

sequence" (i.e., "foreign DNA"). The term "endogenous DNA sequence" refers to a nucleotide sequence which is naturally found in the cell into which it is introduced so long as it does not contain some modification (e.g., a point mutation, the presence of a selectable marker gene, or other like modifications) relative to the naturally-occurring sequence. The term "heterologous DNA sequence" refers to a nucleotide sequence which is ligated to, or is manipulated to become ligated to, a nucleic acid sequence to which it is not ligated in nature, or to which it is ligated at a different location in nature. Heterologous DNA is not endogenous to the cell into which it is introduced, but has been obtained from another cell. Heterologous DNA also includes an endogenous DNA sequence which contains some modification. Generally, although not necessarily, heterologous DNA encodes RNA and proteins that are not normally produced by the cell into which it is expressed. Examples of heterologous DNA include reporter genes, transcriptional and translational regulatory sequences, selectable marker proteins (e.g., proteins which confer drug resistance), or other similar elements.

[0123] The term "foreign gene" refers to any nucleic acid (e.g., gene sequence) which is introduced into the genome of a cell by experimental manipulations and may include gene sequences found in that cell so long as the introduced gene contains some modification (e.g., a point mutation, the presence of a selectable marker gene, or other like modifications) relative to the naturally-occurring gene.

[0124] The term "transformation" as used herein refers to the introduction of a transgene into a cell. Transformation of a cell may be stable or transient. The term "transient transformation" or "transiently transformed" refers to the introduction of one or more transgenes into a cell in the absence of integration of the transgene into the host cell's genome. Transient transformation may be detected by, for example, enzyme-linked immunosorbent assay (ELISA) which detects the presence of a polypeptide encoded by one or more of the transgenes. Alternatively, transient transformation may be detected by detecting the activity of the protein (e.g., β -glucuronidase) encoded by the transgene (e.g., the *uid A* gene) as demonstrated herein (e.g., histochemical assay of GUS enzyme activity by staining with X-gluc which gives a blue precipitate in the presence of the GUS enzyme; and a chemiluminescent assay of GUS enzyme activity using the GUS-Light kit (Tropix)). The term "transient transformant" refers to a cell which has transiently incorporated one or more transgenes. In contrast, the term "stable transformation" or "stably transformed" refers to the introduction and integration of one or more transgenes into the genome of a cell. Stable transformation of a cell may be detected by Southern blot hybridization of genomic DNA of the cell with nucleic acid sequences which are capable of binding to one or more of the transgenes. Alternatively, stable transformation of a cell may also be detected by the polymerase chain reaction of genomic DNA of the cell to amplify transgene sequences. The term "stable transformant" refers to a cell which has stably integrated one or more transgenes into the genomic DNA. Thus, a stable transformant is distinguished from a transient transformant in that, whereas genomic DNA from the stable transformant contains one or more transgenes, genomic DNA from the transient transformant does not contain a transgene.

[0125] The term "host cell" refers to any cell capable of replicating and/or transcribing and/or translating a heterologous gene. Thus, a "host cell" refers to any eukaryotic or prokaryotic cell (e.g., bacterial cells such as *E. coli*, yeast cells, mammalian cells, avian cells, amphibian cells, plant cells, fish cells, and insect cells), whether located *in vitro* or *in vivo*. For example, host cells may be located in a transgenic animal.

[0126] The terms "transformants" or "transformed cells" include the primary transformed cell and cultures derived from that cell without regard to the number of transfers. All progeny may not be precisely identical in DNA content, due to deliberate or inadvertent mutations. Mutant progeny that have the same functionality as screened for in the originally transformed cell are included in the definition of transformants.

[0127] The term "selectable marker" refers to a gene which encodes an enzyme having an activity that confers resistance to an antibiotic or drug upon the cell in which the selectable marker is expressed, or which confers expression of a trait which can be detected (e.g., luminescence or fluorescence). Selectable markers may be "positive" or "negative." Examples of positive selectable markers include the neomycin phosphotransferase (NPTII) gene which confers resistance to G418 and to kanamycin, and the bacterial hygromycin phosphotransferase gene (*hyg*), which confers resistance to the antibiotic hygromycin. Negative selectable markers encode an enzymatic activity whose expression is cytotoxic to the cell when grown in an appropriate selective medium. For example, the HSV-*tk* gene is commonly used as a negative selectable marker. Expression of the HSV-*tk* gene in cells grown in the presence of gancyclovir or acyclovir is cytotoxic; thus, growth of cells in selective medium containing gancyclovir or acyclovir selects against cells capable of expressing a functional HSV TK enzyme.

[0128] The term "reporter gene" refers to a gene encoding a protein that may be assayed. Examples of reporter genes include, but are not limited to, luciferase (See, e.g., de Wet et al., *Mol. Cell. Biol.* 7:725, 1987 and U.S. Pat Nos. 6,074,859; 5,976,796; 5,674,713; and 5,618,682), green fluorescent protein (e.g., GenBank Accession Number U43284; a number of GFP variants are commercially available from CLONTECH Laboratories, Palo Alto, CA), chloramphenicol acetyltransferase, β -galactosidase, alkaline phosphatase, and horse radish peroxidase.

[0129] The term "overexpression" refers to the production of a gene product in transgenic organisms that exceeds levels of production in normal or non-transformed organisms. The term "cosuppression" refers to the expression of a foreign gene which has substantial homology to an endogenous gene resulting in the suppression of expression of both the foreign and the endogenous gene. As used herein, the term "altered levels" refers to the production of gene product(s)

in transgenic organisms in amounts or proportions that differ from that of normal or non-transformed organisms.

[0130] The terms "Southern blot analysis" and "Southern blot" and "Southern" refer to the analysis of DNA on agarose or acrylamide gels in which DNA is separated or fragmented according to size followed by transfer of the DNA from the gel to a solid support, such as nitrocellulose or a nylon membrane. The immobilized DNA is then exposed to a labeled probe to detect DNA species complementary to the probe used. The DNA may be cleaved with restriction enzymes prior to electrophoresis. Following electrophoresis, the DNA may be partially depurinated and denatured prior to or during transfer to the solid support. Southern blots are a standard tool of molecular biologists (J. Sambrook et al., *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Press, NY, pp 9.31-9.58, 1989).

[0131] The term "Northern blot analysis" and "Northern blot" and "Northern" refer to the analysis of RNA by electrophoresis of RNA on agarose gels to fractionate the RNA according to size followed by transfer of the RNA from the gel to a solid support, such as nitrocellulose or a nylon membrane. The immobilized RNA is then probed with a labeled probe to detect RNA species complementary to the probe used. Northern blots are a standard tool of molecular biologists (J. Sambrook, et al., *supra*, pp 7.39-7.52, 1989).

[0132] The terms "Western blot analysis" and "Western blot" and "Western" refers to the analysis of protein(s) (or polypeptides) immobilized onto a support such as nitrocellulose or a membrane. A mixture comprising at least one protein is first separated on an acrylamide gel, and the separated proteins are then transferred from the gel to a solid support, such as nitrocellulose or a nylon membrane. The immobilized proteins are exposed to at least one antibody with reactivity against at least one antigen of interest. The bound antibodies may be detected by various methods, including the use of radiolabeled antibodies.

[0133] The term "antigenic determinant" refers to that portion of an antigen that makes contact with a particular antibody (i.e., an epitope). When a protein or fragment of a protein is used to immunize a host animal, numerous regions of the protein may induce the production of antibodies that bind specifically to a given region or three-dimensional structure on the protein; these regions or structures are referred to as antigenic determinants. An antigenic determinant may compete with the intact antigen (i.e., the "immunogen" used to elicit the immune response) for binding to an antibody.

[0134] The term "isolated" when used in relation to a nucleic acid, as in "an isolated nucleic acid sequence" refers to a nucleic acid sequence that is identified and separated from one or more other components (e.g., separated from a cell containing the nucleic acid, or separated from at least one contaminant nucleic acid, or separated from one or more proteins, one or more lipids) with which it is ordinarily associated in its natural source. Isolated nucleic acid is nucleic acid present in a form or setting that is different from that in which it is found in nature. In contrast, non-isolated nucleic acids are nucleic acids such as DNA and RNA which are found in the state they exist in nature. For example, a given DNA sequence (e.g., a gene) is found on the host cell chromosome in proximity to neighboring genes; RNA sequences, such as a specific mRNA sequence encoding a specific protein, are found in the cell as a mixture with numerous other mRNA which encode a multitude of proteins. However, an isolated nucleic acid sequence comprising, for example, SEQ ID NO:1 includes, by way of example, such nucleic acid sequences in cells which ordinarily contain, for example, SEQ ID NO:1 where the nucleic acid sequence is in a chromosomal or extrachromosomal location different from that of natural cells, or is otherwise flanked by a different nucleic acid sequence than that found in nature. The isolated nucleic acid sequence may be present in single-stranded or double-stranded form. When an isolated nucleic acid sequence is to be utilized to express a protein, the nucleic acid sequence will contain at a minimum at least a portion of the sense or coding strand (i.e., the nucleic acid sequence may be single-stranded). Alternatively, it may contain both the sense and anti-sense strands (i.e., the nucleic acid sequence may be double-stranded).

[0135] The term "purified" refers to molecules, either nucleic or amino acid sequences, that are removed from their natural environment (or components of their natural environment), isolated or separated. An "isolated nucleic acid sequence" may therefore be a purified nucleic acid sequence. "Substantially purified" molecules are at least 60 % free, preferably at least 75 % free, and more preferably at least 90 % free from other components with which they are naturally associated. As used herein, the term "purified" or "to purify" also refer to the removal of contaminants from a sample. The removal of contaminating proteins results in an increase in the percent of polypeptide of interest in the sample. In another example, recombinant polypeptides are expressed in plant, bacterial, yeast, or mammalian host cells and the polypeptides are purified by the removal of host cell proteins; the percent of recombinant polypeptides is thereby increased in the sample. The present disclosure contemplates both purified (including substantially purified) and unpurified hybrid 1 enzyme(s).

[0136] The term "composition comprising" a given polynucleotide sequence or polypeptide refers broadly to any composition containing the given polynucleotide sequence or polypeptide. The composition may comprise an aqueous solution. Compositions comprising polynucleotide sequences encoding GnTIII or fragments thereof may be employed as hybridization probes. In this case, the GnTIII encoding polynucleotide sequences are typically employed in an aqueous solution containing salts (e.g., NaCl), detergents (e.g., SDS), and other components (e.g., Denhardt's solution, dry milk, salmon sperm DNA, etc.).

[0137] The term "test compound" refers to any chemical entity, pharmaceutical, drug, and the like that can be used to treat or prevent a disease, illness, sickness, or disorder of bodily function, or otherwise alter the physiological or

cellular status of a sample. Test compounds comprise both known and potential therapeutic compounds. A test compound can be determined to be therapeutic by screening using the screening methods disclosed herein. A "known therapeutic compound" refers to a therapeutic compound that has been shown (e.g., through animal trials or prior experience with administration to humans) to be effective in such treatment or prevention.

[0138] As used herein, the term "response," when used in reference to an assay, refers to the generation of a detectable signal (e.g., accumulation of reporter protein, increase in ion concentration, accumulation of a detectable chemical product).

[0139] The term "sample" is used in its broadest sense. In one sense it can refer to a animal cell or tissue. In another sense, it is meant to include a specimen or culture obtained from any source, as well as biological and environmental samples. Biological samples may be obtained from plants or animals (including humans) and encompass fluids, solids, tissues, and gases. Environmental samples include environmental material such as surface matter, soil, water, and industrial samples. These examples are not to be construed as limiting the sample types applicable to the present disclosure.

[0140] The term "fusion protein" refers to a protein wherein at least one part or portion is from a first protein and another part or portion is from a second protein. The term "hybrid enzyme" refers to a fusion protein which is a functional enzyme, wherein at least one part or portion is from a first species and another part or portion is from a second species. Preferred hybrid enzymes of the present disclosure are functional glycosyltransferases (or portions thereof) wherein at least one part or portion is from a plant and another part or portion is from a mammal (such as human).

[0141] The term "introduction into a cell" in the context of nucleic acid (e.g., vectors) is intended to include what the art calls "transformation" or "transfection" or "transduction." Transformation of a cell may be stable or transient - and the present disclosure contemplates introduction of vectors under conditions where, on the one hand, there is stable expression, and on the other hand, where there is only transient expression. The term "transient transformation" or "transiently transformed" refers to the introduction of one or more transgenes into a cell in the absence of integration of the transgene into the host cell's genome. Transient transformation may be detected by, for example, enzyme-linked immunosorbent assay (ELISA) which detects the presence of a polypeptide encoded by one or more of the transgenes. Alternatively, transient transformation may be detected by detecting the activity of the protein (e.g., antigen binding of an antibody) encoded by the transgene (e.g., the antibody gene). The term "transient transformant" refers to a cell which has transiently incorporated one or more transgenes. In contrast, the term "stable transformation" or "stably transformed" refers to the introduction and integration of one or more transgenes into the genome of a cell. Stable transformation of a cell may be detected by Southern blot hybridization of genomic DNA of the cell with nucleic acid sequences which are capable of binding to one or more of the transgenes. Alternatively, stable transformation of a cell may also be detected by the polymerase chain reaction (PCR) of genomic DNA of the cell to amplify transgene sequences. The term "stable transformant" refers to a cell which has stably integrated one or more transgenes into the genomic DNA. Thus, a stable transformant is distinguished from a transient transformant in that, whereas genomic DNA from the stable transformant contains one or more transgenes, genomic DNA from the transient transformant does not contain a transgene.

[0142] "Bisected oligosaccharide" shall be defined as an oligosaccharide comprising, e.g., two mannose groups and another saccharide moiety attached to a mannose residue of the oligosaccharide. Examples of bisected oligonucleotides are given in Table 1.

DETAILED DESCRIPTION OF THE INVENTION

[0143] The GnTIII (for example, SEQ ID NO: 1, Figure 4A) expressed in the plant host cell of the method of the present invention is a mammalian GnTIII. In a specific embodiment, the GnTIII is a human GnTIII (for example, SEQ ID NO: 2, Figure 4B). The GnTIII may also in a specific embodiment have 80 % identity with the amino acid sequence of a mammalian GnTIII, more preferably at least about 90 %, even more preferably at least about 95 %, and most preferably at least about 97 % (hereinafter "homologous polypeptides"), which qualitative retain the activity of said mammalian GnTIII. A polypeptide that has an amino acid sequence at least, for example, 95 % "identical" to a query amino acid sequence is identical to the query sequence except that the subject polypeptide sequence may include on average, up to five amino acid alterations per each 100 amino acids of the query amino acid sequence. In other words, to obtain a polypeptide having an amino acid sequence at least 95 % identical to a query amino acid sequence, up to 5 % of the amino acid residues in the subject sequence may be inserted, deleted or substituted with another amino acid. These alterations of the reference sequence may occur at the amino or carboxy terminal positions of the reference amino acid sequence or anywhere between those terminal positions, interspersed either individually among residues in the referenced sequence or in one or more contiguous groups within the reference sequence.

[0144] A preferred method for determining the best overall match between a query sequence (a sequence of the present invention) and a subject sequence, also referred to as a global sequence alignment, can be determined using the FASTDB computer program based on the algorithm of Brutlag, et al. (Com. App. Biosci. 6:237-245, 1990). In a sequence alignment, the query and subject sequence are either both nucleotide sequences or both amino acid sequences.

The result of said global sequence alignment is in percent identity. Preferred parameters used in a FASTDB amino acid alignment are: Matrix=PAM 0, k-tuple=2, Mismatch Penalty=1, Joining Penalty=20, Randomization Group Lengthy, Cutoff Score= 1, Window Size=sequence length, Gap Penalty=5, Gap Size Penalty=0.05, Window Size=500 or the length of the subject amino acid sequence, whichever is shorter.

[0145] If the subject sequence is shorter than the query sequence due to N- or C- terminal deletions, not because of internal deletions, a manual correction must be made to the results. This is because the FASTDB program does not account for N- and C- terminal truncations of the subject sequence when calculating global percent identity. For subject sequences truncated at the N- and C-termini, relative to the query sequence, the percent identity is corrected by calculating the number of residues of the query sequence that are N- and C-terminal of the subject sequence, which are not matched/aligned with a corresponding subject residue, as a percent of the total bases of the query sequence. Whether a residue is matched/aligned is determined by results of the FASTDB sequence alignment. This percentage is then subtracted from the percent identity, calculated by the above FASTDB program using the specified parameters, to arrive at a final percent identity score. This final percent identity score is what is used for the purposes of the present invention. Only residues to the N- and C-termini of the subject sequence, which are not matched/aligned with the query sequence, are considered for the purposes of manually adjusting the percent identity score. That is, only query residue positions outside the farthest N- and C-terminal residues of the subject sequence.

[0146] The GnTIII expressed in the plant host system of the present disclosure is encoded by a nucleic acid sequence that has at least 80 % identity with the nucleic acid sequence encoding an amino acid sequence of a mammalian GnTIII, more preferably at least about 90 %, even more preferably at least about 95 %, and most preferably at least about 97 % (hereinafter "homologous polypeptides"), which qualitatively retain the activity of said mammalian GnTIII. The nucleic acid sequence may be an RNA or DNA sequence.

[0147] A polynucleotide having 95 % "identity" to a reference nucleotide sequence of the present disclosure; is identical to the reference sequence except that the polynucleotide sequence may include, on average, up to five point mutations per each 100 nucleotides of the reference nucleotide sequence encoding the polypeptide. In other words, to obtain a polynucleotide having a nucleotide sequence at least 95 % identical to a reference nucleotide sequence, up to 5 % of the nucleotides in the reference sequence may be deleted or substituted with another nucleotide, or a number of nucleotides up to 5 % of the total nucleotides in the reference sequence may be inserted into the reference sequence. The query sequence may be an entire sequence, the ORF (open reading frame), or any fragment specified as described herein.

[0148] As a practical matter, whether any particular nucleic acid molecule or polypeptide is at least 90 %, 95 %, 96 %, 97 %, 98 % or 99 % identical to a nucleotide sequence of the present disclosure can be determined conventionally using known computer programs. A preferred method for determining the best overall match between a query sequence (a sequence of the present disclosure and a subject sequence, also referred to as a global sequence alignment, can be determined using the FASTDB computer program based on the algorithm of Brutlag, et al., (Comp. App. Biosci., 6:237-245, 1990). In a sequence alignment the query and subject sequences are both DNA sequences. An RNA sequence can be compared by converting U's (uridine) to T's (thymine). The result of said global sequence alignment is in percent identity. Preferred parameters used in a FASTDB alignment of DNA sequences to calculate percent identity are: Matrix=Unitary, k-tuple=4, Mismatch Penalty=1, Joining Penalty=30, Randomization Group Length=0, Cutoff Score=1, Gap Penalty=5, Gap Size Penalty=0.05, Window Size=500 or the length of the subject nucleotide sequence, whichever is shorter.

[0149] Also disclosed are polynucleotides that hybridize to the nucleic acid sequence encoding said mammalian GnTIII. A polynucleotide "hybridizes" to another polynucleotide, when a single-stranded form of the polynucleotide can anneal to the other polynucleotide under the appropriate conditions of temperature and solution ionic strength (see, Sambrook, et al., supra). The conditions of temperature and ionic strength determine the "stringency" of the hybridization. For preliminary screening for homologous nucleic acids, low stringency hybridization conditions, corresponding to a temperature of 42 °C, can be used, e.g., 5X SSC, 0.1 % SDS, 0.25 % milk, and no formamide; or 40 % formamide, 5X SSC, 0.5 % SDS. Moderate stringency hybridization conditions correspond to a higher temperature of 55 °C, e.g., 40 % formamide, with 5X or 6X SCC. High stringency hybridization conditions correspond to the highest temperature of 65 °C, e.g., 50 % formamide, 5X or 6X SCC. Hybridization requires that the two nucleic acids contain complementary sequences, although depending on the stringency of the hybridization, mismatches between bases are possible. The appropriate stringency for hybridizing nucleic acids depends on the length of the nucleic acids and the degree of complementation, variables well known in the art. The greater the degree of similarity or homology between two nucleotide sequences, the greater the value of T_m (melting temperature) for hybrids of nucleic acids having those sequences. The relative stability (corresponding to higher T_m) of nucleic acid hybridizations decreases in the following order: RNA:RNA, DNA:RNA, DNA:DNA.

Expression of GnTIII and other Heterologous Proteins in Plant Host Systems

[0150] In one embodiment, the nucleic acid encoding the mammalian GnTIII or other heterologous proteins, such as

a heterologous glycoprotein or mammalian glycosyltransferase may be inserted into an appropriate expression vector, i.e., a vector which contains the necessary elements for the transcription and translation of the inserted coding sequence, or in the case of an RNA viral vector, the necessary elements for replication and translation, as well as selectable markers. These include but are not limited to a promoter region, a signal sequence, 5' untranslated sequences, initiation codon depending upon whether or not the structural gene comes equipped with one, and transcription and translation termination sequences. Methods for obtaining such vectors are known in the art (see WO 01/29242 for review).

[0151] Promoter sequences suitable for expression in plants are described in the art, e.g., WO 91/198696. These include non-constitutive promoters or constitutive promoters, such as, the nopaline synthetase and octopine synthetase promoters, cauliflower mosaic virus (CaMV) 19S and 35S promoters and the figwort mosaic virus (FMV) 35 promoter (U.S. Pat. No. 6,051,753). Promoters used may also be tissue specific promoters targeted for example to the endosperm, aleurone layer, embryo, pericarp, stem, leaves, kernels, tubers, roots, etc.

[0152] A signal sequence allows processing and translocation of a protein where appropriate. The signal can be derived from plants or could be non-plant signal sequences. The signal peptides direct the nascent polypeptide to the endoplasmic reticulum, where the polypeptide subsequently undergoes post-translational modification. Signal peptides can routinely be identified by those of skill in the art. They typically have a tripartite structure, with positively charged amino acids at the N-terminal end, followed by a hydrophobic region and then the cleavage site within a region of reduced hydrophobicity.

[0153] The transcription termination is routinely at the opposite end from the transcription initiation regulatory region. It may be associated with the transcriptional initiation region or from a different gene and may be selected to enhance expression. An example is the NOS terminator from *Agrobacterium* Ti plasmid and the rice α -amylase terminator. Polyadenylation tails may also be added. Examples include but are not limited to *Agrobacterium* octopine synthetase signal, (Gielen, et al., EMBO J. 3:835-846, 1984) or nopaline synthase of the same species (Depicker, et al., Mol. Appl. Genet. 1:561-573, 1982).

[0154] Enhancers may be included to increase and/or maximize transcription of the heterologous protein. These include, but are not limited to peptide export signal sequence, codon usage, introns, polyadenylation, and transcription termination sites (see, WO 01/29242).

[0155] Markers include herbicide tolerance and prokaryote selectable markers. Such markers include resistance toward antibiotics such as ampicillin, tetracycline, kanamycin, and spectinomycin. Specific examples include but are not limited to streptomycin phosphotransferase (*spt*) gene coding for streptomycin resistance, neomycin phosphotransferase (*uptII*) gene encoding kanamycin or geneticin resistance, hygromycin phosphotransferase (*hpt*) gene encoding resistance to hygromycin.

[0156] The vectors constructed may be introduced into the plant host system using procedures known in the art (reviewed in WO 01/29242 and WO 01/31045). The vectors may be modified to intermediate plant transformation plasmids that contain a region of homology to an *Agrobacterium tumefaciens* vector, a T-DNA border region from *A. tumefaciens*. Alternatively, the vectors used in the methods of the present disclosure may be *Agrobacterium* vectors. Methods for introducing the vectors include but are not limited to microinjection, velocity ballistic penetration by small particles with the nucleic acid either within the matrix of small beads or particles, or on the surface and electroporation. The vector may be introduced into a plant cell, tissue or organ. In a specific embodiment, once the presence of a heterologous gene is ascertained, a plant may be regenerated using procedures known in the art.

Uses of Mammalian GnTIII

[0157] The expression of mammalian GnTIII leads to bisected N-glycans on glycoproteins. Bisected N-glycans are important for biological activity of some mammalian glycoproteins. In particular, bisected monoclonal antibodies have enhanced ADCC (antibody-dependent cellular cytotoxicity). Introduction of bisected structures leads to new or optimized functionalities and increased bioavailability of glycoprotein, e.g., increasing the antennary type increases half-life because of reduced clearance by the kidney. Accordingly, the disclosure is directed to a plant host system comprising said heterologous glycoprotein having bisecting oligosaccharides, particularly bisecting G1cNAc residues and methods for producing said glycoprotein.

[0158] Furthermore, expression of GnTIII in plants leads to drastic increase of terminal G1cNAc's compared to wildtype plants (plant N-glycans contain far less GlcNAc residues compared to mammalian N-glycans). More GlcNAc residues on N-glycans of plant glycoproteins or recombinant glycoprotein produced in plants resembles mammalian N-glycans of glycoproteins. The introduction of bisected GlcNAc in plant N-glycans (and in plant-produced recombinant glycoproteins such as Mabs) due to GnTIII expression in plants seems to prevent the N-glycan from degradation by β -N-acetylhexosaminidases. More GlcNAc residues means more acceptor substrate for β (1,4)-galactosyltransferase (GalT) adding terminal galactose. Co-expression of GnTIII and a functional protein such as a transporter or a (mammalian) enzyme or functional fragment thereof providing N-glycan biosynthesis, such as a galactosyltransferase, such as GalT, or crossing GnTIII plants with GalT plants and vice versa, leads to increased galactosylation of glycoproteins s produced in these

plants. Accordingly, the disclosure is directed to a plant host system comprising said mammalian GnTIII and said functional protein; the plant host system may further comprise a heterologous glycoprotein with increased galactosylation relative to a heterologous glycoprotein produced in a plant host system not comprising said mammalian GnTIII and said functional protein, methods for providing said plant host systems and methods for producing said glycoprotein.

5 **[0159]** Generating stably transformed plants which produce tailored glycoproteins with commercial interest can be established by inoculating plant cells or tissues with *Agrobacterium* strains containing a vector which comprises both nucleotide sequences encoding GnTIII, optionally N-glycosylation modifying enzymes and nucleotide sequences encoding commercially interesting heterologous glycoproteins or by the procedures described above such as electroporation, microinjection, velocity ballistic penetration by small particles with the nucleic acid either within the matrix of small
10 beads or particles, or on the surface and electroporation. Alternatively, stably transformed plants which produce tailored glycoproteins with commercial interest can be generated by simultaneous inoculation (cotransformation) of two or more *Agrobacterium* strains each carrying a vector comprising either nucleotide sequences encoding GnTIII, optionally, other N-glycosylation modifying enzymes or nucleotide sequences encoding glycoproteins of commercial interest or direct cotransformation of plant cells or tissues with said vectors. Alternatively, stably transformed plants which produce tailored
15 glycoproteins with commercial interest can be generated by (multiple) crossing(s) of plants with modified N-glycosylation with plants which express nucleotide sequences encoding proteins of commercial interest. In all of these procedures, the vector may also comprise a nucleotide sequence which confers resistance against a selection agent.

[0160] In order to obtain satisfactory expression of the proteins involved in N-glycosylation, GnTIII and of the glycoproteins or polypeptides of commercial interest, the nucleotide sequences may be adapted to the specific transcription and translation machinery of the host plant as known to people skilled in the art. For example, silent mutations in the
20 coding regions may be introduced to improve codon usage and specific promoters may be used to drive expression of the said genes in the relevant plant tissues. Promoters which are developmentally regulated or which can be induced at will, may be used to ensure expression at the appropriate time, for example, only after plant tissues have been harvested from the field and brought into controlled conditions. In all these cases, choice of expression cassettes of the
25 glycosylation modifying proteins and of the glycoproteins of commercial interest should be such that they express in the same cells to allow desired post translational modifications to the said glycoprotein.

[0161] As described above, in a specific embodiment, a plant that can be used in the method of the present invention is a tobacco plant, or at least a plant related to the genus *Nicotiana*, however, use for the invention of other relatively easy transformable plants, such as *Arabidopsis thaliana* or *Zea mays*, or plants related thereto, is also particularly
30 provided. For the production of recombinant glycoproteins, the use of duckweed offers specific advantages. The plants are in general small and reproduce asexually through vegetative budding. Nevertheless, most duckweed species have all the tissues and organs of much larger plants including roots, stems, flowers, seeds and fronds. Duckweed can be grown cheaply and very fast as a free floating plant on the surface of simple liquid solutions from which they can easily be harvested. They can also be grown on nutrient-rich waste water, producing valuable products while simultaneously
35 cleaning wastewater for reuse. Particularly relevant for pharmaceutical applications, duckweed can be grown indoors under contained and controlled conditions. Stably transformed Duckweed can for example be regenerated from tissues or cells after (co)-inoculating with *Agrobacterium* strains containing each a (binary) vector which comprises one or more nucleotide sequences of interest encoding N-glycosylation modifying enzymes and/or genes encoding commercially interesting heterologous glycoproteins. The duckweed plant may, for example, comprise the genus *Spirodella*, genus
40 *Wolffia*, genus *Wolffiella*, or the genus *Lemna*, *Lemna minor*, *Lemna miniscula* and *Lemna gibba*. Also mosses such as *Physcomitrella patens* offer advantages in that it can be grown cheaply under contained conditions. In addition the haploid genome of *Physcomitrella patens* is relatively easy to manipulate.

[0162] Expression in tomato fruits also offers specific advantages. Tomatoes can be easily grown in greenhouses under contained and controlled conditions and tomato fruit biomass can be harvested continuously throughout the year
45 in enormous quantities. The watery fraction containing the glycoproteins of interest can be readily separated from the rest of the tomato fruit which allows easier purification of the glycoprotein. Expression in storage organs of other crops including but not limited to the kernels of corn, the tubers of potato and the seeds of rape seed or sunflower are also attractive alternatives which provide huge biomass in organs for which harvesting and processing technology is in place. Expression in nectar offers specific advantages with respect to purity and homogeneity of the glycoprotein secreted in
50 the nectar.

[0163] Alternatively, a plant comprising a heterologous glycoprotein is crossed with a plant produced by the method according to the invention comprising GnTIII and optionally at least one functional mammalian protein, e.g., a transporter or an enzyme providing N-glycan biosynthesis that is normally not present in plants, harvesting progeny from said crossing and selecting a desired progeny plant expressing said heterologous glycoprotein and expressing GnTIII and
55 optionally a functional (mammalian) enzyme involved in mammalian-like N-glycan biosynthesis that is normally not present in plants. This process is known as crosspollination. In a preferred embodiment, the invention provides a method according to the invention further comprising selecting a desired progeny plant expressing said recombinant protein comprising bisecting oligosaccharide, particularly galactose residues and/or increased galactosylation. Now that such

a plant is provided, the invention also provides use of a transgenic plant to produce a desired glycoprotein or functional fragment thereof, in particular wherein said glycoprotein or functional fragment thereof comprises bisecting oligosaccharide and/or increased galactosylation.

[0164] The disclosure additionally provides a method for obtaining a desired glycoprotein or functional fragment thereof comprising cultivating a plant according to the disclosure until said plant has reached a harvestable stage, for example when sufficient biomass has grown to allow profitable harvesting, followed by harvesting said plant with established techniques known in the art and fractionating said plant with established techniques known in the art to obtain fractionated plant material and at least partly isolating said glycoprotein from said fractionated plant material. The presence of desired proteins may be screened using methods known in the art, preferably using screening assays where the biologically active site is detected in such a way as to produce a detectable signal. This signal may be produced directly or indirectly. Examples of such assays include ELISA or a radioimmunoassay.

[0165] The introduction of bisected GlcNAc residues due to expression of GnTIII can also be used for the prevention of removal (degradation) of saccharides from N-glycan by "blocking" activity glycosidases, e.g., β -N-acetylhexosaminidases and preventing the addition of other saccharides (driven by "other" subsequent glycosyltransferase genes) to N-linked glycan, e.g., fucosylation, xylosylation. By controlling localization (e.g., by providing other subcellular targeting signals) and/or controlling expression levels (e.g., varying levels in independent transgenic plants or using different promoter) glycoform composition could be modulated. Hence introduction of bisecting GlcNAc residues in glycoproteins in plants including recombinant glycoproteins, inhibits incorporation α -1,3-fucose by blocking activity α 1,3-fucosyltransferase, α -1,4-fucose by blocking α -1,4-fucosyltransferase, β -1,2-xylose by blocking β -1,2-xylosyltransferase, β -1,3-galactose by blocking β -1,3-galactosyltransferase and removal/degradation of saccharides added to the N-glycan especially terminal GlcNAc residues by blocking activity of β -N-acetylhexosaminidases and terminal β -1,4-galactose (added by expression of β -1,4-galactosyltransferase as provided by patent application WO 01/31045) by blocking β -1,4-galactosidase. Thus in this way, controlled expression of GnTIII and controlled introduction of bisecting GlcNAc residues can be used to steer glycoform composition and/or limit glycoform heterogeneity.

EXAMPLES

[0166] The effect of the introduction of GnTIII in plants on the occurrence of bisected oligosaccharides on the glycans of plant glycoproteins has been evaluated. The human gene for GnTIII has been cloned, and a C-terminal c-myc tag for analysis of expression of the tagged fusion protein has been provided and the whole has been placed under control of plant regulatory elements for introduction in tobacco. It is shown that GnTIII is expressed in plants and that expression results in bisected oligosaccharide structures on endogenous plant glycoproteins. The amount of N-glycans containing at least two GlcNAc residues more than doubled compared to those found in normal tobacco plants. Remarkably, the expression of GnTIII also resulted in a significant reduction of complex type N-glycan degradation products as apparent from matrix-assisted laser desorption ionization time-of-flight (MALDI-TOF) analyses of the isolated glycans of endogenous plant glycoprotein. These data suggest that expression of GnTIII in tobacco resulting in the introduction of bisected structures on N-glycans protects the glycans from degradation by β -N-acetylhexosaminidases. β -N-acetylhexosaminidases have broad specificity for non-reducing terminal GlcNAc and β -N-acetylglucosamine (GalNAc) cleaving amongst others GlcNAc- β 1-2 linkages typically present on the trimannosyl core (Man- α 1-3 and Man- α 1-6).

Example 1

[0167] Plasmids and plant transformation. PAC clone RP5-1104E15 GnTIII (SEQ ID NO: 1, Figure 4A) was obtained from Pieter J. de Jong, Children's Hospital Oakland Research Institute (CHORI) and is available on request through Sanger Center being part of clone set HBRC_1.sc. The clone originates from Homo sapiens, male, blood and can be requested through <http://www.sanger.ac.uk/Teams/Team63/CloneRequest/> (from Human chromosome 22q12.3-13.1; The Wellcome Trust Sanger Institute, Wellcome Trust Genome Campus, Hinxton, Cambridge, CB10 1SA, UK; www.sanger.ac.uk)

[0168] The human gene for GnTIII was cloned from said PAC clone by PCR using AccuTaq LA DNA polymerase (SigmaAldrich) and primers GNT3F (5'-atactcgagtaacaatgaagatgagacgct-3'; SEQ ID NO: 3) and GNT3Rmyc (5'-tatggatcctaattcgatcctctctgagatgag-3'; SEQ ID NO: 4). Oligos were from Eurogentec (Belgium). PCR was performed on a PerkinElmerCetus 480 thermal cycler (ABI/PE) using optimal conditions for the AccuTaq polymerase according to the manufacturer. The resulting fragment was cloned in EcoRV site of pBluescribe SK+ (Stratagene, Inc., La Jolla, CA USA) and sequence verified. Sequencing was performed using fluorescently labelled dideoxynucleotides essentially as described (Sanger, et al., "DNA sequencing with the dideoxy chain-terminating inhibitors" Proc. Nat. Acad. Sci. USA 74:5463-5467, 1977) and reaction mixtures were run on an Applied Biosystems 370A or 380 automated DNA sequencer. Data were analysed using different software modules freely available on the web and compared with the DNA sequence of human GnTIII present in the database.

[0169] A 1.6 kb HpaI/BamHI fragment containing the GnTIII gene with C-terminal c-myc tag was subsequently cloned into the Sma/BglII site of pUCAP35S (Van Engelen, et al., "Coordinate expression of antibody subunit genes yields high levels of functional antibodies in roots of transgenic tobacco" Plant Molecular Biology 26:1701-1710, 1994) and named pAMV-GnTIII. The cauliflower mosaic virus 35S (CaMV35S) 20 promoter expression cassette with modified GnTIII gene was subsequently cloned as a AscI/PacI fragment in the binary vector pBINPLUS (Van Engelen, et al., "Coordinate expression of antibody subunit genes yields high levels of functional antibodies in roots of transgenic tobacco" Plant Molecular Biology 26:1701-1710, 1994) resulting in pBINPLUSGnTIII and introduced in *Agrobacterium tumefaciens* strain Ag10 by electroporation. Transformation of *Nicotiana tabacum* variety Samsun NN was as described before (Horsch, et al., "A simple and general method for transferring genes into plants" Science 227:1229-1231, 1985). Sixteen independent transgenic plants were selected and grown to maturity in the greenhouse as described. Leaf material was analysed for expression of GnTIII (SEQ ID NO: 2, Figure 4B) and glycan composition of endogenous cellular glycoproteins.

Example 2

[0170] **Analysis of expression.** Total protein extracts of tobacco leaves were prepared as described before (Bakker, et al., "Galactose-extended glycans of antibodies produced by transgenic plants" Proc. Nat. Acad. Sci. USA 98:2899-2904, 2001). The amount of protein present in samples was estimated by the Bradford method (Bradford, M.M., "A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding" Anal Biochem 72:248-254, 1976) using bovine serum albumin as standard. Fixed amounts of protein samples were run on precast 10 or 12 % SDS-PAGE gels (Bio-Rad) under reduced conditions. Rainbow coloured molecular weight protein markers were from Amersham. Western blot analysis was performed essentially as described (Bakker, et al., "Galactose-extended glycans of antibodies produced by transgenic plants" Proc. Nat. Acad. Sci. USA 98:2899-2904, 2001). Separated proteins were transferred to nitrocellulose (BA85, Schleicher and Schuell or Trans-Blot Transfer Medium, Bio-Rad) using a Bio-Rad Mini Trans-blot Electrophoretic Transfer Cell in 3[(cyclohexylamino)-1-propanesulfonic acid (CAPS) buffer for 60 min. Expression of the GnTIII-c-myc fusion protein was analysed by affinity blotting using a peroxidase labelled c-myc antibody. Introduction of bisecting oligosaccharides in endogenous tobacco glycoproteins was visualized by incubation with biotinylated erythroagglutinating phytohemagglutinin (E-PHA; Vector Laboratories). Detection was performed by enhanced chemiluminescence using Lumi-Light Western Blotting Substrate from Roche (Roche Diagnostics GmbH, Mannheim, Germany) on a Lumi-Imager F 1 apparatus (Boehringer Mannheim GmbH, Mannheim, Germany) using LumiAnalyst software (version 3.0).

Example 3

[0171] **Matrix-assisted Laser Desorption Ionization Time-of-Flight (MALDI-TOF) Mass Spectrometry.** For the analysis of glycan structure cellular proteins were isolated from tobacco leaves of a selected plant transformed with human GnTIII (GnTIII-17). Protein isolation and N-glycan preparation were performed as described (Elbers, et al., 2001). The N-glycans were desalted on a nonporous, graphitized carbon-black column (Carbograph Ultra Clean Tubes, Alltech Associates) before mass spectrometry analysis as described. MALDI-TOF spectra were measured on a Micromass (Manchester, U.K.) ToF spec E MALDI-TOF mass spectrometer. Mass spectra were performed in positive mode by using 2,5-dihydroxybenzoic acid as the matrix essentially as described (Elbers, et al., 2001).

[0172] Expression of human GnTIII introduces bisecting N-glycans on endogenous glycoproteins in *N. tabacum*. Human GnTIII was introduced in tobacco plants by *Agrobacterium-mediated* transformation of binary vector pBINPLUS-GnTIII containing a cDNA harbouring the complete coding sequence fused to a C-terminal c-myc tag under control of the constitutive CaMV35S promoter. Sixty independent transgenic shoots selected for kanamycin resistance were obtained which were analysed for expression of the GnTIII-c-myc fusion protein using the c-myc antibody. Analysis revealed that all expressed the gene at various levels. Fourteen were selected, rooted and transferred to the greenhouse. One plant (GnTIII-17) selected for high expression of the GnTIII-c-myc fusion protein using the c-myc antibody was analysed for the occurrence of bisected GlcNAc residues on N-glycans of endogenous tobacco glycoproteins using a specific binding assay with the biotinylated lectin E-PHA. SDS-PAGE of protein extracts followed by transfer to nitrocellulose and analysis using the specific binding assay with the biotinylated E-PHA lectin revealed that endogenous tobacco glycoproteins of GnTIII-17 contained bisected oligosaccharides whereas those of control tobacco did not. GnTIII-17 was multiplied in the greenhouse for further detailed analysis of glycan structure by MALDI-TOF.

Example 4

[0173] **Oligosaccharide distributions and level of bisected complex oligosaccharides in wildtype and selected transgenic GnTIII-17 tobacco plant.** Endogenous glycoproteins were isolated from young leaves of control tobacco plant and the selected GnTIII-17 plant to investigate in detail the effect of expression of human GnTIII on the structure

of glycans N-linked to glycoproteins. A comparison of the structures of the N-glycans isolated from glycoproteins present in leaves of control wild-type tobacco plants with those from plant GnTIII-17 using MALDI-TOF is represented in Figure 1. MALDI-TOF allows for the detection of different molecular species in the pool of the N-glycans (glycoforms) and shows a mixture of ions that were assigned to (M+Na)⁺ adducts of high-mannose (Man)- type N-glycans ranging from **d**, Mans to **n**, Man₉ and of mature N-glycans from the truncated structure **a**, XM3GN2 to **m**, GN3FXM3GN2 (for structure see Table 1; for a summary of the data see, Table 2). In addition to the N-glycans characterized in the control plants (Figure 1A), the MALDI-TOF MS of the glycan mixture from plant GnTIII-17 (Figure 1B) showed at least two ions assigned to N-linked glycans that result from the action of the human GnTIII enzyme (for a comparison see Table 1 and Table 2). These oligosaccharides, GN3XM3GN2 (**j**) and GN3FXM3GN2 (**k**) representing 8 % and 31 % respectively of the population, contain three GlcNAc residues each linked to one of the three mannoses of the trimannosyl core structure of the N-linked glycan.

[0174] Analysis of glycan structure through MALDI-TOF as performed here cannot distinguish between GlcNAc residues β (1,2)- or β (1,4)-linked to mannose. Hence, it was not clear if or to what extent the structures GN2XM3GN2 and GN2FXM3GN2 have bisecting oligosaccharides. Additional experiments are required to reveal that these structures are a mix of normal and bisected oligosaccharides or a single-compound.

[0175] In the light of the observed lethality of CHO cell that overexpress GnTIII (Umana, et al., "Engineered glycoforms of an antineuroblastoma IgG1 with optimized antibody-dependent cellular cytotoxic activity" Nature Biotechnology 17:176-180, 1999), remarkably transgenic plants having significant amounts of bisected glycans look phenotypically normal and are completely fertile (can be cross-pollinated and self-pollinated).

Example 5

[0176] Expression of human GnTIII in tobacco seems to protect N-glycans from degradation by D-Nacetylhexosaminidases and more than doubles terminal N-glucosaminylation. MALDI-TOF analysis of extracts clearly showed that at least 40 % of the population of glycoforms now has a bisecting GlcNAc in complex-type N-linked glycans of cellular tobacco proteins through the action of the GnTIII enzyme. Moreover 70 % of the population of complex-type N-linked glycans of endogenous glycoproteins of GnTIII-17 has two or three terminal GlcNAc residues compared to about 30 % for wildtype tobacco (Table 1). The observed *de novo* synthesis of at least 40 % bisected complex-type N-linked glycans upon expression of GnTIII in tobacco (Figure 1B, Table 1 and Table 2) coincides with the disappearance of mainly FXM3GN2 (**b**, from 30 % to 4 %) and GNFXM3GN2 (**f**, from 10 to 2%) and to a minor degree GN2FXM3GN2 (**j**, from 29 % to 19 %). In addition it also coincides with a significant increase in GN2XM3GN2 (**h**) from 4 % in wildtype tobacco to 14 % in GnTIII-17. Whether the latter GN2XM3GN2 (**h**) in GnTIII plants has the second GlcNAc linked to the (β -linked mannose of the trimannosyl core of the N-linked glycan and hence is the result of GnTIII activity, or to the second α -linked mannose of the trimannosyl core remains to be investigated (see above).

[0177] Saccharides **a**, **b** and **c** accounting for 40 % of the N-linked glycans in wildtype tobacco plants, are degradation products expected to have arisen from mature glycans of endogenous tobacco glycoproteins after GnTI activity since an Arabidopsis thaliana mutant lacking GnTI activity did not contain xylose and fucose residues in the N-glycans of endogenous glycoproteins (Von Schaewen, et al., "Isolation of a mutant Arabidopsis plant that lacks N-Acetylglucosaminyl transferase I and is unable to synthesize golgi-modified complex N-linked glycans" Plant Physiology 102:1109-1118, 1993). The 7-fold decrease (40 % > 6 %) in these structures in GnTIII-17 together with the threefold reduction of GNXM3GN2 and XM3GN2 (12 % > 4 %) suggests that the introduction of a bisected GlcNAc protects the mature N-linked glycan from degradation by endogenous glycosidases especially β -Nacetylhexosaminidases that removes terminal GlcNAc. The total amount of N-linked glycans expected to have arisen from degradation of mature, full-length N-linked glycans has hence decreased fivefold (from 52 % to 10 %).

Example 6

[0178] Vector construction and DNA preparation for maize transformation. The human GNTIII gene along with its 3' c-myc immunodetection tag was obtained by PCR from plasmid pAMV-GNTIII by the following method. Primers MS20 and MS 19 homologous to the 5' and 3' ends of the hGNTIII gene respectively, were designed and synthesized to add a PmeI site and a stop codon to the 3' end of the gene.

MS20 (5'NcoI site): 5'-CCATGGTGATGAGACGCTAC-3' (SEQ ID NO: 5)

MS19 (adds stop and PmeI site 3'): 5'-GTTTAAACCTAGGATCCTAATTCAGATCCTCT-3' (SEQ ID NO: 6)

[0179] Following gel electrophoresis to identify the correct sized PCR product, the 1.6 kbp PCR product was recovered from the gel with a QIAquick Gel Extraction Kit (Qiagen, Valencia, CA). Plasmid 4005 (see, SEQ ID NO: 8) (Figures 5A and 5B), which contains a Zmubi /GUS /per5 cassette (Christensen, et al., Plant Molec. Biol. 18:675-689, 1992), was

digested with Nco1 and Pme 1 to release the GUS gene and the vector fragment was recovered from a gel with a QIAquick Gel Extraction Kit (Qiagen, Valencia, CA).

[0180] Following digestion with Nco1 and Pme1, the PCR-derived hGNTIII fragment was ligated to the vector fragment left after digestion of pDAB4005 with Nco1 and Pme1, to create the intermediate plasmid pDAB7119 (see, SEQ ID NO: 9) (Figures 6A and 6B). Intermediate plasmid pDAB7119 was cut with Spe1 and Sph1 to release the hGNTIII plant expression cassette, which was treated with T4 DNA polymerase to create blunt ends.

[0181] Plasmid pDAB8504 (SEQ ID NO: 10) (see, Figures 7A and 7B), which contains the RB7 MAR sequences, was digested with Srf1 and blunt ended with T4 DNA polymerase. Following treatment with calf intestinal phosphatase, the treated 8504 fragment and the hGNTIII plant expression cassette were ligated to create plasmid pDAB 7113 (SEQ ID NO: 10) (see, Figures 8A and 8B), which contains RB7 MAR sequences flanking the gene of interest and the selectable marker cassette as follows: RB7 MAR // Zmubi promoter/hGNTIII/per5 3'UTR // Rice actin promoter (D. McElroy, et al., "Isolation of an efficient actin promoter for use in rice transformation" The Plant Cell 2:163-171, 1990) /PAT/ Zm lipase 3'UTR // RB7 MAR.

[0182] The integrity of the GNTIII sequence was checked by sequencing (Big Dye Terminator Cycle Sequencing Ready Reaction, Applied Biosystems, Foster City, CA) and was confirmed to encode the human GNTIII enzyme. One base change, G384 → 384, was found but this substitution does not affect the encoded amino acid, proline 128.

[0183] Plasmid pDAB7113 was grown up in 2 L of medium (LB + amp) and purified with Qiagen plasmid Giga kit to produce 5 milligrams of purified plasmid for plant cell transformation.

Example 7

[0184] **Transformation of maize cells.** Plasmid pDAB7113 was introduced into maize cells with WHISKERS-mediated DNA transfer essentially as described in these citations, and as follows (Frame, B., et al., "Production of fertile transgenic maize plants by silicon carbide whisker-mediated transformation" Plant J. 6:941-948, 1994; Thompson, J., et al., "Maize transformation utilizing silicon carbide whiskers: a review" Euphytica 85:75-80, 1995; P. Song, C. Q. Cai, M. Skokut, B. Kosegi, and J. Petolino, "Quantitative real-time PCR as a screening tool for estimating transgene copy number in Whiskers-derived transgenic maize" Plant Cell Rep. 20:948-954, 2002).

[0185] Embryogenic maize suspension cell cultures were subcultured on medium G-N6 (N6 medium containing 30 gm/L sucrose, 100 mg/L inositol, and 2 mg/L 2,4-D) the day before whisker mediated transformation. On the day of the experiment, cells were pretreated with osmoticum by shaking with medium G-N6 containing 0.2 Molar each mannitol and sorbitol for 30 minutes. Thirty six mls of cells were transferred to a 250 ml centrifuge bottle in 50 ml of medium G-N6, to which was added 8.1 ml of a 5 % (w/v) silicon carbide whiskers suspension (Silar SC-9, Advanced Composite Materials, Greer, S.C.) in medium, plus 170 ul of 1 mg/ml plasmid solution (in TE buffer). The centrifuge bottle containing cells, whiskers and DNA was agitated vigorously on a modified Red Devil brand paint mixer for 10 seconds. Whiskered cells were then shaken for two hours in medium with half the level of added osmoticum. Whiskered cells were recovered by filtration on a sterile Buchner funnel and the filter papers were placed on semisolid G-N6 medium for 1 week. After 1 week the filters were moved to semisolid G-N6 medium containing 1 mg/L Herbiace (a commercial formulation of 20% bialaphos, Meiji Seika, Tokyo, Japan). Two weeks later, the cells were removed from the filter paper, mixed with melted G-N6 + 1 mg/L Herbiace (G-N6 +1H) medium also containing 7 gm/L Seaplaque agarose (BioWhittaker, Rockland, Maine), and spread on top of G-N6 + 1H solid medium. Plates were cultured in the dark at 30 °C. Colonies resistant to the selective agent were recovered 5-7 weeks post embedding, and individually moved to fresh G-N6+1H medium for further increase of tissue mass.

Example 8

[0186] **Molecular analysis for copy number of inserted DNA.** Tissue from each transgenic isolate was individually freeze-dried in a lyophilizer and DNA was extracted by a standard method (DNAeasy 96 Plant Kit, Qiagen). The copy number of inserted transgenic DNA was estimated by the Invader Operating System, available from Third Wave Technologies (Third Wave Technologies, Madison, Wisconsin, twt.com). Primers were designed by the Third Wave Technologies company specifically for the PAT selectable marker and its copy number was estimated relative to genomic DNA copy number for the endogenous maize alpha-tubulin gene.

Example 9

[0187] **Test transgenic maize callus for altered lectin binding due to expression of the GntIII gene.** Callus samples from 100 individually isolated unique transgenic events were extracted as follows. Samples from each event were fresh frozen in 96-well cluster tube boxes (Costar 1.2 ml polypropylene, with lid) along with a steel and a tungsten bead in each well. 450 ul of extraction buffer (25 mM sodium phosphate pH6.6, 100 mM NaCl, 30 mM sodium bisulfate, 1 % v/v

Triton X-100) was added per well and the box of samples was pulverized for 3 minutes full speed on a Kleco Bead Mill. The plate was centrifuged (4 °C) at 2500 rpm for 10 minutes. Extracts were removed to a 96-well deep well plate and frozen for storage. All screening assays were performed on these extracts of individual events.

[0188] Protein analyses (microtiter plate protocol, BioRad 500-0006) were made to determine the total protein for each extract. 25 ug protein per sample were loaded in 20 ul loading buffer (Laemmli, U.K. Nature 277:680 (1970)). Gels (4-20 % Criterion PAGE gels, 12+2 wells, BioRad 345-0032) were electrophoresed at 65 mA in Tris/glycine /SDS running buffer (BioRad 161-077). After soaking in transfer buffer (running buffer plus 20 % v/v methanol) for 10 minutes, the gels were transferred to nitrocellulose membranes using a semi-dry blotter (150 mA/1.5 hrs). The membranes were incubated for 30 minutes in blocking buffer (20 mM Tris, 144 mM NaCl, 0.5 % v/v Tween 20, 10 % w/v nonfat powdered milk) at room temperature, then the blocking buffer was removed and replaced with the primary detection lectin (Phaseolus hemagglutinin E, biotinylated, Vector Laboratories B-1125) 2.5 ug/ml in blocking buffer. The primary detection lectin was incubated on the membrane for 1 hour at room temperature. The primary detection solution was removed, the membrane was rinsed once with blocking buffer and the secondary detection solution was added (avidin-HRP, BioRad 170-6528, at 1:5000, plus molecular weight marker detection agent, StrepTactin-HRP, BioRad 161-0380 at 1:10,000 in blocking buffer. The secondary detection reagent was incubated on the membrane for 1 hour at room temperature. During the blocking, primary, and secondary reagent steps the solutions were mixed on the blots. The secondary detection reagent was then removed and the membrane was rinsed with Tris buffered saline (20 mM Tris, 144 mM NaCl) containing 0.5 % Tween 20 three times at 10 minutes each and once more for 5 minutes. After dripping off the excess rinse solution, the blot was soaked in substrate ECL (Pierce 34080) for 1 minute, excess ECL solution was drained off, and the membrane was exposed to film. Negative controls were included in each gel to discriminate new glycoprotein bands now visible with this bisecting glycan -detecting lectin reagent on the transgenic callus extracts.

[0189] Positive test results (Table 5) for the E-PHA binding were rated as 0 (negative), 1 (one plus, weak) 2 (two pluses, moderately strong) or 3 (three pluses, strongest rating). Callus of events rated 2 or 3 were selected to produce sample for mass analysis. Samples 25, 26, 33, 48, 55, 56 and 59 were pooled to produce the protein extract for MALDI-TOF analysis of glycan substructures. A gel blot example (Figure 12) shows samples 19 through 27.

Example 10

[0190] Test transgenic maize callus for c-myc epitope expression. Callus samples from 100 individually isolated unique transgenic events were extracted as follows. Samples from each event were fresh frozen in 96-well cluster tube boxes (Costar 1.2 ml polypropylene, with lid) along with a steel and a tungsten bead in each well. 450 ul of extraction buffer (25 mM sodium phosphate pH8.6, 100 mM NaCl, 30 mM sodium bisulfate, 1 % v/v Triton X-100) was added per well and the box of samples was pulverized for 3 minutes full speed on a Kleco Bead Mill. The plate was centrifuged (4 °C) at 2500 rpm for 10 minutes. Extracts were removed to a 96-well deep well plate and frozen for storage. All screening assays were performed on these extracts of individual events.

[0191] Protein analyses (microtiter plate protocol, BioRad 500-0006) were made to determine the total protein for each extract. 25 ug protein per sample were loaded in 20 ul loading buffer (Laemmli, U.K. Nature 277:680, 1970)). Gels (4-20 % Criterion PAGE gels, 12+2 wells per gel, BioRad 345-0032) were electrophoresed at 65 mA in Tris_/glycine /SDS running buffer (BioRad 161-0772). After soaking in transfer buffer (running buffer plus 20 % methanol) for 10 minutes, the gels were transferred to nitrocellulose membranes using a semi-dry blotter (150 mA/1.5 hrs). The membranes were incubated for 30 minutes in blocking buffer (20 mM Tris, 144 mM NaCl 0.5 % v/v Tween 20, 10 % w/v dry milk) at room temperature, then the blocking buffer was removed and replaced with the primary detection reagent, Mouse anti-c-myc clone 9E10 (sigma M5546) at 1 ug/ml in blocking buffer. After 1 hour of incubation at room temperature, the primary detection reagent was removed and the membrane was rinsed with blocking buffer. The secondary detection reagent, anti-mouse - HRP (BioRad 170-6516) at 1:10,000 plus a molecular weight marker detection reagent (StrepTactin - HRP, BioRad 161-0380) at 1:10,000 in blocking buffer, was then added and incubated on the membrane for 1 hour at room temperature. During the blocking, primary, and secondary reagent steps the solutions were mixed on the blots. The secondary detection agent was removed, and the membrane was rinsed three times with Tris buffered saline (20 mM Tris, 144 mM NaCl) containing 0.5 % Tween 20 for 10 minutes each, plus another 5 minute rinse. After draining off the excess rinse solution the membrane was soaked in ECL reagent (Pierce 34080) for 1 minute, drained, and then exposed to film.

[0192] As detailed above, callus samples from independent events 1-100 were screened for expression of the c-myc epitope. Then, samples 3, 11, 12, 26, 31, 55 and 64 were analysed and showed the presence of a band in the predicted molecular weight range of 50-55 kilodaltons. These callus samples were pooled to produce a protein sample for glycan analysis by MALDI-TOF. A representative blot is shown in Figure 13.

Example 11

[0193] Preparation of extract for mass spec analysis of glycans. The samples were prepared from combined calluses of several maize callus events which tested positive for GNTIII transgene expression based on lectin blotting using E-PHA. Callus tissue was collected fresh and stored frozen at -80 °C, then ground to a fine powder in liquid nitrogen. Weighed sample was added to extraction buffer (5 mM EDTA, 0.5 mM PMSF, 20 mM sodium bisulfite, 150 mM sodium phosphate buffer pH 7.4, and 0.4 mM PVPP soluble MW 40,000) and stirred for 30 minutes at 4 °C. After centrifugation at 5000 x G at 4 °C, the supernatant was collected. Ammonium sulfate and wash buffer (5 mM EDTA, 150 mM sodium phosphate buffer, pH 7.4) were added to the supernatant to achieve a final concentration of 20 % (w/v) ammonium sulfate. After centrifugation 5 minutes at 5000 x G at 4 °C, the supernatant was transferred to a fresh tube and additional ammonium sulfate plus wash buffer were added to achieve 60 % (w/v) ammonium sulfate. This preparation was stirred overnight at 4 °C, then centrifuged 20 minutes at 10,000 x G. The pellet was recovered in 5 ml of wash buffer and frozen at -80 °C, then lyophilized at 4 °C until dry. Samples were sent to the lab for glycan analysis.

Example 12

[0194] Maize plant regeneration from transgenic callus tissue. For plant regeneration from transformed callus, tissue was placed onto regeneration media containing MS basal salts and vitamins (Murashige T. and F. Skoog, *Physiol Plant* 15:473-497, 1962), 30 g/l sucrose, 5 mg/16-benzylaminopurine (BA), 0.025 mg/l 2, 4-dichlorophenoxyacetic acid (2,4-D), 1 mg/l Herbiace (a commercial formulation of 20 % bialaphos, Meiji Seika, Tokyo, Japan), and 2.5 g/l Gelrite, pH 5.7. Cultures were grown in the light. When shoots reached 1-3 cm in length, they were transferred into vessels containing SH basal salts and vitamins (Schenk R. and A.C. Hildebrandt, *Can J Bot* 50:199-204, 1972), 10 g/l sucrose, 1 g/l myo-inositol, and 2.5 g/l Gelrite, pH 5.8.

[0195] Plants were screened for expression of GNTIII by altered binding of the lectin E-PHA to endogenous proteins. Samples were then screened for E-PHA binding as described in Example 9, *supra*. The protein extract and 20 % / 60 % ammonium sulfate precipitate was prepared exactly as for the callus samples as described in Example 13, *infra*. One plant each from plants regenerated from 23 independent events were screened by lectin blotting for the results of expression of the GNTIII gene. Four of these events gave positive signals for E-PHA binding. These four events had also tested positive at the callus stage. Plants regenerated from those four events were pooled to produce a protein extract for glycan analysis by MALDI-TOF.

Example 13

[0196] Oligosaccharide distributions and level of bisected complex oligosaccharides in wildtype and selected transgenic corn calli. Endogenous glycoproteins were isolated from control corn calli and selected corn calli expressing GNTIII based on lectin blotting using E-PHA. In addition, the present disclosure also contemplates the extraction of c-myc tagged samples. E-PHA and c-myc tagged samples may be callus, plant cells, plant tissues or entire plants as defined in the definitions section *supra*. A comparison of the structures of the N-glycans isolated from glycoproteins present in calli is presented in Figures 9A and 9B. MALDI-TOF allowed for the detection of different molecular species in the pool of the N-glycans (glycoforms) and showed a mixture of ions that were assigned to (M+Na)⁺ adducts of high-mannose (Man)-type N-glycans ranging from d, Man5 to 1, Man8 and of mature N-glycans from the truncated structure a, XM3GN2 to m, bGN3FXM3GN2 (see, Table 3). In addition to the N-glycans characterized in the control callus (Figure 9A), the MALDI-TOF MS of the glycan mixture from selected corn calli expressing GNTIII (Figure 9B) showed at least one ion assigned to N-linked glycans that result from the action of the human GNTIII enzyme (for a comparison see, Table 3). This oligosaccharide, GN3XM3GN2 (**m**) represents 20 % of the population and contains three GlcNAc residues each linked to one of the three mannoses of the trimannosyl core structure of the N-linked glycan. Analysis of glycan structure through MALDI-TOF as performed here cannot distinguish between GlcNAc residues β (1,2)- or β (1,4)-linked to mannose. Hence it is not clear if or to what extent the structures GN2XM3GN2 (**h**) and GN2FXM3GN2 (**k**) have bisecting oligosaccharides. Both had increased numbers in GNTIII corn cells compared to untransformed control corn cells. Additional experiments are required to reveal that these structures are a mix of normal and bisected oligosaccharides or a single compound.

[0197] Besides the new appearance of saccharide structure **m** (bGN3FXM3GN2) in GNTIII corn, it is apparent from the comparison of the glycoforms of control and GNTIII corn, as shown in Table 3, that the amount of structures harbouring high-mannose type N-glycans (M4 and higher) is reduced more than twofold (from 19 % to 7 %) which can be attributed mostly to the reduction of M4-containing N-glycans (from 10 % to 1 % of total) in GNTIII corn versus control corn. In addition the amount of glycoforms having two or more GlcNAc residues has increased from 16 % to 42 % (control versus GNTIII).

[0198] In a follow-up experiment, endogenous glycoproteins were isolated from control corn calli and selected corn

calli expressing GnTIII based on analysis for the presence of c-myc tag sequence by Western blotting. A comparison of the structures of the N-glycans isolated from glycoproteins present in calli is presented in Table 4. MALDI-TOF allows for the detection of different molecular species in the pool of the N-glycans (glycoforms) and shows a mixture of ions that were assigned to (M+Na)⁺ adducts of high-mannose (Man)-type N-glycans ranging from d, Man5 to l, Man8 and of mature N-glycans from the truncated structure a, XM3GN2 to k, GN2FXM3GN2 in control corn.

[0199] Remarkably, in transgenic corn expressing GnTIII (Table 4, GnTIII-2), only three isoforms could be detected: FXM3GN2 (b; accounting for 9 % of total), GN2FXM3GN2/bGN2FXM3GN2 (k; 38 %) and bGN3FXM3GN2 (m; 54 %). It is not clear if or to what extent the structure depicted as k (GN2FXM3GN2/bGN2FXM3GN2) has bisecting oligosaccharides. Its presence is significantly increased in GnTIII corn compared to control corn. Additional experiments are required to reveal that these structures are a mix of normal and bisected oligosaccharides or a single compound.

[0200] Besides the new appearance of saccharide structure m (bGN3FXM3GN2) in GnTIII corn (54 %), it is apparent from the comparison of the glycoforms of control and GnTIII corn, as summarized in Table 4, that the amount of structures harbouring high-mannose type N-glycans (M4 and higher) is reduced to nil in GnTIII corn versus control corn. Furthermore, the total amount of N-glycans bearing 2 or more (3) GlcNAc residues has increased from 16 to 92% (control versus GnTIII) suggesting that the introduction of bisected GlcNAc residue protects the glycan from degradation by endogenous hexosaminidases as observed before for transgenic GnTIII tobacco.

[0201] Additionally, MALDI-TOF mass spectroscopy data (Figure 11) demonstrate the bisected GlcNAc structure.

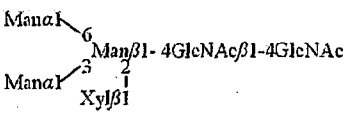
Example 14

[0202] **Oligosaccharide distributions and level of bisected complex oligosaccharides in wildtype and selected transgenic corn plants.** Endogenous glycoproteins were isolated from control corn plant leaves and selected corn plant leaves expressing GnTIII based on analysis for the presence of c-myc tag sequence by Western blotting or lectin blotting using E-PHA. A comparison of the structures of the N-glycans isolated from glycoproteins present in leaves is presented in Table 6. MALDI-TOF allows for the detection of different molecular species in the pool of the N-glycans (glycoforms) and shows a mixture of ions that were assigned to (M+Na)⁺ or (M+K)⁺ adducts of high-mannose (Man)-type N-glycans ranging from f, Man6 to h, Man8 and of mature N-glycans from the truncated structure a, XM3GN2 to g, GN2FXM3GN2 in control corn plant and to i, bGN3FXM3GN2 in transgenic GnTIII-corn plant.

[0203] In addition to the N-glycans characterized in the control plants (Figure A), the MALDI-TOF MS of the glycan mixture from selected corn plant expressing GnTIII (Figure B) showed at least one ion assigned to N-linked glycans that result from the action of the human GnTIII enzyme (for a comparison see Table 6). This oligosaccharide, GN3XM3GN2 (i) represents 15% of the population and contains three GlcNAc residues each linked to one of the three mannoses of the trimannosyl core structure of the N-linked glycan. Analysis of glycan structure through MALDI-TOF as performed here cannot distinguish between GlcNAc residues β (1,2)- or β (1,4)-linked to mannose. Hence it is not clear if or to what extent the structure GN2FXM3GN2 (g) has bisecting oligosaccharides. It has increased in GnTIII corn compared to control corn plant (23 % versus 5 % in control). Additional experiments are required to reveal that these structures are a mix of normal and bisected oligosaccharides or a single compound. Besides this it is apparent from the comparison of the glycoforms of control and GnTIII corn plants, as depicted in Table 6, that the amount of structures harbouring FXM3GN2 is reduced twofold (from 59 to 30) and the amount of glycoforms having two or more GlcNAc residues has increased from 5 to 38 % (control versus GnTIII).

[0204] Additionally, Figure 14 shows a comparison of MALDI-TOF mass spectra of N-glycans of glycoproteins isolated from leaves of control corn (A) and of selected GnTIII-corn plants. GnTIII corn plant was obtained through transformation with human GnTIII gene sequence and selection was performed by Western blotting using either c-myc tag or E-PHA lectin. See Table 6 for structures and abbreviations.

Table 1. Structure, molecular weight and percentage of total pool of N-glycans isolated from control and selected GnTIII-17 plants.

Structure	Abbreviation	Name	Mol. Wt.	%	
				Wildtype	GnTIII-17
	XM3GN2	A	1065	8	4

(continued)

Structure	Abbreviation	Name	Mol. Wt.	%	
				Wildtype	GnTIII-17
	FM3GN2	B	1079	3	0
	FXM3GN2	C	1211	30	4
	Man5	D	1257	2	3
	GNXM3GN2	E	1268	4	0
	GNFXM3GN2	F	1414	10	2
	Man6	G	1419	3	5
	GN2XM3GN2	H	1471	- 4	14
	Man7	I	1581	3	4
	GN2FXM3GN2	J	1617	- 29	19
	Man8		1743	2	4
	GN3FXM3GN2	M	1820	-	31
	Man9	N	1905	1	2

Table 2. Comparison of the results of mass spec (MALDI-TOF) analysis of N-glycans of endogenous glycoproteins isolated from control tobacco and selected GnTIII-17 plant. See also Table 1.

m/z	Type	Wildtype endo	GnTIII-17 endo
1065	XM3	8	4
1079	FM3	3	0
1211	FXM3	30	4
1257	M5	2	3
1268	GNXM3	4	0
1414	GNFXM3	10	2
1419	M6	3	5
1471	GNbGNXM3		14
1471	GN2XM3	4	
1581	M7	3	4
1617	GN2FXM3	29	19
1617	GNbGNXM3		
1674	GN2bGNXM3	0	8
1743	M8	2	4
1820	GN2bGNFXM3	0	31
1905	M9	1	2
TOTAL		99	100

Table 3. Overview N-glycans observed in control and transgenic GnTIII corn. Comparison of N-glycan structures (%of total) found on endogenous glycoproteins of control, untransformed corn and transgenic corn callus expressing GnTIII that could be annotated. Corresponding mass spectra obtained through MALDI-TOF analyses are given below and saccharides are indicated under column "name." Bisecting GlcNAc residues are depicted as bGN.

Structure abbreviation	m/z	name	Corn callus	
			control	GnTIII
XM3GN2	1065	a	1	5
FXM3GN2	1211	b	37	36
XM4GN2	1227	c	6	1
M5GN2	1257	d	1	1
GNFXM3GN2	1414	e	12	3
M6GN2	1419	f	5	4
GNXM4GN2	1430	g	3	
GN2XM3GN2	1471	h		3
bGN2XM3GN2				
GNFXM4GN2	1576	i	1	
M7GN2	1581	j	1	1

(continued)

Structure abbreviation	m/z	name	Corn callus	
			control	GnTIII
GN2FXM3GN2	1617	k	16	19
bGN2FXM3GN2				
M8GN2	1743	l	1	
bGN3FXM3GN2	1820	m		20
		Total	84	93

Table 4. Schematic overview N-glycans observed in control and transgenic GnTIII corn-2. Comparison of N-glycan structures (% of total) found on endogenous glycoproteins of control, untransformed corn and transgenic corn callus expressing GnTIII that could be annotated. Transgenic corn was selected using c-myc tag. Corresponding mass spectra obtained through MALDI-TOF analyses are given below and saccharides are indicated under column "name". Bisecting GlcNAc residues are depicted as bGN.

Structure abbreviation	m/z	name	Corn callus	
			control	GnTIII-2
XM3GN2	1065	a	1	
FXM3GN2	1211	b	37	9
XM4GN2	1227	c	6	
M5GN2	1257	d	1	
GNFXM3GN2	1414	e	12	
M6GN2	1419	f	5	
GNXM4GN2	1430	g	3	
GN2XM3GN2	1471	h		
bGN2XM3GN2				
GNFXM4GN2	1576	i	1	
M7GN2	1581	j	1	
GN2FXM3GN2	1617	k	16	38
bGN2FXM3GN2				
M8GN2	1743	l	1	
bGN3FXM3GN2	1820	m		54
		Total	84	101

Table 5. Positive test results for E-PHA binding.

Sample ID number	Rating for E-PHA Binding	Included in Pooled positive sample
1.	Unclear	
2.	Unclear	

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(continued)

	Sample ID number	Rating for E-PHA Binding	Included in Pooled positive sample
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	6.	0	
10	7.	0	
	8.	0	
	9.	0	
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	11.	Unclear	
	12.	1	
	13.	1	
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	15.	0	
	16.	0	
25	17.	0	
	18.	0	
	19.	0	
	20.	0	
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	22.	0	
	23.	1	
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	36.	0	
	37.	Unclear	
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	39.	0	
	40.	1	

(continued)

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Sample ID number	Rating for E-PHA Binding	Included in Pooled positive sample
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42.	0	
43.	0	
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63.	0	
64.	0	
65.	0	
66.	0	
67.	0	
68.	0	
69.	Negative control	

Table 6. Schematic overview N-glycans observed in control and transgenic GnTIII corn plants.

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Structure abbreviation	m/z	name	Corn plant	
			control	GnTIII
XM3GN2	1065	a	4	14
FM3GN2	1079	b	2	
FXM3GN2	1211	c	59	30

(continued)

Structure abbreviation	m/z	name	Corn plant	
			control	GnTIII
XM4GN2	1227	d	3	12
GNFXM3GN2	1414	e	10	6
M6GN2	1419	f	2	
GN2FXM3GN2	1617	g	5	23
bGN2FXM3GN2				
M8GN2	1743	h	1	
bGN3FXM3GN2	1820	i		15
Total			86	100

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	Leu	Cys	Leu	Ile	Ser	Phe	Leu	His	Phe	Phe	Lys	Thr	Leu	Ser	Tyr	Val
5				20					25					30		
	Thr	Phe	Pro	Arg	Glu	Leu	Ala	Ser	Leu	Ser	Pro	Asn	Leu	Val	Ser	Ser
			35					40					45			
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10	65					70					75					80
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				100					105					110		
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			130				135					140				
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	Gly	Arg	Gly	Ala	Arg	Arg	Lys	Trp	Val	Glu	Cys	Val	Cys	Leu	Pro	Gly
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25					215							220				
	Phe	His	Glu	Leu	Gly	Asp	Val	Val	Asp	Ala	Phe	Val	Val	Cys	Glu	Ser
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	Asn	Phe	Thr	Ala	Tyr	Gly	Glu	Pro	Arg	Pro	Leu	Lys	Phe	Arg	Glu	Met
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		370					375					380				
	Gln	Tyr	Tyr	Thr	Met	Pro	Asn	Phe	Arg	Gln	Tyr	Glu	Asn	Arg	Thr	Gly
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	His	Ile	Leu	Val	Gln	Trp	Ser	Leu	Gly	Ser	Pro	Leu	His	Phe	Ala	Gly
45					405						410				415	
	Trp	His	Cys	Ser	Trp	Cys	Phe	Thr	Pro	Glu	Gly	Ile	Tyr	Phe	Lys	Leu
				420					425					430		
	Val	Ser	Ala	Gln	Asn	Gly	Asp	Phe	Pro	Arg	Trp	Gly	Asp	Tyr	Glu	Asp
			435					440					445			
	Lys	Arg	Asp	Leu	Asn	Tyr	Ile	Arg	Gly	Leu	Ile	Arg	Thr	Gly	Gly	Trp
50							455					460				
	Phe	Asp	Gly	Thr	Gln	Gln	Glu	Tyr	Pro	Pro	Ala	Asp	Pro	Ser	Glu	His
	465					470					475					480
	Met	Tyr	Ala	Pro	Lys	Tyr	Leu	Leu	Lys	Asn	Tyr	Asp	Arg	Phe	His	Tyr
					485					490					495	
	Leu	Leu	Asp	Asn	Pro	Tyr	Gln	Glu	Pro	Arg	Ser	Thr	Ala	Ala	Gly	Gly
55				500					505					510		
	Trp	Arg	His	Arg	Gly	Pro	Glu	Gly	Arg	Pro	Pro	Ala	Arg	Gly	Lys	Leu
			515					520					525			

Asp Glu Ala Glu Val Glu Gln Lys Leu Ile Ser Glu Glu Asp Leu Asn
 530 535 540

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Claims

1. A method for producing a plant-derived glycoprotein comprising bisected oligosaccharides, comprising:
 - 10 introducing a nucleic acid sequence encoding a mammalian UDP-N-acetyl glycosamine: β -D-mannoside β (1,4)-N-acetyl glucosaminyl transferase III (GnTIII) and a nucleic acid sequence encoding a heterologous glycoprotein into a plant or portion thereof, and isolating the heterologous glycoprotein.
- 15 2. The method of claim 1, wherein the mammalian GnTIII comprises the amino acid sequence of SEQ ID NO:2.
3. The method of claim 1 or claim 2, wherein the plant or portion thereof is a plant cell, a whole plant, or a portion thereof, which optionally is selected from the group consisting of leaf, callus, stem, pericarp, protoplast, root, tuber, kernel, endosperm, and embryo.
- 20 4. The method of claim 3, wherein the plant is a tobacco plant.
5. The method of any of claims 1-4, wherein the plant or portion thereof further comprises at least one additional non-plant glycosyltransferase that is involved in N-glycan synthesis.
- 25 6. The method of claim 5, wherein the at least one additional non-plant glycosyltransferase is a mammalian β -1,4 galactosyltransferase.

Patentansprüche

1. Verfahren zum Herstellen eines von einer Pflanze abgeleiteten Glykoproteins, welches zweigeteilte ("bisected") Oligosaccharide umfasst, welches umfasst:
 - 35 Einführen einer Nukleinsäuresequenz, welche für eine SäugerUDP-N-acetylglucosamin- β -D-mannosid β (1,4)-N-acetylglucosaminyltransferase III (GnTIII) kodiert, und einer Nukleinsäuresequenz, welche für ein heterologes Glykoprotein kodiert, in eine Pflanze oder einen Teil davon, und Isolieren des heterologen Glykoproteins.
- 40 2. Verfahren nach Anspruch 1, wobei die Säuger-GnTIII die Aminosäuresequenz von SEQ ID NO:2 umfasst.
3. Verfahren nach Anspruch 1 oder Anspruch 2, wobei die Pflanze oder der Teil davon eine Pflanzenzelle, eine ganze Pflanze oder ein Teil davon ist, welcher gegebenenfalls ausgewählt ist aus der Gruppe bestehend aus Blatt, Kallus, Stängel, Perikarp, Protoplast, Wurzel, Knolle, Kern, Endosperm und Embryo.
- 45 4. Verfahren nach Anspruch 3, wobei die Pflanze eine Tabakpflanze ist.
5. Verfahren nach einem der Ansprüche 1-4, wobei die Pflanze oder ein Teil davon ferner mindestens eine zusätzliche nicht-pflanzliche Glykosyltransferase umfasst, die an N-Glykan-Synthese beteiligt ist.
- 50 6. Verfahren nach Anspruch 5, wobei die mindestens eine zusätzliche nicht-pflanzliche Glykosyltransferase eine Säuger- β -1,4-Galactosyltransferase ist.

Revendications

1. Procédé de production d'une glycoprotéine dérivée de plante comprenant des oligosaccharides en deux parties, comprenant :

l'introduction d'une séquence d'acide nucléique codant pour une UDP-N-acétylglucosamine : β -D-mannoside β (1,4)-N-acétylglucosaminyltransférase III (GnTIII) de mammifère et d'une séquence d'acide nucléique codant pour une glycoprotéine hétérologue dans une plante ou une partie de celle-ci, et l'isolement de la glycoprotéine hétérologue.

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2. Procédé selon la revendication 1, dans lequel la GnTIII de mammifère comprend la séquence d'acides aminés de SEQ ID NO: 2.

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3. Procédé selon les revendications 1 ou 2, dans lequel la plante ou la partie de celle-ci est une cellule végétale, une plante entière, ou une partie de celle-ci, qui est facultativement sélectionnée dans le groupe consistant en une feuille, un cal, une tige, un péricarpe, un protoplaste, une racine, un tubercule, un noyau, un endosperme, et un embryon.

15

4. Procédé selon la revendication 3, dans lequel la plante est une plante de tabac.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel la plante ou la partie de celle-ci comprend en outre au moins une glycosyltransférase non végétale supplémentaire qui est impliquée dans la synthèse de N-glycanes.

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6. Procédé selon la revendication 5, dans lequel la au moins une glycosyltransférase non végétale supplémentaire est une β -1,4-galactosyltransférase de mammifère.

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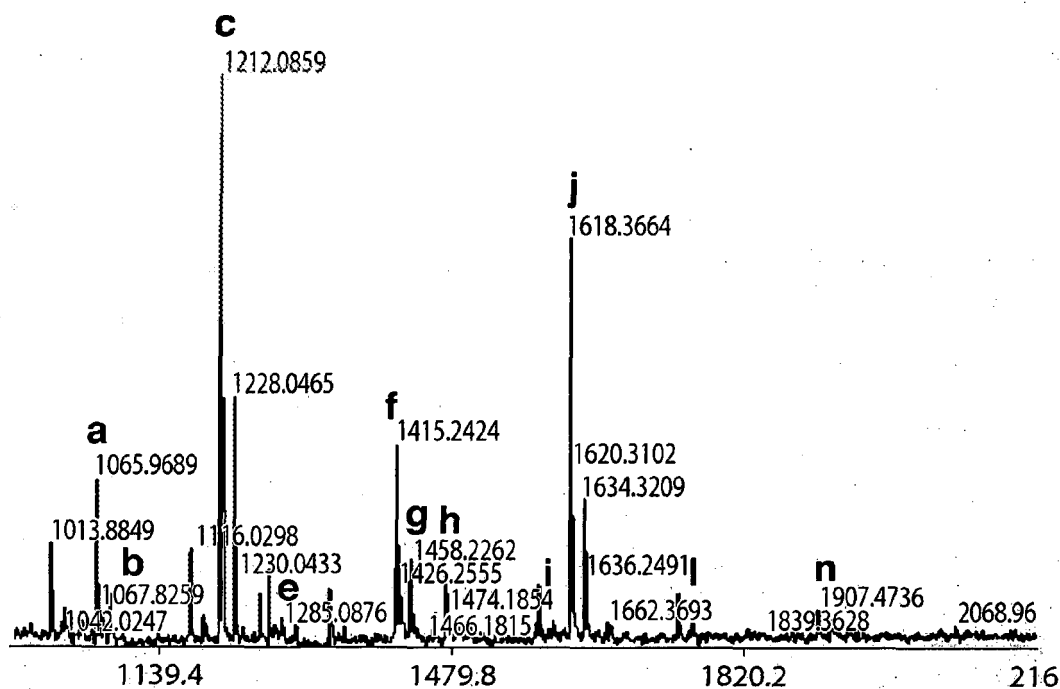


FIG. 1A

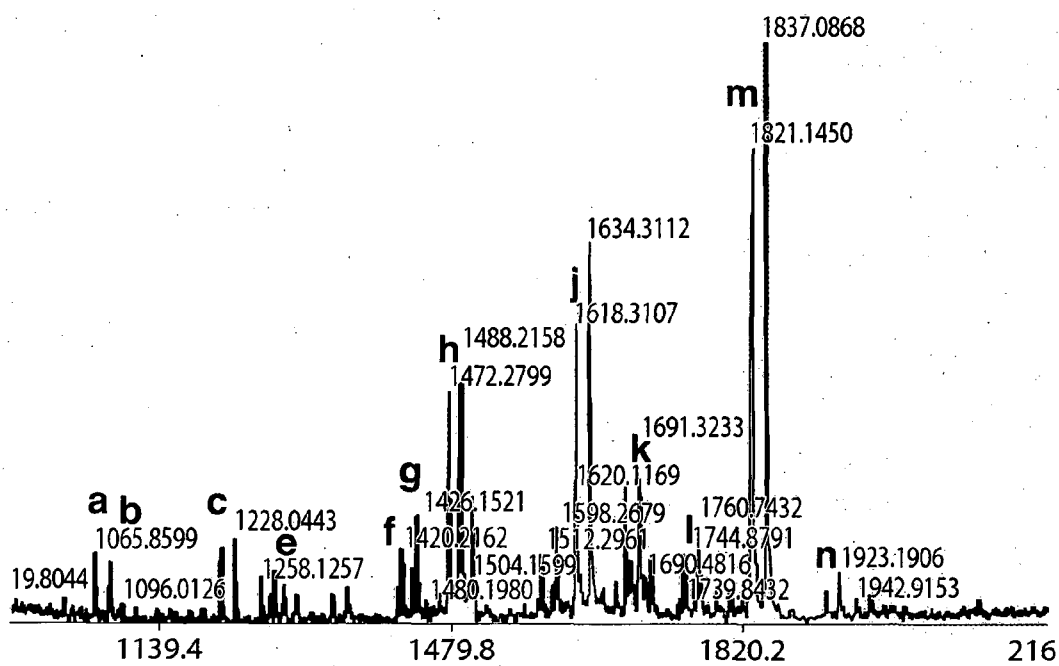


FIG. 1B

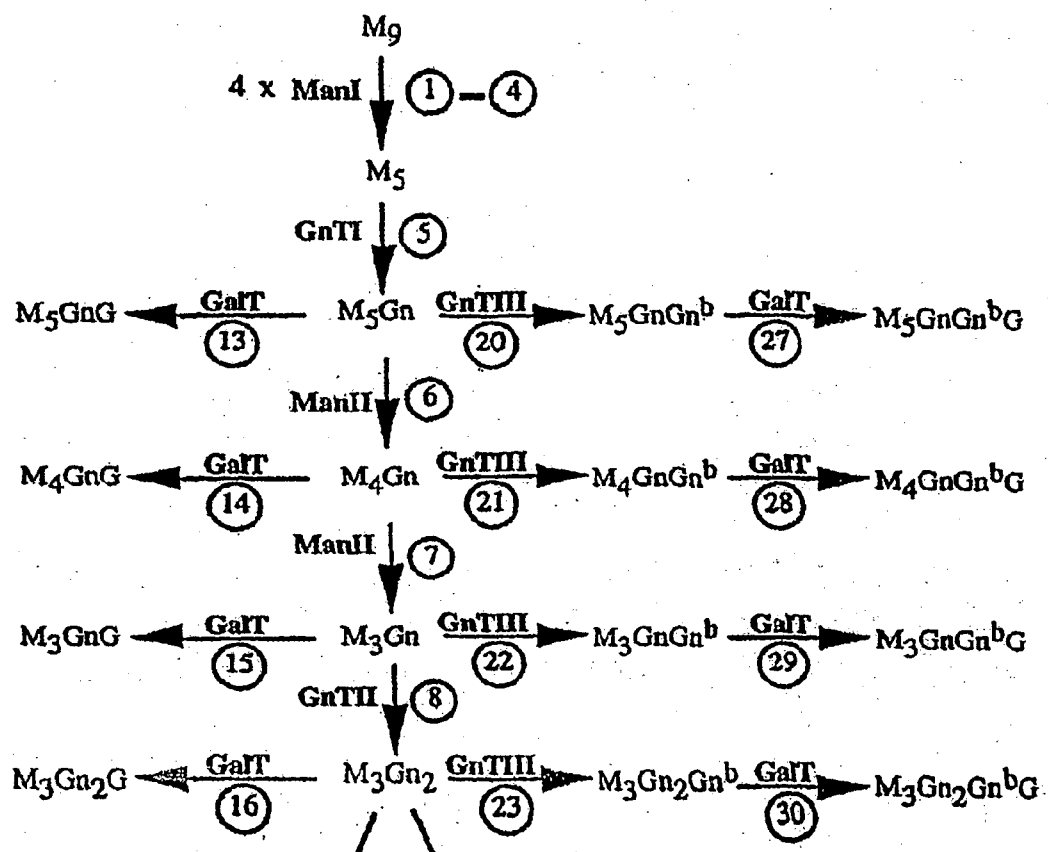
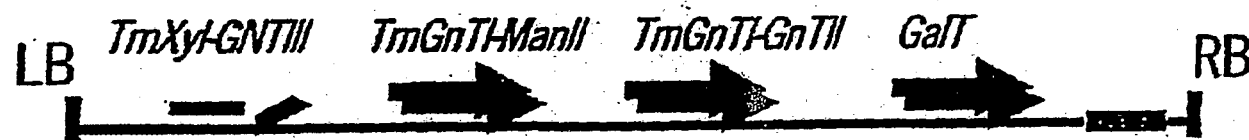
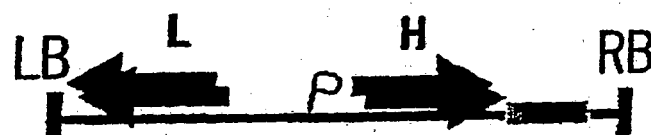


FIG. 2



X



Antibody Construct

FIG. 3

Nucleotide sequence (incl. myc-tag)

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 TGGCCCGGTACAGCCCCAGGCCAGCCCCGAGCCAGGAGGCCCTGACCTGCTG
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 GAGTATTTTCGTGCGCACCAAGGCCGGCGGCGTCTGCTTCAAACCCGGCACCA
 AGATGCTGGAGAGGCCGCCCGGGACGGCCGAGGAGAAGCCTGAGGGGG
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 GCGCACGGGGGGCCGAGGCGCCCGGCGCAAGTGGGTGGAGTGCGTGTGCCT
 GCCCGGCTGGCACGGACCCAGCTGCGGCGTGCCCACTGTGGTGCACTACTCC
 AACCTGCCCACCAAGGAGCGGCTGGTGCCAGGGAGGTGCCGCGCCGCGTCA
 TCAACGCCCATCAACGTCAACCACGAGTTTCGACCTGCTGGACGTGCGCTTCCA
 CGAGCTGGGCGACGTGGTGGACGCCTTTGTGGTGTGCGAGTCCAACCTTCACG
 GCTTATGGGGAGCCGCGGCCGCTCAAGTTCGGGAGATGCTGACCAATGGCA
 CCTTCGAGTACATCCGCCACAAGGTGCTCTATGTCTTCCTGGACCACTTCCCG
 CCCGGCGGCCCGGCAGGACGGCTGGATCGCCGACGACTACCTGCGCACCTTCC
 TCACCCAGGACGGCGTCTCGCGGCTGCGCAACCTGCGGCCCGACGACGTCTT
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 GGAGTACCCGCCTGCAGACCCAGCGAGCACATGTATGCGCCCAAGTACCTG
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 CCAGGAGCACGGCGGGCGGGTGGCGCCACAGGGTCCCCGAGGGAAGGC
 CGCCCGCCCGGGGCAAACTGGACGAGGCGGAAGTCGAACAAAACTCATCT
 CAGAAGAGGATCTGAATTAGGATCC

FIG. 4A

PROTEIN SEQUENCE

MVMRRYKLFL MFCMAGLCLI SFLHFFKTLS YVTFPRELAS LSPNLVSSFF
WNNAPVTPOA SPEPGGPDLL RTPLYSHSPL LOPLPPSKAA EELHRVDLVL
PEDTTEYFVR TKAGGVCFKP GTKMLERPPP GRPEEKPEGA NGSSARRPPR
YLLSARERTG GRGARRKWVE CVCLPGWHGP SCGVPTVVQY SNLPTKERLV
PREVPRRVIN AINVNHEFDL LDVRFHELGD VVDAFVVCES NFTAYGEPRP
LKFREMLTNG TFEYIRHKVL YVELDHFPFG GRODGIWADD YLRTFLTQDG
VSRLRNLRPD DVFIIDDADE IPARDGVLFL KLYDGTWTEPF AFHMRKSLYG
FFWKOPGTLE VVSGCTVDML OAVYGLDGIR LRRROYTMP NFROYENRTG
HILVOWSLGS PLHFAGWHCS WCFTPEGIYF KLVSAONGDF PRWGDYEDKR
DLNYIRGLIR TGGWFDGTQO EYPPADPSEH MYAPKYLLKN YDRFHYLLDN
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FIG. 4B

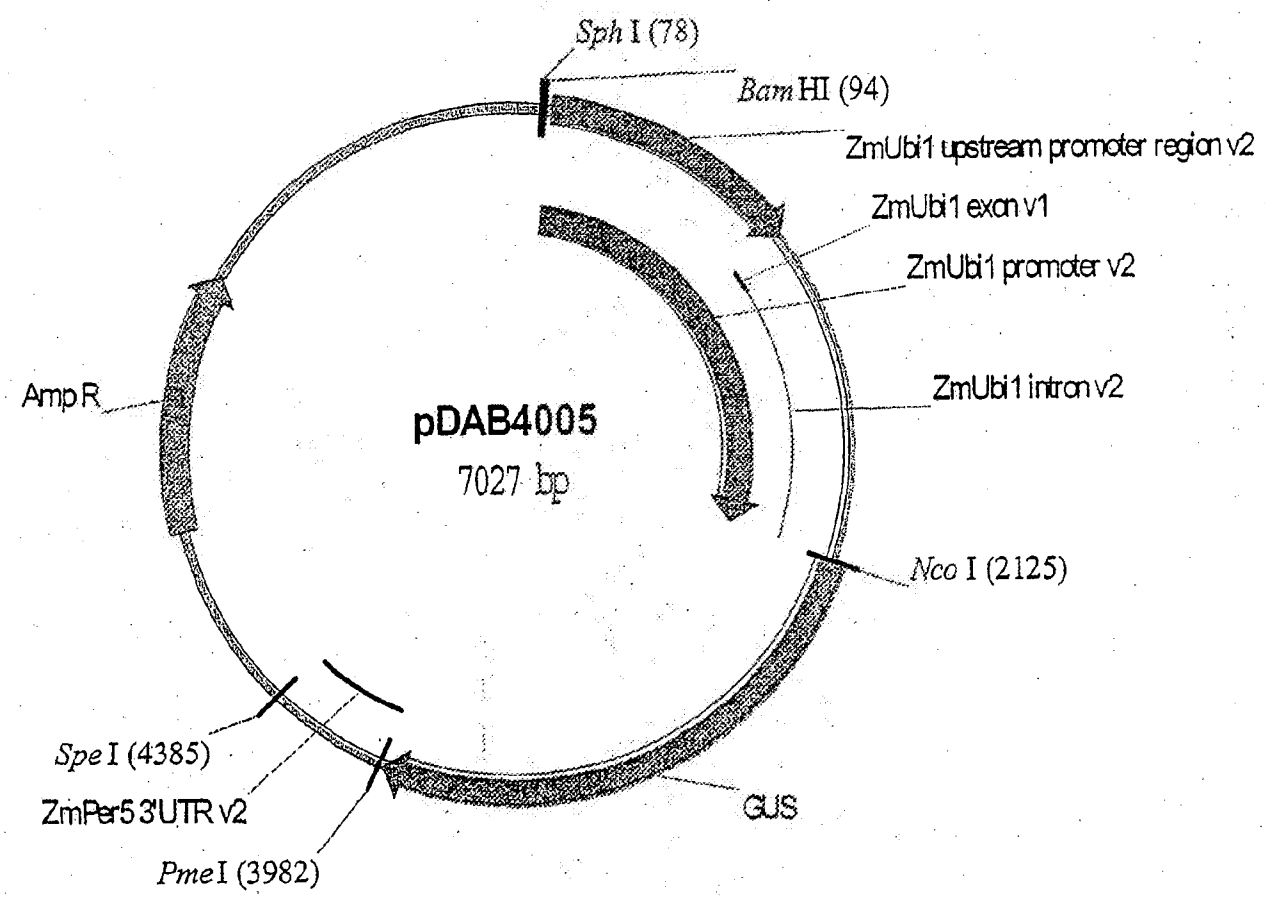


FIG. 5A

Plasmid pDAB4005 (7027 bp)
 Description: ZmUbilpromoter + intron/GUS/Per5 3'UTR

Nucleotide start	Nucleotide end	Sequence Feature
1	115	Linker sequence with multiple cloning site: CATGATTACGCCAAGCTAGCGGCCGCATTCCCGGGAAGCTA GGCCACCGTGGCCCGCCTGCAGGGGAAGCTTGCATGCCTGC AGATCCCGGGGATCCTCTAGAGTCGACCTGCA
116	2105	Maize ubiquitin promoter + intron
1093	2105	Maize ubiquitin intron
2106	2125	Linker sequence: GGGTACCCCGGGGTGCGAC
2126	3967	GUS coding region
3968	3985	Linker sequence: TAATGAGCTCGTTTAAA
3986	4350	Maize peroxidase-5 3' UTR
4351	4405	Linker sequence: CGGCCGGCCTAGCTAGCCACGGTGGCCAGATCCACTAGTTC TAGAGCGGCCGCTT
4406	7027	Puc19
5006	5866	Ampicillin resistance gene

Sequence

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1 CATGATTACG CCAAGCTAGC GGCCGCATTG CCGGGAAGCT AGGCCACCGT
51 GGCCCGCCTG CAGGGGAAGC TTGCATGCCT GCAGATCCCC GGGGATCCTC
101 TAGAGTCGAC CTGCAGTGCA GCGTGACCCG GTCGTGCCCC TCTCTAGAGA
  
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FIG 5B

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151 TAATGAGCAT TGCATGTCTA AGTTATAAAA AATTACCACA TATTTTTTTT
201 GTCACACTTG TTTGAAGTGC AGTTTATCTA TCTTTATACA TATATTTAAA
251 CTTTAATCTA CGAATAATAT AATCTATAGT ACTACAATAA TATCAGTGTT
301 TTAGAGAATC ATATAAATGA ACAGTTAGAC ATGGTCTAAA GGACAATTGA
351 GTATTTTGAC AACAGGACTC TACAGTTTTA TCTTTT TAGT GTGCATGIGT
401 TCTCCTTTTT TTTTGCAAAT AGCTTCACCT ATATAATACT TCATCCATTT
451 TATTAGTACA TCCATTTAGG GTTTAGGGTT AATGGTTTTT ATAGACTAAT
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651 AACTAAGGAA ACATTTTTCT TGTTCGAGT AGATAATGCC AGCCTGTTAA
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751 GTCGGGCCAA GCGAAGCAGA CCGCACGGCA TCTCTGTCGC TGCCTCTGGA
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901 CTCCTCCTCC TCTCACGGCA CGGCAGCTAC GGGGGATTCC TTTCCACCCG
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1101 CTCGTCCTCC CCCCCCCCC CTCTCTACCT TCTCTAGATC GGCCTTCGG
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1201 AGATCCGTGT TTGTGTTAGA TCCGTGCTGC TAGCGTTCGT ACACGGATGC
1251 GACCTGTACG TCAGACACGT TCTGATTGCT AACTTGCCAG TGTTTCTCTT
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1651 CATATACAGA GATGCTTTTT GTTCGCTTGG TTGTGATGAT GTGGTGTGGT

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FIG 5B CONT.

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 1801 CATACTTACG AGTTTAAGAT GGATGGAAAT ATCGATCTAG GATAGGTATA
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 1901 TCTATTCATA TGCTCTAACC TTGAGTACCT ATCTATTATA ATAAACAAGT
 1951 ATGTTTTATA ATTATTTTGA TCTTGATATA CTTGGATGAT GGCATATGCA
 2001 GCAGCTATAT GTGGATTTTT TTAGCCCTGC CTTCATACGC TATTTATTTG
 2051 CTTGGTACTG TTTCTTTTGT CGATGCTCAC CCTGTTGTTT GGTGTTACTT
 2101 CTGCAGGGTA CCCCCGGGT CGACCATGGT AAGGGGCAGC CACCACCACC
 2151 ACCACCACAT GGTCCGTCCT GTAGAAACCC CAACCCGTGA AATCAAAAAA
 2201 CTCGACGGCC TGTGGGCATT CAGTCTGGAT CGCGAAACT GTGGAATTGA
 2251 TCAGCGTTGG TGGGAAAGCG CGTTACAAGA AAGCCGGGCA ATTGCTGTGC
 2301 CAGGCAGTTT TAACGATCAG TTCGCCGATG CAGATATTCG TAATTATGCG
 2351 GGCAACGTCT GGTATCAGCG CGAAGTCTTT ATACCGAAAG GTTGGGCAGG
 2401 CCAGCGTATC GTGCTGCGTT TCGATGCGGT CACTCATTAC GGCAAAAGTG
 2451 GGGTCAATAA TCAGGAAGTG ATGGAGCATC AGGGCGGCTA TACGCCATTT
 2501 GAAGCCGATG TCACGCCGTA TGTATTGCGG GGGAAAAGTG TACGTATCAC
 2551 CGTTTGTGTG AACAAACGAAC TGAAGTGGCA GACTATCCCG CCGGGAATGG
 2601 TGATTACCGA CGAAAACGGC AAGAAAAAGC AGTCTTACTT CCATGATTTT
 2651 TTTAACTATG CCGGAATCCA TCGCAGCGTA ATGCTCTACA CCACGCCGAA
 2701 CACCTGGGTG GACGATATCA CCGTGGTGAC GCATGTGCGG CAAGACTGTA
 2751 ACCACGCGTC TGTGACTGG CAGGTGGTGG CCAATGGTGA TGTCAGCGTT
 2801 GAACTGCGTG ATGCGGATCA ACAGGTGGTT GCAACTGGAC AAGGCACTAG
 2851 CGGGACTTTG CAAGTGGTGA ATCCGCACCT CTGGCAACCG GTTGAAGGTT
 2901 ATCTCTATGA ACTGTGCGTC ACAGCCAAAA GCCAGACAGA GTGTGATATC
 2951 TACCCGCTTC GCGTCGGCAT CCGGTCAGTG GCAGTGAAGG GCGAACAGTT
 3001 CTTGATTAAC CACAAACCGT TCTACTTTAC TGGCTTTGGT CGTCATGAAG
 3051 ATGCGGACTT ACGTGGCAAA GGATTGATA ACGTGTCTGAT GGTGCACGAC
 3101 CACGCATTAA TGGACTGGAT TGGGGCCAAC TCCTACCGTA CCTCGCATT
 3151 CCCTTACGCT GAAGAGATGC TCGACTGGGC AGATGAACAT GGCATCGTGG
 3201 TGATTGATGA AACTGCTGCT GTCGGCTTTA ACCTCTCTTT AGGCATTGGT

FIG 5B CONT.

