Indeed, the e-liquid is usually composed of propylene glycol and/or glycerol as solvents. Propylene glycol and glycerol both have the property to vaporize at low temperature (about 60°C) while forming a vapor that gives the impression of cigarette  
10 smoke. In fact, propylene glycol, monoglycerol and polyethylene glycol are all accepted as safe for human consumption (food grade), and can be used solely or in combination, but this does not take into consideration the fact that they are heated to high temperatures which are often variable prior to being inhaled. In the case of unevenly dispersed molecular size PEG 400 (polyethylene glycol 400), which is  
15 currently popular in liquid formulations from China, the result is also uneven and contaminants are bound to be created as the liquid heats up sometimes over boiling point in certain hotter spots on the vaporizing coil.

**[0006]** In addition, the previous art clearly lack concern for the healthy delivery of flavors and/or ingredients for functional medicinal and therapeutic use as oxidizing  
20 monoglycols readily react with alkaloid, protein, amine or acid ingredients used in flavoring or as an active component. The delivery technology is not improved, and furthermore, users now choose from a larger variety of electronic cigarettes with a variety of power settings. Many models are imprecise and users often intentionally increase the temperature of the coil to achieve a thicker smoke, causing an accidental  
25 burning or polymerisation of the solvents that creates contaminants like formaldehyde and acrolein (as exemplified in recent analysis of some devices, the contaminants are present sometimes in concentrations that are undetectable to the taste and smell but still are harmful to the user). This is due to overheating of the vaporization coil, or wick malfunction which results in a less than optimal flow of liquid to cool the coil ; this can  
30 happen as the coil becomes used or in certain "hot spots". For these two reasons, the previous art fails to really improve on the former electronic vapor liquid formulations, which are basically a copy of sublingual or aerosol formulations (Buccal, sublingual

and mucosally absorbed herbal compositions for relieving nicotine withdrawal symptoms and craving for nicotine and nicotine containing substances US 2004/0013752 A1). Recent analysis also shows that uneven burning might be due to the liquid distribution becoming uneven because of frequent temperature changes in the device that cause side-reactions in the formulation. This can in turn induce solvent dehydration or polymerization over time, causing opportunity for a myriad of side reactions like esterifications and oxidations that create even more contaminants. Polyethylene glycol seems even more susceptible to this effect because of the apparent tendency of its larger particles to agglomerate and osmotically steal water from the small chain glycols contained in the solution. The current formulations can thus change behavior as they are being used up.

[0007] Other patent references abound on trying to copy the basic idea of vaporizing herbal or artificial medicinal components but they all fall short of the common sense idea that random conditions give random results. Not only does the occasional burning of liquid may cause undesirable taste and side-effects, it can also cancel out the medicinal effects of many natural compounds and cause side reactions with the active constituents. Resulting compounds could prove toxic and have hazardous health effects.

[0008] There is also the understated fact that others in the art fail to realize: some flavor components do react and burn if the excipients are not calibrated to buffer this particular flavoring to the variety of heating temperatures and materials users will inevitably use. Some units now offer a degree of control over heating temperatures so it is even more important at this time that the art adopt a new approach to the liquid formulation so that flavors can be enjoyed in a manner that does not endanger the health of the end-user. The present invention aims to improve both safety and homogeneity of the art by providing solvents with a much higher temperature resistance and greater/more uniform water holding capacity that prevents virtually all side reactions.

### Summary of the invention

[0009] A first aspect of the invention being to deliver flavor and/or medicinal substances through a heat and oxidation resistant carrier, which is a needed

improvement in the art due to health concerns associated with previous formulations, namely degradation (to formaldehyde), dehydration (to acrolein), oxidation, ionization and other side reactions.

5       **[0010]**       More particularly, the liquid formulation is devoid of propylene glycol, polyethylene glycol (PEG or polyethylene oxide) and vegetable glycerin (or monoglycerol) as solvents (such as in the prior art) and instead comprises purified linear polyester diols and polyglycerols that, due to their higher molecular weight and high temperature proven safety profile, allow a safer delivery of active principle contained therein.

10       **[0011]**       In a further ideal aspect of the invention, there is provided an ecological and biodegradable liquid base improvement which is composed of only naturally derived or naturally occurring ingredients.