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3251 TTCGAAGCGG GCAACAAGCC GAAAGAAGCTG TACAGCGAAG AGGCAGTCAA
3301 CGGGGAAACT CAGCAAGCGC ACTTACAGGC GATTAAAGAG CTGATAGCGC
3351 GTGACAAAAA CCACCCAAGC GTGGTGATGT GGAGTATTGC CAACGAACCG
3401 GATACCCGTC CGCAAGTGCA CGGGAATATT TCGCCACTGG CGGAAGCAAC
3451 GCGTAAACTC GACCCGACGC GTCCGATCAC CTGCGTCAAT GTAATGTTCT
3501 GCGACGCTCA CACCGATACC ATCAGCGATC TCTTTGATGT GCTGTGCCTG
3551 AACCGTTATT ACGGATGGTA TGTCCAAAGC GGCGATTTGG AAACGGCAGA
3601 GAAGGTACTG GAAAAAGAAC TTCTGGCCTG GCAGGAGAAA CTGCATCAGC
3651 CGATTATCAT CACCGAATAC GGCGTGGATA CGTTAGCCGG GCTGCACTCA
3701 ATGTACACCG ACATGTGGAG TGAAGAGTAT CAGTGTGCAT GGCTGGATAT
3751 GTATACCCGC GTCTTTGATC GCGTCAGCGC CGTCGTCGGT GAACAGGTAT
3801 GGAATTTTCGC CGATTTTTCG ACCTCGCAAG GCATATTGCG CGTTGGCGGT
3851 AACAGAAAG GGATCTTCAC TCGCGACCGC AAACCGAAGT CGGCGGCTTT
3901 TCTGCTGCAA AAACGCTGGA CTGGCATGAA CTTGCGTGAA AAACCGCAGC
3951 AGGGAGGCAA ACAATGATAA TGAGCTCGTT TAAACTGAGG GCACTGAAGT
4001 CGCTTGATGT GCTGAATTGT TTGTGATGTT GGTGGCGTAT TTTGTTTAAA
4051 TAAGTAAGCA TGGCTGTGAT TTTATCATAT GATCGATCTT TGGGGTTTTA
4101 TTTAACACAT TGTAAAATGT GTATCTATTA ATAACTCAAT GTATAAGATG
4151 TGTTCAATCT TCGGTTGCCA TAGATCTGCT TATTTGACCT GTGATGTTTT
4201 GACTCCAAAA ACCAAAATCA CAACTCAATA AACTCATGGA ATATGTCCAC
4251 CTGTTTCTTG AAGAGTTCAT CTACCATTCC AGTTGGCATT TATCAGTGTT
4301 GCAGCGGCGC TGTGCTTTGT AACATAACAA TTGTTACGGC ATATATCCAA
4351 CGGCCGGCCT AGCTAGCCAC GGTGGCCAGA TCCACTAGTT CTAGAGCGGC
4401 CGCTTAATTC ACTGGCCGTC GTTTTACAAC GTCGTGACTG GGAAAACCCCT
4451 GGCGTTACCC AACTTAATCG CCTTGCAGCA CATCCCCCTT TCGCCAGCTG
4501 GCGTAATAGC GAAGAGGCCC GCACCGATCG CCCTTCCCAA CAGTTGCGCA
4551 GCCTGAATGG CGAATGGCGC CTGATGCGGT ATTTTCTCCT TACGCATCTG
4601 TGCGGTATTT CACACCGCAT ATGGTGCACT CTCAGTACAA TCTGCTCTGA
4651 TGCCGCATAG TTAAGCCAGC CCCGACACCC GCCAACACCC GCTGACGCGC
4701 CCTGACGGGC TTGTCTGCTC CCGGCATCCG CTTACAGACA AGCTGTGACC
4751 GTCTCCGGGA GCTGCATGTG TCAGAGGTTT TCACCGTCAT CACCGAAACG

```

FIG 5B CONT.

4801 CGCGAGACGA AAGGGCCTCG TGATACGCCT ATTTTTATAG GTTAATGTCA
 4851 TGATAATAAT GGTTTCTTAG ACGTCAGGTG GCACTTTTCG GGGAAATGTG
 4901 CGCGGAACCC CTATTTGTTT ATTTTCTAA ATACATTCAA ATATGTATCC
 4951 GCTCATGAGA CAATAACCCCT GATAAATGCT TCAATAATAT TGAAAAAGGA
 5001 AGAGTATGAG TATTCAACAT TTCCGTGTCG CCCTTATTCC CTTTTTGGCG
 5051 GCATTTTGCC TTCCTGTTTT TGCTCACCCA GAAACGCTGG TGAAAGTAAA
 5101 AGATGCTGAA GATCAGTTGG GTGCACGAGT GGGTTACATC GAACTGGATC
 5151 TCAACAGCGG TAAGATCCTT GAGAGTTTTT GCCCCGAAGA ACGTTTTCCA
 5201 ATGATGAGCA CTTTTAAAGT TCTGCTATGT GGCGCGGTAT TATCCCGTAT
 5251 TGACGCCGGG CAAGAGCAAC TCGGTCGCCG CATACTAT TCTCAGAATG
 5301 ACTTGTTGA GTACTCACCA GTCACAGAAA AGCATCTTAC GGATGGCATG
 5351 ACAGTAAGAG AATTATGCAG TGCTGCCATA ACCATGAGTG ATAACACTGC
 5401 GGCCAACTTA CTTCTGACAA CGATCGGAGG ACCGAAGGAG CTAACCGCTT
 5451 TTTTGCACAA CATGGGGGAT CATGTAACCT GCCTTGATCG TTGGGAACCG
 5501 GAGCTGAATG AAGCCATACC AAACGACGAG CGTGACACCA CGATGCCGTG
 5551 AGCAATGGCA ACAACGTTGC GCAAACTATT AACTGGCGAA CTACTTACTC
 5601 TAGCTTCCCG GCAACAATTA ATAGACTGGA TGGAGGCGGA TAAAGTTGCA
 5651 GGACCACTTC TGCGCTCGGC CCTTCCGGCT GGCTGGTTTA TTGCTGATAA
 5701 ATCTGGAGCC GGTGAGCGTG GGTCTCGCGG TATCATTGCA GCACTGGGGC
 5751 CAGATGGTAA GCCCTCCCGT ATCGTAGTTA TCTACACGAC GGGGAGTCAG
 5801 GCAACTATGG ATGAACGAAA TAGACAGATC GCTGAGATAG GTGCCTCACT
 5851 GATTAAGCAT TGGTAACTGT CAGACCAAGT TTAATCATAT ATACTTTAGA
 5901 TTGATTTAAA ACTTCATTTT TAATTTAAAA GGATCTAGGT GAAGATCCTT
 5951 TTTGATAATC TCATGACCAA AATCCCTTAA CGTGAGTTTT CGTTCCACTG
 6001 AGCGTCAGAC CCCGTAGAAA AGATCAAAGG ATCTTCTTGA GATCCTTTTT
 6051 TTCTGCGCGT AATCTGCTGC TTGCAAACAA AAAAACCACC GCTACCAGCG
 6101 GTGGTTTGTG TGCCGGATCA AGAGCTACCA ACTCTTTTTT CGAAGGTAAC
 6151 TGGCTTCAGC AGAGCGCAGA TACCAAATAC TGTCTTCTA GTGTAGCCGT
 6201 AGTTAGGCCA CCACTTCAAG AACTCTGTAG CACCGCCTAC ATACCTCGCT
 6251 CTGCTAATCC TGTACCAGT GGCTGCTGCC AGTGGCGATA AGTCGTGTCT
 6301 TACCGGGTTG GACTCAAGAC GATAGTTACC GGATAAGGCG CAGCGGTCCG

FIG 5B CONT.

6351 GCTGAACGGG GGGTTCGTGC ACACAGCCCA GCTTGGAGCG AACGACCTAC
 6401 ACCGAACTGA GATACCTACA GCGTGAGCAT TGAGAAAGCG CCACGCTTCC
 6451 CGAAGGGAGA AAGGCGGACA GGTATCCGGT AAGCGGCAGG GTCGGAACAG
 6501 GAGAGCGCAC GAGGGAGCTT CCAGGGGGAA ACGCCTGGTA TCTTTATAGT
 6551 CCTGTGCGGT TTCGCCACCT CTGACTTGAG CGTCGATTTT TGTGATGCTC
 6601 GTCAGGGGGG CGGAGCCTAT GGAAAAACGC CAGCAACGCG GCCTTTTTTAC
 6651 GGTTCCCTGGC CTTTTCCTGG CCTTTTGCTC ACATGTTCTT TCCTGCGTTA
 6701 TCCCCTGATT CTGTGGATAA CCGTATTACC GCCTTTGAGT GAGCTGATAC
 6751 CGCTCGCCGC AGCCGAACGA CCGAGCGCAG CGAGTCAGTG AGCGAGGAAG
 6801 CGGAAGAGCG CCCAATACGC AAACCGCCTC TCCC CGCGCG TTGGCCGATT
 6851 CATTAAATGCA GCTGGCACGA CAGGTTTCCC GACTGGAAAG CGGGCAGTGA
 6901 GCGCAACGCA ATTAATGTGA GTTAGCTCAC TCATTAGGCA CCCCAGGCTT
 6951 TACACTTTAT GCTTCCGGCT CGTATGTTGT GTGGAATTGT GAGCGGATAA
 7001 CAATTCACA CAGGAAACAG CTATGAC

FIG 5B CONT.

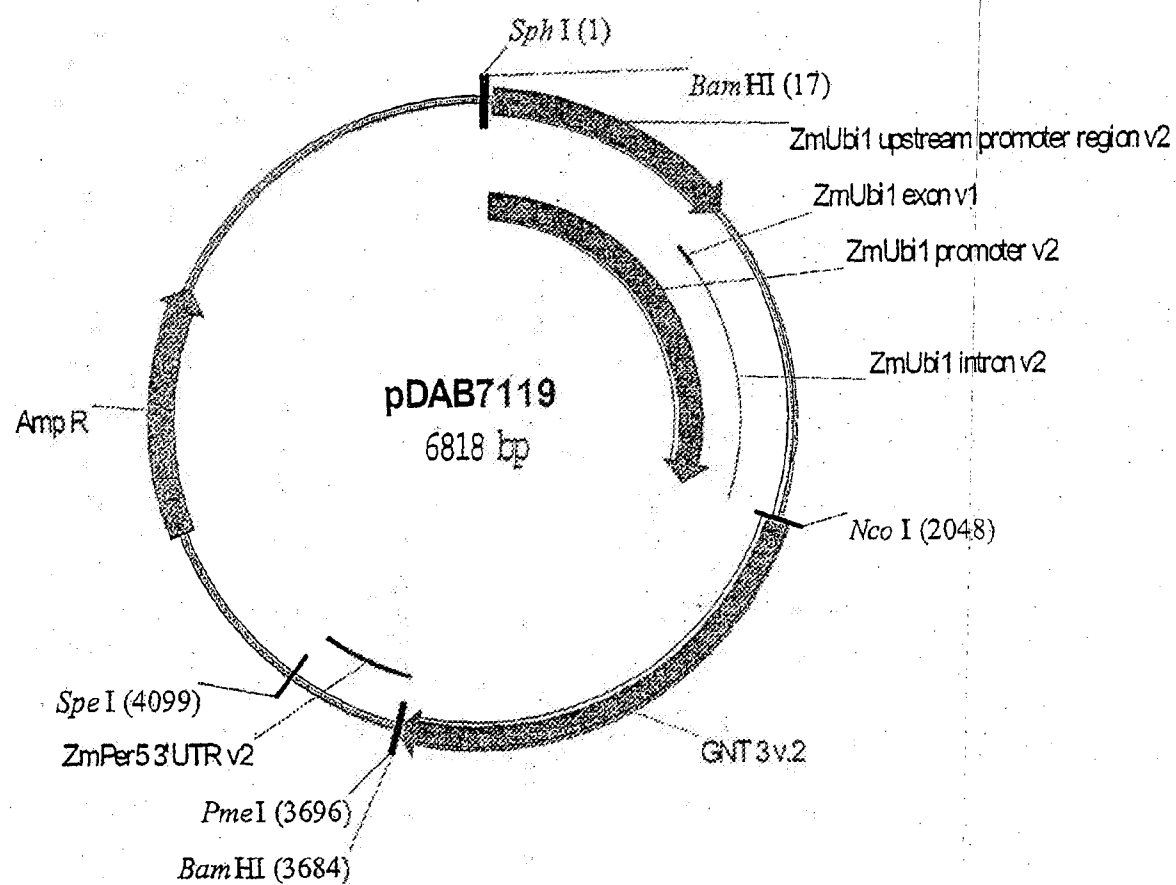


FIG. 6A

pDAB7119 6818bp

Sequence	Feature
1-38 Linker	CCTGCAGATCCCCGGGGATCCTCTAGAGTCGACCTGCA
39-2028	Maize Ubiquitin 1 promoter
2029-2047 Linker	GGGTACCCCCGGGGTCGAC
2048-3695	GNT III v.2 plus TAGGTTT
2462	C to replace G as reported in original sequence
3696-3699 PmeI	AAAC
3700-4064	Maize Per 5' 3'UTR
4065-6818	pUC19 backbone
4259-4264	TGCGCA FspI
4720-5580	Ampicillin Resistance gene
5282-5287	TGCGCA FspI

BamHI

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1  CCTGCAGATC CCCGGGGATC CTCTAGAGTC GACCTGCAGT
   GCAGCGTGAC CCGGTCGTGC CCCTCTCTAG AGATAATGAG
   CATTGCATGT CTAAGTTATA
101 AAAAAATTACC ACATATTTT TTTGTCACAC TTGTTTGAAG
   TGCAGTTTAT CTATCTTAT ACATATATTT AAACTTTAAT
   CTACGAATAA TATAATCTAT
201 AGTACTACAA TAATATCAGT GTTTTAGAGA ATCATATAAA
   TGAACAGTTA GACATGGTCT AAAGGACAAT TGAGTATTTT
   GACAACAGGA CTCTACAGTT
301 TTATCTTTTT AGTGTGCATG TGTTCTCCTT TTTTTTTGCA
   AATAGCTTCA CCTATATAAT ACTTCATCCA TTTTATTAGT
   ACATCCATTT AGGGTTTAGG
401 GTTAATGGTT TTTATAGACT AATTTTTTTA GTACATCTAT
   TTTATTCTAT TTTAGCCTCT AAATTAAGAA AACTAAACT
   CTATTTTAGT TTTTTTATTT
501 AATAATTTAG ATATAAAATA GAATAAAATA AAGTGACTAA
   AAATTAAGCA AATACCCTTT AAGAAATTAA AAAAATAAG
   GAAACATTTT TCTTGTTTCG
601 AGTAGATAAT GCCAGCCTGT TAAACGCCGT CGACGAGTCT
   AACGGACACC AACCAGCGAA CCAGCAGCGT CGCGTCGGGC
   CAAGCGAAGC AGACGGCAGC
701 GCATCTCTGT CGCTGCCTCT GGACCCCTCT CGAGAGTTCC
   GCTCCACCGT TGGACTTGCT CCGCTGTCGG CATCCAGAAA
   TTGCGTGGCG GAGCGGCAGA
801 CGTGAGCCGG CACGGCAGGC GGCCTCCTCC TCCTCTCAGC
   GCACGGCAGC TACGGGGGAT TCCTTTCCCA CCGCTCCTTC
   GCTTTCCCTT CCTCGCCCGC

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FIG 6B

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901  CGTAATAAAT AGACACCCCC TCCACACCCT CTTTCCCCAA
      CCTCGTGTTG TTCGGAGCGC ACACACACAC AACCAGATCT
      CCCCCAAATC CACCCGTCGG
1001  CACCTCCGCT TCAAGGTACG CCGCTCGTCC TCCCCCCCCC
      CCCCTCTCTA CCTTCTCTAG ATCGGCGTTC CGGTCCATGC
      ATGGTTAGGG CCCGGTAGTT
1101  CTACTTCTGT TCATGTTTGT GTTAGATCCG TGTTTGTGTT
      AGATCCGTGC TGCTAGCGTT CGTACACGGA TGCGACCTGT
      ACGTCAGACA CGTTCTGATT
1201  GCTAACTTGC CAGTGTTTCT CTTGGGGGAA TCCTGGGATG
      GCTCTAGCCG TTCCGCAGAC GGGATCGATT TCATGATTTT
      TTTTGTTCG TTGCATAGGG
1301  TTTGGTTTGC CCTTTTCCTT TATTTCAATA TATGCCGTGC
      ACTTGTTTGT CGGGTCATCT TTTCATGCTT TTTTTTGTCT
      TGGTTGTGAT GATGTGGTCT
1401  GGTTGGGCGG TCGTTCTAGA TCGGAGTAGA ATTCTGTTTC
      AACTACCTG GTGGATTAT TAATTTTGA TCTGTATGTG
      TGTGCCATAC ATATTCATAG
1501  TTACGAATTG AAGATGATGG ATGGAAATAT CGATCTAGGA
      TAGGTATACA TGTTGATGCG GGTTTTACTG ATGCATATAC
      AGAGATGCTT TTTGTTGCT
1601  TGGTTGTGAT GATGTGGTGT GGTGGGCGG TCGTTCAATC
      GTTCTAGATC GGAGTAGAAT ACTGTTTCAA ACTACCTGGT
      GTATTTATTA ATTTTGAAC
1701  TGTATGTGTG TGTCATACAT CTTCATAGTT ACGAGTTTAA
      GATGGATGGA AATATCGATC TAGGATAGGT ATACATGTTG
      ATGTGGGTTT TACTGATGCA
1801  TATACATGAT GGCATATGCA GCATCTATTC ATATGCTCTA
      ACCTTGAGTA CCTATCTATT ATAATAAACA AGTATGTTTT
      ATAATTATTT TGATCTTGAT
1901  ATACTTGGAT GATGGCATAT GCAGCAGCTA TATGTGGATT
      TTTTGTAGCCC TGCCTTCATA CGCTATTTAT TTGCTTGGA
      CTGTTTCTTT TGTGATGCT

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NcoI

FseI

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2001  CACCCTGTTG TTTGGTGTTA CTTCTGCAGG GTACCCCCGG
      GGTGACCAT GGTGATGAGA CGCTACAAGC TCTTTCTCAT
      GTTCTGTATG GCCGGCCTGT
2101  GCCTCATCTC CTTCCCTGCAC TTCTTCAAGA CCCTGTCCTA
      TGTCACCTTC CCCCAGAGAAC TGGCCTCCCT CAGCCCTAAC
      CTGGTGTCCA GCTTTTCTG
2201  GAACAATGCC CCGGTCACGC CCCAGGCCAG CCCCAGCCA
      GGAGGCCCTG ACCTGCTGCG TACCCCACTC TACTCCCACT
      CGCCCCTGCT GCAGCCGCTG

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FIG 6B CONT.

SacI

FspI

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2301 CCGCCCAGCA AGGCGGCCGA GGAGCTCCAC CGGGTGGACT
 TGGTGCTGCC CGAGGACACC ACCGAGTATT TCGTGCGCAC
 CAAGGCCGGC GGCGTCTGCT

2401 TCAAACCCGG CACCAAGATG CTGGAGAGGC CCCCCCGGG
 ACGGCCGGAG GAGAAGCCTG AGGGGGCCAA CGGCTCCTCG
 GCGCGGCGGC CACCCCGGTA

2501 CCTCCTGAGC GCGCGGGAGC GCACGGGGGG CCGAGGCGCC
 CGGCGCAAGT GGGTGGAGTG CGTGTGCCTG CCCGGCTGGC
 ACGGACCCAG CTGCGGCGTG

2601 CCCACTGTGG TGCAGTACTC CAACCTGCCC ACCAAGGAGC
 GGCTGGTGCC CAGGGAGGTG CCGCGCCGCG TCATCAACGC
 CATCAACGTC AACCACGAGT

NotI

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2701 TCGACCTGCT GGACGTGCGC TTCCACGAGC TGGGCGACGT  
 GGTGGACGCC TTTGTGGTGT GCGAGTCCAA CTTCACGGCT  
 TATGGGGAGC CGCGGCCGCT

2801 CAAGTTCCGG GAGATGCTGA CCAATGGCAC CTTCGAGTAC  
 ATCCGCCACA AGGTGCTCTA TGTCTTCCTG GACCACTTCC  
 CGCCCGGCGG CCGGCAGGAC

FspI

FspI

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2901 GGCTGGATCG CCGACGACTA CCTGCGCACC TTCCTCACCC
 AGGACGGCGT CTCGCGGCTG CGCAACCTGC GGCCCGACGA
 CGTCTTCATC ATTGACGATG

FspI

FspI

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3001 CGGACGAGAT CCCGGCCCCGT GACGGCGTCC TTTTCCTCAA  
 GCTCTACGAT GGCTGGACCG AGCCCTTCGC CTTCACATG  
 CGCAAGTCGC TCTACGGCTT

3101 CTTCTGGAAG CAGCCGGGCA CCCTGGAGGT GGTGTCAGGC  
 TGCACGGTGG ACATGCTGCA GGCAGTGTAT GGGCTGGACG  
 GCATCCGCCT GCGCCGCCGC

3201 CAGTACTACA CCATGCCCAA CTTCAGACAG TATGAGAACC  
 GCACCGGCCA CATCCTGGTG CAGTGGTCGC TGGGCAGCCC  
 CCTGCACTTC GCCGGCTGGC

FIG 6B CONT.

3301 ACTGCTCCTG GTGCTTCACG CCCGAGGGCA TCTACTTCAA  
 GCTCGTGTCC GCCCAGAATG GCGACTTCCC ACGCTGGGGT  
 GACTACGAGG ACAAGCGGGA  
 3401 CCTGAACTAC ATCCGCGGCC TGATCCGCAC CGGGGGCTGG  
 TTCGACGGCA CGCAGCAGGA GTACCCGCCT GCAGACCCCA  
 GCGAGCACAT GTATGCGCCC  
 3501 AAGTACCTGC TGAAGAACTA CGACCGGTTT CACTACCTGC  
 TGGACAACCC CTACCAGGAG CCCAGGAGCA CGGCGGCGGG  
 CGGGTGGCGC CACAGGGGTC

BamHI

PmeI

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3601 CCGAGGGAAG GCCGCCCCGCC CGGGGCAAAC TGGACGAGGC  
 GGAAGTCGAA CAAAAACTCA TCTCAGAAGA GGATCTGAAT  
 TAGGATCCTA GGTTTAAACT  
 3701 GAGGGCACTG AAGTCGCTTG ATGTGCTGAA TTGTTTGTGA  
 TGTTGGTGGC GTATTTTGTT TAAATAAGTA AGCATGGCTG  
 TGATTTTATC ATATGATCGA  
 3801 TCTTTGGGGT TTTATTTAAC ACATTGTAAA ATGTGTATCT  
 ATTAATAACT CAATGTATAA GATGTGTTCA TTCTTCGGTT  
 GCCATAGATC TGCTTATTTG  
 3901 ACCTGTGATG TTTTGAATCC AAAAACCAAA ATCACAACCTC  
 AATAAACTCA TGGAATATGT CCACCTGTTT CTGAAGAGT  
 TCATCTACCA TTCCAGTTGG

FseI

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4001 CATTTATCAG TGTTGCAGCG GCGCTGTGCT TTGTAACATA
 ACAATTGTTC ACGGCATATA TCCACGGCCG GCCTAGCTAG
 CCACGGTGGC CAGATCCACT

NotI

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4101 AGTTCTAGAG CGGCCGCTTA ATTCACTGGC CGTCGTTTTA  
 CAACGTCGTG ACTGGGAAAA CCCTGGCGTT ACCCAACTTA  
 ATCGCCTTGC AGCACATCCC

FspI

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4201 CCTTTGCGCA GCTGGCGTAA TAGCGAAGAG GCCCGCACCG
 ATCGCCCTTC CCAACAGTTG CGCAGCCTGA ATGGCGAATG
 GCGCCTGATG CGGTATTTTC
 4301 TCCTTACGCA TCTGTGCGGT ATTTACACACC GCATATGGTG
 CACTCTCAGT ACAATCTGCT CTGATGCCGC ATAGTTAAGC
 CAGCCCCGAC ACCCGCCAAC

FIG 6B CONT.

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4401 ACCCGCTGAC GCGCCCTGAC GGGCTTGTCT GCTCCCGGCA
    TCCGCTTACA GACAAGCTGT GACCGTCTCC GGGAGCTGCA
    TGTGTCAGAG GTTTTCACCG
4501 TCATCACCGA AACGCGCGAG ACGAAAGGGC CTCGTGATAC
    GCCTATTTTT ATAGGTTAAT GTCATGATAA TAATGGTTTC
    TTAGACGTCA GGTGGCACTT
4601 TTCGGGGAAA TGTGCGCGGA ACCCCTATTT GTTTATTTTT
    CTAAATACAT TCAAATATGT ATCCGCTCAT GAGACAATAA
    CCCTGATAAA TGCTTCAATA
4701 ATATTGAAAA AGGAAGAGTA TGAGTATTCA ACATTTCCGT
    GTCGCCCTTA TTCCCTTTTT TGCGGCATTT TGCTTCCCTG
    TTTTTGCTCA CCCAGAAACG
4801 CTGGTGAAAG TAAAAGATGC TGAAGATCAG TTGGGTGCAC
    GAGTGGGTTA CATCGAACTG GATCTCAACA GCGGTAAGAT
    CCTTGAGAGT TTTCGCCCCG
4901 AAGAACGTTT TCCAATGATG AGCACTTTTA AAGTTCTGCT
    ATGTGGCGCG GTATTATCCC GTATTGACGC CGGGCAAGAG
    CAACTCGGTC GCCGCATACA
5001 CTATTCTCAG AATGACTTGG TTGAGTACTC ACCAGTCACA
    GAAAAGCATC TTACGGATGG CATGACAGTA AGAGAATTAT
    GCAGTGCTGC CATAACCATG
5101 AGTGATAACA CTGCGGCCAA CTTACTTCTG ACAACGATCG
    GAGGACCGAA GGAGCTAACC GCTTTTTTGC ACAACATGGG
    GGATCATGTA ACTCGCCTTG

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FspI

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5201 ATCGTTGGGA ACCGGAGCTG AATGAAGCCA TACCAAACGA
    CGAGCGTGAC ACCACGATGC CTGTAGCAAT GGCAACAACG
    TTGCGCAAAC TATTAAGTGG
5301 CGAACTACTT ACTCTAGCTT CCCGGCAACA ATTAATAGAC
    TGGATGGAGG CGGATAAAGT TGCAGGACCA CTTCTGCGCT
    CGGCCCTTCC GGCTGGCTGG
5401 TTTATTGCTG ATAAATCTGG AGCCGGTGAG CGTGGGTCTC
    GCGGTATCAT TGCAGCACTG GGGCCAGATG GTAAGCCCTC
    CCGTATCGTA GTTATCTACA
5501 CGACGGGGAG TCAGGCAACT ATGGATGAAC GAAATAGACA
    GATCGCTGAG ATAGGTGCCT CACTGATTAA GCATTGGTAA
    CTGTCAGACC AAGTTTACTC
5601 ATATATACTT TAGATTGATT TAAAACTTCA TTTTAAATTT
    AAAAGGATCT AGGTGAAGAT CCTTTTGTAT AATCTCATGA
    CAAAATCCC TTAACGTGAG
5701 TTTTCGTTCC ACTGAGCGTC AGACCCCGTA GAAAAGATCA
    AAGGATCTTC TTGAGATCCT TTTTCTCTGC GCGTAATCTG
    CTGCTTGCAA ACAAAAAAAC

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FIG 6B CONT.

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5801  CACCGCTACC AGCGGTGGTT TGTTTGCCGG ATCAAGAGCT
      ACCAACTCTT TTTCCGAAGG TAACTGGCTT CAGCAGAGCG
      CAGATACCAA ATACTGTCCT
5901  TCTAGTGTAG CCGTAGTTAG GCCACCACTT CAAGAACTCT
      GTAGCACCGC CTACATACCT CGCTCTGCTA ATCCTGTTAC
      CAGTGGCTGC TGCCAGTGGC
6001  GATAAGTCGT GTCTTACCGG GTTGGACTCA AGACGATAGT
      TACCGGATAA GGC GCAGCGG TCGGGCTGAA CGGGGGGTTT
      GTGCACACAG CCCAGCTTGG
6101  AGCGAACGAC CTACACCGAA CTGAGATACC TACAGCGTGA
      GCATTGAGAA AGCGCCACGC TTCCCGAAGG GAGAAAGGCG
      GACAGGTATC CGGTAAGCGG
6201  CAGGGTCGGA ACAGGAGAGC GCACGAGGGA GCTTCCAGGG
      GGAAACGCCT GGTATCTTTA TAGTCCTGTC GGGTTTCGCC
      ACCTCTGACT TGAGCGTCGA
6301  TTTTGTGAT GCTCGTCAGG GGGGCGGAGC CTATGGAAAA
      ACGCCAGCAA CGCGGCCTTT TTACGGTTCC TGGCCTTTTG
      CTGGCCTTTT GCTCACATGT
6401  TCTTTCCTGC GTTATCCCTT GATTCTGTGG ATAACCGTAT
      TACCGCCTTT GAGTGAGCTG ATACCGCTCG CCGCAGCCGA
      ACGACCGAGC GCAGCGAGTC
6501  AGTGAGCGAG GAAGCGGAAG AGCGCCCAAT ACGCAAACCG
      CCTCTCCCCG CGCGTTGGCC GATTCATTAA TGCAGCTGGC
      ACGACAGGTT TCCCGACTGG
6601  AAAGCGGGCA GTGAGCGCAA CGCAATTAAT GTGAGTTAGC
      TCACTCATTA GGCACCCAG GCTTTACACT TTATGCTTCC
      GGCTCGTATG TTGTGTGGAA

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NotI

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6701  TTGTGAGCGG ATAACAATTT CACACAGGAA ACAGCTATGA
      CCATGATTAC GCCAAGCTAG CGGCCGCATT CCCGGGAAGC
      TAGGCCACCG TGGCCCGCCT

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HindIII

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6801  GCAGGGGAAG CTTGCATG

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FIG 6B CONT.

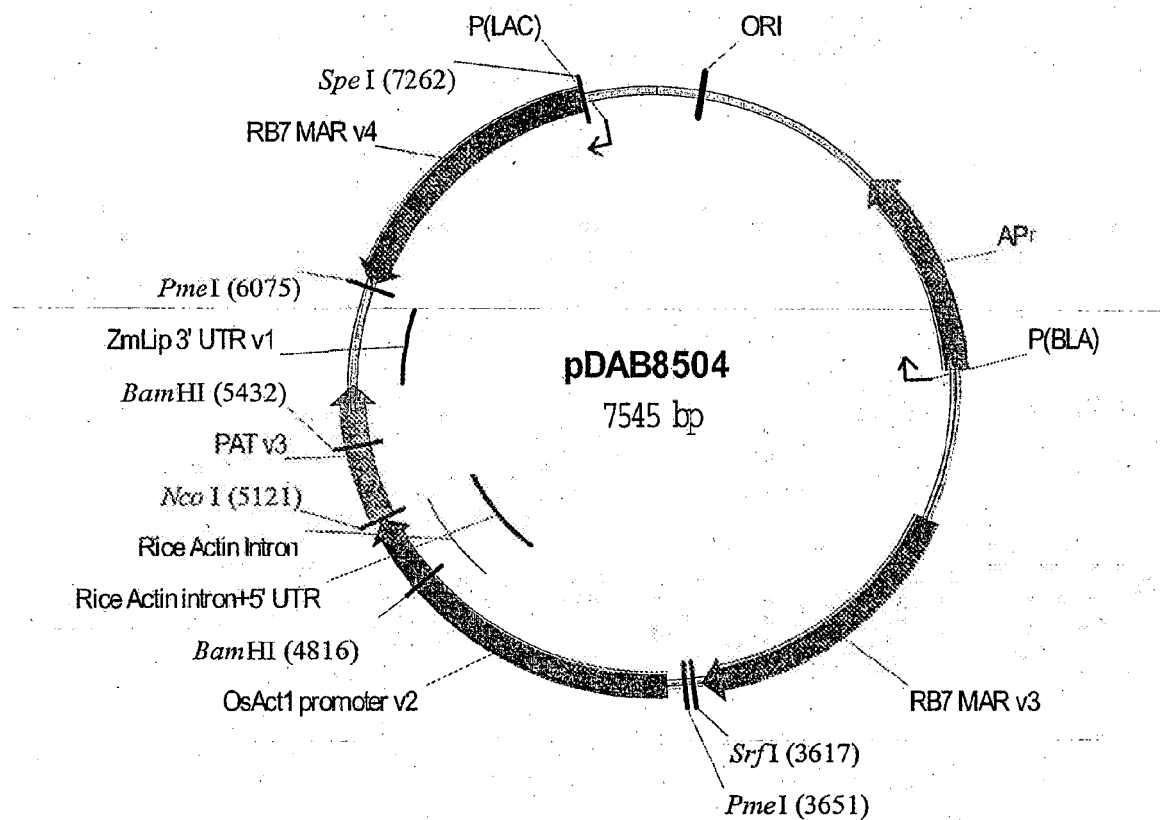


FIG. 7A

Plasmid pDAB8504 (7545 bp)

Description: Cloning vector with Rb7 MARs (inverted orientation) flanking a multiple cloning site and the rice actin/PAT/lipase selectable marker cassette

| Nucleotide start | Nucleotide end | Sequence Feature                                                                                                                                                                                     |
|------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | 1166           | Tobacco Rb7 MARs                                                                                                                                                                                     |
| 1167             | 1304           | Linker Sequence with multiple cloning site:<br>TGGCCACCGCTTAATTAAGGCGCGCCATGCCCGGGCAAGCG<br>GCCGCTTAATTAAATTTAAATGTTTAAACTAGGAAATCCAA<br>GCTTGGGCTGCAGGTCAATCCCATGCTTTTGAAGCAGCTC<br>AACATTGATCTCTTT |
| 1305             | 2701           | Rice actin promoter with intron                                                                                                                                                                      |
| 2235             | 2696           | Rice actin intron                                                                                                                                                                                    |
| 2702             | 2703           | CC                                                                                                                                                                                                   |
| 2704             | 3258           | PAT gene (phosphinothricin acyl transferase)                                                                                                                                                         |
| 3259             | 3272           | Linker sequence: GGTACCCTGAGCTC                                                                                                                                                                      |
| 3273             | 3629           | Maize lipase 3' UTR                                                                                                                                                                                  |
| 3630             | 3670           | Linker sequence:<br>GAATTCATATTTCTCCTGCAGGGTTTAAACTTGCCGTGGC                                                                                                                                         |
| 3671             | 4836           | Tobacco Rb7 MAR (complementary)                                                                                                                                                                      |
| 4837             | 4857           | Linker sequence: CGGCCCACTAGTCACCGGTGT                                                                                                                                                               |
| 4858             | 5103           | Puc19                                                                                                                                                                                                |
| 5104             | 5130           | Linker sequence:<br>GCGCACGCTGCGCACGCTGCGCACGCT                                                                                                                                                      |
| 5130             | 7523           | Puc19                                                                                                                                                                                                |
| 7524             | 7545           | Linker sequence: ACACCGGTGTGATCATGGGCCG                                                                                                                                                              |

#### Sequence

```

1      CGATTAAAAA TCTCAATTAT ATTTGGTCTA ATTTAGTTTG GTATTGAGTA
51     AAACAAATTC GAACCAAAACC AAAATATAAA TATATAGTTT TTATATATAT
101    GCCTTTAAGA CTTTTTATAG AATTTTCFTT AAAAAATATC TAGAAATATT
151    TGGGACTCTT CTGGCATGTA ATATTTCTGT AAATATGAAG TGCTCCATTT
201    TTATTAACCTT TAAATAATTG GTTGTACGAT CACTTTCTTA TCAAGTGTTA
251    CTAAAATGCG TCAATCTCTT TGTTCTTCCA TATTCATATG TCAAAACCTA
301    TCAAAATTCT TATATATCTT TTTCGAATTG GAAGTGAAAT TCGATAAATT
351    TAAAAATTAA TAGAACATAT CATTATTTAG GTATCATATT GATTTTTATA
401    CTTAATTACT AAATTTGGTT AACTTTGAAA GTGTACATCA ACGAAAAATT
451    AGTCAAACGA CTAAAATAAA TAAATATCAT GTGTTATTAA GAAAATTCTC
501    CTATAAGAAT ATTTTAATAG ATCATATGTT TGTAAAAAAA ATTAATTTT
551    ACTAACACAT ATATTTACTT ATCAAAAATT TGACAAAGTA AGATTAAAA
601    AATATTTCATC TAACAAAAAA AAAACCAGAA AATGCTGAAA ACCCGGCAAA
651    ACCGAACCAA TCCAAACCGA TATAGTTGGT TTGGTTTGAT TTTGATATAA
701    ACCGAACCAA CTCGGTCCAT TTGCACCCCT AATCATAATA GCTTTAATAT
751    TTCAAGATAT TATTAAGTTA ACGTTGTCAA TATCCTGGAA ATTTTGCAAA
801    ATGAATCAAG CCTATATGGC TGTAATATGA ATTTAAAAGC AGCTCGATGT
851    GGTGGTAATA TGTAATTTAC TTGATTCTAA AAAAAATATCC CAAGTATTAA

```

FIG 7B



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901 TAATTTCTGC TAGGAAGAAG GTTAGCTACG ATTTACAGCA AAGCCAGAAT
951 ACAATGAACC ATAAAGTGAT TGAAGCTCGA AATATACGAA GGAACAAATA
1001 TTTTAAAAA AATACGCAAT GACTTGGAAC AAAAGAAAGT GATATATTTT
1051 TTGTTCTTAA ACAAGCATCC CCTCTAAAGA ATGGCAGTTT TCCTTTGCAT
1101 GTAACATATTA TGCTCCCTTC GTTACAAAAA TTTTGGACTA CTATTGGGAA
1151 CTTCTTCTGA AAATAGTGGC CACCGCTTAA TTAAGGCGCG CCATGCCCCG
1201 GCAAGCGGCC GCTTAATTAA ATTTAAATGT TTAAACTAGG AAATCCAAGC
1251 TTGGGCTGCA GGTCAATCCC ATTGCTTTTG AAGCAGCTCA ACATTGATCT
1301 CTTTCTCGAG GTCATTCTATA TGCTTGAGAA GAGAGTCGGG ATAGTCCAAA
1351 ATAAAACAAA GGTAAGATTA CCTGGTCAAA AGTGAAAACA TCAGTTAAAA
1401 GGTGGTATAA AGTAAAATAT CGGTAATAAA AGGTGGCCCA AAGTGAAATT
1451 TACTCTTTTC TACTATTATA AAAATTGAGG ATGTTTTTGT CGGTACTTTG
1501 ATACGTCATT TTTGTATGAA TTGGTTTTTA AGTTTATTCG CTTTTGGAAA
1551 TGCATATCTG TATTTGAGTC GGGTTTAAAG TTCGTTTGCT TTTGTAAATA
1601 CAGAGGGATT TGTATAAGAA ATATCTTTAA AAAAACCCAT ATGCTAATTT
1651 GACATAATTT TTGAGAAAAA TATATATTCA GGCGAATTCT CACAATGAAC
1701 AATAATAAGA TTAATAATAGC TTTCCCCCGT TGCAGCGCAT GGGTATTTTT
1751 TCTAGTAAAA ATAAAAGATA AACTTAGACT CAAAACATTT ACAAAAACAA
1801 CCCCTAAAGT TCCTAAAGCC CAAAGTGCTA TCCACGATCC ATAGCAAGCC
1851 CAGCCCAACC CAACCCAACC CAACCCACCC CAGTCCAGCC AACTGGACAA
1901 TAGTCTCCAC ACCCCCCCAC TATCACCGTG AGTTGTCCGC ACGCACCGCA
1951 CGTCTCGCAG CCAAAAAAAA AAAAAGAAAG AAAAAAAGA AAAAGAAAAA
2001 ACAGCAGGTG GGTCCGGGTC GTGGGGGCGG GAAACGCGAG GAGGATCGCG
2051 AGCCAGCGAC GAGGCCGGCC CTCCCTCCGC TTCCAAAGAA ACGCCCCCCA
2101 TCGCCACTAT ATACATACCC CCCCCTCTCC TCCCATCCCC CCAACCCTAC
2151 CACCACCACC ACCACCACCT CCACCTCCTC CCCCCTCGCT GCCGGACGAC
2201 GCCTCCCCCC TCCCCCTCCG CCGCCGCGCG GCCGGTAACC ACCCCGCCCC
2251 TCTCCTCTTT CTTTCTCCGT TTTTTTTTTC CGTCTCGGTC TCGATCTTTG
2301 GCCTTGGTAG TTTGGGTGGG CGAGAGGCGG CTTCTGTGCG GCCCAGATCG
2351 GTGCGCGGGA GGGGCGGGAT CTCGCGGCTG GGGCTCTCGC CGGCGTGGAT
2401 CCGGCCCGGA TCTCGCGGGG AATGGGGCTC TCGGATGTAG ATCTGCGATC
2451 CGCCGTTGTT GGGGAGATG ATGGGGGTT TAAAATTTCC GCCATGCTAA
2501 ACAAGATCAG GAAGAGGGGA AAAGGGCACT ATGGTTTATA TTTTATATA
2551 TTTCTGCTGC TTCGTCAGGC TTAGATGTGC TAGATCTTTC TTTCTTCTTT
2601 TTGTGGGTAG AATTGAATC CCTCAGCAT GTTCATCGGT AGTTTTCTTT
2651 TTCATGATTT GTGACAAATG CAGCCTCGTG CGGAGCTTTT TTGTAGGTAG
2701 ACCATGGCTT CTCGGGAGAG GAGACCAGTT GAGATTAGGC CAGCTACAGC
2751 AGCTGATATG GCCCGGTTT GTGATATCGT TAACCATTAC ATTGAGACGT
2801 CTACAGTGAA CTTTAGGACA GAGCCACAAA CACCACAAGA GTGGATTGAT
2851 GATCTAGAGA GGTGCAAGA TAGATACCCT TGGTTGGTTG CTGAGGTTGA
2901 GGGTGTGTG GCTGGTATTG CTTACGCTGG GCCCTGGAAG GGTAGGAACG
2951 CTTACGATTG GACAGTTGAG AGTACTGTTT ACGTGTCACT TAGGCATCAA
3001 AGGTTGGGCC TAGGATCCAC ATTGTACACA CATTTGCTTA AGTCTATGGA
3051 GGCGCAAGGT TTTAAGTCTG TGGTTGCTGT TATAGGCCCT CCAAACGATC
3101 CATCTGTTAG GTTGCATGAG GCTTTGGGAT ACACAGCCCG GGGTACATTG
3151 CGCGCAGCTG GATACAAGCA TGGTGGATGG CATGATGTTG GTTTTTGGCA
3201 AAGGGATTTT GAGTTGCCAG CTCCTCCAAG GCCAGTTAGG CCAGTTACCC
3251 AGATCTGAGG TACCCTGAGC TCGGTCGCAG CGTGTGCGTG TCCGTCGTAC
3301 GTTCTGGCCG GCCGGGCTT GGGCGCGCGA TCAGAAGCGT TCGGTTGGCG
3351 TGTGTGTGCT TCTGGTTTGC TTTAATTTTA CCAAGTTTGT TTCAAGGTGG
3401 ATCGCGTGGT CAAGGCCCGT GTGCTTTAAA GACCCACCGG CACTGGCAGT
3451 GAGTGTGCT GCTTGTGTAG GCTTTGGTAC GTATGGGCTT TATTTGCTTC

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FIG 7B. CONT.

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3501 TGGATGTTGT GTACTACTTG GGTTTGTTGA ATTATTATGA GCAGTTGCGT
3551 ATTGTAATTC AGCTGGGCTA CCTGGACATT GTTATGTATT AATAAATGCT
3601 TTGCTTTCTT CTAAAGATCT TTAAGTGCTG AATTCATATT TCCTCCTGCA
3651 GGGTTTAAAC TTGCCGTGGC CTATTTTCAG AAGAAGTTCC CAATAGTAGT
3701 CCAAAATTTT TGTAACGAAG GGAGCATAAT AGTTACATGC AAAGGAAAAC
3751 TGCCATTCTT TAGAGGGGAT GCTTGTTTAA GAACAAAAAA TATATCACTT
3801 TCTTTTGTTT CAAGTCATTG CGTATTTTTT TAAAAATAT TGTTCCTTCG
3851 TATATTTTCGA GCTTCAATCA CTTTATGGTT CTTTGTATTC TGGCTTTGCT
3901 GTAAATCGTA GCTAACCTTC TTCCTAGCAG AAATTATTA TACTTGGGAT
3951 ATTTTTTTTAG AATCAAGTAA ATTACATATT ACCACCACAT CGAGCTGCTT
4001 TTAAATTCAT ATTACAGCCA TATAGGCTTG ATTCATTTTG CAAAATTTCC
4051 AGGATATTGA CAACGTTAAC TTAATAATAT CTTGAAATAT TAAAGCTATT
4101 ATGATTAGGG GTGCAAATGG ACCGAGTTGG TTCGGTTTAT ATCAAAATCA
4151 AACCAAACCA ACTATATCGG TTTGGATTGG TTCGGTTTGT CCGGGTTTTTC
4201 AGCATTTTCT GGTTTTTTTT TTGTTAGATG AATATTATTT TAATCTTACT
4251 TTGTCAAATT TTTGATAAGT AAATATATGT GTTAGTAAAA ATTAATTTTT
4301 TTTACAAACA TATGATCTAT TAAATATTC TTATAGGAGA ATTTTCTTAA
4351 TAACACATGA TATTTATTTA TTTTAGTCGT TTGACTAATT TTTCGTTGAT
4401 GTACACTTTC AAAGTTAACC AAATTTAGTA ATTAAGTATA AAAATCAATA
4451 TGATACCTAA ATAATGATAT GTTCTATTTA ATTTTAAATT ATCGAAATTT
4501 CACTTCAAAT TCGAAAAAGA TATATAAGAA TTTTGATAGA TTTTGACATA
4551 TGAATATGGA AGAACAAAGA GATTGACGCA TTTTAGTAAC ACTTGATAAG
4601 AAAGTGATCG TACAACCAAT TATTTAAAGT TAATAAAAAAT GGAGCACTTC
4651 ATATTTAACG AAATATTACA TGCCAGAAGA GTCGCAAATA TTTCTAGATA
4701 TTTTTTAAAG AAAATCTAT AAAAACTCTT AAAGGCATAT ATATAAAAAC
4751 TATATATTTA TATTTTGGTT TGTTTCGAAT TTGTTTTACT CAATACCAAA
4801 CTAAATTAGA CCAAAATATA TTGGGATTTT TAATCGCGGC CCACTAGTCA
4851 CCGGTGTAGC TTGGCGTAAT CATGGTCATA GCTGTTTCCT GTGTGAAATT
4901 GTTATCCGCT CACAATCCA CACAACATAC GAGCCGGAAG CATAAAGTGT
4951 AAAGCCTGGG GTGCCTAATG AGTGAGCTAA CTCACATTAA TTGCGTTGCG
5001 CTCCTGCCC GCTTTCAGT CGGGAACCT GTCGTGCCAG CTGCATTAAAT
5051 GAATCGGCCA ACGCGCGGGG AGAGGCGGTT TCGGTATTGG GCGCTCTTCC
5101 GCTGCGCAGC CTGCGCACGC TGCGCACGCT TCCTCGCTCA CTGACTCGCT
5151 GCGCTCGGTC GTTCGGCTGC GCGGAGCGGT ATCAGCTCAC TCAAAGGCGG
5201 TAATACGGTT ATCCACAGAA TCAGGGGATA ACGCAGGAAA GAACATGTGA
5251 GCAAAAGGCC AGCAAAAGGC CAGGAACCGT AAAAAAGCCG CGTTGCTGGC
5301 GTTTTTCCAT AGGCTCCGCC CCCCTGACGA GCATCACAAA AATCGACGCT
5351 CAAGTCAGAG GTGGCGAAAC CCGACAGGAC TATAAAGATA CCAGGCGTTT
5401 CCCCTGGAA GCTCCCTCGT GCGCTCTCCT GTTCCGACCC TGCCGCTTAC
5451 CGGATACCTG TCCGCTTTTC TCCCTTCGGG AAGCGTGCGG CTTTCTCATA
5501 GCTCACGCTG TAGGTATCTC AGTTCGGTGT AGGTCGTTCC CTCCAAGCTG
5551 GGCTGTGTGC ACGAACCCCC CGTTCAGCCC GACCGCTGCG CCTTATCCGG
5601 TAACTATCGT CTTGAGTCCA ACCCGGTAAG ACACGACTTA TCGCCACTGG
5651 CAGCAGCCAC TGGTAACAGG ATTAGCAGAG CGAGGTATGT AGGCGGTGCT
5701 ACAGAGTTCT TGAAGTGGTG GCCTAACTAC GGCTACACTA GAAGGACAGT
5751 ATTTGGTATC TGCGCTCTGC TGAAGCCAGT TACCTTCGGA AAAAGAGTTG
5801 GTAGCTCTTG ATCCGGCAAA CAAACCACCG CTGGTAGCGG TGGTTTTTTT
5851 GTTTGCAAGC AGCAGATTAC GCGCAGAAAA AAAGGATCTC AAGAAGATCC
5901 TTTGATCTTT TCTACGGGGT CTGACGCTCA GTGGAACGAA AACTCACGTT
5951 AAGGGATTTT GGTCAAGAGA TTATCAAAAA GGATCTTCAC CTAGATCCTT
6001 TTAAATTAAA AATGAAGTTT TAAATCAATC TAAAGTATAT ATGAGTAAAC
6051 TTGGTCTGAC AGTTACCAAT GCTTAATCAG TGAGGCACCT ATCTCAGCGA

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FIG 7B CONT.

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6101 TCTGTCTATT TCGTTCATCC ATAGTTGCCT GACTCCCCGT CGTG TAGATA
6151 ACTACGATAC GGGAGGGCTT ACCATCTGGC CCCAGTGCTG CAATGATACC
6201 GCGAGACCCA CGCTCACCGG CTCCAGATTT ATCAGCAATA AACCAGCCAG
6251 CCGGAAGGGC CGAGCGCAGA AGTGGTCCTG CAACTTTATC CGCCTCCATC
6301 CAGTCTATTA ATTGTTGCCG GGAAGCTAGA GTAAGTAGTT CGCCAGTTAA
6351 TAGTTTGCGC AACGTTGTTG CCATTGCTAC AGGCATCGTG GTGTCACGCT
6401 CGTCGTTTGG TATGGCTTCA TTCAGCTCCG GTTCCCAACG ATCAAGGCGA
6451 GTTACATGAT CCCCCATGTT GTGCAAAAAA GCGGTTAGCT CCTTCGGTCC
6501 TCCGATCGTT GTCAGAAAGTA AGTTGGCCGC AGTGTTATCA CTCATGGTTA
6551 TGGCAGCACT GCATAATTCT CTTACTGTCA TGCCATCCGT AAGATGCTTT
6601 TCTGTGACTG GTGAGTACTC AACCAGTCA TTCTGAGAAT AGTGATGCG
6651 GCGACCGAGT TGCTCTTGCC CGGCGTCAAT ACGGGATAAT ACCGCGCCAC
6701 ATAGCAGAAC TTTAAAAGTG CTCATCATTG GAAAACGTTT TTCGGGGCGA
6751 AAAC TCTCAA GGATCTTACC GCTGTTGAGA TCCAGTTCGA TGTAAACCCAC
6801 TCGTGACCCC AACTGATCTT CAGCATCTTT TACTTTCACC AGCGTTTCTG
6851 GGTGAGCAAA AACAGGAAGG CAAAATGCCG CAAAAAAGGG AATAAGGGCG
6901 ACACGGAAAT GTTGAATACT CATACTCTTC CTTTTTCAAT ATTATTGAAG
6951 CATTTATCAG GGTTATTGTC TCATGAGCGG ATACATATTT GAATGTATTT
7001 AGAAAAATAA ACAAATAGGG GTTCCGCGCA CATTTCCCCG AAAAGTGCCA
7051 CCTGACGTCT AAGAAACCAT TATTATCATG ACATTAACCT ATAAAAATAG
7101 GCGTATCACG AGGCCCTTTC GTCTCGCGCG TTTCGGTGAT GACGGTGAAA
7151 ACCTCTGACA CATGCAGCTC CCGGAGACGG TCACAGCTTG TCTGTAAGCG
7201 GATGCCGGGA GCAGACAAGC CCGTCAGGGC GCGTCAGCGG GTGTTGGCGG
7251 GTGTCGGGGC TGGCTTAAC TATGCGGCATC AGAGCAGATT GACTGAGAG
7301 TGCACCATAT GCGGTGTGAA ATACCGCACA GATGCGTAAG GAGAAAATAC
7351 CGCATCAGGC GCCATTCGCC ATTCAGGCTG CGCAACTGTT GGGAAGGGCG
7401 ATCGGTGCGG GCCTCTTCGC TATTACGCCA GCTGGCGAAA GGGGGATGTG
7451 CTGCAAGGCG ATTAAGTTGG GTAACGCCAG GGTTTTCCCA GTCACGACGT
7501 TGTA AACGA CGGCCAGTGA ATTACACCGG TGTGATCATG GGCCG

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FIG 7B CONT.

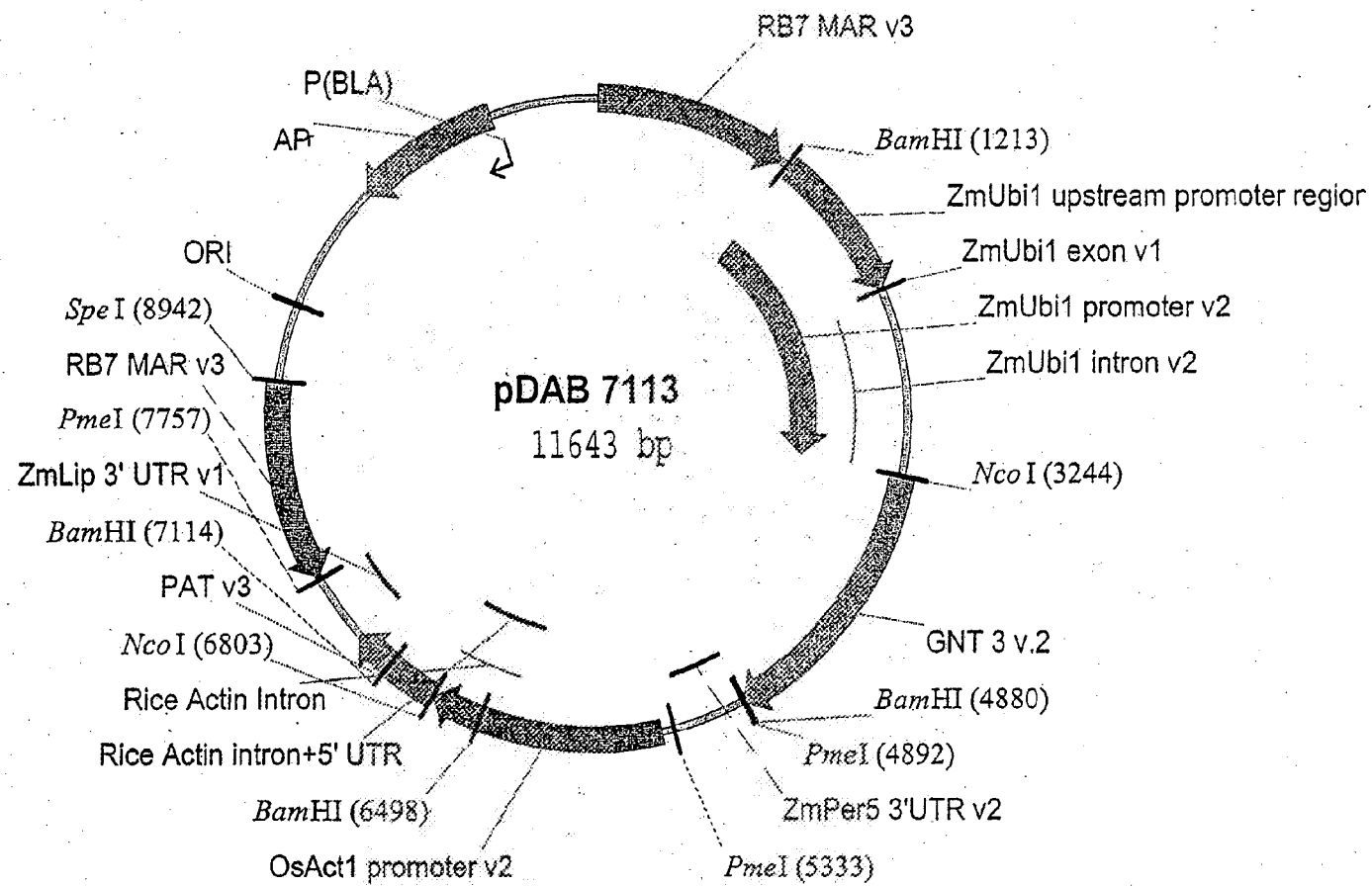


FIG. 8A

## pDAB7113 11643bp

| Sequence                               | Feature                                                                                                                                                     |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-1164bp                               | RB7 MAR v3                                                                                                                                                  |
| 1165-1233<br>Linker                    | TGGCCACCGCTTAATTAAGGCGCGCCATGCCCCCTGCAG<br>ATCCCCGGGGATCCTCTAGAGTCGACCTGC                                                                                   |
| 1234-3224                              | Maize Ubiquitin 1 promoter                                                                                                                                  |
| 3224-4891                              | GNT III v.2                                                                                                                                                 |
| 3627                                   | C to replace G as reported in original<br>sequence                                                                                                          |
| 4892-4895<br>Linker                    | TAGGTTT                                                                                                                                                     |
| 4896-5260                              | Maize Per5 3'UTR v2                                                                                                                                         |
| 5261-5404<br>multiple<br>cloning sites | CGGCCGGCCTAGCTAGCCACGGTGGCCAGATCCACTAGG<br>GGCAAGCGGCCGCTTAATTAAATTTAAATGTTTAAACTA<br>GGAAATCCAAGCTTGGGCTGCAGGTCAATCCCATGCTT<br>TTGAAGCAGCTCAACATTGATCTCTTT |
| 5405-6802                              | Rice Actin 1 Promoter v2                                                                                                                                    |
| 6803-7358                              | PAT v3                                                                                                                                                      |
| 7359-7372<br>Linker                    | GGTACCCTGAGCTC                                                                                                                                              |
| 7373-7729                              | Maize Lipase 3' UTR v1                                                                                                                                      |
| 7730-7770<br>Linker                    | GAATTCATATTTCTCCTGCAGGGTTTAAACTTGCCGTG<br>GC                                                                                                                |
| 7771-8934                              | RB7 MAR v3                                                                                                                                                  |
| 8935-11643                             | PUC19                                                                                                                                                       |
| 9201-9225                              | 3 FspI sites (TGCGCAA) with CG in<br>between sites                                                                                                          |
| 10164-11021                            | Ampicillin resistance gene                                                                                                                                  |
| 10454-10459                            | TGCGCAA FspI                                                                                                                                                |
| 11477-11482                            | TGCGCAA FspI                                                                                                                                                |

```

1  CGATTAAAAA  CCCAATTATA  TTTGGTCTAA  TTTAGTTTGG
   TATTGAGTAA  AACAAATTCG  AACCAAACCA  AAATATAAAT
   ATATAGTTTT  TATATATATG
101 CCTTTAAGAC  TTTTATAGA  ATTTTCTTTA  AAAAATATCT
   AGAAATATTT  GCGACTCTTC  TGGCATGTAA  TATTTTCGTTA
   AATATGAAGT  GCTCCATTTT
201 TATTAACTTT  AAATAATTGG  TTGTACGATC  ACTTTCTTAT
   CAAGTGTTAC  TAAAATGCGT  CAATCTCTTT  GTTCTTCCAT
   ATTCATATGT  CAAAATCTAT
301 CAAAATTCTT  ATATATCTTT  TTCGAATTIG  AAGTGAAATT
   TCGATAATTT  AAAATTAAAT  AGAACATATC  ATTATTTAGG
   TATCATATTG  ATTTTATAC

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FIG 8B

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401 TTAATTACTA AATTTGGTTA ACTTTGAAAG TGTACATCAA
    CGAAAAATTA GTCAAACGAC TAAAATAAAT AAATATCATG
    TGGTATTAAG AAAATTCTCC
501 TATAAGAATA TTTTAATAGA TCATATGTTT GTAAAAAATA
    TTAATTTTTA CTAACACATA TATTTACTTA TCAAAAATTT
    GACAAAGTAA GATTAAAAATA
601 ATATTCATCT AACAAAAAAA AAACCAGAAA ATGCTGAAAA
    CCCGGCAAAA CCGAACCAAT CCAAACCGAT ATAGTTGGTT
    TGGTTTGATT TTGATATAAA
701 CCGAACCAAC TCGGTCCATT TGCACCCCTA ATCATAATAG
    CTTTAATATT TCAAGATATT ATTAAGTTAA CGTTGTCAAT
    ATCCTGGAAA TTTTGCAAAA
801 TGAATCAAGC CTATATGGCT GTAATATGAA TTTAAAAGCA
    GCTCGATGTG GTGGTAATAT GTAATTTACT TGATTCTAAA
    AAAATATCCC AAGTATTAAT
901 AATTTCTGCT AGGAAGAAGG TTAGCTACGA TTTACAGCAA
    AGCCAGAATA CAAAGAACCA TAAAGTGATT GAAGCTCGAA
    ATATACGAAG GAACAAATAT
1001 TTTTAAAAAA ATACGCAATG ACTTGGAACA AAAGAAAGTG
    ATATATTTTT TGTTCTTAAA CAAGCATCCC CTCTAAAGAA
    TGGCAGTTTT CCTTGCATG

PacI
~~~~~

AscI
~~~~~

1101 TAACTATTAT GCTCCCTTCG TTACAAAAAT TTTGGACTAC
    TATTGGGAAT TCTTCTGAAA ATAGTGGCCA CCGCTTAATT
    AAGGCGCGCC ATGCCCCCTG
        BamHI
        ~~~~~

1201 CAGATCCCCG GGGATCCTCT AGAGTCGACC TGCAGTGCAG
 CGTGACCCCG TCGTGCCCCT CTCTAGAGAT AATGAGCATT
 GCATGTCTAA GTTATAAAAA
1301 ATTACCACAT ATTTTTTTTG TCACACTTGT TTGAAGTGCA
 GTTTATCTAT CTTTATACAT ATATTTAAAC TTTAATCTAC
 GAATAATATA ATCTATAGTA
1401 CTACAATAAT ATCAGTGTTT TAGAGAATCA TATAAATGAA
 CAGTTAGACA TGGTCTAAAG GACAATTGAG TATTTTGACA
 ACAGGACTCT ACAGTTTTAT
1501 CTTTTTAGTG TGCATGTGTT CTCCTTTTTT TTTGCAAATA
 GCTTCACCTA TATAATACTT CATCCATTTT ATTAGTACAT
 CCATTTAGGG TTTAGGGTTA

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FIG 8B CONT.

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1601 ATGGTTTTTTA TAGACTAATP TTTTATAGTAC ATCTATTTTA
 TTCTATTTTGA GCCTCTAAAT TAAGAAAACCT AAAACTCTAT
 TTTAGTTTTTT TTATTTAATA
1701 ATTTAGATAT AAAATAGAAT AAAATAAAGT GACTAAAAAT
 TAAACAAATA CCCTTTAAGA AATTAAAAAA ACTAAGGAAA
 CATTTTTCTT GTTTCGAGTA
1801 GATAATGCCA GCCTGTAAAA CGCCGTCGAC GAGTCTAACG
 GACACCAACC AGCGAACCAG CAGCGTCGCG TCGGGCCAAG
 CGAAGCAGAC GGCACGGCAT
1901 CTCTGTGCTGCT GCCTCTGGAC CCCTCTCGAG AGTTCCGCTC
 CACCGTTGGA CTGTCTCCGC TGTCGGCATC CAGAAATTGC
 GTGGCGGAGC GGCAGACGTG
2001 AGCCGGCAGC GCAGGCGGCC TCCTCCTCCT CTCACGGCAC
 GGCAGCTACG GGGGATTCCT TTCCCACCGC TCCTTCGCTT
 TCCCTTCCTC GCCCGCCGTA
2101 ATAAATAGAC ACCCCCTCCA CACCCTCTTT CCCCACCTC
 GTGTTGTTTCG GAGCGCACAC ACACACAACC AGATCTCCCC
 CAAATCCACC CGTCGGCACC
2201 TCCGCTTCAA GGTACGCCGC TCGTCCTCCC CCCCCCCCCC
 TCTCTACCTT CTCTAGATCG GCGTTCGGT CCATGCATGG
 TTAGGGCCCCG GTAGTTCTAC
2301 TTCTGTTTCAT GTTTGTGTTA GATCCGTGTT TGTGTTAGAT
 CCGTGTCTGCT AGCGTTCGTA CACGGATGCG ACCTGTACGT
 CAGACACGTT CTGATTGCTA
2401 ACTTGCCAGT GTTTCTCTTT GGGGAATCCT GGGATGGCTC
 TAGCCGTTCC GCAGACGGGA TCGATTTCAT GATTTTTTTT
 GTTTCGTTGC ATAGGGTTTG
2501 GTTTGCCCTT TTCCTTTATT TCAATATATG CCGTGCACCT
 GTTTGTGCGG TCATCTTTTC ATGCTTTTTT TTGTCTTGGT
 TGTGATGATG TGGTCTGGTT
2601 GGGCGGTCGT TCTAGATCGG AGTAGAATTC TGTTCAAAC
 TACCTGGTGG ATTTATTAAT TTTGGATCTG TATGTGTGTG
 CCATACATAT TCATAGTTAC
2701 GAATTGAAGA TGATGGATGG AAATATCGAT CTAGGATAGG
 TATACATGTT GATGCGGGTT TTAGTGATGC ATATACAGAG
 ATGCTTTTTG TTCGCTTGGT
2801 TGTGATGATG TGGTGTGGTT GGGCGGTCGT TCATTCGTTT
 TAGATCGGAG TAGAATACTG TTTCAAAC TA CCTGGTGTAT
 TTATTAAATTT TGGAACGTGA
2901 TGTGTGTGTC ATACATCTTC ATAGTTACGA GTTTAAGATG
 GATGGAAATA TCGATCTAGG ATAGGTATAC ATGTTGATGT
 GGGTTTTTACT GATGCATATA
3001 CATGATGGCA TATGCAGCAT CTATTCATAT GCTCTAACCT
 TGAGTACCTA TCTATTATAA TAAACAAGTA TGTTTTATAA
 TTATTTTGAT CTTGATATAC
3101 TTGGATGATG GCATATGCAG CAGCTATATG TGGATTTTTT
 TAGCCCTGCC TTCATACGCT ATTTATTTGC TTGGTACTGT
 TTCTTTTGTC GATGCTCACC

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FIG 8B CONT.

NcoI  
FseI

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3201 CTGTTGTTTG GTGTTACTTC TGCAGGGTAC CCCCAGGGGTC  
GACCATGGTG ATGAGACGCT ACAAGCTCTT TCTCATGTTC  
TGTATGGCCG GCCTGTGCCT

3301 CATCTCCTTC CTGCACTTCT TCAAGACCCT GTCCTATGTC  
ACCTTCCCCC GAGAACTGGC CTCCCTCAGC CCTAACCTGG  
TGTCCAGCTT TTTCTGGAAC

3401 AATGCCCCCG TCACGCCCCA GGCCAGCCCC GAGCCAGGAG  
GCCCTGACCT GCTGCGTACC CCACTCTACT CCCACTCGCC  
CCTGCTGCAG CCGCTGCCGC

SacI  
~~~~~

3501 CCAGCAAGGC GGCCGAGGAG CTCCACCGGG TGGACTTGGT  
GCTGCCCCGAG GACACCACCG AGTATTTCTG GCGCACCAAG  
GCCGGCGGCG TCTGCTTCAA

3601 ACCCGGCACC AAGATGCTGG AGAGGCCCCC CCCGGGACGG  
CCGGAGGAGA AGCCTGAGGG GGCCAACGGC TCCTCGGCCC  
GGCGGCCACC CCGGTACCTC

3701 CTGAGCGCCC GGGAGCGCAC GGGGGGCCGA GGCGCCCGGC  
GCAAGTGGGT GGAGTGCCTG TGCCTGCCCC GCTGGCACGG  
ACCCAGCTGC GCGGTGCCCCA

3801 CTGTGGTGCA GTACTCCAAC CTGCCCACCA AGGAGCGGCT  
GGTGCCAGG GAGGTGCCCC GCGCGCTCAT CAACGCCATC  
AACGTCAACC ACGAGTTCTA

NotI

~~~~~

3901 CCTGCTGGAC GTGCGCTTCC ACGAGCTGGG CGACGTGGTG  
GACGCCTTTG TGGTGTGCGA GTCCAACCTC ACGGCTTATG  
GGGAGCCGCG GCCGCTCAAG

4001 TTCCGGGAGA TGCTGACCAA TGGCACCTTC GAGTACATCC  
GCCACAAGGT GCTCTATGTC TTCCTGGACC ACTTCCCGCC  
CGGCGGCCCG CAGGACGGCT

4101 GGATCGCCGA CGACTACCTG CGCACCTTCC TCACCCAGGA  
CGGCGTCTCG CGGCTGCGCA ACCTGCGGCC CGACGACGTC  
TTCATCATTG ACGATGCGGA

4201 CGAGATCCCG GCCCGTGACG GCGTCCTTTT CCTCAAGCTC  
TACGATGGCT GGACCGAGCC CTTGCGCTTC CACATGCGCA  
AGTCGCTCTA CGGCTTCTTC

4301 TGGAAGCAGC CGGGCACCCT GGAGGTGGTG TCAGGCTGCA  
CGGTGGACAT GCTGCAGGCA GTGTATGGGC TGGACGGCAT  
CCGCCTGCGC CGCCGCCAGT

FIG 8B CONT.



4401 ACTACACCAT GCCCAACTTC AGACAGTATG AGAACCGCAC  
 CGGCCACATC CTGGTGCAGT GGTCGCTGGG CAGCCCCCTG  
 CACTTCGCCG GCTGGCACTG  
 4501 CTCCTGGTGC TTCACGCCCC AGGGCATCTA CTTCAAGCTC  
 GTGTCCGCCC AGAATGGCGA CTTCCCACGC TGGGGTGACT  
 ACGAGGACAA GCGGGACCTG  
 4601 AACTACATCC GCGGCCTGAT CCGCACCGGG GGCTGGTTCTG  
 ACGGCACGCA GCAGGAGTAC CCGCCTGCAG ACCCCAGCGA  
 GCACATGTAT GCGCCCAAGT  
 4701 ACCTGCTGAA GAACTACGAC CGGTTCCACT ACCTGCTGGA  
 CAACCCCTAC CAGGAGCCCCA GGAGCACGGC GGCGGGCGGG  
 TGGCGCCACA GGGGTCCCGA

BamHI

PmeI

~~~~~

4801 GGGAAGGCCG CCCGCCCGGG GCAAACCTGGA CGAGGCGGAA  
 GTCGAACAAA AACTCATCTC AGAAGAGGAT CTGAATTAGG  
 ATCCTAGGTT TAAACTGAGG  
 4901 GCACTGAAGT CGCTTGATGT GCTGAATTGT TTGTGATGTT  
 GGTGGCGTAT TTTGTTTAA TAAGTAAGCA TGGCTGTGAT  
 TTTATCATAT GATCGATCTT  
 5001 TGGGGTTTTA TTAAACACAT TGTAATATGT GTATCTATTA  
 ATAACCTCAAT GTATAAGATG TGTTCAATTCT TCGGTTGCCA  
 TAGATCTGCT TATTTGACCT  
 5101 GTGATGTTTT GACTCCAAAA ACCAAAATCA CAACTCAATA  
 AACTCATGGA ATATGTCCAC CTGTTTCTTG AAGAGTTCAT  
 CTACCATTCC AGTTGGCATT

FseI

~~~~~

5201 TATCAGTGTT GCAGCGGCGC TGTGCTTTGT AACATAACAA  
 TTGTTACCG CATATATCCA CGGCCGGCCT AGCTAGCCAC  
 GGTGGCCAGA TCCACTAGGG

PacI

~~~~~

SwaI

~~~~~

NotI

PmeI

HindIII

~~~~~

~~~~~

5301 GCAAGCGGCC GCTTAATTAA ATTTAAATGT TTAAACTAGG  
 AAATCCAAGC TTGGGCTGCA GGTCAATCCC ATTGCTTTTG  
 AAGCAGCTCA ACATTGATCT

FIG 8B CONT.

5401 CTTTCTCGAG GTCATTGATA TGCTTGAGAA GAGAGTCGGG  
 ATAGTCCAAA ATAAAACAAA GGTAAGATTA CCTGGTCAAA  
 AGTGAAAACA TCAGTTAAAA  
 5501 GGTGGTATAA AGTAAATAT CGGTAATAAA AGGTGGCCCA  
 AAGTGAAATT TACTCTTTTC TACTATTATA AAAATTGAGG  
 ATGTTTTTGT CGGTACTTTG  
 5601 ATACGTCAAT TTTGTATGAA TTGGTTTTTA AGTTTATTCG  
 CTTTGTGAAA TGCATATCTG TATTTGAGTC GGGTTTTAAG  
 TTCGTTTGCT TTTGTAAATA  
 5701 CAGAGGGATT TGTATAAGAA ATATCTTTAA AAAAACCCAT  
 ATGCTAATTT GACATAATTT TTGAGAAAAA TATATATTCA  
 GGCGAATTCT CACAATGAAC  
 5801 AATAATAAGA TTAATAAGC TTTCCCCCGT TGCAGCGCAT  
 GGGTATTTTT TCTAGTAAAA ATAAAAGATA AACTTAGACT  
 CAAAACATTT AAAAAACAA  
 5901 CCCCTAAAGT TCCTAAAGCC CAAAGTGCTA TCCACGATCC  
 ATAGCAAGCC CAGCCCAACC CAACCCAACC CAACCCACCC  
 CAGTCCAGCC AACTGGACAA  
 6001 TAGTCTCCAC ACCCCCCCAC TATCACCGTG AGTTGTCCGC  
 ACGCACCGCA CGTCTCGCAG CCAAAAAAAA AAAAAGAAAG  
 AAAAAAAGA AAAAGAAAAA

FseI

~~~~~

6101 ACAGCAGGTG GGTCCGGGTC GTGGGGGCCG GAAACGCGAG  
 GAGGATCGCG AGCCAGCGAC GAGGCCGGCC CTCCCTCCGC  
 TTCCAAAGAA ACGCCCCCA  
 6201 TCGCCACTAT ATACATACCC CCCCCTCTCC TCCCATCCCC  
 CCAACCCCTAC CACCACCACC ACCACCACCT CCACCTCCTC  
 CCCCCTCGCT GCCGGACGAC  
 6301 GCCTCCCCC TCCCCTCCG CCGCCGCCGC GCCGGTAACC  
 ACCCCGCCCC TCTCCTCTTT CTTTCTCCGT TTTTTTTTTT  
 CGTCTCGGTC TCGATCTTTG

BamHI

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6401 GCCTTGGTAG TTTGGGTGGG CGAGAGGCGG CTTCGTGCGC  
 GCCCAGATCG GTGCGCGGGA GGGCGGGAT CTCGCGGCTG  
 GGGCTCTCGC CGGCGTGGAT

BamHI

~~

6501 CCGGCCCCGGA TCTCGCGGGG AATGGGGCTC TCGGATGTAG  
 ATCTGCGATC CGCCGTGTGT GGGGGAGATG ATGGGGGGTT  
 TAAAATTTCC GCCATGCTAA

FIG 8B CONT.

```

6601 ACAAGATCAG GAAGAGGGGA AAAGGGCACT ATGGTTTATA
 TTTTATATA TTTCTGCTGC TTCGTCAGGC TTAGATGTGC
 TAGATCTTTC TTTCTTCTTT
6701 TTGTGGGTAG AATTGAATC CCTCAGCATT GTTCATCGGT
 AGTTTTTCTT TTCATGATTT GTGACAAATG CAGCCTCGTG
 CGGAGCTTTT TTGTAGGTAG
 NcoI
      ~~~~~
6801 ACCATGGCTT CTCCGAGAG GAGACCAGTT GAGATTAGGC
      CAGCTACAGC AGCTGATATG GCCGCGGTTT GTGATATCGT
      TAACCATTAC ATTGAGACGT
6901 CTACAGTGAA CTTTAGGACA GAGCCACAAA CACCACAAGA
      GTGGATTGAT GATCTAGAGA GGTTGCAAGA TAGATACCCT
      TGGTTGGTTG CTGAGGTTGA
7001 GGGTGTGTG GCTGCTATTG CTTACGCTGG GCCCTGGAAG
      GCTAGGAACG CTTACGATTG GACAGTTGAG AGTACTGTTT
      ACGTGTCA CA TAGGCATCAA
      BamHI
      ~~~~~
7101 AGGTTGGGCC TAGGATCCAC ATTGTACACA CATTTGCTTA
 AGTCTATGGA GCGCAAGGT TTTAAGTCTG TGGTTGCTGT
 TATAGGCCTT CCAAACGATC
7201 CATCTGTTAG GTTGCATGAG GCTTTGGGAT ACACAGCCCCG
 GGGTACATTG CGCGCAGCTG GATACAAGCA TGGTGGATGG
 CATGATGTTG GTTTTGGCA
 SacI
      ~~~~~
7301 AAGGGATTTT GAGTTGCCAG CTCCTCCAAG GCCAGTTAGG
      CCAGTTACCC AGATCTGAGG TACCCTGAGC TCGGTCGCAG
      CGTGTGCGTG TCCGTCGTAC
      FseI
      ~~~~~
7401 GTTCTGGCCG GCCGGGCCTT GGGCGCGCGA TCAGAAGCGT
 TCGTGTGGCG TGTGTGTGCT TCTGGTTTGC TTAAATTTTA
 CCAAGTTTGT TTCAAGGTGG
7501 ATCGCGTGGT CAAGGCCCGT GTGCTTTAAA GACCCACCGG
 CACTGGCAGT GAGTGTGCT GCTTGTGTAG GCTTTGGTAC
 GTATGGGCTT TATTTGCTTC
7601 TGGATGTTGT GTACTACTTG GGTTTGTGTA ATTATTATGA
 GCAGTTGCGT ATTGTAATTC AGCTGGGCTA CCTGGACATT
 GTTATGTATT AATAAATGCT
 PmeI
      ~~~~~

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FIG 8B CONT.

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7701 TTGCTTTCTT CTAAAGATCT TTAAGTGCTG AATTCATATT
      TCCTCCTGCA GGGTTTAAAC TTGCCGTGGC CTATTTTCAG
      AAGAATTCCC AATAGTAGTC
7801 CAAAATTTTT GTAACGAAGG GAGCATAATA GTTACATGCA
      AAGGAAAACCT GCCATTCTTT AGAGGGGATG CTTGTTTAAG
      AACAAAAAAT ATATCACTTT
7901 CTTTGTTCCT AAGTCATTGC GTATTTTTTTT AAAAATATTT
      GTTCCTTCGT ATATTTTCGAG CTTCAATCAC TTTATGGTTC
      TTTGTATTCT GGCTTTGCTG
8001 TAAATCGTAG CTAACCTTCT TCCTAGCAGA AATTATTAAT
      ACTTGGGATA TTTTTTTAGA ATCAAGTAAA TTACATATTA
      CCACCACATC GAGCTGCTTT
8101 TAAATTCATA TTACAGCCAT ATAGGCTTGA TTCATTTTGC
      AAAATTTCCA GGATATTGAC AACGTAACT TAATAATATC
      TTGAAATATT AAAGCTATTA
8201 TGATTAGGGG TGCAAATGGA CCGAGTTGGT TCGGTTTATA
      TCAAAATCAA ACCAAACCAA CTATATCGGT TTGGATTGGT
      TCGGTTTTCG CGGGTTTTCA
8301 GCATTTTCFG GTTTTTTTTTT TGTTAGATGA ATATTATTTT
      AATCTTACTT TGTCAAAATT TTGATAAGTA AATATATGTG
      TTAGTAAAAA TTAATTTTTT
8401 TTACAAACAT ATGATCTATT AAAATATTCT TATAGGAGAA
      TTTTCTTAAT AACACATGAT ATTTATTTAT TTTAGTCGTT
      TGACTAATTT TTCGTTGATG
8501 TACACTTTCA AAGTTAACCA AATTTAGTAA TTAAGTATAA
      AAATCAATAT GATACCTAAA TAATGATATG TTCTATTTAA
      TTTTAAATTA TCGAAATTC
8601 ACTTCAAATT CGAAAAAGAT ATATAAGAAT TTTGATAGAT
      TTTGACATAT GAATATGGAA GAACAAAGAG ATTGACGCAT
      TTTAGTAACA CTTGATAAGA
8701 AAGTGATCGT ACAACCAATT ATTTAAAGTT AATAAAAAATG
      GAGCACTTCA TATTTAACGA AATATTACAT GCCAGAAGAG
      TCGCAAATAT TTCTAGATAT
8801 TTTTTAAAGA AAATTCTATA AAAAGTCTTA AAGGCATATA
      TATAAAAACCT ATATATTTAT ATTTTGGTTT GGTTCGAATT
      TGTTTTACTC AATACCAAAC
8901 TAAATTAGAC CAAATATAAT TGGGTTTTTA ATCGCGGCC
      ACTAGTCACC GGTGTAGCTT GGCGTAATCA TGGTCATAGC
      TGTTTCCTGT GTGAAATTGT
9001 TATCCGCTCA CAATCCACA CAACATACGA GCCGGAAGCA
      TAAAGTGTA AGCCTGGGGT GCCTAATGAG TGAGCTAACT
      CACATTAATT GCGTTGCGCT
9101 CACTGCCCCG TTTCCAGTCG GGAAACCTGT CGTGCCAGCT
      GCATTAATGA ATCGGCCAAC GCGCGGGGAG AGGCGGTTTG
      CGTATTGGGC GCTCTTCCGC
9201 TCGGCACGCT GCGCACGCTG CGCACGCTTC CTCGCTCACT
      GACTCGCTGC GCTCGGTCGT TCGGCTGCGG CGAGCGGTAT
      CAGCTCACTC AAAGGCGGTA

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FIG 8B CONT.

```

9301 ATACGGTTAT CCACAGAATC AGGGGATAAC GCAGGAAAGA
    ACATGTGAGC AAAAGGCCAG CAAAAGGCCA GGAACCGTAA
    AAAGGCCGCG TTGCTGGCGT
9401 TTTTCCATAG GCTCCGCCCC CCTGACGAGC ATCACAAAAA
    TCGACGCTCA AGTCAGAGGT GGCAGAAACCC GACAGGACTA
    TAAAGATACC AGGCGTTTCC
9501 CCCTGGAAGC TCCCTCGTGC GCTCTCCTGT TCCGACCCTG
    CCGCTTACCG GATACCTGTC CGCCTTTCTC CCTTCGGGAA
    GCGTGGCGCT TTCTCATAGC
9601 TCACGCTGTA GGTATCTCAG TTCGGTGTAG GTCGTTTCGT
    CCAAGCTGGG CTGTGTGCAC GAACCCCCCG TTCAGCCCGA
    CCGCTGCGCC TTATCCGGTA
9701 ACTATCGTCT TGAGTCCAAC CCGGTAAGAC ACGACTTATC
    GCCACTGGCA GCAGCCACTG GTAACAGGAT TAGCAGAGCG
    AGGTATGTAG GCGGTGCTAC
9801 AGAGTTCTTG AAGTGGTGGC CTAACTACGG CTACACTAGA
    AGGACAGTAT TTGGTATCTG CGCTCTGCTG AAGCCAGTTA
    CCTTCGGAAA AAGAGTTGGT
9901 AGCTCTTGAT CCGGCAAAAC AACCACCGCT GGTAGCGGTG
    GTTTTTTTGT TTGCAAGCAG CAGATTACGC GCAGAAAAAA
    AGGATCTCAA GAAGATCCTT
10001 TGATCTTTTC TACGGGGTCT GACGCTCAGT GGAACGAAAA
    CTCACGTAA GGGATTTTGG TCATGAGATT ATCAAAAAGG
    ATCTTCACCT AGATCCTTTT
10101 AAATTA AAAA TGAAGTTTAA AATCAATCTA AAGTATATAT
    GAGTAACTT GGTCTGACAG TTACCAATGC TTAATCAGTG
    AGGCACCTAT CTCAGCGATC
10201 TGTCTATTTC GTTCATCCAT AGTTGCCTGA CTCCCCGTGG
    TGTAGATAAC TACGATACGG GAGGGCTTAC CATCTGGCCC
    CAGTGCTGCA ATGATACCGC
10301 GAGACCCACG CTCACCGGCT CCAGATTTAT CAGCAATAAA
    CCAGCCAGCC GGAAGGGCCG AGCGCAGAAG TGGTCCTGCA
    ACTTTATCCG CCTCCATCCA
10401 GTCTATTAAAT TGTTGCCGGG AAGCTAGAGT AAGTAGTTCTG
    CCAGTTAATA GTTTGCGCAA CGTTGTTGCC ATTGCTACAG
    GCATCGTGGT GTCACGCTCG
10501 TCGTTTGGTA TGGCTTCATT CAGCTCCGGT TCCCAACGAT
    CAAGGCGAGT TACATGATCC CCCATGTTGT GCAAAAAAGC
    GGTTAGCTCC TTCGGTCCTC
10601 CGATCGTTGT CAGAAGTAAG TTGGCCGCAG TGTTATCACT
    CATGGTTATG GCAGCACTGC ATAATTCTCT TACTGTCATG
    CCATCCGTAA GATGCTTTTC
10701 TGTGACTGGT GAGTACTCAA CCAAGTCATT CTGAGAATAG
    TGTATGCGGC GACCGAGTTG CTCTTGCCCG GCGTCAATAC
    GGGATAATAC CGCGCCACAT
10801 AGCAGAACTT TAAAAGTGCT CATCATTTGA AAACGTTCTT
    CGGGGCGAAA ACTCTCAAGG ATCTTACCGC TGTGAGATC
    CAGTTCGATG TAACCCACTC

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FIG 8B CONT.

```

10901 GTGCACCCAA CTGATCTTCA GCATCTTTTA CTTTCACCAG
      CGTTTCTGGG TGAGCAAAAA CAGGAAGGCA AAATGCCGCA
      AAAAAGGGAA TAAGGGCGAC
11001 ACGGAAATGT TGAATACTCA TACTCTTCCT TTTTCAATAT
      TATTGAAGCA TTTATCAGGG TTATTGTCTC ATGAGCGGAT
      ACATATTTGA ATGTATTTAG
11101 AAAAATAAAC AAATAGGGGT TCCGCGCACA TTTCCCCGAA
      AAGTGCCACC TGACGTCTAA GAAACCATTA TTATCATGAC
      ATTAACCTAT AAAAATAGGC
11201 GTATCACGAG GCCCTTTCGT CTCGCGCGTT TCGGTGATGA
      CGGTGAAAAC CTCTGACACA TGCAGCTCCC GGAGACGGTC
      ACAGCTTGTC TGTAAGCGGA
11301 TGCCGGGAGC AGACAAGCCC GTCAGGGCGC GTCAGCGGGT
      GTTGGCGGGT GTCGGGGCTG GCTTAACTAT GCGGCATCAG
      AGCAGATTGT ACTGAGAGTG
11401 CACCATATGC GGTGTGAAAT ACCGCACAGA TCGGTAAGGA
      GAAAATACCG CATCAGGCGC CATTGCCCAT TCAGGCTGCG
      CAACTGTTGG GAAGGGCGAT
11501 CGGTGCGGGC CTCTTCGCTA TTACGCCAGC TGGCGAAAGG
      GGGATGTGCT GCAAGGCGAT TAAGTTGGGT AACGCCAGGG
      TTTTCCCAGT CACGACGTTG
11601 TAAAACGACG GCCAGTGAAT TACACCGGTG TGATCATGGG CCG

```

FIG 8B CONT.

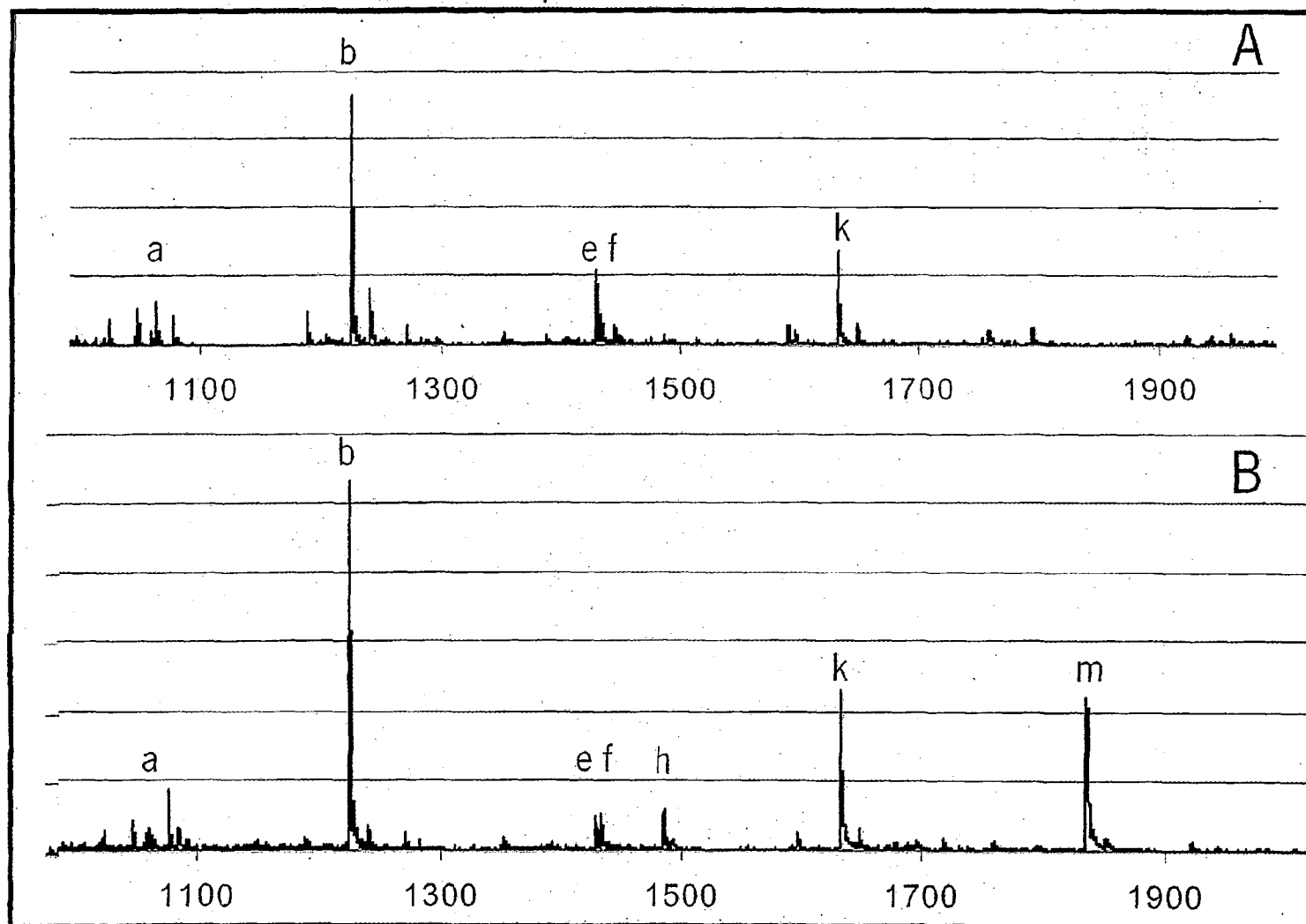


FIG. 9

atgaaatgagacgctacaagctctttcctatgctgtatgcccgcctgtgctcctatctccttctgcacttcttcaagacctg  
gtcctatgtacaccttcccccgagaactggcctccctcagccctaacctgtgtgctccagcttttctlgaacaatgcccggtca  
cgccccagggcagccccgagccaggaggccctgacctgtgtgctaccaccactctactccactcgcacctgtgcagcc  
gctgcgcgcccagcaaggcggccgaggagctccaccgggtggactgtgtgctcccaggacaccaccaggtatttctg  
gcgcaccaaggcggcggtgtgtgtcttcaaacccggcaccagaatgtgtgagaggccgccccgggacggccggag  
gagaagcctgagggggccaacggtctctggccggcgccaccgggtacctctgagcgccccgggagcgcacgg  
ggggccggaggcgccccggcgcaagtgggtggagtgcgtgtgctgtcccggctggcacggaccagctgcggcggtgcc  
cactgtgtgtcagtaactcaacctgccaccaaaggagcggtgtgtgtcccaggggagggtgcggcgccgcgtcatcaacgc  
catcaacgtcaaccacgagttcgacctgtgtgacgtgcgtctccacgagctgggcgacgtgtgtggacggccttgtgtgtg  
cgagtccaacttcacggcttatggggagccgcggccgctcaagtccgggagatgctgaccaatggcaccttcgagtaca  
tcgccacaagggtgctctatgtcttctggaccacttccgccccggcgccggcgaggacggctggtatcgccgacgactac  
ctgcgcaccttctcaccacaggacggcggtctcgcggaacctgcgcccgacgacgtcttcattgacgatgc  
ggacgagatcccgcccggtgacggcgctcttctcctcaagctctacgatggtgtgacggagcccttgccttcacatgcg  
caagtgcgtctacggcttctctggaagcagccgggcacccctggagggtgtgtcaggctgcacgggtggacatgctcagg  
cagtgtatgggctggacggcatccgctgcggccgcccagtaactacacatgcccaacttcagacagtatgagaaccgc  
accggccacatctcgtgtcagtggtcgtggcgagccccctgcacttcgcccgtgtgcactgtctctgtgtcttcacgcc  
cgagggtcatctcaagctcgtgtccgccagaatggcgacttccacgctggggtgactacgaggacaagcggggac  
ctgaactacatccggcctgatccgcacggggggctgtgttcgacgacgcagcaggagtaccgccttcgacagcccc  
agcgactacagatgtatgcgccaaagtacctgtctgaagaactacgacccgggttccactactgtctggacaacccctacaggga  
gccaggagcagcgcggcgccgggtggcgccacaggggtcccaggggaaggccgccccgggggcaaacctgg  
acgagggcggaagctag

FIG. 10



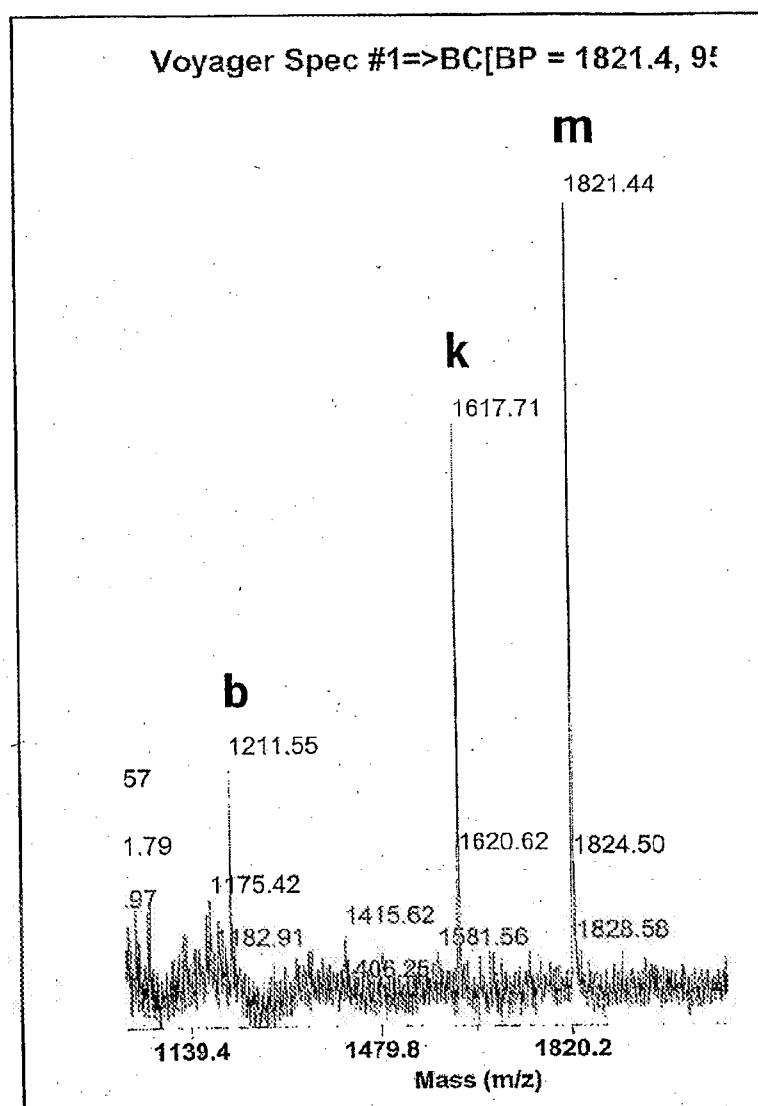


FIG 11

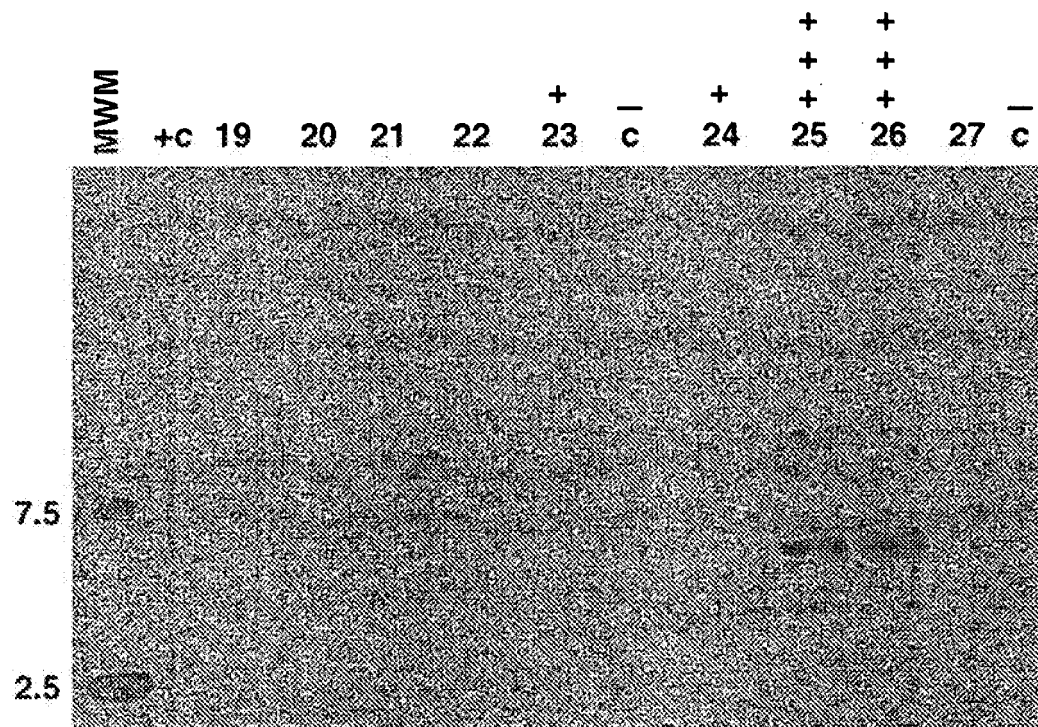


FIG. 12

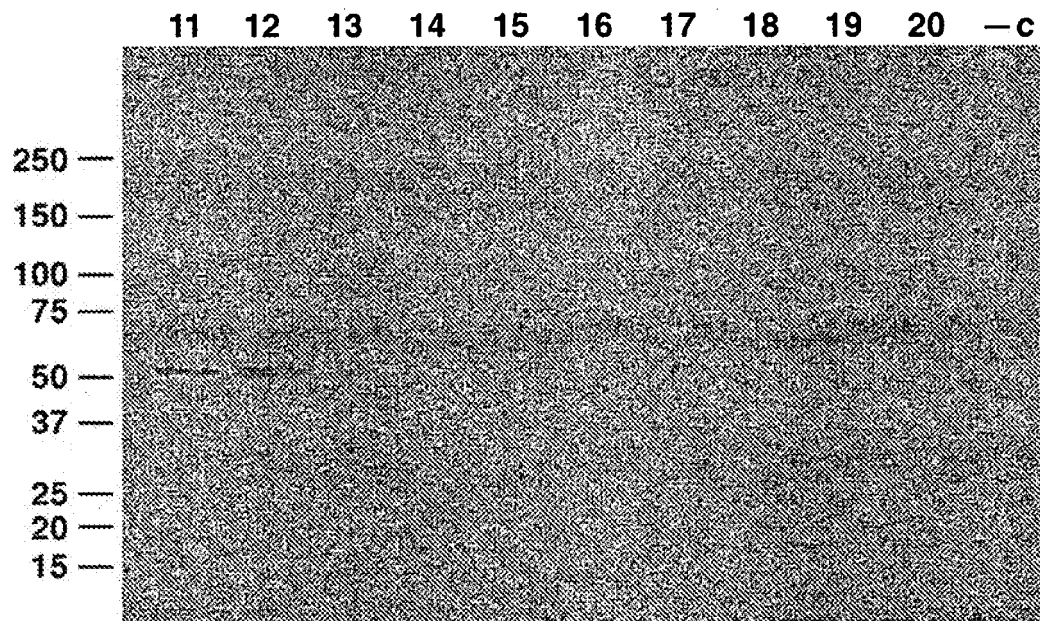


FIG. 13

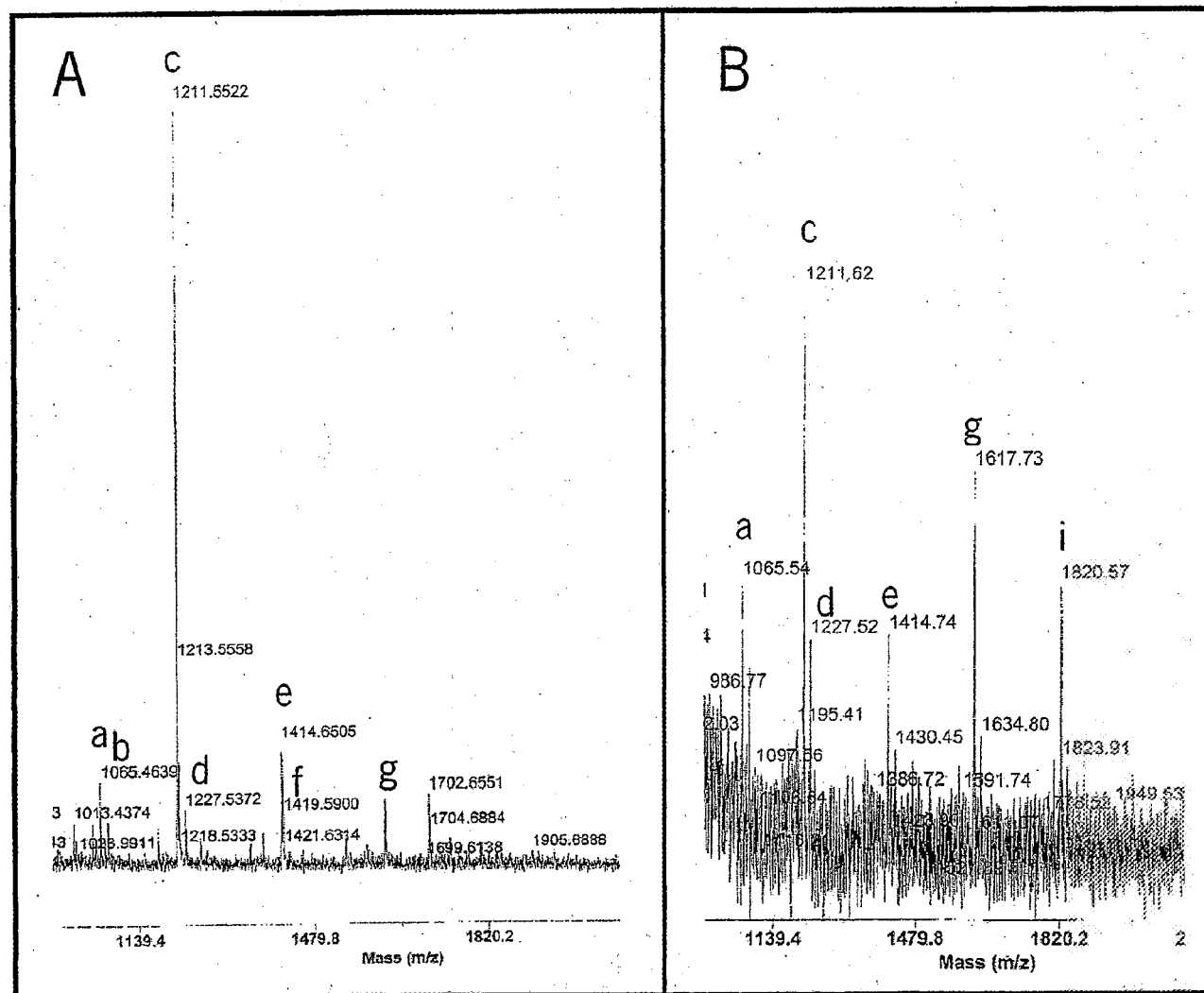


FIG. 14

## REFERENCES CITED IN THE DESCRIPTION

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## Electronic Acknowledgement Receipt

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| <b>EFS ID:</b>                              | 26969979                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Brian Flick                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 19-SEP-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 17:55:50                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

| Submitted with Payment |                      | no                                     |                                          |                  |                  |
|------------------------|----------------------|----------------------------------------|------------------------------------------|------------------|------------------|
| File Listing:          |                      |                                        |                                          |                  |                  |
| Document Number        | Document Description | File Name                              | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1                      |                      | 13211-713-303_IDS_Filing_9-19-2016.pdf | 337673                                   | yes              | 5                |
|                        |                      |                                        | d008f657c4cf834b43d1986d6bcb3fef062b8411 |                  |                  |

|                              | Multipart Description/PDF files in .zip description |                                                |                                          |     |     |
|------------------------------|-----------------------------------------------------|------------------------------------------------|------------------------------------------|-----|-----|
|                              | Document Description                                |                                                | Start                                    | End |     |
|                              | Transmittal Letter                                  |                                                | 1                                        | 3   |     |
|                              | Information Disclosure Statement (IDS) Form (SB08)  |                                                | 4                                        | 5   |     |
| Warnings:                    |                                                     |                                                |                                          |     |     |
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| 2                            | Foreign Reference                                   | EP283672B1.pdf                                 | 1603865                                  | no  | 23  |
|                              |                                                     |                                                | 6ade10480ab98bbdbc3f7ab7edea203c1ea317fd |     |     |
| Warnings:                    |                                                     |                                                |                                          |     |     |
| Information:                 |                                                     |                                                |                                          |     |     |
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|                              |                                                     |                                                | 75e63872d4e2d57f082dc3da685332142911f433 |     |     |
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| Information:                 |                                                     |                                                |                                          |     |     |
| 6                            | Foreign Reference                                   | EP2319934B1.pdf                                | 22795970                                 | no  | 103 |
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Brian Flick

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 14/925,968 Confirmation No.: 2707

First Named Inventor : Adam Bowen

Filed : October 28, 2015

Art Unit : 1747

Examiner : Mayes, Dionne Walls

Title : NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES  
AND METHODS THEREOF

Customer No. : 66854

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In accordance with 37 CFR § 1.97-1.98, applicants hereby submit an Information Disclosure Statement, including attached forms(s) PTO/SB/08. A copy of each reference is being submitted herewith, along with a concise explanation in English for those publications in a foreign language.

Applicants respectfully request that the listed information be considered by the Examiner and be made of record in the above-identified application. Applicants further request that the Examiner initial and return a copy of the attached form(s) PTO/SB/08 in accordance with MPEP §609.

Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and /or to prove that this information may not be enabling for the teachings purportedly offered.

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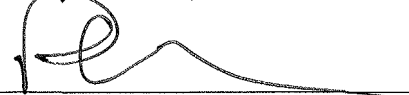
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Respectfully Submitted,

By:   
Richard D. Shoop, Reg. No. 45,763

Dated: September 19, 2016

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|                                                                                                                                              |   |    |   | Filing Date              | October 28, 2015    |
|                                                                                                                                              |   |    |   | First Named Inventor     | Adam Bowen          |
|                                                                                                                                              |   |    |   | Art Unit                 | 1747                |
|                                                                                                                                              |   |    |   | Examiner Name            | Mayes, Dionne Walls |
| Sheet                                                                                                                                        | 2 | of | 2 | Attorney Docket Number   | 13211-713.303       |

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|                                 | 703                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,748 entitled "Cartridge for use with a vaporizer device," filed 9/6/2016                                                                                                                                               |                |
|                                 | 704                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,760 entitled "Vaporizer apparatus," filed 9/6/2016                                                                                                                                                                     |                |
|                                 | 705                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,768 entitled "Vaporizer apparatus," filed 9/6/2016                                                                                                                                                                     |                |
|                                 | 706                   | MONSEES et al.; U.S. Pat. Appl. # 15/261,823 entitled "Low temperature electronic vaporization device and methods," filed 9/9/2016                                                                                                                              |                |
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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau(10) International Publication Number  
**WO 2015/013327 A2**(43) International Publication Date  
29 January 2015 (29.01.2015)(51) International Patent Classification:  
A24F 47/00 (2006.01)(21) International Application Number:  
PCT/US2014/047687(22) International Filing Date:  
22 July 2014 (22.07.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
61/857,931 24 July 2013 (24.07.2013) US(71) Applicant: **ALTRIA CLIENT SERVICES INC.**  
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PC, P. O. Box 1404, Alexandria, Virginia 22313-1404  
(US).(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, DK, DM,DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
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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, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
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**Published:**

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: ELECTRONIC SMOKING ARTICLE WITH ALTERNATIVE AIR FLOW PATHS

(57) **Abstract:** An apparatus and method of controlling resistance-to-draw of an electronic smoking article is disclosed, which includes a reusable portion and a cartomizer portion, and which includes: supplying an air flow from one or more inlets in an outer cylindrical housing of the electronic smoking article to a cartomizer via a cartomizer inlet having a fixed diameter configured to control a resistance-to-draw of the electronic smoking article and wherein the cartomizer inlet is located inside the outer cylindrical housing of the electronic smoking article, wherein a combined air flow area of the one or more inlets in the outer housing of the electronic smoking article are greater than a cross-sectional area of the cartomizer inlet; heating a liquid material from a reservoir to form an aerosol; and combining the at least initially volatilized liquid material with the air flow from the cartomizer inlet.



WO 2015/013327 A2

## ELECTRONIC SMOKING ARTICLE WITH ALTERNATIVE AIR FLOW PATHS

### RELATED APPLICATION(S)

**[0001]** The present application claims priority under 35 U.S.C. 119 to U.S. Provisional Patent Application No. 61/857,931, filed on July 24, 2013, the entire content of which is hereby incorporated by reference.

### WORKING ENVIRONMENT

**[0002]** Electronic smoking articles.

### SUMMARY

**[0003]** In accordance with an exemplary embodiment, an electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprises: an outer cylindrical housing extending in a longitudinal direction, the outer cylindrical housing having one or more inlets configured to allow air to be drawn into the smoking article; a power source; a cartomizer, which includes: a reservoir; a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol; and a gasket in fluid communication with the one or more inlets and configured to provide a seal with an interior surface of the outer cylindrical housing and having a central, longitudinal air passage configured to provide resistance-to-draw (RTD) to the smoking article, and wherein a combined air flow area of the one or more inlets of the outer cylindrical housing is greater than a cross-sectional area of the longitudinal air passage of the gasket; a condensation chamber in communication with an outlet on a downstream end of the cartomizer; and a mouth-end insert.

**[0004]** In accordance with an exemplary embodiment, an electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprises: a reusable portion housing a power source and circuitry; a cartomizer portion housing a cartomizer, which includes: a reservoir; and a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol; a condensation chamber in communication with an outlet on a downstream end of the air flow channel; and a mouth-end insert; and a connector configured to connect the reusable portion to the



cartomizer portion, and wherein the connector has a plurality of circumferentially spaced apart slots, which is in fluid communication with one or more cartomizer holes, and wherein the one or more cartomizer holes are configured to provide a source of air flow to the heater and wick arrangement of the cartomizer, and wherein a combined air flow area of the plurality of circumferentially spaced apart slots is greater than a combined cross-sectional area of the one or more cartomizer holes.

**[0005]** In accordance with an exemplary embodiment, an electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprises: a reusable portion housing a power source and circuitry; a cartomizer portion housing a cartomizer, which includes: a reservoir; and a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol; a condensation chamber in communication with an outlet on a downstream end of the air flow channel; and a mouth-end insert; and at least one vent hole positioned in the reusable portion of the smoking article between a downstream end of the power source and the cartomizer portion, and wherein the at least one vent hole is in fluid communication with a flow control insert located on an upstream end of an air flow channel of the cartomizer, the flow control insert having at least one cartomizer inlet configured to control an amount of air flow to the cartomizer, and wherein an air flow area of the at least one vent hole is greater than an air flow area of the at least one cartomizer inlet.

**[0006]** In accordance with an exemplary embodiment, a method of controlling resistance-to-draw of an electronic smoking article, which includes a reusable portion and a cartomizer portion, comprises: supplying an air flow from one or more inlets in an outer cylindrical housing of the smoking article to a cartomizer via a cartomizer inlet having a fixed diameter configured to control a resistance-to-draw of the smoking article and wherein the cartomizer inlet is located inside the outer cylindrical housing of the electronic smoking article, and wherein a combined air flow area of the one or more inlets in the outer housing of the smoking article is greater than a cross-sectional area of the cartomizer inlet; heating a liquid material from a reservoir to form an aerosol in a central air channel; combining the at least initially volatilized liquid material with the air flow from the cartomizer inlet; and condensing the saturated vapor within the condensation chamber in communication with the air flow channel to form the aerosol.

**[0007]** In accordance with an exemplary embodiment, a method of establishing a common, predetermined RTD consistently amongst a plurality of electronic smoking articles includes: for each electronic smoking article, establishing an airflow path within said electronic smoking article and including at a location along said airflow path a passage through a resilient gasket; and for each smoking article, determining an RTD by disposing a common, rigid tubular member at a location along said passageway, said tubular member having an inner diameter that establishes said common, predetermined RTD in said smoking article.

**[0008]** The electronic smoking article can also include a mouth-end insert in fluid communication with the condensation chamber so as to deliver aerosol to a smoker (or vaper).

**[0009]** As used herein, the term “electronic smoking article” is inclusive of all types of electronic smoking articles, regardless of form, size or shape, including electronic cigarettes, electronic cigars, electronic pipes, electronic hookahs and the like. The liquid aerosol formulation can include nicotine or be nicotine free. Moreover, the liquid aerosol formulation can include tobacco flavors or instead, or in combination include other suitable flavors

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0010]** The accompanying figures are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The figures illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

**[0011]** FIG. 1 is a cross-section view of an electronic smoking article in accordance with an exemplary embodiment.

**[0012]** FIG. 2 is a perspective view of the cartomizer section of an electronic smoking article with and without the outer housing according to an exemplary embodiment.

**[0013]** FIG. 3 is a perspective view of an electronic smoking article in accordance with an exemplary embodiment.

**[0014]** FIG. 4 is a perspective view of the connector as shown in FIG. 3.

**[0015]** FIG. 5 is a perspective view of an electronic smoking article having a connector as shown in FIG. 3 in accordance with an exemplary embodiment.

**[0016]** FIG. 6 is another perspective view of an electronic smoking article having a connector as shown in FIG. 3 in accordance with an exemplary embodiment.

**[0017]** FIG. 7 is a perspective view of an electrical smoking article in accordance with an exemplary embodiment.

**[0018]** FIG. 8 is a perspective view of a flow control insert of the smoking article as shown in FIG. 7 in accordance with an exemplary embodiment.

**[0019]** FIG. 9 is a perspective view of the flow control insert as shown in FIG. 7 in accordance with an exemplary embodiment.

**[0020]** FIG. 10 is a cross-sectional side view of the gasket of the electronic smoking article of FIG. 2.

#### **DETAILED DESCRIPTION**

**[0021]** In an electronic smoking article 100, the difference between the pressure of the incoming and outgoing air can be referred to as the resistance-to-draw (RTD) of the article 100. For example, the resistance-to-draw is the resistance offered by the electronic smoking article 100, as the smoker (or vaper) draws on the article. Having an article's resistance-to-draw (RTD) within an appropriate range can be important for delivering a good smoker experience. For example, the factors that define the RTD of an electronic smoking article 100 can include the resistance offered to the airflow by the geometry of the article 100 and the flow rate at which air is drawn into the article 100. While the flow rate can be controlled by the smoker, the geometry design of the article 100 can be used to achieve a targeted RTD range and regulate which hole(s) or passage(s) within the article 100 can control the RTD of the article 100.

**[0022]** In some electronic smoking article designs, if a smoker or consumer inadvertently blocks one or both of the air vent holes (or cartomizer holes) partially or completely, this can result in an increase in the RTD of the article 100. Accordingly, it would be desirable to provide an electronic smoking article 100, wherein the hole(s) or passage(s), which control the resistance-to-draw (RTD), are inside the electronic smoking article 100 as disclosed herein. In addition, it would be desirable

to have an electronic smoking article 100 that is configured such that if the smoker and/or consumers blocks or obstructs one or more of the air vent holes with his or her fingers, the blockage or obstruction of the one or more air vent holes will not significantly influence the resistance-to-draw (RTD).

**[0023]** In accordance with exemplary embodiments, as shown in FIGS. 1-9, the resistance-to-draw (RTD) can be located inside the electronic smoking article in such a way that the airflow is not impacted by the usage behavior of the consumer, for example, how the smoker and/or consumer holds the electronic smoking article. In accordance with an exemplary embodiment, an electronic smoking article is disclosed having a gasket with a central, longitudinal air passage having a fixed diameter (or hole size), which can be configured to control a desired resistance-to-draw (RTD) of the electronic smoking article. In addition, by controlling the desired resistance-to-draw from within the electronic smoking article, the size of the one or more inlets or vent holes in the outer housing become less critical, such that the resistance-to-draw of the electronic smoking article 100 is not impacted by the usage behavior of the consumer, for example, how he or she handles the electronic smoking article.

**[0024]** FIG. 1 is a cross-sectional view of a schematic diagram of an electronic smoking article 100, such as an electronic cigarette according to an exemplary embodiment. As shown in FIG. 1, the electronic smoking article 100 comprises a reusable fixture (or first section) 110, and a replaceable cartomizer section (or second section) 120, which are coupled together at a threaded joint (not shown) or by other convenience such as a snug-fit, snap-fit, detent, clamp and/or clasp.

**[0025]** In accordance with an exemplary embodiment, the first section 110 can house a power supply 112 and control circuitry 114. In accordance with an exemplary embodiment, the replaceable cartomizer section 120 includes a connector portion 130, a cartomizer 140, a condensation chamber 150, and a mouth-end insert 160.

**[0026]** The reusable fixture 110 and the cartomizer section 120 have a generally cylindrical outer housing 102 extending in a longitudinal direction along the length of the electronic smoking article 100. In accordance with an exemplary embodiment, the electronic smoking article 100 is formed so that the diameter of the electronic

cigarette is substantially uniform along the length thereof. In accordance with an exemplary embodiment, the outer cylindrical housing 102 is substantially continuous along the length thereof and can be rigid.

**[0027]** In accordance with an exemplary embodiment, a pressure activated switch (not shown) can be positioned on an outer surface of the outer cylindrical housing 102, which acts to activate a heater. By applying manual pressure to the pressure switch, the power supply is activated and an electric current heats a liquid or liquid material 144 in the cartomizer 140 via electrical contacts so as to volatilize the liquid material 144. For example, a depression (not shown) can be formed in the outer cylindrical housing 102 to indicate where the smoker or consumer should apply pressure. The depression can extend fully or partially about the circumference of the outer cylindrical housing 102.

**[0028]** In accordance with an exemplary embodiment, the power supply 112 is activated upon application of manual pressure to the pressure switch and the cartomizer 140 is heated to form a heated section wherein the liquid material 144 within a fluid reservoir (or liquid supply region) 142 is volatilized. Upon discharge from a central air flow channel 180, the volatilized material expands, mixes with air and forms an aerosol.

**[0029]** In accordance with an exemplary embodiment, the cartomizer section 120 includes the reservoir 142 including a liquid material 144 and a heater and wick arrangement 170 in fluid communication with the reservoir 142, such that the wick arrangement 170 draws or wicks the liquid material 144 from the reservoir 142 and heats the liquid material 144 to form an aerosol in a central air channel 180. The cartomizer section 120 includes an outer tube (or housing) 104 extending in a longitudinal direction and an inner tube (or chimney) 200 coaxially positioned within the outer tube 104.

**[0030]** In an exemplary embodiment, the power supply 112 is operable to apply voltage across a heater and wick arrangement 170 associated with the cartomizer 140 and volatilizes the liquid material 144 contained therein according to a power cycle of either a predetermined time period, such as a 5 second period, or for so long as the pressure activated switch is pressed. The heater and wick arrangement 170 can include a heater 172 and a filamentary wick 174.

**[0031]** In use, for example, liquid material 144 is transferred from the reservoir 142 in proximity of the heater and wick arrangement 170 by capillary action of the filamentary wick 174. In an embodiment, the filamentary wick 174 has a first end portion and a second end portion, wherein the first end and the second end extend into opposite sides of the reservoir for contact with liquid material contained therein. Also preferably, the heater 172 at least partially surrounds a central portion of the filamentary wick 174 such that when the heater 172 is activated, the liquid in the central portion of the filamentary wick 174 is vaporized by the heater 172 to form an aerosol.

**[0032]** The filamentary wick 174 preferably comprises filaments having a capacity to draw a liquid, more preferably a bundle of glass (or ceramic) filaments and most preferably a bundle comprising a group of windings of glass filaments, preferably three of such windings, all which arrangements are capable of drawing liquid via capillary action via interstitial spacings between the filaments. Alternatively, in place of the filamentary wick 174, a heated capillary or capillary tube (not shown) can be used, which volatilizes a liquid such as by way of the teachings set forth in US Patent 5,743,251, which is incorporated herein in its entirety by reference thereto.

**[0033]** In accordance with an exemplary embodiment, the inner tube 200 has an upstream end portion 202 and a downstream end portion 204. An upstream gasket (or seal) 210 is fitted into the upstream end portion 202 of the inner tube 200, while at the same time, an outer perimeter 222 of the gasket 210 provides a liquid-tight seal with an interior surface 108 of the outer housing 104. In accordance with an exemplary embodiment, the gasket 210 preferably includes a central, longitudinal air passage (or channel) 220, which opens into an interior 212 of the inner tube 200 that defines a central channel 180.

**[0034]** Referring to FIG. 10, in accordance with an exemplary embodiment, the gasket 210 can include a rigid tubular gasket insert 240, which can be inserted into a central passage 220 of the gasket 210 and extends at least partially through the central passage 220 of the gasket 210. In accordance with an exemplary embodiment, the gasket insert 240 can be a metal tubular insert, which is configured to provide a precisely defined orifice or outlet 224 so to consistently provide a desired resistance-to-draw from one electronic smoking article 100 to the next. In this embodiment, the gasket 210 may be constructed of a resilient material so that its

capacity to seal remains intact. The rigid insert 240 not only provides a way to exactly control RTD, but also facilitates effecting a change in the desired RTD, which would require only a change in the inner diameter of the insert 240.

**[0035]** The central, longitudinal passage 220 has an upstream end 221 and a downstream end 223. In accordance with an exemplary embodiment, air enters the electronic smoking article 100 through one or more inlets 190 in the outer housing 104. The upstream end 221 of the longitudinal air passage 220 is in fluid communication with the one or more inlets 190. In accordance with an exemplary embodiment, the downstream end 223 of the longitudinal passage 220 has a gasket outlet 224. Once the air enters the cartomizer section 120, the air passes through the gasket outlet 224 before reaching the heater and wick arrangement 170. In accordance with an exemplary embodiment, the gasket outlet 224 can have a fixed cross-sectional shape, for example, round or oval, which helps control the overall resistance-to-draw (RTD) of the electronic smoking article 100 as opposed to external cartomizer holes or vents within the outer housing 104.

**[0036]** The power source 112 can be a Lithium-ion battery or one of its variants, for example a Lithium-ion polymer battery. The power source 112 may be a Nickel-metal hydride battery, a Nickel cadmium battery, a Lithium-manganese battery, a Lithium-cobalt battery or a fuel cell. In that case, preferably, the electronic smoking article 100 is usable by a smoker until the energy in the power supply is depleted. The power source 112 may be rechargeable and include circuitry allowing the battery to be chargeable by an external charging article. In that case, the circuitry, when charged, provides power for a pre-determined number of puffs, after which the circuitry may be re-connected to an external charging article.

**[0037]** The electronic smoking article 100 also includes control circuitry 114, which can be on a printed circuit board (not shown). Once the pressure switch is pressed, the power supply is activated and supplies power to the heater 172. The control circuitry 114 can also include a heater activation light (not shown) operable to glow when the heater 172 is activated. Preferably, the heater activation light comprises an LED and is at an upstream end 106 of the electronic smoking article 100 so that the heater activation light makes end 106 glow with the appearance of a burning coal during a puff.

**[0038]** The control circuitry 114 is electrically connected to the pressure switch (not shown) and supplies power to a heater 172 of a heater and wick arrangement 170, which is responsive to pressing the pressure switch, preferably with a maximum, time-period limiter (e.g. a timing circuit). The control circuitry 114 can also include a timer operable to limit the time for which power is supplied to the heater 172. The time-period of the electric current supply to the heater 172 may be pre-set depending on the amount of liquid desired to be vaporized. The control circuitry 114 can be programmable for this purpose. The control circuitry can be an application specific integrated circuit (ASIC).

**[0039]** In accordance with an exemplary embodiment, the cartomizer section 120 includes a reservoir 142 including a liquid material 144 and a heater and wick arrangement 170 that draws or wicks liquid material 144 from the reservoir 142 and heats the liquid to form an aerosol in a central air channel 214. Upon completing the threaded connection, the power source 112 is electrically connected with the heater and wick arrangement 170. The liquid material 144 can include a tobacco-containing material including volatile tobacco flavor compounds, which are released from the liquid material 144 upon heating. The liquid material 144 may also be a tobacco flavor containing material and/or a nicotine-containing material. Alternatively, or in addition, the liquid material 144 may include a non-tobacco material and/or may be nicotine-free. For example, the liquid material 144 may include water, solvents, ethanol, plant extracts and natural or artificial flavors. Preferably, the liquid material 144 further includes an aerosol former. Examples of suitable aerosol formers are glycerine and propylene glycol.

**[0040]** The electronic smoking article 100 further includes a mouth-end insert 160, which is in fluid communication with the condensation chamber 150 and includes at least two diverging outlets (not shown), for example 3, 4, 5, or preferably 6 to 10 outlets or more. Preferably, four outlets of the mouth-end insert 160 are located at ends of off-axis passages and are angled outwardly in relation to the longitudinal direction of the electronic smoking article 100 (i.e., divergently). As used herein, the term "off-axis" denotes at an angle to the longitudinal direction of the electronic cigarette. Also preferably, the mouth-end insert 160 includes outlets uniformly distributed around the mouth-end insert 160 so as to substantially uniformly distribute aerosol in a smoker's mouth during use. Thus, as the aerosol passes into



a smoker's mouth, the aerosol enters the mouth and moves in different directions so as to provide a full mouth feel as compared to electronic cigarettes having an on-axis single orifice, which directs the aerosol to a single location in a smoker's mouth.

**[0041]** In an embodiment, the electronic smoking article 100 is about the same size as a conventional cigarette. In some embodiments, the electronic cigarette 60 can be about 80 mm to about 110 mm long, preferably about 80 mm to about 100 mm long and about 7 mm to about 8 mm in diameter. For example, in an embodiment, the electronic cigarette is about 84 mm long and has a diameter of about 7.8 mm.

**[0042]** The outer cylindrical housing 102 of the electronic smoking article 100 may be formed of any suitable material or combination of materials. Examples of suitable materials include metals, alloys, plastics or composite materials containing one or more of those materials, or thermoplastics that are suitable for food or pharmaceutical applications, for example polypropylene, polyetheretherketone (PEEK), ceramic, low density polyethylene (LDPE) and high density polyethylene (HDPE). Preferably, the material is light and non-brittle. Thus, the outer cylindrical housing 102 can be formed of a variety of materials including plastics, rubber and combinations thereof. In a preferred embodiment, the outer cylindrical housing 102 is formed of silicone. The outer cylindrical housing 102 can be any suitable color and/or can include graphics or other indicia printed thereon.

**[0043]** The heater and wick arrangement 170 can include an electrical heating element. The heater portion 172 of the heater and wick arrangement 170 preferably includes an electrically resistive material. Suitable electrically resistive materials include but are not limited to: semiconductors such as doped ceramics, electrically "conductive" ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may include doped or undoped ceramics.

**[0044]** In an exemplary embodiment, the volatilized liquid material 144 formed as described herein can at least partially condense to form an aerosol including particles. Preferably, the particles contained in the vapor and/or aerosol range in size from about 0.5 micron to about 4 microns, preferably about 1 micron to about 4

microns. Also preferably, the particles are substantially uniform throughout the vapor and/or aerosol.

**[0045]** FIG. 2 is a perspective view of the gasket 210 of the cartomizer section 140 of an electronic smoking article 100 with and without the outer housing 104 according to an exemplary embodiment. As shown in FIG. 2, the gasket 210 can include an annular portion 242 having a central, longitudinal air passage 220 having a fixed inner diameter. In accordance with an exemplary embodiment, the longitudinal air passage 220 can be configured to provide a desired resistance-to-draw (RTD) to the smoking article 100, when a total air flow area of the one or more inlets 190 of the outer cylindrical housing 102 is greater than a cross-sectional area of the longitudinal air passage 220 of the gasket 210. In accordance with an exemplary embodiment, by modifying or changing the size or diameter of the longitudinal air passage 220 of the gasket 210 and corresponding cross-sectional area (or diameter) of the gasket outlet 224, the RTD of the electronic smoking article can be controlled from inside the electronic smoking article 100 rather than based on the inlets 190 on the outer housing 102.

**[0046]** In accordance with another exemplary embodiment, the gasket 210 can be made out of any hard material that is easily machineable, for example, plastic (PET, PEEK), stainless steel or metal to maintain a desired diameter of the longitudinal air passage 220 of the gasket 210, which can be used to define the RTD of the electronic smoking article. In accordance with an exemplary embodiment, for example, if the gasket 210 is manufactured from a relatively hard material, an annular seal or O-ring (not shown) can be positioned around the outer perimeter 222 of the gasket 210 to form a seal between the outer perimeter 222 of the gasket 210 and inner portion of the outer housing 104.

**[0047]** FIG. 3 is a perspective view of an electronic smoking article 100 having a connector 300 for connecting the reusable fixture 110 to the cartomizer section 120. In accordance with an exemplary embodiment, air flow enters the electronic smoking article 100 through a plurality of circumferentially spaced apart slots 302 generated by "castling" within the connector 300. The plurality of slots 302 in combination with an outer surface of the cartomizer section 120 forms a continuous annular channel 350 between an inner surface of the plurality of flanges 320 and the outer surface of the cartomizer section 120. The continuous annular channel 350 is configured to be

in fluid communication with the one or more cartomizer vent holes 340. After entering through the plurality of slots 302 into the annular channel 350, the air enters the cartomizer 140 through one or more cartomizer vent holes 340, which are in fluid communication with the annular channel 350.

**[0048]** In accordance with an exemplary embodiment, the one or more cartomizer vent holes 340 are circumferentially spaced around the cartomizer section 120 and provide a controlling parameter for the resistance-to-draw (RTD) of the electronic smoking article 100. In accordance with an exemplary embodiment, for example, the electronic smoking article 100 can be configured with two cartomizer vent holes 340, which are circumferentially spaced apart approximately 180 degrees from one another on an outer portion of the cartomizer 140. The two or more cartomizer vent holes 340 are configured to be in fluid communication with the longitudinal air passage 220 of the cartomizer 140.

**[0049]** In accordance with an exemplary embodiment, depending upon the RTD desired, the one or more cartomizer vent holes 340 and the slots 302 within the connector 300 are configured in such a way that blocking the cartomizer vent holes 340 does not affect the RTD of the electronic smoking article 100. For example, the number and size of slots 302 can be designed in such a way that blocking any of the slots 302 would not change the RTD, which allows consumers to hold and use the article 100 as per their convenience. In accordance with an exemplary embodiment, a combined air flow area of the plurality of circumferentially spaced apart slots 302 is preferably greater than a combined cross-sectional area of the one or more cartomizer holes 340, which allows the one or more cartomizer holes 340 to control the resistance-to-draw of the electronic smoking article.

**[0050]** As shown in FIG. 4, the connector 300 has a cylindrical housing 310 with a first end 312 and a second end 314. The first end 312 has a plurality of flanges 320 (or "castles"), which are concentric to the first end 312 of the connector 300, and one or more openings 330 formed between the plurality of flanges 320. The plurality of flanges 320 and the one or more openings 330 form the plurality of slots 302 when the reusable fixture (or first section) 110 and the replaceable cartomizer section (or second section) 120 are coupled together. The one or more openings 330 are configured to allow air to enter into a continuous annular channel 350 on an

upstream end 121 of the cartomizer section 120. Each of the plurality of flanges 320 preferably has a relatively round portion 322 and an angled portion 324.

**[0051]** In accordance with an exemplary embodiment as shown in FIGS. 4-6, the connector 300 can include four slots 302, which includes two diametrically opposite slots 302, which are aligned with two or more cartomizer vent holes 340 with the other two slots 302 not in alignment with the two or more cartomizer vent holes 340. As shown in FIG. 5, the two or more cartomizer vent holes 340 are located within the continuous annular channel 350. In accordance with an exemplary embodiment, openings for each of the two or more cartomizer vent holes 340 are configured to face the upstream end 106 of the article 100, such that the axes for each of the two or more cartomizer vent holes 340 are preferably perpendicular to the outer housing 102 of the electronic smoking article 100.

**[0052]** In accordance with an exemplary embodiment, for example, to achieve a target RTD of about 100 to 130 mm of water, the cartomizer vent holes 340 can have a diameter of about 0.50 to about 1.0 mm, and more preferably a diameter of about 0.63 mm and the width of the one or more slots can be about 1.0 mm to 3.0 mm, for example, 1.25 mm to 2.75 mm. However, the diameter of the of the cartomizer holes 340 can vary from about 0.50 mm to about 1.50 mm depending on the desired resistance-to-draw of the electronic smoking article in combination with one or more design features of the cartomizer 140 and the amount of air flow which is desired in the interior 212 of the inner tube 200 of the cartomizer 140.

**[0053]** FIG. 5 is a perspective view of an electronic smoking article having a connector as shown in FIG. 3 in accordance with an exemplary embodiment. For example, in accordance with an exemplary embodiment, in order to achieve a target resistance-to-draw (RTD) in a range of about 100 mm to about 130 mm of water, the cartomizer hole 340 size can be approximately 0.63 mm, which can produce a resistance-to-draw of about 119 mm of water when each of the four slots 302 are open and/or unobstructed.

**[0054]** As shown in FIG. 5, the airflow 360 enters the electronic smoking article 100 through the one or more slots 302 and into the cartomizer 140 through two or more cartomizer vent holes 340, which are in fluid communication with the heater and wick arrangement 170. In accordance with an exemplary embodiment, the two

or more cartomizer vent holes 340 are positioned within the outer cylindrical housing 102 such that if one or more of the slots 302 is blocked or obstructed, the flow of air 360 is allowed to enter the cartomizer vent holes 340 via the annular channel 350.

**[0055]** FIG. 6 is another perspective view of an electronic smoking article having a connector as shown in FIG. 3 in accordance with an exemplary embodiment. For example, as shown in FIG. 6, in accordance with an exemplary embodiment, the electronic smoking article 100 can include two cartomizer vent holes 340 having a diameter of approximately 0.63 mm and four slots 302. In accordance with an exemplary embodiment, in which both the slots 302 aligned with the cartomizer holes 340 can produce a resistance-to-draw (RTD) of about 135 mm of water. In an exemplary embodiment, in which one slot 302 aligned with one of the two cartomizer holes 340 is blocked and/or obstructed, and a second slot 302 at about 90 degrees to the first slot 302 is also blocked and which is not aligned with the second of the two cartomizer holes 340, the electronic smoking article 100 can produce a resistance-to-draw of about 137 mm of water.

**[0056]** FIG. 7 is a perspective view of an electronic smoking article 100 having one or more vent holes 400 within the reusable fixture 110 of the electronic smoking article 100 and a flow control insert 500. In accordance with an exemplary embodiment, the air vent holes 400 can be placed in the reusable fixture (or battery end) 110 of the electronic smoking article 100. As shown in FIG. 7, the air enters the electronic smoking article 100 through the plurality of vent holes 400, which are in fluid communication with the opening (not shown) on the upstream end of the cartomizer 140 in the cartomizer section 120 to the electronic smoking article 100. For example, the plurality of vent holes 400 can be in fluid communication with the gasket 210. The air will enter the cartomizer 140 through the gasket outlet 224.

**[0057]** FIG. 8 is a perspective view of a flow control insert 500 of the electronic smoking article 100 as shown in FIG. 7. As shown in FIG. 8, the one or more vent holes 400 can be positioned on a downstream portion of the reusable fixture 110, for example, at a downstream end of the power source (or battery) 112. The one or more vent holes 400 are preferably located around an outer circumference of the outer housing 102 in such a way that if one or more of the vent holes 400 are blocked during use, the blocking of the one or more holes 400 does not change the RTD of the electronic smoking article 100. In accordance with an exemplary

embodiment, the one or more vent holes 400 are in fluid communication with an inner cavity 410 located between a downstream end of the power source 112 and an upstream end 420 of a flow control insert 500, which connects the reusable fixture 110 to the cartomizer section 140. The insert 500 can include a cylindrical housing 510 having an upstream end 512 and a downstream end 514. In accordance with exemplary embodiment, the cylindrical housing 510 has a flange 520 on the downstream end 514. Upon assembly of the electronic smoking article 100, the flange 520 is visible between the reusable fixture 110 and the cartomizer section 140. In accordance with an exemplary embodiment, for example, an air flow area of the one or more vent holes 400 is greater than an air flow area (or cross-sectional area) of one or more cartomizer inlets 530.

**[0058]** In accordance with an exemplary embodiment as shown in FIG. 7, the insert 500 can have one or more cartomizer inlets 530 on an upstream plate 540, which controls the amount of air, which is delivered the cartomizer section 140. The one or more cartomizer inlets 530 are in fluid communication with the one or more vent holes 400 in the outer housing 102 and the inner cavity 410 and provide a means for controlling the amount of air flow to the cartomizer section 140 and the corresponding RTD of the electronic smoking article 100. In accordance with an exemplary embodiment, the one or more cartomizer inlets 530 is a single or one round opening positioned within a center portion of the upstream plate 540. For example, the one or more cartomizer inlets 530 can have a diameter of about 0.8 to 1.0 mm.

**[0059]** The teachings herein are applicable to electronic cigars, and references to "electronic smoking article(s)" is intended to be inclusive of electronic cigars, electronic cigarettes and the like.

**[0060]** When the word "about" is used in this specification in connection with a numerical value, it is intended that the associated numerical value include a tolerance of  $\pm 10\%$  around the stated numerical value. Moreover, when reference is made to percentages in this specification, it is intended that those percentages are based on weight, for example, weight percentages.

**[0061]** Moreover, when the words "generally" and "substantially" are used in connection with geometric shapes, it is intended that precision of the geometric

shape is not required but that latitude for the shape is within the scope of the disclosure. When used with geometric terms, the words "generally" and "substantially" are intended to encompass not only features, which meet the strict definitions, but also features, which fairly approximate the strict definitions.

**[0062]** It will now be apparent that a new, improved, and nonobvious electronic cigarette has been described in this specification with sufficient particularity as to be understood by one of ordinary skill in the art. Moreover, it will be apparent to those skilled in the art that numerous modifications, variations, substitutions, and equivalents exist for features of the electronic cigarette, which do not materially depart from the spirit, and scope of the invention. Accordingly, it is expressly intended that all such modifications, variations, substitutions, and equivalents, which fall within the spirit and scope of the invention as defined by the appended claims, shall be embraced by the appended claims.

**What is Claimed is:**

1. An electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprising:
  - an outer cylindrical housing extending in a longitudinal direction, the outer cylindrical housing having one or more inlets configured to allow air to be drawn into the electronic smoking article;
  - a power source;
  - a cartomizer, which includes:
    - a reservoir;
    - a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol; and
    - a gasket in fluid communication with the one or more inlets and configured to provide a seal with an interior surface of the outer cylindrical housing and having a central, longitudinal air passage configured to provide resistance-to-draw (RTD) to the electronic smoking article, and wherein a combined air flow area of the one or more inlets of the outer cylindrical housing is greater than a cross-sectional area of the longitudinal air passage of the gasket;
  - a condensation chamber in communication with an outlet on a downstream end of the cartomizer; and
  - a mouth-end insert.
2. The electronic smoking article of claim 1, wherein the gasket is positioned on an upstream end of the cartomizer, and is configured to control an amount of air flow to the cartomizer during use, and wherein the amount of air flow through the gasket is mixed with the volatilized liquid material within the cartomizer to produce the aerosol.
3. The electronic smoking article of claim 1, comprising;
  - a rigid tubular insert configured to fit within the gasket, and wherein an inner diameter of the rigid tubular insert defines the fixed diameter of the gasket, and



which is configured to provide the resistance-to-draw (RTD) to the electronic smoking article.

4. The electronic smoking article of claim 1, wherein the gasket is made of a plastic, stainless steel, or a metal, which provides rigidity to the gasket.

5. The electronic smoking article of claim 1, wherein the heater and wick arrangement comprises a heated capillary tube, wherein the heater is operable to heat the capillary tube to a temperature sufficient to at least initially volatilize liquid material contained within the capillary tube.

6. The electronic smoking article of claim 1, comprising:  
control circuitry operable to control supply of power from the power source to the heater and wick arrangement.

7. An electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprising:  
a reusable portion housing a power source and circuitry;  
a cartomizer portion housing a cartomizer, which includes:  
a reservoir; and  
a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol;  
a condensation chamber in communication with an outlet on a downstream end of the air flow channel; and  
a mouth-end insert; and  
a connector configured to connect the reusable portion to the cartomizer portion, and wherein the connector has a plurality of circumferentially spaced apart slots, which is in fluid communication with one or more cartomizer holes, and wherein the one or more cartomizer holes are configured to provide a source of air flow to the heater and wick arrangement of the cartomizer, and wherein a combined air flow area of the plurality of circumferentially spaced apart slots is greater than a combined cross-sectional area of the one or more cartomizer holes.

8. The electronic smoking article of claim 7, wherein the one or more cartomizer holes are in fluid communication with a continuous annular channel formed in an outer portion of the electronic smoking article, and axes of the one or more cartomizer holes are perpendicular to an outer housing of the electronic smoking article.

9. The electronic smoking article of claim 7, wherein the one or more cartomizer holes is two cartomizer holes and the plurality of circumferentially spaced apart slots comprises four slots.

10. The electronic smoking article of claim 7, wherein the connector has a cylindrical housing with a first end and a second end, the first end having a plurality of flanges which are concentric to the first end of the connector and one or more openings formed between the plurality of flanges, and wherein the one or more openings form the plurality of slots when the reusable portion and the cartomizer portion are coupled together.

11. The electronic smoking article of claim 10, wherein each of the plurality of flanges has a relatively round portion and an angled portion.

12. The electronic smoking article of claim 11, comprising:  
a continuous annular channel formed between an outer surface of the cartomizer and an inner portion of the plurality of flanges, and wherein the continuous annular channel is in fluid communication with the one or more cartomizer holes.

13. The electronic smoking article of claim 7, wherein the heater and wick arrangement comprises a heated capillary tube, wherein the heater is operable to heat the capillary tube to a temperature sufficient to at least initially volatilize liquid material contained within the capillary tube.

14. An electronic smoking article capable of providing a cigarette experience without combusting tobacco, comprising:  
a reusable portion housing a power source and circuitry;

a cartomizer portion housing a cartomizer, which includes:

a reservoir; and

a heater and wick arrangement in communication with the reservoir including liquid material and operative to volatilize liquid material to produce an aerosol;

a condensation chamber in communication with an outlet on a downstream end of the air flow channel; and

a mouth-end insert; and

at least one vent hole positioned in the reusable portion of the electronic smoking article between a downstream end of the power source and the cartomizer portion, and wherein the at least one vent hole is in fluid communication with a flow control insert located on an upstream end of an air flow channel of the cartomizer, the flow control insert having at least one cartomizer inlet configured to control an amount of air flow to the cartomizer, and wherein an air flow area of the at least one vent hole is greater than an air flow area of the at least one cartomizer inlet.

15. A method of controlling resistance-to-draw of an electronic smoking article, which includes a reusable portion and a cartomizer portion, the method comprising:

supplying an air flow from one or more inlets in an outer cylindrical housing of the electronic smoking article to a cartomizer via a cartomizer inlet having a fixed diameter configured to control a resistance-to-draw of the electronic smoking article and wherein the cartomizer inlet is located inside the outer cylindrical housing of the electronic smoking article, and wherein a combined air flow area of the one or more inlets in the outer housing of the electronic smoking article is greater than a cross-sectional area of the cartomizer inlet;

heating a liquid material from a reservoir to form an aerosol in a central air channel;

combining the at least initially volatilized liquid material with the air flow from the cartomizer inlet; and

condensing the saturated vapor within the condensation chamber in communication with the air flow channel to form the aerosol.

16. The method of claim 15, wherein the cartomizer inlet comprises:

a gasket in fluid communication with the one or more inlets in the outer cylindrical housing and wherein the gasket is configured to provide a seal with an interior surface of the outer cylindrical housing, and having a central, longitudinal air passage having a fixed inner diameter configured to provide the resistance-to-draw (RTD) to the electronic smoking article, and wherein a combined air flow area of the one or more inlets of the outer cylindrical housing is greater than a cross-sectional area of the longitudinal air passage of the gasket.

17. The method of claim 15, wherein the cartomizer inlet comprises:  
a connector configured to connect the reusable portion to the cartomizer portion, and wherein the connector has a plurality of circumferentially spaced apart slots, which is in fluid communication with one or more cartomizer holes, and wherein the one or more cartomizer holes are configured to provide a source of air flow to a heater and wick arrangement of the cartomizer, and wherein a combined air flow area of the plurality of circumferentially spaced apart slots is greater than a combined cross-sectional area of the one or more cartomizer holes.

18. The method of claim 15, wherein the one or more inlets in the outer housing of the electronic smoking article comprises:  
at least one vent hole positioned in the reusable portion of the electronic smoking article between a downstream end of the power source and the cartomizer portion, and wherein the at least one vent hole is in fluid communication with a flow control insert located on an upstream end of an air flow channel of the cartomizer, the flow control insert having the cartomizer inlet configured to control an amount of air flow to the cartomizer, and wherein an air flow area of the one or more inlets is greater than an air flow area of the at least one cartomizer inlet.

19. The method of claim 15, comprising:  
supplying the aerosol to a smoker via a mouth-end insert.

20. A method of establishing a common, predetermined RTD consistently amongst a plurality of electronic smoking articles, comprising:

for each electronic smoking article, establishing an airflow path within said electronic smoking article and including at a location along said airflow path a passage through a resilient gasket; and

for each electronic smoking article, determining an RTD by disposing a common, rigid tubular member at a location along said passageway, said tubular member having an inner diameter that establishes said common, predetermined RTD in said electronic smoking article.

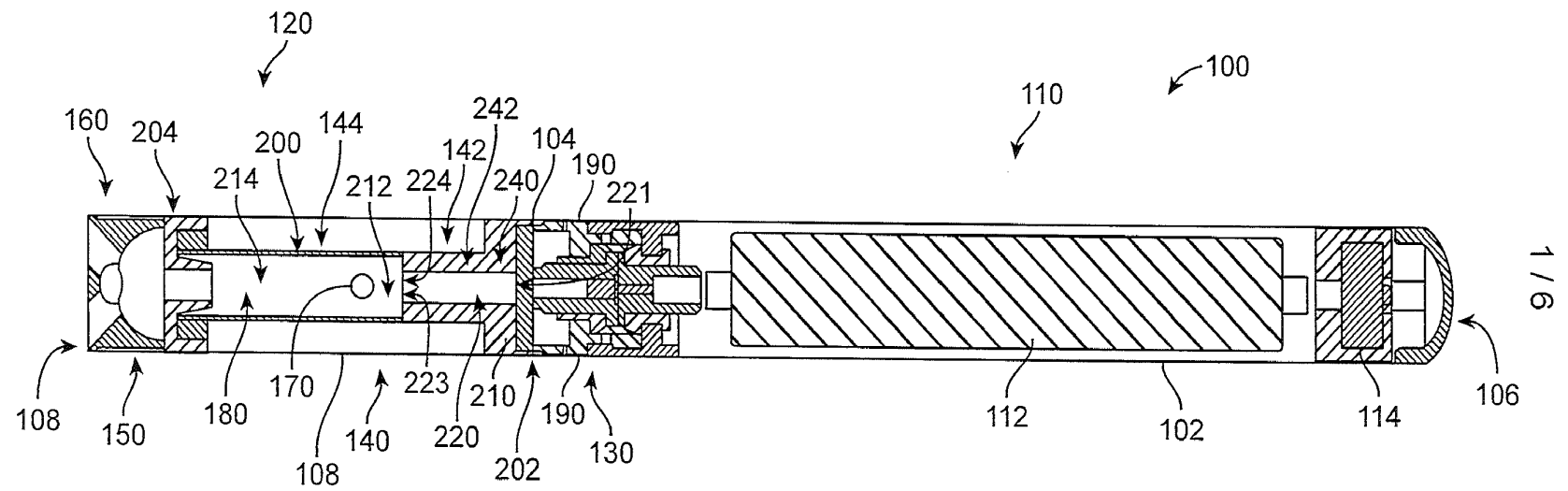


FIG. 1

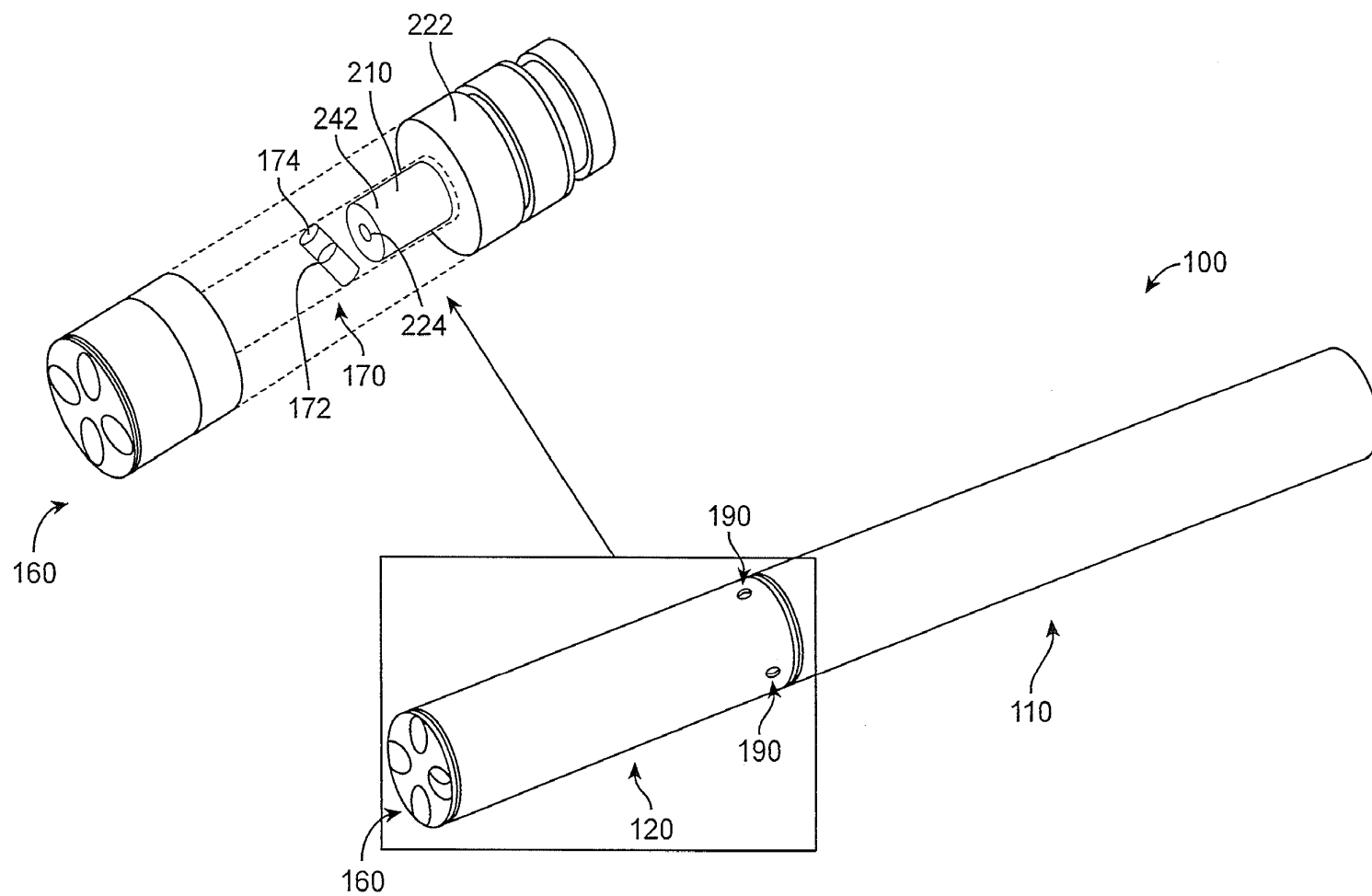


FIG. 2

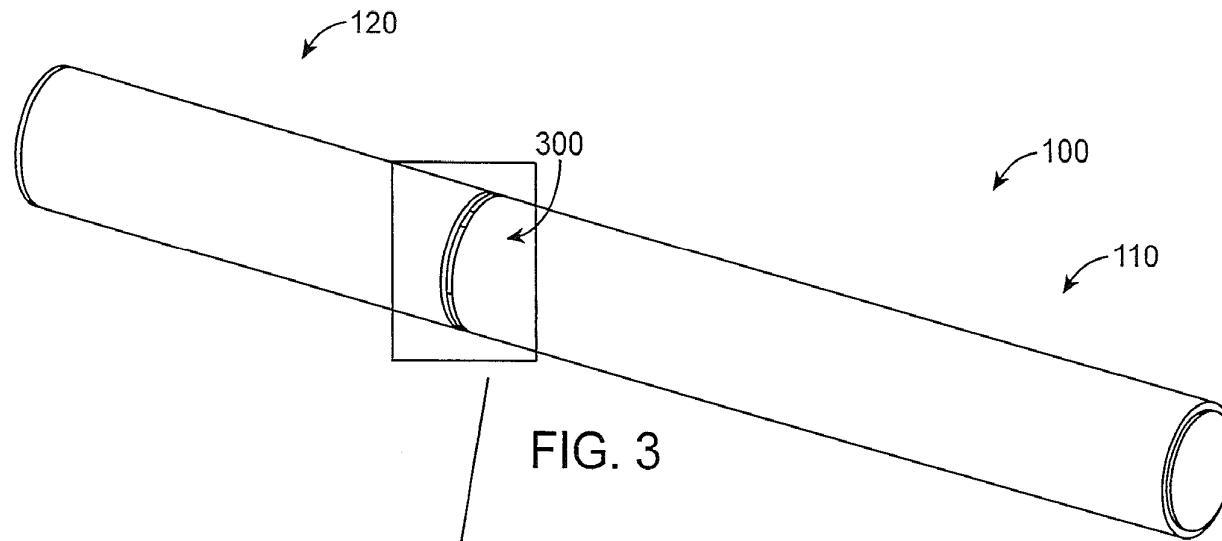


FIG. 3

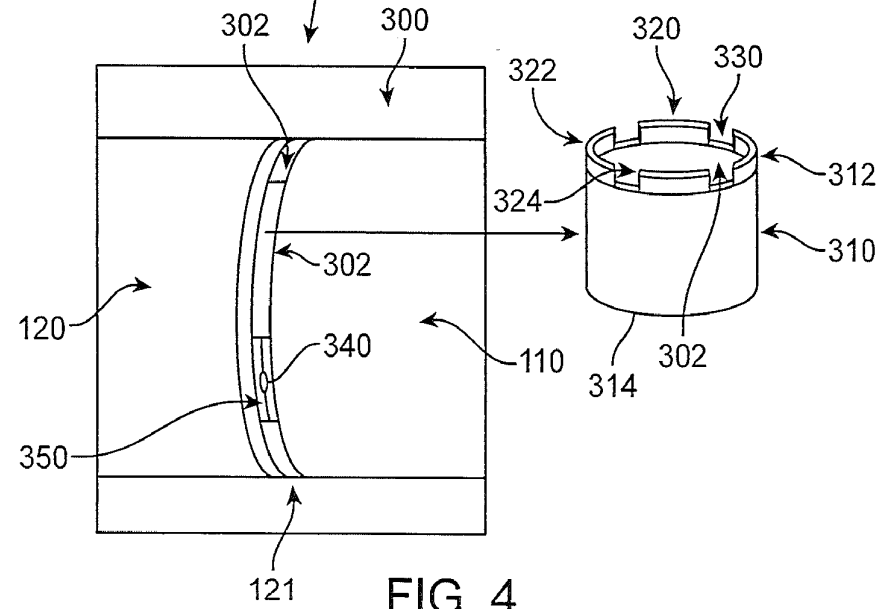


FIG. 4



4 / 6

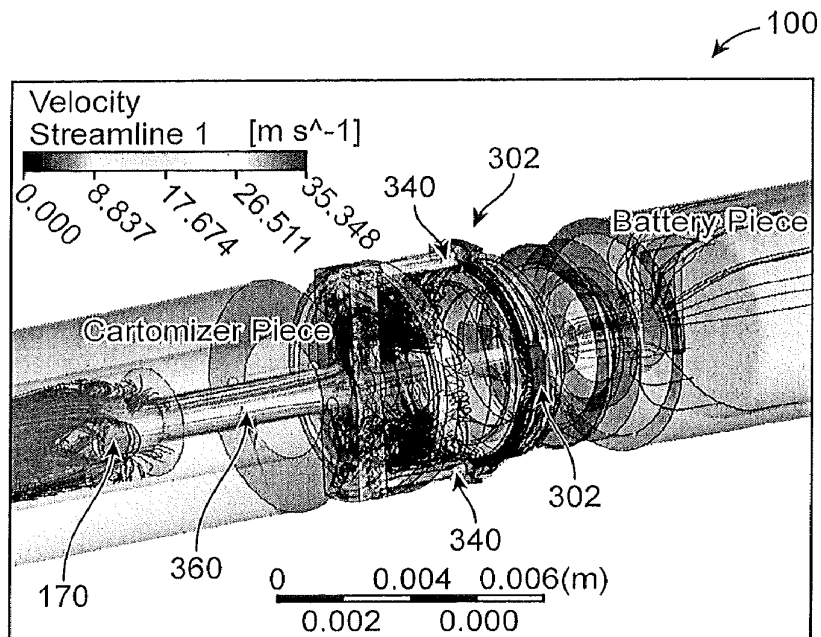


FIG. 5

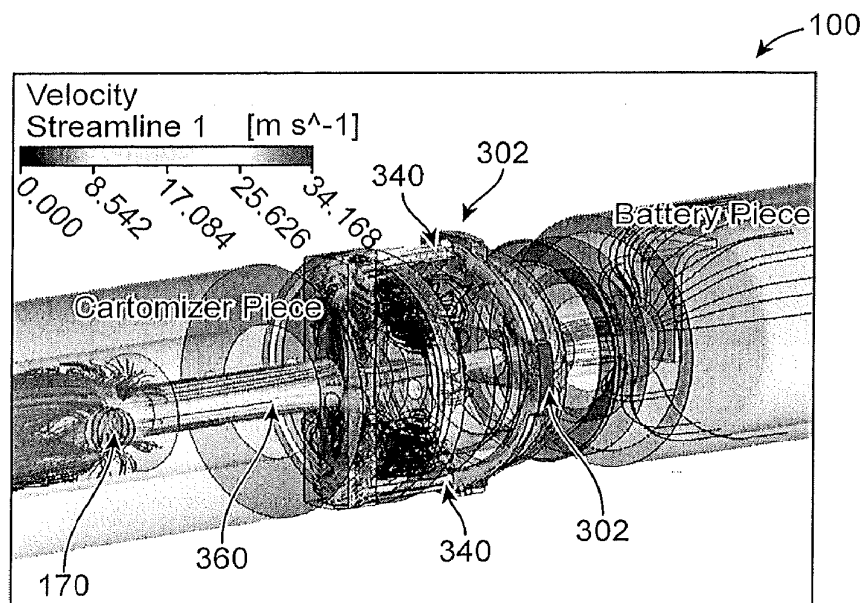


FIG. 6

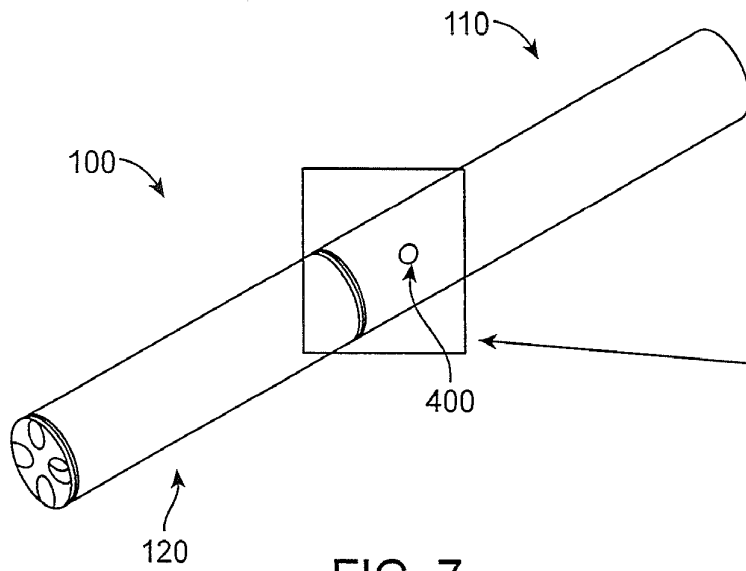


FIG. 7

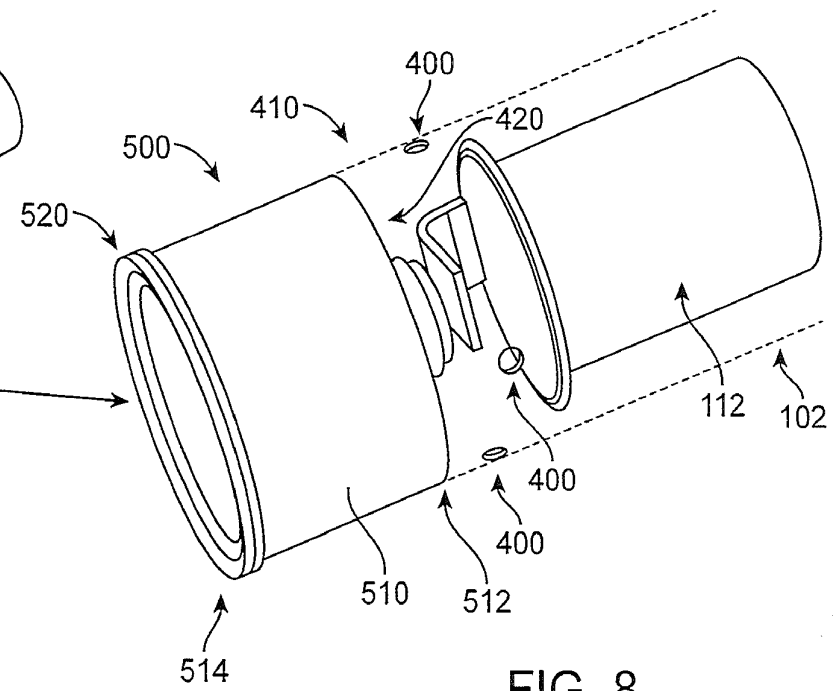


FIG. 8

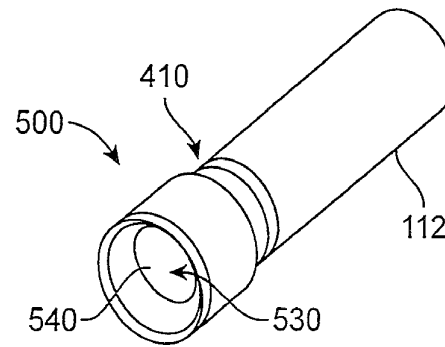


FIG. 9

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6 / 6

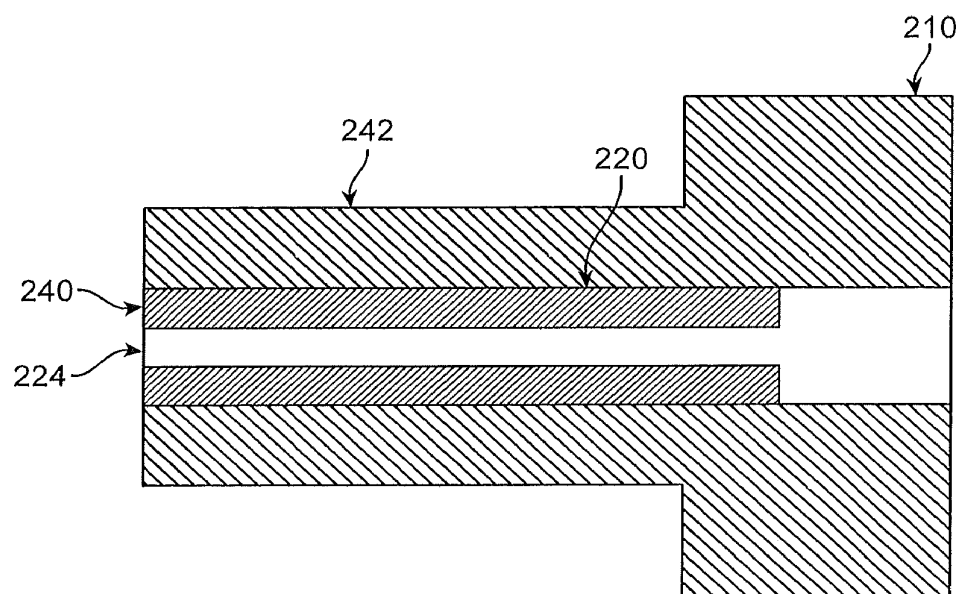


FIG. 10

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
18 December 2003 (18.12.2003)

PCT

(10) International Publication Number  
**WO 03/103387 A2**

(51) International Patent Classification<sup>7</sup>: **A01M 1/20**,  
A61L 9/03

(21) International Application Number: PCT/US03/17767

(22) International Filing Date: 5 June 2003 (05.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/386,998 6 June 2002 (06.06.2002) US

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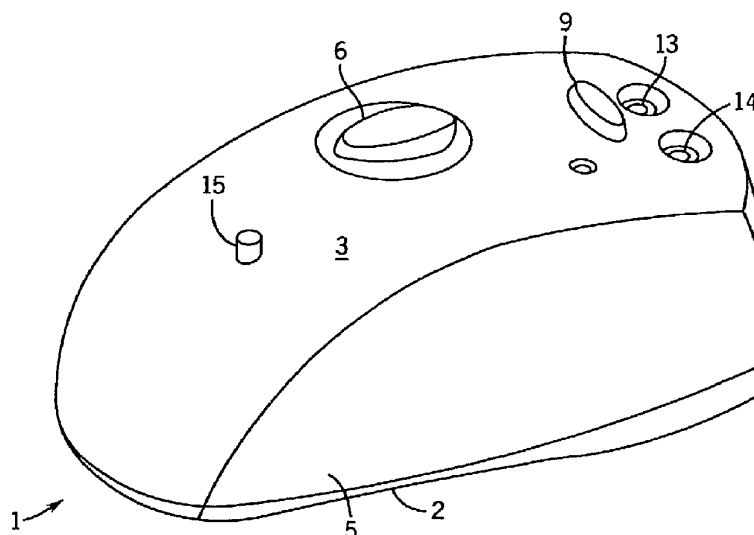
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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: LOCALIZED SURFACE VOLATILIZATION



(57) Abstract: The present invention relates to an apparatus and method for rapid flash-like volatilization of high and low vapor pressure components from liquid or solid emanators which is in contact with a point or localized heat source. Vaporization is promoted by a geometrically small electrically resistive heating element with variable activation for pulsed or cyclic heating of an emanating surface containing the volatile components. The apparatus is primarily directed towards the treatment of residential air for fragrancing, odor elimination, treatment of insects or pests, air sanitization, air and surface antibacterial or antimicrobial treatment, or other ambient air or surface modification by way of gas or vapor distribution.

**Published:**

— without international search report and to be republished  
upon receipt of that report

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## LOCALIZED SURFACE VOLATILIZATION CROSS-REFERENCE TO RELATED APPLICATION

This application is based on and claims priority from provisional patent Application Number 60/386,998 filed on June 6, 2002.

### BACKGROUND OF THE INVENTION

The present invention relates to an apparatus and method for rapid flash-like volatilization of high and low vapor pressure components from liquid or solid emanators which is in contact with a point or localized heat source. Vaporization is promoted by a geometrically small electrically resistive heater material with variable activation for pulsed or cyclic heating of the emanating surface containing the volatile components.

The field of the invention is primarily directed towards the treatment of residential air for fragrancings, odor elimination, treatment for insects or pests, air sanitization, air and surface antibacterial or antimicrobial treatment, or other ambient air or surface modification by way of gas or vapor distribution. Applications include portable, e.g. wearable or carried on an individual's belt, fixed for localized treatment, e.g. covering a relatively small area, or fixed for space treatment, e.g. covering an entire room of a house or building. Other fields of use could include commercial and other public environments requiring air or surface modification by gaseous treatment.

Air modification and treatment has been a part of dwelling, recreational, work, and other indoor and localized outdoor environment aesthetics and functionality throughout history. An inherent problem has been that aesthetic or functional volatiles with sufficiently high vapor pressure to adequately treat the environment by unaided means are limited in number and their treatment benefit. As a result there has been a long history of the use of heat to assist in the vaporization of higher molecular weight and lower vapor pressure compounds.

The use of heat increased the range of aesthetic and functional compounds that can be used for air quality management. Some of the first would have used flame (candle systems, stovetops, etc.). Although effective, and continues to be used today, heat from a flame can be difficult to use because the magnitude of heat

is difficult to regulate, and a flame typically has wide fluctuations of temperature ranges. Other problems include the affect on larger surfaces, i.e. unintended areas may be raised in temperature, the soot from a flame can blacken components, a flame can give off an unpleasant odor, the solution to be volatized can be rapidly  
5 degraded, and there is little adjustment. As a result, many materials are eliminated for use with flame systems.

In addition to flame based systems, there have emerged chemical heat emanation enhancers. Many well-known and simple chemistries are available as described in U.S. Patents 6,248,257 and 6,289,889, and include calcium oxides,  
10 aluminum copper sulfate, potassium chlorate, calcium sulfate, iron oxide, acids and bases, and others. Chemical heat sources suffer from inadequate means to closely control temperature, ability to stop the reaction, and many have pre- or post-reaction aggressive components.

Another generation of delivery methods includes devices such as  
15 compressed gases or aerosols, which propel minute droplets creating great aggregate surface area for volatilization of a liquid composition into the air. These systems work well for instant and situational applications, but have yet to be as viable for continuous air treatment. A simple set of technologies to address this interest area have been dispensing devices with open or semi-closed supported  
20 gelatinous, fibrous, or other material of absorbed or adsorbed actives and enhancers that promotes passive emanation by increased surface area. The needed large surfaces cause these products to be large, heavy, and have unsightly use features as the gels shrink, structures are exposed, surfaces soil, etc.

Other passive metering systems that have emerged and have been used  
25 include semipermeable membranes, wicks, capillaries, porous materials or other fluidic transport and emanating surfaces. Other products such as deodorant and sublimation blocks are also used for dispensing air-treating vapors into the atmosphere by evaporation. The performance of these systems vary widely, and although there are hybrid systems of new materials and designs that promote

vaporization by passive methods, they can suffer from the same drawbacks listed with gel and fibrous systems, and they generally lack optimal performance attributes.

There has been increasing use of electrified systems to promote enhanced volatilization, through the use of heat, air movement, electromechanical aerosolizers, or other methods or combinations. Heat and/or airflow have been combined with many of the passive air modification methods mentioned above. Airflow systems are marginally better than passive systems and continue to require somewhat larger emanating surfaces to achieve enhancement. The added system energy has provided for actives with better effectiveness, and depending upon the complexity of these devices, more optimal delivery performance. Although these systems are generally successful they leave important performance characteristics unaddressed.

## SUMMARY OF THE INVENTION

The present invention provides an apparatus and a heating method using a localized heater with pulsed activation that can be incorporated for use in domestic or commercial, indoor or outdoor, fixed or portable applications. The apparatus includes an electro-resistive heating element such as a wire, thin film, or thick film resistive heater touching or affixed to an emanating surface from which a volatile compound can be vaporized by heat generated from pulsed electrical input. Preferably, the heater includes a Nicrome wire that contacts a wick which is heated to vaporize an active on the surface of the wick into the surrounding air. Heating is preferably accomplished using alkaline or rechargeable batteries, and tabletop as well as portable, wearable devices are contemplated. The localized heater and pulsed cycling work jointly to create rapid heating and cooling, limited thermal conductivity away from the local heat zone, meter effluent release by the magnitude, duration, and frequency of electrical cycles, and impart less thermal damage to the effluent. The heater is a component of technology that can be



integrated with other methods of emanation enhancement, such as moving air, as well as visual or audible stimulus.

The present invention addresses many of the unmet performance attributes of prior devices. One such is the need for portability. Passive devices are portable, but generally ineffective. Powered devices are more effective but restricted to being relatively close to electrical power outlets, and battery powered devices are limited to the use of less energy consuming emanation enhancement technologies such as fans, as resistive heaters rapidly consumes available battery energy. The inability to use heat, again substantially limits the actives that can be effectively used with the unit. All current devices also remain relatively unresponsive to the functional or aesthetic demands and preferences for which the product is intended, such as full space treatment, variable treatment strength, alteration of systems to different chemistries, etc. The present invention overcomes these issues by addressing the important performance issue of using an efficient resistive heater and minimizing the size of the heater to only the very small area needed to achieve desired emanation.

It is a further advantage of this invention to provide volatilization enhancement that improves air treatment performance. Specifically, this involves the use of pulsed heating of a thin film low thermal mass heater that rapidly heats and cools. This permits the heater to be used for metering the amount of active emanated by the magnitude, duration, and frequency of heating. Varying these parameters allows for adjustability to treat environments that change in size, air treatment need, personal preference, and characteristics of different actives and solutions. Such features have not been available with constant heat systems whether the source is a flame, electrical resistive heat, chemical reaction, etc. Air movement systems are also usually fixed in their airflow, and even with those that do modulate, the use of airflow can be limiting for lower vapor pressure component usage.

This invention also provides the advantage of using localized and pulsed heating to reduce changes in emanation effluent composition. Typical use of heat for emanation enhancement has placed the solution at constant and elevated temperature. The result is that not only is the relatively large heater and immediate  
5 area of the emanating surface brought to elevated temperature, but quickly the device, the matrix or container and its contents are also elevated in temperature. This results in not only increased general emanation, but the constant application of heat accelerates concentration change as the high vapor pressure constituents will emanate more rapidly than the lower vapor pressure constituents. This will cause a  
10 continuous change in the solution concentration and create a change in the desired composition of the effluent.

The constant application of heat also places constituents at higher temperature and molecular energy that accelerates the kinetics toward molecular degradation. Using carbon based compounds as an example, with the most  
15 common and weaker of them being C-C, C-H, C-N, and C-O, all having less than 100 kcal/mole bond strength. With an average bond strength being about 80 kcal/mole, these bonds would be supplied with sufficient energy for degradation at high constant temperatures. Considering Joule's Law a relevant value of the amount of heat produced by a conductor from the flow of current can be obtained.  
20 That is,  $H=KI^2Rt = KtP$ , where: H = heat (cal), K = constant of proportionality and is valued at 0.2390 (cal/j), I = current (A), R = resistance of the conductor ( $\Omega$ ), and t = time (s), and P = power (watt = j/s). Typical values for the localized and pulsed resistive heater can range from 0.25 – 3 seconds pulsed on-time, 0.2 – 25 ohms, and 0.2 – 1 amperes per cycle. At the extremes this represents a heat value  $H \ll 80$   
25 kcal/mole for the short pulse cycles. However, by constant heating it is just a few hours before energies have been input into the system equivalent to those needed for degradation of chemical bonds. This energy is dissipated throughout the solution, its container, the wick, and other structural components. The constant application of heat significantly contributes to accelerating degradation kinetics.

These undesirable results can be substantially minimized or eliminated by the combined effect of both cyclic and localized heating.

Localized heating implies the use of reduced emanation surfaces. This is possible because the pulsed heating can vary in magnitude, duration, and frequency to get equivalent emanation amounts needed from a smaller area. The benefit of a smaller area is less surface for low temperature release of the higher vapor pressure components of a product, resulting in more uniform product over time. Also because of the nature of pulsed heating, the emanator and effluent in the vicinity of the heater is usually not in a thermal environment and the effluent is not subjected to long and continuous higher energy environments. Also, because of the discontinuous application of heat there is limited heat transfer at proximal or further distances from the heater. These conditions reduce possible effluent degradation and increase effluent stability over time.

When heat is applied with a localized cyclic heater, it can be controlled and directed for optimal vaporization. Vapor pressure of a liquid occurs because at any temperature there is a distribution of kinetic energy held by the molecules in solution. Those with higher energies sufficient to escape the surface of the liquid are vaporized and an equilibrium of vaporization with condensation is reached at the given conditions. By adding heat into the liquid the distribution of molecules with sufficient escape energy increases, rising the rate of vaporization and vapor pressure. By recognizing that vaporization is a surface event, and it is singly the process of vaporizing of the liquid that is desired, then surface heating provides the most efficient method to transfer heat to surface molecules and minimizing the transfer of heat to bulk liquid and degradation processes. Such a mechanism of vaporization can increase energy efficiency of the system. Submerging a heater results in equivalent energy transfer, but the energy within the liquid is subsequently dissipated. At the liquid interface, high energy molecules are allowed to escape or diffuse short distances to the surface and then escape as a vapor. Within the liquid high energy molecules transfer their energy by collision to other

molecules before escaping, resulting in bulk liquid heating. At temperatures below boiling where vapors do not accumulate into bubbles that can protect the vapor and rise quickly to the surface, many high energy molecules do not reach the surface to escape, thus lowering the efficiency of vaporization for small energy inputs.

5 Consequently, the depth of the surface can extend beyond the distance of a few molecules that are needed for molecular properties at the liquid interface to transition to molecular bulk liquid properties. The nature of the viscosity, intermolecular interaction, and other characteristics of the solution, its various constituents, and their specific ability to reach the surface because of their  
10 molecular size, functionality, structure, degree of intermolecular interaction, and other considerations will determine the effective surface thickness that will allow for the rapid vaporization of such constituents without significant loss to bulk heating. A practical consideration for efficiency is that the majority of vaporized molecules escape the surface to include those vaporizing under the heater or  
15 opposite the surface, if such condition exists, and which would create longer pathways for escape. A practical definition of this surface thickness is considered 300  $\mu\text{m}$  and more preferably 100  $\mu\text{m}$  with an understanding that thermal lines from a heater are often confined to one diameter or thickness away from the heater and this represents the zone of heating by minimal conductive processes. Surface  
20 heating is central to the design of a portable, low energy heat source. Cyclic heating allows for the use of broad temperature ranges with minimal effluent concentration and molecular changes.

Localized and cyclic heating that can vary in its magnitude, duration, and frequency parallels the proportional relationship of increased temperature with  
25 increased vaporization. As a result, optimal evaporation can occur regardless of the chemical and physical characteristics of the substance being evaporated. This relationship follows the condensed phase-vapor equilibrium of  $\log P = -\Delta H/RT + C$ , where  $P$  = pressure,  $\Delta H$  = system interaction enthalpy,  $R$  = gas constant,  $T$  = temperature (K), and  $C$  = constant. A  $\log P$  is plotted against  $1/T$  and shows

increasing vapor pressure with increasing temperature between a condensed phase and a vapor phase. The input of low heat for longer cyclic duration or the input of high heat for short duration and frequency of these cycles each achieve similar amounts of vaporized liquid. Localized low mass heaters allow for rapid heating to  
5 temperatures, preferably near, but below boiling points. This is not a necessity as multicomponent mixtures for many solutions and even complex mixtures for fragrance solutions will have wide ranges in boiling points of the constituents. It is more important that a rapid heating and then cooling cycle occur that promotes uniform evaporation of all components through a rapid or flash-like vaporization.  
10 This mechanism provides for rapid treatment of a space while preserving the concentration and molecular stability of the solution. Lower temperatures and longer on-time cycles can be used to achieve initial treatment or maintenance of the vapor in the space, but then the application becomes more reminiscent of current systems that suffer from extended heating. It is preferred that maintenance be  
15 achieved by rapid heating and then cooling, but with less frequency. Thus continuing to preserve solution concentration and molecular stability. As a result, the magnitude and duration of the heating cycle can meter the rate over time, or quantity per cycle vaporized using localized cyclic heating.

Typically, the addition of heat in the localized cyclic heater preferentially  
20 creates rapid heat for flash-like evaporation. Doing so limits the flow or flux of heat distantly from the heat source, as governed by Fourier's Law,  $q = -kA(MT/Mx)$ , where  $q$  = heat transfer,  $k$  = thermal conductivity of the material,  $A$  = unit area of transfer,  $(MT/Mx)$  = the temperature gradient. Thermal conductivities of  $3.3 \times 10^{-4}$  cal/(sec)(cm<sup>2</sup>)(°C/cm) for light hydrocarbon oils representative of  
25 organic liquids, aqueous solutions of  $4.3 \times 10^{-5}$  cal (gm)/(sec)(cm<sup>2</sup>)(°C), and  $60.3 \times 10^{-6}$  cal/(sec)(cm<sup>2</sup>)(°C/cm) for air. These values indicate that the thermal conductivity for air creates an insulative barrier that does not permit effective thermal transfer from noncontact heat sources which are common in many applications. This invention takes advantage of reduced heat transfer by rapid

contact heating, limited cyclic timing, and use of inherent low thermal conductivity of common light hydrocarbon or aqueous solutions of  $10^{-4} - 10^{-5}$  thermal conductivity to provide an optimal volitalizer of effluents for air modification with limited energy use and improved product stability.

5           In addition, localized and pulsed heating creates the opportunity for greater portability of a product employing these technologies. Localized heating implies that heat is confined to a specific area. This can be accomplished by limiting the magnitude, duration, and frequency of heating and taking advantage of material properties for limiting undesired thermal transfer. It also suggests that the  
10       geometric size and shape of the heater locally confines the influence of heat. Another less obvious aspect of localized heating is the specific composition, performance, spatial positioning, dimension, and design of the heater to provide focused heating. A proper selection of these elements provides for localized heating. The smaller dimension provides for greater design flexibility into products  
15       where size becomes a consideration. Simplicity of the heater allows for broader use and even multiple use within the same application. Incorporating the above considerations as well as efficient power usage criteria, a heater can be specified that allows for conventional or battery power with desirable battery life and heater performance characteristics. Pulsing the heater is integral to permitting extended  
20       use of battery power or efficient use of wall power, and safety considerations as the heater circuit is usually not closed and drawing power.

          A further advantage of this technology is the simplicity that enables previously impractical applications of multiple and independent heaters because of heater size. For example, control of the heater may be analog or digital or the  
25       heater may even be remotely actuatable. This has not been previously available because of the lack of thermal responsiveness in cooling and heating that would cause effluents to emanate simultaneously, unless desired, etc. The simplicity of electrical heating coupled with the benefits of localized and pulsed heating allow for the incorporation of multiple emanators. Such an embodiment creates products

that deliver multiple fragrances to overcome human adaptation, which is manifest by the inability to detect the presence of the fragrance over time. Changing fragrances by pulsing different emanators from time to time, any adaptation is mitigated as the physiological changes associated with the environmental change are then detected. An extension of multiple emanators could also include a combination of fragrances, odor eliminators, insect repellents, insecticides, fungicides, antibacterials, etc.

Central to the volatilization and energy use efficiency of the localized and pulsed heater is its spatial location to the emanator. Preferably the heater is in close proximity and even touching or mounted to the surface of the emanator. Because of the need for only a geometrically small heater, the emanator also need not be large and preferably would be small. This close association is not preferred in the fact that the emanator matrix will absorb heat that is then unavailable for vaporization, but such a close position to the release matrix also places the heater in close proximity to the effluent. Because of the insulative properties of many media such as air, ceramic, etc. it is advantageous to have the heater in contact with the effluent to facilitate the most efficient thermal transfer and volatilization. In connection with this, the heater becomes more supported or affixed to the matrix, becomes more robust, and maintains more consistent spatial proximity to the effluent.

Yet an additional advantage of this invention is the use of an affixed heater to the effluent refill. The refill assembly may thus include not only a reservoir containing a composition having a volatile active, and a wick having an emanating surface for the active, but also the heater element itself. The incorporation of these elements provides for the consistency and robustness suggested above with the heater. A heater affixed to a refill provides the spatial relationship most effective for volatilization of surface liquid. It also provides for a renewed heater with each refill purchase, such that there is reduced risk of matrix fouling near the heater or fouling and reduced efficiency in thermal transfer from the heater to the effluent. It

also provides a proprietary interface between refill and the support system to ensure that the safety, performance, specifically designed effluents, and other factors are preserved by using appropriate refills.

5

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a localized cyclic heater in accordance with the present invention using NiCr resistive wire with multiple emanators;

Fig. 2 is a perspective view of the heater in Fig. 1 with its cover off exposing selected components in the circuitry and user interface;

10

Fig. 3 is a schematic illustration of electronic circuitry for the heater of Figs. 1 and 2 to provide for cyclic localized heating of the multiple emanators;

Figs. 4a-4e schematically illustrate various resistive wire heater designs to change the thermal characteristic of the heater;

15

Figs. 5a-5e schematically illustrate various thin film resistive heater designs to change the thermal characteristic of the heater;

Fig. 6 is a graph illustrating the metering capability of the heater with a fragrance;

Fig. 7 is a graph illustrating the metering capability of the heater with an insecticide;

20

Fig. 8 is a graph illustrating the efficacy of the heater for knockdown (kill) of *Aedes aegypti* female mosquitoes compared to controls and a currently marketed product using a NiCr resistive wire and wall power device;

Fig. 9 is a graph illustrating the particle size generated by the heater that facilitates rapid revaporization and continued loft without fallout;

25

Fig. 10 is a graph illustrating a thin film resistive heater temperature responsiveness after 0.5 to 2 seconds of current;

Fig. 11 schematically illustrates an end view of a wire heating element held in contact with the tip of a wick by a coil spring;



Fig. 12 is a top view of the embodiment of Fig. 11 with the spring not shown for clarity;

Fig. 13 is a plan view of the wire mounting used in the embodiment of Fig. 11;

5 Fig. 14 schematically illustrates a pair of spring fingers used to apply a spring force on the wire heating element;

Fig. 15 schematically illustrates spring force being applied by a pair of coiled sections of the wire heating element itself;

10 Fig. 16 schematically illustrates spring force being applied by corrugations integrally formed in the wire heating element itself;

Fig. 17 schematically illustrates spring force being applied by stretching a wire heating element;

Fig. 18 schematically illustrates a side mounting embodiment of the present invention;

15 Figs. 19a and 19b illustrate the use of notches formed in a wick for receiving a wire heating element;

Fig. 20 illustrates yet another embodiment which utilizes a pair of wire heating elements;

20 Figs. 21a and 21b illustrate a multi-part wick for delivering active to a wire heating element;

Fig. 22 illustrates an all-in-one refill unit for the present invention;

Fig. 23 illustrates the use of a fan and a baffle in the present invention;

Fig. 24 illustrates the use of a fan and a separate chamber for containing the wire heating element;

25 Fig. 25 illustrates the use of a fan and varying the cross sectional area of a housing for the wire heating element to control air movement past the wire heating element;

Fig. 26 illustrates the use of a cap covering the tip of a wire heating element; and

Fig. 27 illustrates a vented housing as yet another embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

5           The localized and pulsed heater 1 operates as an integrated system of electrical, mechanical, and fluid systems as shown in Figs. 1 and 2. The embodiments described herein were specifically designed for portable and semi-portable fragrancings and insecticide delivery devices. While a primary object of the invention is to provide for a portable fragrancings or insect repellent vapor-  
10       dispensing device, it should be understood that other vaporizable fluids are contemplated within the scope of the present invention, such as air fresheners, perfumes, deodorants, medicaments, and the like.

          Referring now to Figs. 1 and 2, there is illustrated one embodiment of a portable cyclic localized heater 1 constructed in accordance with the principles of  
15       the present invention. More specifically, heater 1 includes a housing which comprises a base 2 for supporting the internal components of heater 1, and a cover 3 for enclosing those components. Base 2 is in the shape of a shallow tray and includes a lip 4 at its peripheral edge which engages a corresponding lip 5 formed on cover 3 so that cover 3 may be joined with base 2 in a snap-fit arrangement.  
20       Cover 3 is thus removable so as to permit access to the interior of heater 1, if desired.

          Base 2 and cover 3 can be made of any suitable, lightweight material such as a wide variety of commercially available plastics that are produced by conventional processes and known to those skilled in the art. Any plastic housing material that is  
25       selected, however, must be compatible with the particular active volatile fluid that is to be vaporized. Typically, base 2 and cover 3 may be made of a commercially available polycarbonate material manufactured by known injection molding methods. Base 2 and cover 3 can thus be of any suitable dimension such that it may be readily portable whenever desired.

As shown best in Fig. 1, heater 1 includes an off duration selector knob 6 on cover 3 which is connected to an off duration potentiometer 25 mounted on circuit board 8 which in turn is supported on base 2. Knob 6 can be rotated to vary the interval between vaporization cycles. Also shown in Fig. 1 is an emanator selector knob 9 which is connected to a selector switch 10 on circuit board 8. Selector knob 9 may be slid in one direction to select a corresponding emanator 11, or in the opposite direction to select emanator 12. For example, emanator 11 may vaporize an insect repellent while emanator 12 might vaporize a fragrance so that a user can choose the particular active to be vaporized, as desired. Fig. 1 also illustrates a pair of spaced openings 13, 14 formed through cover 3 at a location which is aligned with emanators 11 and 12, respectively. Openings 13, 14 thus enable the active being vaporized to exit from heater 1 into the atmosphere. Finally, an instant action button 15 extends through cover 3, and when pushed, overrides the time delay set by the off duration knob 6 and permits a user to obtain an instant or immediate burst of active from one or both emanators 11, 12 depending upon the position of selector knob 9.

Referring now to Fig. 2, circuitboard 8 is mounted on supports 16 so as to be raised above base 2 and provide sufficient room for forming a receptacle 17 for receiving a plurality of batteries 7 (schematically shown in Fig. 3) for powering heater 1. Alternately, heater 1 may be powered by an electrical cord 18 and plug for insertion into a wall mounted electrical power outlet.

Fig. 2 also illustrates the emanators 11, 12. Each emanator 11, 12 comprises a wick 19, 20, respectively and a wire heating element 21, 22, respectively. Each wick 19, 20 has a lower end received within a reservoir 23, 24, respectively for containing a solution of an active such as an insecticide, pesticide or fragrance, and an upper end having a relatively flat tip across which wire heating elements 21, 22 respectively extend. Thus, as active is drawn upwardly by capillary action through wicks 19, 20, the solution is volatized when current is passed through wires 21, 22 resulting in heating of the solution and vaporization of the active.

Each reservoir 23, 24 is arranged to contain a volatile solution or fluid, preferably biologically active, such as an evaporable liquid insecticide or an evaporable liquid insect repellent, fragrance or the like. The reservoirs 23, 24 may be unitary with base 2 and as such may be an integral part thereof. Alternately, 5 each reservoir 23, 24 may be separately formed and then attached to base 2 so that reservoirs 23, 24 can be removable and thereby allowing for the replacement of each reservoir after desired vaporization of the fluid contained therein. This would allow for the interchanging of a variety of like dimensioned reservoirs containing a wide variety of vaporizable liquid substances. Accordingly, the reservoirs 23, 24 10 can be so constructed as to be disposable and replaceable by new reservoirs containing a fresh supply of active. Also, if desired, reservoirs 23, 24 may be transparent in order to provide a user with the visual ability to determine the amount of vaporizable active or liquid remaining in the heater 1. Further, although the preferred composition is one which contains the active ingredient in a liquid 15 solution, the composition may also be a solid, semi-solid or gel formulation under ambient conditions. In each case, the composition includes the active ingredient and a carrier for the active ingredient. The carrier may include one or more blowing agents, solvents, stabilizers, synergists, dyes and perfumes. Blowing agents include azodicarbonamide, dinitrosopentamethylenetetramine, 20 azobisisobutyronitrile, and combinations thereof. Suitable blowing agents are disclosed in U.S. Pat. No. 4,228,124, which is hereby incorporated by reference for the purpose of disclosing blowing agents.

Solvents include alcohols such as cetyl alcohol, stearyl alcohol, and mixtures thereof.

25 Stabilizers (e.g., for providing stability to heat, light, and oxidation) include antioxidants such as 2,6-di-tert-butyl-4-methylphenol ("BHT"), 3-tert-butyl-4-hydroxyanisole ("BHA"), 2,2'-methylene-bis(4-ethyl-6-tert-butylphenol), 2,2'-methylene-bis-(4-methyl-6-tert-butylphenol), 4,4'-butylidene-bis(5-methyl-6-tert-butylphenol), 4,4'-methylene-bis(2-methyl-6-tert-butylphenol), 4,4'-thio-bis(3-

methyl-6-tert-butylphenol), 4,4'-methylene-bis(2,6-di-tert-butylphenol), stearyl-beta(3,5-di-tert-butyl-4-hydroxyphenol)-propionate, 1,3,5-trimethyl-2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzylbenzene), 1,1,3-tris(2-methyl-4-hydroxy-5-tert-butyl)-butane, tetrakis[methylene(3,5-di-tert-butyl-4-hydroxycinnamate)]methane, 5 dilauryl thiodipropionate, distearyl thiodipropionate, UV absorbers derived from benzophenone, triazole, and salicylate compounds, and combinations thereof. Suitable stabilizers are disclosed in U.S. Pat. No. 4,874,787 and in U.S. Pat. No. 4,515,768.

10 Synergists include alpha-[2-(2-butoxyethoxy)ethoxy]-4,5-methylene- dioxy- 2-propyltoluene, octachlorodipropyl ether, and N-(2-ethylhexyl)-bicyclo-[2,3,2]-hept-5-en-2,3-dicarboxyimide. Suitable synergists are disclosed in U.S. Pat. No. 4,874,787 and U.S. Pat. No. 4,515,768.

Dyes in the composition can be used to show when the insect repellent is spent. For example, suitable dyes include 3-ethostearate of 9-ortho-carboxyphenyl- 15 6-diethylamin-3-ethylamino-3-isoxanthene and electron-donating dyes. Dyes are disclosed in Japanese Patent Publication No's. 09-175906A and JP 07-324003A, International Patent Publication WO 96/33605 A1, and U.S. Pat. No. 5,891,811.

Perfumes can also be used in the composition. Perfumes can be used, e.g., to show when the insect repellent is spent or for aesthetic purposes. Perfumes must 20 have similar volatility to the insect repellent and must not be attractive to insects. Examples of suitable perfumes include citronella, which can be used herein as a perfume, not an insect repellent.

The pulsed electrical cycling of heater 1 is achieved by solid state electronic circuitry, as shown best in Fig. 3, but is not limited to the specific circuitry 25 illustrated. The primary function for the electronics is to switch the heater 1 on and off at predetermined intervals. The ON/OFF duty cycle reduces the energy and increases battery life as compared with a device that runs continuously. The heater Control Timing can be set to operate for a predetermined specific time duration, e.g. 2 hours, 4 hours, 8 hours, etc. or can be set to turn the heater 1 on and off for

predetermined time periods, e.g. on for 5 seconds and then off for five seconds as long as the Low Voltage Detector indicates a good battery(s). The duty cycle will be adjustable by changing a resistor 28 on the printed circuit board.

5 A secondary function for the electronics is to protect the battery(s) 7 from damage by monitoring the battery voltage and disconnecting the circuit when the voltage decreases to a set value. When the battery voltage is below a preset voltage, the electronics will enter into a Battery Low Mode. In this mode, the controls to the heater will be such that the heater is turned off. Low Battery detection is only performed during the heater off state to avoid false detection due  
10 to the current drain during the on state. The circuit will sample the battery voltage three times just before the heater on cycle and decide if the next state will be low voltage or normal (heater ON). In addition, there will be a hysteresis built into the low voltage detector circuit to remove oscillations of judgement around the low voltage level.

15 Figure 3 represents a potential electronic circuit for heater 1. It is a simple, low-cost circuit and will allow the heater to be switched ON and OFF for a predetermined time (duty cycle). The ASIC, microcontroller or discrete logic component 29 incorporates a conventional Low Battery Detection circuit as is well known in this art.

20 The circuit of Figure 3 will either turn the Heater ON or OFF. Depending on the heater configuration ultimately chosen, the two states of ON and OFF may not be sufficient. Take for example the situation where ON would allow too high a voltage across the heater, resulting in too high of a temperature. In that case, the ASIC, microcontroller or discrete logic component 29 will modulate the output,  
25 reducing the voltage to the heater. A pulse width modulated (PWM) method of control would be an efficient scheme for maintaining the proper voltage across the heater element 21 or 22 that is less than full ON.

The following equation is used for PWM waveforms:

$$V_{\text{RMS}} = V_{\text{pk}} \sqrt{t_{\text{ON}}/T}$$

Where:  $V_{\text{pk}} = V_{\text{batt}}$

$t_{\text{ON}}$  = ON time for the heater (seconds)

5  $T$  = period of time for PWM output (seconds)

As can be seen from the equation, if one monitors battery voltage ( $V_{\text{pk}}$ ) and then adjusts  $t_{\text{ON}}$ , one can keep  $V_{\text{RMS}}$  constant.

10 A beneficial consequence of the use of electronics is the incorporation of a clock within the circuit to create blackout periods of the day when the device is not required and battery energy conservation can take place. As a result, once powered, heater 1 does not need to include an on/off switch such as that shown as 30 in Fig. 3 to depower the board. Specific controls of heater pulsing is provided by three subcircuits. Potentiometer 25 is adjustable to control the duration of heater  
15 off cycles from 5 seconds to 30 seconds. Potentiometer 26 allows for battery energy management with variable pulse width modulation that regulates battery use during the on cycle with an on and off subcycle to manage power needs. Other power conserving methods could be used, if desired. Potentiometer 27 is included to regulate the duration of the on cycle from 0.25 seconds to 2 seconds. Other  
20 subcircuitry can be included for motion, light, or other sensor switching such that the unit could be dormant until needed.

Power is provided by batteries 7 and could be AA, C, D, or other 3 volt battery wall power transformers. Batteries 7 may also be rechargeable. Power may also be signally or simultaneously connected to a permanent power source in a  
25 tethered or untethered manner.

The wicks 19, 20 may be constructed from natural materials, fibers, nonwovens, sintered polymers, ceramics, metal foams, open capillary tubes of ceramic, glass, or other material. A critical consideration for the selection of any of these materials is the temperature required for surface heating for the effluent being

volatilized. The preferred wicking material is ceramic, in part because of its high temperature tolerance. It shares other features with some other wicks with the ability to tailor pore size to address wicking rates and fouling, it has insulative properties to further minimize heat transfer, and is readily available as a material.

- 5 If the wick substrate is conductive then a dielectric material layer of a few thousandths of an inch in thickness must be placed between the electrically resistive heater and the substrate. Materials not requiring the need for dielectrics are preferred for their reduced cost, retained capillary pores for wicking, thermal stability, etc. Ceramic wicks are also preferable in that they can withstand heater  
10 deposition processing temperatures, if required. Other wick materials include wicks made from saw-dust and silica/sand mixtures that are able to withstand needed temperatures to volatilize the actives.

Core to the success of this invention is the selection or creation of an appropriate electro-resistive heating element. A thermally stable material which  
15 functions as a heater when current flows from a battery is passed through it can be achieved with a wide variety of heating materials. Important to the small geometrical scale as well as the energy economy needed, heating elements from traditional materials and sources have been limited to wires, thick films, and thin films. Wire heating elements are commonly associated with alloys with trade  
20 names of Nichrome, Ohmax, Radiohm, Nirex, Nilvar, and more (Omega Engineering, Inc., Handbook and Encyclopedia, Electric Heaters, 200, pg. z-38). Pure metals that may be used, but show less resistivity and include platinum, iron, zinc, molybdenum, tungsten, and more (Omega Engineering, Inc., Handbook and Encyclopedia, Electric Heaters, 200, pg. z-38). Thin films can be derived from  
25 metallic films, oxide films, materials from nitrides, borides, carbides, stanides, and the like. Stannic oxides ( $\text{SnO}_2$ ) or tin oxides can be deposited as a very thin film of 2  $\mu\text{m}$  or less. The other metal oxides are formed as a thicker or intermediate film, but still considered as a thin films. Thick films are also possible sources of resistive heating elements. They can include electrically conductive adhesive



thermosetting or thermoplastic polymeric resin pastes with silver or copper powder as the conductor. Nonresin matrices of glass and ceramics with pure metals or metal oxides such as  $\text{Al}_2\text{O}_3$ ,  $\text{BeO}$ ,  $\text{Pd/Ag}$ ,  $\text{SiO}_2$ ,  $\text{PbO}$ ,  $\text{CaO}$ ,  $\text{B}_2\text{O}_3$ ,  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ,  $\text{MgO}$ , and other dopants have been used as thick films. Most heating elements can be obtained in different shapes and sizes while maintaining physical properties such as electrical resistivity, density, thermal conductivity, and specific heat. These properties are determined by the constituent elements, processing methods, and post-processing techniques.

The most preferred of the above resistive heating elements is either a 49 gauge Nichrome wire or a tin oxide thin film. Important to the selection of these resistive heating elements is their effectiveness at volatilizing solutions and their energy efficiency. The gauge of the wire was selected because of its higher resistance and less energy draw to generate needed wire temperatures. Like other resistive materials, there is an issue of thinning wire diameter and the propensity for failure. The Nichrome large gauge wires are relatively fragile and are subject to mechanical failure during manufacturing, transportation, consumer handling, and use. More significantly, thermal cycling induces stresses and fatigue in the heating elements, which may result in heater failure. Undesirable oxidation of the heater material can also occur causing weakening and possible failure. Figs. 4a through 4f illustrate various resistive wire heater designs showing a wire heating element 123a-123f touching an emanating surface 124a-124f located at the tip of a ceramic wick 125a-125f, respectively. More specifically, Fig. 4a illustrates a single straight wire heating element 123a touching a flat emanating surface 124a at the outer tip end of wick 125a. Fig. 4b illustrates a simple or single serpentine wire heating element 123b touching the flat emanating surface 124b at the tip end of ceramic wick 125b. Fig. 4c illustrates a multi-serpentine design for wire heating element 123c touching the flat emanating surface 124c at the tip end of wick 125c. Fig. 4d illustrates a wire heating element 123d that is wrapped around the circumference of the tip end of wick 125d such that the emanating surface 124d comprises the outer

circumferential surface of wick 125d. Fig. 4e illustrates a pair of spaced wire heating elements 123e touching the flat emanating surface 124e at the tip end of wick 125e. It should be noted that although two wires 123e are illustrated, multiple wires could also be used, i.e. 2, 3 or more, if desired. Fig. 4f illustrates a side mounting embodiment wherein wire heating element 123f touches one side of the tip end of wick 125f such that an arcuate portion of the circumferential surface of wick 125f comprises the emanating surface 124f.

Another type of preferred resistive heating element is a vapor deposited thin film of tin oxide ( $\text{SnO}_2$ ) or other resistive deposited films. An important consideration is the direct deposition of the oxide on the ceramic substrate that creates a mechanically robust heater that may not be as susceptible to mechanical failure. It also does not suffer, as a wire resistive heater does, from inconsistent position with respect to the wick at manufacturing and changes that occur with use. An important consideration with the use of  $\text{SnO}_2$  is that its thermal expansion and that of the ceramic do not substantially differ. As a result, there is no debonding or other failures from thermal stresses that occur with pulsed or cyclic heating. Additionally the  $\text{SnO}_2$  does not suffer from detrimental additional oxidation with use.

In consideration of minimizing energy use, the heating element material must have a resistivity sufficiently low to allow for rapid heating and cooling. It is therefore desirable that the heater resistance correspond to the energy density of the power source in order to minimize power consumption. Suitable heater materials of low mass, such as  $\text{SnO}_2$  can be created with very low density. Not only is the composition of the resistive material important in achieving this, but also the thickness and other geometric consideration with a relationship such as  $R = \rho (L/(WT))$ . Where R is resistance of the heater,  $\rho$  is resistivity of the heater material, L is length, W is width, and T is thickness. The deposition of the thin film by atmospheric, vacuum, electro-spray, thermal, or other vapor deposition allows

the resistive oxide to be applied to contoured surfaces, which also includes some internal pore surfaces.

Another advantage of a thin film heating element is that there can be an increase in surface area. This allows for increased liquid contact with the heating element to create more efficient thermal transfer and volatilization of the solution. Because of the vapor deposition method, this surface coverage can also extend into the pores of the wick, capillaries, or other structures. Yet because of the thinness of the oxide film it does not close the porous structure and does not inhibit loading performance and volatilization sites. The thin 2  $\mu\text{m}$  thick films allows for the potential to layer thin films as needed to achieve desired resistivity of the heater material, in conjunction with composition, and heater design variables. Possible disadvantages of thin film resistors include: (1) some designs may actually require more energy to achieve the same temperature as a Nichrome wire; (2) some designs may become fragile especially if the substrate on which it is deposited is also thin to help minimize heat transfer; and (3) random temperature variations can occur throughout the film depending on the thickness of the film. Figs. 5a through 5e illustrate various resistive thin film heater designs showing a thin film heating element 126a-126e located at the tip of a ceramic wick 127a-127e, respectively. More specifically, Fig. 5a illustrates a thin film heating element 126a deposited on the flat tip end of wick 127a. Fig. 5b illustrates a thin film heating element 126b deposited on flat tip end of wick 127b as well as the outer circumferential surface of wick 127b which is adjacent the flat tip end and comprising the outer edge margin of wick 127b. Fig. 5c illustrates a thin film heating element 126c deposited only around the outer circumferential surface along the edge margin and adjacent to the flat tip end of wick 127c. Fig. 5d illustrates a grid-shaped thin film heating element 126d deposited on the flat tip end of wick 127d. It should be noted that various other designs could be deposited on the flat tip end or on the circumference of wick 127d, e.g. a mesh, a spiral, a polygonal-shaped grid or some other network

of spaced lines. Fig. 5e illustrates a thin film heating element 126e in the form of a thin ribbon deposited on the flat tip end of wick 127e.

As set forth above, one of the primary uses of heater 1 is for providing an insect repellent and insecticidal function. Those insecticidal or insect repellent  
5 evaporable fluids which are useful in heater 1 are limited only to the extent that such fluids are vaporizable, are of a composition which is capable of vaporization, and are registered for use with humans. The composition comprises one or more active insect repellent and one or more optional carrier ingredients. Optional  
10 carrier ingredients include blowing agents, solvents, stabilizers, synergists, dyes, and fragrances well known to those skilled in this art. Suitable insect repellents are exemplified by DEET, pyrethrins, chrysanthemic acid derivatives, and pyrethroids. Examples of some suitable pyrethroids are Allethrin, d-Allethrin, Bioallethrin, S-Bioallethrin, Empenthrin, Prallethrin, and Transfluthrin. A preferred volatile  
15 insecticidal fluid substance is 3-allyl-2-methylcyclopenta-2-ene-4-one sold under the brand name Pynamin-Forte by Sumitomo Chemical Co., Ltd. of Japan. A preferred volatile insect-repellent fluid substance is N,N-diethyl meta-toluamide (commonly known as DEET).

In addition to insect repellents, insecticides, and pesticides, the portable device of the present invention can also be utilized to evaporate other evaporable  
20 fluid substances such as evaporable fluid antiseptics, evaporable fluid agricultural fungicides, evaporable fluid plant-growth regulants, e.g. fertilizers and the like, evaporable fluid herbicides, air fresheners, perfumes, deodorants, medicaments, and the like.

A Nichrome wire will expand and contract approximately 0.001 inches  
25 during the process of heating to 160°C and cooling. A spring mechanism is to be used to keep each Nichrome wire in constant tension against its corresponding wick. However, too much force on the wire will result in permanent deformation (stretching) of the wire or even breakage. The yield strength is the amount of stress required on the wire to permanently stretch the wire. The tensile strength is the

amount of stress that would break the wire. The heater assembly must be constructed such that the stresses on the wire do not exceed one-half the yield strength. The yield and tensile strength for a 35 AWG Nichrome wire is typically 550 MPa (megapascal) and 880 MPa respectively. Therefore,  $\leq 300$  MPa of stress  
5 would be a likely target for the spring mechanism.

Figs. 11-13 schematically illustrate one embodiment of an electro resistive wire heating element or filament 32 being held in contact with the flat tip end 33 of a wick 34. The opposite end of wick 34 is in communication with a composition containing an active ingredient within reservoir or vial 35. A cup 36 having a  