15       **[0012]**       Embodiments of the present invention are directed to liquid formulations for e-cigarettes, e-cigarettes, single use devices, drip atomizers, or as a liquid add-on for herbal or other type of controlled temperature vaporizers and/or in refilling cartridges for e-cigarettes containing a new formulation devoid or substantially devoid of short chain diols such as propylene glycol and already disclosed synthetic ether oxide polymers like PEG (polyethyleneglycol)/PPG (polypropyleneglycol) and vegetable glycerin (or monoglycerol) as seen in the prior art and instead comprises linear  
20       polyester diols and polyglycerols of even molecular size and dispersion that create better water repartition and protect active ingredients and flavors by increasing their solubility and heat-resistance.

25       **[0013]**       In one aspect, a refilling liquid for an e-cigarette or vaporizing apparatus contains a formulation comprising a solvent selected from the group consisting of long-chain polyesterdiols such as for example di-, tri- or higher molecular weight polyesterdiol but in a linear non-oxidized form that is also even in molecular size. Examples for such solvent can be selected from the group consisting of: triethylene glycol (triglycol), trimethylene glycol (1,3-propanediol); tripropylene glycol, dimethylene glycol (2,3-butanediol); and other linear long chain polyesterdiols such as for example:  
30       dipropylene glycol (4-oxa-2,6-heptandiol); dibutylene glycol; pentamethylene glycol and/or including polymers of rarer organic esterdiol groups such as, for example:

limonene, pentylene, octylene, terpenylene, nonylene, linalylene, isoamylene, isobutylene, geranylene, bornylene, benzylene, caprylylene, pinene and allylene glycols, such as for example: dipentylene glycol or dilimonene glycol.

5       **[0014]**       In another aspect, a kit for refilling an e-cigarette or vaporizer apparatus comprises (i) a liquid formulation comprising a solvent selected from the group consisting of polyesterdiols, more particularly: triethylene glycol (triglycol), trimethylene glycol (1,3-propanediol); tripropylene glycol, dimethylene glycol (2,3-butanediol); and other linear long chain polyesterdiols such as for example : dipropylene glycol (4-oxa-2,6-heptandiol); dibutylene glycol; pentamethylene glycol and/or including polymers of  
10       rarer organic esterdiol groups such as, for example: limonene, pentylene, octylene, terpenylene, nonylene, linalylene, isoamylene, isobutylene, geranylene, bornylene, benzylene, caprylylene, pinene and allylene glycols, such as for example: dipentylene glycol or dilimonene glycol.; and (ii) instructions for filling the liquid formulation into the receptacle of an e-cigarette or atomizer.

15       **[0015]**       In another aspect, a method of refilling an e-cigarette includes the steps of (i) providing a liquid formulation comprising a solvent selected from the group consisting of: linear naturally-derived or naturally-occurring polyesterdiols, and (ii) filling the liquid formulation into the receptacle of an e-cigarette or controlled temperature atomizer or vaporizer.

20       **[0016]**       In yet another aspect, an e-cigarette comprises a cartridge containing a liquid formulation comprising a solvent selected from the group consisting of: linear naturally-derived polyesterdiols or naturally-occurring polyesterdiols. The e-cigarette may be of a single-use or disposable type, or may be refillable with the liquid formulation to facilitate reuse.

25       **[0017]**       Further embodiments of the present invention are directed to a liquid formulation for e-cigarettes or other vaporizers, refilling cartridges for e-cigarettes or other vaporizers, e-cigarettes, other vaporizers, all containing a new formulation devoid or substantially devoid of glycerine or monoglycerol (propane-1,2,3-triol) for the same  
30       aforementioned health concerns and instead uses polyglycerols or other polyether triols.

5 [0018] In one aspect, a refilling liquid for an e-cigarette contains a formulation comprising a polyglycerol selected from the group consisting of: diglycerol, triglycerol, tetra-, penta-, hexa-, hepta-, octa-, nona- and decaglycerol and derivatives thereof such as acid or sugar conjugates, ethers or esters and other polyether triols of similar structure.

[0019] In a further aspect, there is provided a bottle comprising a liquid as defined herein.

[0020] In a further aspect, there is provided an e-cigarette comprising a liquid as defined herein.

10 [0021] In a further aspect, there is provided an e-vaporizing product comprising a liquid for vaporizing as defined herein.

## Detailed description of the invention

### *Description of the figures*

15 [0022] FIG. 1. is a schematic illustration of one example of an e-cigarette configuration.

### *Abbreviations and Definitions*

#### Definitions

[0023] The term “monoglycerol” is used herein interchangeably with the terms “vegetable glycerin” or “glycerol”.

20 [0024] The term “polyethylene glycol” refers to a synthetic polydispersed mixture of ethylene oxide glycols used herein interchangeably with “PEG” or “polyethylene oxide”.