10 central opening (not shown) is used to support wick 34 in an upright position, and a seal between this opening and wick 34 prevents excessive evaporation and spillage of the composition within vial 35.

As shown best in Fig. 13, wire heating element 32 is mounted on a bowtie shaped plate 37 which includes a central annular member 38 and oppositely  
15 extending triangular shaped wing members 39 and 40. Central member 38 has an opening therein that has a diameter substantially the same as the diameter of wick 34. Wire 32 is disposed across opening 41 and has opposite ends affixed to plate 37 by rivets 41 and 42 which in turn are electrically connected to a battery 7 by wires 43 and 44 respectively.

20 Plate 37 and wire heating element 32 are captured within a cylindrical spring housing 45 in such a manner that plate 37 freely slides vertically therein, i.e., is free-floating in housing 45. Housing 45 includes an inwardly projecting annular lip 46 at its upper end that provides an annular lower surface 47. One end of a coil spring 48 bears against surface 47 and the other end of spring 48 bears against plate  
25 37 so as to provide a downward force to maintain wire heating element 32 against the emanating surface, i.e., the flat tip end 33, of wick 34, as indicated by arrow 4.

Although a coil spring 48 is illustrated in Fig. 11, other types of springs are also contemplated for use in the present assembly. Fig. 14 schematically illustrates a floating wire heating element 50 mounted across a pair of spring fingers 51, 52

for movement in the direction of arrow 53. Fig. 15 schematically illustrates spring force being applied by a pair of coiled sections 54 and 55 integrally formed as part of a wire heating element 56. Fig. 16 schematically illustrates spring force being applied by corrugations 57 integrally formed as a part of a wire heating element 58.

5 Fig. 17 schematically illustrates spring force being applied by stretching a wire heating element 59. In this embodiment, wick 60 is shouldered against the underside of plate 61 so that the flat tip end thereof projects through the central opening therein to stretch wire element 59 upwardly which provides a downward force against wick 60.

10 Fig. 18 schematically illustrates a side mounting embodiment for the present invention wherein a wire heating element 62 is mounted against the side of a wick 63 at a location beneath the flat tip end 64 thereof and above cap 65 of vial or reservoir 66. Wire 62 is affixed to a U-shaped plate 67 and extends across the opening formed by the U to engage or bear against the side of wick 63. A pair of  
15 spaced apart conductors 68 and 69 provide an electrical connection to the electronic circuitry schematically illustrated by 70 and battery 71. Conductors 68 and 69 are preferably composed of spring steel so as to inherently function as a spring to provide a force to maintain the wire heating element 62 in contact with the emanating surface, i.e., the side of wick 63.

20 Fig. 18 also illustrates a holder for removably mounting reservoir 66, cap 65 and wick 63 (comprising one embodiment of a refill assembly) to the apparatus. The holder comprises a base member 72 for supporting the underside of reservoir 66 and a pair of opposing spring finger members 73 and 74 that grab opposite sides of reservoir 66. Finger members 73 and 74 thus provide a snap-fit assembly for  
25 removably mounting reservoir 66, cap 65 and wick 63.

Fig. 19a illustrates that a wick 75 can have a notch 76 formed in its flat tip end 77 to receive a wire heating element 78. Notch 76 holds the wire heating element 78 in proper position and also increases the wetting effect at the wire

heating element 78. Fig. 19b illustrates a notch 79 formed in the side of a wick 80 to receive a wire heating element 81 for the same reasons noted for Fig. 19a.

Fig. 20 illustrates yet another embodiment wherein two spaced apart wire heating elements 82 and 83 contact the flat tip end 84 of a wick 85. Multiple wire heating elements might be used if desired to volatize more effectively, to volatize at a higher rate, or as a redundant system.

Fig. 21a illustrates a multi-part delivery system wherein the device includes a two-piece (or more) wick comprised of a permanent wick portion 86 and a refill wick portion 87. The permanent wick portion 86 and a wire heating element 88 would be affixed or attached to the device so as to be non-removable while the refill wick portion 87 would be part of a refill assembly which is removable and replaceable by a user. In the case of refills, a user interacts with the device and thus it may be beneficial to isolate the heater element 88 from user interaction, thereby preventing damage to the heater, maintaining the relationship of heater-to-wick, preventing contact with a hot surface, and allowing use of a less expensive low-temperature refill wick (permanent wick portion 86 would be high-temp).

Fig. 21b illustrates that when using a two-piece, or multiple-piece wick a coupling medium 89 may need to be disposed along the interface and between portions 86 and 87 to enhance fluid transfer between the refill wick portion 87 and the permanent wick portion 86. Examples of coupling medium 89 include felt type materials, cotton, absorbent paper (e.g. filter paper) and woven fabrics. Coupling medium 89 could be affixed to either refill wick portion 87 or permanent wick portion 86.

Fig. 22 illustrates an "all-in-one" refill assembly or unit comprised of a wire heating element 90, a wick 91 and a reservoir 92 of active solution. Reservoir 92 can be formed integrally as part of a laminated plastic film package 93. The outer edges of the lamination 93 may contain holes 94, or any other desired and convenient means, for aligning the all-in-one refill unit in the device.

Contacts 95 and 96 provide an electrical connection for wire heating element 90 to a battery or other source of power via electronic circuitry (not shown). There are advantages to an all-in-one refill unit where a simple replacement assembly provides a new heater, a new delivery system (wick), and the refill active solution all at once. This method reduces the life expectancy required of the components, and eliminates the need for expensive robust hardware.

To conserve energy, it is desirable to minimize the air velocity in contact with the heater element. This is because the moving air cools the heater element and takes the heat away, and as a result more power must be supplied to the heater element to maintain a desired temp. However, one also would benefit from evacuating the air inside the housing rapidly, to reduce the active concentration surrounding the pinpoint heater because a lower concentration allows easier volatilizing. Therefore, it is desirable to move air inside the housing, but utilize an air regulation means to reduce its velocity across the heater element. Figs. 23-26 illustrate several different methods of accomplishing this goal when used in combination with a fan while Fig. 27 illustrates another arrangement without a fan.

Fig. 23 illustrates the use of a baffle 97 as the air regulation means. Baffle 97 is disposed between a fan 98 and a wire heater element 99 in the path of the air currents 100 created by fan 98 to prevent direct contact of the air currents 100 with the wire heater element 99.

Fig. 24 illustrates the provision of a chamber 101 to receive a wire heater element 102 below (or above) a passageway 103 as the air regulation means. In Fig. 24, passageway 103 includes an air inlet 104 and an air outlet 105 formed adjacent to chamber 101 and through which air currents 106 from a fan 107 move. Passageway 103 communicates via an opening 108 with chamber 101 so that as air currents 106 flow past opening 108 active vaporized by heater element 102 is drawn into passageway 103 to flow downstream and exit the device via air outlet 105.



Fig. 25 illustrates varying the cross sectional area of a housing containing a wire heater element 109 as the air regulation means. Fig. 25 illustrates a passageway 110 formed downstream of a fan 111 through which air currents 112 move. Passageway 110 has a defined cross sectional area and opens into a larger chamber 113 having a greater cross sectional area than passageway 110 which contains wire heater element 109 therein. As a result, the velocity of the air currents 112 passing through chamber 113 and thus over wire heater element 109 is reduced as compared to the velocity of the air currents in passageway 110.

Fig. 26 illustrates an embodiment wherein the air regulation means comprises a cap 114 covering a wire heater element 115 located in contact with a flat tip end 116 of a wick 117. The cap 114 acts in a manner similar to baffle 97 in Fig. 23 to prevent direct contact of air from a fan (not shown) on wire heater element 115. In this embodiment, cap 114 also includes a plurality of slots 118 formed therein to allow active volatilized by wire heater element 115 to escape the interior thereof. Cap 114 may be held on wick 117 by one or more spring clips 119 which provides a snap-fit retainer for cap 114.

Fig. 27 illustrates yet another embodiment wherein a vented housing 120 is used as the air regulation means. In Fig. 27, housing 120 includes a plurality of spaced openings 121 formed therein so that movement of ambient air therethrough will expel volatilized active from the interior of housing 120. Alternatively, housing 120 may be attached via a wrist-band 122 to a user so that as a user swings or moves his or her arm, air moves through openings 121 to expel volatilized active.

It should be noted that all of the embodiments illustrated and described herein may be attached to and be wearable by a user so that the device is portable and wearable. In addition to wrist band 122 noted above, other attachment means could include various clips, pins, adhesives, hook and loop fasteners, magnets, ties, necklaces, straps, bands and buckles, as is well known in the art.

It should also be noted that various types of fans can be incorporated into the device to enhance efficacy by distributing the volatilized active and moving it away from the wick. For example, in addition to a conventional fan that utilizes a motor driven rotating blade, one could also use a piezo flapper device. The piezo flapper comprises a piezo device that vibrates, causing an attached material to vibrate and move air (low CFM). Alternatively, a conventional fan can be used to provide higher air velocity, as measured using cubic feet per minute (CFM). A piezo flapper uses a piezo ceramic disc or film material attached to a rectangular "flapper". The piezo vibrates at a low frequency (typically 100hz) when excited with the proper voltage. The vibration is mechanically transferred to the flapper creating a fan that moves air. Key benefits of piezo flappers are the low energy required to activate the device, small size and high reliability. Such fans are available under the trade names Piezoelectric Bender, Piezoelectric Flapper, or Piezoelectric Chopper from companies such as Piezo Systems, Physik Instrumente GmbH & Co., and East Electronics. Fig. 3 illustrates an electronic circuit that incorporates a subcircuit including a potentiometer 128 for controlling a piezo fan 129.

#### EXAMPLES

Fig. 6 is a graph that illustrates the ability of localized and cyclic heating used in heater 1 to meter the release of fragrance. This method of dispensing provides for increased control and flexibility. Current heated systems create an equilibrium release between temperature, surface area, and effluent physical properties. By controlling the amount of heat or more directly the magnitude of temperature reached, the on-time duration, and the frequency of the cycle this heating method can provide a wide range of effluent release, as shown. This experiment was conducted as shown in Table 1 with a 15G NiCr wire resistive heating element.

TABLE 1

| Temp<br>+/- 5 (F) | Weight per<br>Dispensings<br>( $\mu$ g) | Weight        |                |              | Dispensings<br>(or minutes) | Dispensing<br>Cycle<br>(min) |
|-------------------|-----------------------------------------|---------------|----------------|--------------|-----------------------------|------------------------------|
|                   |                                         | Change<br>(g) | Initial<br>(g) | Final<br>(g) |                             |                              |
| 110               | 18.18                                   | 0.00020       | 14.0901        | 14.0899      | 11                          | 1                            |
| 130               | 20.00                                   | 0.00020       | 14.0894        | 14.0892      | 10                          | 1                            |
| 150               | 20.00                                   | 0.00020       | 14.0887        | 14.0885      | 10                          | 1                            |
| 170               | 40.00                                   | 0.00040       | 14.0882        | 14.0878      | 10                          | 1                            |
| 190               | 81.82                                   | 0.00090       | 14.0173        | 14.0164      | 11                          | 1                            |
| 210               | 120.00                                  | 0.00120       | 14.0853        | 14.0841      | 10                          | 1                            |
| 230               | 200.00                                  | 0.00200       | 14.0830        | 14.0810      | 10                          | 1                            |
| 250               | 510.00                                  | 0.00510       | 14.0751        | 14.0700      | 10                          | 1                            |
| 270               | 680.00                                  | 0.00680       | 14.0303        | 14.0235      | 10                          | 1                            |
| 290               | 815.38                                  | 0.01060       | 14.0098        | 13.9992      | 13                          | 1                            |
| 310               | 800.00                                  | 0.00880       | 13.9033        | 13.8945      | 11                          | 1                            |

Current from wall power was passed through the wire for one minute and then turned off. The amperes were controlled such that the maximum temperature achieved was that shown. Increasing the current increased the temperature and subsequently increased the weight loss per cycle. Ten to thirteen cycles were performed to obtain the average weight loss. The inflection in the profile indicates that there are temperatures that volatilize fragrance at a rate faster than fragrance can feed the heat zone during the on-cycle for volatilization. As a result, the weight loss per dispensing begins to fall with greater temperatures until a plateau occurs. During the off-cycle there is time for the emanator to recharge for another heat cycle.

Fig. 7 is an example of the control of an insecticide by a similar experimental protocol as that described for Fig. 6. This experiment was conducted as shown in Table 2 also with a 15G NiCr wire resistive heating element.

TABLE 2

| Temp<br>+/- 5 (F) | Weight per<br>Dispensings<br>( $\mu$ g) | Weight        |                |              | Dispensings<br>(or minutes) | Dispensing<br>Cycle<br>(min) |
|-------------------|-----------------------------------------|---------------|----------------|--------------|-----------------------------|------------------------------|
|                   |                                         | Change<br>(g) | Initial<br>(g) | Final<br>(g) |                             |                              |
| 100               | 3.18                                    | 0.0005        | 8.8945         | 8.8940       | 157                         | 1                            |
| 150               | 7.58                                    | 0.0005        | 9.0076         | 9.0071       | 66                          | 1                            |
| 200               | 18.48                                   | 0.0017        | 8.8962         | 8.8945       | 92                          | 1                            |
| 250               | 46.34                                   | 0.0038        | 9.0010         | 8.9972       | 82                          | 1                            |
| 300               | 109.84                                  | 0.0067        | 8.9972         | 8.9905       | 61                          | 1                            |
| 350               | 154.41                                  | 0.0105        | 8.9905         | 8.9800       | 68                          | 1                            |
| 400               | 195.96                                  | 0.0158        | 8.9800         | 8.9642       | 81                          | 1                            |
| 450               | 231.37                                  | 0.0118        | 8.9642         | 8.9524       | 51                          | 1                            |
| 500               | 352.85                                  | 0.0434        | 8.8940         | 8.8506       | 123                         | 1                            |
| 550               | 90.54                                   | 0.0067        | 8.9379         | 8.9312       | 74                          | 1                            |

The insecticides showed a similar rate limiting behavior as that with fragrances with increasing temperature.

- 5            Fig. 8 represents a bioefficacy example where the same localized heating and cyclic control device used as in Fig. 7. Figure 8 represents the adjustable performance of localized and cyclic heating against experimental controls and marketed products. Data was gathered by preparing 6.12 m<sup>2</sup> enclosed chamber with ventilation control. The chamber was cleaned with soap and water for any
- 10 residual insecticide from previous tests and ventilation stopped. 100 female *Aedes Aegypti* mosquitoes were released in the chamber and observed for the number of mosquitoes that fell unresponsive over the course of time. Figure 8 indicates that no mosquitoes were lost during the control experiment. The performance standard for mosquito kill or knockdown is that of the pre-burned coil. This occurs by
- 15 burning a standard coil treated with an insecticide solution. Upon burning the insecticide is released and fills the chamber. A sample of 100 mosquitoes is released in this treated chamber and observed for knockdown over time. It is observed that 90% of the insects are killed with about three minutes of exposure and the remainder within the next few minutes. The "45-Night" designation
- 20 represents a currently marketed product in a common form, which provides

nighttime protection for 45 nights. In this and all remaining experiments in this example the chambers were prepared to control standards, the mosquitoes released and then the insecticide product released by the various devices or methods. These experiments required the device to treat the room and begin causing insect

5 knockdown. The 45 night product showed a twelve minute lag to first efficacy.

The coil from a cold start showed a seven minute lag with steeper effect against the mosquitoes. PPH represents the localized and cyclic heater and shows that it can be operated with adjustable temperature magnitude, on-time duration, and

frequency to have very fast two minute onset and steep bioefficacy slope for such

10 reasons as initial space treatment and then can be adjusted for slower onset at seven minutes and shallower slope which may represent a maintenance treatment, adjustment for smaller space, or for personal preference.

Table 3 shows an important additional conclusion from this example is the observation that the insecticide active was not destroyed by the intensive localized heating. It has been shown that the amount of active released is that which is

15 theoretically needed for knockdown. Such theoretical values have been shown experimentally and correspond to the performance of this technology. This indicating that there is limited destruction of the chemical entity through localized cyclic heating.

TABLE 3

Active Delivered:

| Wt. Of Formula Used (g) |         |         | Theoretical Air Concentration |        |        |
|-------------------------|---------|---------|-------------------------------|--------|--------|
|                         | Test 1  | Test 2  |                               | Test 1 | Test 2 |
| Before                  | 10.3947 | 10.3938 | Volume                        | 420    | 6120   |
|                         |         |         | (L)                           |        |        |
| After                   | 10.3938 | 10.3917 | ug Al                         | 27     | 63     |
| Total used              | 0.0009  | 0.0021  | ug/L                          | 0.0643 | 0.0103 |
| ug Al used              | 27      | 63      |                               |        |        |

## Test 1:

Test: 0.42 M3 chamber.

Insect: *A. aegypti*.

Formula: Raid Electric 45 night

5 3% EBT, 1% BHT, 96% Isopar V

Heater cycle time: 1:03 min.

| Dispensing No. | Temp. (C) | Time (Min) | KD (#) | Total No. | KD (%) |
|----------------|-----------|------------|--------|-----------|--------|
| 1              | 116       | 1          | 0      | 9         | 0      |
| 2              | 119       | 2          | 0      | 9         | 0      |
| 3              | 121       | 3          | 0      | 9         | 0      |
| 4              | 118       | 4          | 1      | 9         | 11     |
| 5              | 120       | 5          | 1      | 9         | 11     |
| 6              | 115       | 6          | 1      | 9         | 11     |
| 7              | 116       | 7          | 3      | 9         | 33     |
| 8              | 116       | 8          | 7      | 9         | 78     |
| 9              | 118       | 9          | 8      | 9         | 89     |
| 10             | 119       | 10         | 8      | 9         | 89     |
| 11             | 119       | 11         | 8      | 9         | 89     |
| 12             | 120       | 12         | 9      | 9         | 100    |

10 Similarly, by the use of fragrance and human panelist trained in fragrance hedonics, it has been qualitatively shown that the quality of a fragrance is also not degraded with localized cyclic heating. The burst of high temperature heating preferentially facilitates volatilization rather than degradation.

15 Fig. 9 and Table 4 illustrate the favorable particle sizes created by the operation of the localized and cyclic heating of heater 1.

TABLE 4

|                | 10       | 20       | 30       | 40       | 50       |
|----------------|----------|----------|----------|----------|----------|
| 0.3 um Profile | 69269.38 | 26828    | 17878.5  | 15459.63 | 14119    |
| 0.5 um Profile | 57631.25 | 18322.38 | 10794.13 | 8980.25  | 7921     |
| 0.7 um Profile | 47058.5  | 10181.75 | 5176.75  | 4096.875 | 3425.875 |
| 1 um Profile   | 39238    | 6952.125 | 3285.375 | 2535.125 | 2073.75  |
| 5 um Profile   | 730.625  | 21.5     | 12.375   | 10.625   | 9.75     |
| 10 um Profile  | 5        | 0.25     | 0.25     | 0.25     | 0.25     |

The mechanism of molecular volatilization and detection of particles results from the condensation of the vapor within the vicinity of the emanator. The size and energy (retained heat) of these particles is important in their post condensation behavior. Particles that are too large suffer from lack of time aloft and lack of surface area. Large particles of 2 - 3  $\mu\text{m}$  and particularly above 10  $\mu\text{m}$  in diameter or more are affected by gravity and will fall out of suspension in the air near the emanator. Because of the lack of loft the particles are not able to drift to lower concentrated areas where they can revaporize. Contributing to the difficulty to revolatilize is the reduced surface area per volume of the larger particles, which limits the amount of surface available for volatilizations. Just the opposite is available from the localized cyclic heating method of the present invention. These particles have reduced diameter below 1  $\mu\text{m}$ , which are too small to settle out from gravitational forces, are too small to deposit in human respiratory system, and have large surface to volume ratios such that revolatilization is quickly promoted. The particles from the localized cyclic heat source of heater 1 efficiently disperse and remain dispersed in air.

Fig. 10 and Table 5 demonstrate the variable temperatures that are achievable with a single thin film oxide heater with variable current input.

TABLE 5

| Amp  | 0.5<br>Temp (F) | 1<br>Temp (F) | 1.5<br>Temp (F) | 2<br>Temp (F) |
|------|-----------------|---------------|-----------------|---------------|
| 0.3  | 119.72          | 103.30        | 85.66           | 63.14         |
| 0.35 | 130.19          | 111.89        | 92.43           | 69.01         |
| 0.4  | 126.72          | 106.92        | 89.96           | 67.46         |
| 0.45 | 0.45            | 0.45          | 0.45            | 0.45          |
| 0.5  | 0.50            | 0.50          | 0.50            | 0.50          |
| 0.55 | 120.75          | 106.80        | 88.93           | 65.50         |
| 0.6  | 128.90          | 111.11        | 91.01           | 67.34         |

This example illustrates one composition with surface temperatures can vary over broad ranges. It also represents that final temperatures are largely achieved

within the first half second of current application. There is little temperature change between one-half second and two seconds. This example confirms the rapid heating characteristics of the thin film heating element within appropriate ranges for use within the fields described by this application.



## CLAIMS

I claim:

1. A portable apparatus for dispersing a volatile active into air,  
comprising:
  - a base;
  - a reservoir containing a composition having a volatile active;
  - 5 a holder for mounting said reservoir to said base;
  - a wick having an emanating surface and communicating with said  
composition for delivering said composition to said emanating surface;
  - a heating element in contact with said emanating surface; and
  - a source of power communicating with said heating element to heat said  
10 heating element and vaporize said volatile active.
2. The apparatus of claim 1 wherein said volatile active is selected from  
the group consisting of an insect repellant, an insecticide, a pesticide, an antiseptic, a  
fungicide, a plant growth regulator, a herbicide, an air freshener, a perfume, a  
deodorant, a medicament, and mixtures thereof.
3. The apparatus of claim 1 wherein said volatile active is an insect  
repellant.
4. The apparatus of claim 3 wherein said insect repellant is selected from  
the group consisting of pyrethrins, chrysanthemic acid derivatives, pyrethroids, and  
mixtures thereof.
5. The apparatus of claim 4 wherein said insect repellant is a pyrethroid  
and is selected from the group consisting of allethrin, d-allethrin, bioallethrin, S-  
bioallethrin, empenethrin, prallethrin, and transfluthrin, and combinations thereof.
6. The apparatus of claim 3 wherein said insect repellant is 3-allyl-2-  
methylcyclopenta-2-ene-4-one.
7. The apparatus of claim 3 wherein said insect repellant is N,N-diethyl  
meta-toluamide.

8. The apparatus of claim 1 wherein said holder provides a removable mounting for said reservoir.

9. The apparatus of claim 8 wherein said reservoir and wick are integral with each other to provide removable and replaceable refill assembly.

10. The apparatus of claim 9 wherein said refill assembly further includes said heating element.

11. The apparatus of claim 8 wherein said holder provides a snap-fit mounting for said refill assembly.

12. The apparatus of claim 1 wherein said wick is composed of a material selected from the group consisting of natural materials, fibers, nonwovens, sintered polymers, ceramics, metal foams and glass.

13. The apparatus of claim 1 wherein said heating element is an electro-resistive heating element.

14. The apparatus of claim 13 wherein said electro-resistive heating element is selected from the group consisting of a wire, a thin film and a thick film.

15. The apparatus of claim 13 wherein said electro-resistive heating element is a wire composed of nichrome.

16. The apparatus of claim 13 wherein said electro-resistive heating element is a thin film composed of tin oxide.

17. The apparatus of claim 1 wherein said composition is in the form of a liquid, solid, semi-solid or gel at ambient conditions.

18. The apparatus of claim 1 further including a spring providing a force to maintain said heating element in contact with said emanating surface.

19. The apparatus of claim 18 wherein said wick includes a relatively flat tip end defining said emanating surface and said heating element contacts said flat tip end.

20. The apparatus of claim 18 wherein said wick includes opposite ends and at least one side surface between said opposite ends defining said emanating surface and said heating element contacts said side surface.

21. A portable apparatus for dispersing a volatile active into air, comprising:

- a base;
- a reservoir containing a composition having a volatile active;
- 5 a holder for mounting said reservoir to said base;
- a wick having an emanating surface and communicating with said composition for delivering said composition to said emanating surface;
- a wire heating element in contact with said emanating surface;
- a spring providing a force to maintain said wire heating element in contact
- 10 with said emanating surface; and
- a source of power communicating with said heating element to heat said heating element and vaporize said volatile active.

22. The apparatus of claim 21 wherein said volatile active is selected from the group consisting of an insect repellent, an insecticide, a pesticide, an antiseptic, a fungicide, a plant growth regulator, a herbicide, an air freshener, a perfume, a deodorant, a medicament, and mixtures thereof.

23. The apparatus of claim 21 wherein said volatile active is an insect repellent.

24. The apparatus of claim 23 wherein said insect repellent is selected from the group consisting of pyrethrins, chrysanthemic acid derivatives, pyrethroids, and mixtures thereof.

25. The apparatus of claim 24 wherein said insect repellent is a pyrethroid and is selected from the group consisting of allethrin, d-allethrin, bioallethrin, S-bioallethrin, empenethrin, prallethrin, and transfluthrin, and combinations thereof.

26. The apparatus of claim 23 wherein said insect repellent is 3-allyl-2-methylcyclopenta-2-ene-4-one.

27. The apparatus of claim 23 wherein said insect repellent is N,N-diethyl meta-toluamide.

28. The apparatus of claim 21 wherein said holder provides a removable mounting for said reservoir.

29. The apparatus of claim 28 wherein said reservoir and wick are integral with each other to provide removable and replaceable refill assembly.

30. The apparatus of claim 29 wherein said refill assembly further includes said heating element.

31. The apparatus of claim 28 wherein said holder provides a snap-fit mounting for said refill assembly.

32. The apparatus of claim 21 wherein said wick is composed of a material selected from the group consisting of natural materials, fibers, nonwovens, sintered polymers, ceramics, metal foams and glass.

33. The apparatus of claim 21 wherein said wire heating element is composed of nichrome.

34. The apparatus of claim 21 wherein said composition is in the form of a liquid, solid, semi-solid or gel at ambient conditions.

35. The apparatus of claim 21 wherein said wick includes a relatively flat tip end defining said emanating surface and said heating element contacts said flat tip end.

36. The apparatus of claim 21 wherein said wick includes opposite ends and at least one side surface between said opposite ends defining said emanating surface and said heating element contacts said side surface.

37. A portable apparatus for dispersing a volatile active into air, comprising:

a base;

5 a refill assembly comprising a reservoir containing a composition having a volatile active, a wick having an emanating surface and communicating with said composition for delivering said composition to said emanating surface, and a heating element in contact with said emanating surface;

a holder for removably mounting said refill assembly to said base;

- a source of power communicating with said heating element to heat said  
10 heating element and vaporize said volatile active;  
a spring providing a force to maintain said heating element in contact with  
said emanating surface;  
a cover attachable to said base to enclose said refill assembly, holder and  
spring, and including at least one air inlet and one air outlet; and  
15 a fan mounted to move a current of air from said inlet past said emanating  
surface to cause egress of said volatile active from said air outlet.

38. The apparatus of claim 37 wherein said volatile active is selected from the group consisting of an insect repellant, an insecticide, a pesticide, an antiseptic, a fungicide, a plant growth regulator, a herbicide, an air freshener, a perfume, a deodorant, a medicament, and mixtures thereof.

39. The apparatus of claim 37 wherein said volatile active is an insect repellant.

40. The apparatus of claim 39 wherein said insect repellant is selected from the group consisting of pyrethrins, chrysanthemic acid derivatives, pyrethroids, and mixtures thereof.

41. The apparatus of claim 40 wherein said insect repellant is a pyrethroid and is selected from the group consisting of allethrin, d-allethrin, bioallethrin, S-bioallethrin, empenethrin, prallethrin, and transfluthrin, and combinations thereof.

42. The apparatus of claim 39 wherein said insect repellant is 3-allyl-2-methylcyclopenta-2-ene-4-one.

43. The apparatus of claim 39 wherein said insect repellant is N,N-diethyl meta-toluamide.

44. The apparatus of claim 37 wherein said holder provides a removable mounting for said reservoir.

45. The apparatus of claim 44 wherein said holder provides a snap-fit mounting for said refill assembly.

46. The apparatus of claim 37 wherein said wick is composed of a material selected from the group consisting of natural materials, fibers, nonwovens, sintered polymers, ceramics, metal foams and glass.

47. The apparatus of claim 37 wherein said heating element is an electro-resistive heating element.

48. The apparatus of claim 47 wherein said electro-resistive heating element is selected from the group consisting of a wire, a thin film and a thick film.

49. The apparatus of claim 47 wherein said electro-resistive heating element is a wire composed of nichrome.

50. The apparatus of claim 47 wherein said electro-resistive heating element is a thin film composed of tin oxide.

51. The apparatus of claim 37 further including a battery housing mounted on said base, and wherein said source of power comprises at least one battery receivable in said battery housing for powering said heating element and fan.

52. The apparatus of claim 37 further including air regulation means for minimizing the velocity of said air current across said heater element.

53. The apparatus of claim 52 wherein said air regulation means includes a baffle disposed between said fan and said heater element to prevent direct contact of said air current with said heater element.

54. The apparatus of claim 52 wherein said air regulation means comprises a passageway formed adjacent to said heater element and communicating with said air inlet and said air outlet and through which said air current moves, said passageway communicating with said heater element to draw  
5 active vaporized by said heater element into said passageway as said air moves downstream therein.

55. The apparatus of claim 52 wherein said air regulation means comprises a passageway formed downstream of said fan through which said air current moves and having a first cross sectional area, and a chamber downstream of

5 said passageway through which said air current moves and having a second cross sectional area, said second cross sectional area being greater than said first cross sectional area to thereby reduce the velocity of said air current through said chamber, and said heater element is disposed in said chamber.

56. The apparatus of claim 37 further including a non-removable permanent wick portion engageable with said wick of said refill assembly.

57. The apparatus of claim 56 further including a fluid coupling medium disposed between said permanent wick portion and said wick of said refill assembly.

58. The apparatus of claim 37 wherein said source of power includes electronic circuitry providing pulsed heating of said heating element.

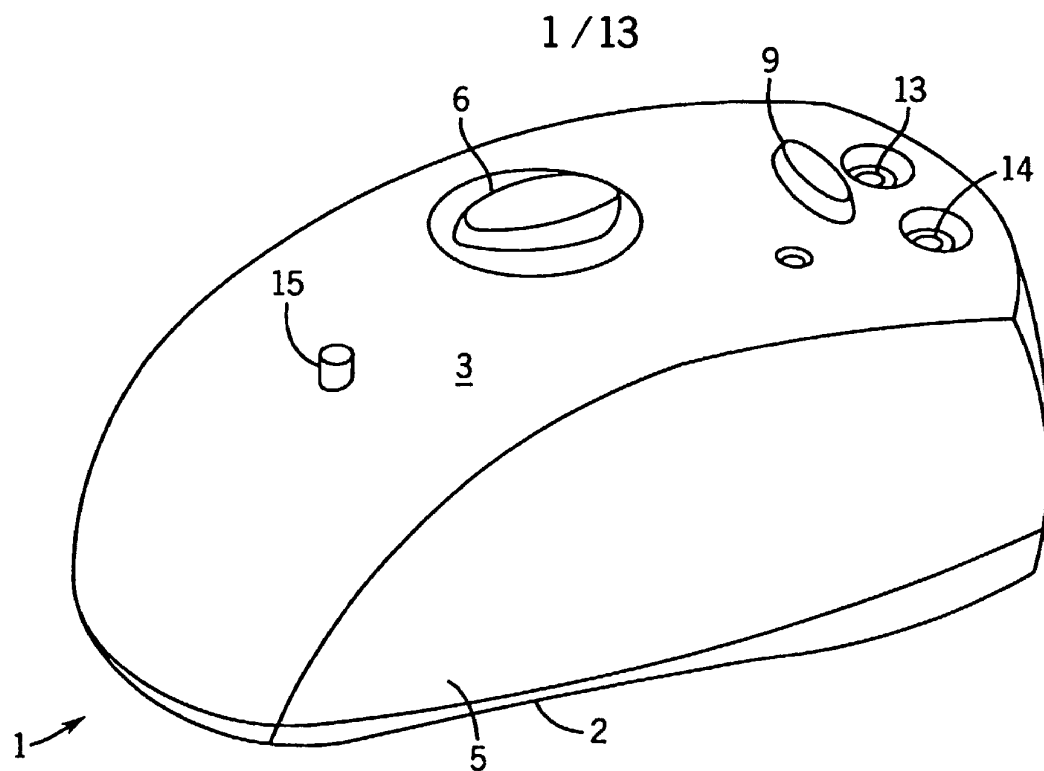


FIG. 1

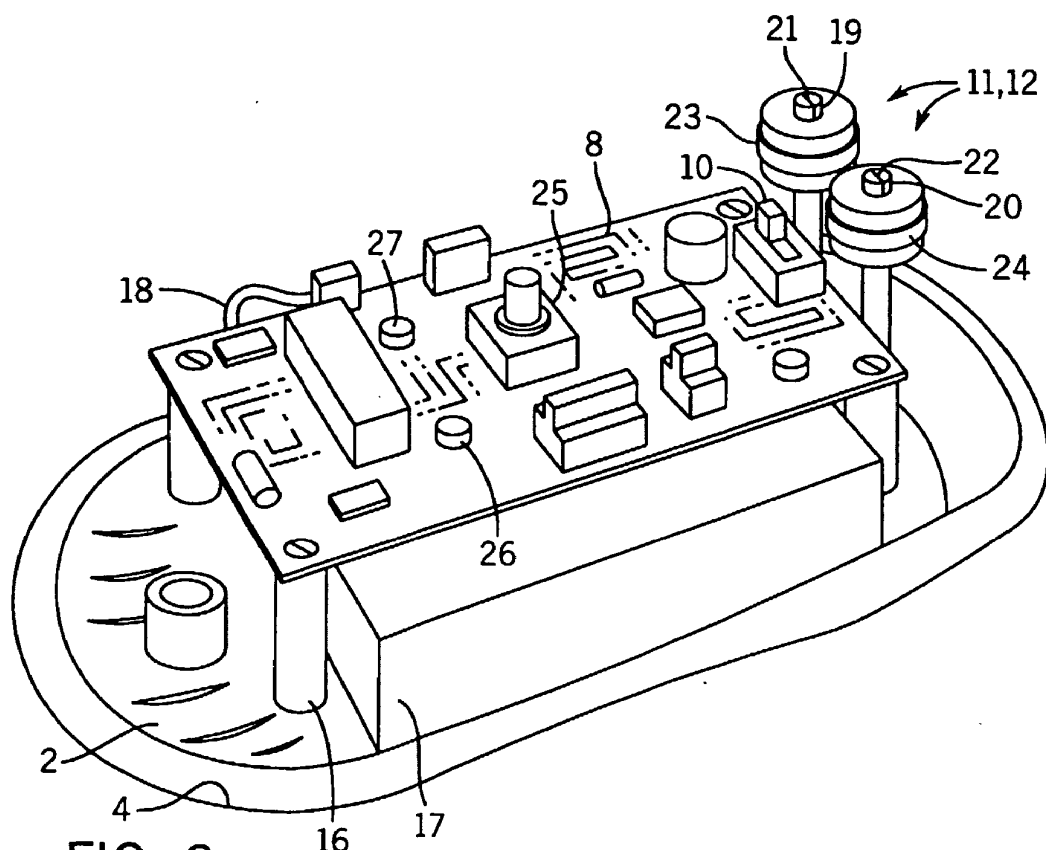


FIG. 2

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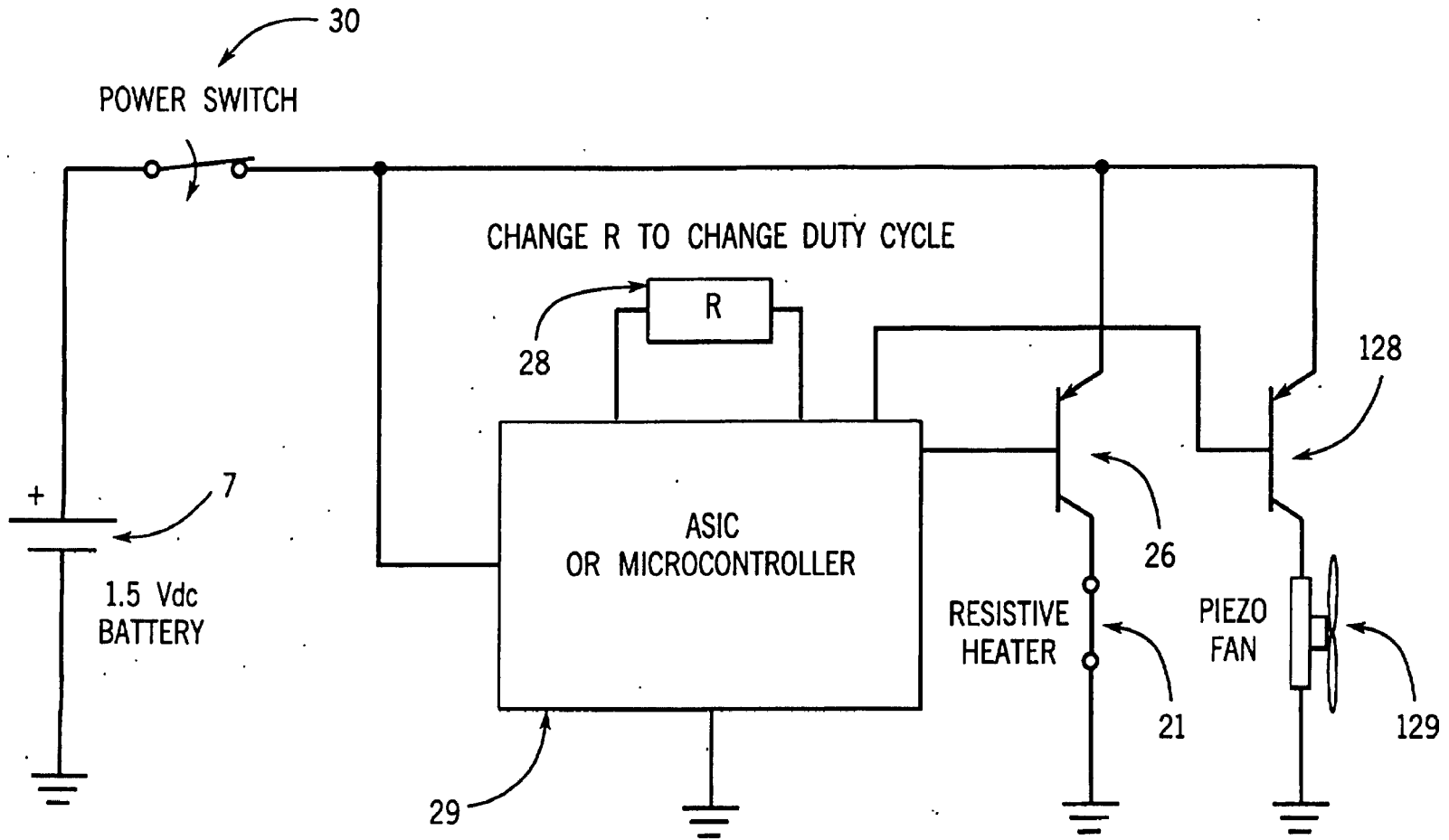


FIG. 3

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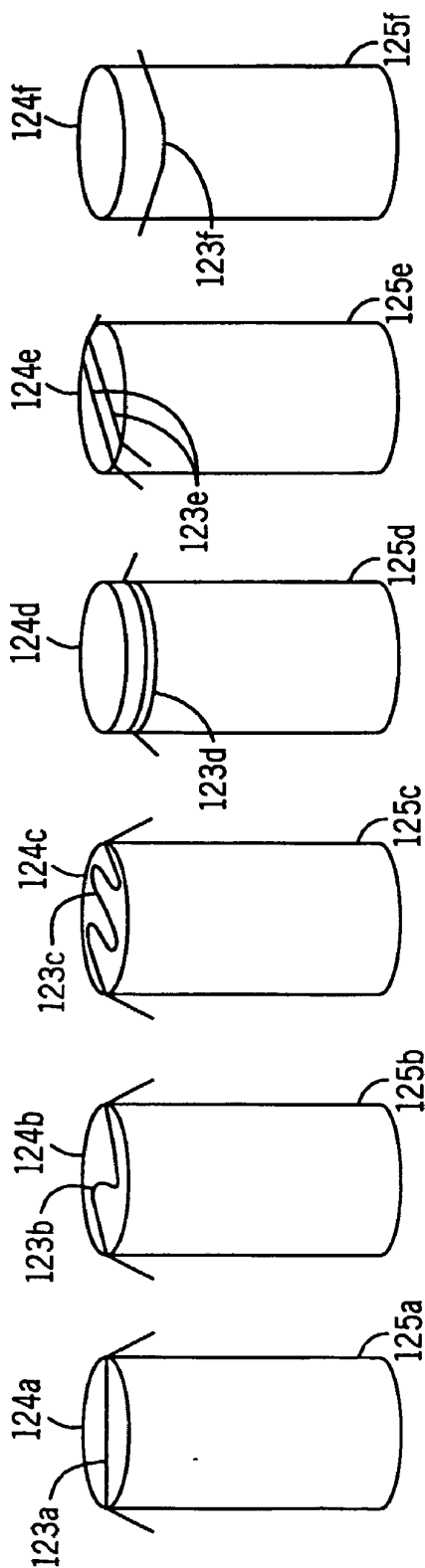


FIG. 4a FIG. 4b FIG. 4c FIG. 4d FIG. 4e FIG. 4f

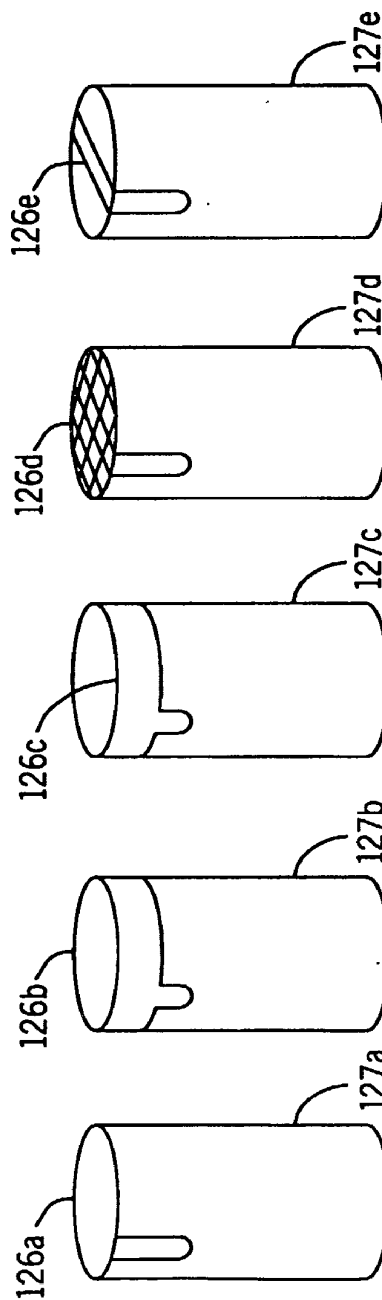


FIG. 5a FIG. 5b FIG. 5c FIG. 5d FIG. 5e

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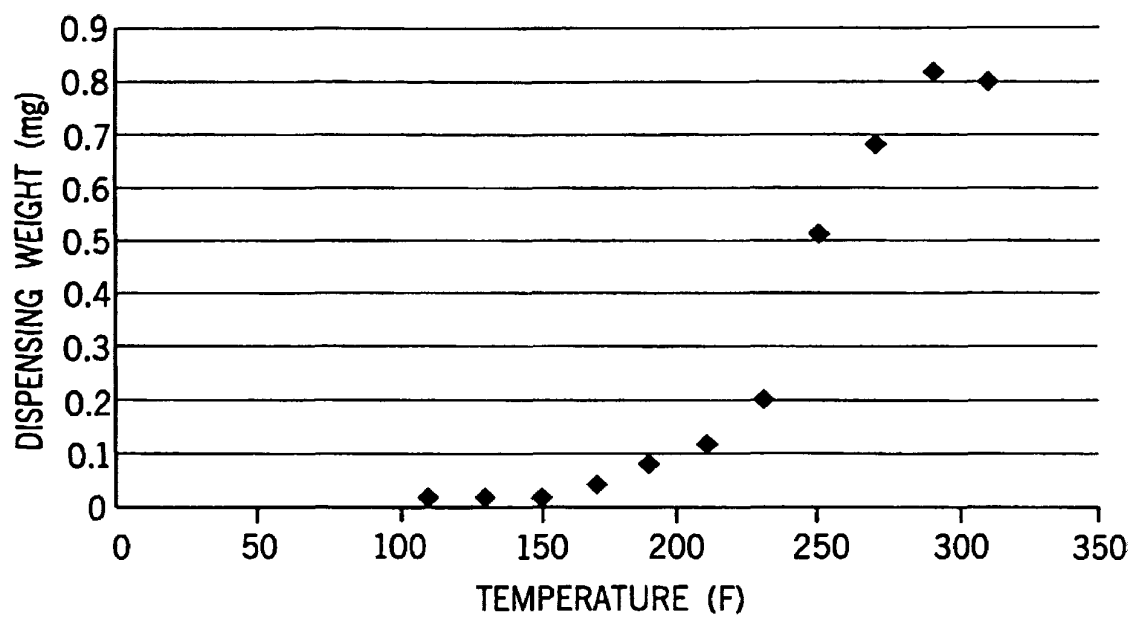


FIG. 6

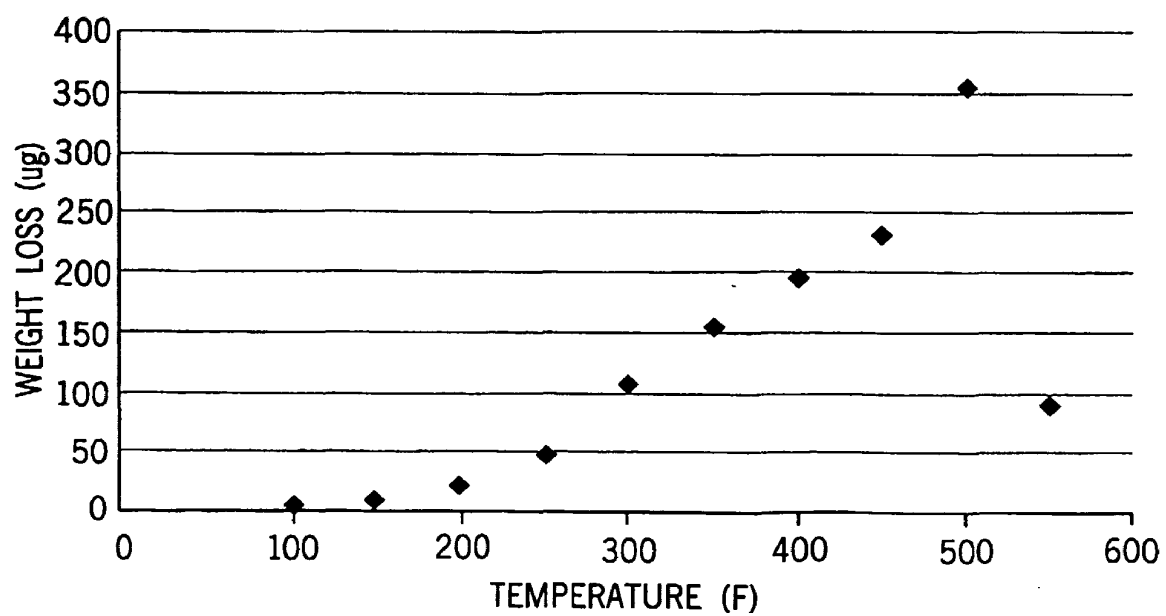


FIG. 7

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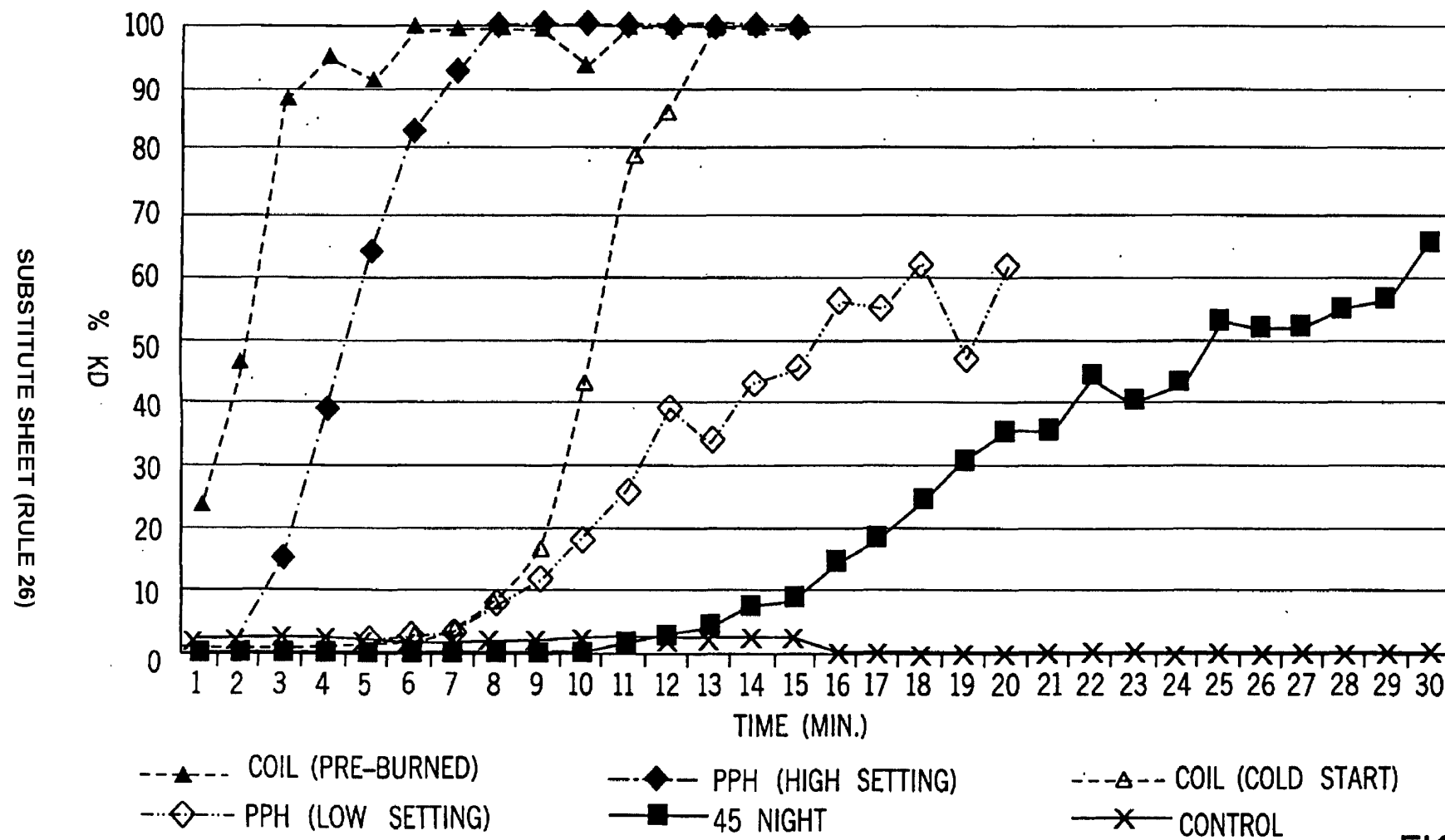


FIG. 8

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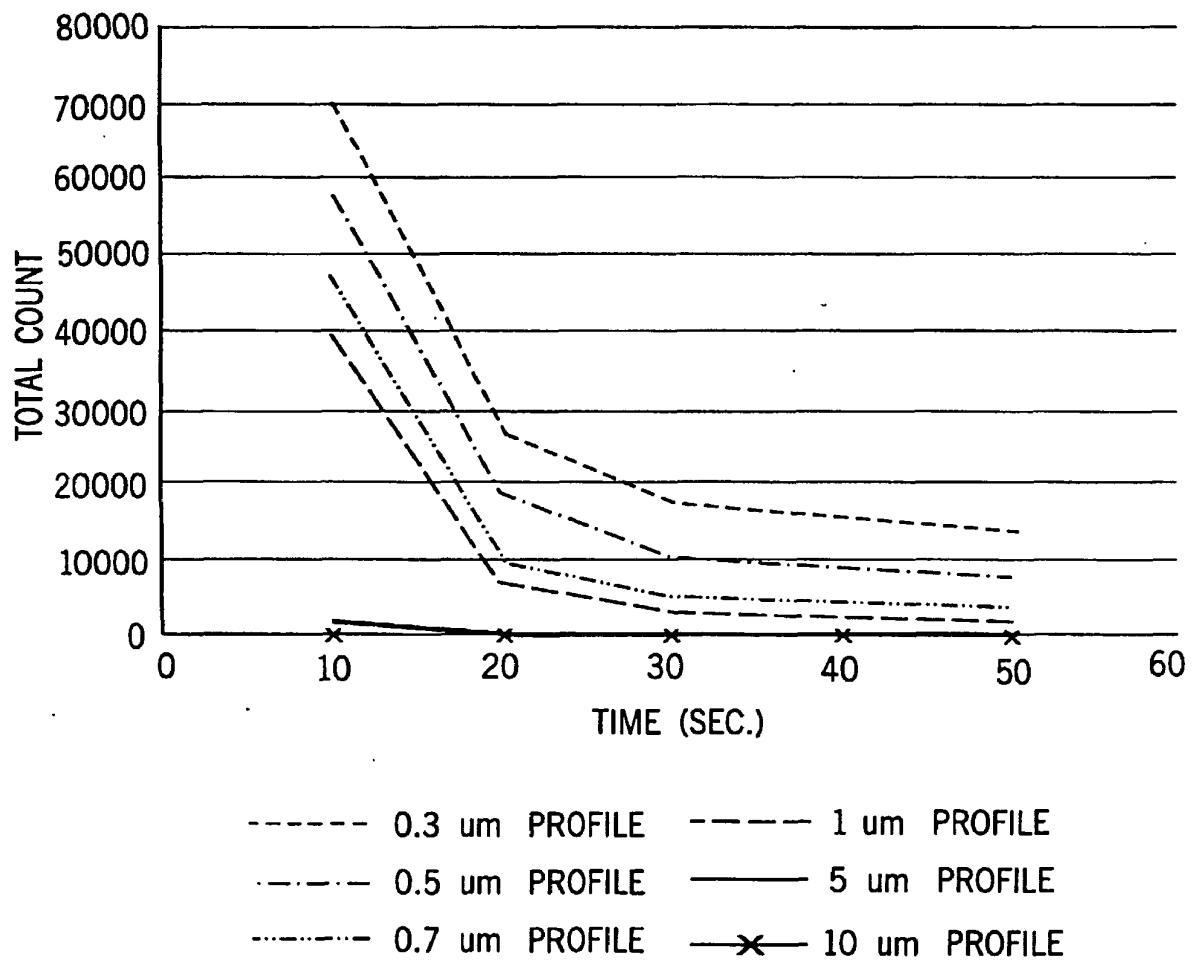
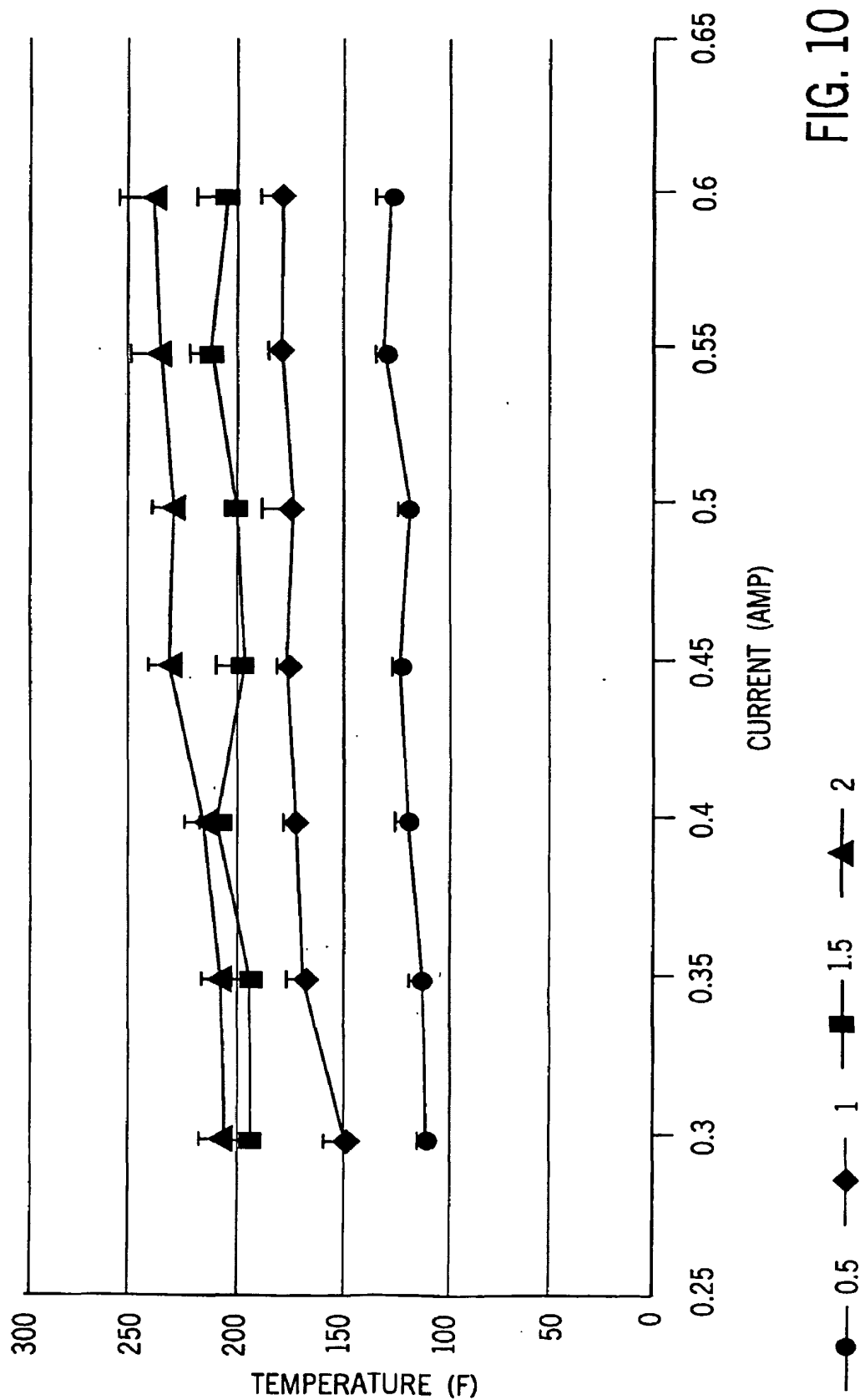


FIG. 9

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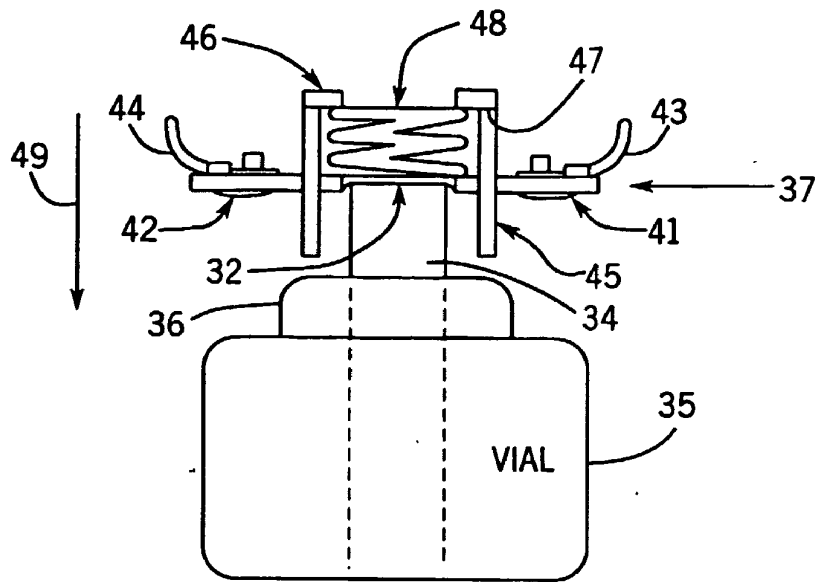


FIG. 11

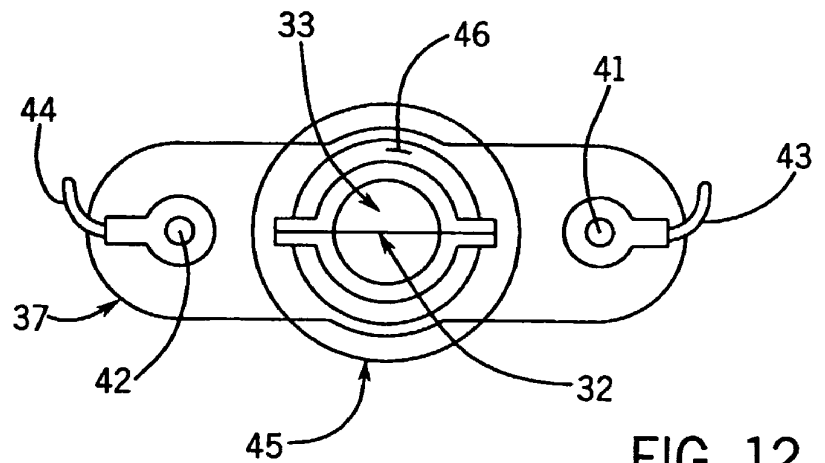


FIG. 12

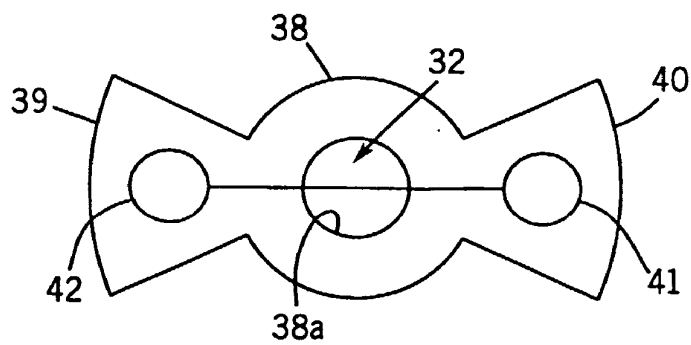


FIG. 13

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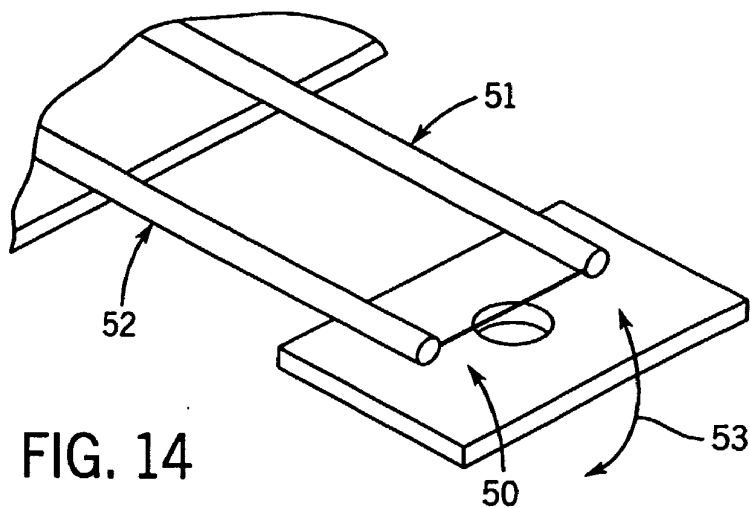


FIG. 14

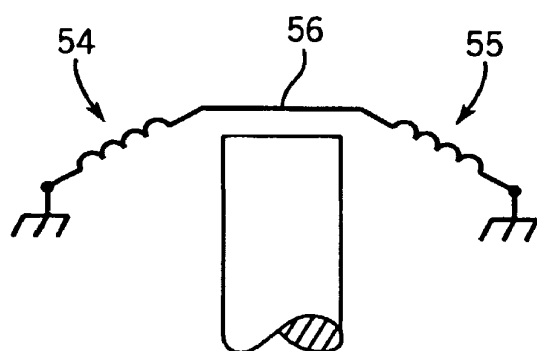


FIG. 15

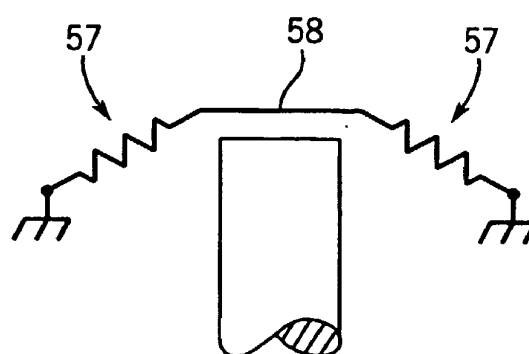


FIG. 16

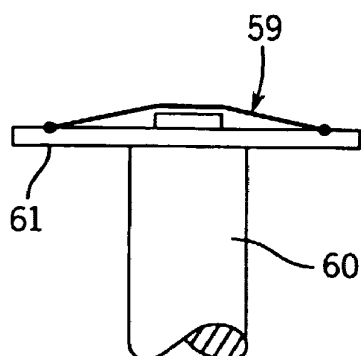


FIG. 17

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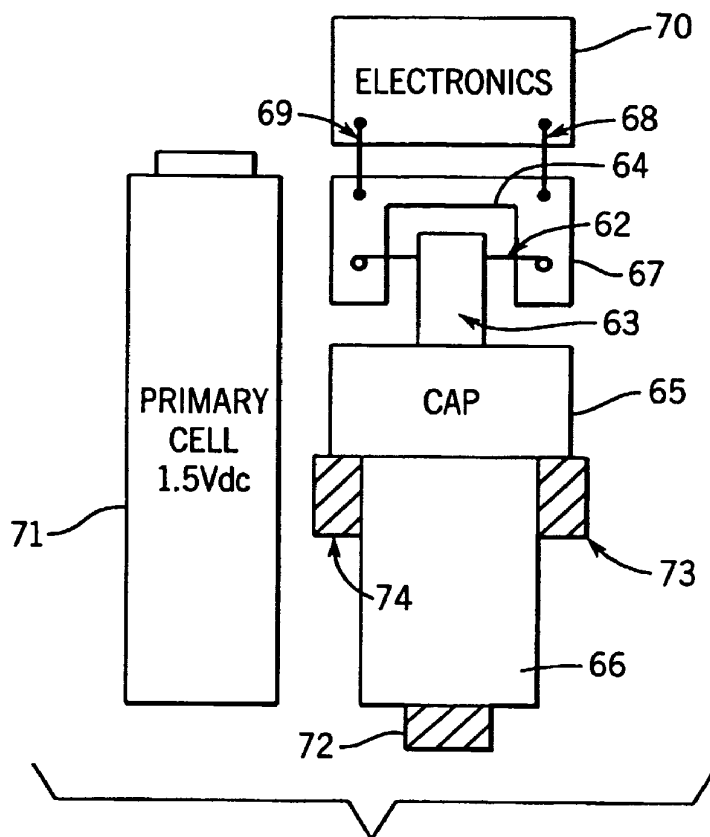


FIG. 18

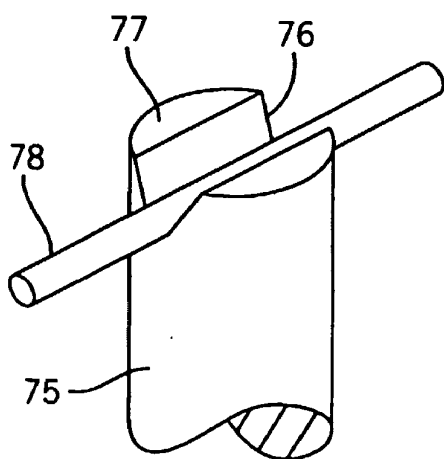


FIG. 19a

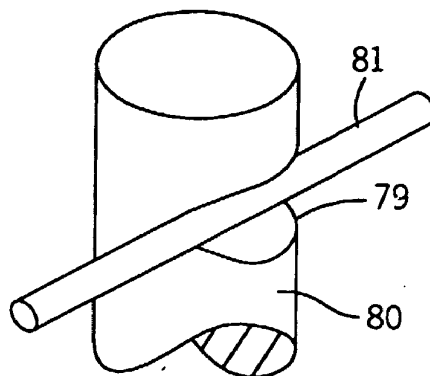


FIG. 19b

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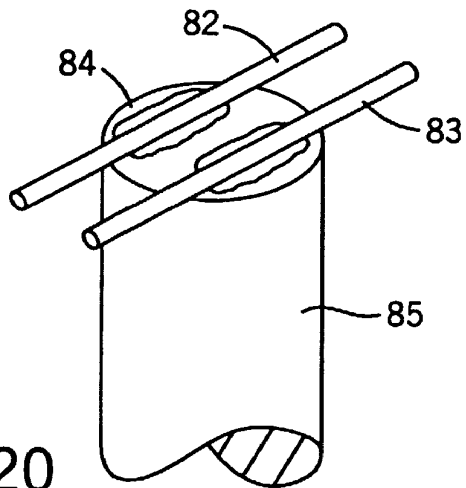


FIG. 20

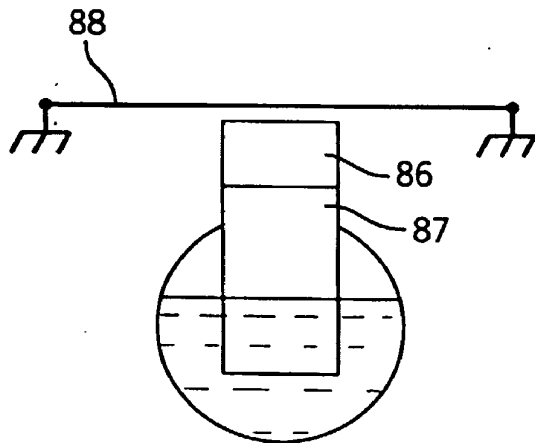


FIG. 21a

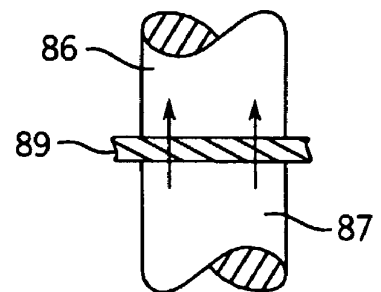


FIG. 21b

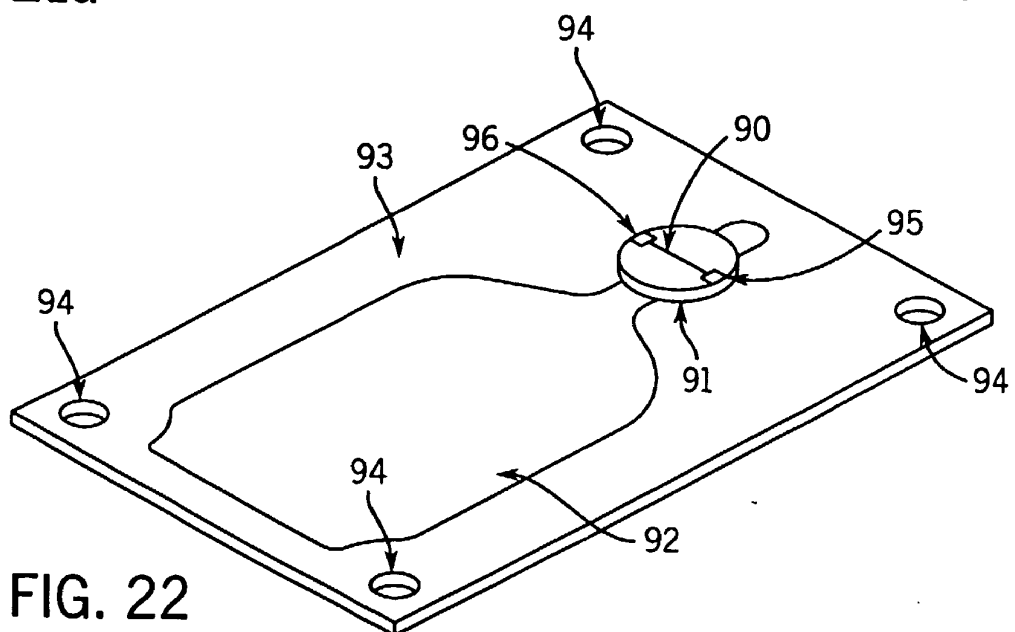
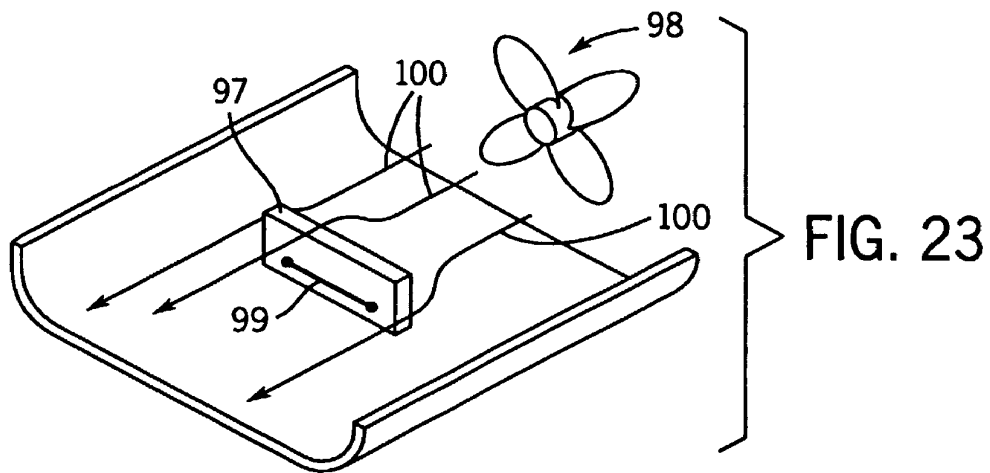
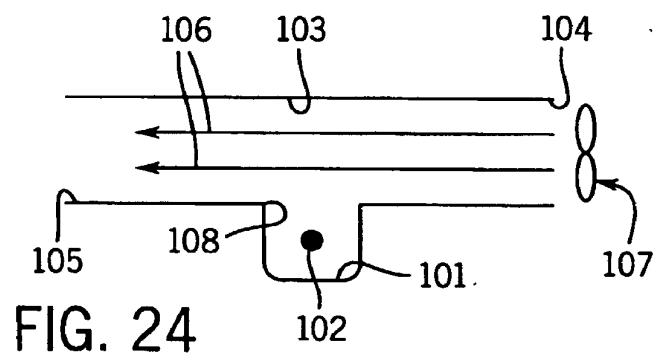
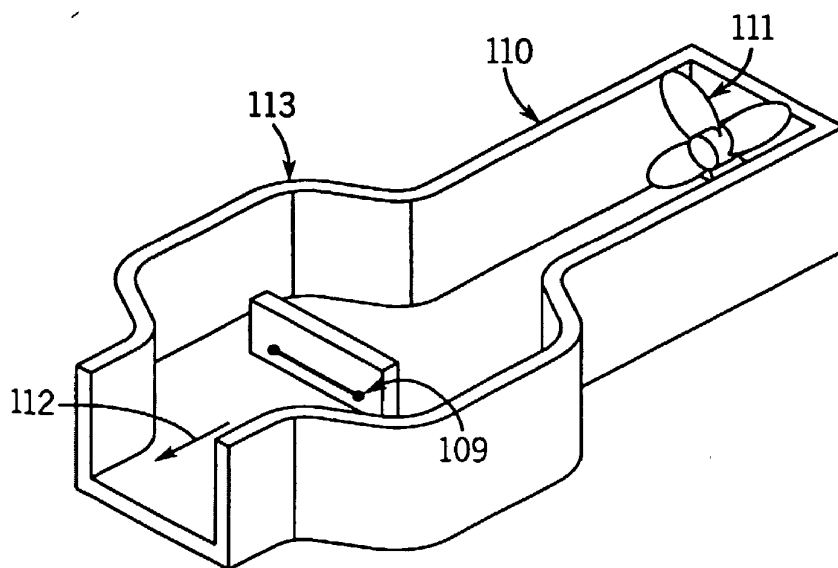


FIG. 22

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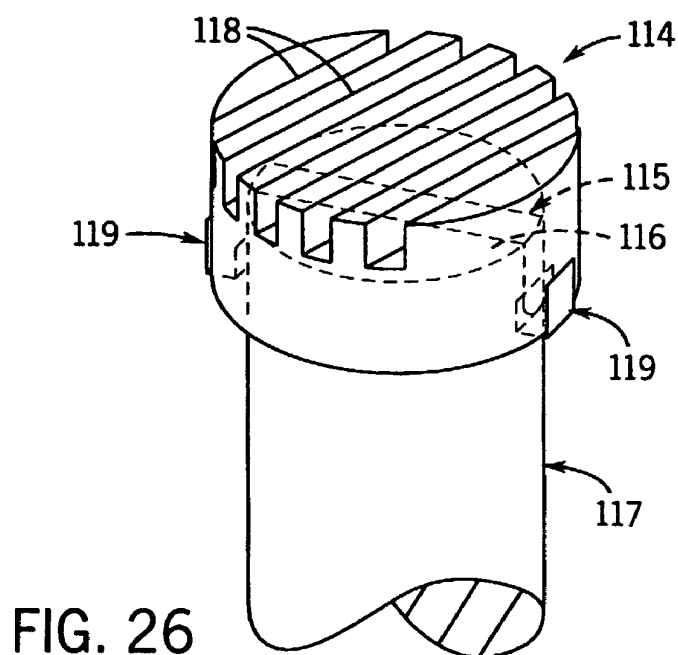


FIG. 26

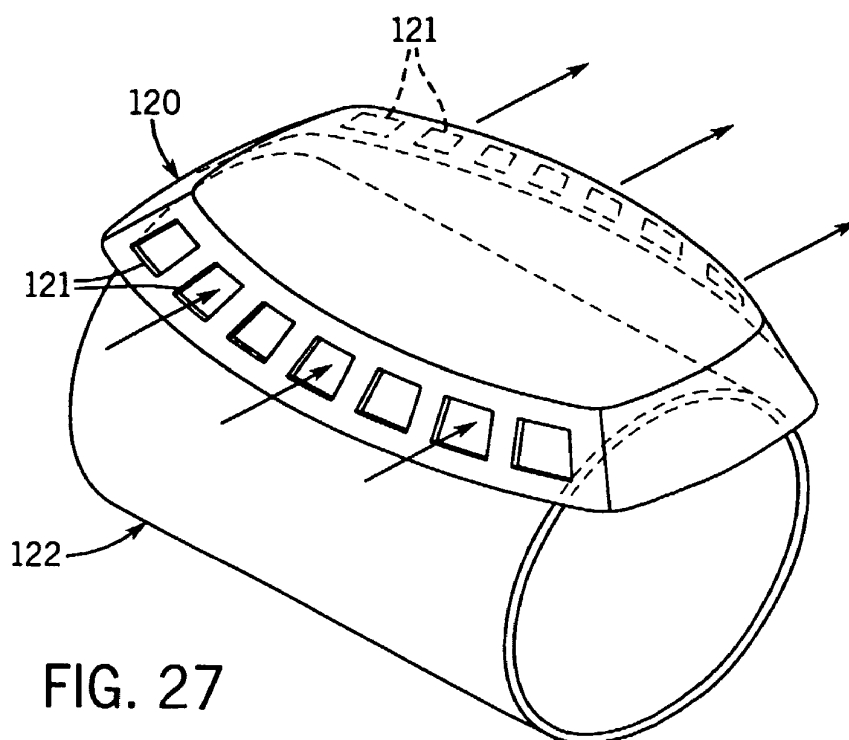


FIG. 27

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(51) International Patent Classification:  
A24F 47/00 (2006.01)(21) International Application Number:  
PCT/US2014/025565(22) International Filing Date:  
13 March 2014 (13.03.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
13/802,950 14 March 2013 (14.03.2013) US(71) Applicant: **R. J. REYNOLDS TOBACCO COMPANY**  
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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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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).

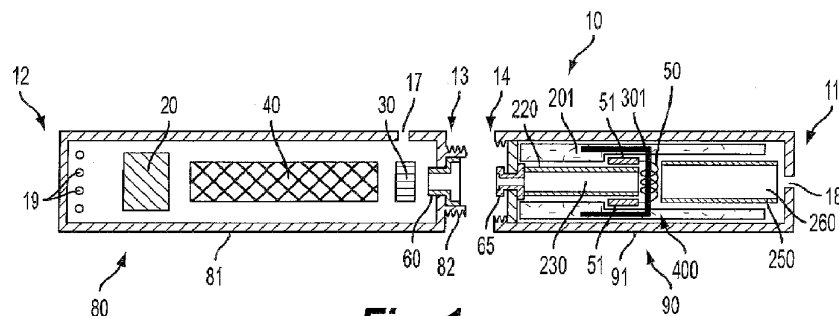
**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

**Published:**

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: ELECTRONIC SMOKING ARTICLE WITH IMPROVED STORAGE MEANS

**Fig. 1**

(57) Abstract: The present disclosure relates to reservoirs for storing products in electronic smoking articles. The reservoir is manufactured from cellulose acetate fiber, thermoplastic fiber, non-thermoplastic fiber, or a combination thereof. The reservoir is substantially tubular in shape and is adapted to accommodate internal components of the smoking article thereby increasing reservoir capacity. The internal components particularly can comprise an atomizer, which may include a braided wick.

## **ELECTRONIC SMOKING ARTICLE WITH IMPROVED STORAGE MEANS**

### **FIELD OF THE DISCLOSURE**

The present disclosure relates to aerosol delivery articles and uses thereof, and in particular to articles that can be considered to be smoking articles for purposes of yielding components of tobacco and other materials in an inhalable form. Highly preferred components of such articles are made or derived from tobacco, or those articles can be characterized as otherwise incorporating tobacco for human consumption.

### **BACKGROUND**

Many smoking devices have been proposed through the years as improvements upon, or alternatives to, smoking products that require combusting tobacco for use. Many of those devices purportedly have been designed to provide the sensations associated with cigarette, cigar, or pipe smoking, but without delivering considerable quantities of incomplete combustion and pyrolysis products that result from the burning of tobacco. To this end, there have been proposed numerous smoking products, flavor generators, and medicinal inhalers that utilize electrical energy to vaporize or heat a volatile material, or attempt to provide the sensations of cigarette, cigar, or pipe smoking without burning tobacco to a significant degree. See, for example, the various alternative smoking articles, aerosol delivery devices and heat generating sources set forth in the background art described in U.S. Pat. No. 7,726,320 to Robinson et al., US Pat. Pub. No. 2013/0255702 to Griffith, Jr. et al., US Pat. Pub. No. 2014/0000638 to Sebastian et al., US Pat. Pub. No. 2014/0060554 to Collett et al., and US Pat. App. Ser. No. 13/647,000, filed October 8, 2012, which are incorporated herein by reference.

Certain tobacco products that have employed electrical energy to produce heat for smoke or aerosol formation, and in particular, certain products that have been referred to as electronic cigarette products, have been commercially available throughout the world. Representative products that resemble many of the attributes of traditional types of cigarettes, cigars or pipes have been marketed as ACCORD<sup>®</sup> by Philip Morris Incorporated; ALPHA<sup>™</sup>, JOYE 510<sup>™</sup> and M4<sup>™</sup> by InnoVapor LLC; CIRRUS<sup>™</sup> and FLING<sup>™</sup> by White Cloud Cigarettes; COHITA<sup>™</sup>, COLIBRI<sup>™</sup>, ELITE CLASSIC<sup>™</sup>, MAGNUM<sup>™</sup>, PHANTOM<sup>™</sup> and SENSE<sup>™</sup> by Epuffer<sup>®</sup> International Inc.; DUOPRO<sup>™</sup>, STORM<sup>™</sup> and VAPORKING<sup>®</sup> by Electronic Cigarettes, Inc.; EGAR<sup>™</sup> by Egar Australia; eGo-C<sup>™</sup> and eGo-T<sup>™</sup> by Joyetech; ELUSION<sup>™</sup> by Elusion UK Ltd; EONSMOKE<sup>®</sup> by Eonsmoke LLC; GREEN SMOKE<sup>®</sup> by Green Smoke Inc. USA;

GREENARETTE™ by Greenarette LLC; HALLIGAN™, HENDU™, JET™, MAXXQ™, PINK™ and PITBULL™ by Smoke Stik®; HEATBAR™ by Philip Morris International, Inc.; HYDRO IMPERIAL™ and LXETM from Crown7; LOGIC™ and THE CUBAN™ by LOGIC Technology; LUCI® by Luciano Smokes Inc.; METRO® by Nicotek, LLC; NJOY® and ONEJOY™ by Sottera, Inc.; NO. 7™ by SS Choice LLC; PREMIUM ELECTRONIC CIGARETTE™ by PremiumEstore LLC; RAPP E-MYSTICK™ by Ruyan America, Inc.; RED DRAGON™ by Red Dragon Products, LLC; RUYAN® by Ruyan Group (Holdings) Ltd.; SMART SMOKER® by The Smart Smoking Electronic Cigarette Company Ltd.; SMOKE ASSIST® by Coastline Products LLC; SMOKING EVERYWHERE® by Smoking Everywhere, Inc.; V2CIGS™ by VMR Products LLC; VAPOR NINE™ by VaporNine LLC; VAPOR4LIFE® by Vapor 4 Life, Inc.; VEPPOTM by E-CigaretteDirect, LLC and VUSE® by R. J. Reynolds Vapor Company. Yet other electrically powered aerosol delivery devices, and in particular those devices that have been characterized as so-called electronic cigarettes, have been marketed under the tradenames BLU™; COOLER VISIONS™; DIRECT E-CIG™; DRAGONFLY™; EMIST™; EVERSMOKE™; GAMUCCI®; HYBRID FLAME™; KNIGHT STICKS™; ROYAL BLUES™; SMOKETIP® and SOUTH BEACH SMOKE™.

It would be desirable to provide a smoking article that employs heat produced by electrical energy to provide the sensations of cigarette, cigar, or pipe smoking, that does so without combusting tobacco to any significant degree, that does so without the need of a combustion heat source, and that does so without necessarily delivering considerable quantities of incomplete combustion and pyrolysis products.

## BRIEF SUMMARY

The present disclosure provides a smoking article and related components and methods. According to one aspect, disclosed herein is an electronic smoking article that includes an electrical power source and a reservoir that includes cellulose acetate and is configured to hold a product. The product can include an aerosol precursor composition. The reservoir can be substantially shaped as a cylinder having a hollow interior portion. The reservoir includes an exterior surface substantially adapted to conform to an interior surface of the smoking article. The reservoir can be shaped and dimensioned to accommodate one or more further components of the smoking article. The one or more further components can be an atomizer. The atomizer can include a heater such as, for example, a resistive heating element. The atomizer can further include a liquid transport element. For example, the liquid transport element can be a continuous, elongated article. The article can be adapted for wicking a liquid. The heater can be in a heating arrangement with at least

a portion of the liquid transport element. For example, the heater can be in contact with the liquid transport element and can be positioned at about a midpoint of the liquid transport element. The liquid transport element can be a braided wick. The braided wick can be a sheath/core wick, and the sheath can be braided. The core of the sheath/core wick can be a twisted yarn. The atomizer can include electrically conducting terminals extending along at least a portion of the liquid transport element and in an electrically conducting arrangement with the heater. The hollow interior of the reservoir can include a central cavity defined by an inner wall of the reservoir. Such inner wall can include one or more indentations or protrusions formed therein. For example, the inner wall can include diametrically opposed grooves extending into the reservoir. Such grooves (or similar arrangement) can be adapted to mate with at least a portion of the atomizer. The liquid transport element can be operatively positioned within the smoking article to be substantially in contact with the product. The reservoir can be formed from a cellulose acetate fiber tow. In some embodiments, the cellulose acetate fibers can have a size of about 0.5 dpf or greater, particularly about 0.5 to about 20 dpf. The hollow cellulose acetate reservoir in the shape of a tube or a cylinder can have a wall thickness of about 1 mm to about 4 mm. The reservoir can comprise about 70% to about 99% by weight cellulose acetate and about 2% to about 25% by weight of a binder. In further embodiments, the reservoir can consist of 100% cellulose acetate. If desired, further fibers and materials can be comprised with the cellulose acetate. In certain embodiments, the reservoir can be a woven or non-woven fibrous mat in the form of a tube or a hollow cylinder.

The present disclosure also provides wicks that can be particularly useful in an electronic smoking article. In certain embodiments, a wick suitable for use in an electronic smoking article can comprise a braid of at least 4 separate fibers or yarns. In particular, at least one of the fibers or yarns forming the braid can be C-glass or E-glass. In further embodiments the wick can comprise a braid of at least 8 separate fibers or yarns. Moreover, the braided wick can be a sheath/core wick. Specifically, the braided wick can be a sheath that surrounds a core. The core can be non-braided, can be formed of a different material than the braided sheath, or can be both non-braided and formed of a different material than the braided sheath. In some embodiments, the core can comprise a twisted yarn.

In further embodiments, the present disclosure can provide an electronic smoking article comprising a reservoir with an aerosol precursor composition (e.g., a liquid composition) stored therein and a braided wick in fluid communication with the reservoir. The braided wick can be as discussed above. The reservoir particularly may be substantially shaped as a cylinder or be tube shaped and have a hollow interior portion. The reservoir particularly can comprise cellulose acetate. The reservoir may be a molded element. The reservoir also may be a woven or non-woven



fibrous mat, such as comprising fibers of cellulose acetate. The fibrous mat can be rolled or otherwise formed to the tube or hollow cylinder shape.

In other embodiments, the present disclosure can provide a cartridge for an electronic smoking article. The cartridge can comprise an atomizer at least partially positioned within a hollow interior of a tube-shaped reservoir adapted for holding an aerosol precursor composition, the reservoir tube being positioned within a hollow shell. In particular, the reservoir tube can be formed of cellulose acetate. The atomizer specifically can comprise a continuous, elongated wick having two opposing ends, a heater in connection with the wick and positioned at about a midpoint thereof, and electrically conducting terminals positioned in physical contact with the wick and in electrical connection with the heater. The hollow shell can comprise a first end adapted to engage a control component (e.g., a controller or power unit of an electronic smoking article) and an opposing mouthend. The heater of the atomizer can extend out of the reservoir tube in a cavity formed at the mouthend of the hollow shell. The wick can be a braided wick as discussed herein.

In another aspect, a method of making an electronic smoking article is provided. The method includes the step of providing a cylinder comprising cellulose acetate having a hollow interior portion. At least part of the hollow interior can be shaped and dimensioned to accommodate one or more further components of the smoking article. The method further includes the step of inserting an atomizer into the hollow interior of the cellulose acetate cylinder. The method can further include the steps of inserting the cylinder and atomizer into a hollow shell and connecting the atomizer to a power source. The power source can be a battery. The hollow shell can be a cartridge portion of the electronic smoking article.

#### BRIEF DESCRIPTION OF THE FIGURES

Having thus described the disclosure in the foregoing general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 illustrates a sectional view through an embodiment of a smoking article;

FIG. 2 illustrates a partial cut-away view of an electronic smoking article containing a reservoir according to an embodiment of the present disclosure;

FIG. 3 illustrates an exploded view of an electronic smoking article containing a reservoir and an atomizer according to an embodiment of the present disclosure;

FIG. 4 provides a perspective view of a combined reservoir and atomizer according one embodiment of the disclosure;

FIG. 5 is a cross-section of a sheath/core wick according to an exemplary embodiment of the present disclosure;

FIG. 6 and FIG. 7 are images of a reservoir according to an embodiment of the present disclosure and a comparative reservoir after being placed in a liquid composition to evaluate the ability of the reservoir to become saturated by the liquid;

FIG. 8 is an image of a reservoir according to an embodiment of the present disclosure being saturated with an aerosol precursor composition;

FIG. 9 is an image of the reservoir from FIG. 8 after depletion of the aerosol precursor composition through use of the reservoir in an aerosolization smoking article;

FIG. 10 is a graph illustrating aerosol forming efficiency of reservoirs according to embodiments of the present disclosure;

FIG. 11 is a graph illustrating the change in average mg of total particulate matter (TPM) delivered in a puff of an aerosolization smoking article utilizing a twisted wick or a braided wick according to an embodiment of the present disclosure; and

FIG. 12 is a graph illustrating the change in average mg of total particulate matter (TPM) delivered in a puff of an aerosolization smoking article including braided wicks according to embodiments of the present disclosure formed from 8, 12, or 16 separate fiberglass yarns.

#### DETAILED DESCRIPTION

The present disclosure will now be described more fully hereinafter with reference to exemplary embodiments thereof. These exemplary embodiments are described so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Indeed, the present disclosure may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. As used in the specification, and in the appended claims, the singular forms “a”, “an”, “the”, include plural referents unless the context clearly dictates otherwise.

The present disclosure relates to articles that use electrical energy to heat a material (preferably without combusting the material to any significant degree) to form an inhalable substance, the articles being sufficiently compact to be considered “hand-held” devices. Particularly, the present disclosure relates to reservoirs for storing aerosol precursor compositions in electronic smoking articles. The reservoir can be fibrous and can be made from a variety of fibers. For example, the reservoir can be manufactured from cellulose acetate fiber. The reservoir can be substantially tubular in shape and can be adapted to accommodate further internal components of the smoking article.

The present disclosure relates to articles (and the manufacture thereof) that use electrical energy to heat a material (preferably without combusting the material to any significant degree) to form an inhalable substance, the articles being sufficiently compact to be considered “hand-held” devices. In certain embodiments, the articles can particularly be characterized as smoking articles. As used herein, the term “smoking article” is intended to mean an article that provides many of the sensations (e.g., inhalation and exhalation rituals, types of tastes or flavors, organoleptic effects, physical feel, use rituals, visual cues such as those provided by visible aerosol, and the like) of smoking a cigarette, cigar, or pipe without any substantial degree of combustion of any component of the article. As used herein, the term “smoking article” does not necessarily mean that, in operation, the article produces smoke in the sense of the aerosol resulting from by-product of combustion or pyrolysis of tobacco, but rather, that the article yields vapors (including vapors within aerosols that can be considered to be visible aerosols that might be considered to be described as smoke-like) resulting from volatilization or vaporization of certain components of the article or device. In highly preferred embodiments, articles characterized as smoking articles incorporate tobacco and/or components derived from tobacco.

In further embodiments, the articles that can be manufactured according to the present disclosure can be characterized as being vapor-producing articles, aerosolization articles, or medicament delivery articles. Thus, the articles can be arranged so as to provide one or more substances (e.g., flavors and/or pharmaceutical active ingredients) in an inhalable form or state. For example, inhalable substances can be substantially in the form of a vapor (i.e., a substance that is in the gas phase at a temperature lower than its critical point). Alternatively, inhalable substances can be in the form of an aerosol (i.e., a suspension of fine solid particles or liquid droplets in a gas). For purposes of simplicity, the term “aerosol” as used herein is meant to include vapors, gases and aerosols of a form or type suitable for human inhalation, whether or not visible, and whether or not of a form that might be considered to be smoke-like.

In use, smoking articles according to the disclosure may be subjected to many of the physical actions of an individual in using a traditional type of smoking article (e.g., a cigarette, cigar or pipe that is employed by lighting with a flame and used by inhaling tobacco that is subsequently burned). For example, the user of a smoking article of the present invention can hold that article much like a traditional type of smoking article, draw on one end of that article for inhalation of aerosol produced by that article, and take puffs at selected intervals of time.

A smoking article that can be manufactured according to one aspect of the present disclosure can include a number of components provided within an outer shell or body. The overall design of the outer shell or body can vary, and the format or configuration of the outer body that

can define the overall size and shape of the smoking article can vary. Typically, an elongated body resembling shape of a cigarette or cigar can be a formed from a single, unitary shell; or the elongated body can be formed of two or more separable pieces. For example, a smoking article can comprise an elongated shell or body that can be substantially tubular in shape, and as such, resemble the shape of a conventional cigarette or cigar. In one embodiment, all of the components of the smoking article are contained within one outer body or shell. Alternatively, a smoking article can comprise two shells that are joined and are separable. For example, a smoking article can possess at one end a control body comprising a shell containing one or more reusable components (e.g., a rechargeable battery and various electronics for controlling the operation of that article), and at the other end and removably attached thereto a shell containing a disposable portion (e.g., a disposable flavor-containing cartridge). Additionally, various smoking article designs and component arrangements can be appreciated upon consideration of the commercially available electronic smoking articles, such as those representative products listed in the background art section of the present disclosure.

A smoking article that can be manufactured according to one aspect of the present disclosure can include some combination of power source (i.e., an electrical power source), at least one control component (e.g., means for actuating, controlling, regulating and ceasing power for heat generation, such as by controlling electrical current flow the power source to other components of the article), a heater or heat generation component (e.g., an electrical resistance heating element or component commonly referred to as an “atomizer”), and an aerosol precursor component (e.g., commonly a liquid capable of yielding an aerosol upon application of sufficient heat, such as ingredients commonly referred to as “smoke juice,” “e-liquid” and “e-juice”), and a mouthend region or tip for allowing draw upon the smoking article for aerosol inhalation (e.g., a defined air flow path through the article such that aerosol generated can be withdrawn therefrom upon draw). Alignment of the components within the article can vary. In specific embodiments, the aerosol precursor component can be located near an end of the article (e.g., with a cartridge, which in certain circumstances can be replaceable and disposable) that is proximal to the mouth of a user so as to maximize aerosol delivery to the user. Other configurations, however, are not excluded. Generally, the heater component can be positioned sufficiently near that aerosol precursor component so that heat from the heater component can volatilize the aerosol precursor (as well as one or more flavorants, medicaments, or the like that may likewise be provided for delivery to a user) and form an aerosol for delivery to the user. When the heating member heats the aerosol precursor component, an aerosol is formed, released, or generated in a physical form suitable for inhalation by a consumer. It should be noted that the foregoing terms are meant to be

interchangeable such that reference to release, releasing, releases, or released includes form or generate, forming or generating, forms or generates, and formed or generated. Specifically, an inhalable substance is released in the form of a vapor or aerosol or mixture thereof. Additionally, the selection of various smoking article components can be appreciated upon consideration of the commercially available electronic smoking articles, such as those representative products listed in the background art section of the present disclosure.

A smoking article that can be manufactured according to one aspect of the present disclosure can include a battery or other electrical power source to provide current flow sufficient to provide various functionalities to the article, such as resistive heating, powering of control systems, powering of indicators, and the like. The power source can take on various embodiments. Preferably, the power source is able to deliver sufficient power to rapidly heat the heating member to provide for aerosol formation and power the article through use for the desired duration of time. The power source preferably is sized to fit conveniently within the article so that the article can be easily handled; and additionally, preferred a preferred power source is of a sufficiently light weight to not detract from a desirable smoking experience.

An exemplary smoking article 10 according to the disclosure is shown in FIG. 1. As seen in the surface illustrated therein, the smoking article 10 can comprise a control body 80 and a cartridge 90 that can be aligned in a functioning relationship. In this regard, the control body 80 and the cartridge 90 may be attachable and detachable from each other. Although a threaded engagement is illustrated in FIG. 1, it is understood that further means of engagement are encompassed, such as a press-fit engagement, a magnetic engagement, or the like. The cartridge can particularly include a single use connector as otherwise described herein.

In specific embodiments, the control body 80 may be referred to as being reusable, and the cartridge 90 may be referred to as being disposable. In some embodiments, the entire smoking article may be characterized as being disposable in that the control body may be configured for only a limited number of uses (e.g., until a battery power component no longer provides sufficient power to the smoking article) with a limited number of cartridges and, thereafter, the entire smoking article 10, including the control body, may be discarded. In other embodiments, the control body may have a replaceable battery such that the control body can be reused through a number of battery exchanges and with many cartridges. Similarly, the smoking article 10 may be rechargeable and thus may be combined with any type of recharging technology, including connection to a typical electrical outlet, connection to a car charger (i.e., cigarette lighter receptacle), and connection to a computer, such as through a USB cable.

The control body 80 includes a control component 20, a flow sensor 30, and a battery 40. Although these components are illustrated in a specific alignment, it is understood that various alignments of the components are encompassed by the present disclosure. The control body 80 further includes a plurality of indicators 19 at a distal end 12 of the control body shell 81. Such indicators 19 can show the number of puffs taken or remaining from the smoking article, can be indicative of an active or inactive status, can light up in response to a puff, or the like. The indicators can be provided in varying numbers and can take on different shapes and can even be simply an opening in the body (such as for release of sound when such indicators are present).

Various positions for one or more air intakes 17 are encompassed by the present disclosure. As shown, the air intake 17 may be positioned in the control body shell 81 such that air drawn through the intake sufficiently contacts the flow sensor 30 to activate the sensor (although other positions are encompassed, particularly if different sensing means are provided or if manual actuation, such as with a push button, is provided). A receptacle 60 also is included at the proximal attachment end 13 of the control body 80 and extends into the control body projection 82 to allow for ease of electrical connection with the resistive heating element 50 when the cartridge 90 is attached to the control body. In the illustrated embodiment, the receptacle 60 includes a central open passage to facilitate air flow from the air intake in the control body into the cartridge during use of the article 10.

The cartridge 90 includes a cartridge shell 91 with a mouth opening 18 at the mouthend 11 thereof to allow passage of air and entrained vapor (i.e., the components of the aerosol precursor composition in an inhalable form) from the cartridge to a consumer during draw on the smoking article 10. The smoking article 10 according to the present disclosure may have an overall shape that may be defined as being substantially rod-like or substantially tubular shaped or substantially cylindrically shaped. As illustrated in FIG. 1, the smoking article 10 has a substantially round cross-section; however, other cross-sectional shapes (e.g., oval, square, triangle, etc.) also are encompassed by the present disclosure. Such language that is descriptive of the physical shape of the smoking article may also be applied to the individual units of the smoking article in embodiments comprising multiple units, such as a control body and a cartridge.

In preferred embodiments, the smoking article 10 may take on a size that is comparative to a cigarette or cigar shape. Thus, the smoking article may have a diameter of about 5 mm to about 25 mm, about 5 mm to about 20 mm, about 6 mm to about 15 mm, or about 6 mm to about 10 mm. Such dimension may particularly correspond to the outer diameter of the control body shell 81 and/or the cartridge shell 91. The control body can have a length of about 50 mm to about 110 mm, about 60 mm to about 100 mm, or about 65 mm to about 95 mm. The cartridge can have a length

of about 20 mm to about 60 mm, about 25 mm to about 55 mm, or about 30 mm to about 50 mm. The overall length of the combined cartridge and control body (or the overall length of a smoking article according to the disclosure formed of a single, unitary shell) can be approximately equal to or less than the length of a typical cigarette – e.g., about 70 mm to about 130 mm, about 80 mm to about 125 mm, or about 90 mm to about 120 mm.

The cartridge shell 91 of the smoking article 10 can be formed of any material suitable for forming and maintaining an appropriate conformation, such as a tubular shape, and for retaining therein the suitable components of the smoking article. The body can be formed of a single wall, as shown in FIG. 1. The cartridge shell 91 can be formed of a material (natural or synthetic) that is heat resistant so as to retain its structural integrity – e.g., does not degrade – at least at a temperature that is the heating temperature provided by the resistive heating element. In some embodiments, a heat resistant polymer may be used. In other embodiments, the body can be formed from paper, or from metal, such as stainless steel. As further discussed herein, the body, such as a paper tube, may have one or more layers associated therewith that function to substantially prevent movement of vapor therethrough. In one example, an aluminum foil layer may be laminated to one surface of the body. Ceramic materials also may be used.

The cartridge 90 further includes a resistive heating element 50 in the form of a metal wire coil. The resistive heating element includes terminals 51 (e.g., positive and negative terminals) at the opposing ends thereof for facilitating current flow through the resistive heating element and for attachment of the appropriate wiring (not illustrated) to form an electrical connection of the resistive heating element with the battery 40 when the cartridge 90 is connected to the control body 80. Specifically, a plug 65 is positioned at the distal attachment end 14 of the cartridge. When the cartridge 90 is connected to the control body 80, the plug 65 engages the receptacle 60 to form an electrical connection such that current controllably flows from the battery 40, through the receptacle and plug, and to the resistive heating element 50. The cartridge shell 91 can continue across the distal attachment end such that this end of the cartridge is substantially closed with the plug protruding therefrom. As illustrated in FIG. 1, the plug 65 includes an open central passage that aligns with the open central passage in the receptacle 60 to allow air to flow from the control body 80 and into the cartridge 90.

Generally, in use, when a consumer draws on the mouthend 11 of the cartridge, the flow sensor 30 detects the change in flow and activates the control component 20 to facilitate current flow through the resistive heating element 50. Thus, it is useful for air flow to travel through the control body 80 in a manner that flow sensor 30 detects air flow almost instantaneously.

The control algorithm may call for power to the resistive heating element 50 to cycle and thus maintain a defined temperature. The control algorithm therefore can be programmed to automatically deactivate the smoking article 10 and discontinue power flow through the smoking article after a defined time lapse without a puff by a consumer. Moreover, the smoking article can include a temperature sensor to provide feedback to the control component. Such sensor can be, for example, in direct contact with the resistive heating element 50. Alternative temperature sensing means likewise may be used, such as relying upon logic control components to evaluate resistance through the resistive heating element and correlate such resistance to the temperature of the element. In other embodiments, the flow sensor 30 may be replaced by appropriate components to provide alternative sensing means, such as capacitive sensing. Still further, one or more control buttons can be included to allow for manual actuation by a consumer to elicit a variety of functions, such as powering the article 10 on and off, turning on the heating element 50 to generate a vapor or aerosol for inhalation, or the like.

When the flow sensor 30 is positioned within the control body 80, it can be useful to have an air intake 17 on the control body. If desired, a sealed flow path can be provided such that the flow sensor 30 within the control body 80 is in fluid connection with the cartridge interior after the cartridge and the control body are engaged, such fluid connection being sealed with respect to the remainder of the components within the control body but opening into the cartridge 90 when attached to the control body. Further, in other embodiments, the flow sensor 30 can be located within the cartridge 90 instead of the control body 80.

A reservoir may utilize a transport element to transport an aerosol precursor composition to an aerosolization zone. As used herein, the term “reservoir” refers to a receptacle or chamber for holding, storing, or retaining a product such as a liquid, fluid, or aerosol. One such example is shown in FIG. 1. As seen therein, the cartridge 90 includes a reservoir layer 201 comprising layers of nonwoven fibers formed into the shape of a tube encircling the interior of the cartridge shell 91, in this embodiment. An aerosol precursor composition is retained in the reservoir layer 201. Liquid components, for example, can be sorptively retained by the reservoir layer 201. The reservoir layer 201 is in fluid connection with a transport element 301 (a wick in this embodiment). The transport element 301 transports the aerosol precursor composition stored in the reservoir layer 201 via capillary action to an aerosolization zone 400 of the cartridge 90. As illustrated, the transport element 301 is in direct contact with the resistive heating element 50 that is in the form of a metal wire coil in this embodiment.

In use, when a user draws on the article 10, the resistive heating element 50 is activated (e.g., such as via a puff sensor), and the components for the aerosol precursor composition are



vaporized in the aerosolization zone 400. Drawing upon the mouthend 11 of the article 10 causes ambient air to enter the air intake 17 and pass through the central opening in the receptacle 60 and the central opening in the plug 65. In the cartridge 90, the drawn air passes through an air passage 230 in an air passage tube 220 and combines with the formed vapor in the aerosolization zone 400 to form an aerosol. The aerosol is whisked away from the aerosolization zone, passes through an air passage 260 in an air passage tube 250, and out the mouth opening 18 in the mouthend 11 of the article 10. If desired, the air passage tube 250 can be absent, and an open cavity may reside in the location for formation of aerosol as the aerosol precursor composition is vaporized by the resistive heating element 50.

The smoking article 10 in the embodiment illustrated in FIG. 1 can be characterized as a disposable article. Accordingly, it can be desirable for the reservoir 201 in such embodiments to include a sufficient amount of aerosol precursor composition and any further inhalable materials so that a consumer can obtain more than a single use of the smoking article. For example, the smoking article can include sufficient aerosolizable and/or inhalable materials such that the smoking article can provide a number of puffs substantially equivalent to the number of puffs (of about two seconds duration) available from a plurality of conventional cigarettes – e.g., 2 or more, 5 or more, 10 or more, or 20 or more conventional cigarettes. More particularly, a disposable, single unit article according to the embodiment of FIG. 1 can provide about 20 or more, about 50 or more, or about 100 or more puffs.

Although FIG. 1 is illustrative of a smoking article according to the present disclosure, the scope of the disclosure should not be viewed as being limited to the specific combination and/or arrangement of components illustrated therein. Rather, the present disclosure can encompass a variety of combinations of components useful in forming an electronic smoking article. Reference is made for example to the smoking articles disclosed in US Pat. Pub. No. 2014/0000638 to Sebastian et al., and US Pat. Pub. No. 2013/0255702 to Griffith, Jr., et al., the disclosures of which are incorporated herein by reference in their entirety. Further to the above, representative heating element and materials for use therein are described in US Pat. No. 5,060,671 to Counts et al.; US Pat. No. 5,093,894 to Deevi et al.; 5,224,498 to Deevi et al.; 5,228,460 to Sprinkel Jr., et al.; 5,322,075 to Deevi et al.; US Pat. No. 5,353,813 to Deevi et al.; US Pat. No. 5,468,936 to Deevi et al.; US Pat. No. 5,498,850 to Das; US Pat. No. 5,659,656 to Das; US Pat. No. 5,498,855 to Deevi et al.; US Pat. No. 5,530,225 to Hajaligol; US Pat. No. 5,665,262 to Hajaligol; US Pat. No. 5,573,692 to Das et al.; and US Pat. No. 5,591,368 to Fleischhauer et al., the disclosures of which are incorporated herein by reference in their entirety.

The various components of a smoking article according to the present invention can be chosen from components described in the art and commercially available. Examples of batteries that can be used according to the disclosure are described in US Pub. App. No. 2010/0028766, the disclosure of which is incorporated herein by reference in its entirety.

An exemplary mechanism that can provide puff-actuation capability includes a Model 163PC01D36 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Ill. Further examples of demand-operated electrical switches that may be employed in a heating circuit according to the present disclosure are described in US Pat. No. 4,735,217 to Gerth et al., which is incorporated herein by reference in its entirety. Further description of current regulating circuits and other control components, including microcontrollers, that can be useful in the present smoking article are provided in US Pat. Nos. 4,922,901, 4,947,874, and 4,947,875, all to Brooks et al., US Pat. No. 5,372,148 to McCafferty et al., US Pat. No. 6,040,560 to Fleischhauer et al., and US Pat. No. 7,040,314 to Nguyen et al., all of which are incorporated herein by reference in their entireties.

The aerosol precursor composition, or vapor precursor composition, can comprise one or more different components. For example, the aerosol precursor can include a polyhydric alcohol (e.g., glycerin, propylene glycol, or a mixture thereof). Representative types of further aerosol precursor compositions are set forth in US Pat. No. 4,793,365 to Sensabaugh, Jr. et al.; US Pat. No. 5,101,839 to Jakob et al.; PCT WO 98/57556 to Biggs et al.; and Chemical and Biological Studies on New Cigarette Prototypes that Heat Instead of Burn Tobacco, R. J. Reynolds Tobacco Company Monograph (1988); the disclosures of which are incorporated herein by reference.

Aerosol precursor compositions can include further liquid materials, such as water. For example, aerosol precursor compositions can incorporate mixtures of glycerin and water, or mixtures of propylene glycol and water, or mixtures of propylene glycol and glycerin, or mixtures of propylene glycol, glycerin, and water. Exemplary aerosol precursor compositions also include those types of materials incorporated within devices available through Atlanta Imports Inc., Acworth, Ga., USA., as an electronic cigar having the brand name E-CIG, which can be employed using associated Smoking Cartridges Type C1a, C2a, C3a, C4a, C1b, C2b, C3b and C4b; and as Ruyan Atomizing Electronic Pipe and Ruyan Atomizing Electronic Cigarette from Ruyan SBT Technology and Development Co., Ltd., Beijing, China. Exemplary formulations for aerosol precursor compositions that may be used according to the present disclosure are described in U.S. Pat. Pub. No. 2013/0008457 to Zheng et al., the disclosure of which is incorporated herein by reference in its entirety.

The aerosol precursor composition used in the disclosed smoking article further can comprise one or more flavors, medicaments, or other inhalable materials. For example, liquid nicotine can be used. Such further materials can comprise one or more components of the aerosol precursor or vapor precursor composition. Thus, the aerosol precursor or vapor precursor composition can be described as comprising an inhalable substance. Such inhalable substance can include flavors, medicaments, and other materials as discussed herein. Particularly, an inhalable substance delivered using a smoking article according to the present invention can comprise a tobacco component or a tobacco-derived material. Alternately, the flavor, medicament, or other inhalable material can be provided separate from other aerosol precursor components – e.g., in a reservoir. As such, defined aliquots of the flavor, medicament, or other inhalable material may be separately or simultaneously delivered to the resistive heating element to release the flavor, medicament, or other inhalable material into an air stream to be inhaled by a user along with the further components of the aerosol precursor or vapor precursor composition.

A wide variety of types of flavoring agents, or materials that alter the sensory or organoleptic character or nature of the mainstream aerosol of the smoking article, can be employed. Such flavoring agents can be provided from sources other than tobacco, can be natural or artificial in nature, and can be employed as concentrates or flavor packages. Of particular interest are flavoring agents that are applied to, or incorporated within, those regions of the smoking article where aerosol is generated. Again, such agents can be supplied directly to the resistive heating element or may be provided on a substrate as already noted above. Exemplary flavoring agents include vanillin, ethyl vanillin, cream, tea, coffee, fruit (e.g., apple, cherry, strawberry, peach and citrus flavors, including lime and lemon), maple, menthol, mint, peppermint, spearmint, wintergreen, nutmeg, clove, lavender, cardamom, ginger, honey, anise, sage, cinnamon, sandalwood, jasmine, cascarilla, cocoa, licorice, and flavorings and flavor packages of the type and character traditionally used for the flavoring of cigarette, cigar, and pipe tobaccos. Syrups, such as high fructose corn syrup, also can be employed. Flavoring agents also can include acidic or basic characteristics (e.g., organic acids, such as levulinic acid, succinic acid, lactic acid, and pyruvic acid). The flavoring agents can be combined with the aerosol-generating material if desired. Exemplary plant-derived compositions that may be used are disclosed in US Pat. Pub. No. 2012/0152265 to Dube et al. and US Pat. Pub. No. 2012/0192880 to Dube et al., the disclosures of which are incorporated herein by reference in their entireties.

Organic acids particularly may be incorporated into the aerosol precursor to provide desirable alterations to the flavor, sensation, or organoleptic properties of medicaments, such as nicotine, that may be combined with the aerosol precursor. For example, organic acids, such as

levulinic acid, succinic acid, lactic acid, and pyruvic acid, may be included in the aerosol precursor with nicotine in amounts up to being equimolar (based on total organic acid content) with the nicotine. Any combination of organic acids can be used. For example, the aerosol precursor can include about 0.1 to about 0.5 moles of levulinic acid per one mole of nicotine, about 0.1 to about 0.5 moles of pyruvic acid per one mole of nicotine, about 0.1 to about 0.5 moles of lactic acid per one mole of nicotine, or combinations thereof, up to a concentration wherein the total amount of organic acid present is equimolar to the total amount of nicotine present in the aerosol precursor.

In embodiments of the aerosol precursor material that contain a tobacco extract, including pharmaceutical grade nicotine derived from tobacco, it is advantageous for the tobacco extract to be characterized as substantially free of compounds collectively known as Hoffmann analytes, including, for example, tobacco-specific nitrosamines (TSNAs), including N'-nitrosonornicotine (NNN), (4-methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), N'-nitrosoanatabine (NAT), and N'-nitrosoanabasine (NAB); polyaromatic hydrocarbons (PAHs), including benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene, and the like. In certain embodiments, the aerosol precursor material can be characterized as completely free of any Hoffmann analytes, including TSNAs and PAHs.

Embodiments of the aerosol precursor material may have TSNA levels (or other Hoffmann analyte levels) in the range of less than about 5 ppm, less than about 3 ppm, less than about 1 ppm, or less than about 0.1 ppm, or even below any detectable limit. Certain extraction processes or treatment processes can be used to achieve reductions in Hoffmann analyte concentration. For example, a tobacco extract can be brought into contact with an imprinted polymer or non-imprinted polymer such as described, for example, in US Pat. Pub. Nos. 2007/0186940 to Bhattacharyya et al.; 2011/0041859 to Rees et al.; and 2011/0159160 to Jonsson et al.; and US Pat. Appl. No. 13/111,330 to Byrd et al., filed May 19, 2011, all of which are incorporated herein by reference. The tobacco extract may be treated with ion exchange materials having amine functionality, which can remove certain aldehydes and other compounds. See, for example, US Pat. Nos. 4,033,361 to Horsewell et al. and 6,779,529 to Figlar et al., which are incorporated herein by reference in their entireties.

In certain embodiments, the aerosol precursor can be adapted to increase in surface area during heating for aerosol formation in an electronic smoking article. The aerosol precursor can comprise an effervescent material, which can be adapted to degrade during heating and release carbon dioxide (or other gaseous substance) sufficient to cause foaming of at least a portion of the aerosol precursor or to produce fine droplets. Inclusion of such effervescent can be beneficial to reduce the amount of heat needed to form an aerosol from the aerosol precursor.

The aerosol precursor composition may take on a variety of conformations based upon the various amounts of materials utilized therein. For example, a useful aerosol precursor composition may comprise up to about 98% by weight up to about 95% by weight, or up to about 90% by weight of a polyol. This total amount can be split in any combination between two or more different polyols. For example, one polyol can comprise about 50% to about 90%, about 60% to about 90%, or about 75% to about 90% by weight of the aerosol precursor, and a second polyol can comprise about 2% to about 45%, about 2% to about 25%, or about 2% to about 10% by weight of the aerosol precursor. A useful aerosol precursor also can comprise up to about 25% by weight, about 20% by weight or about 15% by weight water – particularly about 2% to about 25%, about 5% to about 20%, or about 7% to about 15% by weight water. Flavors and the like (which can include medicaments, such as nicotine) can comprise up to about 10%, up to about 8%, or up to about 5% by weight of the aerosol precursor.

As a non-limiting example, an aerosol precursor according to the invention can comprise glycerol, propylene glycol, water, nicotine, and one or more flavors. Specifically, the glycerol can be present in an amount of about 70% to about 90% by weight, about 70% to about 85% by weight, or about 75% to about 85% by weight, the propylene glycol can be present in an amount of about 1% to about 10% by weight, about 1% to about 8% by weight, or about 2% to about 6% by weight, the water can be present in an amount of about 10% to about 20% by weight, about 10% to about 18% by weight, or about 12% to about 16% by weight, the nicotine can be present in an amount of about 0.1% to about 5% by weight, about 0.5% to about 4% by weight, or about 1% to about 3% by weight, and the flavors can be present in an amount of up to about 5% by weight, up to about 3% by weight, or up to about 1% by weight, all amounts being based on the total weight of the aerosol precursor. One specific, non-limiting example of an aerosol precursor comprises about 75% to about 80% by weight glycerol, about 13% to about 15% by weight water, about 4% to about 6% by weight propylene glycol, about 2% to about 3% by weight nicotine, and about 0.1% to about 0.5% by weight flavors. The nicotine, for example, can be from a tobacco extract.

The amount of aerosol precursor composition that is used within the smoking article is such that the article exhibits acceptable sensory and organoleptic properties, and desirable performance characteristics. For example, it is highly preferred that sufficient aerosol precursor composition components, such as glycerin and/or propylene glycol, be employed in order to provide for the generation of a visible mainstream aerosol that in many regards resembles the appearance of tobacco smoke. Typically, the amount of aerosol-generating material incorporated into the smoking article is in the range of about 1.5 g or less, about 1 g or less, or about 0.5 g or less. The amount of aerosol precursor composition can be dependent upon factors such as the number of

puffs desired per cartridge used with the smoking article. It is desirable for the aerosol precursor composition not to introduce significant degrees of unacceptable off-taste, filmy mouth-feel, or an overall sensory experience that is significantly different from that of a traditional type of cigarette that generates mainstream smoke by burning tobacco cut filler. The selection of the particular aerosol-generating material and reservoir material, the amounts of those components used, and the types of tobacco material used, can be altered in order to control the overall chemical composition of the mainstream aerosol produced by the smoking article.

Still further components can be utilized in the smoking article of the present disclosure. For example, US 5,261,424 to Sprinkel, Jr. discloses piezoelectric sensors that can be associated with the mouth-end of a device to detect user lip activity associated with taking a draw and then trigger heating; US 5,372,148 to McCafferty et al. discloses a puff sensor for controlling energy flow into a heating load array in response to pressure drop through a mouthpiece; US 5,967,148 to Harris et al. discloses receptacles in a smoking device that include an identifier that detects a non-uniformity in infrared transmissivity of an inserted component and a controller that executes a detection routine as the component is inserted into the receptacle; US 6,040,560 to Fleischhauer et al. describes a defined executable power cycle with multiple differential phases; US 5,934,289 to Watkins et al. discloses photonic-optronic components; US 5,954,979 to Counts et al. discloses means for altering draw resistance through a smoking device; US 6,803,545 to Blake et al. discloses specific battery configurations for use in smoking devices; US 7,293,565 to Griffen et al. discloses various charging systems for use with smoking devices; US 2009/0320863 by Fernando et al. discloses computer interfacing means for smoking devices to facilitate charging and allow computer control of the device; US 2010/0163063 by Fernando et al. discloses identification systems for smoking devices; and WO 2010/003480 by Flick discloses a fluid flow sensing system indicative of a puff in an aerosol generating system; all of the foregoing disclosures being incorporated herein by reference in their entireties. Further examples of components related to electronic aerosol delivery articles and disclosing materials or components that may be used in the present article include US Pat. No. 4,735,217 to Gerth et al.; US Pat. No. 5,249,586 to Morgan et al.; US Pat. No. 5,666,977 to Higgins et al.; US Pat. No. 6,053,176 to Adams et al.; US 6,164,287 to White; US Pat No. 6,196,218 to Voges; US Pat. No. 6,810,883 to Felter et al.; US Pat. No. 6,854,461 to Nichols; US Pat. No. 7,832,410 to Hon; US Pat. No. 7,513,253 to Kobayashi; US Pat. No. 7,896,006 to Hamano; US Pat. No. 6,772,756 to Shayan; US Pat. Pub. Nos. 2009/0095311, 2006/0196518, 2009/0126745, and 2009/0188490 to Hon; US Pat. Pub. No. 2009/0272379 to Thorens et al.; US Pat. Pub. Nos. 2009/0260641 and 2009/0260642 to Monsees et al.; US Pat. Pub. Nos. 2008/0149118 and 2010/0024834 to Oglesby et al.; US Pat. Pub. No. 2010/0307518 to Wang; US Pat. Pub. No.

2013/0037041 to Worm et al.; and WO 2010/091593 to Hon. A variety of the materials disclosed by the foregoing documents may be incorporated into the present devices in various embodiments, and all of the foregoing disclosures are incorporated herein by reference in their entireties.

Although an article according to the disclosure may take on a variety of embodiments, as discussed in detail below, the use of the article by a consumer will be similar in scope. In particular, the article can be provided as a single unit or as a plurality of components that are combined by the consumer for use and then are dismantled by the consumer thereafter. Generally, a smoking article according to the disclosure can comprise a first unit that is engagable and disengagable with a second unit, the first unit comprising the resistive heating element, and the second unit comprising the electrical power source. In some embodiments, the second unit further can comprise one or more control components that actuate or regulate current flow from the electrical power source. The first unit can comprise a distal end that engages the second unit and an opposing, proximate end that includes a mouthpiece (or simply the mouthend) with an opening at a proximate end thereof. The first unit can comprise an air flow path opening into the mouthpiece of the first unit, and the air flow path can provide for passage of aerosol formed from the resistive heating element into the mouthpiece. In preferred embodiments, the first unit can be disposable. Likewise, the second unit can be reusable.

During use, the consumer initiates heating of the resistive heating element, the heat produced by the resistive heating element aerosolizes the aerosol precursor composition and, optionally, further inhalable substances. Such heating releases at least a portion of the aerosol precursor composition in the form of an aerosol (which can include any further inhalable substances included therewith), and such aerosol is provided within a space inside the cartridge that is in fluid communication with the mouthend of the cartridge. When the consumer inhales on the mouth end of the cartridge, air is drawn through the cartridge, and the combination of the drawn air and the aerosol is inhaled by the consumer as the drawn materials exit the mouth end of the cartridge (and any optional mouthpiece present) into the mouth of the consumer. To initiate heating, the consumer may actuate a pushbutton, capacitive sensor, or similar component that causes the resistive heating element to receive electrical energy from the battery or other energy source (such as a capacitor). The electrical energy may be supplied for a pre-determined length of time or may be manually controlled. Preferably, flow of electrical energy does not substantially proceed in between puffs on the article (although energy flow may proceed to maintain a baseline temperature greater than ambient temperature – e.g., a temperature that facilitates rapid heating to the active heating temperature). In further embodiments, heating may be initiated by the puffing action of the consumer through use of various sensors, as otherwise described herein. Once the

puff is discontinued, heating will stop or be reduced. When the consumer has taken a sufficient number of puffs so as to have released a sufficient amount of the inhalable substance (e.g., an amount sufficient to equate to a typical smoking experience), the cartridge can be removed from the control housing and discarded. Indication that the cartridge is spent (i.e., the aerosol precursor composition has been substantially removed by the consumer) can be provided. In some embodiments, a single cartridge can provide more than a single smoking experience and thus may provide a sufficient content of aerosol precursor composition to simulate as much as full pack of conventional cigarettes or even more.

The foregoing description of use of the article can be applied to the various embodiments described through minor modifications, which can be apparent to the person of skill in the art in light of the further disclosure provided herein. The above description of use, however, is not intended to limit the use of the article but is provided to comply with all necessary requirements of disclosure of the present disclosure.

In various embodiments, the present disclosure particularly can provide a reservoir that can be easily combined with further elements of a smoking article, particularly a cartridge. For example, FIG. 2 provides a cut-away view of a cartridge 500 that can be included in an electronic smoking article. The cartridge 500 includes a reservoir 501 according to one embodiment. The cartridge 500 can be substantially tubular in shape and can be formed of a reservoir wall 502 as described herein. As illustrated, the reservoir 501 can be in the general shape of a substantially hollow tube that is concentric with the cartridge wall 502. The reservoir 501 can be substantially rod-like or substantially tubular shaped or substantially cylindrically shaped. Thus, the reservoir 501 can have a diameter such that the reservoir 501 can be adapted to fit within the cartridge 500. The reservoir 501 can be formed from a plurality of combined layers that can be concentric or overlapping. For example, the reservoir 501 can be a continuous sheet of material that is rolled to form the hollow tube. The reservoir also may be a mat of nonwoven material. In other embodiments, the reservoir 501 can be substantially a unitary component. For example, the reservoir 501 can be shaped or molded so as to be a singular element in the form of a substantially hollow tube that is substantially continuous in composition across the length and thickness thereof. The reservoir 501 can be rigid or semi-rigid. The reservoir 501 can include a first end 503 and an opposing second end 504. The reservoir 501 includes an exterior surface 505 that can be substantially shaped and adapted to conform to an interior surface 506 of cartridge wall 502. If desired, one or more additional components of a smoking article according to the present disclosure can be accommodated within or around the reservoir 501. While the reservoir 501 is shown in the cartridge 500 portion of a smoking article in FIG. 2, one skilled in the art will appreciate that the



reservoir 501 can be positioned within any portion of a smoking article so as not to impede the storage and delivery of an aerosol precursor composition stored therein.

In certain embodiments, a reservoir according to the present disclosure can be provided in a form such that at least part of the hollow interior thereof is shaped and dimensioned to accommodate one or more further components of the smoking article. In some embodiments, the term “shaped and dimensioned” can indicate that a wall of the hollow interior includes one or more indentations or protrusions that cause the interior to have a shape that is other than substantially smooth and continuous. In other embodiments, the hollow nature of the reservoir can be sufficient to allow for accommodation of further components of the smoking article without the need for formation of cavities or protrusions.

The articles of the present disclosure can be particularly beneficial in that the reservoir can be pre-formed and can have a hollow interior with a wall that is shaped and dimensioned to accommodate a further component of the smoking article in a mating arrangement. This particularly can facilitate ease of assembly of the smoking article and can maximize the reservoir volume while also providing sufficient space for aerosol formation. One embodiment of a cartridge according to the present disclosure is shown in FIG. 3, which provides an exploded view of a cartridge 500. As seen therein, a cartridge wall 502 can be adapted to enclose a reservoir 501 as described herein. The exterior surface 505 of the reservoir 501 can be adapted to conform to the interior surface 506 of the cartridge wall 502.

The reservoir 501 also has an inner surface 508 that defines a central cavity 507 of the reservoir. In the illustrated embodiment, the inner surface 508 of the reservoir 501 includes two diametrically opposed grooves (515, 516) that extend inward into the reservoir from the central cavity. As illustrated, the grooves extend substantially the entire length of the reservoir 501 from the first end 503 to the second end 504 thereof. In other embodiments, the grooves may be absent, and the inner surface of the reservoir still may be characterized as being shaped and dimensioned to accommodate an atomizer in that the atomizer can be positioned with the central cavity such that a portion of the atomizer is in fluid connection with the reservoir.

In the embodiment of FIG. 3, the atomizer specifically comprises a heater, a liquid transport element, and electrically conducting terminals. As illustrated in FIG. 3, the liquid transport element is a continuous, elongated wick 509, and the heater is a resistive heating coil 510 that is in connection with the wick and is positioned at about a midpoint of the wick. The portions of the wick extending beyond the resistive heating coil can be referred to as distal arms of the wick. The electrically conducting terminals 511 of the atomizer 520 are positioned in contact with the wick 509 distal to the resistive heating coil 510. The electrically conducting terminals particularly can

be characterized as being in contact with the wick at one or more portions of the wick distal to the resistive heating coil. As illustrated, the electrically conducting terminals 511 extend beyond the ends of the wick 509. Such extension is not necessarily required. In light of the nature of the reservoir 501 with its hollow interior portion, an atomizer can be easily positioned interior to the reservoir during assembly of the smoking article. Likewise, as the hollow interior can be shaped and dimensioned to mate with the atomizer, the combination can be easily assembled, and the atomizer can snugly mate with the reservoir while simultaneously placing the wick in fluid connection with the reservoir.

The above configuration is further illustrated in FIG. 4, which provides a perspective view of a reservoir 501 according one embodiment having an atomizer 520 combined therewith. The reservoir 501 includes a central cavity 507 that can be devoid of fibrous material and capable of storing, holding, or retaining a product such as an aerosol precursor composition. The atomizer 520 is combined with the reservoir 501 in that the distal arms of the wick 509 are mated with and engaging the diametrically opposed grooves (515, 516). The grooves may be pre-formed in the reservoir or the grooves may be formed by the engagement of the atomizer wick with the inner walls of the reservoir such that the fibrous reservoir is locally compressed by the atomizer wick. By adapting the inner surface 508 of the central cavity 507 of the reservoir 501 to accommodate the various smoking article components, available open space in the smoking article can be fully maximized by extending the reservoir 501 into the previously open spaces. As a result, the overall size and capacity of the reservoir 501 can be increased in comparison to traditional woven or non-woven fiber mats that are typically utilized in electronic smoking articles. The increased capacity allows the reservoir 501 to hold an increased amount of aerosol precursor composition which, in turn, results in longer use and enjoyment of the smoking article by the end user.

As illustrated in FIG. 4, the portion of the atomizer 520 comprising the resistive heating element extends beyond the second end 504 of the reservoir 501. When assembled with a cartridge, the second end 504 of the reservoir 501 can be positioned proximate to a mouthend (see element 11 in FIG. 1) of the cartridge. Desirably, the mouthend of the cartridge can include an open cavity wherein aerosol can be formed as the aerosol precursor composition is vaporized by the resistive heating element. In other embodiments, it is not necessary for the atomizer to extend beyond the end of the reservoir, and the atomizer can be positioned relative to the reservoir such that the resistive heating element is within the hollow cavity of the reservoir.

The reservoir can be manufactured from any material capable of being shaped into a rigid or semi-rigid hollow tube while retaining the ability to store a liquid product such as, for example, an aerosol precursor composition. In certain embodiments, the reservoir material can be absorbent,

adsorbent, or otherwise porous so as to provide the ability to retain the aerosol precursor composition. As such, the aerosol precursor composition can be characterized as being coated on, adsorbed by, or absorbed in the reservoir material. The reservoir can be positioned within the smoking article to be in substantial contact with one or more transport elements (e.g., wicks). More particularly, a reservoir can be manufactured from any material suitable for retaining the aerosol precursor composition (e.g., through absorption, adsorption, or the like) and allowing wicking away of the precursor composition for transport to the resistive heating element.

The reservoir material is suitable for forming and maintaining an appropriate conformation, such as a substantially tubular shape, and for accommodating therein the suitable components of the smoking article. The reservoir material can be heat resistant so as to retain its structural integrity – e.g., does not degrade – at least at a temperature that is received in a position proximal to the heating temperature provided by the resistive heating element. The size and strength of the reservoir may vary according to the features and requirements of the corresponding electronic smoking article. In some embodiments, the reservoir can be manufactured from a material suitable for a high-speed, automated manufacturing process. In certain embodiments, the reservoir can comprise a woven or non-woven fibrous mat, which may be rolled or otherwise formed into a tube or hollow cylinder shape. In other embodiments, the reservoir can be a molded tube or hollow cylinder.

According to one embodiment, the reservoir can be manufactured from a cellulose acetate tow which can be processed to form a hollow acetate tube. Cellulose acetate tow can be prepared according to various processes known to one skilled in the art. See, for example, the processes forth in US Pat. No. 4,439,605 to Yabune, US Pat No. 5,167,764 to Nielsen et al., and US Pat No. 6,803,458 to Ozaki which are incorporated herein by reference in their entireties. Typically, cellulose acetate is derived from cellulose by reacting purified cellulose from wood pulp with acetic acid and acetic anhydride in the presence of sulfuric acid. The resulting product is then put through a controlled, partial hydrolysis to remove the sulfate and a sufficient number of acetate groups to produce the required properties for a cellulose acetate that is capable of ultimately forming a rigid or semi-rigid hollow tube. Cellulose acetate can then be extruded, spun, and arranged into a tow. The cellulose acetate fibers can be opened, crimped, or a continuous filament.

In further embodiments, the cellulose acetate can be any acetate material of the type that can be employed for providing a tobacco smoke filter for cigarettes. A traditional cigarette filter material can be used, such as cellulose acetate tow, gathered cellulose acetate web, or gathered cellulose acetate web. Examples of materials that can be used as an alternative to cellulose acetate include polypropylene tow, gathered paper, strands of reconstituted tobacco, or the like. One filter

material that can provide a suitable filter rod and thus a suitable hollow tube reservoir is cellulose acetate tow having 3 denier per filament and 40,000 total denier. As another example, cellulose acetate tow having 3 denier per filament and 35,000 total denier can be used. As another example, cellulose acetate tow having 8 denier per filament and 40,000 total denier can be used. Further examples include the types of filter materials set forth in U.S. Pat. No. 3,424,172 to Neurath; U.S. Pat. No. 4,811,745 to Cohen et al.; U.S. Pat. No. 4,925,602 to Hill et al.; U.S. Pat. No. 5,225,277 to Takegawa et al. and U.S. Pat. No. 5,271,419 to Arzonico et al.; each of which is incorporated herein by reference.

Cellulose acetate fibers can be mixed with other materials, such as, cellulose, viscose, cotton, cellulose acetate-butyrate, cellulose propionate, polyester – e.g., polyethylene terephthalate (PET), polylactic acid (PLA), activated carbon, glass fibers, metal fibers, wood fibers, and the like. The fibers of a cellulose acetate tow emerging from the spinneret can be bunched together to form a “raw tow” which can be collected into a bale for subsequent processing into a tube as described herein. Additional examples of fiber materials that can be suitable for use in a reservoir according to the present disclosure are described in US Pat Publication No. 2013/0025610 to Sebastian et al., the disclosure of which is incorporated herein by reference.

Cellulose acetate can be processed and formed into a tube using conventional filter tow processing means. For example, a steam bonding process can be used to produce the hollow acetate tubes. Exemplary processes for forming tubes of cellulose acetate can be found US Pat. Publication No. 2012/0255569 to Beard et al. In further embodiments, cellulose acetate can be processed using a conventional filter tow processing unit. For example, filter tow can be bloomed using bussel jet methodologies or threaded roll methodologies. An exemplary tow processing unit has been commercially available as E-60 supplied by Arjay Equipment Corp., Winston-Salem, N.C. Other exemplary tow processing units have been commercially available as AF-2, AF-3 and AF-4 from Hauni-Werke Korber & Co. KG. and as Candor-ITM Tow Processor from International Tobacco Machinery. Other types of commercially available tow processing equipment, as are known to those of ordinary skill in the art, can be employed. Alternative materials for forming the hollow tube reservoir, such as gathered paper, nonwoven polypropylene web, or gathered strands of shredded web, can be provided using the types of materials, equipment and techniques set forth in U.S. Pat. No. 4,807,809 to Pryor et al. and U.S. Pat. No. 5,025,814 to Raker. In addition, representative manners and methods for operating a filter material supply units and filter-making units are set forth in U.S. Pat. No. 4,281,671 to Bynre; U.S. Pat. No. 4,850,301 to Green, Jr. et al.; U.S. Pat. No. 4,862,905 to Green, Jr. et al.; U.S. Pat. No. 5,060,664 to Siems et al.; U.S. Pat. No. 5,387,285 to Rivers and U.S. Pat. No. 7,074,170 to Lanier, Jr. et al.

The hollow acetate tubes as described herein can be particularly useful because of a surprisingly efficient liquid storing capacity. According to one embodiment, the cellulose acetate tow can have a linear mass density of about 0.5 denier per filament (dpf) or greater, about 1 dpf or greater, or about 2 dpf or greater. In other embodiments, the cellulose acetate tow can have a linear mass density of about 0.5 dpf to about 20 dpf, about 0.75 dpf to about 15 dpf, about 1 dpf to about 10 dpf, or about 2 dpf to about 6 dpf. The cellulose acetate used according to the present disclosure can comprise staple fibers. The staple fibers can have an average length of about 0.1 in. to about 6 in., about 0.2 in. to about 5 in. or about 0.25 in. to about 3 in.

The reservoir comprising cellulose acetate can be formed of various compositions and in various manners. In particular embodiments, the reservoir can comprise cellulose acetate fibers. If desired, the reservoir can comprise a binder. Fillers (e.g., cellulose) and fibers formed of different materials also can be used. The reservoir can comprise about 70% to about 99% by weight cellulose acetate fibers, and the weights noted herein are measured on a dry weight basis. More specifically, the reservoir can comprise about 75% to about 98%, about 80% to about 97.5%, or about 90% to about 97% by weight cellulose acetate fibers. The reservoir can comprise about 1% to about 30% by weight of the binder. More specifically, the reservoir can comprise about 2% to about 25%, about 2.5% to about 20%, or about 3% to about 10% by weight of the binder. In specific embodiments, a reservoir according to the disclosure can comprise about 95% to about 97% by weight cellulose acetate fiber and about 3% to about 5% by weight binder. In other specific embodiments, a reservoir according to the disclosure can comprise about 80% to about 85% by weight cellulose acetate fiber and about 15% to about 20% by weight binder. A binder is understood to be a material that imparts a cohesive effect to the fibers used in forming the disclosed reservoirs. For example, the binder can be a material that partially solubilizes the cellulose acetate fibers such that the fibers bind to each other or to further fibrous materials included in the woven or non-woven reservoir. Exemplary binders that can be used include polyvinyl acetate (PVA) binders, starch, and triacetin. One of skill in the art of cigarette filter manufacture may recognize triacetin as being a plasticizer for such filters. As such, it is understood that there may be overlap between the group of binders useful according to the present disclosure and materials that may be recognized in further arts as plasticizers. Accordingly, the cohesion agent used and described herein as a binder may encompass materials that may be recognized in other fields as being plasticizers. Moreover, materials recognized in the field of cigarette filters as plasticizers for cellulose acetate may be encompassed by the use of the term binders herein.

The cellulose acetate fibers can have various cross-sectional shapes – e.g., round, elongated, or multi-lobal. In specific embodiments, cellulose acetate having a tri-lobal or Y-shaped cross-sectional shape can be used.

In some embodiments, a non-woven fibrous mat reservoir according to the present disclosure can be formed by a wet-laid process or by a dry-laid process. When using a wet-laid process, it can be beneficial to use cellulose acetate fibers having shorter lengths – e.g., in the range of about 0.25 in. to about 2 in. When using a dry-laid process, it can be beneficial to use cellulose acetate fibers having longer lengths – e.g., in the range of about 2.5 in. to about 3 in. In each case, a resulting mat comprising the cellulose acetate fibers can be at a thickness of about 1 mm to about 4 mm, about 1.25 mm to about 3.5 mm, or about 1.5 mm to about 3 mm. The cellulose acetate mat can have a basis weight of about 70 grams per square meter (gsm) to about 240 gsm, about 80 gsm to about 220 gsm, or about 90 gsm to about 200 gsm. The cellulose acetate mat can be sized to a desired width. In various embodiments, the width can be about 10 mm to about 25 mm, about 15 mm to about 24 mm, or about 20 mm to about 23 mm. The cellulose acetate mats can be cut to lengths suitable to be rolled into a tube having an outer diameter suitable for insertion into a smoking article as described herein and having an inner diameter suitable to allow insertion of an atomizer therein according to the present disclosure. The ends of the rolled mats can form a butt joint or may overlap. In further embodiments, the cellulose acetate composition can be molded into a formed shape that is substantially tubular. The shaped hollow acetate tube can have one or more shapes formed into the inner wall thereof, such as the diametrically opposed grooves discussed above.

In some embodiments, the fibers of the formed mats can be entangled. For example, hydroentangling and needle punching each can be used separately or in combination. In specific embodiments, needle punching can be used with at least 250, at least 500, at least 1,000, or at least 1,500 needle punches per square inch (NPPSI). In particular, about 250 to about 2,500, about 500 to about 2,000, or about 750 to about 1,500 NPPSI can be used.

According to one embodiment, the reservoir can comprise a mixture of different types of fibers. Suitable fibers for forming such mixture include, but are not limited to, fibers formed from cellulose acetate, wood pulp, wool, silk, polyesters (e.g., polyethylene terephthalate) polyamides (e.g., nylons), polyolefins, polyvinyl alcohol, and the like.

It has been found according to the present disclosure that hydrophilic fibers, particularly cellulose acetate, can be particularly useful in forming a reservoir for an aerosol precursor composition, particularly a composition formed predominately with a polyhydric alcohol, such as glycerin. Such reservoirs can provide improved storage and release of the aerosol precursor

composition. For example, such reservoirs can provide for faster loading of the aerosol precursor composition, for more consistent release of the aerosol precursor composition when drawn away, such as by a wick, during use of the smoking article, and a reduction in the total volume of aerosol precursor composition that must be loaded in the reservoir.

The filaments used in a wick according to the present disclosure can be formed of any material that provides sufficient wicking action to transport one or more components of the aerosol precursor composition along the length of the filament. Non-limiting examples include natural and synthetic fibers, such as cotton, cellulose, polyesters, polyamides, polylactic acids, glass fibers, combinations thereof, and the like. Other exemplary materials that can be used in wicks include metals, ceramics, and carbonized filaments (e.g., a material formed of a carbonaceous material that has undergone calcining to drive off non-carbon components of the material).

The filaments (or the wick generally) can be coated with materials that alter the capillary action of the filaments – i.e., to increase (or decrease, if desired) the wicking action of the filament. Also, fiber material selection can be utilized to increase or decrease wicking action and thus control the wicking rate of a specific component of the aerosol precursor composition. Wicking also can be customized through choice of the dimensions of the fibers used in the wicks and the overall dimensions of the wick, including wick length and wick diameter.

The filaments used in forming wicks can have specific cross-sectional shape and/or can be grooved so as to alter the capillary action of the fibers. Filaments can have a substantially round cross-section, and altering fiber cross-section shape can increase the surface area per denier of the fiber and thus improve wicking along the filament. For example, a filament can be formed with longitudinal grooves that are intended to facilitate wicking, such as a 4DG fiber (available from Fiber Innovation Technology) and winged fibers (available from Alasso Industries). Filaments formed with an “X” or “Y” shaped cross-section similarly can provide desirable wicking properties.

In other embodiments, at least a portion of a filament utilized in a wick can be designed to promote radial wicking. Continuous filament fibers, such as fiberglass, tend to promote wicking primarily along the axis of the filament – i.e., axial wicking. Through appropriate design, the filament also can be caused to promote radial wicking – i.e., outward from the axis of the filament. For example, radial wicking can be facilitated through use of filaments having a fibrillated fiber surface. Such design particularly can be useful in the area of the filaments that are in proximity to or in contact with the heater as it can cause more of the precursor composition to be available for aerosolization in the specific area of the heater. Similarly particles or beads can be sintered or otherwise interconnected to provide a continuous wick structure with a like effect.

Filaments used in forming wicks can be provided singly or can be bundled (including meshes and braids). A filament can be a single fiber, or a filament can be formed of a group of combined fibers that provide a larger mass. Porosity of the filaments used in the wick also can be controlled to alter the capillary action and can include controlling average pore size and total porosity, controlling filament geometry, controlling overall wick shape, and controlling surface characteristics. Separate filaments also can have different lengths. Varying the nature of the filaments can be useful to customize vapor formation. For example, filaments with greater wicking ability can be used to transport a component of an aerosol precursor composition that is to be vaporized in a high amount, and filaments with a reduced wicking ability can be used to transport a component of an aerosol precursor composition that is desired to be vaporized in a lesser amount.

The type of material used to form the individual filaments of the wicks also can be customized to transport specific types of compounds. For example, one or more wicks can be formed of filaments utilizing hydrophobic materials so as to preferentially wick hydrophobic liquids. Further, one or more wicks can be formed of filaments utilizing hydrophilic materials so as to preferentially wick hydrophilic liquids. Moreover, one or more wicks can include filaments formed of materials that are neither hydrophilic nor hydrophobic, such as natural materials, so as to preferentially wick liquids that are neither significantly polar nor significantly non-polar.

In particular embodiments, a wick useful as the liquid transport component is a braided wick. The braided wick can be formed from at least 3 separate fibers or yarns. Further, the braided wick can be formed from at least 4, at least 6, at least 8, at least 10, at least 12, at least 14, or at least 16 separate fibers or yarns. Each of the separate fibers or yarns may be identical in composition. Alternatively, the separate fibers or yarns may comprise fibers or yarns formed of two or more different compositions (e.g., a fiberglass yarn braided with a cotton yarn). Thus, the braided wick can be formed of a plurality of synthetic fibers or yarns, a plurality of natural fibers or yarns, of a combination of at least one synthetic fiber or yarn and at least one natural fiber or yarn. In certain embodiments, E-glass can be used. In preferred embodiments, C-glass can be used. Use of C-glass has been determined to be of particular use because of the higher solubility of the material in lung fluid compared to other materials, particularly other fiberglass materials.

A braided wick in particular may be provided as a component of a sheath/core yarn. In particular, a first wick material can form a yarn core, and a second wick material can surround the core to form a yarn sheath. The sheath and core can differ in at least one of physical structure and the material from which the yarn is formed. In a preferred example, a twisted yarn can comprise the core, and braided yarn can form the sheath.



An example of a sheath/core wick according to some embodiments of the disclosure is shown in the cross-section of FIG. 5 where a sheath/core wick 202 can be formed of a sheath component 203 and a core component 204. The sheath 203 is formed of braided fibers or yarn, as otherwise described herein. The core 204 is formed of a non-braided yarn. In some embodiments, the relative dimensions of the sheath/core wick cross-section can vary. The core may be in direct contact with the sheath, or a space may be provided between the sheath and the core.

A method of making an electronic smoking article is provided. The method includes the step of providing a cylinder comprising cellulose acetate and having a hollow interior portion. At least part of the hollow interior can be shaped and dimensioned to accommodate one or more further components of the smoking article. The method can further include the step of inserting an atomizer into the hollow interior of the cellulose acetate cylinder. The atomizer can comprise a liquid transport element, a heater, and electrical contacts. The method can further include the steps of inserting the cylinder and atomizer into a hollow shell, and connecting the atomizer to a power source. The power source can be a battery. Portions of the liquid transport element can be attached to or embedded in the reservoir to form a fluid connection that enables transport of the aerosol precursor composition out of the reservoir. The atomizer can comprise a continuous, elongated wick having two opposing ends. The wick particularly can be a braided wick and can comprise C-glass. The atomizer can further comprise a heater in connection with the wick and positioned at about a midpoint thereof. The atomizer also can comprise electrically conducting terminals positioned in physical contact with the wick and in electrical contact with the heater. According to one embodiment, the heater can be a resistive heating element. In some embodiments, the step of inserting the atomizer into the cellulose acetate cylinder can comprise extending a portion of the atomizer beyond an end of the cellulose acetate cylinder.

## EXPERIMENTAL

The presently disclosed subject matter is more fully illustrated by the following examples, which are set forth to illustrate the presently disclosed subject matter and provide full disclosure, and they are not to be construed as limiting thereof.

### EXAMPLE 1

#### Preparation of Cellulose Acetate Reservoirs

Drylaid cellulose acetate (CA) substrates were constructed from conventional cigarette filter tow (Eastman Estron acetate tow, 3.0 dpf, 40,000 total denier, Y cross section) chopped to a staple length of 2.5 in. for evaluation of suitability for use as a reservoir according to the present

disclosure. The sheet was mechanically entangled in a needlepunch process. There were no additional fibers or binders added to the sheet. Other CA fiber and tow sizes can be used, as well as various fiber cross sections, and staple lengths compatible with carding/needling. Needling at 500, 1000, and 1500 needle punches per square inch (NPPSI) all produced a usable sheet. The finished substrate sheets were produced from about 70 gsm to about 240 gsm, which yielded thicknesses from about 1 mm to about 4 mm. A preferred embodiment had a basis weight of 150 gsm at about 2 mm thickness and 1000 NPPSI. The lighter basis weight substrates resulted in greater amounts of aerosol generated from the product, all other factors being equal. These sheet parameters were chosen in part to accommodate the needs of the cartridge design and assembly process. They can be adjusted to match larger or smaller liquid loadings and/or physical cartridge size.

Hydroentangling was also tested as a method of entangling the staple fibers to create a cohesive sheet. Other methods such as stitch bonding, ultrasonic, or thermal bonding can also be used. Triacetin or other plasticizers, or a sprayed bonding agent might also be used. Mixtures of fibers can also be used to adjust the sheet properties with regard to liquid affinity, wicking, strength, elongation, and stiffness.

Wetlaid CA substrates were constructed from non-crimped CA yarns produced by Celanese and Eastman Chemical. The Eastman yarn was specified at 4.0 dpf and 150 total denier, regular (round) cross-section, with a conventional cigarette tow finish. The yarns were cut to 0.25 in. and 0.5 in. lengths for use in the wetlaid process. The 0.5 in. cut was preferred in the testing due to increased sheet integrity. Longer staple lengths may also improve this. Other filament deniers, total deniers, or cross-sections also can be used.

Several sheet compositions were tested. All compositions used a majority of CA fiber from about 75% to about 92% of the total dry weight. Additional fibers (singly or mixed) were added to strengthen the sheet from about 8% to about 25% of the total dry weight. These included: HP-11 wood pulp from Buckeye Technologies; DPL-2607, a PET (polyethylene terephthalate) bicomponent fiber, from Fiber Innovation Technologies; and Kuralon VPB 105-2x4, PVOH (polyvinyl alcohol) fiber from Kuraray Co., Ltd. The final material selected for production had a composition of 92% CA, 4% wood pulp, and 4% PVOH.

The finished substrate sheets were produced from about 70 gsm to about 160 gsm, with thicknesses from about 0.7 mm to about 3 mm. An exemplary material was about 115 gsm and about 1.5 mm thick. These sheet parameters were chosen in part to accommodate the needs of the cartridge design and assembly process. They can be adjusted to match larger or smaller liquid loadings and/or physical cartridge size. The substrate sheets were useful for formation into a hollow tube reservoir.

Other cellulosic fibers including rayon or cotton can be used in place of, or in addition to, wood pulp for substantially the same effect. Other methods of binding the sheet can include spray binders such as latex or solvent bonding with triacetin or other plasticizers.

An advantage to the wetlaid process is the ability to adjust fiber orientation to alter the “squareness” of the sheet. This works to reduce machine direction elongation, which in turn can improve the slit width uniformity.

## EXAMPLE 2

### Improved Uptake and Release of Aerosol Precursor Composition

Reservoirs in known aerosolization devices typically have been formed of a nonwoven mat of polyester (PET) fibers. This has the advantage of being a relatively cheap and widely available material; however, it has been found that the hydrophobic nature of the material can lead to disadvantages, particularly when an aerosol precursor composition is formed primarily of hydrophilic materials. For example, PET nonwoven sheets promote little or no movement of the liquid precursor composition and can take on the order of several hours for full movement of a liquid precursor composition through the entire reservoir.

Experiments were conducted to evaluate cellulose acetate (CA) based substrates as reservoirs. A drylaid, nonwoven cellulose acetate reservoir (100% CA, 2.5 in. average fiber length, 150 gsm weight) was compared to a PET reservoir of like dimensions. FIG. 6 shows the two reservoirs one minute after placing the dry reservoirs on a liquid substrate comprising glycerin. FIG. 7 shows the reservoirs two minutes after placement. At one minute the CA tube had absorbed significant amounts of liquid while the PET had little to no absorption. At two minutes, the CA tube was saturated while the PET tube still had little to no absorption. This higher affinity for the liquid affects the product in multiple ways. For manufacturing, it allows rapid filling of the cartridge with the substrate absorbing liquid more readily and evenly. For product use, it permits the liquid in the cartridge to migrate more easily to the wick making more efficient use of the liquid in the cartridge.

The CA substrate was also tested against the PET substrate to evaluate filling times when used as a reservoir in a cartridge for a smoking article. The filling time for the PET substrate when applying liquid at the top of the substrate in the cartridge was greater than 30 minutes. The filling time under the same conditions for the CA substrate was less than two minutes.

With PET based substrates, it has been frequently observed at the end of product life that regions of the substrate not in contact with the wick are still saturated with liquid while the substrate in contact with the wick has become depleted. This is an inefficient system because more

liquid must be put in the cartridge than can be effectively converted to aerosol. The images in FIG. 8 and FIG. 9 show a CA substrate before use (FIG. 8) and after use (FIG. 9). The figures show that when a CA reservoir is used in a smoking article, the applied aerosol precursor composition is depleted evenly throughout the reservoir. This advantageously can allow for the use of both a smaller reservoir and a smaller volume of aerosol precursor composition to achieve a desired number of puffs on a smoking article incorporating the CA reservoir. As seen in FIG. 10, aerosol forming efficiency increased as the size of the reservoir (saturated with aerosol precursor composition) decreased indicating that the aerosol precursor composition is efficiently and evenly transferred from the reservoir for aerosolization.

### EXAMPLE 3

#### Improved Uptake and Release of Liquid Transport Component

One of the major deficiencies identified with many known aerosolization smoking articles is the change in aerosol delivery over the life of the article. Most articles decline from 25% to 60% in aerosol delivery when comparing initial performance (e.g., puffs 1-20) to end-of-life performance (e.g., puffs 180-200). Ideally, the performance would be consistent over the life of the product. Testing was carried out to evaluate improving performance based on the nature of the liquid transport component (i.e., the wick) in the smoking article.

A comparative wick was formed of a twisted fiberglass yarn (9 micron E-glass) having a diameter of approximately 0.054 in. and a linear mass of about 2.15 mg/mm. The twisted yarn exhibited little cohesive structure, especially when cut to short lengths. The yarn was easily compressed which was considered a disadvantage for maintaining good contact with the resistive wire heater. When cut, the ends of the yarn were prone to blooming open as the tension or torsion imparted in the twisting process was released. This was expected to decrease the effectiveness of the wick for fluid transport.

In order to address these physical deficiencies, a braided fiberglass wick was developed at approximately the same specifications: 9-micron E-glass, 0.052 in. diameter, 2.47 mg/mm linear mass. This braided wick performed similarly to the original twisted wick. In both designs, the average mg of total particulate matter (TPM) per puff decreased by about 25% from the initial puffs to the end-of life puffs. This is illustrated in FIG. 11.

In a further test, a braided wick sheath was formed around a twisted core. The diameter and mass of the wick were also reduced. Three sheath/core wicks were formed with diameters of 0.043 in. to 0.047 in. and linear masses of 1.65 mg/mm to 1.85 mg/mm. The braided exterior of the sheath/core wicks were formed using 8 bobbins, 12 bobbins, and 16 bobbins, respectively, and thus

were characterized as comprising 8, 12, or 16 braids. Each of the three sheath/core wicks provided a significantly higher TPM yield. See FIG. 12. The sheath/core wicks also exhibited smaller changes in TPM over the product life declining by about 20% in two cases. Compared to the original twisted wick, all of the braided designs exhibited greater physical integrity when cut with little unraveling or fraying. The braided designs were also firmer, potentially improving contact between the wire heater and the braid.

Many modifications and other embodiments of the disclosure will come to mind to one skilled in the art to which this disclosure pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the disclosure is not to be limited to the specific embodiments disclosed herein and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

## CLAIMS:

1. An electronic smoking article comprising:  
an electrical power source; and  
a reservoir that comprises cellulose acetate and is configured to hold an aerosol precursor material.
2. The electronic smoking article of claim 1, wherein the reservoir is substantially shaped as a cylinder having a hollow interior portion, and optionally wherein at least part of the hollow interior is shaped and dimensioned to accommodate one or more further components of the smoking article.
3. The electronic smoking article of claim 2, wherein the one or more further components is an atomizer comprising one or both of a heater and a liquid transport element.
4. The electronic smoking article of claim 3, wherein the liquid transport element is a continuous, elongated article adapted for wicking a liquid.
5. The electronic smoking article of claim 3, wherein the liquid transport element comprises a braided wick.
6. The electronic smoking article of claim 5, wherein the liquid transport element is in the form of a sheath/core wick.
7. The electronic smoking article of claim 6, wherein the sheath portion of the wick is braided.
8. The electronic smoking article of claim 7, wherein the core portion of the wick is non-braided or is formed of a different material than the braided sheath, or both.
9. The electronic smoking article of claim 5, wherein the braided wick is a braid of at least 4 separate fibers or yarns.

10. The electronic smoking article of claim 3, wherein the liquid transport element comprises fiberglass, which optionally is C-glass.
11. The electronic smoking article of claim 2, wherein the hollow interior comprises a central cavity with diametrically opposed grooves extending into the reservoir, and wherein the grooves are adapted to mate with portions of an atomizer.
12. The electronic smoking article of claim 1, wherein the cellulose acetate fiber has a linear mass density of about 0.5 dpf or greater.
13. The electronic smoking article of claim 1, wherein the reservoir comprises about 70% to about 99% by weight cellulose acetate and about 2% to about 25% by weight of a binder.
14. The electronic smoking article of claim 2, further comprising an atomizer positioned within the hollow interior portion of the reservoir, the atomizer comprising:
  - a continuous, elongated wick having two opposing ends;
  - a heater in connection with the wick and positioned at about a midpoint thereof; and
  - electrically conducting terminals positioned in physical contact with the wick and in electrical connection with the heater.
15. An electronic smoking article comprising:
  - a reservoir with a liquid aerosol precursor composition stored therein; and
  - a braided wick in fluid communication with the reservoir.
16. The electronic smoking article of claim 15, wherein the braided wick is a sheath/core wick.
17. The electronic smoking article of claim 16, wherein the braided wick is the sheath and surrounds the core.
18. The electronic smoking article of claim 17, wherein the core is one or more of:
  - non-braided;
  - formed of a different material than the braided sheath; and
  - formed of a twisted yarn.

19. The electronic smoking article of claim 15, wherein the braided wick is a braid of at least 4 separate fibers or yarns.

20. The electronic smoking article of claim 15, wherein the braided wick comprises fiberglass that is C-glass or E-glass.

21. The electronic smoking article of claim 15, wherein the reservoir comprises cellulose acetate.

22. A cartridge for an electronic smoking article, the cartridge comprising an atomizer at least partially positioned within a hollow interior of a tube-shaped reservoir adapted for holding an aerosol precursor composition, the reservoir tube being positioned within a hollow shell, wherein the atomizer comprises:

a continuous, elongated wick having two opposing ends;

a heater in connection with the wick and positioned at about a midpoint thereof; and

electrically conducting terminals; and

wherein the reservoir tube is formed of cellulose acetate, the wick is a braided wick, or both.

23. The cartridge of claim 22, wherein the hollow shell comprises a first end adapted to engage a control component and an opposing mouthend, and wherein the heater of the atomizer extends out of the reservoir tube in a cavity formed at the mouthend of the hollow shell.

24. The cartridge of claim 22, wherein the braided wick is a sheath/core wick.

25. The cartridge of claim 24, wherein the braided wick is the sheath and surrounds the core.

26. The cartridge of claim 25, wherein the core is non-braided or is formed of a different material than the braided sheath, or both.

27. The cartridge of claim 22, wherein the braided wick is a braid of at least 4 separate fibers or yarns.



28. The cartridge of claim 22, wherein the wick comprises fiberglass that is C-glass or E-glass.
29. A method of making an electronic smoking article, the method comprising:  
providing a cylinder comprising cellulose acetate and having a hollow interior portion; and  
inserting an atomizer into the hollow interior of the cellulose acetate cylinder.
30. The method of claim 29, further comprising:  
inserting the cylinder and atomizer into a hollow shell; and  
connecting the atomizer to a power source.
31. The method of claim 30, wherein the atomizer comprises a continuous, elongated wick having two opposing ends and a heater in connection with the wick and positioned at about a midpoint thereof.
32. The method of claim 30, wherein said inserting comprises extending a portion of the atomizer beyond an end of the cellulose acetate cylinder.
33. A wick suitable for use in an electronic smoking article, the wick comprising a braid of at least 4 separate fibers or yarns, at least one of which is C-glass or E-glass.
34. The wick of claim 33, wherein the braided wick is a sheath/core wick.
35. The wick of claim 34, wherein the braided wick is the sheath and surrounds the core.
36. The wick of claim 34, wherein the core is one or more of:  
non-braided;  
formed of a different material than the braided sheath; and  
formed of a twisted yarn.

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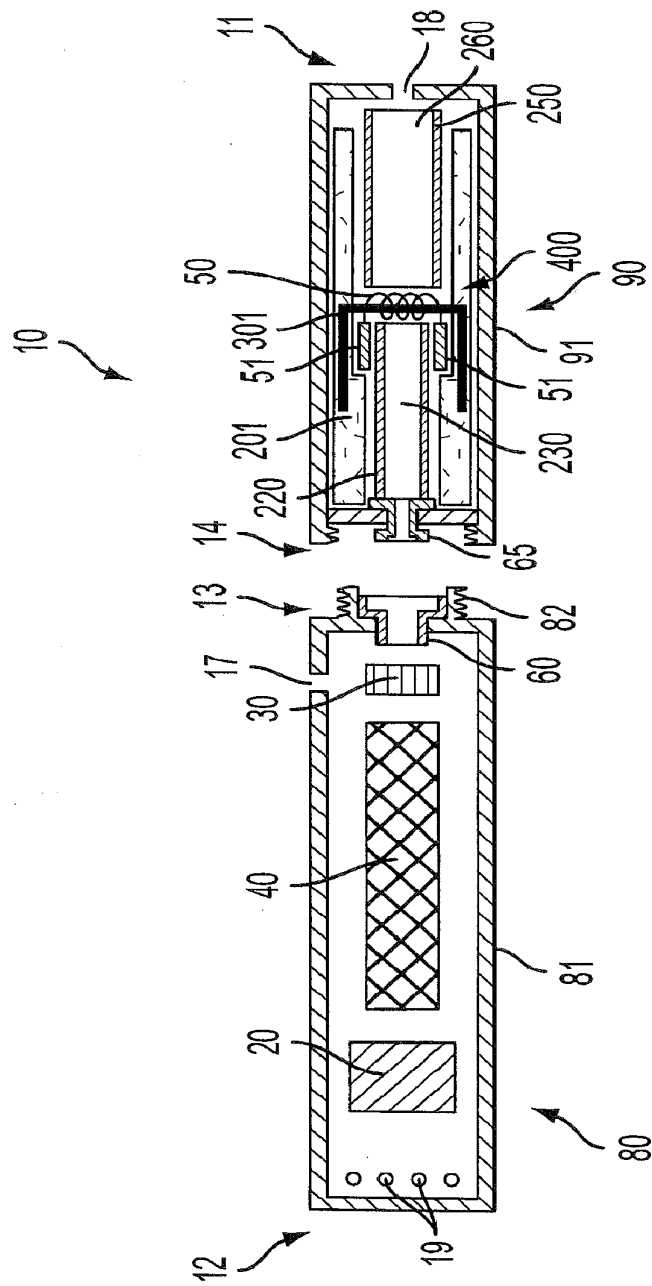
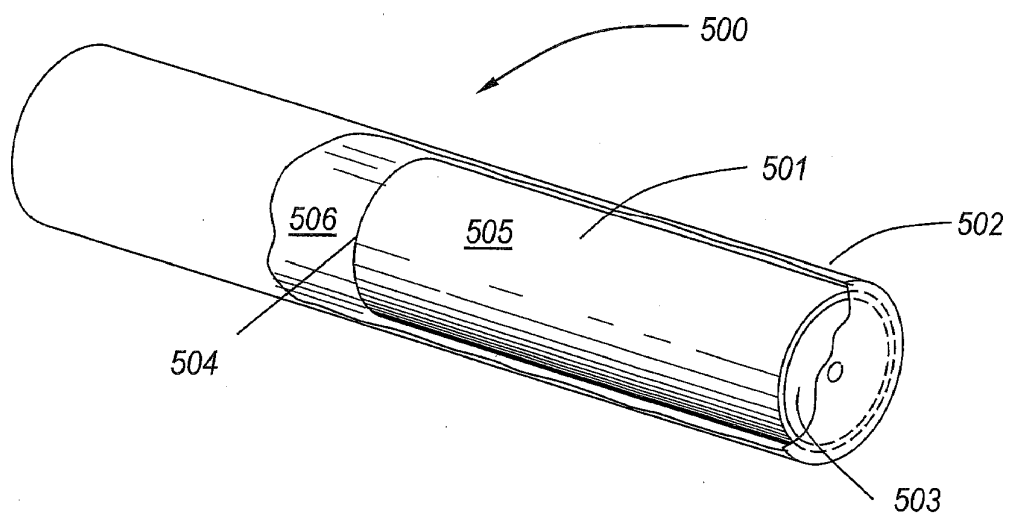
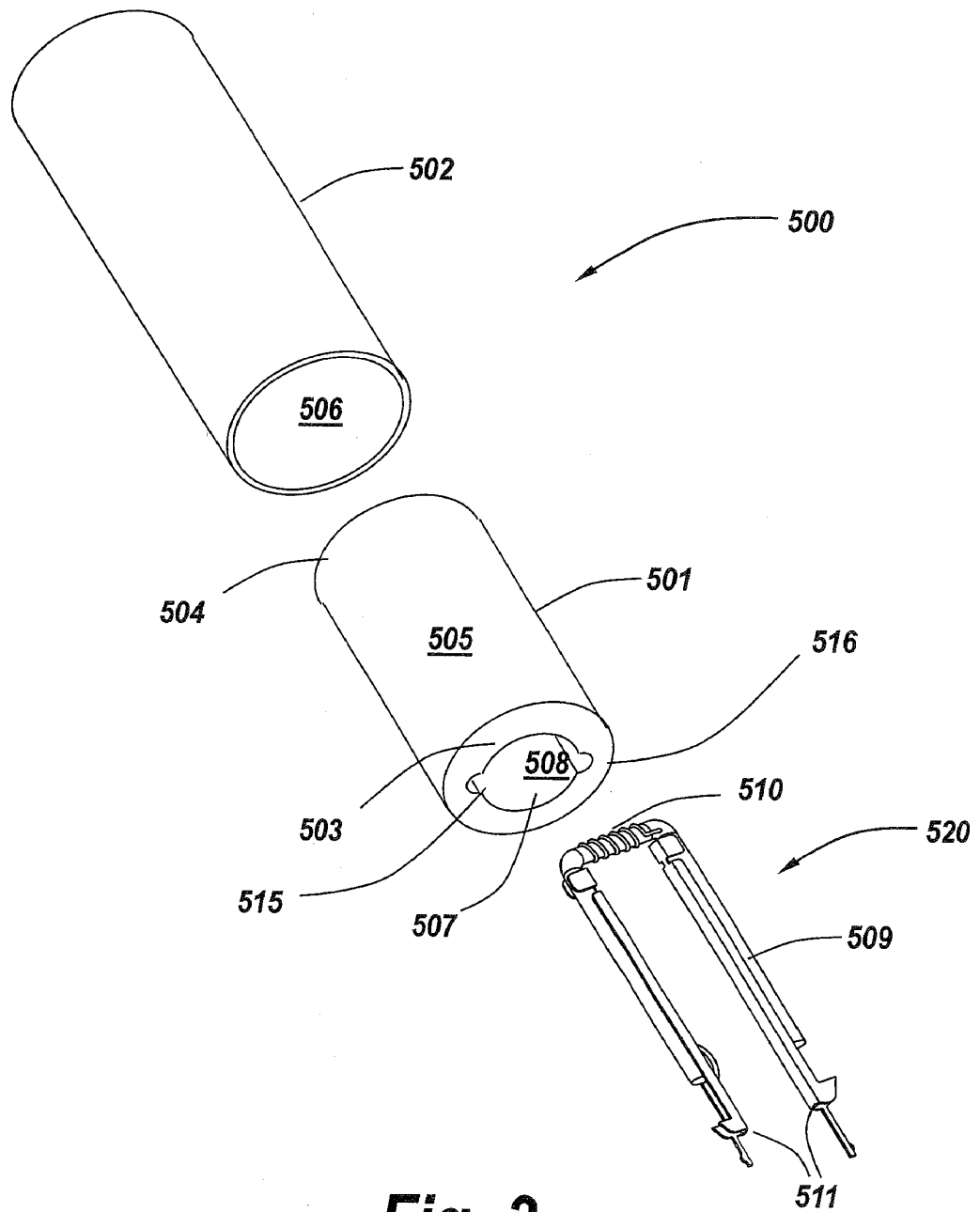
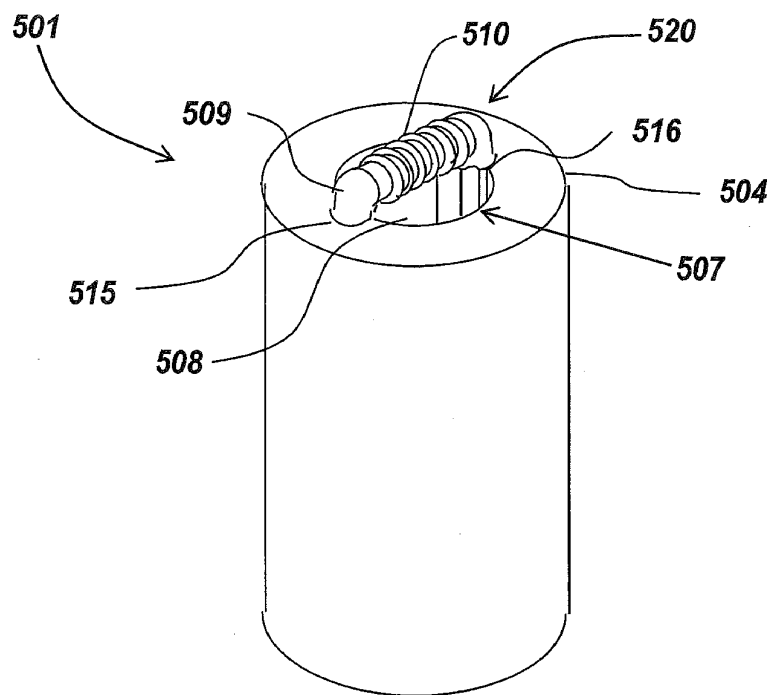


**Fig. 1**

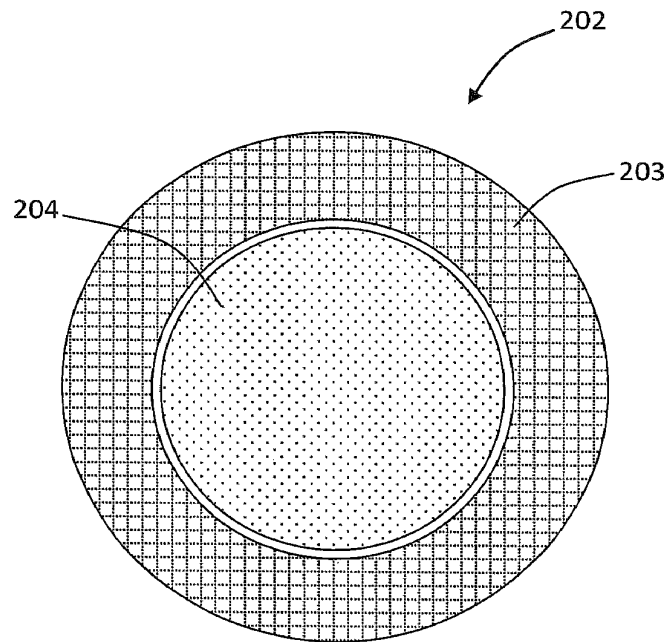
2/9

**Fig. 2**

**Fig. 3**

**Fig. 4**

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**Fig. 5**

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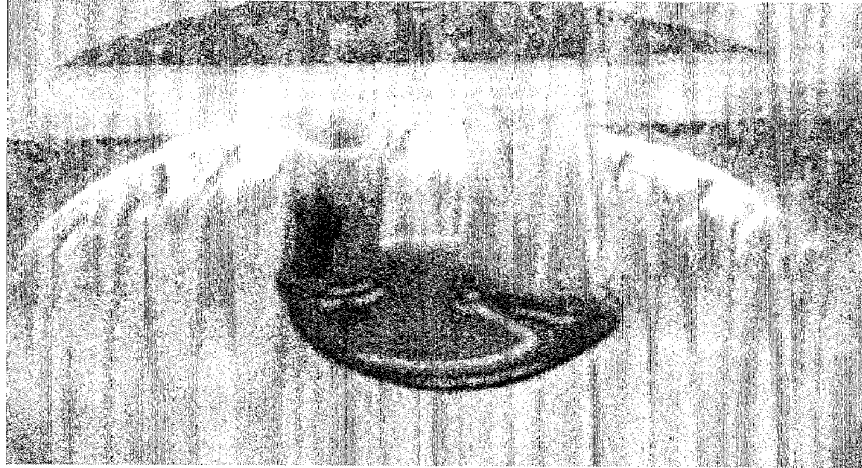


***Fig. 6***

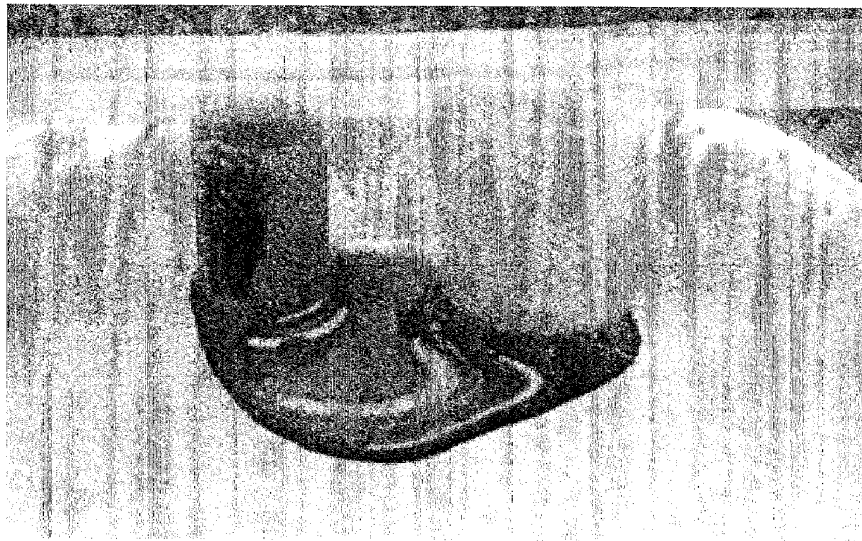


***Fig. 7***

SUBSTITUTE SHEET (RULE 26)

7/9



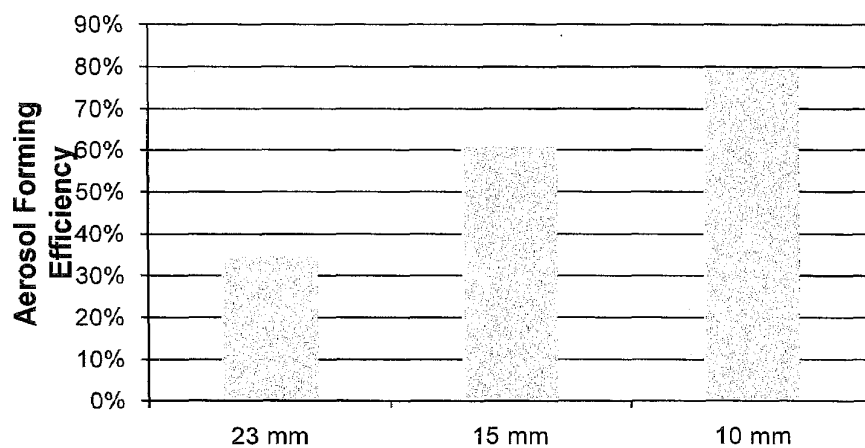
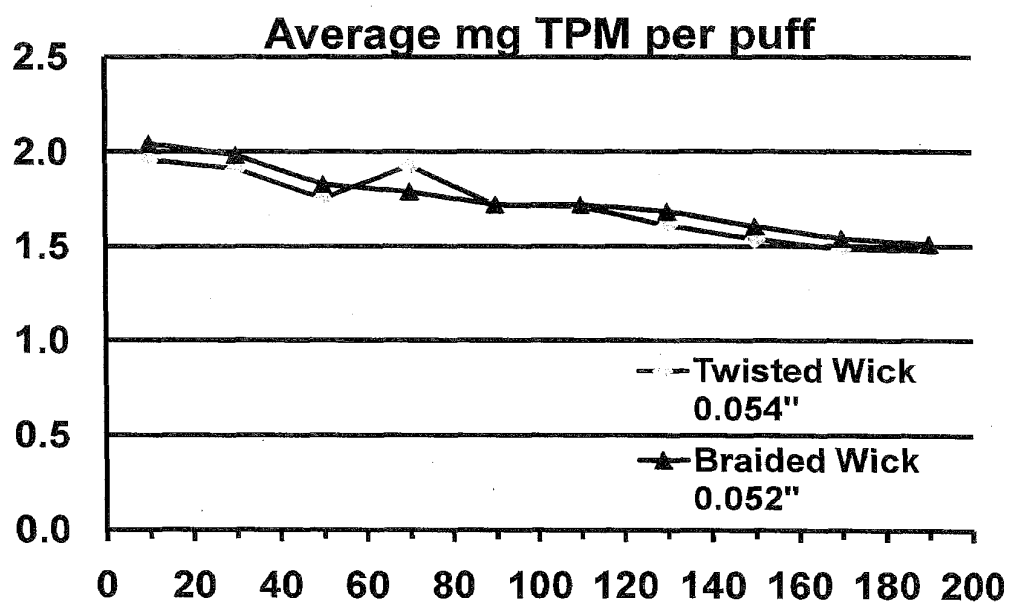
***Fig. 8***



***Fig. 9***

SUBSTITUTE SHEET (RULE 26)



**Fig. 10****Fig. 11**

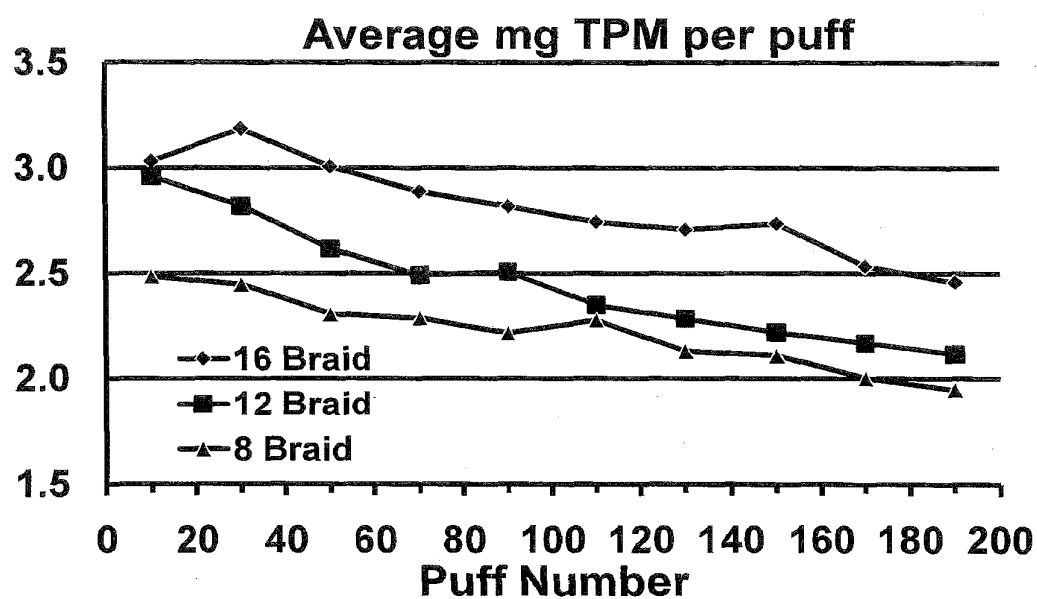


**Fig. 12**

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/025565

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

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<br>A    | EP 0 358 114 A2 (REYNOLDS TOBACCO CO R [US]) 14 March 1990 (1990-03-14)<br>the whole document<br>----- | 1-14,<br>29-32<br>22-28 |
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| X         | US 2 332 799 A (HUNN EDWARD B ET AL)<br>26 October 1943 (1943-10-26)<br>the whole document<br>-----    | 1-14,<br>22-32          |
| X<br>A    | EP 2 022 349 A1 (HAN LI [HK])<br>11 February 2009 (2009-02-11)<br>the whole document<br>-----<br>-/-   | 1-14,<br>29-32<br>22-28 |



Further documents are listed in the continuation of Box C.



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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

14 August 2014

Date of mailing of the international search report

25/08/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Cardan, Cosmin

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/025565

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                    | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------|-----------------------|
| A         | EP 2 468 116 A1 (PHILIP MORRIS PROD [CH])<br>27 June 2012 (2012-06-27)<br>the whole document<br>----- | 15-36                 |
| A         | US 2012/199146 A1 (MARANGOS BILL [CA])<br>9 August 2012 (2012-08-09)<br>the whole document<br>-----   | 15-36                 |

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2014/025565

### 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.:  
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:
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:

see additional sheet

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**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14, 29-32

the subject-matter of the first group of inventions refers  
to a improved reservoir for an electronic cigarette  
---

2. claims: 15-21, 33-36

the subject-matter of the second group of inventions refers  
to an improved wick for an electronic cigarette  
---

3. claims: 22-28

the subject-matter of the third group of inventions refers  
to a cartridge for an electronic cigarette  
---

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/025565

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
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Form PCT/ISA/210 (patent family annex) (April 2005)

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/025565

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
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## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 27331565                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Brian Flick                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 26-OCT-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 16:36:18                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

| Submitted with Payment |                      | no                                      |                                          |                  |                  |
|------------------------|----------------------|-----------------------------------------|------------------------------------------|------------------|------------------|
| File Listing:          |                      |                                         |                                          |                  |                  |
| Document Number        | Document Description | File Name                               | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1                      |                      | 13211-713-303_IDS_Filing_10-26-2016.pdf | 344918                                   | yes              | 5                |
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| Multipart Description/PDF files in .zip description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                              |                                          |     |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------|------------------------------------------|-----|----|
| Document Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |                              | Start                                    | End |    |
| Transmittal Letter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |                              | 1                                        | 3   |    |
| Information Disclosure Statement (IDS) Form (SB08)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |                              | 4                                        | 5   |    |
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| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                              |                                          |     |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Foreign Reference | EP3024343_WO2015013327A2.pdf | 1551941                                  | no  | 29 |
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| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                              |                                          |     |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                              |                                          |     |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Foreign Reference | WO2003103387A2.pdf           | 2281687                                  | no  | 57 |
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| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                              |                                          |     |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                              |                                          |     |    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Foreign Reference | WO2014159982A1.pdf           | 3297006                                  | no  | 52 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |                              | fd807d68a49865ed1945bd6c5b092fb648c255f7 |     |    |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                              |                                          |     |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                   |                              |                                          |     |    |
| Total Files Size (in bytes):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                              | 7475552                                  |     |    |
| <p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p> |                   |                              |                                          |     |    |

**CERTIFICATE OF TRANSMISSION UNDER 37 CFR 1.8**

I hereby certify that this correspondence is being transmitted to the USPTO via EFS-Web on October 26, 2016.

/Brian Flick/  
Brian Flick

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 14/925,968 Confirmation No.: 2707  
 First Named Inventor : Adam Bowen  
 Filed : October 28, 2015  
 Art Unit : 1747  
 Examiner : Mayes, Dionne Walls  
 Title : NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES  
 AND METHODS THEREOF  
 Customer No. : 66854

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**INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.97 & § 1.98**

Sir:

In accordance with 37 CFR § 1.97-1.98, applicants hereby submit an Information Disclosure Statement, including attached forms(s) PTO/SB/08. A copy of each reference is being submitted herewith, along with a concise explanation in English for those publications in a foreign language.

Applicants respectfully request that the listed information be considered by the Examiner and be made of record in the above-identified application. Applicants further request that the Examiner initial and return a copy of the attached form(s) PTO/SB/08 in accordance with MPEP §609.

Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and /or to prove that this information may not be enabling for the teachings purportedly offered.

This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, prior art or material to patentability as defined in 37 CFR §1.56.

**FILING OF INFORMATION DISCLOSURE STATEMENT**

☒ **37 CFR §1.97(b)**

This statement is being submitted under 37 CFR §1.97(b) because the IDS is being filed:

- ☐ 1). Within 3 months of the application filing date, or
- ☐ 2). Within 3 months of entry of a national stage as set forth in § 1.491, or
- ☐ 3). Before the mail date of a first Office Action on the merits, or
  - ☐ 3a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below
- ☒ 4). With or after the filing of a request for continued examination (RCE) under § 1.114 but before the mailing date of a first Office Action (after RCE).
  - ☐ 4a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below

☐ **37 CFR § 1.97(c)**

This statement is being filed after the latest of:

- ☐ 1). Three months beyond the filing date of a national application, or
- ☐ 2). Three months beyond the date of entry of the national stage as set forth in § 1.491 in an international application, or
- ☐ 3). The mailing date of a first Office Action on the merits, but before the mailing date of the earlier of a final Office Action under § 1.113 or a Notice of Allowance under § 1.311, and then either:
  - ☐ A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or included with the payment of other papers filed together with this statement.
  - or
  - ☐ B). A certification as specified in § 1.97(e) is provided below; thus no fee is required.

☐ **37 CFR § 1.97(d)**

This statement is being filed after the mailing date of a Final Office action, a Notice of Allowance under § 1.311, or an action that otherwise closes prosecution, but on or before payment of the issue fee, and then:

A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or payment is included with other papers filed together with this statement

--AND--

B). A certification as specified in § 1.97(e) is included below.

**CONTENT OF INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.98**

☒ **37 CFR §1.98 (a)(2)(ii), U.S. patents or patent application publication(s) cited**

- ☒ 1). Since not requested by the Office, U.S. patents and U.S. patent application publications are not included.
- ☐ 2). At the request of the Office, a copy of the following U.S. patent or patent application publication is attached:
- ☐ 3). Items identified by a double asterisk (\*\*) on the SB08A are \*commonly-owned U.S. patents and U.S. patent application publications.

☒ **37 CFR §1.98 (a)(2)(iii) and (d), \*Commonly-owned, unpublished U.S. applications cited**

- ☐ 1). A copy of each application specification including the claim(s), and any drawing, or that portion of the application that caused it to be listed, is attached.
- ☐ 2). A copy of each application specification is not submitted because the specification was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☒ 3). A copy of each application specification is not submitted because the application is stored in the IFW.

*\*Applicant(s) assume the Examiner has access to the file histories of these items. However, if the Examiner would like to receive copies of Office Actions in any of the commonly-owned applications, publications and/or patents identified on the attached SB08, please inform the undersigned and copies will be provided.*

☐ **37 CFR §1.98 (a)(2)(iii) and (d), English language publication (other than U.S. patents, patent applications, or pending unpublished applications) cited**

- ☐ 1). A legible copy of each publication or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each publication or that portion which caused it to be listed is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

- ☒ **37 CFR §1.98 (a)(2)(i) and (d), Foreign patent(s) in English cited**
- ☒ 1). A legible copy of each foreign patent or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☐ **37 CFR §1.98 (a)(2)(i), (a)(3)(i-ii) and 609.04(a)III, Foreign patent(s) or other foreign documents not in English cited. Either:**
- ☐ 1). A legible copy of each foreign patent, each publication or that portion which caused it to be listed, is attached **--AND--**
- ☐ 2a). An English language abstract or an English language copy of a foreign search report or other action by a foreign patent office is provided herewith to fulfill the requirement for a concise explanation of the relevance, as it is presently understood by the individual designated in § 1.56(c) most knowledgeable about the content of the information, of each patent, publication, or other information listed that is not in the English language: Cite no(s): **--AND/OR--**
- ☐ 2b). A copy of a written, English-language translation or portion thereof is readily available and attached: Cite no(s): **--OR--**
- ☐ 3). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

**STATEMENT UNDER 37 CFR § 1.97(e)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. Cite no(s):
- ☐ No item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement. Cite no(s):

**STATEMENT UNDER 37 CFR § 1.704(d)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

**FEE AUTHORIZATION**

- ☒ The Commissioner is hereby authorized to charge the above-referenced fees of \$0.00 and charge any additional fees or credit any overpayment associated with this communication to Deposit Account No. 50-4050.

Respectfully Submitted,

Dated: October 26, 2016

By: /Richard D. Shoop/  
Richard D. Shoop, Reg. No. 45,763

Shay Glenn LLP  
2755 Campus Drive, Suite 210  
San Mateo, CA 94403  
(650) 212-1700  
Customer No. 66854

**AUTHORIZATION FOR INTERNET  
COMMUNICATIONS IN A PATENT  
APPLICATION OR REQUEST TO  
WITHDRAW AUTHORIZATION FOR  
INTERNET COMMUNICATIONS**

|                         |                     |
|-------------------------|---------------------|
| Application No.         | 14/925,968          |
| Filing Date             | October 28, 2015    |
| First Named Inventor    | Adam BOWEN          |
| Art Unit                | 1747                |
| Examiner Name           | Mayes, Dionne Walls |
| Practitioner Docket No. | 13211-713.303       |

To: Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**I. To authorize permission for Internet Communications.**

☒ Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned and practitioners in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via video conferencing, instant messaging, or electronic mail. I understand that a copy of these communications will be made of record in the application file. (MPEP 502.03)

**II. To withdraw authorization for Internet Communications.**

☐ The authorization given on \_\_\_\_\_, to the USPTO to communicate with the undersigned and any practitioner in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via Internet communications such as video conferencing, instant messaging, or electronic mail is hereby withdrawn. I understand that the withdrawal is effective when approved rather than when received.

I am the

☐ applicant.

☒ attorney or agent of record. Registration number 45,763

☐ attorney or agent acting under 37 CFR 1.34. Registration number \_\_\_\_\_

/Richard D. Shoop/  
Signature

November 11, 2016  
Date

Richard D. Shoop  
Typed or printed name

(650) 287-2164  
Telephone Number

**NOTE:** This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Juristic entities must be represented by a patent practitioner (see 37 CFR 1.31, which is applicable to any paper filed on or after September 16, 2012, that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below\*.

☐ \* Total of \_\_\_\_\_ forms are submitted.

## Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 27491946                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Mary Buggie                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 11-NOV-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 21:04:21                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description               | File Name                                               | File Size(Bytes)/<br>Message Digest               | Multi Part /.zip | Pages (if appl.) |
|-----------------|------------------------------------|---------------------------------------------------------|---------------------------------------------------|------------------|------------------|
| 1               | Internet Communications Authorized | 13211-713-303_Authorization_Internet_Communications.pdf | 82168<br>a93b6d2983f549841d771bb9c14364215ef934af | no               | 2                |

### Warnings:



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
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| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 82168 |
| <p><b>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> <b>If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> <b>If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> <b>If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</b></p> |       |



Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

|                                                                                                                                              |                     |                          |                  |
|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------|------------------|
| Substitute for form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><br><i>(Use as many sheets as necessary)</i> |                     | <b>Complete if Known</b> |                  |
|                                                                                                                                              |                     | Application Number       | 14/925,968       |
|                                                                                                                                              |                     | Filing Date              | October 28, 2015 |
|                                                                                                                                              |                     | First Named Inventor     | Adam Bowen       |
|                                                                                                                                              |                     | Art Unit                 | 1747             |
| Examiner Name                                                                                                                                | Mayes, Dionne Walls |                          |                  |
| Sheet 2                                                                                                                                      | of 2                | Attorney Docket Number   | 13211-713.303    |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                                                                                                                                                 |                |
|---------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.                                                                                                                                 | T <sup>2</sup> |
|                                 | 721                   | FARSALINOS et al.; Electronic cigarettes do not damage the heart; European Society of Cardiology; 4 pages; retrieved from the internet ( <a href="http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart/">http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart/</a> ); August 25, 2012 |                |
|                                 | 720                   | VANSICKEL et al.; Electronic cigarettes: effective nicotine delivery after acute administration; Nicotine & Tobacco Research; 15(1); pp. 267-270; January 2013                                                                                                                                                                                                                                  |                |
|                                 |                       |                                                                                                                                                                                                                                                                                                                                                                                                 |                |
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|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO:**

**Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 27548579                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Brian Flick                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 17-NOV-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 18:16:43                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

| Submitted with Payment |                      | no                                                    |                                         |                  |                  |
|------------------------|----------------------|-------------------------------------------------------|-----------------------------------------|------------------|------------------|
| File Listing:          |                      |                                                       |                                         |                  |                  |
| Document Number        | Document Description | File Name                                             | File Size(Bytes)/ Message Digest        | Multi Part /.zip | Pages (if appl.) |
| 1                      |                      | 13211-713-303_IDS_Filing_Wit<br>hResp__11-17-2016.pdf | 341552                                  | yes              | 5                |
|                        |                      |                                                       | 34f459e934576beb95d01048404f6e9383c6678 |                  |                  |

| Multipart Description/PDF files in .zip description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                       |                                                           |                                          |     |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------------------------------------------|------------------------------------------|-----|---|
| Document Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |                                                           | Start                                    | End |   |
| Transmittal Letter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |                                                           | 1                                        | 3   |   |
| Information Disclosure Statement (IDS) Form (SB08)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |                                                           | 4                                        | 5   |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |                                                           |                                          |     |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                       |                                                           |                                          |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Non Patent Literature | Farsalinos_et_al_ElectronicCigarettesDoNotDamage_2012.pdf | 60065                                    | no  | 4 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                                                           | 60439509eb9ffb3386f6b00a5c61f547def2e017 |     |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |                                                           |                                          |     |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                       |                                                           |                                          |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Non Patent Literature | Vansickel_et_al_ElectronicCigarettesEffective_2013.pdf    | 1994756                                  | no  | 4 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                                                           | 6e5877e04f3be9d23e60ca8831e34168e1fa18e8 |     |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |                                                           |                                          |     |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                       |                                                           |                                          |     |   |
| Total Files Size (in bytes):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |                                                           | 2396373                                  |     |   |
| <p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p> |                       |                                                           |                                          |     |   |

**CERTIFICATE OF TRANSMISSION UNDER 37 CFR 1.8**

I hereby certify that this correspondence is being transmitted to the USPTO via EFS-Web on November 17, 2016.

/Brian Flick/

Brian Flick

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 14/925,968 Confirmation No.: 2707  
 First Named Inventor : Adam Bowen  
 Filed : October 28, 2015  
 Art Unit : 1747  
 Examiner : Mayes, Dionne Walls  
 Title : NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES  
 AND METHODS THEREOF  
 Customer No. : 66854

---

**INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.97 & § 1.98**

Sir:

In accordance with 37 CFR § 1.97-1.98, applicants hereby submit an Information Disclosure Statement, including attached forms(s) PTO/SB/08. A copy of each reference is being submitted herewith, along with a concise explanation in English for those publications in a foreign language.

Applicants respectfully request that the listed information be considered by the Examiner and be made of record in the above-identified application. Applicants further request that the Examiner initial and return a copy of the attached form(s) PTO/SB/08 in accordance with MPEP §609.

Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and /or to prove that this information may not be enabling for the teachings purportedly offered.

This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, prior art or material to patentability as defined in 37 CFR §1.56.

**FILING OF INFORMATION DISCLOSURE STATEMENT**

☒ **37 CFR §1.97(b)**

This statement is being submitted under 37 CFR §1.97(b) because the IDS is being filed:

- ☐ 1). Within 3 months of the application filing date, or
- ☐ 2). Within 3 months of entry of a national stage as set forth in § 1.491, or
- ☐ 3). Before the mail date of a first Office Action on the merits, or
  - ☐ 3a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below
- ☒ 4). With or after the filing of a request for continued examination (RCE) under § 1.114 but before the mailing date of a first Office Action (after RCE).
  - ☐ 4a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below

☐ **37 CFR § 1.97(c)**

This statement is being filed after the latest of:

- ☐ 1). Three months beyond the filing date of a national application, or
- ☐ 2). Three months beyond the date of entry of the national stage as set forth in § 1.491 in an international application, or
- ☐ 3). The mailing date of a first Office Action on the merits, but before the mailing date of the earlier of a final Office Action under § 1.113 or a Notice of Allowance under § 1.311, and then either:
  - ☐ A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or included with the payment of other papers filed together with this statement.
  - or
  - ☐ B). A certification as specified in § 1.97(e) is provided below; thus no fee is required.

☐ **37 CFR § 1.97(d)**

This statement is being filed after the mailing date of a Final Office action, a Notice of Allowance under § 1.311, or an action that otherwise closes prosecution, but on or before payment of the issue fee, and then:

A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or payment is included with other papers filed together with this statement

--AND--

B). A certification as specified in § 1.97(e) is included below.

**CONTENT OF INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.98**

☒ **37 CFR §1.98 (a)(2)(ii), U.S. patents or patent application publication(s) cited**

- ☒ 1). Since not requested by the Office, U.S. patents and U.S. patent application publications are not included.
- ☐ 2). At the request of the Office, a copy of the following U.S. patent or patent application publication is attached:
- ☐ 3). Items identified by a double asterisk (\*\*) on the SB08A are \*commonly-owned U.S. patents and U.S. patent application publications.

☐ **37 CFR §1.98 (a)(2)(iii) and (d), \*Commonly-owned, unpublished U.S. applications cited**

- ☐ 1). A copy of each application specification including the claim(s), and any drawing, or that portion of the application that caused it to be listed, is attached.
- ☐ 2). A copy of each application specification is not submitted because the specification was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☐ 3). A copy of each application specification is not submitted because the application is stored in the IFW. Cite no(s):

*\*Applicant(s) assume the Examiner has access to the file histories of these items. However, if the Examiner would like to receive copies of Office Actions in any of the commonly-owned applications, publications and/or patents identified on the attached SB08, please inform the undersigned and copies will be provided.*

☒ **37 CFR §1.98 (a)(2)(iii) and (d), English language publication (other than U.S. patents, patent applications, or pending unpublished applications) cited**

- ☒ 1). A legible copy of each publication or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each publication or that portion which caused it to be listed is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

- ☐ **37 CFR §1.98 (a)(2)(i) and (d), Foreign patent(s) in English cited**
- ☐ 1). A legible copy of each foreign patent or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☐ **37 CFR §1.98 (a)(2)(i), (a)(3)(i-ii) and 609.04(a)III, Foreign patent(s) or other foreign documents not in English cited. Either:**
- ☐ 1). A legible copy of each foreign patent, each publication or that portion which caused it to be listed, is attached **--AND--**
- ☐ 2a). An English language abstract or an English language copy of a foreign search report or other action by a foreign patent office is provided herewith to fulfill the requirement for a concise explanation of the relevance, as it is presently understood by the individual designated in § 1.56(c) most knowledgeable about the content of the information, of each patent, publication, or other information listed that is not in the English language: Cite no(s):
- AND/OR--**
- ☐ 2b). A copy of a written, English-language translation or portion thereof is readily available and attached: Cite no(s):
- OR--**
- ☐ 3). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

**STATEMENT UNDER 37 CFR § 1.97(e)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.
- ☐ No item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement.

**STATEMENT UNDER 37 CFR § 1.704(d)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

**FEE AUTHORIZATION**

- ☒ The Commissioner is hereby authorized to charge the above-referenced fees of \$0.00 and charge any additional fees or credit any overpayment associated with this communication to Deposit Account No. 50-4050.

Respectfully Submitted,

Dated: November 17, 2016

By: /Richard D. Shoop/  
Richard D. Shoop, Reg. No. 45,763

Shay Glenn LLP  
2755 Campus Drive, Suite 210  
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(650) 212-1700  
Customer No. 66854



**CERTIFICATE OF TRANSMISSION UNDER 37 CFR 1.8**

I hereby certify that this correspondence is being transmitted to the USPTO via EFS-Web on November 17, 2016.

/Mary Buggie/

11/17/2016

Mary Buggie

Date

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Appl. No. : 14/925,968 Confirmation No. : 2707  
First Named Inventor: : Adam BOWEN  
Filing Date : October 28, 2015  
Art Unit : 1747  
Examiner : Mayes, Dionne Walls  
Title : NICOTINE SALT FORMULATIONS FOR AEROSOL  
DEVICES AND METHODS THEREOF  
Customer No. : 66854

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**SUPPLEMENTAL AMENDMENT AND COMMENTS UNDER 37 C.F.R. § 1.114**

This communication is submitted following the Request for Continued Examination (RCE) and the fees for Prioritized Examination - Track 1 status filed on August 19, 2016. A Declaration Under 37 C.F.R. § 1.132 providing support and evidence of Unexpected Results is also submitted herewith

The Commissioner is authorized to charge any fees to make this filing timely to Deposit Account No. 50-4050.

**Amendments to the Claims** are shown in the listing of claims that begins on page 2.

**Remarks/Arguments** begin on page 7 of this paper.

### AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A method of delivering nicotine to a user comprising:  
deploying a low-temperature vaporizer comprising a nicotine formulation that comprises nicotine, ~~lactic acid~~ lactate, and a biologically acceptable liquid carrier ~~in conditions sufficient to form nicotine lactate salt~~, wherein:
  - a. the nicotine lactate concentration is ~~from about~~ about ~~[[0.5%]]~~ 4% (w/w) ~~to about 20% (w/w);~~
  - b. the biologically acceptable liquid carrier comprises ~~propylene glycol and 90%-30% vegetable glycerol; and~~
  - c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate ~~between about 100°C and about 300°C;~~wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about [[5]]3 minutes results in [[at a]] an increase in heart rate that peaks within about 3.5 minutes from the first puff of about one inhalation per 30 seconds results in a nicotine plasma Tmax from about 3 minutes to about 8 min and a Cmax of over 10 ng/mL on average, and further wherein the user may modify the amount of nicotine delivered by adjusting inhalation strength.
2. (Previously presented) The method of claim 1, wherein a molar ratio of nicotine to lactic acid is between about 1:1 and 1:3.
3. (Original) The method of claim 1, wherein the nicotine formulation further comprises at least one flavorant.

4. (Cancelled)
5. (Cancelled)
6. (Original) The method of claim 1, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.
7. (Currently amended) A method of delivering nicotine to a user comprising:  
deploying a low-temperature vaporizer comprising a nicotine formulation that comprises nicotine, ~~lactic acid~~ lactate, and a biologically acceptable liquid carrier ~~in conditions sufficient to form nicotine lactate salt~~, wherein:
  - a. the nicotine lactate concentration is from about ~~[[0.5]]~~ 4% (w/w) to about ~~[[20]]~~ 6.5% (w/w);
  - ~~b. the nicotine formulation comprises protonated nicotine;~~
  - ~~[[c]]~~ b. the biologically acceptable liquid carrier comprises propylene glycol and 90%-30% vegetable glycerol;
  - ~~d. the lactic acid does not decompose at room temperature and does not decompose at the operating temperature of the low-temperature vaporizer; and~~
  - ~~[[e]]~~ c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to the heating element and heating at least a portion of the nicotine formulation between about 100°C and 300°C to generate an inhalable aerosol;wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about [[5]] 3 minutes results in [[at a]] an increase in heart rate that peaks within about 3.5 minutes from the first puff of about one inhalation per 30 seconds results in a nicotine plasma Tmax from about 3 minutes to about 8 min and further wherein the user may modify the amount of nicotine delivered by adjusting inhalation strength.

8. (Previously presented) The method of claim 7, wherein a molar ratio of nicotine to lactic acid is between 1:1 and 1:3.
9. (Original) The method of claim 7, wherein the nicotine formulation further comprises at least one flavorant.
10. (Original) The method of claim 7, wherein the nicotine concentration is about 4.5%.
11. (Cancelled)
12. (Original) The method of claim 7, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.
13. (Currently amended) A low-temperature vaporizer, comprising:
  - a liquid reservoir;
  - a nicotine formulation within the liquid reservoir, the nicotine formulation comprising:
    - nicotine lactate;
    - ~~propylene glycol;~~ and
    - ~~90%-30% vegetable~~ glycerol;
  - wherein a concentration of the nicotine lactate in the nicotine formulation is ~~from~~ about ~~[[0.5]]~~4% (w/w) to about ~~[[20]]~~6.5% (w/w);
  - a vaporizing component configured to produce an aerosol from the nicotine formulation by heating at least a portion of the nicotine formulation ~~between 100°C and 300°C~~,
  - wherein the liquid reservoir is connected to the vaporizing component by a wick; and
  - a mouthpiece configured to connect to the reservoir for inhalation of the aerosol;
  - wherein inhalation of the aerosol into the user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about [[5]]3 minutes results in [[at a]] an increase in heart rate that peaks within about 5 minutes from the first puff of about one inhalation per 30 seconds results in a nicotine plasma Tmax from about 3 min to about 8 min and a Cmax of over 10 ng/mL on average, and further wherein the user may modify the amount of nicotine delivered by adjusting inhalation strength.

14. (Original) The electronic cigarette of claim 13, further comprises a battery configured to provide power to the vaporizing component.
15. (Previously presented) The electronic cigarette of claim 13, wherein a molar ratio of nicotine to lactic acid is between 1:1 and 1:3.
16. (Original) The electronic cigarette of claim 13, wherein the nicotine formulation further comprises at least one flavorant.
17. (Original) The electronic cigarette of claim 13, wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation.
18. (Original) The electronic cigarette of claim 13, wherein the nicotine concentration is about 4.5%.
19. (Cancelled)
20. (Original) The electronic cigarette of claim 13, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.
21. (Previously presented) The method of claim 1, wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.
22. (Previously presented) The method of claim 7, wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.
23. (New) A method of delivering nicotine to a user comprising:  
deploying a low-temperature vaporizer comprising a nicotine formulation that comprises nicotine lactate, and a biologically acceptable liquid carrier, wherein:
  - a. the nicotine lactate concentration is about 4.5% (w/w);
  - b. the biologically acceptable liquid carrier comprises glycerol; and

c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate; wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes from the first puff.

### REMARKS

Claims 1-4, 6-10, 12-18 and 20-22 were pending in this application. By this response, claims 1, 7 and 13 have been amended, and claim 4 has been cancelled. New claim 23 has been added. The amendments to the claims and the new claims are supported throughout the specification, including in provisional patent application no. 61/820,128.

Thus, claims 1-3, 6-10, 12-18, and 20-24 are pending.

### DECLARATION OF ADAM BOWEN

Also submitted herewith is a declaration from Adam Bowen, providing additional experimental evidence in support of the heart rate effect of vaporizing nicotine lactate as well as providing evidence of unexpected results.

### UNEXPECTED RESULTS

Applicants respectfully submit that the claimed invention, as supported by the present specification and further supported by the attached declaration under 37 C.F.R. § 1.132, exhibits unexpected results over the cited art and is accordingly nonobvious. Per *Graham v. John Deere Co.*, 383 U.S. 1 (1966), unexpected results are a secondary consideration that may tip the scales towards a conclusion of nonobviousness. Such unexpected results may include:

- Greater than expected results;
- Superiority of a shared property;
- Presence of an unexpected property; and
- Absence of an expected property.

(See MPEP § 716.02(a)). In the present case, the nicotine lactate possesses the unexpected property that inhalation of an aerosol of the claimed nicotine lactate composition into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes from the first puff. As discussed in the present specification, including

FIG. 1 and 2, and as further demonstrated in the attached declaration under 37 C.F.R. § 1.132, this property was surprising.

As described in paragraph [013] of the Provisional Application no. 61/820128, to which the instant application claims priority:

“This experience of increased heart rate comparable to that of a traditional burned cigarette has not been demonstrated or identified in other electronic cigarette devices. Nor has it been demonstrated or identified in low temperature tobacco vaporization devices that do not burn the tobacco, even when a nicotine salt is used as an additive to the tobacco (typically, the concentration of nicotine salt within the solution as an additive for the tobacco is about 20 weight percent or more). Thus, this experience and combination is surprising and unexpected with regard to any of these types of devices.” (emphasis added)

The Declaration of Adam Bowen explains this in additional detail. See in particular, paragraphs 6 and 7, which describes the published prior art, in which inhaling vaporized nicotine was not found to effect heart rate in a manner that is comparable to inhaling smoke from a burned tobacco cigarette. For example, Vansickel et al. (“A Clinical laboratory assessment of the abuse liability of an electronic cigarette described a comparison between vaporized nicotine (as found in commercially available vaporizers) and burned cigarettes and concluded that: “[n]o significant changes in heart rate were observed for the Hydro EC, NPRO EC [electronic cigarettes], or sham conditions.”). Thus, the results yielded by the claimed invention are unexpected in view of the cited art. Accordingly, it is respectfully submitted that the claims are allowable over the prior art.



Supplemental Amendment dated: November 17, 2016  
App. No.: 14/925,968; Filed: October 28, 2015

**CONCLUSION**

Applicants respectfully request that the Examiner expedite the prosecution of this patent application to issuance. If the Patent Office determines that an extension of time and/or other relief is required, Applicants petition for any required relief including extension of time, and authorize the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 50-4050**, referencing 13211-713.303. However, the Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Date: November 17, 2016

Respectfully submitted,



Richard D. Shoop  
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 14/925,968 Confirmation No. : 2707  
Inventor(s) : Adam BOWEN  
Filing Date : October 28, 2015  
Art Unit : 1747  
Examiner : Mayes, Dionne Walls  
Title : NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND  
METHODS THEREOF  
Customer No. : 66854

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**DECLARATION UNDER 37 C.F.R. § 1.132**

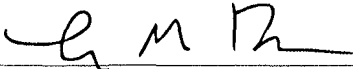
I, Adam Bowen, declare as follows:

- (1) In January of 2005, I co-founded Ploom, Inc., now PAX Labs, which develops and produces nicotine vaporizers ("electronic cigarettes"), and am currently the Chief Technical Officer (CTO) of the company.
- (2) I am also an inventor on the patent application, U.S. Application no. 14/925,968, titled "NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF" (hereafter "the '968 application"), as well as on U.S. provisional patent application 61/820,128, filed on May 6, 2013 (hereafter "the '128 provisional application"), to which the '968 application claims priority.
- (3) The '968 patent application describes the use of liquid nicotine salts formulations in a vaporizer to form an aerosol of nicotine. The nicotine in these formulations is formed by a nicotine salt in a liquid carrier such as a glycerol, glycol or mixture of these. As described in the '128 provisional application, the use of certain nicotine salts, including carboxylic acid nicotine salts such as nicotine lactate, produces a physiological effect when vaporized that is comparable to that from inhaling a traditional burned cigarette. Specifically, the resulting vapor produces an increase in heart rate that peaks within the first five minutes, just as seen when inhaling traditional burned cigarettes. FIG. 1 of the '128 provisional application was provided as an example of this. This figure is reproduced in the attached Exhibit A. The data shown in FIG. 1 of the '128 provisional application was for nicotine levulinate.

- (4) Although nicotine lactate was included as an example of a nicotine salt in the '128 provisional application, the experimental data was not explicitly included in FIG. 1. Nicotine lactate also has a physiological effect on the heart rate that closely resembles that of smoking a tobacco cigarette. Specifically, nicotine lactate also causes an increase in heart rate that peaks within about 5 minutes from the first puff. This data is shown in Exhibit B, attached herewith.
- (5) The data shown in Exhibit B was collected in the same manner as is shown in FIG. 1 of the '128 provisional application. A 6.5% (w/w) solution of nicotine lactate solution was prepared in glycerol by adding neat nicotine lactate into the glycerol, which was mixed thoroughly. A 4.0% (w/w) solution of nicotine lactate was similarly prepared. Both formulations were administered as to a subject as described for FIG. 1 of the '128 provisional application, and heart rate measurements (e.g., at 30-second intervals) were taken for ten minutes from start of puffing. The test participant took 10 puffs over 3 minutes in each case. The increase in heart rate seen with both the 6.5% and 4.0% nicotine lactate solutions are directly comparable to that seen for nicotine levulinate, and are similar to that seen with a traditional burned cigarette. This is in contrast with freebase nicotine which did not induce a peak in heart rate within the first five minutes, as shown in FIG. 1 of the '128 provisional application.
- (6) This result was unexpected. Prior to my work, it was widely believed by those of skill in the art that vaporized nicotine did not evoke the same physiological response as traditional burned cigarettes. This belief was supported by data showing that vaporized nicotine did not evoke the same or similar peak increase in heart rate as traditional burned cigarettes. In FIG 1 of the the '128 provisional, the bottom trace (freebase nicotine) is typical for the heart rate effect of prior art nicotine vaporizers showing a more gradual increase in heart rate. It was surprising and unexpected that nicotine salt formulations such as nicotine lactate instead produce a peak heart rate that matches that produced by traditional burned cigarettes.
- (7) Prior to my invention, those of skill in the art believed that vaporized nicotine did not result in an effect on heart rate comparable to that seen with a traditional cigarette. At the time of my invention, published data comparing the physiological effect of vaporized nicotine delivered from an electronic cigarette to that caused by traditional burned cigarettes concluded that vaporized nicotine differed from traditional tobacco cigarettes, and either did not produce any significant change in heart rate, or resulted in only a slowly increasing, sustained increase in heart rate, in contrast to the rapid onset (within 5 minute) peak increase in heart rate that seen with burned cigarettes. For example, Vansickel et al. ("A Clinical laboratory assessment of the abuse liability of an electronic cigarette. *Addiction* 2012;107:1493–500, attached hereto as Exhibit C) examined the effect on heart rate between vaporized nicotine and burned cigarettes, and reported that there were not any significant changes in heart rate following two 10-puff bouts with a 16 or 18 mg nicotine/cartridge e-cigarette (n=32; n=16). Significant increases in HR were reported with burned cigarettes. Vansickel et al. used a protocol that was similar to what I used in generating the data shown in FIG. 1 of the '128 provisional and Exhibit B. Heart rate was measured every 20 seconds, and subjects were instructed to take 10 puffs with a 30-second interpuff interval. The electronic

cigarettes used included nicotine (16- or 18-mg), propylene glycol, water and flavorants. Vansickel et al. reported that there was a peak in heart rate within the first 5 minutes for the burned cigarettes, while there was no significant peak in the same time period for any of the electronic cigarettes ("Heart rate increased from an average (SD) of 65.7 (10.4) bpm at baseline to a peak of 80.3 (10.9) bpm five minutes after the first administration under the own-brand condition [burned cigarettes]. No significant changes in heart rate were observed for the Hydro EC, NPRO EC [electronic cigarettes], or sham conditions."). Later work by the same researchers (Vansickel AR, Eissenberg T. Electronic cigarettes: Effective nicotine delivery after acute administration. *Nicotine Tob Res* 2013;15:267-70, attached hereto as Exhibit D) reported that even when higher levels of nicotine were included in the electronic cigarette, such as 18 mg/ml nicotine, 9 mg/ml nicotine and 24 mg/ml nicotine, only a gradual increase in heart rate was seen which did not peak within 5 minutes, but continued to increase and remain elevated over a longer time period ("heart rate increased significantly within 5 min of the first puff and remained elevated throughout the ad lib puffing period."). Similar or identical effects were reported by others (see, e.g., the European Society for Cardiology, <http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart>, attached hereto as Exhibit E), comparing how a heart reacts to cigarette smoke compared to inhaling nicotine vapor, and pointing out that heart rate and blood pressure increases quickly and dramatically when smoking a traditional cigarette, but the inhaling vapor from an electronic cigarette results in only a slight uptick in blood pressure, and "hardly any increase in heart rate." In light of the published literature, it was surprising unexpected that the use of nicotine lactate to form the nicotine in the solution being vaporized would have a physiological effect on a body that closely resembles that of smoking a tobacco cigarette such that inhaling 10 puffs of the aerosol over a period of about 3 minutes would result in an increase in heart rate that peaks within about 5 minutes from the first puff.

- (8) I declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under the provisions of 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of any patent issuing upon U.S. Application Serial No. 14/632,161, or any continuing application thereof.

Signature:   
Adam Bowen

Date: 11/17/16

**EXHIBIT A**

*Figure 1 of U.S. provisional patent application 61/820,128 (filed on May 6, 2013)*

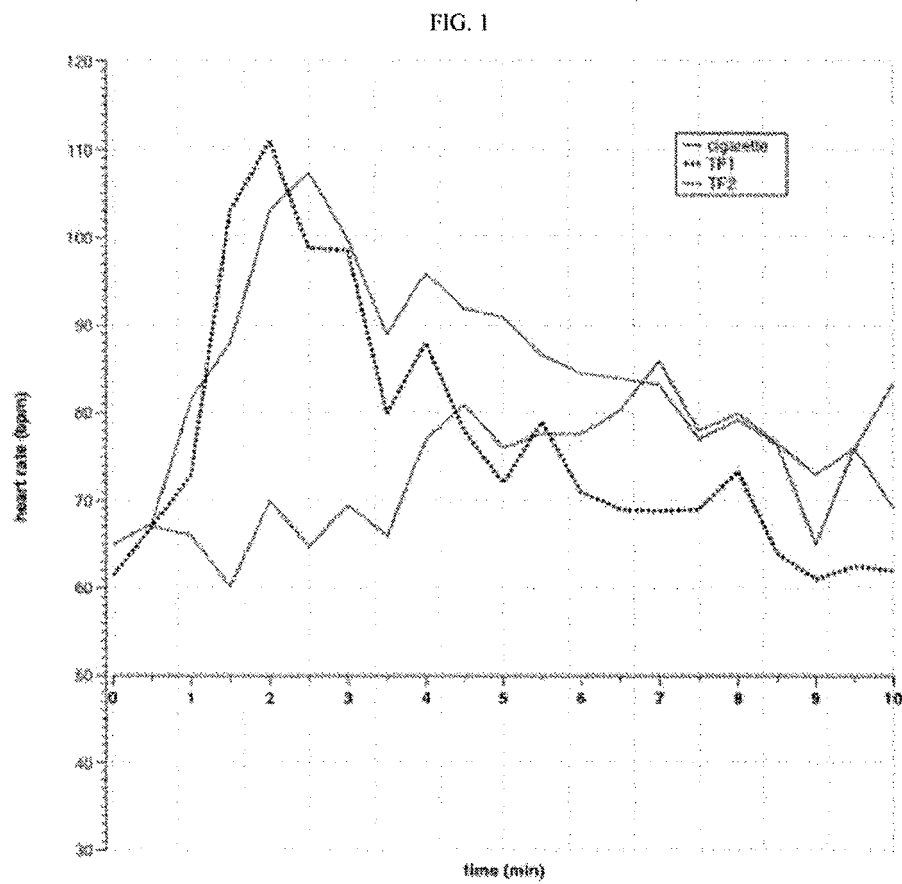
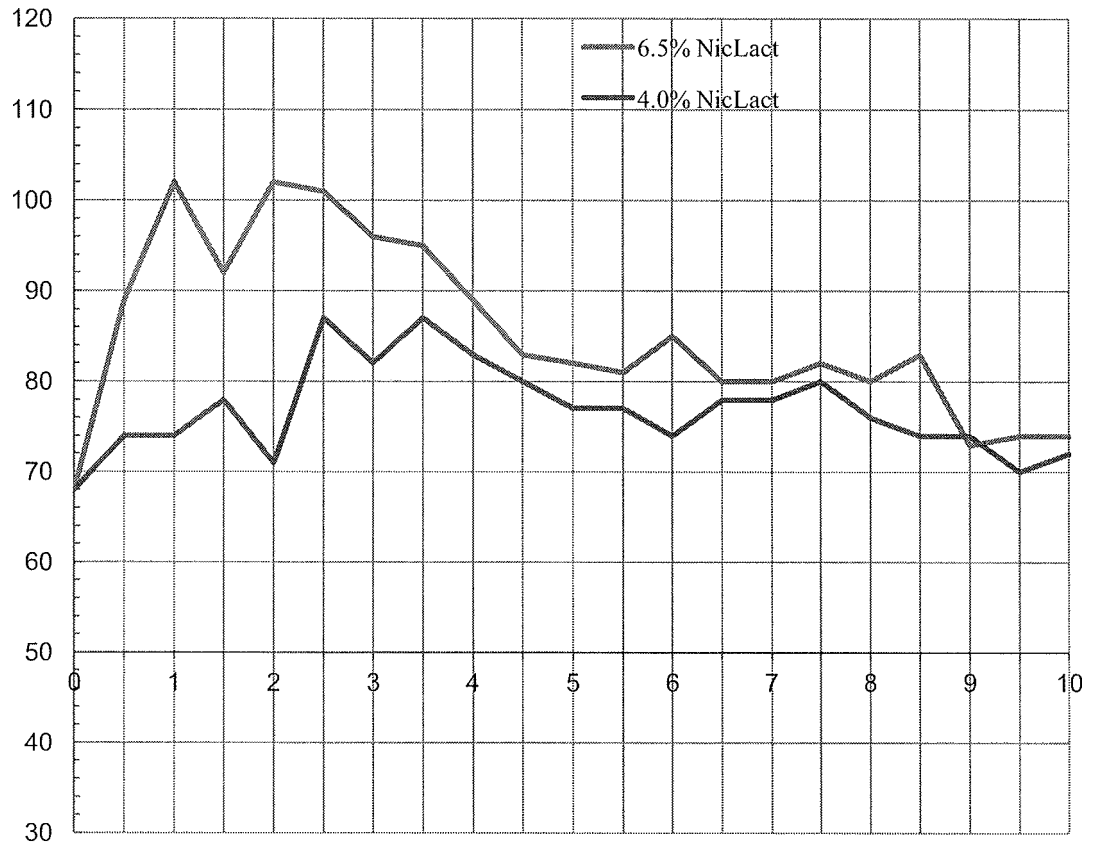


**EXHIBIT B**

***Nicotine Lactate effect on heart rate***



## A Clinical Laboratory Model for Evaluating the Acute Effects of Electronic "Cigarettes": Nicotine Delivery Profile and Cardiovascular and Subjective Effects

Andrea R. Vansickel, Caroline O. Cobb, Michael F. Weaver, and Thomas E. Eissenberg

### Abstract

**Background:** Electronic "cigarettes" are marketed to tobacco users as potential reduced exposure products (PREP), albeit with little information regarding electronic cigarette user toxicant exposure and effects. This information may be obtained by adapting clinical laboratory methods used to evaluate other PREPs for smokers.

**Methods:** Thirty-two smokers participated in four independent Latin-square ordered conditions that differed by product: own brand cigarette, "NPRO" electronic cigarettes (NPRO EC; 18 mg cartridge), "Hydro" electronic cigarettes (Hydro EC; 16 mg cartridge), or sham (unlit cigarette). Participants took 10 puffs at two separate times during each session. Plasma nicotine and carbon monoxide (CO) concentration, heart rate, and subjective effects were assessed.

**Results:** Own brand significantly increased plasma nicotine and CO concentration and heart rate within the first five minutes of administration whereas NPRO EC, Hydro EC, and sham smoking did not. Own brand, NPRO EC, and Hydro EC (but not sham) significantly decreased tobacco abstinence symptom ratings and increased product acceptability ratings. The magnitude of symptom suppression and increased acceptability was greater for own brand than for NPRO EC and Hydro EC.

**Conclusions:** Under these acute testing conditions, neither of the electronic cigarettes exposed users to measurable levels of nicotine or CO, although both suppressed nicotine/tobacco abstinence symptom ratings.

**Impact:** This study illustrates how clinical laboratory methods can be used to understand the acute effects of these and other PREPs for tobacco users. The results and methods reported here will likely be relevant to the evaluation and empirically based regulation of electronic cigarettes and similar products. *Cancer Epidemiol Biomarkers Prev*; 19(8); OF1-9. ©2010 AACR.

### Introduction

A variety of potential reduced exposure products (PREP) are/were marketed to cigarette smokers with explicit or implied claims that their use is associated with less exposure to lethal smoke constituents (1-3). These PREPs for smokers include products that involve burning specially cured tobacco that contains lower levels of some toxicants, that primarily heat rather than burn tobacco, or smokeless tobacco (4-6). As has been argued many times (1, 7, 8), objective empirical evaluation of these products is critical as a means of determining

the extent to which PREP use is associated with reduced toxicant exposure, e.g., to nicotine or carbon monoxide (CO), and suppression of tobacco/nicotine abstinence symptoms. Clinical laboratory work has been very revealing, and sometimes shows reduced toxicant exposure and often shows a failure to suppress aversive abstinence symptoms fully (9, 10). In theory, toxicant exposure reduction may be associated with long-term decreased health risk, but this theoretical decreased risk is very unlikely with a product that is not used because it fails to suppress abstinence symptoms and/or is otherwise unacceptable.

So-called electronic "cigarettes" are one of the newest types of PREPs available, and anecdotal evidence suggests that, at least for some smokers, electronic cigarettes can completely replace tobacco cigarettes (11, 12). Many electronic cigarette brands are available in retail outlets and over the internet. Electronic cigarettes consist of a rechargeable battery, heater, and a cartridge that contains a liquid made of propylene glycol, nicotine, and other chemicals (13). When the battery-powered heater is activated, it heats the solution to produce a vapor that can then be inhaled by the user (14, 15). Electronic cigarettes are

**Authors' Affiliation:** Virginia Commonwealth University, Richmond, Virginia

**Note:** The results of this study were presented in poster form at the annual Society for Research on Nicotine and Tobacco meeting held in Baltimore, MD February 24-27, 2010.

**Corresponding Author:** Thomas E. Eissenberg, VCU, Box 980205, Richmond, VA, 23298. Phone: 804-827-4617; Fax: 804-828-7862. E-mail: teissenb@vcu.edu

doi: 10.1158/1055-9965.EPI-10-0288

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marketed as PREPs for smokers, with manufacturer claims such as "alternative to smoking that will satisfy your nicotine urges and cravings" (16), "helps smokers quit, cut down or smoke healthier" (17), and "gives smokers all the pleasure and satisfaction of traditional smoking without all the health, social and economic problems" (18). To date, however, there are few objective data to substantiate these claims. Indeed, there is little objective information describing electronic cigarette toxicant content and yield or user toxicant exposure and effect.

The little available data suggest that electronic cigarette cartridges and vapors may contain trace amounts of impurities and tobacco-specific nitrosamines (13, 19). Electronic cigarette cartridge nicotine content may be less than the product labeling indicates, and the vapor produced from the cartridge may yield very little nicotine (13, 19). The scant data from human laboratory studies suggest that electronic cigarette use is likely to involve little nicotine exposure and tobacco abstinence symptom suppression that is far less than that produced by a tobacco cigarette (20, 21). Existing clinical models that have been used to evaluate combustible and noncombustible PREPs (10, 22, 23) might be adapted to quickly and efficiently provide necessary information regarding electronic cigarette toxicant exposure and effect.

The purpose of this study was to describe clinical laboratory methods that could be used to characterize electronic cigarette users' nicotine and CO exposure, cardiovascular response, and ratings of tobacco/nicotine abstinence symptom suppression and product acceptability. Accordingly, this within-subject study used these outcomes to compare, in 32 tobacco cigarette smokers, the effect of two marketed electronic cigarette brands with own brand cigarettes and sham smoking (i.e., puffing on an unlit cigarette). Based on preliminary data presented elsewhere (20, 21) we hypothesized that, compared with own brand, electronic cigarettes would deliver less nicotine and no CO and would be less effective at reducing symptoms of tobacco abstinence while producing lower acceptability ratings.

## Materials and Methods

### Participants

This study was approved by the Institutional Review Board of Virginia Commonwealth University and was conducted in accordance with the Declaration of Helsinki. Sixty-six men and women recruited from the Richmond, Virginia area provided written, informed consent. Prior to participation in any experimental sessions, 18 individuals were disqualified based on health concerns (e.g., high blood pressure) or failure to meet other inclusion/exclusion criteria (see below). In addition, 2 participants withdrew from the study and another 14 were withdrawn due to failure to comply with study procedures ( $n = 9$ ), poor venous access ( $n = 3$ ), or because study enrollment was completed ( $n = 2$ ). The remaining 32 participants (13 women; 18 white) completed the study proper and

were included in the analyses. Participants smoked at least 15 cigarettes per day (mean, 22 cigarettes per day; SD, 8.8), were between the ages of 18 to 55 years (mean, 33.6; SD, 12), provided an afternoon screening CO of at least 15 ppm (mean, 23.5; SD, 8.8), and had a urine cotinine result of at least 4 on a 7-point scale (0-6; NicAlert, Nymox Corp.; mean, 5.9; SD, 0.2). Exclusion criteria included self-reported history of any chronic mental or physical health condition, pregnancy or breastfeeding, active menopause, self-reported use of electronic cigarettes, current smoking cessation attempt, current drug use (other than marijuana), and >20 days self-reported marijuana or alcohol use in the past 30 days.

### Study design and procedures

This study was conducted on an outpatient basis at the Clinical Behavioral Pharmacology Laboratory at Virginia Commonwealth University. Participants completed four laboratory sessions; each approximately 150 minutes in duration. One of four Latin-square ordered conditions was presented each session (separated by at least 48 hours) that differed by product administered: own brand (i.e., a lit cigarette of the participant's preferred brand), sham (i.e., an unlit cigarette of the participant's preferred brand), "NPRO" electronic cigarettes (NPRO EC; 18-mg cartridge; NJOY), and "Hydro" electronic cigarettes (Hydro EC; 16-mg cartridge; Crown Seven).

Participants were asked to refrain from cigarette smoking for at least 12 hours prior to their scheduled session. Smoking abstinence was verified upon arrival at the laboratory by an expired air CO level  $\leq 10$  ppm. At the start of a session, a heparinized catheter was inserted into a forearm vein, physiologic monitoring equipment was attached, and continuous physiologic recording commenced. Thirty minutes after session onset, participants responded to the subjective effect questionnaires, blood (7 mL) was sampled, and product was administered. Product administration consisted of 10 puffs with a 30-second interpuff interval (IPI; puff number and IPI were monitored by study staff); package instructions state that electronic cigarettes should be used similarly to a tobacco cigarette, and 10 puffs with a 30-second IPI approximates *ad libitum* cigarette smoking (24). Five, 15, 30, and 45 minutes after the first of 10 puffs of the initial product administration, participants responded to the subjective effect questionnaires and blood (7 mL) was sampled. Expired air CO was recorded at 15, 30, and 45 minutes. At 60 minutes, participants responded to the subjective effect questionnaires, blood (7 mL) was sampled, and product was administered a second time (again, 10 puffs, 30-second IPI). Five, 15, 30, and 45 minutes after the second product administration, participants responded to the subjective effects questionnaires and blood (7 mL) was sampled. Expired air CO was recorded at 15, 30, and 45 minutes. At session's end, the venous catheter was removed, participants were compensated for their time, and, if necessary, additional sessions were scheduled.



## Materials

NPRO EC was purchased from NJOY (25). The NPRO EC resembles a tobacco cigarette in length and diameter and consists of a disposable mouthpiece that houses a cartridge, a small heating element (vaporizer) that is activated when the user draws air through the device, and a rechargeable lithium battery. Cartridges come in a variety of flavors with varying nicotine content (0-18 mg). According to the NJOY website, cartridge ingredients include nicotine, propylene glycol, water, ethanol, glycerol, acetylpyrazine, guaiacol, mysomine, cotinine, and vanillin.

Hydro EC was purchased from Crown Seven (26). Hydro EC is similar in composition to NPRO EC and, according to the manufacturer's website, cartridges also come in a variety of flavors and contain nicotine (0-16 mg), propylene glycol, water, and tobacco flavoring.

For electronic cigarette conditions, a new 16-mg (Hydro EC) or 18-mg (NPRO EC) nicotine cartridge was used and batteries were fully charged before each session. The flavor of each electronic cigarette was matched to the participants' usual brand of cigarettes (regular or menthol). Consistent with product instructions, participants were instructed to puff from the electronic cigarette devices as they would a normal cigarette.

Participants' usual brand of cigarette was used in the own brand and sham conditions. According to the Federal Trade Commission (FTC, 2001), on average, usual brand yield was 1.06 mg nicotine (27), 14.7 mg tar, and 14.6 mg CO (based on available data for 26 participants).

## Outcome measures

**Physiologic measures.** Heart rate was measured every 20 seconds (Model 506, Criticare Systems, fitted with a reusable pulse oximeter sensor). Blood samples were centrifuged and plasma was stored at  $-70^{\circ}\text{C}$ . Plasma samples were sent to the Bioanalytical Analysis Core Laboratories of Virginia Commonwealth University's Department of Pharmaceutics and were analyzed for nicotine content using liquid chromatography/tandem mass spectrometry [limit of quantitation (LOQ) = 2.0 ng/mL; see ref. 24 for details]. Expired air CO was assessed using a BreathCO monitor (Vitalograph).

**Subjective effect questionnaires.** Participants responded to a computerized version of the Tiffany Drobes Questionnaire of Smoking Urges Brief (QSU Brief; ref. 28). The questionnaire consists of 10 items rated from 0 (strongly disagree) to 6 (strongly agree). Items from this scale are loaded onto two previously validated factors; factor 1 (intention to smoke) and factor 2 (anticipation of relief from withdrawal).

Participants responded to three computerized questionnaires containing visual analog scale (VAS) items. Each word or phrase was centered above a horizontal line that represented a scale from 0 to 100 points; the left anchor was "Not at all" and the right anchor was "Extremely". A mouse-controlled cursor produced a vertical mark on the line that could be adjusted by the

participant. Scores on visual analog scale items were calculated as the distance between the vertical mark and the left anchor and were expressed as a percentage of line length.

Eleven VAS items were used to assess nicotine/tobacco abstinence symptom suppression (29). The direct effects of nicotine were assessed using 10 VAS items sensitive to nicotine effects (30, 31). Participants also responded to 14 visual analog scale items that assessed the direct effects of tobacco.

## Data analyses

Heart rate values were averaged for 5-minute periods prior to each product administration or blood sampling. One heart rate measurement was missing for one participant in one session, and the missing value was replaced with an average of values before and after it. For plasma nicotine, values below the LOQ were replaced by the LOQ as in previous work (10, 32, 33).

We had previously reported the interim findings of this study, in a letter that examined nicotine exposure, heart rate, and craving results (21). The first 16 participants were included in that analysis. Prior to analyzing the data from all 32 participants described here, we first compared results of the first group of 16 participants with those of the second group of 16 participants using a repeated measures ANOVA with two within-subjects factors: condition (4 levels) and time [10 levels for nicotine, subjective, and heart rate (HR) data; 7 for CO data], and one between-subjects factor: study group (first 16 or second 16). No significant main effects or interactions involving the study group factor were observed on any measure. Given this failure to observe any differences across the two groups, all data were combined. Thus, the data from all 32 participants for plasma nicotine, CO, heart rate, and subjective measures were analyzed using repeated measures ANOVA with two factors: condition (4 levels) and time (10 levels for nicotine, HR data, and subjective data; 7 levels for CO). Huynh-Feldt corrections were used to account for violations of sphericity. Tukey's Honestly Significant Difference (HSD) test was used to examine differences between means ( $P < 0.05$ ).

## Results

Table 1 presents the main effects and interactions for all measures. The primary results of interest are those for which a significant condition by time interaction were observed, indicating that changes over time observed on that measure depended upon product used in that condition.

### Physiologic measures

**Plasma nicotine.** A significant condition by time interaction was observed for plasma nicotine (Fig. 1A). Mean (SD) plasma nicotine increased from a preadministration level of 2.1 (0.32) ng/mL to a peak of 18.8 (11.8) ng/mL

**Table 1.** Results of statistical analyses for all outcome measures

| Measure                           | Condition<br>F (P) | Time<br>F (P)  | Condition × time<br>F (P) |
|-----------------------------------|--------------------|----------------|---------------------------|
| Heart rate*                       | 13.5 (>0.001)      | 62.0 (>0.001)  | 16.1 (>0.001)             |
| Plasma nicotine*                  | 112.2 (>0.001)     | 53.0 (>0.001)  | 45.2 (>0.001)             |
| Carbon monoxide†                  | 105.5 (>0.001)     | 107.0 (>0.001) | 205.5 (>0.001)            |
| Hughes and Hatsukami*             |                    |                |                           |
| Anxious                           | 4.8 (0.01)         | 5.7 (>0.001)   | 1.8 (0.05)                |
| Craving a cigarette               | 37.7 (>0.001)      | 25.7 (>0.001)  | 10.6 (>0.001)             |
| Depression/feeling blue           | 0.5 (ns)           | 1.5 (ns)       | 1.1 (ns)                  |
| Difficulty concentrating          | 0.5 (ns)           | 3.4 (0.02)     | 0.8 (ns)                  |
| Drowsy                            | 0.6 (ns)           | 3.9 (0.007)    | 1.6 (ns)                  |
| Hunger                            | 2.6 (ns)           | 7.8 (>0.001)   | 1.8 (ns)                  |
| Impatient                         | 4.3 (0.009)        | 3.7 (0.006)    | 2.5 (0.005)               |
| Irritability/frustration/anger    | 5.8 (0.004)        | 2.3 (ns)       | 3.3 (0.001)               |
| Restless                          | 1.5 (ns)           | 2.5 (0.05)     | 1.9 (0.025)               |
| Desire for sweets                 | 1.7 (ns)           | 1.7 (ns)       | 1.7 (ns)                  |
| Urge to smoke                     | 40.8 (>0.001)      | 28.2 (>0.001)  | 9.7 (>0.001)              |
| QSU*                              |                    |                |                           |
| Factor 1                          | 40.6 (>0.001)      | 35.7 (>0.001)  | 16.9 (>0.001)             |
| Factor 2                          | 19.5 (>0.001)      | 16.6 (>0.001)  | 7.6 (>0.001)              |
| Direct effects of nicotine*       |                    |                |                           |
| Confused                          | 1.0 (ns)           | 1.4 (ns)       | 1.4 (ns)                  |
| Dizzy                             | 1.5 (ns)           | 5.2 (0.002)    | 4.1 (0.002)               |
| Headache                          | 0.7 (ns)           | 0.9 (ns)       | 1.6 (ns)                  |
| Heart pounding                    | 0.4 (ns)           | 2.9 (0.05)     | 1.9 (ns)                  |
| Lightheaded                       | 1.2 (ns)           | 7.6 (>0.001)   | 5.8 (>0.001)              |
| Nausea                            | 0.1 (ns)           | 0.8 (ns)       | 1.1 (ns)                  |
| Nervous                           | 1.0 (ns)           | 1.0 (ns)       | 1.2 (ns)                  |
| Salivation                        | 0.5 (ns)           | 0.2 (ns)       | 1.0 (ns)                  |
| Sweaty                            | 0.8 (ns)           | 0.9 (ns)       | 1.3 (ns)                  |
| Weak                              | 0.1 (ns)           | 0.8 (ns)       | 1.1 (ns)                  |
| Direct effects of tobacco*        |                    |                |                           |
| Satisfying                        | 76.2 (>0.001)      | 61.6 (>0.001)  | 17.2 (>0.001)             |
| Pleasant                          | 66.5 (>0.001)      | 68.5 (>0.001)  | 17.6 (>0.001)             |
| Taste good                        | 47.7 (>0.001)      | 66.8 (>0.001)  | 14.4 (>0.001)             |
| Dizzy                             | 19.2 (>0.001)      | 17.6 (>0.001)  | 7.2 (>0.001)              |
| Calm                              | 42.0 (>0.001)      | 31.1 (>0.001)  | 10.3 (>0.001)             |
| Concentrate                       | 17.9 (>0.001)      | 15.8 (>0.001)  | 5.5 (>0.001)              |
| Awake                             | 27.0 (>0.001)      | 22.0 (>0.001)  | 6.6 (>0.001)              |
| Reduce hunger                     | 24.2 (>0.001)      | 19.4 (>0.001)  | 5.6 (>0.001)              |
| Sick                              | 3.6 (0.02)         | 3.6 (0.01)     | 0.9 (ns)                  |
| Taste like own brand              | 115.5 (>0.001)     | 60.0 (>0.001)  | 26.9 (>0.001)             |
| Feel like own brand               | 65.9 (>0.001)      | 67.0 (>0.001)  | 21.6 (>0.001)             |
| Harsh as own brand                | 64.9 (>0.001)      | 49.2 (>0.001)  | 21.3 (>0.001)             |
| Mild as own brand                 | 62.4 (>0.001)      | 54.0 (>0.001)  | 20.5 (>0.001)             |
| Smoke another cigarette RIGHT NOW | 6.5 (>0.001)       | 38.3 (>0.001)  | 4.8 (>0.001)              |

Abbreviation: ns, nonsignificant.

\* $df_{\text{Condition}}$ , 3,93;  $df_{\text{Time}}$ , 9,279;  $df_{\text{Condxtime}}$ , 27,837.† $df_{\text{Condition}}$ , 3,93;  $df_{\text{Time}}$ , 6,186;  $df_{\text{Condxtime}}$ , 18,558.

five minutes after the first administration under the own-brand condition. No significant changes in plasma nicotine were observed for the Hydro EC, NPRO EC, or sham conditions.

**Heart rate.** A significant condition by time interaction was also observed for heart rate (Fig. 1B). Heart rate increased from an average (SD) of 65.7 (10.4) bpm at baseline to a peak of 80.3 (10.9) bpm five minutes after the

first administration under the own-brand condition. No significant changes in heart rate were observed for the Hydro EC, NPRO EC, or sham conditions.

**Expired air CO.** A significant condition by time interaction was observed for expired air CO levels (Fig. 2). Mean (SD) CO increased from a preadministration level of 5.3 (2.1) ppm to a peak of 16.2 (4.5) ppm 15 minutes after the second administration under the own-brand condition. No significant changes in CO level were observed for the Hydro EC, NPRO EC, or sham conditions.

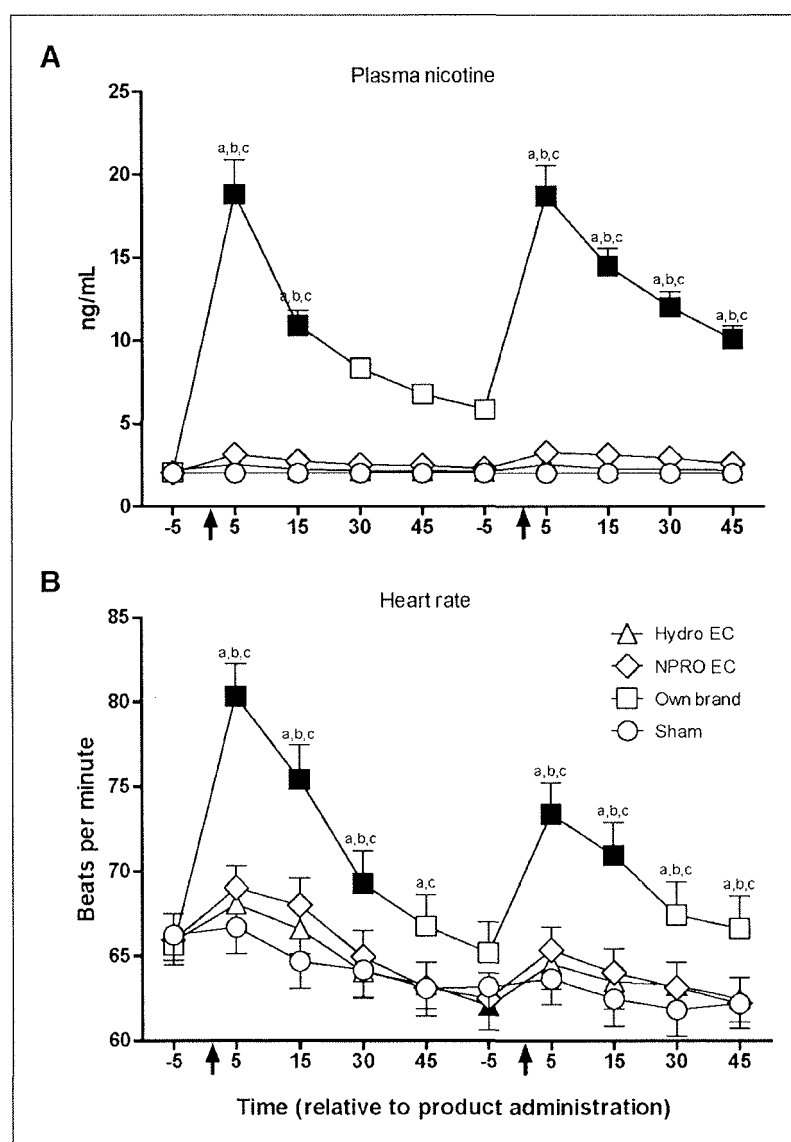
#### Subjective effect questionnaires

**QSU brief.** A significant condition by time interaction was observed for both factors of the QSU brief. Figure 3A shows data for factor 1 (intention to smoke; the QSU fac-

tor with the greater condition by time F value). Hydro EC and NPRO EC significantly decreased scores on both factors (relative to sham and/or baseline) at several time points. In contrast, own brand significantly decreased scores (relative to baseline and sham) on both factors at nearly every time point. In addition, the scores observed for own brand after product administration were significantly lower than Hydro EC and NPRO EC at almost every time point. A nearly identical pattern of results was observed for factor 2, although ratings were generally lower than those observed on factor 1.

**Nicotine/tobacco abstinence symptom suppression.** Significant condition by time interactions were observed on ratings of "anxious," "craving a cigarette/nicotine," "impatient," "irritability/frustration/anger," "restless,"

**Figure 1.** Mean data for nicotine blood plasma (A) and heart rate (B) as a function of condition and time. X-axes, time in minutes relative to product administration; arrows, first and second product administrations. Y-axes, A, nicotine blood plasma concentration (ng/mL); B, heart rate (beats per minute); filled symbols, significant difference from baseline. An "a," "b," or "c" indicates that own brand was significantly different from sham, Hydro EC, or NPRO EC at that time point. A "d" indicates that Hydro EC was significantly different from sham at that time point. An "e" indicates that NPRO EC was significantly different from sham at that time point (Tukey's HSD,  $P < 0.05$ ). Unidirectional error bars, 1 SE.



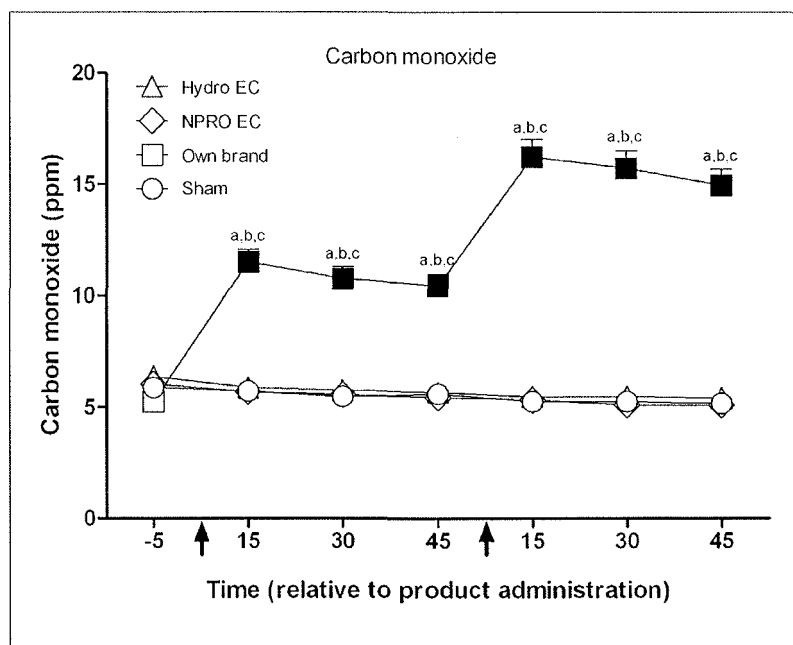


**Figure 2.** Mean data for carbon monoxide (CO) as a function of condition and time. X-axis, time in minutes relative to product administration; arrows, first and second product administrations. Y-axis, CO in parts per million (ppm); filled symbols, significant difference from baseline. An "a," "b," or "c" indicates that own brand was significantly different from sham, Hydro EC, or NPRO EC at that time point. A "d" indicates that Hydro EC was significantly different from sham at that time point. An "e" indicates that NPRO EC was significantly different from sham at that time point (Tukey's HSD,  $P < 0.05$ ). Unidirectional error bars, 1 SE.

and "urge to smoke a cigarette." Own brand generally decreased ratings on all of these measures. NPRO EC and Hydro EC produced some abstinence symptom suppression on two measures: "craving a cigarette" and "urge to smoke." Figure 3B depicts data for ratings of "craving a cigarette" (the measure with the largest F-value). Ratings of "urge to smoke" decreased significantly 5 minutes following the first Hydro EC administration, and 5, 15, and 30 minutes following the first and second NPRO EC administrations relative to baseline. Ratings of "urge to smoke" decreased significantly at all time points following the first and second own-brand administrations relative to baseline, and own brand was significantly different from Hydro EC and NPRO EC at several time points. Similar effects of own brand, Hydro EC, and NPRO EC were observed on ratings of "craving a cigarette" (Fig. 3B).

**Direct effects of nicotine.** Significant condition by time interactions were observed on VAS items assessing "dizzy" and "lightheaded." Own brand significantly increased ratings of "lightheaded" and "dizzy" within the first five minutes following the first administration. NPRO EC, Hydro EC, and sham did not alter ratings significantly on these measures.

**Direct effects of tobacco.** Significant condition by time interactions were observed for ratings of "satisfying," "pleasant," "taste good," "dizzy," "calm," "concentrate," "awake," "reduce hunger," "taste like own brand," "feel like own brand," "harsh as own brand," "mild as own brand," and "smoke another cigarette right now." Ratings of "calm" and "satisfying" are shown in Fig. 3C and D. Ratings of "satisfying" and "pleasant" increased significantly at all time points under the Hydro EC, NPRO EC, and own-brand conditions (relative to base-

line). Own brand increased ratings of "satisfying" and "pleasant" to a significantly greater degree than Hydro EC or NPRO EC. Ratings of "taste good," "calm," "concentrate," "awake," and "reduce hunger" increased significantly at all time points after own brand and at several time points after Hydro EC and NPRO EC (relative to baseline). Ratings of "taste like own brand," "feel like own brand," "harsh as own brand," and "dizzy" increased significantly at all time points under the own-brand condition (relative to baseline and sham). Ratings of "mild as own brand" increased significantly at all time points under the own-brand condition (relative to baseline and sham) and at nearly all time points under the Hydro EC condition (relative to baseline). Ratings of "smoke another cigarette right now" increased significantly relative to baseline at all time points under the Hydro EC and NPRO EC conditions, and 30 and 45 minutes postadministration 1 and 45 minutes postadministration 2 under the own-brand condition.

## Discussion

The purpose of this acute study was to describe clinical laboratory methods that could be used to understand electronic cigarettes better by examining users' toxicant exposure, cardiovascular response, and subjective reports. The results of this study show the usefulness of the clinical model and suggest that, unlike puffing from a tobacco cigarette, two 10-puff bouts with the two electronic cigarettes described here expose users to no measurable nicotine or CO and do not increase heart rate. Despite the failure to deliver nicotine, acute use of

the two products tested in this study produced some tobacco abstinence symptom suppression and increased subjective ratings of acceptability. Relative to the effects produced by an own-brand tobacco cigarette, these subjective effects of electronic cigarettes were modest.

With regard to nicotine exposure, the observation that 20 puffs from Hydro EC (16-mg cartridge) and NPRO EC (18-mg cartridges) did not increase plasma nicotine concentration significantly is entirely consistent with our preliminary report regarding these products (21). The plasma nicotine results are also consistent with the heart rate data reported here. That is, heart rate increases are observed when nicotine is administered via pharmaceutical products (34, 35) or tobacco products (32, 33, 36), and we observed increased heart rate when participants in this study smoked their own brand of cigarette (that also delivered nicotine). However, no heart rate increases were observed in either electronic cigarette condition (where no significant increases in plasma nicotine were observed). Finally, the mean peak changes from baseline in plasma nicotine concentration observed for NPRO EC (1.4 ng/mL) and

Hydro EC (0.5 ng/mL) during the first product administration were similar in magnitude to the maximum nicotine concentration reported for a third electronic cigarette brand with a 16-mg cartridge (1.3 ng/mL; ref. 20). The consistency of results across participants, measures, and laboratories highlights the reliability of the clinical methods reported here (see also ref. 24), while also calling into question the ability of the three different electronic cigarettes that have been tested to date to approximate the nicotine delivery of a tobacco cigarette under acute conditions.

In spite of delivering no measurable nicotine, both electronic cigarettes tested in this study reduced ratings of "craving a cigarette" and "urge to smoke" and increased subjective ratings of product acceptability (e.g., "satisfying," "taste good," "pleasant"). These results are consistent with anecdotal reports from long-term electronic cigarette users and support the notion that electronic cigarettes may provide an alternative, perhaps a substitute, to cigarette smoking in some cases (11, 12). Interestingly, denicotinized cigarettes have also been shown to suppress tobacco abstinence symptoms for as

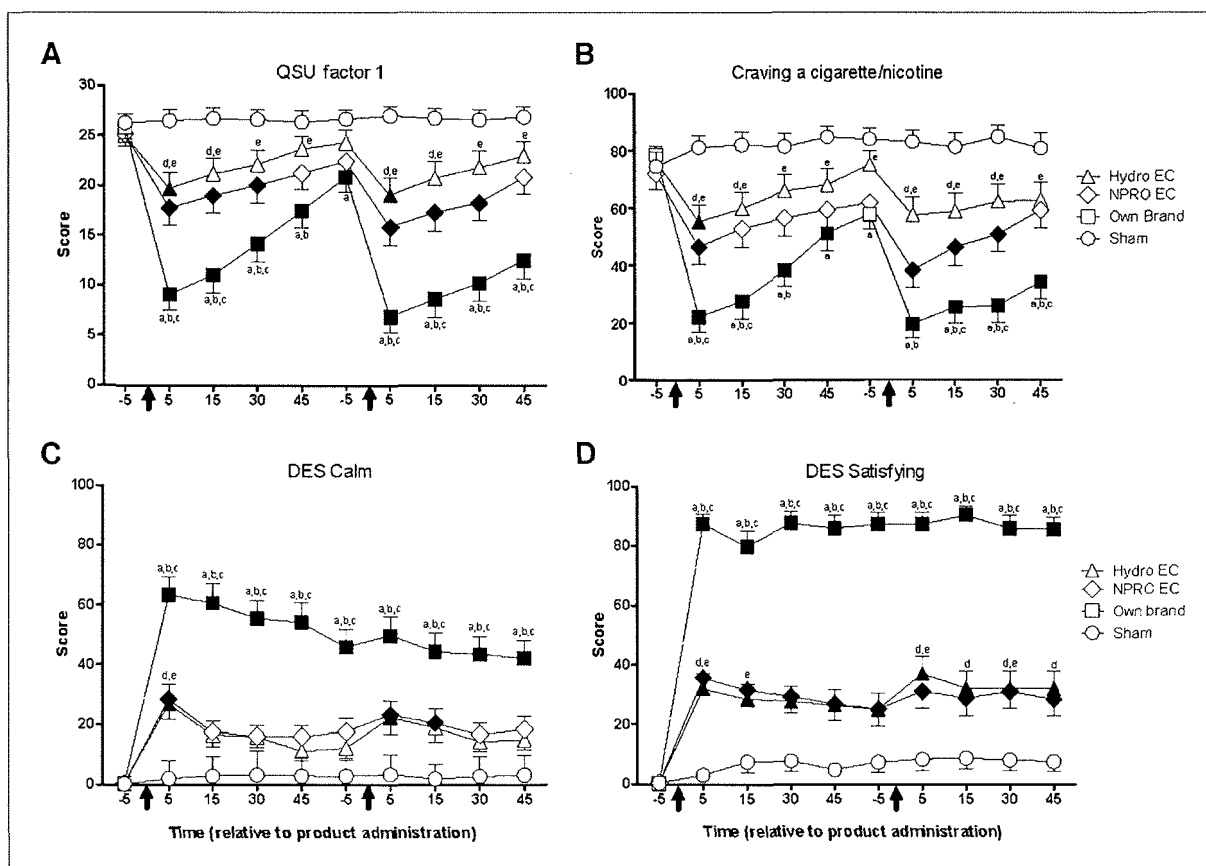


**Figure 3.** Mean data for QSU factor 1 ratings (A), ratings of "craving a cigarette" (B), ratings of "calm" (C), and ratings of "satisfying" (D) as a function of condition and time. X-axes, time in minutes relative to product administration; arrows, first and second product administrations. Y-axes, subjective ratings; filled symbols, significant difference from baseline. An "a," "b," or "c" indicates that own brand was significantly different from sham, Hydro EC, or NPRO EC at that time point. A "d" indicates that Hydro EC was significantly different from sham at that time point. An "e" indicates that NPRO EC was significantly different from sham at that time point (Tukey's HSD,  $P < 0.05$ ). Unidirectional error bars, 1 SE. DES, direct effects of smoking.

long as 96 hours (37). However, under the acute conditions reported here, the two electronic cigarettes did not suppress nicotine/tobacco abstinence symptoms fully, relative to own-brand smoking. Other PREPs that failed to suppress abstinence symptoms fully have been shown to supplement rather than substitute for cigarette smoking (9, 24, 37, 38). Further controlled evaluation is needed to determine the extent to which the effects reported here are sufficient for electronic cigarettes to substitute for tobacco cigarettes, and in what proportion of smokers and under what conditions this substitution effect might occur.