### *Detailed description of particular embodiments*

#### Solvent

25 [0025] Particularly, with respect to the ideal solvent of the invention, the polyesterdiol is a linear two to ten units polymer (also referred to as (ester)<sub>2-10</sub> glycol),

that is naturally-produced or naturally-derived from sources such as vegetables, fruits, bacteria, yeast, algae, etc.. and subsequently purified to give a compound free of variable viscosity and dehydration effects.

**[0026]** Particularly, the naturally-derived or naturally-occurring polyesterdiol is 1) a polymethylene glycol such as; dimethylene glycol (2,3-butanediol); trimethylene glycol (1,3-propanediol), including tetra-, penta-, hexa-, hepta-, octa-, nona- and decamethylene glycols and other derivatives thereof such as acid esters, sugar conjugates, and ether or alcohol derivatives; 2) a polypropylene glycol such as: dipropylene glycol; tripropylene glycol, including tetra-, penta-, hexa-, hepta-, octa-, nona- and decapropylene glycol and other derivatives thereof; 3) a polybutylene glycol such as: dibutylene glycol, tributylene glycol, including tetra-, penta-, hexa-, hepta-, octa-, nona- and decabutylene glycol, and other derivatives thereof; 4) also including 2-10 unit polymers of rare organic ester types such as pentylene, octylene, terpentylene, nonylene, linalylene, isoamylenes, isobutylene, geranylene, bornylene, benzylene and allylene, caprylylene, such as for example, polyisobutylene glycol such as diisobutylene glycol; and 5) triethylene glycol, including tetra-, penta-, hexa-, hepta-, octa-, nona- and decaethylene glycols and other derivatives thereof such as acid or sugar conjugates, and esters or ether or alcohol derivatives.

**[0027]** Particularly, the solvent is a linear naturally-derived or naturally-occurring polyesterdiol selected from the group consisting of: (ethylene)<sub>3-10</sub> glycol; (methylene)<sub>2-10</sub> glycol; (propylene)<sub>2-10</sub> glycol; (butylene)<sub>2-10</sub> glycol; (pentylene)<sub>2-10</sub> glycol; (octylene)<sub>2-10</sub> glycol; (terpentylene)<sub>2-10</sub> glycol; (nonylene)<sub>2-10</sub> glycol; (linalylene)<sub>2-10</sub> glycol; (isoamylenes)<sub>2-10</sub> glycol; (isobutylene)<sub>2-10</sub> glycol; (geranylene)<sub>2-10</sub> glycol; (bornylene)<sub>2-10</sub> glycol; (benzylene)<sub>2-10</sub> glycol; (allylene)<sub>2-10</sub> glycol; and (caprylylene)<sub>2-10</sub> glycol; acid or sugar conjugates thereof, and ester or ether or alcohol derivatives thereof.

**[0028]** More particularly, the solvent is selected from the group consisting of: dimethylene glycol (2,3-butanediol); trimethylene glycol (1,3-propanediol); tetramethyleneglycol, pentamethyleneglycol, hexamethyleneglycol, heptamethyleneglycol, octamethyleneglycol, nonamethyleneglycol; decamethylene glycol; triethylene glycol; tetraethyleneglycol, pentaethyleneglycol, hexaethyleneglycol, heptaethyleneglycol, octaethyleneglycol, nonaethyleneglycol; decaethylene glycol; dipropylene glycol; tripropylene glycol; tetrapropylene glycol, pentapropylene glycol,



hexapropylene glycol, heptapropylene glycol, octapropylene glycol, nonapropylene glycol; decapropylene glycol; dibutylene glycol, tributylene glycol; tetrabutylene glycol, pentabutylene glycol, hexabutylene glycol, heptabutylene glycol, octabutylene glycol, nonabutylene glycol, decabutylene glycol and diisobutylene glycol. The chemical  
5 structure of the invention is clearly defined ranging from the simpler trimethylene glycol to longer forms like 1,6-hexanediol (or hexamethylene glycol) to even longer forms like decamethylene glycol or even longer forms which are specially chosen to differ from the commonly used monomers or polydisperse polyesters (like synthetic PEG 400 or PPG). The intended objective of this aspect of the invention is to use a substance with  
10 strong and even hygroscopic properties which solves the uneven distribution of water and flavor/active ingredients. These new purified compounds such as produced by Sigma and Dow are also resistant to heat-related dehydration, polymerization and oxidation, effectively solving direct health concerns associated with the prior art formulations (acrolein and formaldehyde).

15 **[0029]** Even more particularly, the solvent used for the formulation of the invention comprises : trimethylene glycol (1,3-propanediol); dimethylene glycol (2,3-butanediol); pentamethylene glycol; dipropylene glycol; tripropylene glycol; tetraethylene glycol or triethylene glycol due to their recent ecological production methods and proven safety.

**[0030]** Most particularly, the formulation's solvent comprises dipropylene glycol  
20 and/or tripropylene glycol and/or triethylene glycol and/or tetraethylene glycol and/or pentamethylene glycol due to their temperature and oxidation resistance and proven vapor safety profiles.

**[0031]** The above polyesterdiols are new ingredients on the market that have a remarkable safety profile and better heat and chemical stability than propylene glycol  
25 due to their molecular structure. These ingredients are now considered natural eco-glycol because of a new process to produce a very pure form by fermenting corn sugars which is expected to eventually cover all glycols/glycerols of the present invention. They are now labeled ECOCERT and FDA food safe, 100% natural and made through sustainable development. Their unique behavior makes them a perfect  
30 replacement for propylene glycol. Not only they are safer and less irritating, but they also have a smoother, sweeter taste and are known anti-bacterial and sanitizers when vaporized.

[0032] Some commercial buildings and airplanes now keep their air clean by injecting a vapor of these glycols (produced much in the same manner as electronic cigarettes) inside the air circulation system. All the information in the field seem to agree they are the less toxic inhalation hazards of the glycol family; for example

5 repeated exposure to rats by triethylene glycol vapor caused no toxic effects and the NOEL (no observable effect level) was 1800mg/cubic meter which is dozens of times higher than the levels achieved with personal atomizers. *Neither high dosage acute nor repeated exposures to triethylene glycol produced hepatorenal injury characteristic of that caused by the lower glycol homologues.* They are also known to be rapidly

10 metabolized in-vivo to harmless compounds of the krebs cycle such as lactic and pyruvic acids.

#### Co-solvent

[0033] Optionally, the polyesterdiol such as triethylene glycol or dipropylene glycol can be mixed with a co-solvent ester triol such as polyglycerol of the formula

15 (glycerol)<sub>2-10</sub>, such as, for example: diglycerol; triglycerol; tetraglycerol, pentaglycerol, hexaglycerol, heptaglycerol, octaglycerol, nonaglycerol or decaglycerol or other polyether triols (trihydric alcohols).

[0034] In particular, diglycerol has shown to have much better heat resistance than its parent monoglycerol. It is also found in food preparations and produced from

20 natural sources.

[0035] We are looking away from vegetable glycerin (monoglycerol) because of its tendency to dehydrate under high heat and create toxic substances such as formaldehyde and acrolein. It also has a tendency to react with organic compounds and flavors, changing the behavior and concentration of the liquids it is mixed

25 therewith. The use of higher molecular weight polyglycerols solves this problem because the molecule is much harder to break and also holds water captive much better than its "mono" counterpart, thereby allowing active cooling of the heating element and smoother less drying vapor.

E-cigarette configuration

[0036] The e-cigarette may be of various types of configurations, the details of which form no part of the present invention. In general, e-cigarettes may be of a single-use or disposable type, or may be refillable with liquid alkaloid compositions and/or cartridges containing liquid compositions to facilitate reuse. One example of an e-cigarette is shown in FIG. 1. An air inlet 4 is provided on the external wall of a shell 14 which houses LED 1, cell 2, electronic circuit board 3, normal pressure cavity 5, sensor 6, vapor-liquid separator 7, atomizer 9, liquid-supplying bottle 11, mouthpiece 15, microswitch 16, gas vent 17, and air passage 18. The electronic circuit board 3 has an electronic switching circuit and a high frequency generator. A negative pressure cavity 8 is provided in the sensor 6 and is separated from the sensor 6 by a ripple film. An atomization cavity 10 is provided in the atomizer 9. A retaining ring 13 is provided for locking the liquid-supplying bottle 11 between one side of the liquid-supplying bottle 11 and the shell 14; and an aerosol passage 12 is provided on the other side of the liquid-supplying bottle. Other details are described in U.S. Pat. No. 7,832,410, the disclosure of which is hereby incorporated by reference in its entirety.