Importantly, neither of the electronic cigarettes tested in this study was associated with any measurable CO exposure. Long-term CO exposure has been linked to cardiovascular disease caused by tobacco cigarette smoking (39). In part for this reason, substituting noncombustible tobacco or nicotine products for cigarettes has been suggested as a potentially effective strategy for reducing the harm of tobacco smoking (40). Following this same logic, and taking into account the trace levels of tobacco-specific nitrosamines found in some electronic cigarette products (13), electronic cigarettes may also warrant careful empirical examination by those interested in harm reduction for smokers. Clinical laboratory methods have an important role to play in this empirical examination, and can reveal carcinogen exposure and abstinence symptoms suppression over several days' PREP use (22, 24, 33, 41). These methods will likely be extremely important to any future regulation of electronic cigarettes either as tobacco products or drug delivery devices in the United States (i.e., by the Food and Drug Administration) and elsewhere.

Methodologic considerations of the current study include the brief electronic cigarette exposure period, rigorous control over some aspects of smoking behavior, use of two brands of electronic cigarette with similar cartridge nicotine content, and inclusion of electronic cigarette-naïve participants who may be representative of cigarette smokers sampling an electronic cigarette for the first time, but not of a more experienced electronic cigarette user population. The results of some outcome measures might be influenced by longer-term use, different puffing profiles, other electronic cigarette models/cartridge strengths, and/or the user's previous experience with electronic cigarettes. In future studies, control conditions other than own brand and sham smoking might be of interest. Indeed, a recently published study compared the subjective and physiologic effects of another brand of electronic cigarette, the Ruyan electronic cigarette, to that of a pharmaceutical nicotine inhalator and found that the two products were associated with similar low levels of nico-

tine exposure, incomplete withdrawal suppression, and moderate acceptability (20). In addition, behavioral studies that assess the reinforcing/rewarding properties of electronic cigarettes could reveal the extent to which electronic cigarettes might be used or abused (42). Finally, the adverse event profile associated with long-term use of electronic cigarettes is uncertain, and must be explored empirically. Many of these methodologic issues and research questions can be addressed parametrically and conveniently in the clinical laboratory, highlighting the strength of these efficient and reliable evaluation methods (see also ref. 24).

In sum, this study revealed that two electronic cigarette brands do not expose electronic cigarette-naïve users to nicotine or carbon monoxide under the acute testing procedures described here, but do produce some tobacco abstinence symptom suppression and positive ratings of product acceptability. Although these results are necessarily a function of the products tested and procedures used, they suggest that electronic cigarette-naïve individuals may require substantial motivation if they are to learn whatever product/procedure combination maximizes these outcomes for them. Future clinical laboratory evaluation can build on these methods and results to establish the extent to which electronic cigarettes might be expected to substitute for tobacco cigarettes, and help to identify under what conditions this substitution might occur. Parallel studies addressing the abuse liability and long-term adverse event profile of electronic cigarettes are also required to ensure safety and appropriate labeling and marketing of these products.

#### Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

#### Acknowledgments

We acknowledge the expert technical and medical assistance provided by the staff of VCU's Behavioral Pharmacology Laboratory (Janet Austin, M.S. and Barbara Kilgallen, R.N.) as well as the staff at VCU's Bioanalytical Core Laboratory Service Center.

#### Grant Support

US NCI. This research was supported by USPHS grants R01CA103827, R01CA120142, and T32DA007027-34.

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Received 03/31/2010; revised 05/12/2010; accepted 05/17/2010; published OnlineFirst 07/20/2010.

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EXHIBIT D

Brief Report

# Electronic Cigarettes: Effective Nicotine Delivery After Acute Administration

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Received October 21, 2011; accepted December 12, 2011

## Abstract

**Introduction:** Electronic cigarettes (ECs) are marketed as nicotine delivery devices. Two studies with EC-naïve participants suggest that ECs deliver little or no nicotine. In those studies, standard-sized ECs were used, though experienced EC users often use larger devices that house higher voltage and/or longer lasting batteries. Whether user experience and device characteristics influence EC nicotine delivery is uncertain. The purpose of the present study was to examine the effects of ECs in experienced users who were using their preferred devices.

**Methods:** Eight EC users (3 women) who had been using ECs for at least 3 months, completed one 5-hr session using devices they provided and the flavor/strength nicotine cartridges they selected. Sessions consisted of 4 phases: baseline, 10 puffs (30-s interpuff interval) from the device, 1-hr ad lib puffing period, and a 2-hr rest period (no puffing). Outcome measures in each phase included plasma nicotine concentration, heart rate, and subjective ratings of nicotine/product effects and abstinence symptoms.

**Results:** Relative to baseline, plasma nicotine and heart rate increased significantly within 5 min of the first puff and remained elevated throughout the ad lib puffing period. Increases in ratings of direct effects of nicotine and product were observed as well as decreases in abstinence symptoms.

**Conclusions:** User experience and/or device characteristics likely influence EC nicotine delivery and other effects. Systematic manipulation of these and other variables could elucidate conditions that produce intended effects.

## Introduction

Electronic cigarettes (ECs) that consist of a battery, heater, and nicotine-containing liquid are marketed as devices that deliver nicotine to the user. ECs have become increasingly popular, and some reports suggest that they help users quit or reduce cigarette smoking (Ayers, Ribisi, & Brownstein, 2011; Etter, 2010; Etter and Bullen, 2011a; Heavner, Dunworth, Bergen, Nissen, & Phillips, 2009; McQueen, Tower, & Sumner, 2011; Polosa et al.,

2011). Results of two clinical laboratory studies, conducted with EC-naïve cigarette smokers, suggest that ECs either deliver nicotine inefficiently or not at all (Bullen, McRobbie, Thornley, Glover, & Laugesen, 2010; Vansickel, Cobb, Weaver, & Eissenberg, 2010). Those studies used standard-sized cigarette-like ECs, while experienced EC users (“vapers”) often use models that are larger than a cigarette and house higher voltage or longer life batteries (Foulds, Veldheer, & Berg, 2011). Furthermore, EC and tobacco cigarette puffing characteristics may differ, suggesting that inexperienced users may not use ECs in a manner that allows for sufficient nicotine delivery (Tritchounian et al., 2011). Whether user experience and/or device characteristics influence nicotine delivery is unknown. The purpose of the present study was to characterize the nicotine delivery profile, subjective, and cardiovascular effects of ECs in experienced ECs users who were using their preferred devices.

## Methods

Eight EC users (3 women; 8 Caucasian) consented to and completed this single-session (5 hr) Institutional Review Board-approved protocol. Participants used their own fully charged EC, and a pre-filled cartomizer (heater + liquid) of their chosen flavor/nicotine content was provided. At the start of the session, participants were surveyed regarding health, demographics, and EC use habits. Participants were included in the study if they reported using an EC for at least 3 months, used at least 2–3 ml of nicotine solution or two cartridges per day, used nicotine solution of at least 10 mg/ml nicotine, smoked fewer than five cigarettes per day, and were between the ages of 18 and 55. Participants were excluded if they reported any chronic health or psychiatric conditions, had a history of high or low blood pressure, or were unwilling to use a cartridge or cartomizer during the session.

Participants were required to abstain from all nicotine and tobacco product use, including ECs, for at least 12 hr prior to the session. Abstinence was verified upon arrival at the laboratory by a carbon monoxide level of 10 ppm or less and was further verified later by plasma nicotine levels at or below the limit of quantification (2 ng/ml). At session onset, a venous catheter was inserted into the participant's forearm vein and continuous physiological monitoring commenced. Approximately 55 min

doi:10.1093/ntr/ntr316

Advance Access publication February 6, 2012

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## EXHIBIT D

later, blood was sampled, and 5 min after that, participants were provided with their EC and were instructed to take 10 puffs (30-s interpuff interval [IPI; as in Eissenberg, 2010; Vansickel et al., 2010]). Blood was sampled 5 and 15 min after the start of the 10-puff period. Then, a 60-min ad lib puffing period began, and blood was sampled every 15 min. Participants then entered a 2-hr rest period during which no puffing occurred, and blood was sampled every 30 min. Participants completed subjective questionnaires at baseline and again after the 10-puff, ad lib, and rest periods. At session's end, the venous catheter was removed, physiological monitoring ceased, and participants were compensated.

Physiological outcome measures included heart rate (measured every 20 s) and plasma nicotine concentration (blood centrifuged and plasma stored at  $-70^{\circ}\text{C}$  for analysis of nicotine concentration). Subjective and behavioral outcome measures included the Tiffany–Drobes Questionnaire of Smoking Urges Brief (QSU Brief; Cox, Tiffany, & Christen, 2001), 11 visual analogue scale (VAS) items that assessed nicotine/EC abstinence symptoms (Kleykamp et al., 2008), 10 VAS items that assessed the direct effects of nicotine (Blank, Sams, Weaver, & Eissenberg, 2008), 14 VAS items that assessed the direct effects of the EC (Vansickel et al., 2010) as well as the total number of puffs taken during the ad lib period.

## Results

Participants were former smokers who had tried to quit smoking an average (*SD*) of 3.9 (1.8) times in their lifetime, had quit smoking for 11.4 (5.4) months, and had been using ECs for 11.5 (5.4) months. Their average age was 33.4 (8.6) years, and they had completed 15.3 (2) years of education. Seven participants used devices that did not resemble tobacco cigarettes and housed higher voltage and/or longer lasting batteries than in previous work (e.g., Vansickel et al., 2010). Six participants used 18 mg/ml nicotine solution, one used 9, and the other used 24 mg/ml solution.

Plasma nicotine increased significantly from a baseline mean of 2 ng/ml (*SEM* = 0) to a mean of 10.3 ng/ml (*SEM* = 2) within 5 min of the first puff. Plasma nicotine reached a maximum mean concentration ( $M = 16.3$  ng/ml, *SEM* = 4.5) by the end of the ad lib period (see Figure 1; relative to baseline all  $P < .05$  by paired  $t$  test). Heart rate increased significantly from a baseline mean of 73.2 (*SEM* = 2.0) beats per minute (bpm) to 78 (*SEM* = 1.9) bpm within 5 min of the first puff and remained elevated during the ad lib period. The number of puffs during the 1-hr ad lib period ranged from 4 to 76 ( $M = 46.6$ ,  $N = 7$ ).

VAS ratings of "Anxious" were elevated at baseline ( $M = 13.9$ , *SEM* = 4.5), were significantly reduced following the 10-puff ( $M = 2.8$ , *SEM* = 2.5) and ad lib ( $M = 0.9$ , *SEM* = 0.6) periods, and returned to baseline levels after the rest period ( $M = 12.4$ , *SEM* = 4). VAS ratings of "Restlessness" were elevated at baseline ( $M = 26$ , *SEM* = 9), were significantly reduced following the ad lib period ( $M = 4.8$ , *SEM* = 4), and increased following the rest period ( $M = 8.8$ , *SEM* = 4) (see Figure 1). Similarly QSU Factor 1 (intention to smoke) scores were elevated at baseline ( $M = 21$ , *SEM* = 2.7), were significantly reduced following the ad lib puffing period ( $M = 5.6$ , *SEM* = 1.9), and returned to baseline levels after the rest period ( $M = 18.3$ , *SEM* = 2.2). Positive direct effects of EC administration were also observed. VAS ratings of Did the EC help you "Feel awake," "Calm you down," and

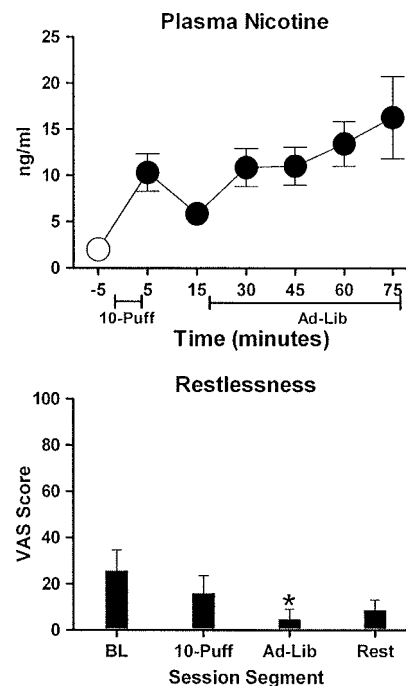


**Figure 1.** Top panel:  $M (\pm 1 \text{ SEM})$  plasma nicotine (assay's limit of quantitation = 2 ng/ml; Breland, Kleykamp, & Eissenberg, 2006) levels at baseline ( $-5$ ) and during the 10-puff and 1-hr ad lib puffing periods. Filled symbols indicate a significant difference from baseline. Bottom panel:  $M (\pm 1 \text{ SEM})$  response to a visual analogue scale item assessing "restlessness" (0–100 scale) at baseline and the end of the 10-puff, ad lib, and rest periods. An asterisk indicates a significant difference from baseline. Data are from eight electronic cigarettes (EC) using participants who abstained from ECs for at least 12 hr before session. Paired  $t$  tests were used to compare means,  $p \leq .05$ .

"Concentrate" as well as Was the EC "Pleasant" and "Satisfying" and Did the EC "Reduce your hunger for food" and "Taste Good" increased significantly following the 10-puff period, peaked following the ad lib period, and decreased after the rest period. For example, ratings of "Satisfying" increased from 0.125 (*SEM* = 0.125) to 83.9 (*SEM* = 7) after the 10-puff bout and further increased to 92.6 (*SEM* = 3.3) following the ad lib period before dropping to 36.9 (*SEM* = 13.5) after the rest period. EC use did not significantly affect ratings on any other measure.

## Discussion

Previous reports have described conditions of EC use that support minimal or no nicotine delivery (Bullen et al., 2010; Eissenberg, 2010; Vansickel et al., 2010). In those studies, current cigarette smokers, who were not experienced with ECs, engaged in brief periods of EC use. In addition, the ECs used in those studies were cigarette-sized EC models. In the current study, experienced EC users who provided their preferred ECs loaded with their selected flavor/nicotine concentration completed a 10-puff (30-s IPI) bout and a 1-hr ad lib puffing period. Under these conditions, EC use resulted in reliable nicotine delivery. These results are the first to demonstrate unequivocally that ECs alone are capable of increasing plasma nicotine concentrations to levels seen during cigarette smoking. In support of this conclusion, the results of a recent study in which the saliva cotinine

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concentration of self-reported EC users was measured are also consistent with nicotine exposure that approximated tobacco cigarette use (e.g., Etter & Bullen, 2011b). However, unlike the current laboratory study, results of this previous work may have been influenced by the concurrent use of other nicotine-containing products.

Interestingly, abstinence symptoms were observed prior to EC use, and these symptoms were suppressed after EC use, a potential indicator of nicotine dependence (Carter and Griffiths, 2009). Of course, these participants were former cigarette smokers and thus may have been nicotine dependent prior to initiating EC use. The extent to which EC use leads to the development of nicotine dependence in nicotine-naïve users is unknown.

Some reports suggest that ECs have the potential to be safe and efficacious replacements for tobacco cigarettes due to nicotine's effects (Etter & Bullen, 2011a; Siegel, Tanwar, & Wood, 2011). That potential is undermined by ineffective devices and a requirement that users learn specific but as-yet-undetermined behaviors in order to maximize nicotine delivery. Thus, an important area for future research is the parametric manipulation of device characteristics and user behavior (i.e., puff topography) as well as other factors (e.g., nicotine concentration) that might contribute to safety and efficacy. In addition, the potential deleterious health effects of chronic inhalation of vaporized nicotine solutions are unknown (Etter, Bullen, Fouris, Laugesen, & Eissenberg, 2011). Clinical laboratory evaluation of lung and cardiovascular function, measurement of biomarkers of harm (e.g., inflammatory biomarkers such as C-reactive protein), as well as population level surveillance of adverse events associated with EC use will be necessary for ensuring safety and proper regulation. Taken together, results of the current and previous studies demonstrate considerable variability in EC nicotine delivery, device performance, and/or cartridge and vapor nicotine content (Bullen et al., 2010; Eissenberg, 2010; U.S. Food and Drug Administration, 2009; Vansickel et al., 2010; Williams & Talbot, 2011). One important potential benefit of EC regulation may be more consistent nicotine delivery, device performance, and cartridge and vapor content.

## Funding

This report was supported partially by the National Institutes of Health (R01 CA120142 to TE and T32 DA007027 to ARV).

## Declaration of Interests

The authors have no conflicts of interest to declare. The sponsor had no role in the design and conduct of the study; or in the preparation, review, or approval of the manuscript. The authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

## Acknowledgments

The authors acknowledge, with gratitude, the hard work and dedication of the staff and students of VCU's Clinical Behavioral Pharmacology Laboratory (Ms. Barbara Kilgallen, Ms. Janet Austin, and Ms. Caroline Cobb) as well as the staff of VCU's Bioanalytical Core Laboratory Service Center.

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## EXHIBIT E

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# ELECTRONIC CIGARETTES DO NOT DAMAGE THE HEART

## First-hand smoke, second-hand smoke or electronic cigarettes

25 AUG 2012

Electronic cigarettes have no acute adverse effects on cardiac function, according to research presented today at an ESC Congress 2012 press conference by Dr Konstantinos Farsalinos from Greece.

Topic(s): Prevention;

Smoking is the most preventable risk factor for cardiac and lung disease and is expected to cause 1 billion deaths during the 21st century. Electronic cigarettes have been marketed in recent years as a safer habit for smokers, with several millions of people already using them worldwide.

Electronic cigarettes simulate the effect of smoking by producing an inhaled vapor. The device consists of a battery, a cartridge containing liquid and a heating element which gets warm and evaporates the liquid. Laboratory analyses of the liquids show that they are less toxic than regular cigarettes. Most studies have found no nitrosamines, but even in studies where nitrosamines were found, the levels detected were

## EXHIBIT E

500-1400 times less than the amount present in one tobacco cigarette. This means that electronic cigarettes must be used daily for 4-12 months to get the amount of nitrosamines present in a single tobacco cigarette.

Since heart disease is the main cause of morbidity and mortality in smokers, with 40% of deaths in smokers due to coronary artery disease alone, the research team decided to perform the first clinical study of the acute effects of electronic cigarettes on cardiac function.

They decided to compare their results with the acute effects of regular cigarettes on cardiac function since electronic cigarettes are marketed to smokers only, as an alternative habit.

Previous studies from the research group and several others have shown that acute smoking inhalation produces significant defects in myocardial function. This indicates that subclinical dysfunction is already present in apparently healthy asymptomatic young people who smoke tobacco cigarettes. The goal was to evaluate whether these signs of preclinical disease appear in a similar population after using electronic cigarettes.

The researchers measured myocardial function in 20 healthy young daily smokers aged 25-45 years before and after smoking one tobacco cigarette and 22 daily electronic cigarette users of similar age before and after using the device for 7 minutes.

Experienced users of electronic cigarettes were studied because they use the device more intensively than first-time users. Although both groups were of equal age, users of electronic cigarettes had a 44% higher lifetime tobacco smoking exposure compared to current smokers.

For the electronic cigarettes, a commercially available liquid with a nicotine concentration of 11mg/ml was used (NOBACCO USA Mix). This was tested by an independent toxicology laboratory and found to contain no nitrosamines or polycyclic aromatic hydrocarbons.

Myocardial function was examined using cardiac ultrasound (echocardiography) and hemodynamic measurements (blood pressure and heart rate).

The researchers found that smoking one tobacco cigarette led

**EXHIBIT E**

to significant acute myocardial dysfunction but electronic cigarettes had no acute adverse effects on cardiac function. Smoking a tobacco cigarette had important hemodynamic consequences, with significant increases in systolic and diastolic blood pressure and in heart rate. In contrast, electronic cigarettes produced only a slight elevation in diastolic blood pressure. Dr Farsalinos said: "This is an indication that although nicotine was present in the liquid used (11mg/ml), it is absorbed at a lower rate compared to regular cigarette smoking."

The echocardiography examination focused on the function of the left ventricle, the part of the heart that receives oxygenated blood from the lungs (filling or diastolic phase) and then delivers the blood to the whole body (pumping or systolic phase). The investigators found significant defects in the diastolic phase of left ventricular function after smoking one cigarette, with four echocardiographic parameters indicating worsening function. In contrast, none of the echocardiographic parameters showed any significant worsening in subjects after using the electronic cigarette. "Diastolic dysfunction is very important because it is usually the first defect that is detected before any clinically-evident cardiac disease develops," said Dr Farsalinos.

He added: "It is too early to say whether the electronic cigarette is a revolution in tobacco harm reduction but the potential is there. It is the only available product that deals with both the chemical (nicotine delivery) and psychological (inhaling and exhaling 'smoke', holding it, etc) addiction to smoking, laboratory analyses indicate that it is significantly less toxic and our study has shown no significant defects in cardiac function after acute use."

Dr Farsalinos continued: "More clinical studies need to be done before suggesting that this is a revolutionary product. However, considering the extreme hazards associated with cigarette smoking, currently available data suggest that electronic cigarettes are far less harmful and substituting tobacco with electronic cigarettes may be beneficial to health."

Dr Farsalinos will also present his results during an ESC Congress 2012 scientific session tomorrow.

## Abstract

## EXHIBIT E

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## References

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This press release accompanies both a presentation and an ESC press conference at the ESC Congress 2012. The press release has been written by the investigator and edited by the ESC and does not necessarily reflect the opinion of the European Society of Cardiology.

Refers to session: Tobacco: from early damage to late impact

Refers to press conference: First-hand smoke, second-hand smoke or electronic cigarettes



## Notes to editor

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**About the European Society of Cardiology**  
The European Society of Cardiology (ESC) represents more than 75,000 cardiology professionals across Europe and the Mediterranean. Its mission is to reduce the burden of cardiovascular disease in Europe.

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| Electronic Patent Application Fee Transmittal |          |                                                                    |        |                      |
|-----------------------------------------------|----------|--------------------------------------------------------------------|--------|----------------------|
| Application Number:                           |          | 14925968                                                           |        |                      |
| Filing Date:                                  |          | 28-Oct-2015                                                        |        |                      |
| Title of Invention:                           |          | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |        |                      |
| First Named Inventor/Applicant Name:          |          | Adam BOWEN                                                         |        |                      |
| Filer:                                        |          | Richard Douglas Shoop/Mary Buggie                                  |        |                      |
| Attorney Docket Number:                       |          | 13211-713.303                                                      |        |                      |
| Filed as Small Entity                         |          |                                                                    |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                                                    |        |                      |
| Description                                   | Fee Code | Quantity                                                           | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                                                    |        |                      |
| Pages:                                        |          |                                                                    |        |                      |
| Claims:                                       |          |                                                                    |        |                      |
| INDEPENDENT CLAIMS IN EXCESS OF 3             | 2201     | 1                                                                  | 210    | 210                  |
| Miscellaneous-Filing:                         |          |                                                                    |        |                      |
| Petition:                                     |          |                                                                    |        |                      |
| Patent-Appeals-and-Interference:              |          |                                                                    |        |                      |
| Post-Allowance-and-Post-Issuance:             |          |                                                                    |        |                      |



| Description        | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|--------------------|----------|----------|--------|----------------------|
| Extension-of-Time: |          |          |        |                      |
| Miscellaneous:     |          |          |        |                      |
| Total in USD (\$)  |          |          |        | 210                  |

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 27550000                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Mary Buggie                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 17-NOV-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 21:43:37                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

|                                          |                             |
|------------------------------------------|-----------------------------|
| Submitted with Payment                   | yes                         |
| Payment Type                             | DA                          |
| Payment was successfully received in RAM | \$210                       |
| RAM confirmation Number                  | 111816INTEFSW00006523504050 |
| Deposit Account                          | 504050                      |
| Authorized User                          | Richard Shoop               |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

|                              |                                                     |                                                                 |                                          |                  |                  |
|------------------------------|-----------------------------------------------------|-----------------------------------------------------------------|------------------------------------------|------------------|------------------|
|                              |                                                     |                                                                 |                                          |                  |                  |
| File Listing:                |                                                     |                                                                 |                                          |                  |                  |
| Document Number              | Document Description                                | File Name                                                       | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1                            |                                                     | 13211-713-303_Supp_Amendment_Decl_1-132_Exhibits_11-17-2016.pdf | 2096665                                  | yes              | 31               |
|                              |                                                     |                                                                 | b6688ec737f482a2708ad66392aa8d79252cec07 |                  |                  |
|                              | Multipart Description/PDF files in .zip description |                                                                 |                                          |                  |                  |
|                              | Document Description                                |                                                                 | Start                                    | End              |                  |
|                              | Supplemental Response or Supplemental Amendment     |                                                                 | 1                                        | 1                |                  |
|                              | Claims                                              |                                                                 | 2                                        | 6                |                  |
|                              | Applicant Arguments/Remarks Made in an Amendment    |                                                                 | 7                                        | 9                |                  |
|                              | Affidavit-traversing rejectns or objectns rule 132  |                                                                 | 10                                       | 31               |                  |
| Warnings:                    |                                                     |                                                                 |                                          |                  |                  |
| Information:                 |                                                     |                                                                 |                                          |                  |                  |
| 2                            | Fee Worksheet (SB06)                                | fee-info.pdf                                                    | 30681                                    | no               | 2                |
|                              |                                                     |                                                                 | 493bd4d7eb0a2fc17be23767b61ad788038df03b |                  |                  |
| Warnings:                    |                                                     |                                                                 |                                          |                  |                  |
| Information:                 |                                                     |                                                                 |                                          |                  |                  |
| Total Files Size (in bytes): |                                                     |                                                                 | 2127346                                  |                  |                  |

**This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.**

**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

|                                                                                   |                                                   |                                  |                                       |
|-----------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------------------------------|
| <b>PATENT APPLICATION FEE DETERMINATION RECORD</b><br>Substitute for Form PTO-875 | Application or Docket Number<br><b>14/925,968</b> | Filing Date<br><b>10/28/2015</b> | <input type="checkbox"/> To be Mailed |
|-----------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------------------------------|

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

### APPLICATION AS FILED – PART I

| FOR                                                                        | NUMBER FILED | NUMBER EXTRA | RATE (\$)                                                                                                                                                                                                                     | FEE (\$) |
|----------------------------------------------------------------------------|--------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <input type="checkbox"/> BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))        | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| <input type="checkbox"/> SEARCH FEE<br>(37 CFR 1.16(k), (j), or (m))       | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| <input type="checkbox"/> EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))  | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                           | minus 20 =   | *            | X \$ =                                                                                                                                                                                                                        |          |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                     | minus 3 =    | *            | X \$ =                                                                                                                                                                                                                        |          |
| <input type="checkbox"/> APPLICATION SIZE FEE<br>(37 CFR 1.16(s))          |              |              | If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). |          |
| <input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) |              |              |                                                                                                                                                                                                                               |          |
| * If the difference in column 1 is less than zero, enter "0" in column 2.  |              |              | TOTAL                                                                                                                                                                                                                         |          |

### APPLICATION AS AMENDED – PART II

| AMENDMENT | (Column 1)                                                                               | (Column 2)                       | (Column 3) | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$)       | ADDITIONAL FEE (\$) |
|-----------|------------------------------------------------------------------------------------------|----------------------------------|------------|------------------------------------|---------------|-----------------|---------------------|
|           | <b>11/17/2016</b>                                                                        | CLAIMS REMAINING AFTER AMENDMENT |            |                                    |               |                 |                     |
|           | Total (37 CFR 1.16(i))                                                                   | * 19                             | Minus      | ** 20                              | = 0           | X \$40 =        | 0                   |
|           | Independent (37 CFR 1.16(h))                                                             | * 4                              | Minus      | ***3                               | = 1           | X \$210 =       | 210                 |
|           | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |               |                 |                     |
|           | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |               |                 |                     |
|           |                                                                                          |                                  |            |                                    |               | TOTAL ADD'L FEE | <b>210</b>          |

| AMENDMENT | (Column 1)                                                                               | (Column 2)                       | (Column 3) | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$)       | ADDITIONAL FEE (\$) |
|-----------|------------------------------------------------------------------------------------------|----------------------------------|------------|------------------------------------|---------------|-----------------|---------------------|
|           |                                                                                          | CLAIMS REMAINING AFTER AMENDMENT |            |                                    |               |                 |                     |
|           | Total (37 CFR 1.16(i))                                                                   | *                                | Minus      | **                                 | =             | X \$ =          |                     |
|           | Independent (37 CFR 1.16(h))                                                             | *                                | Minus      | ***                                | =             | X \$ =          |                     |
|           | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |               |                 |                     |
|           | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |               |                 |                     |
|           |                                                                                          |                                  |            |                                    |               | TOTAL ADD'L FEE |                     |

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.  
 \*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".  
 \*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".  
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE  
TARA WASHINGTON

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**  
 If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



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| APPLICATION NO.                                                         | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.             | CONFIRMATION NO. |
|-------------------------------------------------------------------------|-------------|----------------------|---------------------------------|------------------|
| 14/925,968                                                              | 10/28/2015  | Adam BOWEN           | 13211-713.303                   | 2707             |
| 66854                                                                   | 7590        | 12/02/2016           |                                 |                  |
| SHAY GLENN LLP<br>2755 CAMPUS DRIVE<br>SUITE 210<br>SAN MATEO, CA 94403 |             |                      | EXAMINER<br>MAYES, DIONNE WALLS |                  |
|                                                                         |             |                      | ART UNIT                        | PAPER NUMBER     |
|                                                                         |             |                      | 1747                            |                  |
|                                                                         |             |                      | NOTIFICATION DATE               | DELIVERY MODE    |
|                                                                         |             |                      | 12/02/2016                      | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

info@shayglenn.com

|                              |                                      |                                     |                                                   |
|------------------------------|--------------------------------------|-------------------------------------|---------------------------------------------------|
| <b>Office Action Summary</b> | <b>Application No.</b><br>14/925,968 | <b>Applicant(s)</b><br>BOWEN ET AL. |                                                   |
|                              | <b>Examiner</b><br>DIONNE W. MAYES   | <b>Art Unit</b><br>1747             | <b>AIA (First Inventor to File) Status</b><br>Yes |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1) ☒ Responsive to communication(s) filed on 11/17/2016.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_\_.

2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.

3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on \_\_\_\_\_; the restriction requirement and election have been incorporated into this action.

4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims\***

5) ☒ Claim(s) 1-3,6-10,12-18 and 20-23 is/are pending in the application.  
5a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.

6) ☐ Claim(s) \_\_\_\_\_ is/are allowed.

7) ☒ Claim(s) 1-3,6-10,12-18 and 20-23 is/are rejected.

8) ☐ Claim(s) \_\_\_\_\_ is/are objected to.

9) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

\* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

**Application Papers**

10) ☐ The specification is objected to by the Examiner.

11) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

**Priority under 35 U.S.C. § 119**

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

**Certified copies:**

a) ☐ All    b) ☐ Some\*\*    c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\*\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)  
Paper No(s)/Mail Date \_\_\_\_\_.

3) ☒ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.

4) ☐ Other: \_\_\_\_\_.

## **DETAILED ACTION**

### ***Notice of Pre-AIA or AIA Status***

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

### ***Continued Examination Under 37 CFR 1.114***

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on August 19, 2016, and also the Supplemental Amendment filed on November 17, 2016, has been entered.

### ***Declaration of Adam Bowen Under 32 CFR 1.132***

3. The Declaration of Adam Bowen, under 37 CFR 1.132, filed on November 17, to the extent that it provides additional experimental evidence in support of the heart rate effect of vaporizing nicotine lactate has been accepted and, for the purposes of Examination, the subject matter thereof will be considered to have been incorporated into Applicant's Provisional Application filed on May 6, 2013. This same Declaration, to the extent that it articulates "unexpected results" is insufficient to establish the same. As shown in the following prior art rejection over Sebastian et al, the use of as much as 10% (w/w) nicotine in a equimolar ratio with lactic acid (hence, forming nicotine lactate) in a liquid solution of glycerol by heating the same in an electronic cigarette and being



inhaled by a user is already known, and would provide the claimed increases in heart rate comparable to inhaling a traditional burned cigarette. As such, the results indicated by Applicant, and that which is instantly claimed, are not “unexpected”.

***Declaration of Gal Cohen Under 32 CFR 1.132***

4. The Declaration of Gal Cohen, filed on August 19, 2016, has now been rendered moot due to the subsequent filing of the Supplemental Amendment on November 17, 2016 which substantially changed the scope of the instant claims.

***Claim Rejections - 35 USC § 112***

5. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 7-20 and 22-23 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112

(pre-AIA), first paragraph, as failing to comply with the written description requirement.

The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention.

In the amendment filed on November 17, 2016, Applicant has amended the claims to recite nicotine lactate concentrations which are “from about 4% (w/w) to about 6.5% (w/w)” (both independent claims 7 and 13), and “about 4.5% (w/w)” (independent claim 23); and, also, that there is an “increase in heart rate that peaks within about 5 minutes from the first puff” (independent claim 13). However, there appears to be no evidence provided in the Declaration of Adam Bowen filed on November 17, 2016 that supports such values. As indicated on Exhibit B “Nicotine Lactate effect on heart rate”, concentrations which are reflected on the chart/graph reflect values of “4.0%” and “6.5%”, **only** - *not* a range between these two concentrations or a concentration of “about 4.5%”. Also, the chart/graph reflects that the heart rate peaks at within about 3.5 minutes at a nicotine lactate concentration of 6.5%, and within about 2 minutes at a nicotine lactate concentration of about 4.0% **only** - *not* “within 5 minutes”. Correction is requested.

### ***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

8. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

Art Unit: 1747

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

9. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

10. Claims 1-3, 7-10, 13-18 and 21-23 are rejected under 35 U.S.C. 103 as being unpatentable over Sebastian et al (US. Pat. App. Pub. 2014/0000638).

Regarding independent claims 1 and 23, Sebastian et al discloses an electronic smoking article (i.e., electronic cigarette) that provides for delivery of aerosolized components of an aerosol precursor composition to at least one heating element (See abstract. Note: According to Applicant's instant disclosure, the terms "electronic cigarette" and "low temperature vaporization device" are synonymous. See instant published application, para. [0119]) (corresponding to the claimed "deploying a low-temperature vaporizer").

The aerosol precursor composition may include a medicament, such as nicotine, which may comprise up to 10% of the weight of the aerosol precursor (see para.

[0060]). When nicotine is chosen, organic acids can be combined with the nicotine in order to favorably affect the flavor, sensation, or organoleptic properties. Organic acids such as lactic acid may be used, such that the total amount of acid present is equimolar to the total amount of nicotine present in the aerosol precursor (see para. [0059]). The aerosol precursor composition may include glycerol in an amount of up to 98% (see para. [0060]). Since the nicotine and lactic acid can be provided in equimolar ratios, it is presumed that "nicotine lactate" is thereby formed, resulting in the claimed "nicotine formulation that comprises nicotine lactate, and a biologically acceptable liquid carrier...the biologically acceptable liquid carrier comprises glycerol".

Further, Sebastian et al discloses that, as a non-limiting example, an aerosol precursor composition may include nicotine in an amount of about 0.1-5.0%. This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of nicotine to add to the precursor composition and, in doing so, selected the high end of this range, i.e. 3-5%, after determining that such nicotine concentration provided for superior flavor, sensation and organoleptic properties for the user (Note: "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (corresponding to the claimed "the nicotine lactate concentration is about 4%/4.5% (w/w)").

At least one wick can be used to transport the aerosolized components of the aerosol precursor composition from a reservoir to an aerosolization zone (i.e., at or around a resistive heating element) within the electronic smoking article (para. [0009])

(corresponding to the claimed “operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate”).

Lastly, it follows to reason, that the upon inhalation of the aerosolized vapor resulting from heating the aerosol precursor composition in the modified Sebastian et al electronic smoking article, the user would experience the claimed heart rate increase as, absent any indication to the contrary, such effects would “flow naturally” from use of said article (corresponding to the claimed “wherein inhalation of the aerosol into a user’s lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes form the first puff”).

Regarding claim 2, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para. [0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 3, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).

Regarding independent claims 7 and 13, and claims 10 and 17-18, Sebastian et al discloses an electronic smoking article (i.e., electronic cigarette) that provides for delivery of aerosolized components of an aerosol precursor composition to at least one heating element (See abstract. Note: According to Applicant’s instant disclosure, the

terms “electronic cigarette” and “low temperature vaporization device” are synonymous. See instant published application, para. [0119] (corresponding to the claimed “deploying a low-temperature vaporizer”).

The aerosol precursor composition may include a medicament, such as nicotine, which may comprise up to 10% of the weight of the aerosol precursor (see para. [0060]). When nicotine is chosen, organic acids can be combined with the nicotine in order to favorably affect the flavor, sensation, or organoleptic properties. Organic acids such as lactic acid may be used, such that the total amount of acid present is equimolar to the total amount of nicotine present in the aerosol precursor (see para. [0059]). The aerosol precursor composition may include glycerol in an amount of up to 98% (see para. [0060]). Since the nicotine and lactic acid can be provided in equimolar ratios, it is presumed that “nicotine lactate” is thereby formed, resulting in the claimed “nicotine formulation that comprises nicotine lactate, and a biologically acceptable liquid carrier...the biologically acceptable liquid carrier comprises glycerol”.

Further, Sebastian et al discloses that, as a non-limiting example, an aerosol precursor composition may include nicotine in an amount of about 0.1-5.0%. This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of nicotine to add to the precursor composition and, in doing so, selected the high end of this range, i.e. 3-5%, after determining that such nicotine concentration provided for superior flavor, sensation and organoleptic properties for the user (Note: “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re*

*Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (corresponding to the claimed “the nicotine lactate concentration is from about 4% (w/w) to about 6.5% (w/w)”;  
and the “wherein the nicotine concentration is about 4.5%” recitation of claims 10 and 18).

At least one wick can be used to transport the aerosolized components of the aerosol precursor composition from a reservoir to an aerosolization zone (i.e., at or around a resistive heating element) within the electronic smoking article (para. [0009]) (corresponding to the claimed “operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate”; and the “wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation” recitation of claim 17).

Lastly, it follows to reason, that the upon inhalation of the aerosolized vapor resulting from heating the aerosol precursor composition in the modified Sebastian et al electronic smoking article, the user would experience the claimed heart rate increase as, absent any indication to the contrary, such effects would “flow naturally” from use of said article (corresponding to the claimed “wherein inhalation of the aerosol into a user’s lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5/5 minutes form the first puff”).

Regarding claim 8, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para.

[0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 9, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).

Regarding claim 12, based on the disclosure of Gonda, as discussed above, that by decreasing the particle size, the aerosolized particles of nicotine will deposit deeper in the lungs, which increases the rate of absorption of the nicotine and leads to an increase in peak nicotine plasma levels, it would have been obvious to one having ordinary skill in the art to have optimized the particle size of its aerosol to fall between 0.1 - 5 microns (Corresponding to the claimed “wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns”).

Regarding claim 14, the electronic smoking article of Sebastian et al may include a battery (40)(see Fig. 1, para. [0078]) (corresponding to the claimed “further comprises a battery configured to provide power to the vaporizing component”).

Regarding claim 15, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para. [0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 16, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).



Regarding claim 17, as stated above, Griffith, Jr. et al discloses that the aerosol, from an inside cavity, is vaporized by a resistive heating element (50) that heats the nicotine-containing aerosol precursor material located on a substrate (53)(see para. [0137])(corresponding to the claimed “wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation”).

Regarding claim 18, Griffith, Jr. et al discloses that a specific non-limiting example of the nicotine content in its aerosol precursor may be about 2-3% by weight (see para. [00888]). However, it would have been obvious to one having ordinary skill in the art to have adjusted this amount to be a bit higher - corresponding to the claimed amount - in order to satisfy the particular organoleptic preferences of the user (corresponding to the claimed “wherein the nicotine concentration is about 4.5%”).

Regarding claim 20, based on the disclosure of Gonda, as discussed above, that by decreasing the particle size, the aerosolized particles of nicotine will deposit deeper in the lungs, which increases the rate of absorption of the nicotine and leads to an increase in peak nicotine plasma levels, it would have been obvious to one having ordinary skill in the art to have optimized the particle size of its aerosol to fall between 0.1 - 5 microns (Corresponding to the claimed “wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns”).

Regarding claims 21-22, Sebastian et al discloses that the aerosol precursor composition can take a variety of conformations, and may comprises up to 95% by weight of a polyol. This total amount can be split in any combination between two or more different polyols, such as glycerol (i.e., vegetable glycerol) and propylene glycol.

This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of each polyol to add to the precursor composition and, in doing so, selected the claimed polyol combination (Note: “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955))(corresponding to the claimed “wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin” recitation of claim 21; and the “wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin” recitation of claim 22”).

11. Claims 6, 12 and 20 are rejected under 35 U.S.C. 103 as being unpatentable over Sebastian et al (US. Pat. App. Pub. 2014/0000638) in view of Gonda (US. Pat. No. 2014/0261474).

Regarding claims 6, 12 and 20, based on the disclosure of Gonda, that by decreasing the particle size, the aerosolized particles of nicotine will deposit deeper in the lungs, which increases the rate of absorption of the nicotine and leads to an increase in peak nicotine plasma levels, it would have been obvious to one having ordinary skill in the art to have optimized the particle size of its aerosol to fall between 0.1 - 5 microns (Corresponding to the claimed “wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns”).

### ***Response to Arguments***

12. Applicant’s arguments with respect to the claims have been considered but are moot in view of the new grounds for rejection, presented above, involving a new

combination of prior art references, which were necessitated because of the amendments made to the claims, filed on November 17, 2016.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DIONNE W. MAYES whose telephone number is (571)272-5836. The examiner can normally be reached on Tuesdays and Thursdays, 8:00A - 4:30P.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael H. Wilson can be reached on (571) 270-3882. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DIONNE W MAYES/  
Examiner, Art Unit 1747

|                                                     |                                      |                                     |  |
|-----------------------------------------------------|--------------------------------------|-------------------------------------|--|
| <b><i>Applicant-Initiated Interview Summary</i></b> | <b>Application No.</b><br>14/925,968 | <b>Applicant(s)</b><br>BOWEN ET AL. |  |
|                                                     | <b>Examiner</b><br>DIONNE W. MAYES   | <b>Art Unit</b><br>1747             |  |

All participants (applicant, applicant's representative, PTO personnel):

(1) DIONNE W. MAYES. (3) ADAM BOWEN.

(2) RICHARD SHOOP. (4) GAL COHEN.

Date of Interview: 10 November 2016.

Type:    ☒ Telephonic    ☐ Video Conference  
              ☐ Personal [copy given to: ☐ applicant    ☐ applicant's representative]

Exhibit shown or demonstration conducted:    ☐ Yes    ☐ No.  
              If Yes, brief description: \_\_\_\_\_.

Issues Discussed    ☐ 101    ☒ 112    ☐ 102    ☐ 103    ☒ Others  
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: Those of Record.

Identification of prior art discussed: None.

**Substance of Interview**  
 (For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner Mayes, Applicant Adam Bowen, Declarant Gal Cohen and Applicant's Representative, Richard Shoop, discussed the RCE filed on August 19, 2016 - which included claim amendments and a Commercial Success Declaration by Gal Cohen. Examiner Mayes indicated that she felt the amended claim language raised potential 112-1 issues, and support for some of the subject matter of the claims didn't appear to be present in the earliest filed Provisional Application (61/820,128) - whose filing date (May 6, 2013) Applicant desires to use as a prior art date. It was determined that a further Declaration would be filed to provide evidence to support the amended claim language particularly as it pertains to nicotine lactate and heart rate increase resulting from inhaling vaporized nicotine lactate. Applicants also indicated that the claims would be amended to be commensurate in scope with the newly provided evidence.

**Applicant recordation instructions:** The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

**Examiner recordation instructions:** Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☒ Attachment

|                                             |  |
|---------------------------------------------|--|
| /DIONNE W MAYES/<br>Examiner, Art Unit 1747 |  |
|---------------------------------------------|--|

## Summary of Record of Interview Requirements

### Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

#### Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,  
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

#### Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

|                                   |                                       |  |                                                            |             |
|-----------------------------------|---------------------------------------|--|------------------------------------------------------------|-------------|
| <b>Notice of References Cited</b> | Application/Control No.<br>14/925,968 |  | Applicant(s)/Patent Under<br>Reexamination<br>BOWEN ET AL. |             |
|                                   | Examiner<br>DIONNE W. MAYES           |  | Art Unit<br>1747                                           | Page 1 of 1 |

#### U.S. PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name            | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|-----------------|--------------------|-------------------|
| * | A | US-2014/0000638 A1                               | 01-2014         | Sebastian et al | A24F47/008         | 131/328           |
|   | B | US-                                              |                 |                 |                    |                   |
|   | C | US-                                              |                 |                 |                    |                   |
|   | D | US-                                              |                 |                 |                    |                   |
|   | E | US-                                              |                 |                 |                    |                   |
|   | F | US-                                              |                 |                 |                    |                   |
|   | G | US-                                              |                 |                 |                    |                   |
|   | H | US-                                              |                 |                 |                    |                   |
|   | I | US-                                              |                 |                 |                    |                   |
|   | J | US-                                              |                 |                 |                    |                   |
|   | K | US-                                              |                 |                 |                    |                   |
|   | L | US-                                              |                 |                 |                    |                   |
|   | M | US-                                              |                 |                 |                    |                   |

#### FOREIGN PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Country | Name | CPC Classification |
|---|---|--------------------------------------------------|-----------------|---------|------|--------------------|
|   | N |                                                  |                 |         |      |                    |
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|   | T |                                                  |                 |         |      |                    |

#### NON-PATENT DOCUMENTS

| * |   | Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages) |
|---|---|-------------------------------------------------------------------------------------------|
|   | U |                                                                                           |
|   | V |                                                                                           |
|   | W |                                                                                           |
|   | X |                                                                                           |

\*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)  
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Substitute for form 1449/PTO

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet 1

of 2

**Complete if Known**

|                        |                     |
|------------------------|---------------------|
| Application Number     | 14/925,968          |
| Filing Date            | October 28, 2015    |
| First Named Inventor   | Adam Bowen          |
| Art Unit               | 1747                |
| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

**U. S. PATENT DOCUMENTS**

| Examiner Initials* | Cite No. <sup>1</sup> | Document Number                          | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages or Relevant<br>Figures Appear |
|--------------------|-----------------------|------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|
|                    |                       | Number-Kind Code <sup>2</sup> (if known) |                                |                                                    |                                                                                 |
|                    | 595                   | US- 9,220,302                            | 12/29/2015                     | DePiano et al.                                     |                                                                                 |
|                    | 596                   | US- 9,226,526                            | 1/5/2016                       | Liu                                                |                                                                                 |
|                    | 597                   | US- 9,271,525                            | 3/1/2016                       | Liu                                                |                                                                                 |
|                    | 598                   | US- 9,271,529                            | 3/1/2016                       | Alima                                              |                                                                                 |
|                    | 599                   | US- 9,272,103                            | 3/1/2016                       | Storz                                              |                                                                                 |
|                    | 600                   | US- 9,277,769                            | 3/8/2016                       | Liu                                                |                                                                                 |
|                    | 601                   | US- 9,282,772                            | 3/15/2016                      | Tucker et al.                                      |                                                                                 |
|                    | 602                   | US- 9,282,773                            | 3/15/2016                      | Greim et al.                                       |                                                                                 |
|                    | 603                   | US- 9,289,014                            | 3/22/2016                      | Tucker et al.                                      |                                                                                 |
|                    | 604                   | US- 9,308,336                            | 4/12/2016                      | Newton                                             |                                                                                 |
|                    | 605                   | US- 9,326,547                            | 5/3/2016                       | Tucker et al.                                      |                                                                                 |
|                    | 606                   | US- 9,351,522                            | 5/31/2016                      | Safari                                             |                                                                                 |
|                    | 590                   | US- 2013/0199528                         | 8/8/2013                       | Goodman et al.                                     |                                                                                 |
|                    | 591                   | US- 2014/0144429                         | 5/29/2014                      | Wensley et al.                                     |                                                                                 |
|                    | 592                   | US- 2015/0272220                         | 10/1/2015                      | Spinka et al.                                      |                                                                                 |
|                    | 608                   | US- 2015/0282525                         | 10/8/2015                      | Plojoux et al.                                     |                                                                                 |
|                    | 609                   | US- 2015/0313275                         | 11/5/2015                      | Anderson et al.                                    |                                                                                 |
|                    | 611                   | US- 2015/0351456                         | 12/10/2015                     | Johnson et al.                                     |                                                                                 |
|                    | 614                   | US- 2016/0021931                         | 1/28/2016                      | Hawes et al.                                       |                                                                                 |

**FOREIGN PATENT DOCUMENTS**

| Examiner Initials* | Cite No. <sup>1</sup> | Foreign Patent Document                                                           | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages Or Relevant<br>Figures Appear | T <sup>6</sup> |
|--------------------|-----------------------|-----------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|----------------|
|                    |                       | Country Code <sup>3</sup> "Number" <sup>4</sup> Kind Code <sup>5</sup> (if known) |                                |                                                    |                                                                                 |                |
|                    | 639                   | WO2015/149647A1(w/ Eng Abs)                                                       | 10/8/2015                      | Kimree Hi-Tech Inc.                                |                                                                                 |                |
|                    | 640                   | WO2015/168828A1(w/ Eng Abs)                                                       | 11/12/2015                     | Kimree Hi-Tech Inc.                                |                                                                                 |                |
|                    |                       |                                                                                   |                                |                                                    |                                                                                 |                |
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Examiner  
Signature

/Dionne Walls Mayes/

Date  
Considered

10/27/2016

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. <sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> See Kinds Codes of USPTO Patent Documents at [www.uspto.gov](http://www.uspto.gov) or MPEP 901.04. <sup>3</sup> Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>5</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup> Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND**

TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.W.M./

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**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet 2 of 2**Complete if Known**

|                        |                     |
|------------------------|---------------------|
| Application Number     | 14/925,968          |
| Filing Date            | October 28, 2015    |
| First Named Inventor   | Adam Bowen          |
| Art Unit               | 1747                |
| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

| U. S. PATENT DOCUMENTS |                          |                                          |                                |                                                    |                                                                                 |
|------------------------|--------------------------|------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|
| Examiner<br>Initials*  | Cite<br>No. <sup>1</sup> | Document Number                          | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages or Relevant<br>Figures Appear |
|                        |                          | Number-Kind Code <sup>2</sup> (if known) |                                |                                                    |                                                                                 |
|                        | 607                      | US- 2016/0058071                         | 3/3/2016                       | Hearn                                              |                                                                                 |
|                        | 618                      | US- 2016/0058072                         | 3/3/2016                       | Liu                                                |                                                                                 |
|                        | 621                      | US- 2016/0081395                         | 3/24/2016                      | Thorens et al.                                     |                                                                                 |
|                        | 623                      | US- 2016/0106154                         | 4/21/2016                      | Lord                                               |                                                                                 |
|                        | 624                      | US- 2016/0106155                         | 4/21/2016                      | Reevell                                            |                                                                                 |
|                        | 627                      | US- 2016/0120218                         | 5/5/2016                       | Schennum et al.                                    |                                                                                 |
|                        | 630                      | US- 2016/0135503                         | 5/19/2016                      | Liu                                                |                                                                                 |
|                        | 632                      | US- 2016/0143359                         | 5/26/2016                      | Xiang                                              |                                                                                 |
|                        | 635                      | US- 2016/0143365                         | 5/26/2016                      | Liu                                                |                                                                                 |
|                        |                          | US-                                      |                                |                                                    |                                                                                 |
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| FOREIGN PATENT DOCUMENTS |                          |                                                                                   |                                   |                                                    |                                                                                 |                |
|--------------------------|--------------------------|-----------------------------------------------------------------------------------|-----------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|----------------|
| Examiner<br>Initials*    | Cite<br>No. <sup>1</sup> | Foreign Patent Document                                                           | Publication<br>Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines,<br>Where Relevant Passages<br>Or Relevant Figures Appear | T <sup>6</sup> |
|                          |                          | Country Code <sup>3</sup> *Number <sup>4</sup> *Kind Code <sup>5</sup> (if known) |                                   |                                                    |                                                                                 |                |
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|-----------------------|----------------------|--------------------|------------|
| Examiner<br>Signature | /Dionne Walls Mayes/ | Date<br>Considered | 10/27/2016 |
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## INFORMATION DISCLOSURE STATEMENT BY APPLICANT

*(Use as many sheets as necessary)*

**Complete if Known**

|                        |                     |
|------------------------|---------------------|
| Application Number     | 14/925,968          |
| Filing Date            | October 28, 2015    |
| First Named Inventor   | Adam Bowen          |
| Art Unit               | 1747                |
| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

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## U. S. PATENT DOCUMENTS

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FOREIGN PATENT DOCUMENTS

| FOREIGN PATENT DOCUMENTS |                       |                                                                                   |                                |                                                 |                                                                           |                |
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|                          |                       | Country Code <sup>3</sup> ~Number <sup>4</sup> ~Kind Code <sup>5</sup> (if known) |                                |                                                 |                                                                           |                |
|                          | 668                   | EP2152313B1                                                                       | 9/3/2014                       | McNeil AB                                       |                                                                           |                |
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| Substitute for form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><br><i>(Use as many sheets as necessary)</i> |                        | <b>Complete if Known</b> |                  |
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|                                                                                                                                              |                        | First Named Inventor     | Adam Bowen       |
|                                                                                                                                              |                        | Art Unit                 | 1747             |
| Examiner Name                                                                                                                                | Mayes, Dionne Walls    |                          |                  |
| Sheet 2 of 2                                                                                                                                 | Attorney Docket Number |                          | 13211-713.303    |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                 |                |
|---------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>2</sup> |
|                                 | 587                   | MONSEES et al.; U.S. Pat. Appl. # 15/165,954 entitled "Devices for vaporization of a substance," filed 5/26/2016                                                                                                                                                |                |
|                                 | 588                   | MONSEES et al.; U.S. Pat. Appl. # 15/166,001 entitled "Electronic vaporization device," filed 5/26/2016                                                                                                                                                         |                |
|                                 | 589                   | MONSEES et al.; U.S. Pat. Appl. # 15/165,972 entitled "Portable devices for generating an inhalable vapor," filed 5/26/2016                                                                                                                                     |                |
|                                 | 665                   | BOWEN et al.; U.S. Pat Appl. # 15/101,303 entitled "Nicotine liquid formulations for aerosol devices and methods thereof," filed 6/2/2016                                                                                                                       |                |
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| Examiner Signature | /Dionne Walls Mayes/ | Date Considered | 10/27/2016 |
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| Examiner Name          | Mayes, Dionne Walls |
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## U. S. PATENT DOCUMENTS

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**FOREIGN PATENT DOCUMENTS**

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|--------------------------|-----------------------|------------------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------|------------------------------------------------------------------------------|----------------|
| Examiner Initials*       | Cite No. <sup>1</sup> | Foreign Patent Document                                                                  | Publication Date<br>MM-DD-YYYY | Name of Patentee or Applicant of Cited Document | Pages, Columns, Lines,<br>Where Relevant Passages Or Relevant Figures Appear | T <sup>6</sup> |
|                          |                       | Country Code <sup>3</sup> -Number <sup>4</sup> -Kind Code <sup>5</sup> <i>(if known)</i> |                                |                                                 |                                                                              |                |
|                          | 585                   | JP10-501999A(w/EngEquiv)                                                                 | 2/24/1998                      | Boehringer Ingelheim                            |                                                                              |                |
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Examiner  
Signature

/Dionne Walls Mayes/

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| Date       |  |
| Considered |  |

07/12/2016

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| Sheet 2 of 2                                                                                                                                 | Attorney Docket Number | 13211-713.303            |                  |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                                                                                                                                               |                |
|---------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.                                                                                                                               | T <sup>2</sup> |
|                                 | 721                   | FARSALINOS et al.; Electronic cigarettes do not damage the heart; European Society of Cardiology; 4 pages; retrieved from the internet ( <a href="http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart">http://www.escardio.org/The-ESC/Press-Office/Press-releases/Electronic-cigarettes-do-not-damage-the-heart</a> ); August 25, 2012 |                |
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## U. S. PATENT DOCUMENTS

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|                          |                       | Country Code <sup>3</sup> *Number <sup>4</sup> *Kind Code <sup>5</sup> (if known) |                                |                                                 |                                                                           |                |
|                          | 712                   | EP3024343A2(WO2015/013327)                                                        | 1/29/2015                      | Altria Client Serv. Inc.                        |                                                                           |                |
|                          | 716                   | WO 03/103387A2                                                                    | 12/18/2003                     | S.C. Johnson & Son Inc.                         |                                                                           |                |
|                          | 715                   | WO2014/159982A1                                                                   | 10/2/2014                      | R.J. Reynolds Tobacco Co.                       |                                                                           |                |
|                          |                       |                                                                                   |                                |                                                 |                                                                           |                |
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| Examiner<br>Signature | /Dionne Walls Mayes/ |
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| Date Considered | 10/27/2016 |
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PTO/SB/08b (07-09)

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|                                                                                                                                              |      | Application Number       | 14/925,968          |
|                                                                                                                                              |      | Filing Date              | October 28, 2015    |
|                                                                                                                                              |      | First Named Inventor     | Adam Bowen          |
|                                                                                                                                              |      | Art Unit                 | 1747                |
|                                                                                                                                              |      | Examiner Name            | Mayes, Dionne Walls |
| Sheet 2                                                                                                                                      | of 2 | Attorney Docket Number   | 13211-713.303       |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                 |                |
|---------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>2</sup> |
|                                 | 703                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,748 entitled "Cartridge for use with a vaporizer device," filed 9/6/2016                                                                                                                                               |                |
|                                 | 704                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,760 entitled "Vaporizer apparatus," filed 9/6/2016                                                                                                                                                                     |                |
|                                 | 705                   | MONSEES et al.; U.S. Pat. Appl. # 15/257,768 entitled "Vaporizer apparatus," filed 9/6/2016                                                                                                                                                                     |                |
|                                 | 706                   | MONSEES et al.; U.S. Pat. Appl. # 15/261,823 entitled "Low temperature electronic vaporization device and methods," filed 9/9/2016                                                                                                                              |                |
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| Examiner Signature | /Dionne Walls Mayes/ | Date Considered | 10/27/2016 |
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<sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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|                                                                                                                                            |   |    | Application Number       | 14/925,968          |
|                                                                                                                                            |   |    | Filing Date              | October 28, 2015    |
|                                                                                                                                            |   |    | First Named Inventor     | Adam Bowen          |
|                                                                                                                                            |   |    | Art Unit                 | 1747                |
|                                                                                                                                            |   |    | Examiner Name            | Mayes, Dionne Walls |
|                                                                                                                                            |   |    | Attorney Docket Number   | 13211-713.303       |
| Sheet                                                                                                                                      | 1 | of | 2                        |                     |

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| FOREIGN PATENT DOCUMENTS |                       |                                                                                   |                                |                                                 |                                                                           |                |
|--------------------------|-----------------------|-----------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------|---------------------------------------------------------------------------|----------------|
| Examiner Initials*       | Cite No. <sup>1</sup> | Foreign Patent Document                                                           | Publication Date<br>MM-DD-YYYY | Name of Patentee or Applicant of Cited Document | Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear | T <sup>6</sup> |
|                          |                       | Country Code <sup>3</sup> -Number <sup>4</sup> -Kind Code <sup>5</sup> (if known) |                                |                                                 |                                                                           |                |
|                          | 687                   | EP0283672B1                                                                       | 9/22/1993                      | R J Reynolds Tobacco                            |                                                                           |                |
|                          | 688                   | EP2319934B1                                                                       | 9/2/2015                       | Stichting Dienst                                |                                                                           |                |
|                          | 689                   | WO2007/078273A1                                                                   | 7/12/2007                      | Augite Inc.                                     |                                                                           |                |
|                          | 690                   | WO2015/009862A2                                                                   | 1/22/2015                      | Altria Client Services                          |                                                                           |                |
|                          |                       |                                                                                   |                                |                                                 |                                                                           |                |
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| Examiner<br>Signature | /Dionne Walls Mayes/ | Date<br>Considered | 10/27/2016 |
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PTO/SB/08b (07-09)

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><br><i>(Use as many sheets as necessary)</i> |                     | <b>Complete if Known</b> |                  |
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|                                                                                                          |                     | Filing Date              | October 28, 2015 |
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|                                                                                                          |                     | Art Unit                 | 1747             |
| Examiner Name                                                                                            | Mayes, Dionne Walls |                          |                  |
| Attorney Docket Number                                                                                   | 13211-713.303       |                          |                  |
| Sheet                                                                                                    | 2                   | of                       | 2                |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                 |                |
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| Examiner Initials*              | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>2</sup> |
|                                 | 683                   | BURCH et al.; Effect of pH on nicotine absorption and side effects produced by aerosolized nicotine; Journal of Aerosol Medicine: Deposition, Clearance, and Effects in the Lung; 6(1); pp. 45-52; 1993                                                         |                |
|                                 |                       |                                                                                                                                                                                                                                                                 |                |
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| Examiner Signature | /Dionne Walls Mayes/ | Date Considered | 10/27/2016 |
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| <b>Search Notes</b><br><br> | <b>Application/Control No.</b><br><br>14925968 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>BOWEN ET AL. |
|                                                                                                              | <b>Examiner</b><br><br>DIONNE W MAYES          | <b>Art Unit</b><br><br>1747                                        |

| CPC- SEARCHED         |           |          |
|-----------------------|-----------|----------|
| Symbol                | Date      | Examiner |
| a24f47/00; a24f47/008 | 4/27/2016 | DWM      |

| CPC COMBINATION SETS - SEARCHED |      |          |
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| Symbol                          | Date | Examiner |
|                                 |      |          |

| US CLASSIFICATION SEARCHED |          |      |          |
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| Class                      | Subclass | Date | Examiner |
|                            |          |      |          |

| SEARCH NOTES                                         |            |          |
|------------------------------------------------------|------------|----------|
| Search Notes                                         | Date       | Examiner |
| EAST Search conducted (see attached search strategy) | 12/10/2015 | DWM      |
| Inventor search conducted                            | 12/10/2015 | DWM      |
| EAST Search conducted (see attached search strategy) | 4/27/2016  | DWM      |
| Inventor search updated                              | 4/27/2016  | DWM      |
| EAST Search conducted (see attached search strategy) | 11/28/2016 | DWM      |

| INTERFERENCE SEARCH     |                         |      |          |
|-------------------------|-------------------------|------|----------|
| US Class/<br>CPC Symbol | US Subclass / CPC Group | Date | Examiner |
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## EAST Search History

## EAST Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                                         | DBs                                                      | Default Operator | Plurals | Time Stamp       |
|-------|------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|------------------|---------|------------------|
| S1    | 3    | ((("20060195518") or ("20120256567") or ("20080241255")).PN.                                                         | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:41 |
| S2    | 3    | ((("20060195518") or ("20120255567") or ("20080241255")).PN.                                                         | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:41 |
| S3    | 2    | ((("20120255567") or ("20080241255")).PN.                                                                            | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:42 |
| S4    | 0    | ("2006").pn. and (hon).in.                                                                                           | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 11:42 |
| S5    | 42   | (hon).in. and cigarette                                                                                              | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 11:44 |
| S6    | 25   | ("131"/\$ or "128"/\$).ccls. and electronic cigarette and nicotine and plasma                                        | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:06 |
| S7    | 6    | ("131"/\$ or "128"/\$).ccls. and (fuisz).in. and nicotine and plasma                                                 | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:06 |
| S8    | 91   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and plasma                                                 | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:15 |
| S9    | 25   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and plasma and ((max or maxim\$3) near25 time)             | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:16 |
| S10   | 23   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and (plasma near25 (peak or max or maxim\$3) near25 time)  | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:25 |
| S11   | 9    | ("131"/\$ or "128"/\$).ccls. and inhal\$5 same (nicotine same (plasma near25 (peak or max or maxim\$3) near25 time)) | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:25 |
| S12   | 9    | ("131"/\$ or "128"/\$).ccls. and inhal\$5 same (nicotine same (plasma near25 (peak or max or maxim\$3) near25 time)) | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ              | ON      | 2015/01/20 15:26 |
| S13   | 32   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 and (nicotine same (plasma near25 (peak or max or maxim\$3) same time))    | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ              | ON      | 2015/01/20 15:28 |
| S14   | 2    | ("131"/\$ or "128"/\$).ccls. and nicotine benzoate                                                                   | US-PGPUB; USPAT; USOCR; FPRS;                            | ADJ              | ON      | 2015/01/20 15:51 |

|     |     |                                                                                      |                                                                            |     |     |                     |
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|     |     |                                                                                      | EPO; JPO;<br>DERWENT;<br>IBM_TDB                                           |     |     |                     |
| S15 | 2   | (vaporiz\$3 or electronic cigarette) and nicotine benzoate                           | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:52 |
| S16 | 346 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine)                               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:53 |
| S17 | 230 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) same (acid )                  | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:54 |
| S18 | 210 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) near35 (acid )                | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:55 |
| S19 | 17  | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) near35 (carboxylic or citric) | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>16:08 |
| S20 | 1   | ("2356185").PN.                                                                      | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>16:32 |
| S21 | 1   | ("2356185").PN.                                                                      | USOCR                                                                      | OR  | OFF | 2015/01/20<br>16:33 |
| S22 | 4   | nicotine benzoate                                                                    | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>16:38 |
| S23 | 1   | ("20010029959").PN.                                                                  | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>16:43 |
| S24 | 0   | electronic cigarette and inhal\$4 near25 every near15 (seconds or secs)              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/01/20<br>16:47 |
| S25 | 1   | nicotine and inhal\$4 near25 every near15 (seconds or secs)                          | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/01/20<br>16:48 |
| S26 | 1   | nicotine and inhal\$4 near25 every near15 (seconds or secs)                          | US-PGPUB;<br>USPAT;<br>USOCR;                                              | ADJ | ON  | 2015/01/20<br>16:59 |

|     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                            |     |     |                     |
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|     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                                  |     |     |                     |
| S27 | 53   | inhal\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:33 |
| S28 | 222  | puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:37 |
| S29 | 207  | ("131"/\$ or "128"/\$ or cigarette) and puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                    | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:40 |
| S30 | 179  | ("131"/\$ or "128"/\$) and puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:40 |
| S31 | 28   | ((("20070163610") or ("20090293895") or ("20130186416") or ("7832410") or ("8,156,944") or ("8,511,318") or ("20140345631") or ("20140345635") or ("20040191322") or ("20060018840") or ("20060196518") or ("20080241255") or ("20090004249") or ("20100242976") or ("20110268809") or ("20120255567") or ("4,830,028") or ("4,836,224") or ("6,102,036") or ("6,234,169") or ("6,799,576") or ("6,874,507") or ("7,767,698") or ("8,079,371") or ("8,322,350") or ("8,375,957") or ("8,381,739") or ("8,741,348"))).PN. | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>20:10 |
| S32 | 1    | (14/512311).APP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/03/23<br>22:03 |
| S33 | 1    | (14/512311).APP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/05/14<br>15:25 |
| S34 | 1605 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent)                                                                                                                                                                                                                                                                                                                                                                                                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:07 |
| S35 | 237  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic                                                                                                                                                                                                                                                                                                                                                                                                  | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:08 |
| S36 | 221  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4)                                                                                                                                                                                                                                                                                                                                                               | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:08 |

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| S37 | 191 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood)                                                                                       | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:08 |
| S38 | 163 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:09 |
| S39 | 108 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size)              | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:10 |
| S40 | 87  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4  | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:11 |
| S41 | 77  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4                      | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:12 |
| S42 | 4   | ("2004076289").PN.                                                                                                                                                                                                                                                     | FPRS; EPO; JPO         | OR  | OFF | 2015/05/14 18:13 |
| S43 | 15  | ANDERSSON near3 SVEN-BORJE                                                                                                                                                                                                                                             | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:15 |
| S44 | 13  | ANDERSSON near3 SVEN-BORJE and nicotine                                                                                                                                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:15 |
| S45 | 71  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4 and lung             | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:26 |
| S46 | 21  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and (ph near5 "7") and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4 and lung | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:27 |
| S47 | 26  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                   | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:28 |
| S48 | 38  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and                                                                                                                 | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:31 |

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|     |     | (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                                                                                                                                                                                                                    |                        |     |     |                  |
| S49 | 1   | ("20060196518").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/05/14 19:32 |
| S50 | 34  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and (salicylic or sorbic or lauric or levulinic or citric or benzoic or pyruvic) and (inhal\$5) and ((plasma or blood or peek or peak) near10 concentration) and (ph near5 "7") and heat\$4 and lung | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 08:30 |
| S51 | 1   | ("8831739").PN.                                                                                                                                                                                                                                                                                                              | US-PGPUB; USPAT        | OR  | OFF | 2015/05/15 08:43 |
| S52 | 1   | ("8381739").PN.                                                                                                                                                                                                                                                                                                              | US-PGPUB; USPAT        | OR  | OFF | 2015/05/15 08:43 |
| S53 | 14  | (igor near3 gonda) and nicotine and ng/ml                                                                                                                                                                                                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:42 |
| S54 | 13  | (igor near3 gonda) and nicotine near50 concentration near50 ng/ml                                                                                                                                                                                                                                                            | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:42 |
| S55 | 0   | (igor near3 gonda) and nicotine near50 concentration near50 ng/ml near50 salt                                                                                                                                                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:43 |
| S56 | 64  | (igor near3 gonda) and ((blood or plasma or nicotine) near50 concentration)                                                                                                                                                                                                                                                  | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:46 |
| S57 | 13  | (igor near3 gonda) and ((blood or plasma or nicotine) near50 concentration) same nicotine                                                                                                                                                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:46 |
| S58 | 1   | ("20030136404").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/05/17 15:16 |
| S59 | 1   | (14/512311).APP.                                                                                                                                                                                                                                                                                                             | US-PGPUB; USPAT        | OR  | OFF | 2015/07/14 09:12 |
| S60 | 1   | ("20140261474").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/07/14 10:27 |
| S61 | 1   | (14/512311).APP.                                                                                                                                                                                                                                                                                                             | US-PGPUB; USPAT        | OR  | OFF | 2015/09/17 14:40 |
| S62 | 934 | (A24F47/008).cpc.                                                                                                                                                                                                                                                                                                            | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:46 |
| S63 | 78  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and acid and (inhal\$5) and (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:46 |
| S64 | 367 | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and acid and (inhal\$5) and (plasma or blood) and heat\$4 and lung                                                                                                                                   | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:47 |
| S65 | 283 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and (levulinic or pyruvic or salicylic or sorbic or lauric or benzoic) and (inhal\$5 or mouth or oral\$4) and                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:48 |



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|     |      | (plasma or blood)                                                                                                                                        |                                                          |     |     |                  |
| S69 | 2    | ((("20060196518") or ("20140261474")).PN.                                                                                                                | US-PGPUB; USPAT                                          | OR  | OFF | 2015/12/10 16:09 |
| S70 | 1    | ("9215895").PN.                                                                                                                                          | US-PGPUB; USPAT                                          | OR  | OFF | 2016/03/30 20:38 |
| S71 | 0    | (14/925958).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:41 |
| S72 | 1    | (14/925968).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:41 |
| S73 | 2    | (12/236439).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:56 |
| S74 | 120  | (A24F47/008).cpc. and temperature near25 ("100" or "200" or "300")                                                                                       | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:53 |
| S75 | 34   | (A24F47/008).cpc. and temperature near25 ("100" or "200" or "300") near25 degrees                                                                        | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:56 |
| S76 | 35   | (A24F47/008 or A24F47/00 or A24F47/002).cpc. and temperature near25 ("100" or "200" or "300") near25 degrees                                             | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:57 |
| S77 | 0    | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees              | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:27 |
| S78 | 1787 | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature                                                           | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:28 |
| S79 | 118  | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees              | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:28 |
| S80 | 29   | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees and nicotine | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:29 |
| S81 | 2    | (12/336439).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 13:38 |
| S82 | 1    | ("5,544,646").PN.                                                                                                                                        | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 19:16 |
| S83 | 10   | (rose).in. and pyruvic and nicotine                                                                                                                      | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 19:18 |
| S84 | 1    | (12/481908).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 21:20 |
| S85 | 389  | nicotine near50 (lactic or lactate)                                                                                                                      | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/27 09:16 |
| S86 | 440  | nicotine near50 (lactic or lactate)                                                                                                                      | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ | ON  | 2016/04/27 09:16 |
| S87 | 65   | ((a24f47/00)".cpc" or (131/\$.ccls.) or (128/\$.ccls.) and nicotine near50 (lactic                                                                       | US-PGPUB; USPAT;                                         | ADJ | ON  | 2016/04/27 09:20 |

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|      |      | or lactate)                                                                                                  | USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                        |     |     |                     |
| S88  | 70   | ((a24f47/00).cpc. or (131/\$.ccls.) or (128/\$).ccls.) and nicotine near50 (lactic or lactate)               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>09:20 |
| S89  | 73   | ((a24f47/00 or a24f47/008).cpc. or (131/\$.ccls.) or (128/\$).ccls.) and nicotine near50 (lactic or lactate) | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>09:20 |
| S90  | 1    | ("9,215,895").PN.                                                                                            | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/04/27<br>11:18 |
| S91  | 6717 | (a24f47/00 or a24f47/008).cpc.                                                                               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>18:29 |
| S92  | 754  | glycerol near50 ((veggie or vegetable) near2 glycerol)                                                       | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:10 |
| S93  | 719  | glycerol near5 ((veggie or vegetable) near2 glycerol)                                                        | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:10 |
| S94  | 48   | glycerol near5 (veggie glycerol or vegetable glycerol)                                                       | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:14 |
| S95  | 3    | glycerin near5 (veggie glycerol or vegetable glycerol)                                                       | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:15 |
| S96  | 3    | glycerin near25 (veggie glycerol or vegetable glycerol)                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:15 |
| S97  | 3    | (a24f47/00 or a24f47/008).cpc. and (veggie glycerol or vegetable glycerol)                                   | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:17 |
| S99  | 1    | ("20130255702").PN.                                                                                          | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/06/09<br>12:43 |
| S100 | 1    | (14/925968).APP.                                                                                             | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/06/09<br>12:44 |
| S101 | 7    | ((han near3 li) or (lik near3 hon)).in. and wick\$4                                                          | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/06/09<br>12:50 |
| S102 | 16   | a24f47/\$2.cpc. and wick\$3                                                                                  | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/06/09<br>12:53 |
| S103 | 1    | ("20150128967").PN.                                                                                          | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/07/12<br>08:38 |

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| S104 | 1   | (14/213108).APP.                                                                                                       | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/07/12<br>11:29 |
| S105 | 2   | ((("4,793,365") or ("5,101,839"))).PN.                                                                                 | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/07/12<br>12:51 |
| S106 | 686 | (131/\$.ccls. or a24f47/\$.cpc.) and lactic                                                                            | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:04 |
| S107 | 252 | (131/\$.ccls. or a24f47/\$.cpc.) and lactic<br>and nicotine                                                            | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:04 |
| S108 | 219 | (131/\$.ccls. or a24f47/\$.cpc.) and lactic<br>and nicotine and (glycer\$\$ or glycol)                                 | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:05 |
| S109 | 218 | (131/\$.ccls. or a24f47/\$.cpc.) and lactic<br>and nicotine and (glycer\$4 or glycol)                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:05 |
| S110 | 76  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol)                                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:06 |
| S111 | 72  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol) and temperature                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:42 |
| S112 | 73  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol) and heat\$4                                      | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:44 |
| S113 | 57  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and heat\$4                                     | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S114 | 57  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and heat\$4 and<br>temperature                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S115 | 52  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and (heat\$4<br>near50 temperature)             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S116 | 38  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and (heat\$4<br>near50 temperature) and wick\$4 | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:46 |
| S117 | 1   | ("20060196518").PN.                                                                                                    | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/10/23<br>19:49 |
| S118 | 195 | ((han or hon) near3 (lik or li)).in. and<br>temperature                                                                | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:52 |
| S119 | 48  | ((han or hon) near3 (lik or li)).in. and<br>temperature near5 (low)                                                    | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:53 |
| S120 | 0   | ((han or hon) near3 (lik or li)).in. and low-<br>temperature and cigarette                                             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:54 |
| S121 | 12  | ((han or hon) near3 (lik or li)).in. and low<br>near10 temperature and cigarette                                       | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:54 |
| S122 | 19  | ((han or hon) near3 (lik or li)).in. and<br>citric and glycerol                                                        | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>20:32 |
| S123 | 6   | (adam near3 bowen).in. and "C.sub.max"                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>20:55 |

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| S124 | 1   | (14/925968).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/10/23<br>20:55 |
| S125 | 23  | (adam near3 bowen).in. and nicotine                                                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>20:58 |
| S126 | 6   | (adam near3 bowen).in. and (plasma or blood) near15 (peak or max or maxim\$3)                                            | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>20:59 |
| S127 | 102 | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3)                                                    | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:00 |
| S128 | 82  | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3) and acid and nicotine                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:01 |
| S129 | 61  | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3) and ((organic or citric) near30 acid) and nicotine | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:02 |
| S130 | 1   | (14/925968).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/09<br>13:58 |
| S131 | 2   | (14/512311).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/10<br>09:32 |
| S132 | 1   | (14/271071).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/10<br>09:33 |
| S133 | 22  | 131/\$.ccls. and nicotine and levulinate                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>20:23 |
| S134 | 153 | 131/\$.ccls. and nicotine and levul\$5                                                                                   | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>21:59 |
| S135 | 140 | 131/\$.ccls. and nicotine and (levul\$5 near50 acid)                                                                     | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>21:59 |
| S136 | 47  | 131/\$.ccls. and (nicotin\$3 near50 (levul\$5 near50 acid))                                                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>22:00 |
| S137 | 70  | 131/\$.ccls. and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                                   | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:30 |
| S138 | 70  | (131/\$.ccls. or a24f47/\$.cpc) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:30 |
| S139 | 0   | (a24f47/\$.cpc) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                                | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:31 |
| S140 | 94  | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                               | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:31 |
| S141 | 103 | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/11/27<br>12:31 |
| S142 | 49  | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or                                         | US-PGPUB;<br>USPAT;                                                        | ADJ | ON  | 2016/11/27<br>14:14 |

|      |    |                                                                                                                    |                                                                            |     |     |                     |
|------|----|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----|-----|---------------------|
|      |    | lactate)) and wick\$4                                                                                              | USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                        |     |     |                     |
| S143 | 1  | (14/925968).APP.                                                                                                   | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/27<br>14:31 |
| S144 | 1  | ("9,215,895").PN.                                                                                                  | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/27<br>21:05 |
| S145 | 30 | (131/\$.ccls. or a24f47/\$.cpc.) and<br>(nicotin\$3 near50 ((lactic near50 acid) or<br>lactate)) and particle size | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/11/27<br>23:17 |

EAST Search History (Interference)

| Ref # | Hits | Search Query                                                                                                                                                                                                                                               | DBs      | Default Operator | Plurals | Time Stamp          |
|-------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------|---------|---------------------|
| S66   | 723  | (A24F47/008).cpc.                                                                                                                                                                                                                                          | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:46 |
| S67   | 246  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls.<br>and nicotine near25 (formulation or solution or<br>liquid or solvent) and acid and (inhal\$5) and<br>(plasma or blood) and heat\$4 and lung                                                        | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:47 |
| S68   | 196  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and<br>nicotine near25 (formulation or solution or<br>liquid or solvent) and (levulinic or pyruvic or<br>salicylic or sorbic or lauric or benzoic) and<br>(inhal\$5 or mouth or oral\$4) and (plasma or<br>blood) | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:49 |

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| First Named Inventor   | Adam Bowen          |
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| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

Sheet 1 of 6

**U. S. PATENT DOCUMENTS**

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|                       | 696                      | US- 2007/0277816                         | 12/6/2007                         | Morrison et al.                                    |                                                                                 |
|                       | 674                      | US- 2009/0111287                         | 4/30/2009                         | Lindberg et al.                                    |                                                                                 |
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|                       | 676                      | US- 2011/0240047                         | 10/6/2011                         | Adamic                                             |                                                                                 |
|                       | 297                      | US- 2012/0285475                         | 11/15/2012                        | Liu                                                |                                                                                 |
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|                       | 387                      | EP2856893A1                                                                       | 4/8/2015                          | Fontem Holdings                                    |                                                                                 |                |
|                       | 388                      | EP2908675A1(asWO2014/060268)                                                      | 8/26/2015                         | Nicoventures Holdings Ltd                          |                                                                                 |                |
|                       | 389                      | EP2915443A1                                                                       | 9/9/2015                          | Fontem Holdings                                    |                                                                                 |                |
|                       | 757                      | EP3062646A1 (WO2015/66136)                                                        | 9/7/2016                          | Rai Strategic Holdings Inc                         |                                                                                 |                |
|                       | 758                      | EP3065581A2 (WO2015/68044)                                                        | 9/14/2016                         | SIS Resources Ltd                                  |                                                                                 |                |
|                       | 759                      | EP3068244A1 (WO2015/73975)                                                        | 9/21/2016                         | VMR Products LLC                                   |                                                                                 |                |

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| Attorney Docket Number | 13211-713.303       |

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|                    | 312                   | US- 2013/0340775                         | 12/26/2013                     | Juster et al.                                      |                                                                                 |
|                    | 723                   | US- 2014/0007891                         | 1/9/2014                       | Liu                                                |                                                                                 |
|                    | 314                   | US- 2014/0014126                         | 1/16/2014                      | Peleg et al.                                       |                                                                                 |
|                    | 316                   | US- 2014/0053856                         | 2/27/2014                      | Liu                                                |                                                                                 |
|                    | 318                   | US- 2014/0060556                         | 3/6/2014                       | Liu                                                |                                                                                 |
|                    | 319                   | US- 2014/0096782                         | 4/10/2014                      | Ampolini et al.                                    |                                                                                 |
|                    | 320                   | US- 2014/0109921                         | 4/24/2014                      | Chen                                               |                                                                                 |
|                    | 321                   | US- 2014/0116455                         | 5/1/2014                       | Youn                                               |                                                                                 |
|                    | 322                   | US- 2014/0123990                         | 5/8/2014                       | Timmermans                                         |                                                                                 |
|                    | 323                   | US- 2014/0150810                         | 6/5/2014                       | Hon                                                |                                                                                 |
|                    | 324                   | US- 2014/0174459                         | 6/26/2014                      | Burstyn                                            |                                                                                 |
|                    | 327                   | US- 2014/0196735                         | 7/17/2014                      | Liu                                                |                                                                                 |
|                    | 328                   | US- 2014/0216450                         | 8/7/2014                       | Liu                                                |                                                                                 |
|                    | 329                   | US- 2014/0230835                         | 8/21/2014                      | Saliman                                            |                                                                                 |
|                    | 331                   | US- 2014/0270727                         | 9/18/2014                      | Ampolini et al.                                    |                                                                                 |
|                    | 332                   | US- 2014/0301721                         | 10/9/2014                      | Ruscio et al.                                      |                                                                                 |
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|                    | 336                   | US- 2014/0355969                         | 12/4/2014                      | Stern                                              |                                                                                 |
|                    | 340                   | US- 2015/0020825                         | 1/22/2015                      | Galloway et al.                                    |                                                                                 |

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|                    | 416                   | WO2004/080216A1(EngAbs)                                                           | 9/23/2004                      | Hon, Lik                                           |                                                                                 |                |
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|                    | 427                   | WO2012/120487A2                                                                   | 9/13/2012                      | Chong Corp                                         |                                                                                 |                |
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|                    | 435                   | WO2014/101734A1                                                                   | 7/3/2014                       | Shenzhen Smoore Tech                               |                                                                                 |                |

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|                       | 341                      | US- 2015/0020831                         | 1/22/2015                      | Weigensberg et al.                                 |                                                                                 |
|                       | 343                      | US- 2015/0027472                         | 1/29/2015                      | Amir                                               |                                                                                 |
|                       | 344                      | US- 2015/0034103                         | 2/5/2015                       | Hon                                                |                                                                                 |
|                       | 724                      | US- 2015/0034104                         | 2/5/2015                       | Zhou                                               |                                                                                 |
|                       | 345                      | US- 2015/0040929                         | 2/12/2015                      | Hon                                                |                                                                                 |
|                       | 346                      | US- 2015/0101625                         | 4/16/2015                      | Newton et al.                                      |                                                                                 |
|                       | 347                      | US- 2015/0122252                         | 5/7/2015                       | Frija                                              |                                                                                 |
|                       | 348                      | US- 2015/0122274                         | 5/7/2015                       | Cohen et al.                                       |                                                                                 |
|                       | 349                      | US- 2015/0128965                         | 5/14/2015                      | Lord                                               |                                                                                 |
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|                       | 697                      | US- 2015/0136158                         | 5/21/2015                      | Stevens et al.                                     |                                                                                 |
|                       | 352                      | US- 2015/0142387                         | 5/21/2015                      | Alarcon et al.                                     |                                                                                 |
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|                       | 356                      | US- 2015/0164144                         | 6/18/2015                      | Liu                                                |                                                                                 |
|                       | 698                      | US- 2015/0164147                         | 6/18/2015                      | Verleur et al.                                     |                                                                                 |
|                       | 357                      | US- 2015/0181928                         | 7/2/2015                       | Liu                                                |                                                                                 |
|                       | 358                      | US- 2015/0189695                         | 7/2/2015                       | Xiang                                              |                                                                                 |
|                       | 359                      | US- 2015/0196059                         | 7/16/2015                      | Liu                                                |                                                                                 |
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|                       | 439                      | WO2014/150704A2                                                                   | 9/25/2014                         | Altria Client Svs Inc.                             |                                                                                 |                |
|                       | 442                      | WO2014/205263A1                                                                   | 12/24/2014                        | Loec Inc.                                          |                                                                                 |                |
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|                    | 361                   | US- 2015/0208731                         | 7/30/2015                      | Malamud et al.                                     |                                                                                 |
|                    | 700                   | US- 2015/0216237                         | 8/6/2015                       | Wensley et al.                                     |                                                                                 |
|                    | 362                   | US- 2015/0223521                         | 8/13/2015                      | Menting et al.                                     |                                                                                 |
|                    | 363                   | US- 2015/0224268                         | 8/13/2015                      | Henry et al.                                       |                                                                                 |
|                    | 364                   | US- 2015/0237917                         | 8/27/2015                      | Lord                                               |                                                                                 |
|                    | 365                   | US- 2015/0237918                         | 8/27/2015                      | Liu                                                |                                                                                 |
|                    | 366                   | US- 2015/0245654                         | 9/3/2015                       | Memari et al.                                      |                                                                                 |
|                    | 367                   | US- 2015/0245660                         | 9/3/2015                       | Lord                                               |                                                                                 |
|                    | 368                   | US- 2015/0257445                         | 9/17/2015                      | Henry Jr. et al.                                   |                                                                                 |
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|                    | 370                   | US- 2015/0282527                         | 10/8/2015                      | Henry Jr.                                          |                                                                                 |
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| Application Number     | 14/925,968          |
| Filing Date            | October 28, 2015    |
| First Named Inventor   | Adam Bowen          |
| Art Unit               | 1747                |
| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

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|       |   |    |   | Filing Date            | October 28, 2015    |
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|       |   |    |   | Art Unit               | 1747                |
|       |   |    |   | Examiner Name          | Mayes, Dionne Walls |
|       |   |    |   | Attorney Docket Number | 13211-713.303       |

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(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**08.04.2015 Bulletin 2015/15**

(51) Int Cl.:  
**A24F 47/00** (2006.01) **A61M 15/06** (2006.01)  
**G05D 23/19** (2006.01)

(21) Application number: **13004749.1**

(22) Date of filing: **02.10.2013**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB**  
**GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO**  
**PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

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(54) **Electronic smoking device**

(57) An electronic smoking device comprises a housing accommodating a battery (10) as an electric power source powering an electrically heatable atomizer comprising an electric heater (22) and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer. The heater (22) of the atomizer is controlled by means of control electronics (14). A puff detector (18) indicates an aerosol inhaling puff to the control electronics. (14). The control electronics (14) oper-

ates, for a puff, the heater (22) of the atomizer with a pre-determined level of electric power. Preferably, the electronic smoking device comprises a voltage sensor (34) measuring the battery voltage, wherein the control electronics (14) distributes the pre-determined level of electric power, for a puff, by pulse width modulation, based on the battery voltage measured by the voltage sensor (34).

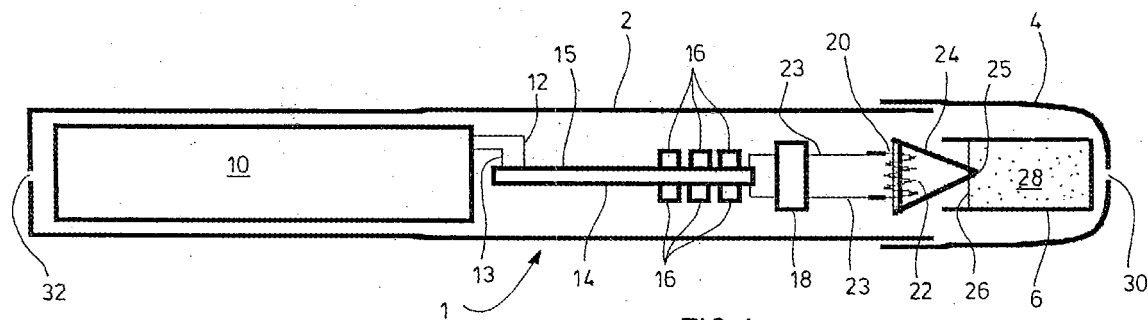


**FIG. 1**

## Description

**[0001]** The invention relates to an electronic smoking device, in particular an electronic cigarette.

**[0002]** An electronic smoking device, e.g. designed as an electronic cigarette, generally comprises a housing accommodating an electric power source (usually a battery or a rechargeable battery), an electrically heatable atomizer including an electric heater adapted to atomize a liquid supplied from a reservoir (usually a capsule) in order to provide an aerosol exiting from the atomizer, and control electronics which control the heater of the atomizer. A puff detector indicates or signals an aerosol inhaling puff to the control electronics. Usually, the puff detector is designed as an inhaling sensor detecting a user's puff, but it can also be accomplished, e.g., as a simple push button pressed by the user while inhaling the aerosol. When a puff is indicated to the control electronics, the heater in the atomizer is powered, which causes the creation of aerosol. Here and in the following, the action of the atomizer is called "atomize" and the related product is called "aerosol", irrespective of its composition, which might include gaseous and smoke constituents.

**[0003]** EP 2 443 946 A1 discloses an electronic cigarette and a capsule containing a liquid to be atomized (or evaporated) in an atomizer. The capsule comprises a shell which is sealed at one end side by a puncturable membrane. To mount the capsule at the mouth-ended side of the electronic cigarette, a soft sleeve surrounding the capsule is placed on the end area of a tube accommodating the atomizer. During the mounting step, a spike provided at the end of a kind of metal wick pierces the membrane, and the liquid of the capsule is guided by the wick to the atomizer. The aerosol generated by the atomizer passes the area of the capsule through some ducts provided at the exterior surface of the capsule to reach an end opening where it can be inhaled by the consumer.

**[0004]** US 2011/0304282 A1 describes a power supply section for an electronic cigarette. This section comprises an elongate housing sleeve, which accommodates a rechargeable battery, an inhaling sensor for detecting an aerosol inhaling puff of a user, and control electronics connected to the inhaling sensor and adapted to control the heater of an atomizer. At an end side of the housing sleeve, a connector provides a mechanical support to a mouth-sided section of the electronic cigarette, which comprises the atomizer and holds a capsule containing a liquid to be atomized. The connector includes electrical connections for the atomizer.

**[0005]** In the known electronic smoking devices, the heater of the atomizer is generally driven by the voltage provided by the battery and powered for a certain time period, usually the period during which the inhaling sensor signals the presence of a puff or for a pre-determined period. When the battery is discharged during use, its voltage drops so that the power of the heater decreases,

which results in less intensive puffs. In some devices, the user can influence the heater by external settings, which might affect the aerosol emerging from the atomizer in an undesired manner, however. Generally, when the heater is not hot enough, aerosol creation is poor or stops completely. On the other hand, when the heater gets too hot, too much aerosol is created or, even worse, aerosol substances may burn or disintegrate, and the battery is discharged too quickly. It would be desirable to measure the temperature of the heater, but this would require a temperature sensor close to the heater, implying an appreciable technical effort.

**[0006]** US 6,040,560 discloses a power controller for an electrical smoking system which externally heats a tobacco-containing cigarette. This controller uses a power cycle including at least two phases, each having a predetermined total energy input.

**[0007]** The object of the invention is to provide an electronic smoking device, in which the heater of the atomizer can be operated in a simple, reliable and reproducible manner, largely independent of changes of the battery voltage.

**[0008]** This object is achieved by an electronic smoking device having the features of claim 1. Advantageous embodiments of the invention follow from the dependant claims.

**[0009]** The electronic smoking device according to the invention comprises a housing, which accommodates a battery as an electric power source powering an electrically heatable atomizer. The atomizer comprises an electric heater and is able to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer. Moreover, the electronic smoking device comprises control electronics and a puff detector. The puff detector, for example an inhaling sensor or a manually actuable switch (see below), indicates an aerosol inhaling puff to the control electronics. The control electronics are adapted to control the heater of the atomizer. For example, when the puff detector detects a puff and indicates or signals that to the control electronics, the heater is powered by means of the control electronics in order to create aerosol.

**[0010]** According to the invention, the control electronics operates, for a puff, the heater of the atomizer with a pre-determined level of electric power. That means, the electric power (i.e. electric energy per time unit) supplied to the heater is controlled in a way so that it is maintained at the pre-determined level for the actual puff. This does not exclude fluctuations of the power during the puff, provided the fluctuations are on a time scale which is short compared to the duration of the puff. In other words, the electric power by which the heater is operated is kept constant at the pre-determined level, during the puff, to a rather high degree of accuracy. Thus, the conditions during an inhaling puff are largely reproducible, even when the battery voltage drops due to consumption and discharging. Given the latent heat for aerosol production in the atomizer and the thermal losses due to radiation

and convective heat transport by means of the aerosol, the pre-determined power level may correspond to a more or less well-defined temperature of the heater and the atomizer. Such a general relation between power and temperature permits a pre-selection of a suitable power level, which in practice is preferably performed experimentally.

**[0011]** A complete electronic smoking device according to the invention, for example an electronic cigarette, may include components in addition to the housing, the puff detector and the control electronics mentioned above. For example, the atomizer and the reservoir may be accommodated in a separate section connected to the above housing. However, per definition the term "electronic smoking device" is also used for a device just including the housing, the puff detector and the control electronics because that device is related to electronic smoking and might be marketed separately. In this sense, the battery (which is mounted in the housing, but which usually is replaceable), the atomizer and/or the reservoir may be or may be not components of the electronic smoking device.

**[0012]** In advantageous embodiments, the electronic smoking device according to the invention comprises a voltage sensor. The voltage sensor measures the battery voltage and is connected to the control electronics. Moreover, the control electronics is adapted to distribute the pre-determined level of electric power, for a puff, by pulse width modulation, based on the battery voltage measured by the voltage sensor.

**[0013]** For example, the voltage sensor detects when the battery voltage drops in the course of time. Based on that information, the control electronics is able to adjust the duty cycle of the pulse-width-modulated voltage provided to the heater terminals. Assuming that the electrical resistance of the heater is largely constant, i.e. independent of temperature (see below) and has a pre-determined value, an instantaneous voltage level at the heater terminals corresponds to a certain instantaneous current flowing through the heater ( $\text{current} = \text{voltage}/\text{resistance}$ ) and thus to a certain instantaneous electrical power dissipated in the heater resistance ( $\text{power} = \text{voltage} \times \text{current} = \text{voltage}^2/\text{resistance}$ ). The voltage supplied to the heater terminals can be the battery voltage. Thus, the pre-determined level of electric power can be maintained as long as it is smaller than  $(\text{battery voltage})^2/\text{resistance}$ , and the control is performed via the duty cycle of the pulse width modulation. This will be explained in more detail by means of an embodiment, see below.

**[0014]** If the electrical resistance of the heater is not constant, pulse width modulation may be used as well. In any case, a look-up table determining the relation between measured battery voltage and duty cycle can be established experimentally, for a pre-determined electrical power.

**[0015]** Due to the internal resistance of the battery, the battery voltage available at the terminals of the battery depends on the current flowing through the heater. Since

the current is switched on and off in pulse width modulation, the battery voltage will change during a puff. Additionally, when no current is flowing, the battery voltage recovers as a function of time, which also depends on the charge state of the battery. In practice, the battery voltage fluctuates during a puff, which creates the problem of selecting appropriate values for the battery voltage in order to run the pulse width modulation in a reliable manner.

**[0016]** In advantageous embodiments of the invention, the control electronics is adapted to receive multiple measured values of the battery voltage during a puff and to derive a representative value of the battery voltage therefrom. This representative value is taken as an appropriate value for the battery voltage, which can be used for determining the duty cycle of the pulse width modulation. In principle, the representative value of the battery voltage might be selected by an analogue technique, e.g. by filtering, which takes some average over the fluctuations.

**[0017]** A digital technique may be more advantageous, however. For example, the control electronics can be adapted to derive the representative value of the battery voltage as the smallest individually measured value of the battery voltage plus a constant. In other words, the battery voltage is frequently measured during a certain puff (puff  $n$ ), and the results are stored. Lower measured values tend to be associated with the heater being switched on and are representative for the battery under load. On the other hand, the lowest value of the battery voltage will not be realistic because of fluctuations and short-time recovery of the battery. Therefore, a constant is added, for example a constant of 200 mV.

**[0018]** The representative value of the battery voltage derived in this way during puff  $n$  can be applied in the next puff (i.e. in puff  $n+1$ ) as the value for the battery voltage. That means, this value is taken as a constant value for the battery voltage during puff  $n+1$  for the purposes of determining the pulse widths to observe the pre-determined level of electric power during puff  $n+1$ . During puff  $n+1$ , the battery voltage can be frequently measured as well, as in puff  $n$ , to derive a new representative value of the battery voltage, which is to be used in puff  $n+2$ , and so on. In this way, during each puff, the battery voltage is taken as a constant, but it is considered that the battery voltage will change with increasing puff number. For the first puff (puff 1), e.g. the first puff after the battery has been freshly charged, an empirical value can be taken as the representative value of the battery voltage, e.g. the nominal voltage (highest voltage) of a lithium ion battery minus an empirical correction constant.

**[0019]** In other embodiments, the control electronics receives multiple measured values of the battery voltage during a puff and re-adjusts the pulse widths (duty cycle) during a puff to observe the pre-determined level of electric power. That means that the control electronics is able to react on changes of the battery voltage during a puff and to adjust the duty cycle accordingly still during this

puff.

**[0020]** The voltage sensor can be integrated in the control electronics. It may also be provided as an independent voltage meter. A person skilled in the art knows many possibilities for accomplishing a voltage sensor for measuring the battery voltage and transmitting the result to the control electronics. For example, the battery voltage can be measured by using an ADC (analog-to-digital converter) either integrated in a microcontroller (system on chip) or provided as an independent IC (integrated circuit) that is connected through an I2C (inter-integrated circuit bus) or SPI (serial peripheral interface bus) interface to the microcontroller or system on chip.

**[0021]** There are several options for the kind of response initiated when a puff is indicated to the control electronics. In an advantageous embodiment, the control electronics is adapted to operate, upon indication of a puff, the heater of the atomizer with the pre-determined level of electric power as long as the puff is indicated. That means, the amount of energy delivered to the heater (and thus the amount of aerosol created) is variable and depends on the length of the puff. In another embodiment, the control electronics is adapted to operate, upon indication of a puff, the heater of the atomizer with the pre-determined level of electric power for a pre-determined period. In that case, indication of a puff just triggers a pre-determined action, i.e. the delivery of a pre-selected amount of electrical energy to the atomizer.

**[0022]** In advantageous embodiments of the invention, the control electronics operates the heater of the atomizer with a reduced level of electric power, when it is not operated with the pre-determined level of electric power. That means, in the intervals between the puffs, the heater is not switched off, but run at a lower temperature, which avoids that the heater cools down too much so that it can be quickly re-activated upon demand. On the other hand, the overall energy consumption is higher in this operating mode.

**[0023]** As already explained further above, the puff detector transmits (indicates) to the control electronics the message that the user takes an inhaling puff. To this end, a manually actuatable switch (e.g. a push button) is sufficient, which is pressed by the user during inhaling. In a more elaborate design, the puff detector comprises an inhaling sensor, e.g. a sensor detecting a vacuum or an air flow in the housing of the electronic smoking device, which is created when the user is inhaling at a mouthpiece.

**[0024]** In advantageous embodiments of the invention, the heater of the atomizer comprises a heating resistor, wherein the material of the heating resistor comprises a nickel-chromium alloy, a nickel-chromium alloy comprising 80% per weight nickel and 20% per weight chromium (NiCr alloy 80/20), a film polyimide, and/or an iron-chromium-aluminium alloy (FeCrAl alloy, Kanthal alloys). The temperature dependence of the electrical resistivity is relatively low for these alloys, which facilitates the control of the atomizer.

**[0025]** The battery can be a component of the electronic smoking device. Preferably, the battery is designed as a re-chargeable lithium ion battery protected by safety circuitry. In this case, the control electronics described so far does not monitor the charge-state of the battery in order to prevent the battery from completely discharging or from over-charging. Such safety-relevant tasks are performed by the safety circuitry, which may be designed as a part of the battery.

**[0026]** In the following, the invention is explained in more detail by means of examples. The drawings show in

Figure 1 a schematic longitudinal section of an embodiment of the electronic smoking device according to the invention,

Figure 2 a block diagram of the electronics of the embodiment according to Figure 1, and

Figure 3 a graphical representation of the voltage applied to an electric heater of an atomizer of the embodiment according to Figure 1 as a function of time (pulse width modulation).

**[0027]** Figure 1 illustrates an embodiment of an electronic smoking device 1 in a schematic longitudinal section.

**[0028]** The electronic smoking device 1 comprises a cylinder-like housing 2 and a mouthpiece 4, which is designed as a detachable cap. Taking off the mouthpiece 4 provides access to a replaceable capsule 6, which serves as a reservoir for a liquid.

**[0029]** The housing 2 accommodates a battery 10. In the embodiment, the battery 10 is designed as a re-chargeable lithium ion battery and includes its own safety circuitry. The battery 10 is connected, via leads 12 and 13, to control electronics 14, which includes integrated circuits mounted on a printed circuit board 15. The printed circuit board 15 also supports a plurality of light-emitting diodes (LEDs) 16, which are assembled behind respective windows provided in the housing 2 and indicate the current status of the electronic smoking device 1.

**[0030]** A puff detector 18 is connected to the control electronics 14. In the embodiment, the puff detector 18 is designed as an inhaling sensor, which detects the vacuum generated inside the housing 2 when a user inhales at the mouthpiece 4.

**[0031]** An atomizer 20 comprises a heater 22 connected via leads 23 to the control electronics 14. The heater 22 includes a heating wire mounted at a ceramics shell (not shown in the Figures), which also supports a wick device 24 made of braided metal or sponge-like metal material. A piercing tip 25 at the distant end of the wick device 24 is able to penetrate a membrane 26 used for sealing the capsule 6 so that liquid 28 contained in the capsule 6 can be guided out of the capsule 6 and through the wick device 24 to the area of the heater 22.

**[0032]** At its free end, the mouthpiece 4 comprises an

inhaling aperture 30. At the opposite end of the electronic smoking device 1, a charging port 32 is provided which permits re-charging of the battery 10, e.g. via a USB port.

**[0033]** To use the electronic smoking device 1, a consumer inserts a fresh capsule 6 so that its membrane 26 is pierced and liquid is supplied from the capsule 6 via the wick device 24 to the area of the heater 22. When the consumer inhales at the inhaling aperture 30, the puff detector 18 senses the resulting vacuum inside the housing 2 and indicates that to the control electronics 14. In response thereto, the heater 22 is powered so that its heating wire is able to atomize the liquid in its proximity in order to create an aerosol, which is inhaled by the consumer. In the embodiment, the heater remains switched on as long as the puff detector 18 senses a vacuum.

**[0034]** Figure 1 is a schematic illustration of the general set-up of the electronic smoking device 1. The functional set-up of the electronic smoking device 1 is shown in Figure 2 in a more appropriate way, by means of a block diagram of the electronics.

**[0035]** According to Figure 2, the battery 10 is connected to the control electronics 14 via the leads 12 and 13. The puff detector 18 is displayed as a block connected to the control electronics 14, because its output signal is fed to the control electronics 14. The heater 22 is also connected to the control electronics 14, by means of the leads 23. In the embodiment, the heater 22 comprises a heating resistor made of wire of a nickel-chromium alloy (80% per weight nickel and 20% by weight chromium). Other materials for the heating resistor, which are well-known in the art, are conceivable as well. The above nickel chromium alloy has the advantage of a low dependency of the electrical resistivity on temperature. So far, the components shown in Figure 2 are present in Figure 1 as well.

**[0036]** Moreover, Figure 2 displays a voltage sensor 34, which is connected between the leads 12 and 13 of the battery 10 and detects the actual battery voltage. The output of the voltage sensor 34 is supplied to the control electronics 14. In the embodiment, the voltage sensor 34 is designed as a component of the control electronics 14. The voltage sensor 34 comprises an analogue-to-digital converter (ADC) which outputs a numerical value representative for the actual battery voltage, which can be processed by a micro-processor which is part of the control electronics 14. Other embodiments of the voltage sensor 34 are conceivable as well.

**[0037]** During use of the electronic smoking device 1, the voltage of the battery 10 drops due to discharging. This process is monitored by the voltage sensor 34 so that the control electronics 14 is quasi continuously informed on the charge state of the battery 10. In order to operate the heater 22 of the atomizer 20, for each puff, with a pre-determined level of electric power, the control electronics 14 distributes the electric power supplied to the heater 22 by pulse width modulation, based on the battery voltage measured by the voltage sensor 34.

When the battery voltage changes, the duty cycle of the pulse width modulation is adjusted so that the resulting power is maintained at the predetermined value.

**[0038]** In the embodiment, an appropriate value for the battery voltage in each puff is determined in the following way.

**[0039]** The control electronics 14 receives, via the voltage sensor 34, multiple measured values of the battery voltage during a puff, and these values are stored. A puff is typically considerably longer than a typical measurement time for the battery voltage, which in turn is considerably longer than the period of pulse width modulation. In the embodiment, the measurements of battery voltage and the period of pulse width modulation are not synchronised to each other.

**[0040]** At the end of the puff (called "puff  $n$ "), a representative value of the battery voltage is derived from the stored measured values. To this end, the control electronics 14 selects the smallest battery voltage value measured during this puff and adds a constant thereto. Appropriate values for the constant can be determined empirically. In the embodiment, the constant is 200 mV.

**[0041]** The representative value of the battery voltage derived in this way during puff  $n$  is applied in the next puff (i.e. in puff  $n+1$ ) as the value for the battery voltage. That means, this value is taken as the battery voltage during puff  $n+1$  for the purposes of determining the pulse widths (duty cycle) to keep the electric power delivered to the heater 22 during puff  $n+1$  at the pre-determined constant level.

**[0042]** During puff  $n+1$ , however, the battery voltage is also frequently measured, as in puff  $n$ , to derive a new representative value of the battery voltage, which is to be used in puff  $n+2$ , and so on. In this way, during each puff, the battery voltage is assumed to be a constant, but it is taken into consideration that the battery voltage will change with increasing puff number, i.e. that it usually will decrease due to discharging of the battery.

**[0043]** For the first puff (puff 1), e.g. the first puff after the battery 10 has been freshly charged, an empirical value can be taken as the representative value of the battery voltage, e.g. the nominal voltage (highest voltage) of a lithium ion battery minus an empirical correction constant.

**[0044]** When the puff detector 18 does not sense a vacuum inside the housing 2, the heater 22 is not powered. Alternatively, during these intervals the heater 22 may be operated at a reduced or even much reduced power level in order to keep some elevated temperature at the atomizer 20, which permits a faster restart of the atomizer 20 when the next puff is detected. Such a reduced power level can also be controlled by means of pulse width modulation, by applying a different duty cycle.

**[0045]** In the following, a numerical example is given which explains the operation of the heater 22 by means of pulse width modulation of the voltage applied to the heater leads 23. In this example, the heater 22 is considered as an Ohmic resistor having a constant resist-



ance of  $R = 2.25$  Ohms, neglecting any inductive or capacitive effects. The required duty cycle, as a function of the actual battery voltage (i.e. the representative value of the battery voltage described above), for achieving a constant heater power of  $P_0 = 3$  W is determined by a simple calculation. The results can be stored as a look-up table in a memory so that a microprocessor of the control electronics 14 can select the duty cycle in response to a representative value of the battery voltage. Inductive or capacitive effects may be taking into consideration, for example, by empirical corrections of the duty cycle values in the look-up table.

[0046] Figure 3 schematically illustrates the voltage pulses supplied to the heater 22 as a function of time. The time unit is relative, i.e. related to the period of one complete pulse. In the embodiment, this period is about 4 ms, which is very short compared to the typical duration of one puff (several seconds). During each pulse, either the actual battery voltage or zero voltage is supplied, and the respective duty cycle is taken from the look-up table. Figure 3 shows the pulses for two different battery voltages, i.e. 3 V and 4 V.

[0047] Using Ohm's law ( $U = R \cdot I$ , with battery voltage  $U$ , heater resistance  $R$  and heater current  $I$ ), the power  $P$  dissipated in the heater 22 during the switched-on state of one pulse is  $P = U \cdot I = U^2/R$ . This state lasts for a fraction  $c$  of one pulse period. During the fraction  $(1 - c)$ , the voltage is switched off. Thus,  $c$  can be calculated by  $c \cdot P = P_0$  or  $c = P_0 \cdot R/U^2$ . The duty cycle of the pulse is determined by  $c$ .

[0048] The following table provides  $c$  as a function of the battery voltage  $U$ . It is assumed that  $U$  drops from an initial value of 4.2 V to 2.9 V. When the battery voltage gets too low, the battery 10 is disabled by its own safety circuitry.

| Battery voltage $U$ [V] | $c$   |
|-------------------------|-------|
| 2.9                     | 0.803 |
| 3.0                     | 0.750 |
| 3.1                     | 0.702 |
| 3.2                     | 0.659 |
| 3.3                     | 0.620 |
| 3.4                     | 0.584 |
| 3.5                     | 0.551 |
| 3.6                     | 0.521 |
| 3.7                     | 0.493 |
| 3.8                     | 0.467 |
| 3.9                     | 0.444 |
| 4.0                     | 0.422 |
| 4.1                     | 0.402 |
| 4.2                     | 0.383 |

[0049] In practice, the look-up table can be calculated and stored in finer steps.

## Claims

### 1. Electronic smoking device, comprising

- a housing (2) adapted to accommodate a battery (10) as an electric power source powering an electrically heatable atomizer (20) comprising an electric heater (22) and adapted to atomize a liquid (28) supplied from a reservoir (6) to provide an aerosol exiting from the atomizer (20),
  - control electronics (14) adapted to control the heater (22) of the atomizer (20),
  - a puff detector (18) adapted to indicate an aerosol inhaling puff to the control electronics (14),
- characterised in that** the control electronics (14) is adapted to operate, for a puff, the heater (22) of the atomizer (20) with a pre-determined level of electric power.

### 2. Electronic smoking device according to claim 1, **characterised in that** the electronic smoking device (1) comprises a voltage sensor (34) adapted to measure the battery voltage and connected to the control electronics (14), and **in that** the control electronics (14) is adapted to distribute the pre-determined level of electric power, for a puff, by pulse width modulation, based on the battery voltage measured by the voltage sensor (34).

### 3. Electronic smoking device according to claim 2, **characterised in that** the control electronics (14) is adapted to receive multiple measured values of the battery voltage during a puff and to derive a representative value of the battery voltage therefrom.

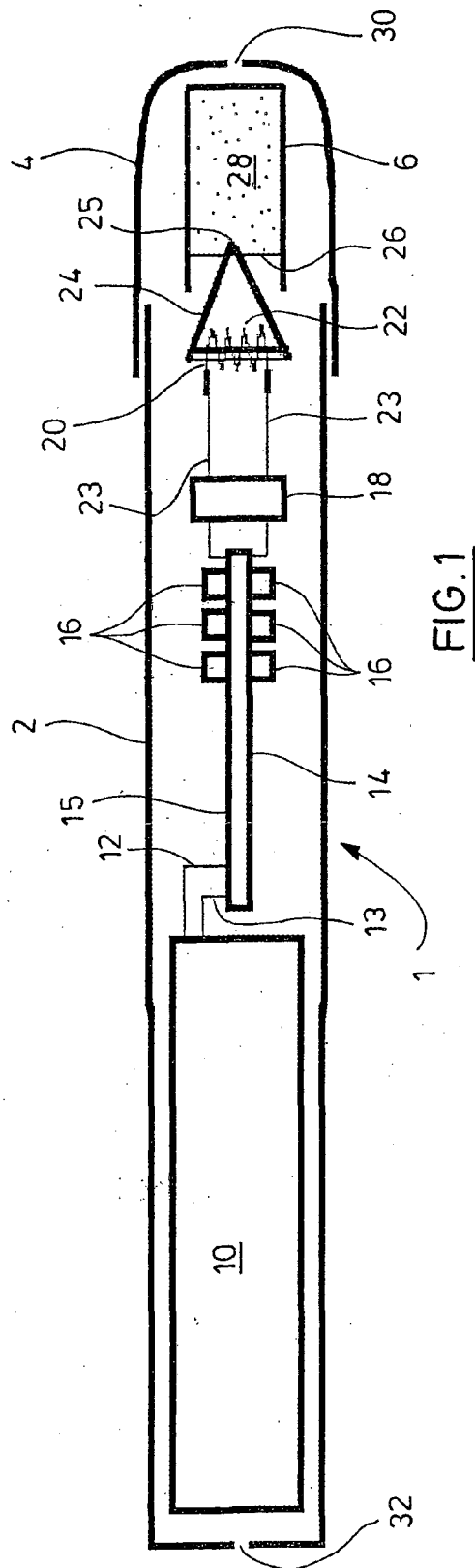
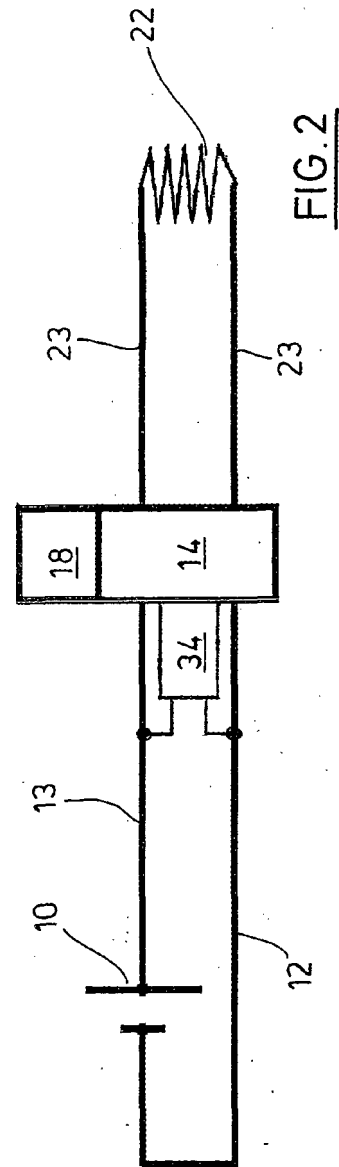
### 4. Electronic smoking device according to claim 3, **characterised in that** the control electronics (14) is adapted to derive the representative value of the battery voltage as the smallest individually measured value of the battery voltage plus a constant, preferably the constant being 200 mV.

### 5. Electronic smoking device according to claim 3 or 4, **characterised in that** the control electronics (14) is adapted to apply the representative value of the battery voltage derived during the puff as a constant value for the battery voltage when determining the pulse widths during the next puff to observe the pre-determined level of electric power.

### 6. Electronic smoking device according to claim 2, **characterised in that** the control electronics (14) is adapted to receive multiple measured values of the battery voltage during a puff and to re-adjust the pulse widths during the puff to observe the pre-determined level of electric power.

7. Electronic smoking device according to any one of claims 2 to 6, **characterised in that** the control electronics (14) is adapted to determine the required pulse width modulation by using a pre-determined, constant value of the electrical resistance of the heater (22). 5
8. Electronic smoking device according to any one of claims 2 to 7, **characterised in that** the voltage sensor (34) is integrated in the control electronics (14). 10
9. Electronic smoking device according to any one of claims 1 to 8, **characterised in that** the control electronics (14) is adapted to operate, upon indication of a puff, the heater (22) of the atomizer (20) with the pre-determined level of electric power for a pre-determined period. 15
10. Electronic smoking device according to any one of claims 1 to 8, **characterised in that** the control electronics (14) is adapted to operate, upon indication of a puff, the heater (22) of the atomizer (20) with the pre-determined level of electric power as long as the puff is indicated. 20  
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11. Electronic smoking device according to any one of claims 1 to 10, **characterised in that** the control electronics (14) is adapted to operate the heater (22) of the atomizer (20) with a reduced level of electric power, when it is not operated with the pre-determined level of electric power. 30
12. Electronic smoking device according to any one of claims 1 to 11, **characterised in that** the puff detector comprises a manually actuatable switch. 35
13. Electronic smoking device according to any one of claims 1 to 11, **characterised in that** the puff detector (18) comprises an inhaling sensor. 40
14. Electronic smoking device according to any one of claims 1 to 13, **characterised in that** at least one of the following items is a component of the electronic smoking device (1): the battery (10), the atomizer (20), the reservoir (6). 45
15. Electronic smoking device according to any one of claims 1 to 14, **characterised in that** the atomizer (20) is a component of the electronic smoking device (1) and **in that** the heater (22) of the atomizer (20) comprises a heating resistor, wherein the material of the heating resistor comprises at least one of the following materials: a nickel-chromium alloy, a nickel-chromium alloy comprising 80% per weight nickel and 20% per weight chromium, a film polyimide, an iron-chromium-aluminium alloy. 50  
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16. Electronic smoking device according to anyone of

claims 1 to 15, **characterised in that** the battery (10) is a component of the electronic smoking device and **in that** the battery (10) is designed as a re-chargeable lithium ion battery protected by safety circuitry.



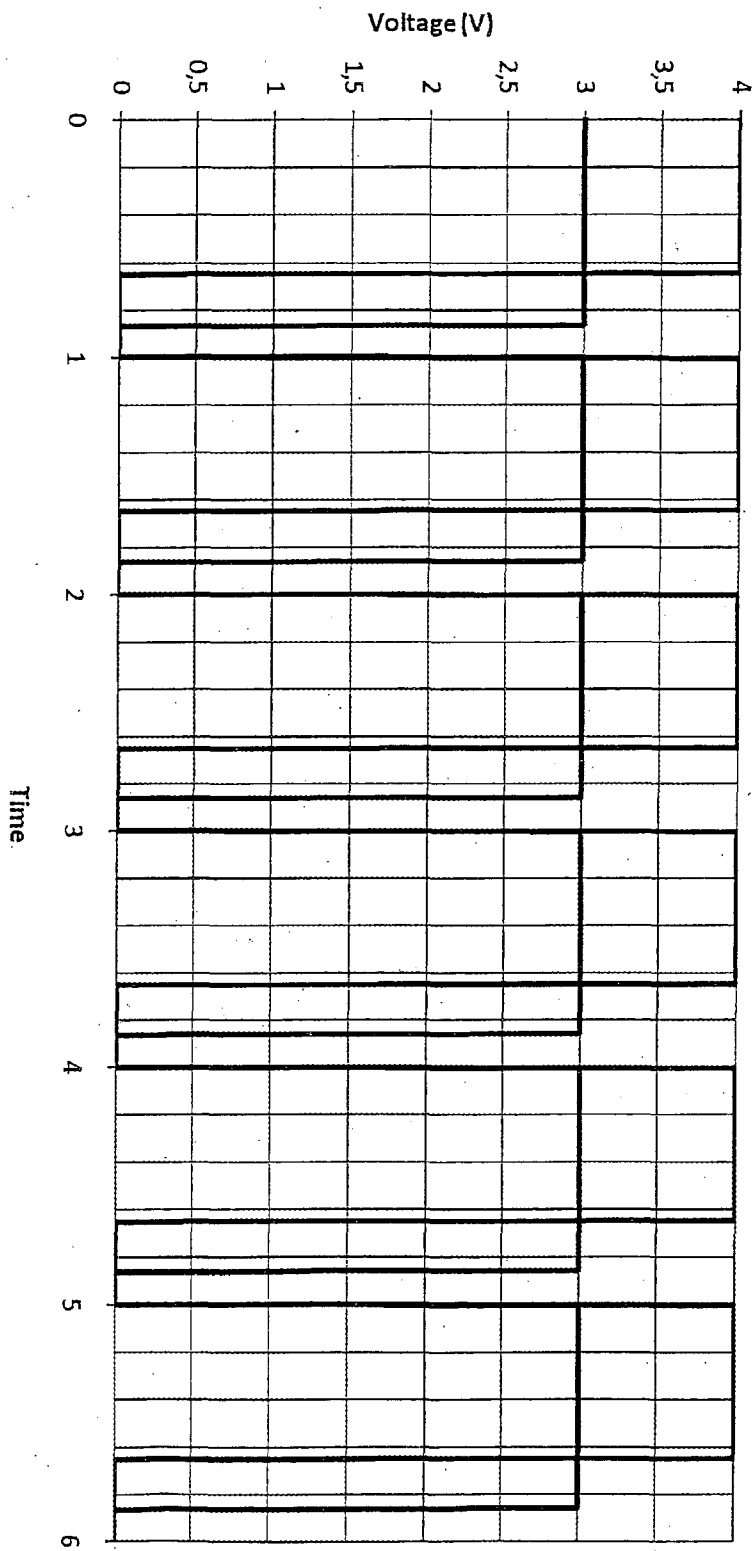
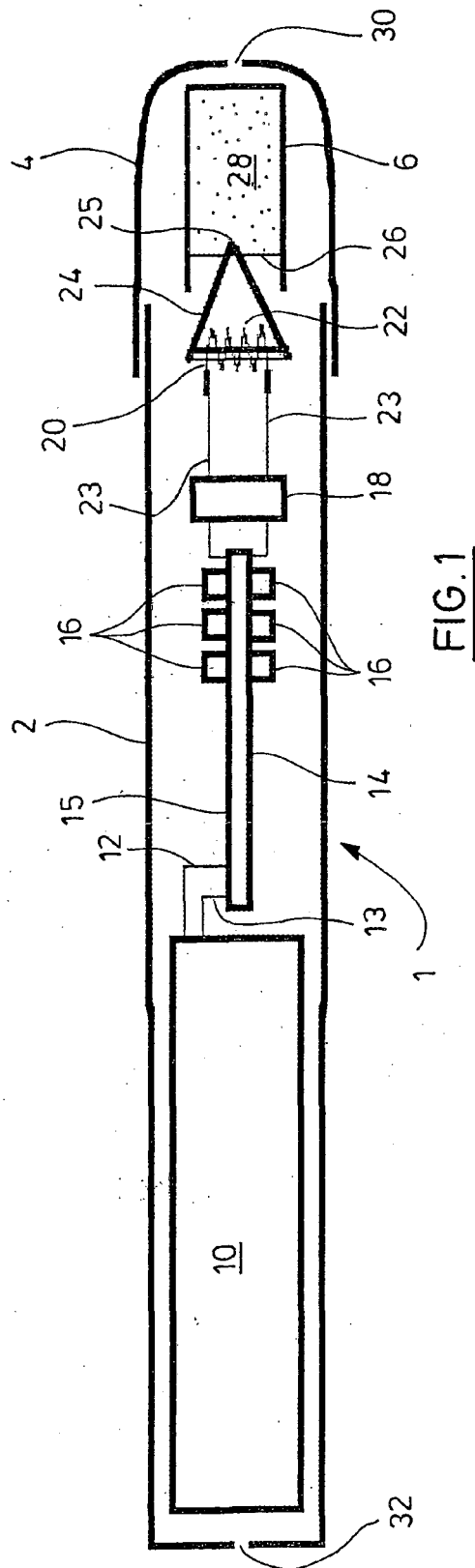
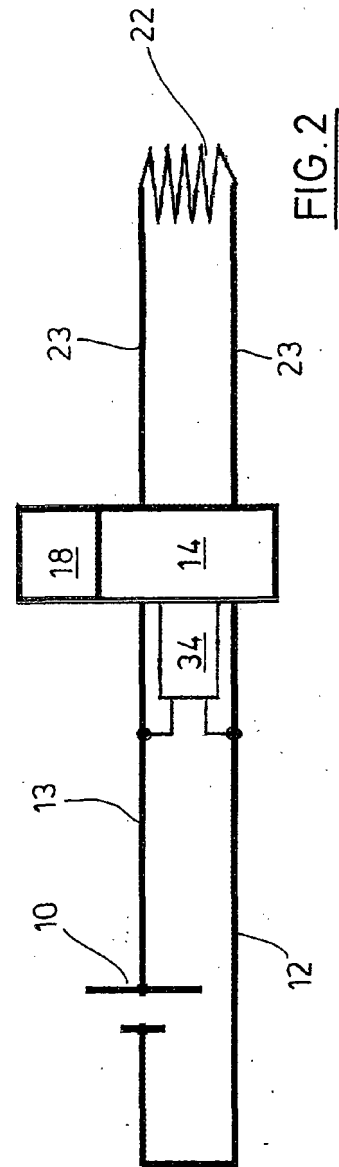


FIG. 3





## EUROPEAN SEARCH REPORT

Application Number  
EP 13 00 4749

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                     |                                                                                                                           |                                                                                                                                                                                                                                                                              |                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Category                                                                                                                                                                                                                | Citation of document with indication, where appropriate, of relevant passages                                             | Relevant to claim                                                                                                                                                                                                                                                            | CLASSIFICATION OF THE APPLICATION (IPC)     |
| X                                                                                                                                                                                                                       | US 2013/104916 A1 (BELLINGER JOHN [US] ET AL) 2 May 2013 (2013-05-02)<br>* paragraph [0019] - paragraph [0051] *<br>----- | 1,2,6,8                                                                                                                                                                                                                                                                      | INV.<br>A24F47/00<br>A61M15/06<br>G05D23/19 |
| X                                                                                                                                                                                                                       | EP 2 460 423 A1 (PHILIP MORRIS PROD [CH]) 6 June 2012 (2012-06-06)<br>* paragraph [0050] - paragraph [0095] *<br>-----    | 1,2,6,8                                                                                                                                                                                                                                                                      |                                             |
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|                                                                                                                                                                                                                         |                                                                                                                           |                                                                                                                                                                                                                                                                              | A24F<br>A61M<br>G05D                        |
| <del>The present search report has been drawn up for all claims</del>                                                                                                                                                   |                                                                                                                           |                                                                                                                                                                                                                                                                              |                                             |
| Place of search<br>Munich                                                                                                                                                                                               |                                                                                                                           | Date of completion of the search<br>15 May 2014                                                                                                                                                                                                                              | Examiner<br>Koob, Michael                   |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                             |                                                                                                                           |                                                                                                                                                                                                                                                                              |                                             |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                           | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                             |

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Application Number

EP 13 00 4749

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing claims for which payment was due.

☒ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-8

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION**  
**SHEET B**

Application Number

EP 13 00 4749

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-8

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the electronic smoking device comprises a voltage sensor adapted to measure the battery voltage and connected to the control electronics, and in that the control electronics is adapted to distribute the pre-determined level of electric power, for a puff, by pulse width modulation, based on the battery voltage measured by the voltage sensor.

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2. claims: 9, 10

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the control electronics is adapted to operate, upon indication of a puff, the heater of the atomizer with the pre-determined level of electric power for a specific time.

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3. claim: 11

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the control electronics is adapted to operate the heater of the atomizer with a reduced level of electric power, when it is not operated with the





**LACK OF UNITY OF INVENTION**  
**SHEET B**

Application Number

EP 13 00 4749

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

pre-determined level of electric power.

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4. claims: 12, 13

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the puff detector is further specified.

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5. claim: 14

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby at least one of the following items is a component of the electronic smoking device: the battery, the atomizer, the reservoir.

---

6. claim: 15

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the atomizer is a component of the electronic smoking device and whereby the heater of the atomizer comprises a heating resistor, wherein the material of the heating resistor comprises at least one of the following materials: a nickel-chromium alloy, a nickel-chromium alloy comprising 80% per weight nickel and



**LACK OF UNITY OF INVENTION  
SHEET B**

Application Number

EP 13 00 4749

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

20% per weight chromium, a film polyimide, an iron-chromium-aluminium alloy.

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7. claim: 16

Electronic smoking device, comprising a housing adapted to accommodate a battery as an electric power source powering an electrically heatable atomizer comprising an electric heater and adapted to atomize a liquid supplied from a reservoir to provide an aerosol exiting from the atomizer, control electronics adapted to control the heater of the atomizer to operate, for a puff, the heater of the atomizer with a pre-determined level of electric power, a puff detector adapted to indicate an aerosol inhaling puff to the control electronics, whereby the battery is a component of the electronic smoking device and in that the battery is designed as a re-chargeable lithium ion battery protected by safety circuitry.

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 00 4749

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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

(19) World Intellectual Property  
Organization  
International Bureau



(10) International Publication Number  
**WO 2014/060268 A1**

(43) International Publication Date  
24 April 2014 (24.04.2014)

(51) International Patent Classification:  
A24F 47/00 (2006.01)

(21) International Application Number:  
PCT/EP2013/071070

(22) International Filing Date:  
9 October 2013 (09.10.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
1218817.3 19 October 2012 (19.10.2012) 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, 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, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, 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, 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))

— before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))

(54) Title: ELECTRONIC INHALATION DEVICE

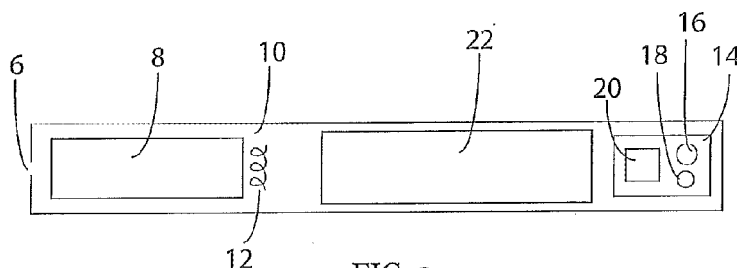


FIG. 2

(57) Abstract: An electronic inhalation device comprising a power cell and a computer. The computer comprises a computer processor, a memory and an input-output means. The computer is configured in use to enter a menu mode when a user activates the menu mode.

WO 2014/060268 A1

## **Electronic Inhalation Device**

### **Technical Field**

This specification relates to electronic inhalation devices such as electronic smoking  
5 devices, including electronic cigarettes.

### **Background**

Electronic inhalation devices such as electronic smoking devices, including electronic  
or e-cigarettes, may be cigarette-sized and function by allowing a user to inhale a  
10 nicotine vapour from a liquid store by applying a suction force to a mouthpiece. Some  
electronic inhalation devices have a pressure sensor that activates when a user applies  
the suction force and causes a heater coil to heat up and vaporise the liquid

### **Summary**

15 An electronic inhalation device comprising a power cell and a computer, where the  
computer comprises a computer processor, a memory and an input-output means;  
wherein the computer is configured in use to enter a menu mode when a user activates  
the menu mode.

20 By activating a menu mode, the user is able to interface with the electronic inhalation  
device and configure it accordingly. This is an advantage for the user who can  
customise certain settings according to their use preferences.

Suitably, the electronic inhalation device is an electronic cigarette.

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Suitably, the computer is a microprocessor.

Suitably, the menu mode enables a user to select a menu option from two or more  
menu options.

30

Suitably, the menu mode enables a user to alter an operational parameter of the  
device.

Having two or more options gives the user a greater degree of freedom for  
35 configuration and alteration of operation parameters.

Suitably, the computer comprises a normal mode that allows a user to use the device for its primary function and inhale using the inhalation device. Suitably, the computer is configured in use to change from normal mode to menu mode when a user activates the menu mode. Suitably, in menu mode the normal mode function of inhalation is suspended.

In normal mode, the user is able to use the electronic inhalation device for its primary purpose which is to inhale substances used in nicotine replacement therapy. Suspending this normal mode when a user enters the menu mode provides enhanced safety for the user and the ability to use the device for a function other than inhaling substances, namely operating the menu to change operational parameters.

Suitably, the menu mode is activated by a user interacting with the device. Suitably, a menu option is selected by a user interacting with the device.

Suitably, the device comprises an input device connected to the computer and the menu mode is activated through the input device. Suitably, the device comprises an input device connected to the computer and a menu option is selected through the input device.

Suitably, the input device comprises a switch. Suitably, the input device comprises a button.

By providing an input device connected to the computer, a user is able to easily access the computer menu system.

Suitably, the input device comprises a pressure sensor. Suitably, the computer is configured in use to enter the menu mode when the pressure sensor detects operation of the device outside of normal mode use.

Suitably, the computer is configured to enter the menu mode when the pressure sensor detects blowing into the device. Suitably, the computer is configured to enter the menu mode when the pressure sensor detects sucking on the device.

Suitably, the computer is configured to enter the menu mode when the pressure sensor detects a short burst of blowing into the device. Suitably, the computer is

configured to enter the menu mode when the pressure sensor detects a short burst of sucking on the device.

5 Suitably, the computer is configured to enter the menu mode when the pressure sensor detects two or more short bursts of blowing into the device. Suitably, the computer is configured to enter the menu mode when the pressure sensor detects two or more short bursts of sucking on the device.

10 A pressure sensor may in normal mode be used to identify when a user is inhaling on the device so as to activate the vaporiser to vaporise a liquid for inhalation. Using the same pressure sensor as an input device therefore reduces the number of components needed for a device and provides the user with a means to enter a menu mode and control menu option selection.

15 Suitably, the device further comprises a vaporiser having a heating element. Suitably, the vaporiser is prevented from activating when the device is in menu mode.

It is advantageous to disable the vaporiser in menu mode since this provides greater safety for the user. Also, when the pressure sensor is used as an input device for the  
20 menu mode, this prevents unintended activation of the vaporiser.

Suitably, in menu mode, a selected menu option changes an electrical current delivered to the heating element. Suitably, in menu mode, a selected menu option changes an electrical current profile delivered to the heating element.

25 Suitably, in menu mode, when the device comprises a pressure sensor, a selected menu option changes a threshold pressure value at which the heating element is activated.

30 Suitably, in menu mode, a selected menu option changes a power delivered to the heating element.

Suitably, in menu mode, a selected menu option changes a vaporisation parameter.

35 Suitably, in menu mode, a selected menu option changes a heating element activation time.



Suitably, in menu mode, a selected menu option enables a vapour boost which provides increased power to the heating element at the start of an inhalation.

5 Suitably, the heating element is a heating coil.

Suitably, in menu mode, a selected menu option enables calibration of the device. Suitably, in menu mode, a selected menu option enables a parameter to be adjusted to calibrate the device. Suitably, calibration comprises adjusting the current supplied to  
10 the heating element. Suitably, calibration comprises adjusting the vaporisation effect of the coil.

Suitably, the device further comprises a liquid in a liquid store and the calibration comprises adjusting the amount of liquid that is vaporised by the heating element.  
15

Advantageously, the menu mode allows the control and modification of parameters that affect the technical operation of the device. This enables a user to change variables that affect vaporisation thereby providing an enhanced and customised product for the user.

20

Suitably, in menu mode, a selected menu option enables the device to be reset.

Since settings can be changed by the user, it is advantageous to supply a means to reset the device to factory settings.

25

Suitably, the device further comprises use data relating to a user's use of the device, and the use data is stored in the computer memory. Suitably, in menu mode, a selected menu option clears the use data from the computer memory. Suitably, in menu mode, a selected menu option activates the transmission of the use data.

30

Another advantage of the menu mode is that it enables control of functions outside the normal use of the electronic inhalation device. This gives the device further technical function and provides a more useful device for the user. Providing a more useful device may lead to better adherence to usage.

35

Suitably, the device further comprises an audio signaling means. Suitably, in menu mode, data relating to a user's use of the device is transmitted using the audio signaling means.

5 Suitably, the device is configured to notify a user by a sound signal when the device enters the menu mode. Suitably, the device is configured to notify a user by a sound signal when the device leaves the menu mode. Suitably, the device is configured to notify a user by a sound signal as the user navigates through menu options. Suitably, the device is configured to notify a user by a sound signal when a menu option is  
10 selected.

Using sound to notify the user of menu operations has the advantage that a number of different sound signals can easily be used that a user is able to distinguish between. Thus a user can easily identify where they are in the menu system without having to  
15 look at the device. This is especially an advantage when the device is controlled using a pressure sensor since the device will be in a user's mouth and a user will find it difficult to look at it. However, when the device is in the mouth, it will be near the user's ears so the sound will be easily heard.

20 Suitably, the device is configured to leave menu mode after a predetermined time of device inactivity.

Suitably, in menu mode, a selected menu option causes the device to leave the menu mode.

25 Suitably, the device comprises a control unit comprising the power cell and the computer, and the control unit is releasably-attachable to a vaporiser unit, wherein the device is configured to leave the menu mode when the vaporiser is disconnected from the control unit.

30 As used herein the term electronic smoking device includes not only an electronic cigarette but also electronic smoking articles other than an electronic cigarette, for example a heat-not-burn (HNB) device or an electrically powered spray device in which a pressurised liquid is stored in a canister and released under the control of an  
35 electronic valve in response to a pressure drop produced by the user drawing on the device. These devices are referred to herein collectively as "electronic smoking

devices”, which term is intended to cover any electronic device which can be used as a substitute for a cigarette or as a cessation device, which does not involve the conventional combustion of tobacco.

## 5 **Brief Description of the Drawings**

Embodiments will now be described, by way of example only, with reference to the accompanying drawings in which:

- Figure 1 is a side perspective view of an electronic inhalation device;
- 10 Figure 2 is a side sectional view through the device of Figure 1;
- Figure 3 is an exploded side perspective view of an electronic inhalation device having separated mouthpiece and control unit;
- Figure 4 is a side sectional view through the device of Figure 3 with connected mouthpiece and control unit;
- 15 Figure 5 is an exploded side perspective view of an electronic inhalation device having separated mouthpiece, vaporiser and control unit;
- Figure 6 is a side sectional view through the device of Figure 5 with connected mouthpiece, vaporiser and control unit;
- Figure 7 is an exploded longitudinal sectional view of another embodiment of an
- 20 electronic inhalation device similar to that of Figures 3 and 4, and that of Figures 5 and 6, showing the internal components thereof in greater detail;
- Figure 8 is a sectional view of the electronic inhalation device of Figure 7 when assembled; and
- Figure 9 is a schematic circuit diagram of the electronic inhalation device of Figures 7
- 25 and 8.

## **Detailed description**

- Referring to Figure 1 and Figure 2 there is shown an electronic inhalation device in the form of a cigarette-shaped electronic cigarette. The electronic cigarette has a
- 30 mouthpiece 2 and a cigarette body 4. The mouthpiece 2 has an air outlet 6 at a first end and is connected to the cigarette body 4 at a second end.

- Inside the electronic cigarette there is a liquid store 8 towards the mouthpiece end and a vaporiser 10 having a heating coil 12. The vaporiser 10 is arranged next to the liquid
- 35 store 8 to allow liquid to be transferred onto the vaporiser 10 for vaporising. A circuit

board 14 contains a pressure sensor 16, an audio signalling means 18 such as a buzzer or a speaker, and a computer 20. A power cell 22 provides power to the device.

The general operation of the electronic cigarette is similar to that of known devices.

- 5 When a user takes a draw on the electronic cigarette, a suction force is applied to the mouthpiece 2 and the air outlet 6. A reduced pressure inside the electronic cigarette causes the power cell 22 to provide power to the vaporiser 10 which in turn vaporises the nicotine liquid solution. The resultant vapour is then inhaled by the user.
- 10 In this example the operation of the electronic cigarette goes beyond that of a general device. In a normal operating mode, when a user applies a suction force to the electronic cigarette, the resultant airflow causes a drop in pressure from ambient pressure to a lower pressure, within the device. The pressure sensor 16 provides a signal to the computer 20. The computer 20 runs software that monitors the pressure
- 15 signal from the pressure sensor 16 and when it determines that the pressure has been reduced below a threshold pressure, the computer 20 provides an electrical current to the heating coil 12 in order to heat the heating coil 12 and vaporise liquid from the liquid store 8.
- 20 The software running on the computer 20 controls the operation of the device. The computer 20 allows a user to enter a menu mode. When a user has finished using the device and wishes to enter a menu mode they can activate the menu mode by carrying out an action on the device that is different to how they use it in a normal mode. In a normal mode, a user typically inhales on the device for 2 to 3 seconds, replicating the
- 25 action of smoking a real cigarette. In this situation the computer 20 receives a signal from the pressure sensor 16 and activates the vaporiser 10, heating up the heating coil 12.
- To enter a menu mode, a user can blow briefly into the device. The pressure sensor 16
- 30 sends a signal to the computer 20, and the computer recognises that this is not normal operation but a signal to enter a menu mode. Alternatively a user can blow briefly into the device, suck suddenly on the device in a quick burst or indeed blow or suck two or more times in rapid succession. In each of these circumstances, the pressure sensor 16 will send a signal to the computer 20 and the computer 20 will determine that this is
- 35 not normal operation but a signal for the device to enter a menu mode.

When the device enters the menu mode the user is notified by a sound being played by the audio signalling means 18. In addition, the normal operation of vaporisation is suspended. In this way, whilst the user is in menu mode, the user can suck or blow on the device without activating the vaporiser 10 and heating coil 12.

5

After entering a menu mode, the user is able to control the menu and navigate through the menu options using the pressure sensor for control. For example, slight blowing on the device could move forward through the menu options, and slight sucking could move backwards through the menu options. By having a sensitive control of the menu options, the user would not interfere with the liquid transfer process of the liquid out of the liquid store 8 and onto the vaporiser 10.

10

As a user progresses through the menu options, the user is notified by sound signals and is able to differentiate between the menu options by the different sound signals. For example a first menu option could sound a single beep, a second menu options could sound a double beep and so on.

15

When a user wishes to select a menu option then again they can do this by sucking or blowing into the device. For instance, if slight pressure change is used to control the navigation through the menu as described, a more forceful pressure change from a more forceful sucking or blowing can select an menu option.

20

In this way, the user is able to have complete control of the menu options including navigating through the different menu options and selecting a given menu option.

25

The menu options are selectable to change the technical configuration of the electronic inhalation device. One of the menu options is selectable to configure the vaporisation properties. A user can select this option and set the vaporisation lower or higher. The computer 20 would then act to modify the current sent to the heating coil 12 to change the vaporisation properties during normal use.

30

Another menu option is to provide a boost such that at the start of the vaporisation during normal use, a higher current is delivered providing a peak in the temperature and an initial boost to vaporisation.

35

Another menu option acts to calibrate the device. If the device is required to have a fixed amount of liquid vaporisation per unit time, then the control of vaporisation could be used to achieve this.

- 5 Another menu option acts to change the device country settings. Different countries may have different tastes and requirements for vaporisation and vapour delivery so enabling the user to select their host country would provide a simple means for them to achieve this. This enables a single product to be sold across multiple territories.
- 10 Another menu option acts to change the threshold pressure at which the device is activated during normal operation. This enables the threshold pressure to be increased or decreased. Changing of the threshold pressure could also be a result of the country selection by the user because a given location may be at a particular altitude and this affects the ambient pressure, which may have an impact on the
- 15 threshold pressure.

- Another menu option acts to modify the heating element activation time. In normal mode, a user inhaling on the device activates the heating coil to vaporise liquid. In an example use, the vaporiser may be activated for a predetermined time once activated
- 20 and this time may be modified using the menu system.

- Another menu option acts to modify other time parameters such as the time an electronic inhalation device is deactivated following a coil overheat scenario or the time until a device is deactivated following lack of use of the device.
- 25

Another menu option acts to reset the device such that the variables and parameters modified by the user are reset back to factory conditions.

- The computer 20 comprises a memory means and use data corresponding to the user's use of the device can be stored in the memory means. Another menu option acts to initiate transmission of this data. Once activated the data may be transmitted using modulated sound and received by a device configured to interpret this modulated sound signal. A related menu option acts to wipe the data from the memory, thereby clearing the memory.
- 30

35

Another menu option acts to leave the menu mode, returning the device to a normal mode. A user is notified by a sound signal that the menu mode has been exited and a normal mode has been entered into.

5 In addition, whilst in menu mode, if the computer 20 determines that the device is inactive for a given threshold inactive time, the device leaves menu mode and may enter either a normal mode or a sleep mode. The sleep mode being a lower power mode.

10 Figure 3 and Figure 4 show a device similar to that shown in relation to Figure 1 and Figure 2. The difference is that the mouthpiece 2 is releasably-attachable to the cigarette body 4. The mouthpiece comprises a female screw thread connection means, the cigarette body 4 is a control unit 24 having a male screw thread connection means. The mouthpiece 2 and the control unit 24 can be screwed together or taken apart.

15 In this example, the mouthpiece 2 comprises the liquid store 8 and the vaporiser 10 with heating coil 12. The control unit 24 comprises the power cell 22 and circuit board 14 with pressure sensor 16, audio signaling means 18 and computer 20. The screw thread connection provides an electrical connection such that when the mouthpiece 2 and control unit 24 are screwed together, electrical current can be delivered to the heating coil 12 upon activation of the vaporiser 10.

In this example, the device can only enter a menu mode when the parts are assembled since the user can only operate the device when it is assembled. Whilst in menu mode, 25 if the user disconnects the mouthpiece, the device leaves menu mode and the user is notified by a sound signal.

Figure 5 and Figure 6 show a device similar to that shown in relation to Figure 3 and Figure 4. However in this example, the vaporiser 10 is removable from the mouthpiece 30 2. The mouthpiece 2 has a cylindrical opening that forms an interference push-fit with the vaporiser 10. As such the mouthpiece 2 can be separated from the vaporiser 10. The mouthpiece 2 comprises the liquid store 8. The vaporiser 10 comprises the heating coil 12 and a wick 26. The wick 26 protrudes from the end of the vaporiser 10 such that when the mouthpiece 2 and the vaporiser 10 are connected, the wick 26 dips 35 into the liquid store 8.

In use, as a user inhales on the device, liquid is transferred from the liquid store 8 and onto the wick 26 before being transferred onto the heating coil 12 for vaporisation.

Figures 7 and 8 illustrate another embodiment of an electronic inhalation device in the form of an electronic cigarette. The device is similar to the embodiment shown in Figures 3 and 4, and the embodiment shown in Figures 5 and 6, although the embodiment in Figures 7 and 8 shows the internal components thereof in greater detail. The device comprises a mouthpiece 31, vaporiser device 32 and control unit 33 which can be assembled as shown in Figure 8 to provide a generally cylindrical device that can be used as a substitute for a conventional tobacco burning cigarette. The control unit 33 is provided with a threaded extension 34 that is received in an interior thread 35 in the vapour device 32. The mouthpiece 31 comprises a generally cylindrical plastics casing 36 that can be push-fitted on to the vapour device 32.

The mouthpiece 31 has an outlet 37 to supply vapour to the mouth of the user and an outlet passageway 38 for the vapour which, in use is produced by the vapour device 32. The mouthpiece 31 also includes a liquid reservoir comprising a porous storage matrix 39 such as plastics open foam material impregnated with a vaporisable liquid, such as a nicotine containing liquid that in use is vaporised by the vapour device 32. The matrix 39 acts as a reservoir for the liquid and since the mouthpiece 31 is readily removable and replaceable, it can be used as a refill capsule when the liquid in the porous matrix 39 becomes depleted and needs to be replenished.

The vapour device 32 includes an electronic heating coil 40 that is wound around a ceramic core 41, supported on a ceramic base 42. A generally U-shaped wicking member 43 is configured to wick liquid from the reservoir 39 towards the heating element 40 by capillary action. The wicking member 43 may for example be made of a metallic foam such as nickel foam.

The heater coil 40 is powered by a rechargeable battery 44 located in the control unit 33 through electrical contacts 48, 49 (not shown in Figs 7 and 8, see Figure 9) which electrically couple the heater coil to the battery 44 when the control unit 33 is fitted to the vapour device 32 by the engagement of threads 34, 35. The electrical power of the battery 44 is supplied to the heater coil 40 under the control of a control circuit 45 mounted on circuit board 46 within the control unit 33.



As shown in Figure 9, the control circuit 45 includes a microcontroller 47 powered by battery 44 to supply an electric heating current to the coil 40 through the contacts 48, 49 that are brought into electrical connection when the control unit 33 is threadedly engaged with the vapour device 32 by means of threads 34, 35 shown in Figure 7.

- 5 A pressure sensor 50 detects when a user draws on the mouthpiece 38, as described in more detail hereinafter.

Also, a signalling unit 51 is provided to provide audio or visual outputs to the user indicative of operational conditions of the device. For example, the signalling device may include a light emitting diode that glows red when the user draws on the device.

- 10 The signalling device may provide predetermined audio or visual signals to indicate for example that the battery 44 needs to be recharged.

The supply of current from the battery 44 to the mouth controller is controlled by switching transistor 52.

- When the user draws on the mouthpiece 1 so as to draw vapour through the outlet 37,  
 15 the pressure sensor 50 detects the drop in pressure which is communicated from within the vapour device 32 through the interior of the control unit 33 to the circuit board 45. Microcontroller 47 responds to the pressure drop detected by the sensor 50 to supply electrical current to the heater coil 40, which vaporises liquid supplied by capillary action through the U-shaped wicking member 43. An air inlet passageway 55  
 20 is provided in the joint between the vapour unit 32 and control unit 33 so that air can be drawn through the threaded extension 34 of the control unit 33 into the vapour device 32 in the direction of arrows A, so that the resulting vapour is drawn in the direction of arrows B through passageway 38 to the outlet 37.

- The operation of the device of Figures 7 and 8 may be the same as that of the devices  
 25 of Figures 1 to 6 described previously and so a detailed description of such operation will not be repeated here. However, it is intended that the control circuit 46 of the embodiment of Figures 7 and 8 may be configured as per the circuit board 14 of the embodiments of Figures 1 to 6, and vice versa. Specifically, the circuit board 46 may comprise a separate audio signalling means 18. Alternatively, the signalling unit 51  
 30 may act as the audio signalling means described in the previous embodiments. Also, the pressure sensor 50 may be disposed on the circuit board 46 within the control unit 33 and the vapour device 32 may be in fluid communication with the area within the control unit 33, via an open passageway for example (not shown), such that a drop in

pressure within the vapour device 32 is detectable by a pressure sensor on the circuit board 46 within control unit 33. Also, the microcontroller 47 of the embodiment of Figures 7 and 8 may be programmed as per the computer 20 of the embodiment of Figures 1 to 6 to monitor the measured pressure from the pressure sensor 16 to control the device accordingly and as described previously, particularly to run software to control the various menu modes as described previously.

Although examples have been shown and described it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention. The computer processor could be a microprocessor or a microcontroller. The device is not restricted to being cigarette shaped. The computer processor, audio signaling means and pressure sensor are not restricted to being on the same circuit board. The heating coil used for vaporisation could be replaced by another type of non-coil heating element. The control for the menu could be a button or a switch or some other means, rather than the pressure sensor

In order to address various issues and advance the art, the entirety of this disclosure shows by way of illustration various embodiments in which the claimed invention(s) may be practiced and provide for superior electronic inhalation devices. The advantages and features of the disclosure are of a representative sample of embodiments only, and are not exhaustive and/or exclusive. They are presented only to assist in understanding and teach the claimed features. It is to be understood that advantages, embodiments, examples, functions, features, structures, and/or other aspects of the disclosure are not to be considered limitations on the disclosure 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 and/or spirit of the disclosure. Various embodiments may suitably comprise, consist of, or consist essentially of, various combinations of the disclosed elements, components, features, parts, steps, means, etc. In addition, the disclosure includes other inventions not presently claimed, but which may be claimed in future. Any feature of any embodiment can be used independently of, or in combination with, any other feature.

Claims

1. An electronic inhalation device comprising a power cell and a computer, where the computer comprises a computer processor, a memory and an input-output means;  
5 wherein the computer is configured in use to enter a menu mode when a user activates the menu mode.
2. The electronic inhalation device of claim 1, wherein the electronic inhalation device is an electronic cigarette.
- 10 3. The electronic inhalation device of claim 1 or claim 2, wherein the computer is a microprocessor.
4. The electronic inhalation device of any preceding claim, wherein the menu mode  
15 enables a user to select a menu option from two or more menu options.
5. The electronic inhalation device of any preceding claim, wherein the menu mode enables a user to alter an operational parameter of the device.
- 20 6. The electronic inhalation device of any preceding claim, wherein the computer comprises a normal mode that allows a user to use the device for its primary function and inhale using the inhalation device.
7. The electronic inhalation device of claim 6, wherein the computer is configured  
25 in use to change from normal mode to menu mode when a user activates the menu mode.
8. The electronic inhalation device of claim 6 or claim 7, wherein in menu mode the normal mode function of inhalation is suspended.
- 30 9. The electronic inhalation device of any preceding claim, wherein the menu mode is activated by a user interacting with the device.
10. The electronic inhalation device of any preceding claim, wherein a menu option  
35 is selected by a user interacting with the device.

11. The electronic inhalation device of any preceding claim, wherein the device comprises an input device connected to the computer and the menu mode is activated through the input device.
- 5 12. The electronic inhalation device of any preceding claim, wherein the device comprises an input device connected to the computer and a menu option is selected through the input device.
- 10 13. The electronic inhalation device of claim 11 or claim 12, wherein the input device comprises a switch.
14. The electronic inhalation device of any one of claims 11 to 13, wherein the input device comprises a button.
- 15 15. The electronic inhalation device of any one of claims 11 to 14, wherein the input device comprises a pressure sensor.
16. The electronic inhalation device of claim 15, wherein the computer is configured in use to enter the menu mode when the pressure sensor detects operation of the device outside of normal mode use.
- 20 17. The electronic inhalation device of claim 15 or claim 16, wherein the computer is configured to enter the menu mode when the pressure sensor detects blowing into the device.
- 25 18. The electronic inhalation device of any one of claims 15 to 17, wherein the computer is configured to enter the menu mode when the pressure sensor detects sucking on the device.
- 30 19. The electronic inhalation device of any one of claims 15 to 18, wherein the computer is configured to enter the menu mode when the pressure sensor detects a short burst of blowing into the device.
- 35 20. The electronic inhalation device of any one of claims 15 to 19, wherein the computer is configured to enter the menu mode when the pressure sensor detects a short burst of sucking on the device.