Other components

[0037] Additional components ingredients may be added to the formulation to improve taste or stability. Such additional components include, but are not limited to, sweeteners, natural flavorants, artificial flavorants, colorants, antioxidants, preservatives, chelating agents, viscomodulators, tonicifiers, odorants, opacifiers, suspending agents, binders, thickeners, co-solvents and mixtures thereof, including, but not limited to, xanthum gum, carboxymethylcellulose, carboxyethylcellulose, hydroxypropylcellulose, methylcellulose, microcrystalline cellulose, starches, dextrins, maltodextrins, other polyols (including sugar alcohols, such as sorbitol, lactitol or mannitol), carbohydrates (e.g., lactose), propylene glycol alginate, gellan gum, guar, pectin, tragacanth gum, gum acacia, locust bean gum, gum arabic, mannitol, natural and/or artificial mint flavors, sucralose, silicon dioxide, stearic acid, hydroxypropyl methylcellulose, mono and diglycerides (acyl glycerols), ether and sugar acetates or other acid esters such as dimethyl acetate, ethyl acetate, isopropyl acetate, ethylhexyl acetate, butyl acetate, triethyl citrate, dimethyl butyrate and the like.

**[0038]** If desired, one or more flavorants may be added to the composition, non-limiting examples of which include peppermint, menthol, wintergreen, spearmint, propolis, eucalyptus, cinnamon, tobacco, fruits or the like. The total amount of flavorants typically ranges from about 0.5 to about 15 wt. %, often from about 1 to about 10 wt. %, based on the total weight of the composition.

**[0039]** The following examples are put forth so as to provide those of ordinary skill in the art with a complete disclosure and description of how to make and use the present invention, and are not intended to limit the scope of what the inventor regards as their invention nor are they intended to represent that the experiments below are all or the only experiments performed. Efforts have been made to ensure accuracy with respect to numbers used (e.g. amounts, weights, etc.) but some experimental errors and deviations should be accounted for.

### Examples

#### *Example 1*

Flavor or active medicinal substance recipes may be prepared by mixing the ingredients listed in Table 1.

**TABLE 1**

	Example 1	Example 2	Example 3	Example 4	Example 5
Active substance (mg) (such as for example : nicotine)	10 mg/ml	10mg/ml	25mg/ml	10mg/ml	10mg/ml
Triethylene glycol (ml)	90ml	75ml	60ml		
Dipropylene glycol (ml)				80ml	
Tripropylene glycol (ml)					70ml
Diglycerol (ml)	8 ml	25ml	3ml	17 ml	8 ml
Triglycerol (ml)		5ml	35ml		20 ml
Water (ml)	2ml	5ml	2ml	3ml	2ml

Flavors (mg)	800 mg	1200 mg	1300 mg	1000 mg	1500 mg
Stabilisers / antioxidants (mg)	800 mg	1000 mg	1100 mg	900 mg	1000 mg

**[0040]** While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice within the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as follows in the scope of the appended claims.

**[0041]** All patents, patent applications and publications mentioned in this specification are herein incorporated by reference to the same extent as if each independent patent, patent application, or publication was specifically and individually indicated to be incorporated by reference.

**CLAIMS**

1. A liquid formulation for an e-cigarette and/or other heat-controlled atomizer/vaporizer devices, comprising a solvent comprising a linear naturally-derived and/or naturally occurring polyesterdiol.
2. A kit for refilling an e-cigarette and/or other heat-controlled vaporizer/atomizer devices, comprising:
  - (i) a liquid formulation comprising a solvent comprising a linear naturally-derived and/or naturally-occurring polyesterdiol; and
  - (ii) instructions for filling the liquid formulation into a liquid receptacle of an e-cigarette and/or other heat controlled atomizer/vaporizer device.
3. A method of refilling an e-cigarette and/or other heat-controlled atomizer/vaporizer devices, comprising the steps of:
  - (i) providing a liquid formulation comprising a solvent comprising a linear naturally-derived or naturally-occurring polyesterdiol, and
  - (ii) filling the liquid formulation into a liquid receptacle of an e-cigarette or other heat-controlled atomizer/vaporizer device.
4. A cartridge containing a liquid formulation comprising a solvent comprising a linear naturally-derived or naturally-occurring polyesterdiol.
5. The solvent as defined in any one of claims 1 to 4, wherein the linear polyesterdiol is selected from the group consisting of: (methylene)<sub>2-10</sub> glycol; (ethylene)<sub>3-10</sub> glycol; (propylene)<sub>2-10</sub> glycol; (butylene)<sub>2-10</sub> glycol; (pentylene)<sub>2-10</sub> glycol; (octylene)<sub>2-10</sub> glycol; (terpentylene)<sub>2-10</sub> glycol; (nonylene)<sub>2-10</sub> glycol; (linalylene)<sub>2-10</sub> glycol; (isoamylene)<sub>2-10</sub> glycol; (isobutylene)<sub>2-10</sub> glycol; (geranylene)<sub>2-10</sub> glycol; (bornylene)<sub>2-10</sub> glycol; (benzylene)<sub>2-10</sub> glycol; (allylene)<sub>2-10</sub> glycol; and (caprylylene)<sub>2-10</sub> glycol; acid or sugar conjugates thereof, and ester or ether or alcohol derivatives and isomers thereof.

6. The solvent as defined in claim 5, selected from the group consisting of: dimethylene glycol (2,3-butanediol); trimethylene glycol (1,3-propanediol); tetramethyleneglycol, pentamethylenglycol, hexamethyleneglycol, heptamethyleneglycol, octamethyleneglycol, nonamethylenglycol; decamethylene glycol; triethylene glycol; tetraethyleneglycol, pentaethylenglycol, hexaethyleneglycol, heptaethyleneglycol, octaethyleneglycol, nonaethylenglycol; decaethylene glycol; dipropylene glycol; tripropylene glycol; tetrapropylene glycol, pentapropylene glycol, hexapropylene glycol, heptapropylene glycol, octapropylene glycol, nonapropylene glycol; decapropylene glycol; dibutylene glycol, tributylene glycol; tetrabutylene glycol, pentabutylene glycol, hexabutylene glycol, heptabutylene glycol, octabutylene glycol, nonabutylene glycol, decabutylene glycol and other derivatives or isomers such as diisobutylene glycol.
7. The solvent defined in any one of claims 1-6 selected from the group consisting of: trimethylene glycol (1,3-propanediol); dimethylene glycol (2,3-butanediol); dipropylene glycol; tripropylene glycol; triethylene glycol; tetraethylene glycol and pentamethylene glycol including isomers and derivatives thereof.
8. The solvent defined in claim 7 selected from the group consisting of: dipropylene glycol; tripropylene glycol; triethylene glycol; tetraethylene glycol; pentamethylene glycol including isomers and derivatives thereof.
9. A liquid formulation for an e-cigarette or other heat-controlled atomizer/vaporizing devices comprising a polyglycerol of the formula (glycerol)<sub>2-10</sub> and/or other polyether triols of similar molecular structure.
10. The liquid formulation according to claim 9, wherein said polyglycerol is selected from the group consisting of: diglycerol, triglycerol, tetraglycerol, pentaglycerol, hexaglycerol, heptaglycerol, octaglycerol, nonaglycerol and decaglycerol and/or other similar polyether triols and isomers or derivatives thereof.
11. The liquid formulation according to claim 10, wherein said polyglycerol is selected from the group consisting of: diglycerol and triglycerol.
12. A kit for refilling an e-cigarette comprising:

- (i) a liquid formulation as defined in claim 10 or 11; and
  - (ii) instructions for filling or using the liquid formulation into a liquid receptacle of an e-cigarette or other atomizer/vaporizer.
- 13.** A method of refilling an e-cigarette or other personal atomizer/vaporizer comprising the steps of:
- (i) providing a liquid formulation as defined in claim 10 or 11; and
  - (ii) filling the liquid formulation into a liquid receptacle of an e-cigarette or other atomizer/vaporizer.
- 14.** A cartridge containing a liquid formulation as defined in claim 10 or 11.
- 15.** A solvent for e-cigarette filling liquid formulation, said liquid formulation being substantially devoid a solvent selected from the group consisting of: ethylene glycol, polyethylene glycol(PEG), monopropylene glycol, polypropyleneglycol(PPG), monobutylene glycol and monoglycerol.
- 16.** A bottle comprising a liquid as defined in any one of claims 1 to 15.
- 17.** An e-cigarette comprising a liquid as defined in any one of claims 1 to 15.
- 18.** An e-vaporizing product comprising a liquid for vaporizing as defined in any one of claims 1 to 15.



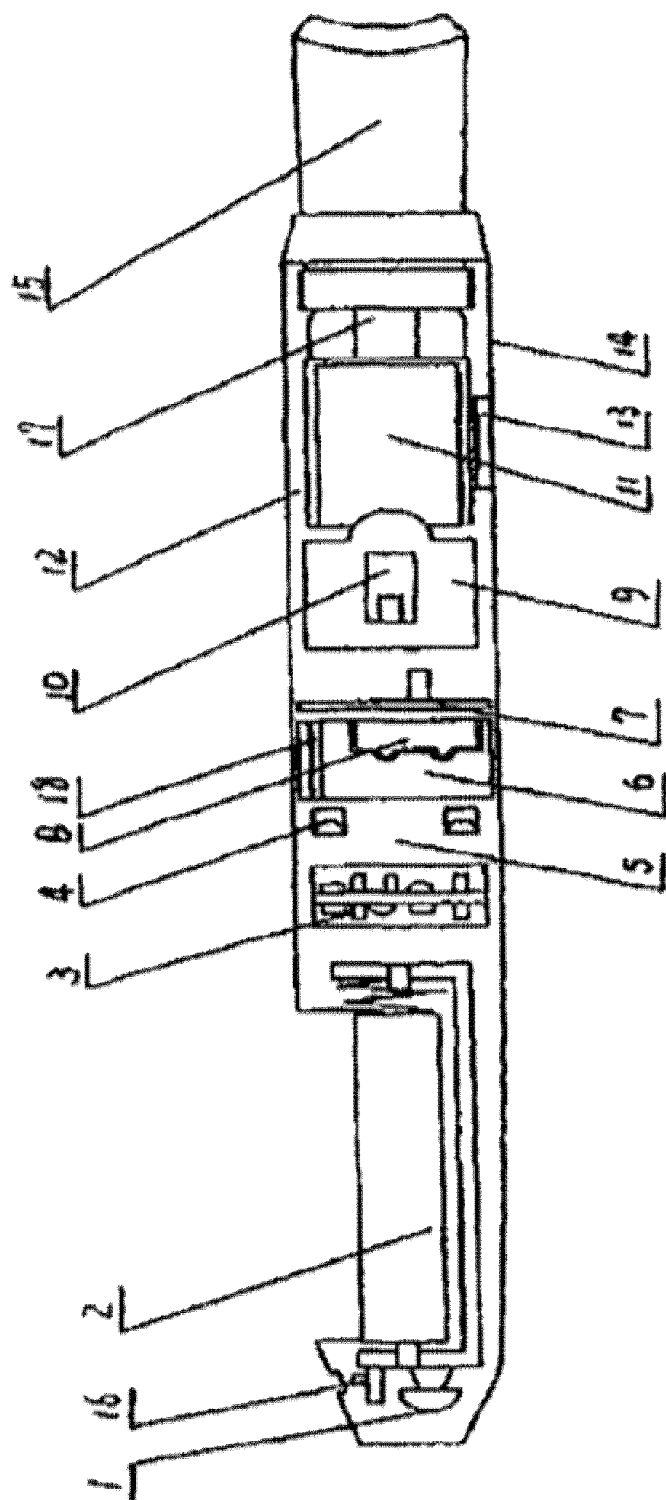


FIG. 1  
PRIOR ART

## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2015/050088**

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC: **A24B 15/16** (2006.01), **A24F 47/00** (2006.01)

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)  
 A24B (2006.01), A24F (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)  
 Canadian Patent Database, Orbit, Google (electronic cigarette, e-cigarette, liquid, solvent, glycol, polyethylene glycol, triethylene glycol, diglycerol, triglycerol)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E, X	US 2015/0101606 (White) 16 April 2015 (16-04-2015) *whole document*, *abstract*, *paragraph [0010]*, *claim 11*	1-8, 12-18
P, X	CN 104256885 (Zhu et al.) 07 January 2015 (07-01-2015) *whole document*	1-8, 12-18
X	CA 2,766,749 (Zheng et al.) 04 January 2013 (04-01-2013) *whole document*	1-5, 12-18
X	US 2012/0325228 (Williams) 27 December 2012 (27-12-2012) *Table 1*, *paragraph [0028]*, *claim 4*	1-5, 12-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* "A" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier application or patent but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	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 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 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
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Date of the actual completion of the international search  
 16 April 2015 (16-04-2015)

Date of mailing of the international search report  
 14 May 2015 (14-05-2015)

Name and mailing address of the ISA/CA  
 Canadian Intellectual Property Office  
 Place du Portage I, C114 - 1st Floor, Box PCT  
 50 Victoria Street  
 Gatineau, Quebec K1A 0C9  
 Facsimile No.: 001-819-953-2476

Authorized officer

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## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2015/050088****Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the 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. ☐ Claim Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☒ Claim Nos.: 1-10, 12-18  
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 supplemental sheet

3. ☐ Claim 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:

The common concept linking the subject matter of claims 1-18 appears to be a liquid formulation comprising a solvent comprising a polymeric polyol. However, this is known in the art (see for example D1 and D2), therefore this cannot serve as an inventive linking feature. As a result, each class of compound such as defined in claim 5 or 9, as well as each compound within each class of compound defined as the solvent in the claims would constitute a separate alleged invention. Furthermore, the claims directed to an e-cigarette, an e-vaporizing product, a cartridge, a solvent, and a bottle comprising almost any possible solvent would also each constitute a separate alleged invention. Therefore the claims are not unified.

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 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 claim 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 claim 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.

## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2015/050088**

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Aldrich Handbook of Fine Chemicals 2009-2010 *pages 1040, 2197, 2584, 2617*	1, 4-11, 14-16
A	EP 0 337 504 (Banerjee et al.) 22 September 1993 (22-09-1993) *whole document*	1-18

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/CA2015/050088**

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US2015101606A1	16 April 2015 (16-04-2015)	None	
CN104256885A	07 January 2015 (07-01-2015)	None	
CA2766749A1	04 January 2013 (04-01-2013)	CA2766749A1 CN102349699A CN102349699B EP2543265A2 EP2543265A3 JP2013013394A RU2012102830A TW201302106A US2013008457A1 WO2013004160A1	04 January 2013 (04-01-2013) 15 February 2012 (15-02-2012) 03 July 2013 (03-07-2013) 09 January 2013 (09-01-2013) 10 December 2014 (10-12-2014) 24 January 2013 (24-01-2013) 10 August 2013 (10-08-2013) 16 January 2013 (16-01-2013) 10 January 2013 (10-01-2013) 10 January 2013 (10-01-2013)
US2012325228A1	27 December 2012 (27-12-2012)	US2012325228A1 US2013298921A1 WO2012177510A2 WO2012177510A3 WO2015009500A1	27 December 2012 (27-12-2012) 14 November 2013 (14-11-2013) 27 December 2012 (27-12-2012) 28 February 2013 (28-02-2013) 22 January 2015 (22-01-2015)
EP0337504A2	18 October 1989 (18-10-1989)	EP0337504A2 EP0337504B1 CA1257827A1 CA1295203C CA1304648C CA1305387C CA1309312C CA1310561C2 CA1312251C2 CN87105964A CN1015228B CN86105536A CN1017588B CN1051492A CN85106876A CN1018607B CN1044391A CN1061329A CN1024996C CN1061330A CN1024997C DE3587920D1 DE3587951D1 DE3587952D1 DE3587954D1 DE3588051D1 DE3650177D1 DE3689075D1 DE3777105D1 US4714082A US4793365A US4854331A US4938238A US4989619A US5020548A US5027836A US5042509A US5067499A US5076292A	18 October 1989 (18-10-1989) 22 September 1993 (22-09-1993) 25 July 1989 (25-07-1989) 04 February 1992 (04-02-1992) 07 July 1992 (07-07-1992) 21 July 1992 (21-07-1992) 27 October 1992 (27-10-1992) 24 November 1992 (24-11-1992) 05 January 1993 (05-01-1993) 22 June 1988 (22-06-1988) 01 January 1992 (01-01-1992) 25 February 1987 (25-02-1987) 29 July 1992 (29-07-1992) 22 May 1991 (22-05-1991) 03 September 1986 (03-09-1986) 14 October 1992 (14-10-1992) 08 August 1990 (08-08-1990) 27 May 1992 (27-05-1992) 15 June 1994 (15-06-1994) 27 May 1992 (27-05-1992) 15 June 1994 (15-06-1994) 06 October 1994 (06-10-1994) 12 January 1995 (12-01-1995) 12 January 1995 (12-01-1995) 12 January 1995 (12-01-1995) 28 September 1995 (28-09-1995) 02 February 1995 (02-02-1995) 28 October 1993 (28-10-1993) 09 April 1992 (09-04-1992) 22 December 1987 (22-12-1987) 27 December 1988 (27-12-1988) 08 August 1989 (08-08-1989) 03 July 1990 (03-07-1990) 05 February 1991 (05-02-1991) 04 June 1991 (04-06-1991) 02 July 1991 (02-07-1991) 27 August 1991 (27-08-1991) 26 November 1991 (26-11-1991) 31 December 1991 (31-12-1991)

Continued from Box II

Claims 1-10, 12-18 relate to an extremely large number of possible liquid formulations and are thus too broad for a meaningful search to be performed under PCT Article 17(2)(a). As an example, claim 15 is directed to practically any liquid that is not one of the ones defined in the Markush grouping. Therefore, a complete search of the claimed subject matter is impossible to perform, and so the search has been limited in accordance with the examples and claim 11, particularly polyethylene glycol, triethylene glycol, tripropylene glycol, dipropylene glycol, diglycerol, and triglycerol.