21. The electronic inhalation device of any one of claims 15 to 20, wherein the computer is configured to enter the menu mode when the pressure sensor detects two or more short bursts of blowing into the device.
- 5 22. The electronic inhalation device of any one of claims 15 to 21, wherein the computer is configured to enter the menu mode when the pressure sensor detects two or more short bursts of sucking on the device.
- 10 23. The electronic inhalation device of any preceding claim, wherein the device further comprises a vaporiser having a heating element.
24. The electronic inhalation device of claim 23, wherein the vaporiser is prevented from activating when the device is in menu mode.
- 15 25. The electronic inhalation device of claim 23 or claim 24, wherein in menu mode, a selected menu option changes an electrical current delivered to the heating element.
26. The electronic inhalation device of any one of claims 23 to 25, wherein in menu mode, a selected menu option changes an electrical current profile delivered to the heating element.
- 20 27. The electronic inhalation device of any one of claims 23 to 26, wherein in menu mode, when the device comprises a pressure sensor, a selected menu option changes a threshold pressure value at which the heating element is activated.
- 25 28. The electronic inhalation device of any one of claims 23 to 27, wherein in menu mode, a selected menu option changes a power delivered to the heating element.
- 30 29. The electronic inhalation device of any one of claims 23 to 28, wherein in menu mode, a selected menu option changes a vaporisation parameter.
- 35 30. The electronic inhalation device of any one of claims 23 to 29, wherein in menu mode, a selected menu option changes a heating element activation time.

31. The electronic inhalation device of any one of claims 23 to 30, wherein in menu mode, a selected menu option enables a vapour boost which provides increased power to the heating element at the start of an inhalation.
- 5 32. The electronic inhalation device of any one of claims 23 to 31, wherein the heating element is a heating coil.
33. The electronic inhalation device of any one of claims 23 to 32, wherein in menu mode, a selected menu option enables calibration of the device.
- 10 34. The electronic inhalation device of claim 33, wherein in menu mode, a selected menu option enables a parameter to be adjusted to calibrate the device.
35. The electronic inhalation device of claim 33 or claim 34, wherein calibration  
15 comprises adjusting the current supplied to the heating element.
36. The electronic inhalation device of any one of claims 33 to 35, wherein calibration comprises adjusting the vaporisation effect of the coil.
- 20 37. The electronic inhalation device of any one of claims 33 to 36, wherein the device further comprises a liquid in a liquid store and the calibration comprises adjusting the amount of liquid that is vaporised by the heating element.
38. The electronic inhalation device of any preceding claim, wherein in menu mode,  
25 a selected menu option enables the device to be reset.
39. The electronic inhalation device of any preceding claim, wherein the device further comprises use data relating to a user's use of the device, and the use data is stored in the computer memory.
- 30 40. The electronic inhalation device of claim 39, wherein in menu mode, a selected menu option clears the use data from the computer memory.
41. The electronic inhalation device of claim 39 or claim 40, wherein in menu mode,  
35 a selected menu option activates the transmission of the use data.

42. The electronic inhalation device of any preceding claim, wherein the device further comprises an audio signaling means.

5 43. The electronic inhalation device of claim 42, wherein in menu mode, data relating to a user's use of the device is transmitted using the audio signaling means.

44. The electronic inhalation device of claim 42 or claim 43, wherein the device is configured to notify a user by a sound signal when the device enters the menu mode.

10

45. The electronic inhalation device of any one of claims 42 to 44, wherein the device is configured to notify a user by a sound signal when the device leaves the menu mode.

15 46. The electronic inhalation device of any one of claims 42 to 45, wherein the device is configured to notify a user by a sound signal as the user navigates through menu options.

20 47. The electronic inhalation device of any one of claims 42 to 46, wherein the device is configured to notify a user by a sound signal when a menu option is selected.

48. The electronic inhalation device of any preceding claim, wherein the device is configured to leave menu mode after a predetermined time of device inactivity.

25 49. The electronic inhalation device of any preceding claim, wherein in menu mode, a selected menu option causes the device to leave the menu mode.

30 50. The electronic inhalation device of any preceding claim, wherein the device comprises a control unit comprising the power cell and the computer, and the control unit is releasably-attachable to a vaporiser, wherein the device is configured to leave the menu mode when the vaporiser is disconnected from the control unit.

51. The electronic inhalation device, substantially as described herein with reference to the accompanying drawings.

35

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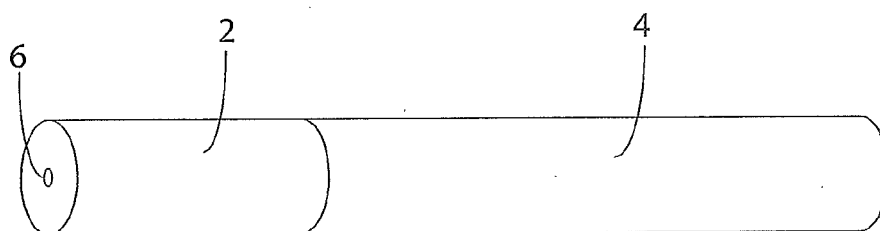


FIG. 1

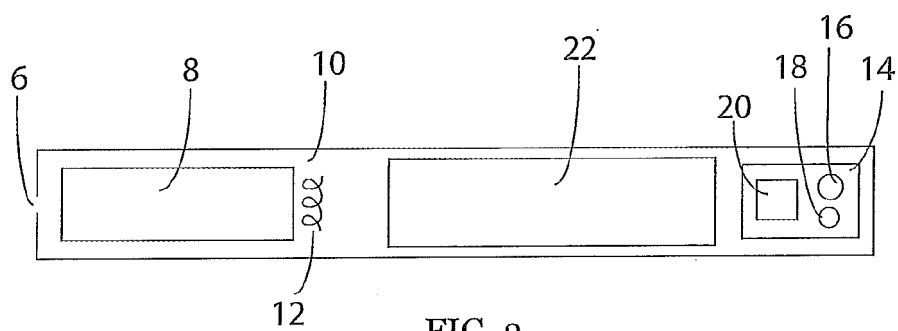


FIG. 2



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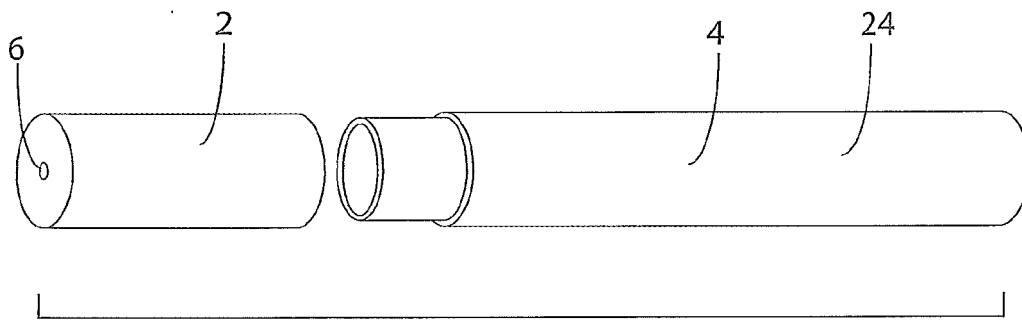


FIG. 3

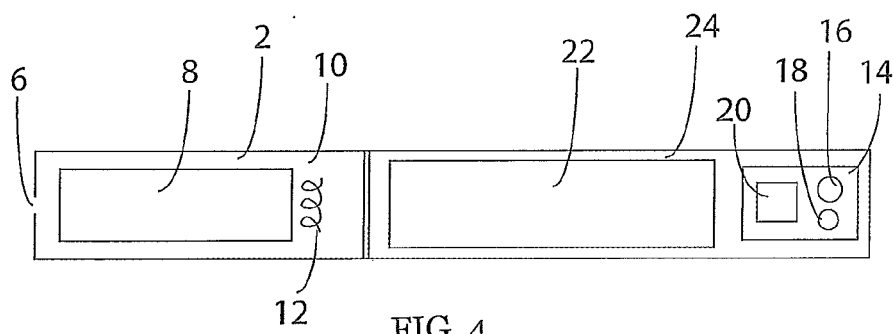


FIG. 4

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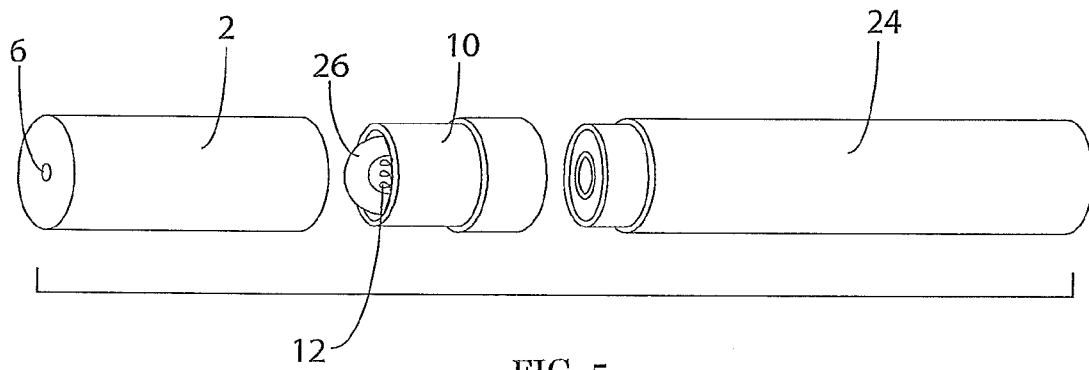


FIG. 5

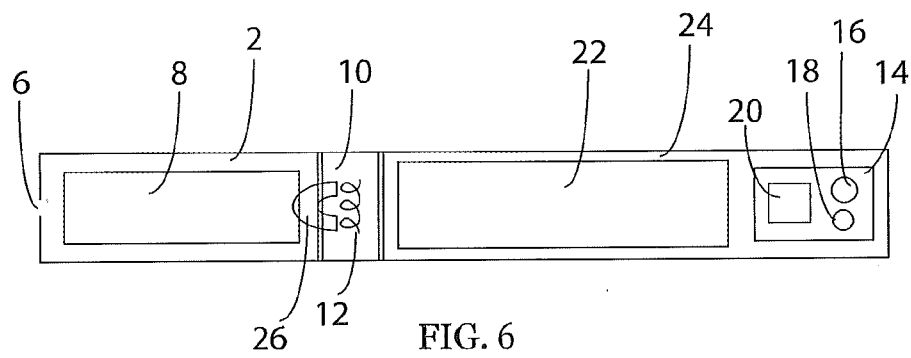


FIG. 6

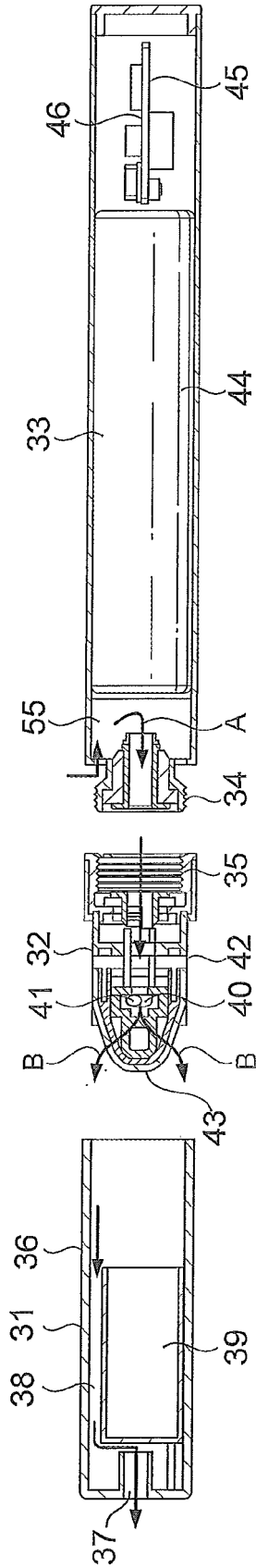


FIG. 7

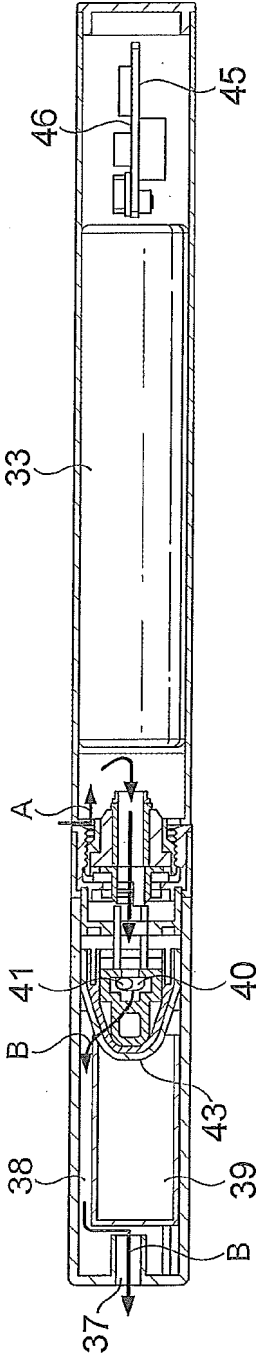


FIG. 8

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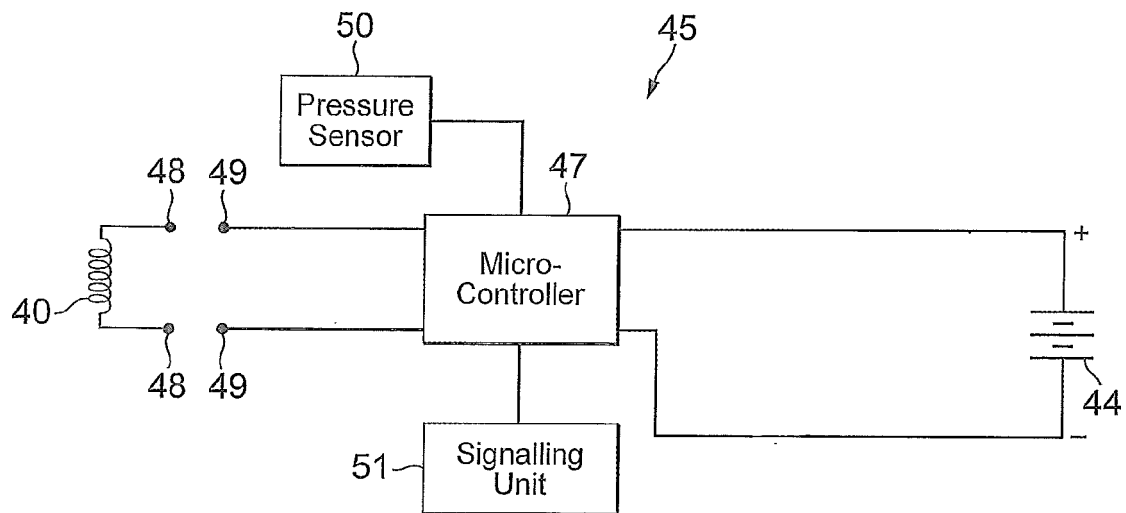


FIG. 9

A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

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)

EP0-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         | US 2012/048266 A1 (ALELOV ELI [US])<br>1 March 2012 (2012-03-01)<br>paragraph [0024] - paragraph [0031]<br>figures                | 1-7,<br>9-20,23       |
| X         | WO 95/01137 A1 (VOGES INNOVATION PTY LTD<br>[AU]; VOGES ROBERT MARTIN [AU])<br>12 January 1995 (1995-01-12)<br>the whole document | 1-3                   |

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

☒ See patent family annex.

\* Special categories of cited documents :

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"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)

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Date of the actual completion of the international search

26 March 2014

Date of mailing of the international search report

02/04/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
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Authorized officer

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/071070

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
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(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**09.09.2015 Bulletin 2015/37**

(51) Int Cl.:  
**A24F 47/00 (2006.01)**

(21) Application number: **14000757.6**

(22) Date of filing: **03.03.2014**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO  
PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

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(54) **Electronic smoking device**

(57) An electronic smoking (1) device comprises a housing (2), control electronics (14) and a puff detector (18). The housing (2) accommodates a battery (10) as an electric power source powering an electrically heatable atomizer (20) comprising an electric heater (22) and adapted to atomize a liquid supplied from a reservoir (6) to provide an aerosol exiting from the atomizer (20). The

control electronics (14) controls the heater (22) of the atomizer (20) and is adapted to operate the heater (22) in at least two predetermined modes. The puff detector (18) indicates an aerosol inhaling puff to the control electronics (14). The control electronics (14) selects a specific mode for operating the heater (22) via a control signal initiated by the puff detector (18).

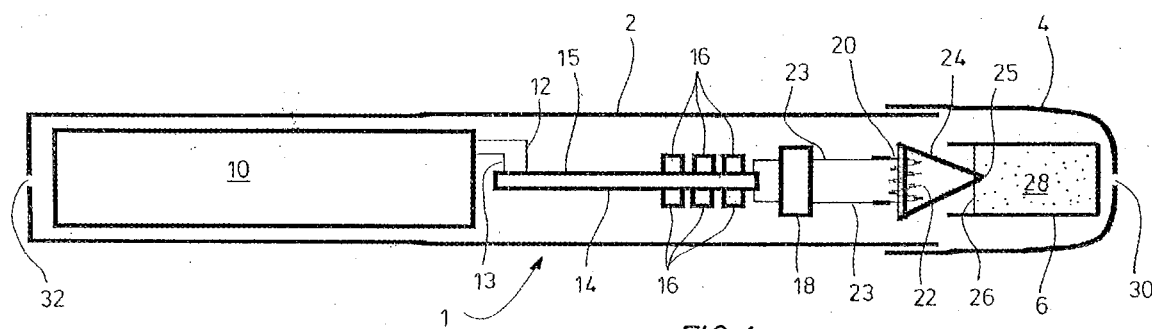


**FIG. 1**

## Description

**[0001]** The invention relates to an electronic smoking device.

**[0002]** An electronic smoking device, e.g. designed as an electronic cigarette, comprises a housing accommodating an electric power source (usually a battery or a rechargeable battery), an electrically heatable atomizer including an electric heater adapted to atomize a liquid supplied from a reservoir (usually a capsule) in order to provide an aerosol exiting from the atomizer, and control electronics which controls activation of the heater of the atomizer. A puff detector is provided within the electronic smoking device which detects a user puffing on the device (e.g., by sensing an underpressure or an air flow pattern through the device) and indicates or signals the puff to the control electronics. When a puff is indicated to the control electronics, the heater in the atomizer is powered, which causes the creation of aerosol. Here and in the following, the action of the atomizer is called "atomize" and the related product is called "aerosol", irrespective of its composition, which might include gaseous and smoke constituents.

**[0003]** EP 2 443 946 A1 discloses an electronic cigarette and a capsule containing a liquid to be atomized by an atomizer. The capsule comprises a shell which is sealed at one end by a puncturable membrane. To mount the capsule to the electronic cigarette, the capsule is inserted into a soft sleeve mouthpiece and attached to the end of a tube accommodating the atomizer. When mounting, a spike provided at the end of a metal wick pierces the membrane, and the liquid of the capsule is guided by the wick to the atomizer. When the atomizer is activated, an aerosol is generated and the aerosol passes through some ducts provided at the exterior surface of the capsule to reach an end opening where it can be inhaled by the user via the mouthpiece.

**[0004]** The natural interaction between a user and an electronic smoking device is puffing on the device. As described above, in an electronic smoking device, the device produces an aerosol in direct response to puffing on the device.

**[0005]** It is known to provide additional user interface elements on electronic smoking devices. Such interface elements are commonly represented by additional sliders, switches, buttons or knobs on the device, and they can be used, e.g., to adjust the strength or intensity of an aerosol created in response to a puff. However, such additional user interface elements complicate the operation of an electronic smoking device and may even result in the generation of undesirable kinds of aerosols, e.g. when the operation is faulty or user inputs are incompatible, resulting in a heater being over activated.

**[0006]** In contrast, the smoker of a conventional cigarette has several options to control the behaviour of the cigarette, which are commonly understood and applied by the smoker in a natural way. For example, more frequent inhalation and stronger puffs result in more and

stronger smoke being inhaled. In this case, the cigarette will last shorter time than if being smoked gently, i.e. with longer breaks between the puffs and with shorter inhalations.

**[0007]** The object of the invention is to provide an electronic smoking device which presents an improved functionality and which nevertheless can be controlled by a user in an intuitive way, without the need for additional user interface elements.

**[0008]** This object is achieved by an electronic smoking device comprising the features of claim 1. Advantageous embodiments of the invention follow from the dependent claims.

**[0009]** Electronic smoking devices to which the claimed invention can be applied comprise a housing, which accommodates a battery as an electric power source powering an electrically heatable atomizer. The atomizer comprises an electric heater and is able to atomize a liquid supplied from a reservoir to create an aerosol exiting from the atomizer. The electronic smoking devices also comprise control electronics and a puff detector. The puff detector is an inhalation sensor which is responsive to the detection of the variation of airflow within the device which is representative of a user sucking on the device to initiate a control signal to the control electronics. The control electronics are then adapted to respond to this control signal by activating the heater of the atomizer to generate an aerosol which is inhaled by the user.

**[0010]** According to the invention, the control electronics are adapted to operate the heater of the atomizer in two or more predetermined modes, e.g. a "low" mode in which the atomizer generates a predetermined small amount of aerosol per puff and a "high" mode in which the atomizer generates a predetermined large amount of aerosol per puff. A specific mode for operating the heater is selected by the control electronics on the basis of control signals initiated by the puff detector. Thus a user can select or switch to a specific mode of operation by interacting with the device such that the puff detector is actuated in a particular way which then causes the puff detector to send a control signal to the control electronics, which is recognised by the control electronics as a mode change request.

**[0011]** In other words, mode selection is performed simply by applying sucking on the device in a certain way so that there is no need for extra user interface elements like those mentioned above. This is convenient to the user and greatly facilitates the handling of the electronic smoking device. Since the control electronics are adapted to operate the heater of the atomizer in predetermined modes, these modes can be designed in a co-ordinated way avoiding malfunction.

**[0012]** In some embodiments the control electronics may be adapted to measure the time interval between two subsequent actuations of the puff detector and to interpret the corresponding actuations of the puff detector as a control signal initiated by the puff detector for selec-



tion of a specific mode, if the measured value for the time interval is within a predetermined range. For example, if a user wants to switch to a "high" mode and the user may be required to suck twice at the mouthpiece of the electronic smoking device within a relatively short time interval. In such an embodiment a timer in the control electronics may be started upon the first sucking event and stopped upon the second sucking event. If the time interval between both events is smaller than a preselected value, the second sucking event is not interpreted as an additional aerosol-inhaling puff but as a mode selection demand. In this example, the higher sucking rate of the user resembles the typical behaviour when smoking a conventional cigarette in a more intense manner.

**[0013]** Alternatively, the control electronics could be adapted to measure the duration of an actuation of the puff detector and to interpret the corresponding actuation of the puff detector as a control signal initiated by the puff detector for selection of a specific mode, if the measured value for the duration is within a predetermined range. For example, if the electronic smoking device were to be in a "low" mode and the user was detected taking an unusual long puff, the control electronics could firstly cause the atomiser to generate a certain volume of aerosol and then, after realising that the duration of the user's puff had exceeded a predetermined value, switch the mode of operation for the atomizer to a "high" mode. Equally, if a user were to be detected taking a very short durations puff when the device was in a "high" mode, the control electronics might utilise that to initiate a switch to a "low" mode.

**[0014]** From the above it will be apparent that there are many options for assigning certain signals initiated via the puff detector to certain predetermined modes for operating the heater of the atomizer.

**[0015]** In some embodiments, the control electronics may be adapted to select a specific mode different from the previously used mode if the measured value for the time interval or duration, respectively, is smaller than a predetermined threshold value, and to maintain the previously used mode if the measured value is greater than the threshold value. In this case, the user would suck on the device rapidly in a way which was detected by the puff detector in order to signal to the control electronics that a change of mode is desired. On the other hand, if the puff detector detects a user is operating the device in the usual, relatively slow manner, this can be interpreted by the control electronics as a demand for ordinary aerosol delivery, and the mode is not changed. To this end, the control electronics can be adapted to interpret the latest actuation of the puff detector as a signal to indicate an aerosol inhaling puff, if the measured value for the time interval or duration, respectively, exceeds a predetermined threshold value.

**[0016]** In some embodiments, the control electronics may be adapted to indicate the selection of a specific mode different from the previously used mode to a user by an externally detectable acknowledgment signal. In

this way, the user gets a feedback upon selection of a new mode in order to be sure that the user command, transmitted via the puff detector, has been recognised by the control electronics. The acknowledgement signal may be, e.g., an optical signal (e.g. a flash of an LED) or an acoustic signal (e.g. a beep sound) or, less noticeable to the user's environment, a vibration.

**[0017]** Puff detectors in conventional electronic cigarettes are ordinarily arranged to respond to a single physical parameter or change of that parameter, e.g. an under-pressure or vacuum. In embodiments of the present invention a puff detector may be provided which is able to distinguish between different qualities of a physical parameter and to transmit corresponding signals to the control electronics.

**[0018]** Thus for example in some embodiments, the puff detector may be able to detect an over-pressure and to initiate a control signal upon detection of an over-pressure (which would be different from the usual under-pressure or aerosol inhaling signal). In response to that control signal, the control electronics would then select a specific mode. In such an embodiment, the user would blow into the mouthpiece of the electronic smoking device in order to indicate to the control electronics request for a change of mode. If a user inhales at the mouthpiece in the usual manner, the puff detector would merely transmit its normal signals to indicate to the control electronics to initiate an aerosol inhaling puff in accordance with the device's current mode of operation. In this way, the user's actions for changing the mode and for normal operation of the electronic smoking device would be clearly different.

**[0019]** In a more elaborate device, the control electronics may be adapted to store signals initiated by the puff detector to create a history of puff detector signals. The control electronics could then consider this history when selecting a specific mode. For example, a calm user may tend to smoke more slowly, having longer breaks between individual puffs. After analysing the history of puff detector signals resulting from such a behaviour, the control electronics could re-adjust the parameters of the predetermined modes, e.g. in order to better adapt a mode to the user or in order to better distinguish between the puff detector signals for aerosol demand and mode selection.

**[0020]** Predetermined modes may be directed to provide, e.g., a certain (more or less precisely defined) total amount of aerosol per puff or a certain (more or less precisely defined) amount of aerosol per time unit. For example, one of the predetermined modes may be directed to provide less aerosol during a puff than another one of the predetermined modes is directed to.

**[0021]** If the control electronics are adapted to measure the time lapsed after the latest puff, it may transfer the electronic smoking device into a dormant state, if this time exceeds a predetermined level. That means that the electronic smoking device recognises when the user stops smoking so that the heating power for the atomizer

can be shut down, which saves energy.

**[0022]** In the electronic smoking device according to the invention, components like the housing, the battery, the atomizer, the puff detector (as far as it is not able to detect over-pressure), and the liquid reservoir may be designed as known in the art. This even holds for the hardware or major parts of the hardware of the control electronics. As explained above, however, the control electronics preferably comprises a timer. Moreover, the programs stored in and executed by the control electronics (firmware, software) are adapted to the invention.

**[0023]** Components like the battery, the atomizer and/or the reservoir may be parts of the electronic smoking device. It is conceivable as well that they are not part thereof, in particular if the electronic smoking device has a modular design or if articles like the reservoir are sold separately, e.g. as capsules or cartridges.

**[0024]** In the following, the invention is further explained by means of embodiments. The drawings show in

Figure 1 a schematic longitudinal section of an embodiment of the electronic smoking device according to the invention and

Figure 2 a schematic block diagram illustrating mode selection by means of the puff detector and the control electronics of the electronic smoking device.

**[0025]** Figure 1 illustrates an embodiment of an electronic smoking device 1 in a schematic longitudinal section.

**[0026]** The electronic smoking device 1 comprises a cylinder-like housing 2 and a mouthpiece 4, which is designed as a detachable cap. Taking off the mouthpiece 4 provides access to a replaceable capsule 6, which serves as a reservoir for a liquid. The housing 2 accommodates a battery 10. In the embodiment, the battery 10 is designed as a re-chargeable lithium ion battery and may include its own circuitry. The battery 10 is connected, via leads 12 and 13, to control electronics 14, which includes integrated circuits mounted on a printed circuit board 15. The printed circuit board 15 also supports a plurality of light-emitting diodes (LEDs) 16, which are assembled behind respective windows provided in the housing 2 and indicate the current status of the electronic smoking device 1.

**[0027]** A puff detector 18 is connected to the control electronics 14. In the embodiment, the puff detector 18 is designed as an inhalation sensor, which detects the vacuum generated inside the housing 2 when a user inhales at the mouthpiece 4.

**[0028]** An atomizer 20 comprises a heater 22 connected via leads 23 to the control electronics 14. The heater 22 includes a heating wire mounted at a ceramics shell (not shown in the Figures), which also supports a wick device 24 made of braided metal or sponge-like metal material. A piercing tip 25 at the distant end of the wick

device 24 is able to penetrate a membrane 26 used for sealing the capsule 6 so that liquid 28 contained in the capsule 6 can be guided out of the capsule 6 and through the wick device 24 to the area of the heater 22.

**[0029]** At its free end, the mouthpiece 4 comprises an inhalation aperture 30. At the opposite end of the electronic smoking device 1, a charging port 32 is provided which permits re-charging of the battery 10, e.g. via a USB port.

**[0030]** To use the electronic smoking device 1, a consumer inserts a fresh capsule 6 so that its membrane 26 is pierced and liquid is supplied from the capsule 6 via the wick device 24 to the area of the heater 22. When the consumer inhales at the inhalation aperture 30, the puff detector 18 senses the resulting vacuum inside the housing 2 and indicates that to the control electronics 14. In response thereto, the heater 22 is powered so that its heating wire is able to atomize the liquid in its proximity in order to create an aerosol, which is inhaled by the consumer. In the embodiment, the heater 22 remains switched on for a predetermined period of time, which is given by a predetermined mode. This mode for operating the heater in the atomizer can be selected by the consumer (user) via the puff detector 18, as explained in the following.

**[0031]** The heater 22 may be provided in various other forms of direct heating and indirect heating of the liquid, each having advantages. In direct heating designs, the liquid directly contacts the heating element, which may be a wire coil, rod or other heater surface. In indirect heating designs, the liquid contacts a surface heated by a separate heating element, which does not come into direct contact with the liquid. Other types of atomizers or vaporizers may alternatively be used. Various ultrasonic atomizers are effective in creating vapour without heating. For example, an ultrasonic atomizer using a free-running Colpitts oscillator generates high frequency energy in the range between 800 kHz and 2000 kHz driving a piezoelectric vibrator converting liquid into vapour. Atomizers having electrostatic, electromagnetic or pneumatic elements have also been proposed.

**[0032]** Figure 2 illustrates the functional relationship for mode selection by means of a schematic diagram.

**[0033]** The puff detector 18 is arranged in the airflow pathway within the housing 2. In the embodiment, the puff detector 18 senses an under-pressure (vacuum) in relation to the ambient air pressure. Such kind of sensor is already in common use in electronic cigarettes. The puff detector 18 may be an airflow sensor, such as a rocking vane sensor or a Hall element sensor. These may be used in place of the vacuum sensor, as in some designs, airflow is more easily and accurately measured in comparison to vacuum or pressure. Airflow sensors may also have faster response times. The sensor may be designed to allow airflow through or around the sensor, such as with a sensor having an annular shape. Diaphragm and MEMS sensors may similarly be used. Silica gel corrugated membrane sensors have also been

proposed for this type of application. These and similar such sensors are available from Micro Pneumatic Logic, Pompano Beach FL, USA and from Honeywell Microswitch, Freeport, IL, USA.

**[0034]** Upon actuation of the puff detector 18, i.e. when the pressure drops, a control signal is transmitted to the control electronics 14. The control electronics 14 comprises a timer circuit 40 (preferably a gate timer), which can be a common component of control electronics in electronic cigarettes. The timer circuit 40 generates, from the control signal, a time marking. A controller 42 in the control electronics 14 is programmed to determine the time intervals elapsed between consecutive control signals from the puff detector 18. This is achieved by simply subtracting the time values of two consecutive time markings (readings). In this way, it is possible to obtain the time interval between two consecutive puffs. This time interval is compared with threshold values for, e.g., normal, short and long intervals. If it turns out that the time interval is in a predetermined range for normal intervals, this is interpreted as normal user activity and does not result in a change of mode. If, however, the time interval is in a predetermined range for short intervals or long intervals, this is interpreted as a user demand for selection of a different mode of operating the electronic smoking device. These predetermined ranges are stored in the control electronics 14, e.g. via firmware.

**[0035]** For example, normal smoking consists of puffs having a minimum puff duration and a typical pause between subsequent puffs, e.g. a minimum puff duration of 2 seconds and a minimum pause between puffs of 5 seconds. If the timer arrangement described above records a user's activity falling in these limits, it is assumed that no user command has been given except regular puffing. That means, the heater 22 of the atomizer 20 is activated upon puffing, and the mode of the electronic smoking device is not changed.

**[0036]** However, in the example, if the user takes only a short pause between puffs, then this will be considered as a command for selection of a different one of the predetermined modes, in this case a mode which delivers more aerosol per puff. In the embodiment, the provision of more aerosol is achieved by actuating the heater 22 of the atomizer 20 for a longer (predetermined) time interval per puff.

**[0037]** The user can be given a feedback to acknowledge the recognition of the mode change command. This can be an optical feedback of any kind, e.g. via the LEDs 16. In a more simple form, the atomizer does not produce aerosol on the second puff to indicate that the user command was understood. Other kinds of feedback, like a sound or a vibration, are conceivable as well.

**[0038]** Similarly, if the user takes a rather long pause between puffs, e.g. more than 20 seconds, this will be interpreted as a command for selection of another mode, i.e. a mode which delivers less aerosol per puff, which is achieved by activating the heater of the atomizer for a shorter time interval per puff.

**[0039]** So far, it was assumed that the beginning of each actuation of the puff detector 18 provides a time marking. However, it is also possible to create time markings via the duration of an individual puff so that, e.g., a very short puff may be interpreted as a command to select a different one of the predetermined modes.

**[0040]** Puff intervals of excessive duration, i.e. of more than one minute, may be ignored as this indicates that the user has simply stopped smoking for a while without any intent to provoke a user interaction.

**[0041]** Similarly, if the time lapsed after the latest puff exceeds a predetermined level, the control electronics 14 may transfer the electronic smoking device into a dormant state or switch it completely off in order to save energy.

**[0042]** In another embodiment, the puff detector is able to detect over-pressure, in addition to detecting under-pressure (vacuum), and to initiate a control signal indicating over-pressure upon detection of an over-pressure. In response to that control signal, the control electronics can select a specific predetermined mode. Thus, in such an embodiment, there is no need for analysing the timing sequence of the signals provided by the puff detector in order to find out whether a signal in question is an ordinary demand for an actuation of the atomizer to generate aerosol or whether that signal is a mode selection signal. On the other hand, the puff detector has to be more elaborate. For example, it may comprise a conventional puff detector for sensing under-pressure plus an additional subunit which is able to detect overpressure. As used here, the word puff means the user inhaling on the mouthpiece of the device, or blowing into the mouthpiece of the device.

**[0043]** In an embodiment including a puff detector operable to detect both under pressure and over pressure, the user blows into the electronic smoking device in order to change the mode or to select a specific mode. An analysis of the timing of the blowing events may nevertheless be helpful in order to assign to the blowing events a plurality of options for different modes. When the user inhales at the mouthpiece of the electronic smoking device, an under-pressure is sensed, which causes the control electronics to activate the heater of the atomizer for providing aerosol.

**[0044]** Although in the above description reference has been made to an electronic smoking device operating in a "high" and a "low" mode, it will be appreciated that in embodiments of the present invention more than two modes might be available.

**[0045]** Thus for example, in some embodiments, the atomizer may be operated at a greater number of levels of activation (e.g. "low", "medium" and "high"). In some embodiments an even greater number of activation levels might be provided with a user being able to set the desired activation level by utilizing the device in a way which was detectable by a puff detector 18.

**[0046]** It will be appreciated that the selection of a mode of operation may be more complex than simply setting a

level of activation for the heater 22 of an atomizer 20.

[0047] Thus for example, the interaction with the puff detector 18, could cause the device to enter a mode where the activation of a heater 18 was to be set on the basis of the duration of one or more immediately previous inhalations. Such a system could better mimic the variation in heating and smoke generation of a conventional cigarette.

[0048] So for example, in such a mode, the heating power of the atomizer 20 could be set based on the duration of the latest detected inhalations within a set time period with the power increasing when the puff detector 18 has determined that a user has been sucking on the device for a higher proportion of the most recent period of time under consideration.

[0049] From the foregoing, it is evident that the selection of two or more than two predetermined modes for operating the electronic smoking device can be encoded by control signals initiated by the puff detector in many different ways. In all cases, the user does not have to press any buttons, but it is sufficient just to interact via the mouthpiece of the electronic smoking device in order to change or select a mode.

#### Claims

##### 1. An electronic smoking device, comprising:

- a puff detector (18) operable to detect a user sucking on or blowing into the device;
- an atomizer (20) operable to create an aerosol for inhalation by a user by atomizing a liquid supplied from a reservoir (6); and
- control electronics (14) responsive to the puff detector (18) detecting a user sucking on or blowing into the device to activate the atomizer to atomize a liquid supplied from a reservoir (6) to create an aerosol for inhalation, **characterised in that:**
- the control electronics (14) are responsive to the puff detector (18) detecting a user sucking on or blowing into the device to activate the atomizer in an accordance with a mode of operation selected from a plurality of modes of operation, wherein the control electronics (14) are arranged to select the mode of operation to be utilised to activate the atomizer on the basis of the detected manner of the activation of the puff detector (18).

##### 2. An electronic smoking device according to claim 1, **characterised in that** the control electronics (14) are adapted to measure the time interval between two subsequent activations of the puff detector (18) and interpret the corresponding activations of the puff detector (18) as a control signal initiated by the puff detector (18) for selection of a specific mode of

operation, if the measured value for the time interval is within a predetermined range.

3. An electronic smoking device according to claim 1 or 2, **characterised in that** the control electronics (14) are adapted to measure the duration of an activation of the puff detector (18) and to interpret the corresponding activation of the puff detector (18) as a control signal initiated by the puff detector (18) for selection of a specific mode of operation, if the measured value for the duration is within a predetermined range.
4. An electronic smoking device according to claim 2 or 3, wherein the control electronics (14) are adapted to select an alternative mode of operation to a previously used mode of operation if the measured value for the time interval or duration, respectively, is smaller than a predetermined threshold value, and to maintain the previously used mode if the measured value is greater than the threshold value.
5. An electronic smoking device according to any one of claims 2 to 4, wherein the control electronics (14) are adapted to utilise a default mode of operation to activate the heater (22) if the measured value for the time interval or duration, respectively, has exceeded a predetermined threshold value.
6. An electronic smoking device according to any one of claims 1 to 5, wherein the control electronics (14) are adapted to indicate the selection of a specific mode different from the previously used mode by an externally detectable acknowledgment signal.
7. An electronic smoking device according to any one of claims 1 to 6, wherein the atomizer includes a heater (22) and the puff detector (18) is adapted to detect an over-pressure and the control electronics (14) are responsive to detection of an over pressure by the puff detector (18) to change the currently selected mode of operation for the heater (22).
8. An electronic smoking device according to any one of claims 1 to 7, wherein the atomizer includes a heater (22) and the control electronics (14) are adapted to store data recording a history of activation of the puff detector (18) and select a mode of operation to be utilised to activate the heater (22) on the basis of the current detected manner of the activation of the puff detector (18) and the stored data recording the history of activation of the puff (18) detector.
9. An electronic smoking device according to claim 8 wherein the control electronics are adapted to compare the current detected manner of the activation of the puff detector (18) with one or more thresholds, wherein the thresholds are set on the basis of the

stored data recording the history of activation of the puff detector (18).

10. An electronic smoking device according to claim 9 wherein the thresholds are set on the basis of the stored data recording the history of activation of the puff detector (18) comprise thresholds relating to any of: the duration, frequency or extent of inhalation detected by the puff detector (18) detecting a user sucking on the device.
 

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11. An electronic smoking device according to any one of claims 1 to 10, wherein at least one of the predetermined modes of operation is operable to create less aerosol during a puff than at least one of the other predetermined modes of operation.
 

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12. An electronic smoking device according to any one of claims 1 to 11, wherein the control electronics (14) are adapted to measure the time lapsed after the latest puff and to transfer the electronic smoking device (1) into a dormant state, if this time exceeds a predetermined level.
 

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13. An electronic smoking device in accordance with claim 14 wherein the reservoir (6) comprises a replaceable reservoir (6) operable to be mounted and demounted from the atomizer (20).
 

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14. A method for operating an electronic smoking device characterised in that:
 

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the user sucks on and/or blows into the device using a predetermined sequence corresponding to a specific mode of operation of the device;

control electronics (14) within the device detect the predetermined sequence of sucking and/or blowing applied to the device by the user;

the control electronics (14) identifies the specific mode of operation of the device corresponding to the predetermined sequence; and

the control electronics (14) switches the device into the specific mode of operation identified.

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15. The method of claim 14 wherein the control electronics identifies the specific mode of operation corresponding to the sequence by using a look-up table stored in the control electronics.
 

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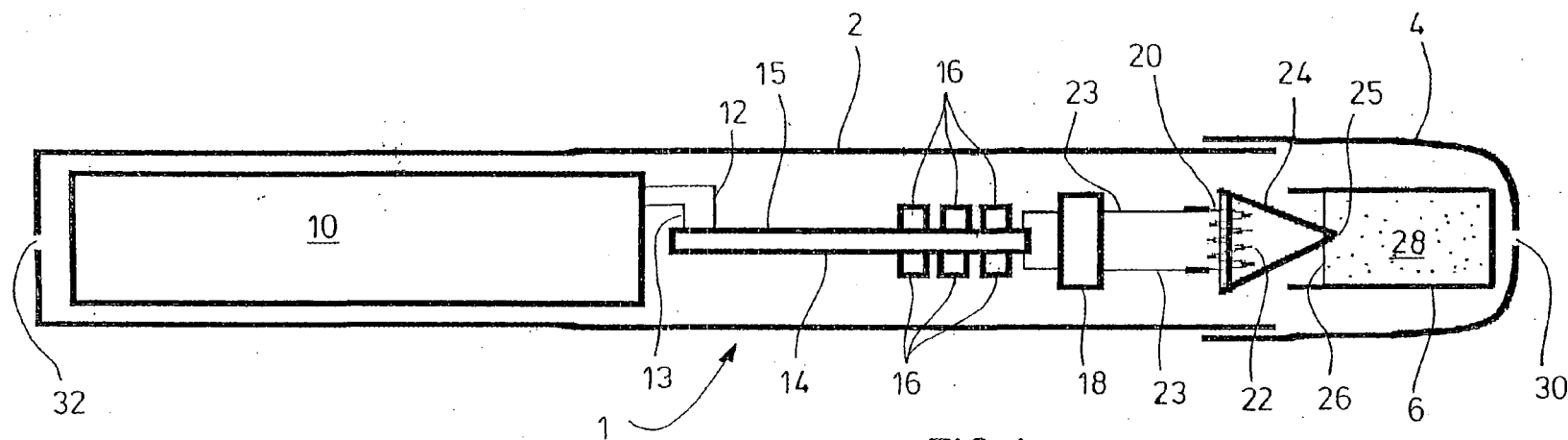


FIG. 1

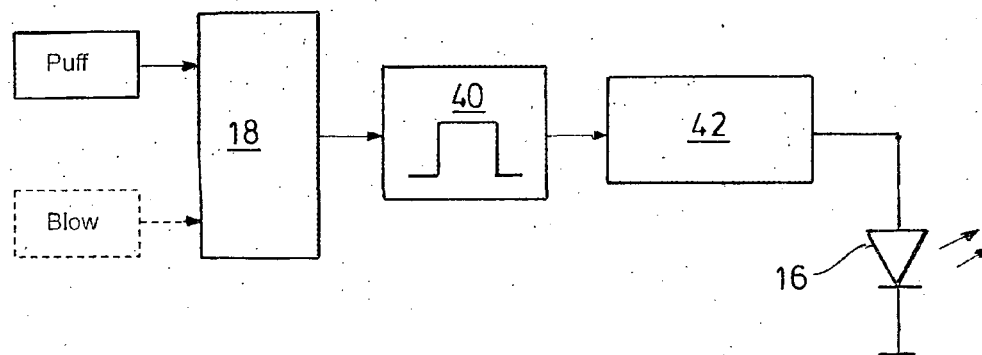


FIG. 2



## EUROPEAN SEARCH REPORT

 Application Number  
 EP 14 00 0757

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                     |                                                                                                  |                                                                                                                                                                                                                                                                              |                                         |
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| The present search report has been drawn up for all claims                                                                                                                                                              |                                                                                                  |                                                                                                                                                                                                                                                                              |                                         |
| Place of search<br>Munich                                                                                                                                                                                               |                                                                                                  | Date of completion of the search<br>28 August 2014                                                                                                                                                                                                                           | Examiner<br>MacCormick, Duncan          |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                             |                                                                                                  | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                         |
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ON EUROPEAN PATENT APPLICATION NO.**

EP 14 00 0757

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(51) International Patent Classification:  
A24F 47/00 (2006.01)(21) International Application Number:  
PCT/US2014/062835(22) International Filing Date:  
29 October 2014 (29.10.2014)

(25) Filing Language: English

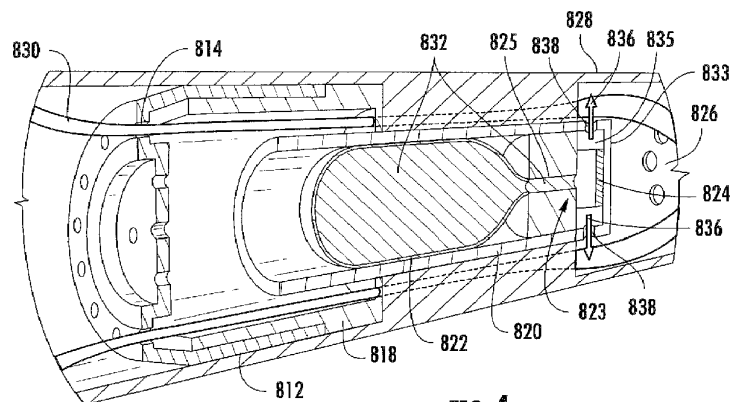
(26) Publication Language: English

(30) Priority Data:  
61/897,917 31 October 2013 (31.10.2013) US  
14/289,101 28 May 2014 (28.05.2014) US(71) Applicant: **R. J. REYNOLDS TOBACCO COMPANY**  
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Sandridge & Rice, LLP, Attn: Patent Docketing, P.O. Box  
7037, Atlanta, GA 30357-0037 (US).(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, 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, KN, KP, KR,  
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).**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: AEROSOL DELIVERY DEVICE INCLUDING A PRESSURE-BASED AEROSOL DELIVERY MECHANISM

**FIG. 4**

(57) Abstract: The present disclosure relates to aerosol delivery devices. The aerosol delivery devices include mechanisms configured to deliver an aerosol precursor composition from a reservoir to an atomizer including a heating element to produce a vapor. A pressure controller may control dispensing of the aerosol precursor composition from the reservoir based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer. The first pressure within the reservoir may be substantially equal to atmospheric pressure. Alternatively, the first pressure within the reservoir may be greater than atmospheric pressure.

**Published:**

— with international search report (Art. 21(3))

# AEROSOL DELIVERY DEVICE INCLUDING A PRESSURE-BASED AEROSOL DELIVERY MECHANISM

## FIELD OF THE DISCLOSURE

The present disclosure relates to aerosol delivery devices, such as smoking articles; and more particularly, to aerosol delivery devices that utilize electrically generated heat for the production of aerosol (e.g., smoking articles commonly referred to as electronic cigarettes). Aerosol delivery devices including mechanisms for delivery of an aerosol precursor composition to an atomizer are provided. The smoking articles may be configured to heat an aerosol precursor, which may incorporate materials made or derived from tobacco or otherwise incorporate tobacco, capable of vaporizing to form an inhalable aerosol for human consumption.

## BACKGROUND

Many smoking devices have been proposed through the years as improvements upon, or alternatives to, smoking products that require combusting tobacco for use. Many of those devices purportedly have been designed to provide the sensations associated with cigarette, cigar, or pipe smoking, but without delivering considerable quantities of incomplete combustion and pyrolysis products that result from the burning of tobacco. To this end, there have been proposed numerous smoking products, flavor generators, and medicinal inhalers that utilize electrical energy to vaporize or heat a volatile material, or attempt to provide the sensations of cigarette, cigar, or pipe smoking without burning tobacco to a significant degree. See, for example, the various alternative smoking articles, aerosol delivery devices and heat generating sources set forth in the background art described in U.S. Pat. No. 7,726,320 to Robinson et al. and U.S. Pat. Pub. Nos. 2013/0255702 to Griffith, Jr. et al. and 2014/0096781 to Sears et al., which are incorporated herein by reference. See also, for example, the various types of smoking articles, aerosol delivery devices and electrically powered heat generating sources referenced by brand name and commercial source in U.S. Pat. App. Ser. No. 14/170,838, filed February 3, 2014, to Bless et al., which is incorporated herein by reference.

However, it may be desirable to provide aerosol delivery devices with enhanced functionality. In this regard, it may be desirable to improve delivery of an aerosol precursor composition to an atomizer.

## BRIEF SUMMARY OF THE DISCLOSURE

The present disclosure relates to aerosol delivery systems. Such systems have the ability to generate aerosol as a result of heat generated by electrical power sources, and to deliver aerosol that is intended to be drawn into the mouth of a user. Of particular interest are aerosol delivery systems that provide components of tobacco in an aerosol form, such as is provided to smokers by devices commonly known or characterized as electronic cigarettes. As used herein, term “aerosol” is meant to include vapors, gases and aerosols of a form or type suitable for human inhalation, whether or not visible, and whether or not of a form that might be considered to be “smoke-like.”

Various embodiments of mechanisms for delivering an aerosol precursor composition to an atomizer are provided. These mechanisms may include pumps, passively puff-induced delivery of the aerosol precursor composition, pressurized aerosol precursor reservoirs, bubble jet heads, and other mechanisms as described hereinafter.

In one aspect an aerosol delivery device is provided. The aerosol delivery device may include a control body and a cartridge including a reservoir at least partially filled with an aerosol precursor composition. The cartridge may be configured to receive an airflow from the control body. The aerosol delivery device may additionally include an atomizer including a heating element. Further, the aerosol delivery device may include a pressure controller configured to control dispensing of the aerosol precursor composition from the reservoir based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer. The atomizer may be configured to heat the aerosol precursor composition received from the reservoir to add an aerosol to the airflow.

In some embodiments the first pressure within the reservoir may be greater than an ambient pressure. The pressure controller may include a valve configured to selectively release the aerosol precursor composition from the reservoir. The aerosol delivery device may additionally include a flow sensor, and the valve may be configured to actuate in response to a signal from the flow sensor.

In some embodiments the cartridge may include the valve and the atomizer. In another embodiment the control body may include the valve and the atomizer. The control body may include a coupler and the cartridge may include a base. The valve may be in fluid communication with the reservoir when the coupler of the control body is coupled to the base of the cartridge.

In some embodiments the first pressure within the reservoir may be substantially equal to an ambient pressure. The pressure controller may include a flow restrictor configured to produce the pressure differential between the first pressure within the reservoir and the second pressure

proximate the atomizer. The control body may include the flow restrictor. The flow restrictor may include one or more restrictor apertures.

In some embodiments the reservoir may include an aerosol precursor bag. The atomizer may additionally include a fluid delivery tube configured to deliver the aerosol precursor composition from the reservoir to the heating element during application of the pressure differential and otherwise resist flow of the aerosol precursor composition to the heating element. The atomizer may define a chamber and the heating element may be positioned within the chamber.

In an additional aspect a method for aerosolization in an aerosol delivery device is provided. The method may include directing an airflow from a control body through a cartridge including a reservoir at least partially filled with an aerosol precursor composition, controlling dispensing of the aerosol precursor composition from the reservoir to an atomizer including a heating element based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer, and heating the aerosol precursor composition dispensed from the reservoir with the heating element to add an aerosol to the airflow.

In some embodiments the first pressure within the reservoir may be greater than an ambient pressure. Further, controlling dispensing of the aerosol precursor composition may include selectively releasing the aerosol precursor composition from the reservoir with a valve. The method may additionally include detecting an airflow with a flow sensor. Controlling dispensing of the aerosol precursor composition may include actuating the valve in response to a signal from the flow sensor. Selectively releasing the aerosol precursor composition from the reservoir with the valve may include directing the aerosol precursor composition from the reservoir in the cartridge through the valve in the control body.

In some embodiments an internal pressure within the reservoir may be substantially equal to an ambient pressure. Controlling dispensing of the aerosol precursor composition may include producing the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer with a flow restrictor. The method may additionally include delivering the aerosol precursor composition through a fluid delivery tube to the heating element during application of the pressure differential and otherwise resisting flow of the aerosol precursor composition to the heating element. Controlling dispensing of the aerosol precursor composition may include directing the aerosol precursor composition to a chamber of the atomizer in which the heating element is positioned.

The invention includes, without limitation, the following embodiments.

Embodiment 1: An aerosol delivery device, comprising:  
a control body;

a cartridge comprising a reservoir at least partially filled with an aerosol precursor composition, the cartridge being configured to receive an airflow from the control body;  
an atomizer comprising a heating element; and

5 a pressure controller configured to control dispensing of the aerosol precursor composition from the reservoir based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer,

the atomizer being configured to heat the aerosol precursor composition received from the reservoir to add an aerosol to the airflow.

10 Embodiment 2: The aerosol delivery device of any preceding or subsequent embodiment, wherein the first pressure within the reservoir is greater than an ambient pressure.

Embodiment 3: The aerosol delivery device of any preceding or subsequent embodiment, wherein the pressure controller comprises a valve configured to selectively release the aerosol precursor composition from the reservoir.

15 Embodiment 4: The aerosol delivery device of any preceding or subsequent embodiment, further comprising a flow sensor, wherein the valve is configured to actuate in response to a signal from the flow sensor.

Embodiment 5: The aerosol delivery device of any preceding or subsequent embodiment, wherein the cartridge includes the valve and the atomizer.

20 Embodiment 6: The aerosol delivery device of any preceding or subsequent embodiment, wherein the control body includes the valve and the atomizer.

Embodiment 7: The aerosol delivery device of any preceding or subsequent embodiment, wherein the control body comprises a coupler and the cartridge comprises a base, the valve being in fluid communication with the reservoir when the coupler of the control body is coupled to the base of the cartridge.

25 Embodiment 8: The aerosol delivery device of any preceding or subsequent embodiment, wherein the first pressure within the reservoir is substantially equal to an ambient pressure.

30 Embodiment 9: The aerosol delivery device of any preceding or subsequent embodiment, wherein the pressure controller comprises a flow restrictor configured to produce the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer.

Embodiment 10: The aerosol delivery device of any preceding or subsequent embodiment, wherein the control body includes the flow restrictor.

Embodiment 11: The aerosol delivery device of any preceding or subsequent embodiment, wherein the flow restrictor comprises one or more restrictor apertures.

Embodiment 12: The aerosol delivery device of any preceding or subsequent embodiment, wherein the reservoir comprises an aerosol precursor bag.

Embodiment 13: The aerosol delivery device of any preceding or subsequent embodiment, wherein the atomizer further comprises a fluid delivery tube configured to deliver the aerosol precursor composition from the reservoir to the heating element during application of the pressure differential and otherwise resist flow of the aerosol precursor composition to the heating element.

Embodiment 14: The aerosol delivery device of any preceding or subsequent embodiment, wherein the atomizer defines a chamber and the heating element is positioned within the chamber.

Embodiment 15: A method for aerosolization in an aerosol delivery device, comprising:

directing an airflow from a control body through a cartridge comprising a reservoir at least partially filled with an aerosol precursor composition;

controlling dispensing of the aerosol precursor composition from the reservoir to an atomizer comprising a heating element based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer; and

heating the aerosol precursor composition dispensed from the reservoir with the heating element to add an aerosol to the airflow.

Embodiment 16: The method of any preceding or subsequent embodiment, wherein the first pressure within the reservoir is greater than an ambient pressure, and

wherein controlling dispensing of the aerosol precursor composition comprises selectively releasing the aerosol precursor composition from the reservoir with a valve.

Embodiment 17: The method of any preceding or subsequent embodiment, further comprising detecting an airflow with a flow sensor,

wherein controlling dispensing of the aerosol precursor composition comprises actuating the valve in response to a signal from the flow sensor.

Embodiment 18: The method of any preceding or subsequent embodiment, wherein selectively releasing the aerosol precursor composition from the reservoir with the valve comprises directing the aerosol precursor composition from the reservoir in the cartridge through the valve in the control body.

Embodiment 19: The method of any preceding or subsequent embodiment, wherein an internal pressure within the reservoir is substantially equal to an ambient pressure, and

wherein controlling dispensing of the aerosol precursor composition comprises producing the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer with a flow restrictor.



Embodiment 20: The method of any preceding or subsequent embodiment, further comprising delivering the aerosol precursor composition through a fluid delivery tube to the heating element during application of the pressure differential and otherwise resisting flow of the aerosol precursor composition to the heating element.

5 Embodiment 21: The method of any preceding or subsequent embodiment, wherein controlling dispensing of the aerosol precursor composition comprises directing the aerosol precursor composition to a chamber of the atomizer in which the heating element is positioned.

These and other features, aspects, and advantages of the disclosure will be apparent from a reading of the following detailed description together with the accompanying drawings, which are  
10 briefly described below. The invention includes any combination of two, three, four, or more of the above-noted embodiments as well as combinations of any two, three, four, or more features or elements set forth in this disclosure, regardless of whether such features or elements are expressly combined in a specific embodiment description herein. This disclosure is intended to be read holistically such that any separable features or elements of the disclosed invention, in any of its  
15 various aspects and embodiments, should be viewed as intended to be combinable unless the context clearly dictates otherwise.

#### BRIEF DESCRIPTION OF THE FIGURES

Having thus described the disclosure in the foregoing general terms, reference will now be  
20 made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 illustrates an exploded view of a control body according to an example embodiment of the present disclosure;

FIG. 2 illustrates a sectional view through an aerosol delivery device including bag filled with an aerosol precursor composition that is configured to passively dispense the aerosol precursor  
25 composition during a puff according to an example embodiment of the present disclosure;

FIG. 3 illustrates an enlarged sectional view through the aerosol delivery device of FIG. 2 showing airflow therethrough according to an example embodiment of the present disclosure;

FIG. 4 illustrates an enlarged sectional view through the aerosol delivery device of FIG. 2 showing the aerosol precursor composition dispensing from the bag to an atomizer according to an  
30 example embodiment of the present disclosure;

FIG. 5 illustrates a sectional view through an aerosol delivery device including a valve and a pressurized reservoir filled with an aerosol precursor composition according to an example embodiment of the present disclosure;

FIG. 6 illustrates a sectional view through the aerosol delivery device of FIG. 5 showing airflow therethrough according to an example embodiment of the present disclosure;

FIG. 7 illustrates an enlarged sectional view through the aerosol delivery device of FIG. 5 showing the valve dispensing the aerosol precursor composition to an atomizer according to an example embodiment of the present disclosure; and

FIG. 8 schematically illustrates a method for aerosolization with an aerosol delivery device including dispensing an aerosol precursor composition with a pressure differential.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present disclosure will now be described more fully hereinafter with reference to exemplary embodiments thereof. These exemplary embodiments are described so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Indeed, the disclosure may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. As used in the specification, and in the appended claims, the singular forms “a”, “an”, “the”, include plural variations unless the context clearly dictates otherwise.

As described hereinafter, embodiments of the present disclosure relate to aerosol delivery systems, devices, and components therefor. Aerosol delivery systems according to the present disclosure use electrical energy to heat a material (preferably without combusting the material to any significant degree) to form an inhalable substance; and components of such systems have the form of articles that are most preferably sufficiently compact to be considered hand-held devices. That is, use of components of preferred aerosol delivery systems does not result in the production of smoke in the sense that aerosol results principally from by-products of combustion or pyrolysis of tobacco, but rather, use of those preferred systems results in the production of vapors resulting from volatilization or vaporization of certain components incorporated therein. In preferred embodiments, components of aerosol delivery systems may be characterized as electronic cigarettes, and those electronic cigarettes most preferably incorporate tobacco and/or components derived from tobacco, and hence deliver tobacco derived components in aerosol form.

Aerosol generating pieces of certain preferred aerosol delivery systems may provide many of the sensations (e.g., inhalation and exhalation rituals, types of tastes or flavors, organoleptic effects, physical feel, use rituals, visual cues such as those provided by visible aerosol, and the like) of smoking a cigarette, cigar, or pipe that is employed by lighting and burning tobacco (and hence inhaling tobacco smoke), without any substantial degree of combustion of any component thereof.

For example, the user of an aerosol generating piece of the present disclosure can hold and use that piece much like a smoker employs a traditional type of smoking article, draw on one end of that piece for inhalation of aerosol produced by that piece, take or draw puffs at selected intervals of time, and the like.

5           Aerosol delivery systems of the present disclosure also can be characterized as being suitable vapor-producing articles or medicament delivery articles. Thus, such articles or devices can be adapted so as to provide one or more substances (e.g., flavors and/or pharmaceutical active ingredients) in an inhalable form or state. For example, inhalable substances can be substantially in the form of a vapor (i.e., a substance that is in the gas phase at a temperature lower than its critical  
10           point). Alternatively, inhalable substances can be in the form of an aerosol (i.e., a suspension of fine solid particles or liquid droplets in a gas).

          Aerosol delivery systems of the present disclosure most preferably comprise some combination of a power source (i.e., an electrical power source), at least one control component (e.g., means for actuating, controlling, regulating and/or ceasing power supplied for heat  
15           generation, such as by controlling electrical current flow from an electrical power release unit to other components of the aerosol generating piece), a heater or heat generation component (e.g., an electrical resistance heating element and related components commonly referred to as providing an “atomizer”), and an aerosol precursor (e.g., a composition that commonly is a liquid capable of yielding an aerosol upon application of sufficient heat, such as ingredients commonly referred to as  
20           “smoke juice,” “e-liquid” and “e-juice”), and a mouthend region or tip for allowing draw upon the aerosol delivery device for aerosol inhalation (e.g., a defined air flow path through the aerosol generation piece such that aerosol generated can be withdrawn therefrom upon draw). Exemplary formulations for aerosol precursor materials that may be used according to the present disclosure are described in U.S. Pat. Pub. No. 2013/0008457 to Zheng et al., the disclosure of which is  
25           incorporated herein by reference in its entirety.

          More specific formats, configurations and arrangements of components within the aerosol delivery systems of the present disclosure will be evident in light of the further disclosure provided hereinafter. Additionally, the selection and arrangement of various aerosol delivery system components can be appreciated upon consideration of the commercially available electronic aerosol  
30           delivery devices, such as those representative products referenced in background art section of the present disclosure.

          Alignment of the components within the aerosol delivery device can vary. In specific embodiments, the aerosol precursor composition can be located near an end of the article (e.g., within a cartridge, which in certain circumstances can be replaceable and disposable), which may

be configured to be positioned proximal to the mouth of a user so as to maximize aerosol delivery to the user. Other configurations, however, are not excluded. Generally, the heating element can be positioned sufficiently near the aerosol precursor composition so that heat from the heating element can volatilize the aerosol precursor composition (as well as one or more flavorants, medicaments, or the like that may likewise be provided for delivery to a user) and form an aerosol for delivery to the user. When the heating element heats the aerosol precursor composition, an aerosol is formed, released, or generated in a physical form suitable for inhalation by a consumer. It should be noted that the foregoing terms are meant to be interchangeable such that reference to release, releasing, releases, or released includes form or generate, forming or generating, forms or generates, and formed or generated. Specifically, an inhalable substance is released in the form of a vapor or aerosol or mixture thereof. Additionally, the selection of various aerosol delivery device components can be appreciated upon consideration of the commercially available electronic aerosol delivery devices, such as those representative products listed in the background art section of the present disclosure.

An aerosol delivery device incorporates a battery or other electrical power source to provide current flow sufficient to provide various functionalities to the article, such as powering of a heater, powering of control systems, powering of indicators, and the like. The power source can take on various embodiments. Preferably, the power source is able to deliver sufficient power to rapidly heat the heating element to provide for aerosol formation and power the article through use for the desired duration of time. The power source preferably is sized to fit conveniently within the aerosol delivery device so that the aerosol delivery device can be easily handled; and additionally, a preferred power source is of a sufficiently light weight to not detract from a desirable smoking experience.

An aerosol delivery device can include a cartridge and a control body that can be permanently or detachably aligned in a functioning relationship. Various embodiments of engagement between the cartridge and the control body may be employed such as a threaded engagement, a press-fit engagement, an interference fit, a magnetic engagement, or the like. The aerosol delivery device may be substantially rod-like, substantially tubular shaped, or substantially cylindrically shaped in some embodiments when the cartridge and the control body are in an assembled configuration. However, various other shapes and configurations may be employed in other embodiments.

In specific embodiments, one or both of the cartridge and the control body may be referred to as being disposable or as being reusable. For example, the control body may have a replaceable battery or a rechargeable battery and thus may be combined with any type of recharging

technology, including connection to a typical alternating current electrical outlet, connection to a car charger (i.e., cigarette lighter receptacle), and connection to a computer, such as through a universal serial bus (USB) cable. Further, in some embodiments the cartridge may comprise a single-use cartridge, as disclosed in U.S. Pat. Pub. No. 2014/0060555 to Chang et al., which is incorporated herein by reference in its entirety.

In some embodiments a cartridge may include a base that may comprise anti-rotation features that substantially prevent relative rotation between the cartridge and the control body as disclosed in U.S. Pat. App. Ser. No. 13/840,264 to Novak et al., filed March 15, 2013, which is incorporated herein by reference in its entirety.

An aerosol delivery device may include a component configured to hold an aerosol precursor composition. The aerosol precursor composition, also referred to as a vapor precursor composition, may comprise a variety of components including, by way of example, a polyhydric alcohol (e.g., glycerin, propylene glycol, or a mixture thereof), nicotine, tobacco, tobacco extract, and/or flavorants. Various components that may be included in the aerosol precursor composition are described in U.S. Pat. No. 7,726,320 to Robinson et al., which is incorporated herein by reference in its entirety. Additional representative types of aerosol precursor compositions are set forth in U.S. Pat. No. 4,793,365 to Sensabaugh, Jr. et al.; U.S. Pat. No. 5,101,839 to Jakob et al.; PCT WO 98/57556 to Biggs et al.; U.S. Pat. App. Ser. No. 14/245,105 to Henry, Jr., filed April 4, 2014; and Chemical and Biological Studies on New Cigarette Prototypes that Heat Instead of Burn Tobacco, R. J. Reynolds Tobacco Company Monograph (1988); the disclosures of which are incorporated herein by reference in their entireties.

A variety of heater components may be used in the present aerosol delivery device. In various embodiments, one or more microheaters or like solid state heaters may be used. Embodiments of microheaters that may be utilized are further described herein. Further microheaters and atomizers incorporating microheaters suitable for use in the presently disclosed devices are described in U.S. Pat. Pub. No. 2014/0060554 to Collett et al., which is incorporated herein by reference in its entirety. In some embodiments a heating element may be formed by winding a wire about a liquid transport element as described in U.S. Pat. App. Ser. No. 13/708,381 to Ward et al., filed December 7, 2012, which is incorporated herein by reference in its entirety. Further, in some embodiments the wire may define a variable coil spacing, as described in U.S. Pat. App. Ser. No. 13/827,994 to DePiano et al., filed March 14, 2013, which is incorporated herein by reference in its entirety. Various embodiments of materials configured to produce heat when electrical current is applied therethrough may be employed to form a resistive heating element. Example materials from which the wire coil may be formed include Kanthal (FeCrAl), Nichrome,

Molybdenum disilicide ( $\text{MoSi}_2$ ), molybdenum silicide ( $\text{MoSi}$ ), Molybdenum disilicide doped with Aluminum ( $\text{Mo}(\text{Si},\text{Al})_2$ ), graphite and graphite-based materials; and ceramic (e.g., a positive or negative temperature coefficient ceramic). In further embodiments a stamped heating element may be employed in the atomizer, as described in U.S. Pat. App. Ser. No. 13/842,125 to DePiano et al.,  
5 filed March 15, 2013, which is incorporated herein by reference in its entirety. Further to the above, additional representative heating elements and materials for use therein are described in U.S. Pat. No. 5,060,671 to Counts et al.; U.S. Pat. No. 5,093,894 to Deevi et al.; U.S. Pat. No. 5,224,498 to Deevi et al.; U.S. Pat. No. 5,228,460 to Sprinkel Jr., et al.; U.S. Pat. No. 5,322,075 to Deevi et al.; U.S. Pat. No. 5,353,813 to Deevi et al.; U.S. Pat. No. 5,468,936 to Deevi et al.; U.S. Pat. No.  
10 5,498,850 to Das; U.S. Pat. No. 5,659,656 to Das; U.S. Pat. No. 5,498,855 to Deevi et al.; U.S. Pat. No. 5,530,225 to Hajaligol; U.S. Pat. No. 5,665,262 to Hajaligol; U.S. Pat. No. 5,573,692 to Das et al.; and U.S. Pat. No. 5,591,368 to Fleischhauer et al., the disclosures of which are incorporated herein by reference in their entireties. Further, chemical heating may be employed in other embodiments. Various additional examples of heaters and materials employed to form heaters are  
15 described in U.S. Pat. Pub. No. 2014/0060554 to Collett et al., which is incorporated herein by reference, as noted above.

In some embodiments the aerosol delivery devices of the present disclosure may include a control body and a cartridge. When the control body is coupled to the cartridge, an electronic control component in the cartridge may form an electrical connection with the control body. The  
20 control body may thus employ the electronic control component to determine whether the cartridge is genuine and/or perform other functions. Further, various examples of electronic control components and functions performed thereby are described in U.S. Pat. App. Pub. No. 2014/0096781 to Sears et al., which is incorporated herein by reference in its entirety.

During use, a user may draw on a mouthpiece of the cartridge of the aerosol delivery  
25 device. This may pull air through an opening in the control body or in the cartridge. For example, in one embodiment an opening may be defined between the coupler and the outer body of the control body, as described in U.S. Pat. App. Serial No. 13/841,233 to DePiano et al., filed March 15, 2013, which is incorporated herein by reference in its entirety. However, the flow of air may be received through other parts of the aerosol delivery device in other embodiments.

30 A sensor in the aerosol delivery device (e.g., a puff or flow sensor in the control body) may sense the puff. When the puff is sensed, the control body may direct current to the heater through a circuit. Accordingly, the heater may vaporize the aerosol precursor composition, and the mouthpiece may allow passage of air and entrained vapor (i.e., the components of the aerosol precursor composition in an inhalable form) from the cartridge to a consumer drawing thereon.

Various other details with respect to the components that may be included in the cartridge, are provided, for example, in U.S. Pat. App. Ser. No. 13/840,264 to Novak et al., filed March 15, 2013, which is incorporated herein by reference in its entirety. In this regard, FIG. 7 thereof illustrates an enlarged exploded view of a base and a control component terminal; FIG. 8 thereof illustrates an enlarged perspective view of the base and the control component terminal in an assembled configuration; FIG. 9 thereof illustrates an enlarged perspective view of the base, the control component terminal, an electronic control component, and heater terminals of an atomizer in an assembled configuration; FIG. 10 thereof illustrates an enlarged perspective view of the base, the atomizer, and the control component in an assembled configuration; FIG. 11 thereof illustrates an opposing perspective view of the assembly of FIG. 10 thereof; FIG. 12 thereof illustrates an enlarged perspective view of the base, the atomizer, the flow tube, and the reservoir substrate in an assembled configuration; FIG. 13 thereof illustrates a perspective view of the base and an outer body in an assembled configuration; FIG. 14 thereof illustrates a perspective view of a cartridge in an assembled configuration; FIG. 15 thereof illustrates a first partial perspective view of the cartridge of FIG. 14 thereof and a coupler for a control body; FIG. 16 thereof illustrates an opposing second partial perspective view of the cartridge of FIG. 14 thereof and the coupler of FIG. 11 thereof; FIG. 17 thereof illustrates a perspective view of a cartridge including a base with an anti-rotation mechanism; FIG. 18 thereof illustrates a perspective view of a control body including a coupler with an anti-rotation mechanism; FIG. 19 thereof illustrates alignment of the cartridge of FIG. 17 with the control body of FIG. 18; FIG. 3 thereof illustrates an aerosol delivery device comprising the cartridge of FIG. 17 thereof and the control body of FIG. 18 thereof with a modified view through the aerosol delivery device illustrating the engagement of the anti-rotation mechanism of the cartridge with the anti-rotation mechanism of the connector body; FIG. 4 thereof illustrates a perspective view of a base with an anti-rotation mechanism; FIG. 5 thereof illustrates a perspective view of a coupler with an anti-rotation mechanism; and FIG. 6 thereof illustrates a sectional view through the base of FIG. 4 thereof and the coupler of FIG. 5 thereof in an engaged configuration.

Various components of an aerosol delivery device according to the present disclosure can be chosen from components described in the art and commercially available. Reference is made for example to the reservoir and heater system for controllable delivery of multiple aerosolizable materials in an electronic smoking article disclosed in U.S. Pat. Pub. No. 2014/0000638 to Sebastian et al., which is incorporated herein by reference in its entirety.

FIG. 1 illustrates an exploded view of a control body 300 of an aerosol delivery device according to an example embodiment of the present disclosure. As illustrated, the control body 300 may comprise a coupler 302, an outer body 304, a sealing member 306, an adhesive member 308

(e.g., KAPTON® tape), a flow sensor 310 (e.g., a puff sensor or pressure switch), a control component 312, a spacer 314, an electrical power source 316 (e.g., a battery, which may be rechargeable), a circuit board with an indicator 318 (e.g., a light emitting diode (LED)), a connector circuit 320, and an end cap 322. Examples of electrical power sources are described in U.S. Pat.

5 App. Pub. No. 2010/0028766 by Peckerar et al., the disclosure of which is incorporated herein by reference in its entirety. An exemplary mechanism that can provide puff-actuation capability includes a Model 163PC01D36 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Ill. Further examples of demand-operated electrical switches that may be employed in a heating circuit according to the present disclosure are described in U.S. Pat. No.  
10 4,735,217 to Gerth et al., which is incorporated herein by reference in its entirety. Further description of current regulating circuits and other control components, including microcontrollers that can be useful in the present aerosol delivery device, are provided in U.S. Pat. Nos. 4,922,901, 4,947,874, and 4,947,875, all to Brooks et al., U.S. Pat. No. 5,372,148 to McCafferty et al., U.S. Pat. No. 6,040,560 to Fleischhauer et al., and U.S. Pat. No. 7,040,314 to Nguyen et al., all of which  
15 are incorporated herein by reference in their entireties. Reference also is made to the control schemes described in U.S. App. Serial No. 13/837,542 to Ampolini et al., filed March 15, 2013, which is incorporated herein by reference in its entirety.

In one embodiment the indicator 318 may comprise one or more light emitting diodes. The indicator 318 can be in communication with the control component 312 through the connector  
20 circuit 320 and illuminate, for example, during a user drawing on a cartridge coupled to the coupler 302, as detected by the flow sensor 310. The end cap 322 may be adapted to make visible the illumination provided thereunder by the indicator 318. Accordingly, the indicator 318 may illuminate during use of the aerosol delivery device to simulate the lit end of a smoking article. However, in other embodiments the indicator 318 can be provided in varying numbers and can take  
25 on different shapes and can even be an opening in the outer body (such as for release of sound when such indicators are present).

Still further components can be utilized in the aerosol delivery device of the present disclosure. For example, U.S. Pat. No. 5,154,192 to Sprinkel et al. discloses indicators for smoking articles; U.S. Pat. No. 5,261,424 to Sprinkel, Jr. discloses piezoelectric sensors that can be  
30 associated with the mouth-end of a device to detect user lip activity associated with taking a draw and then trigger heating; U.S. Pat. No. 5,372,148 to McCafferty et al. discloses a puff sensor for controlling energy flow into a heating load array in response to pressure drop through a mouthpiece; U.S. Pat. No. 5,967,148 to Harris et al. discloses receptacles in a smoking device that include an identifier that detects a non-uniformity in infrared transmissivity of an inserted



component and a controller that executes a detection routine as the component is inserted into the receptacle; U.S. Pat. No. 6,040,560 to Fleischhauer et al. describes a defined executable power cycle with multiple differential phases; U.S. Pat. No. 5,934,289 to Watkins et al. discloses photonic-optronic components; U.S. Pat. No. 5,954,979 to Counts et al. discloses means for altering draw resistance through a smoking device; U.S. Pat. No. 6,803,545 to Blake et al. discloses specific battery configurations for use in smoking devices; U.S. Pat. No. 7,293,565 to Griffen et al. discloses various charging systems for use with smoking devices; U.S. Pat. No. 8,402,976 to Fernando et al. discloses computer interfacing means for smoking devices to facilitate charging and allow computer control of the device; U.S. Pat. No. 8,689,804 to Fernando et al. discloses identification systems for smoking devices; and WO 2010/003480 by Flick discloses a fluid flow sensing system indicative of a puff in an aerosol generating system; all of the foregoing disclosures being incorporated herein by reference in their entirety. Further examples of components related to electronic aerosol delivery articles and disclosing materials or components that may be used in the present article include U.S. Pat. No. 4,735,217 to Gerth et al.; U.S. Pat. No. 5,249,586 to Morgan et al.; U.S. Pat. No. 5,666,977 to Higgins et al.; U.S. Pat. No. 6,053,176 to Adams et al.; U.S. 6,164,287 to White; U.S. Pat. No. 6,196,218 to Voges; U.S. Pat. No. 6,810,883 to Felter et al.; U.S. Pat. No. 6,854,461 to Nichols; U.S. Pat. No. 7,832,410 to Hon; U.S. Pat. No. 7,513,253 to Kobayashi; U.S. Pat. No. 7,896,006 to Hamano; U.S. Pat. No. 6,772,756 to Shayan; U.S. Pat. No. 8,156,944 and 8,375,957 to Hon; U.S. Pat. App. Pub. Nos. 2006/0196518 and 2009/0188490 to Hon; U.S. Pat. App. Pub. No. 2009/0272379 to Thorens et al.; U.S. Pat. App. Pub. Nos. 2009/0260641 and 2009/0260642 to Monsees et al.; U.S. Pat. App. Pub. Nos. 2008/0149118 and 2010/0024834 to Oglesby et al.; U.S. Pat. App. Pub. No. 2010/0307518 to Wang; WO 2010/091593 to Hon; WO 2013/089551 to Foo; and U.S. Pat. App. Ser. No. 13/841,233 to DePiano et al., filed March 15, 2013, each of which is incorporated herein by reference in its entirety. A variety of the materials disclosed by the foregoing documents may be incorporated into the present devices in various embodiments, and all of the foregoing disclosures are incorporated herein by reference in their entirety.

Accordingly, example embodiments of aerosol delivery devices are described above. However, the present disclosure provides various other embodiments of aerosol delivery devices. As described hereinafter, such aerosol delivery devices may include differing configurations of components for storing, delivering, and/or vaporizing an aerosol precursor composition. For example, as illustrated in FIGS. 2 – 7 and described in the following text associated therewith, in some embodiments the aerosol precursor composition may be dispensed from a reservoir by a pressure differential, which may be controlled by various embodiments of pressure controllers.

In this regard, FIG. 2 illustrates a sectional view through an aerosol delivery device 800 according to an additional example embodiment of the present disclosure. As illustrated, the aerosol delivery device 800 may include a control body 802 and a cartridge 804. The control body 802 may include an indicator 806 (e.g., an LED), an electrical power source 808 (e.g., a battery, which may be rechargeable), a flow sensor 810, a coupler 812 including one or more restrictor apertures 814 defined therethrough, and an outer body 816. The cartridge 804 may include a base 818, a reservoir 820 that may include an aerosol precursor bag 822 received therein, an atomizer 823 comprising a heating element 824 and a fluid delivery tube 825, a mouthpiece 826, and an outer body 828. The base 818 of the cartridge 804 may be configured to releasably engage the coupler 812 of the control body 802 to form a mechanical and electrical connection therebetween.

FIG. 3 illustrates an additional sectional view through the aerosol delivery device 800. More particularly, FIG. 3 illustrates a flow path of air through the aerosol delivery device 800 when a user draws on the mouthpiece 826. As illustrated, an airflow or flow of ambient air 830 may enter the aerosol delivery device 800 and travel past the flow sensor 810. Although the ambient air 830 is illustrated as flowing past the electrical power source 808, in other embodiments the air may not flow past the electrical power source and/or the flow sensor may be positioned at an alternative location. The air 830 may then travel through the coupler 812 through the restrictor apertures 814 defined therethrough, through the base 818, around the reservoir 820, and out the mouthpiece 826.

As illustrated in FIG. 3, in one embodiment the air 830 may enter the aerosol delivery device 800 through a longitudinal end thereof, opposite from the mouthpiece 826. However, in other embodiments the air may enter the aerosol delivery device at an alternate location. For example, the air may enter through the coupler or the base, or at a location between the base and the mouthpiece. Accordingly, it should be understood that the particular airflow patterns described herein are provided for example purposes only.

As will be described below, an aerosol precursor composition 832 may be directed from the aerosol precursor bag 822 to the atomizer 823. In this regard, the atomizer 823 may comprise a housing 833 defining a chamber 835 in which the heating element 824 is positioned and to which the aerosol precursor composition 832 is delivered. Thus, issues with respect to the aerosol precursor composition 832 being directed into the air 830 and to a user without being vaporized may be avoided. In this regard, the aerosol precursor composition 832 may be directed into contact with the heating element 824 at the chamber 835 to ensure vaporization thereof.

When a user puffs on the mouthpiece 826 of the aerosol delivery device 800, a pressure differential may be created on opposing sides of the aerosol precursor bag 822. More particularly, restricted flow of the air 830 around the reservoir 820 may cause a portion of the aerosol delivery

device 800 between the base 818 and the aerosol precursor bag 822 (e.g., within the control body 802) to have a relatively higher pressure than a portion of the aerosol delivery device between the aerosol delivery bag and the mouthpiece 826 (e.g., within the cartridge 804). In other embodiments, the pressure differential on opposing sides of the aerosol precursor bag may be formed in other manners wherein the pressure differential is employed to direct an aerosol precursor composition therefrom.

Although a pressure differential is described above as being defined between first and second opposing sides of the aerosol precursor bag 822 during a draw on the aerosol delivery device 800, a pressure differential may additionally or alternatively be defined between other locations. For example, a pressure differential may be defined between a first pressure within the reservoir 820 (and more particularly, within the aerosol precursor bag 822) and a second pressure proximate the atomizer 823 (and more particularly, proximate an outlet to the fluid delivery tube 825 within the chamber 835 defined by the housing 833) during a draw on the aerosol delivery device 800. In this regard, as a user draws on the mouthpiece 826, the pressure within the cartridge 804 may be reduced. Accordingly, the second pressure proximate the atomizer 823 may be reduced and may become less than the first pressure with the aerosol precursory bag 822. In this regard, in some embodiments the first pressure within the aerosol precursor bag 822 of the reservoir 820 may be substantially equal to an ambient pressure (e.g., atmospheric pressure). Thus, as a result of a sub-atmospheric pressure being defined proximate the outlet to the fluid delivery tube 825 at the atomizer 823 during a draw on the aerosol delivery device 800, the aerosol precursor composition 832 may be expelled from the aerosol precursor bag 822 through the fluid delivery tube to the heating element 824 during a draw on the mouthpiece 826.

However, in instances in which a small pressure drop is associated with the draw on the aerosol delivery device 800, the pressure differential between the first pressure in the aerosol precursor bag 822 and the second pressure proximate the atomizer 823 may be relatively small. In other words, when there is relatively little resistance to a draw on the aerosol delivery device 800, the decrease in pressure within the cartridge 804 relative to an atmospheric pressure may be relatively low. Accordingly, the aerosol delivery device 800 may include a pressure controller configured to produce the pressure differential.

In particular, the pressure controller may comprise a flow restrictor configured to restrict the airflow through the aerosol delivery device 800 in order to produce the pressure differential. Various embodiments of flow restrictors may be employed. For example, the flow restrictors may comprise the restrictor apertures 814 defined through the coupler 812. Thus, restrictor apertures 814 may define a relatively small area, which increases a pressure drop associated with air traveling

from the control body 802 to the cartridge 804. In another embodiment, the restrictor apertures may be additionally or alternatively defined in the cartridge (e.g., through the base or around the reservoir) and function in substantially the same manner to increase the pressure drop associated with drawing on the aerosol delivery device. In other embodiments various other restrictions along the airflow path through the aerosol delivery device 800 may be employed.

Use of the aerosol precursor bag 822, as opposed to a rigid container, may assist in dispensing the aerosol precursor composition 832 from the reservoir 820. In this regard, the aerosol precursor bag 822 may collapse as the aerosol precursor composition 832 is dispensed therefrom. In one embodiment the aerosol precursor bag 822 may comprise an elastic material (e.g., rubber) that promotes the delivery of the aerosol precursor composition 832 therefrom while resisting formation of a vacuum therein. In this regard, the elastic material may be in slight tension when the aerosol precursor bag is filled with the aerosol precursor composition and may define a neutral state when empty. Accordingly, a vacuum may not be created in the reservoir 820 as the aerosol precursor composition 832 is dispensed, which may otherwise make it difficult to dispense the aerosol precursor composition without including features configured to vent the reservoir to allow for air entry thereto.

Regardless of the particular manner in which the pressure differential is formed and the particular embodiment of reservoir employed, the pressure differential may cause the aerosol precursor composition 832 to be expelled through the fluid delivery tube 825 to the atomizer 823 at which the heating element 824 vaporizes the aerosol precursor composition, as illustrated in FIG. 4. In this regard, when the flow sensor 810 detects a puff on the aerosol delivery device 800, current from the electrical power source 808 may be directed to the atomizer 823 to produce heat. Accordingly, as illustrated in FIG. 4, the aerosol precursor composition 832 directed to the atomizer 823 may be heated and vaporized. The aerosol or vapor 836 formed in the chamber 835 may then mix with the air 830 and exit through the mouthpiece 826.

The chamber 835 may be configured to provide for optimal rates of release of the vapor 836 therefrom and into the air 830. In this regard, as illustrated in FIGS. 2-4, the chamber 835 may include one or more outlet apertures 838. As illustrated in FIG. 4, the vapor 836 may exit the chamber 933 through the outlet apertures 838.

Further, in one embodiment the chamber may additionally define one or more inlet apertures. The inlet apertures may be configured to allow flow of air therethrough into the chamber. Thus, as a user draws on the aerosol delivery device, air entering through the inlet apertures may mix with the vapor and exit through the outlet apertures. In this regard, the inlet apertures may be positioned such that air flowing through the aerosol delivery device is incident upon the inlet

apertures (e.g., the inlet apertures may extend substantially parallel to a longitudinal axis of the aerosol delivery device and hence substantially parallel to the airflow therethrough). Thus, the inlet apertures may assist in removing the vapor from the chamber.

Further, in some embodiments valves may be provided at one or both of the inlet apertures and the outlet apertures. Such valves may passively or actively open and close to allow flow of air into the chamber and/or allow flow of vapor out of the chamber. Alternatively or additionally, the inlet apertures and/or the outlet apertures may be particularly sized to provide a desired flow of the vapor from the chamber while ensuring substantially complete vaporization of the aerosol precursor composition.

Although the fluid delivery tube 825 allows flow of the aerosol precursor composition 832 therethrough when a pressure differential is applied in order to produce the vapor 836 as described above, in other instances (e.g., at other times) the fluid delivery tube may resist flow of the aerosol precursor composition to the heating element 824. In this regard, the fluid delivery tube may be sized such that flow therethrough is resisted when the pressure differential is not present. For example, surface tension may resist flow therethrough. Accordingly, the dimensions of the fluid delivery tube 825 may be particularly selected to resist flow therethrough, in instances other than when the pressure differential is applied, based on the viscosity of the aerosol precursor composition 832.

FIG. 5 illustrates a sectional view through an aerosol delivery device 900 according to an additional example embodiment of the present disclosure. The aerosol delivery device 900 may employ a differing embodiment of a pressure controller to produce a pressure differential, as described below. As illustrated, the aerosol delivery device 900 may include a control body 902 and a cartridge 904. The control body 902 may include an indicator 906 (e.g., an LED), an electrical power source 908 (e.g., a battery, which may be rechargeable), a flow sensor 910, an active valve 912 (e.g., a micro pressure valve), an atomizer 914 (e.g., comprising a heating element), a coupler 916, and an outer body 918. The cartridge 904 may include a base 920, a pressurized reservoir 922, a mouthpiece 924, and an outer body 926. The base 920 of the cartridge 904 may be configured to releasably engage the coupler 916 of the control body 902 to form a mechanical and electrical connection therebetween. Thus, the active valve 912 may be in fluid communication with the pressurized reservoir 922 when the coupler 916 of the control body 902 is coupled to the base 920 of the cartridge 904. For example, as illustrated, the active valve 912 may define an extension 927 configured to engage a recess 929 in the pressurized reservoir 922. However, various other connection components and methods may be employed in other embodiments, so long as the mechanism is configured to provide a substantially fluid-tight seal that

resists pressure loss from the pressurized reservoir 922 other than that which occurs when the active valve 912 opens, as described below.

FIG. 6 illustrates an additional sectional view through the aerosol delivery device 900. More particularly, FIG. 6 illustrates a flow path of air through the aerosol delivery device 900 when a user draws on the mouthpiece 924. As illustrated, an airflow or flow of ambient air 928 may enter the aerosol delivery device 900 and travel past the flow sensor 910. Although the ambient air 928 is illustrated as flowing past the electrical power source 908, in other embodiments the air may not flow past the electrical power source and/or the flow sensor may be positioned at an alternative location. The air 928 may then travel through the coupler 916 through one or more apertures 930 defined therethrough, through the base 920, around the pressurized reservoir 922, and out the mouthpiece 924.

As illustrated in FIG. 6, in one embodiment the air 928 may enter the aerosol delivery device 900 through a longitudinal end thereof, opposite from the mouthpiece 924. However, in other embodiments the air may enter the aerosol delivery device at an alternate location. For example, the air may enter through the coupler or the base, or at a location between the base and the mouthpiece. Accordingly, it should be understood that the particular airflow patterns described herein are provided for example purposes only.

The aerosol delivery device 900 may include a pressure controller configured to control dispensing of the aerosol precursor composition from the pressurized reservoir 922 based on a pressure differential between a first pressure within the reservoir 922 and a second pressure proximate the atomizer 913. However, whereas the embodiment of the aerosol delivery device 800 described above and illustrated in FIGS. 2 – 4 passively dispensed the aerosol precursor composition based on a pressure differential caused by a user draw thereon, the aerosol delivery device 900 illustrated in FIGS. 5 – 7 may employ the active valve 912 to selectively release the aerosol precursor composition from the reservoir 922 based on a preexisting pressure differential. In this regard, a first pressure within the pressurized reservoir 922 may be greater than an ambient pressure (e.g., atmospheric pressure) and hence also greater than a second pressure proximate the atomizer 913. In other words, the reservoir 922 may be pressurized.

The reservoir 922 may be pressurized in a variety of manners. For example, carbon dioxide, air, or other compressible fluid may be introduced into the reservoir 922 at a positive pressure in addition to the aerosol precursor composition. By way of further example, a piston and a compressed spring within the reservoir may be configured to force the aerosol precursor composition therefrom.

FIG. 7 illustrates an enlarged partial sectional view through the aerosol delivery device 900. As illustrated, when the flow sensor 910 (see, e.g., FIG. 6) detects the puff, current may be applied to the active valve 912, such that the active valve momentarily opens one or more times. For example, a signal from the flow sensor 910 may directly cause the active valve 912 to actuate, or the signal from the flow sensor may be provided to a controller which directs the active valve to actuate. Thereby, an aerosol precursor composition 932 retained in the pressurized reservoir 922 may be expelled toward the heating element 914 of the atomizer 913, as a result of the air proximate the atomizer being at a relatively lower pressure than the pressurized reservoir. Further, the atomizer 913 may comprise a housing 931 defining a chamber 933 (see, e.g., FIG. 6) in which the heating element 914 is positioned and to which the aerosol precursor composition 932 is delivered. Thus, issues with respect to the aerosol precursor composition 932 being directed into the air 928 and to a user without being vaporized may be avoided. In this regard, the aerosol precursor composition 932 may be directed into contact with the heating element 914 at the chamber 933 to ensure vaporization thereof.

In this regard, when the flow sensor 910 detects a puff on the aerosol delivery device 900, current from the electrical power source 908 may be directed to the heating element 914 to produce heat. Accordingly, the aerosol precursor composition 932 directed thereto may be heated and vaporized to define an aerosol or vapor 934. The vapor 934 may be formed in the chamber 933 and then exit therefrom. The vapor 934 may then mix with the air 928 and exit through the mouthpiece 924.

The chamber 933 may be configured to provide for optimal rates of release of the vapor 934 therefrom and into the air 928. In this regard, as illustrated in FIGS. 5-7, the chamber 933 may include one or more outlet apertures 936. As illustrated in FIG. 7, the vapor 934 may exit the chamber 933 through the outlet apertures 936.

Further, as illustrated in FIG. 7, in one embodiment the chamber 933 may additionally define one or more inlet apertures 938. The inlet apertures 938 may be configured to allow flow of air 928 therethrough into the chamber 933. Thus, as a user draws on the aerosol delivery device 900, air 928 entering through the inlet apertures 938 may mix with the vapor 934 and exit through the outlet apertures 936. In this regard, as illustrated, the inlet apertures 938 may be positioned such that air 928 flowing through the aerosol delivery device 900 is incident upon the inlet apertures 938 (e.g., the inlet apertures may extend substantially parallel to a longitudinal axis of the aerosol delivery device and hence substantially parallel to the airflow therethrough). Thus, the inlet apertures 928 may assist in removing the vapor 934 from the chamber 933.

Further, in some embodiments valves may be provided at one or both of the inlet apertures 938 and the outlet apertures 936. Such valves may passively or actively open and close to allow flow of air 928 into the chamber 933 and/or allow flow of vapor 934 out of the chamber. Alternatively or additionally, the inlet apertures 938 and/or the outlet apertures 936 may be particularly sized to provide a desired flow of the vapor 934 from the chamber 933 while ensuring substantially complete vaporization of the aerosol precursor composition.

Note that various embodiments of atomizers may be employed to vaporize the aerosol precursor composition in the embodiments of aerosol delivery devices described above. Such atomizers may include flat heaters, wound wire surfaces, micro heaters (e.g., embodied on a chip) glass plates, lasers, resistive heaters, and any other shape and embodiment of heater. Further, the materials employed in the first heating elements and the second heating elements may vary. For example, the materials described above with respect to wire coil heating elements may be employed. Various other materials which may be employed in the heating elements described herein may include platinum or a platinum-coated materials and resistive inks (e.g., printed on a ceramic material).

Certain aerosol delivery devices described herein may avoid certain issues associated with conventional aerosol delivery devices that employ a wick. In this regard, use of a wick may cause separation of the ingredients of an aerosol precursor composition. Further, use of a wick to transfer the aerosol precursor composition from a substrate to a heating element may result in leakage. Accordingly, the embodiments of the aerosol delivery devices disclosed herein may provide these and/or other advantages.

As noted above, embodiments of aerosol delivery devices of the present disclosure may include a cartridge and a control body. Although the aerosol delivery devices have been described such that certain components thereof are positioned within the control body whereas other components are positioned within the cartridge, it should be understood that these configurations are provided for example purposes only. In this regard, any of the components of the aerosol delivery devices may be positioned within the cartridge or the control body. However, it may generally be desirable to position the reservoir within the cartridge such that the cartridge may be easily replaced or refilled by detaching the cartridge from the control body.

Note also that while the aerosol delivery devices disclosed herein are generally described as including a cartridge (e.g., a replaceable cartridge) and a control body (e.g., a reusable control body), various other embodiments may be employed. For example, in other embodiments the aerosol delivery devices may include more than two-pieces. In an additional embodiment the aerosol delivery device may define an integral, one-piece configuration.



In an additional embodiment a method for aerosolization in an aerosol delivery device is provided. As illustrated in FIG. 8, the method may include directing an airflow from a control body through a cartridge comprising a reservoir at least partially filled with an aerosol precursor composition at operation 1502. Further, the method may include controlling dispensing of the aerosol precursor composition from the reservoir to an atomizer comprising a heating element based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer at operation 1504. The method may additionally include heating the aerosol precursor composition dispensed from the reservoir with the heating element to add an aerosol to the airflow at operation 1506.

In some embodiments of the method the first pressure within the reservoir may be greater than an ambient pressure (e.g., atmospheric pressure). Additionally, controlling dispensing of the aerosol precursor composition at operation 1504 may comprise selectively releasing the aerosol precursor composition from the reservoir with a valve. Further, the method may include detecting an airflow with a flow sensor. Controlling dispensing of the aerosol precursor composition at operation 1504 may comprise actuating the valve in response to a signal from the flow sensor. Selectively releasing the aerosol precursor composition from the reservoir with the valve may comprise directing the aerosol precursor composition from the reservoir in the cartridge through the valve in the control body.

In some embodiments an internal pressure within the reservoir may be substantially equal to an ambient pressure (e.g., atmospheric pressure). Additionally, controlling dispensing of the aerosol precursor composition at operation 1504 may comprise producing the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer with a flow restrictor. The method may further comprise delivering the aerosol precursor composition through a fluid delivery tube to the heating element during application of the pressure differential and otherwise resisting flow of the aerosol precursor composition to the heating element. Controlling dispensing of the aerosol precursor composition at operation 1504 may comprise directing the aerosol precursor composition to a chamber of the atomizer in which the heating element is positioned.

Many modifications and other embodiments of the disclosure will come to mind to one skilled in the art to which this disclosure pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the disclosure is not to be limited to the specific embodiments disclosed herein and that modifications and other embodiments are intended to be included within the scope of the appended claims.

Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

## WHAT IS CLAIMED IS:

1. An aerosol delivery device, comprising:  
a control body;  
a cartridge comprising a reservoir at least partially filled with an aerosol precursor composition, the cartridge being configured to receive an airflow from the control body;  
5 an atomizer comprising a heating element; and  
a pressure controller configured to control dispensing of the aerosol precursor composition from the reservoir based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer,  
the atomizer being configured to heat the aerosol precursor composition received from the  
10 reservoir to add an aerosol to the airflow.
2. The aerosol delivery device of Claim 1, wherein the atomizer defines a chamber and the heating element is positioned within the chamber.
- 15 3. The aerosol delivery device of any one of Claims 1 and 2, wherein the first pressure within the reservoir is greater than an ambient pressure.
4. The aerosol delivery device of Claim 3, wherein the pressure controller comprises a valve configured to selectively release the aerosol precursor composition from the reservoir.  
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5. The aerosol delivery device of Claim 4, further comprising a flow sensor, wherein the valve is configured to actuate in response to a signal from the flow sensor.
6. The aerosol delivery device of Claim 4, wherein the cartridge includes the valve and  
25 the atomizer.
7. The aerosol delivery device of Claim 4, wherein the control body includes the valve and the atomizer.
- 30 8. The aerosol delivery device of Claim 7, wherein the control body comprises a coupler and the cartridge comprises a base, the valve being in fluid communication with the reservoir when the coupler of the control body is coupled to the base of the cartridge.

9. The aerosol delivery device of any one of Claims 1 and 2, wherein the first pressure within the reservoir is substantially equal to an ambient pressure.

10. The aerosol delivery device of Claim 9, wherein the pressure controller comprises a flow restrictor configured to produce the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer.

11. The aerosol delivery device of Claim 10, wherein the control body includes the flow restrictor.

12. The aerosol delivery device of any one of Claims 10 and 11, wherein the flow restrictor comprises one or more restrictor apertures.

13. The aerosol delivery device of any one of Claims 9 to 12, wherein the reservoir comprises an aerosol precursor bag.

14. The aerosol delivery device of Claim 9, wherein the atomizer further comprises a fluid delivery tube configured to deliver the aerosol precursor composition from the reservoir to the heating element during application of the pressure differential and otherwise resist flow of the aerosol precursor composition to the heating element.

15. A method for aerosolization in an aerosol delivery device, comprising:  
directing an airflow from a control body through a cartridge comprising a reservoir at least partially filled with an aerosol precursor composition;  
controlling dispensing of the aerosol precursor composition from the reservoir to an atomizer comprising a heating element based on a pressure differential between a first pressure within the reservoir and a second pressure proximate the atomizer; and  
heating the aerosol precursor composition dispensed from the reservoir with the heating element to add an aerosol to the airflow.

16. The method of Claim 15, wherein controlling dispensing of the aerosol precursor composition comprises directing the aerosol precursor composition to a chamber of the atomizer in which the heating element is positioned.

17. The method of any one of Claims 15 and 16, wherein the first pressure within the reservoir is greater than an ambient pressure, and

5 wherein controlling dispensing of the aerosol precursor composition comprises selectively releasing the aerosol precursor composition from the reservoir with a valve.

18. The method of Claim 17, further comprising detecting an airflow with a flow sensor, wherein controlling dispensing of the aerosol precursor composition comprises actuating the valve in response to a signal from the flow sensor.

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19. The method of any one of Claims 17 and 18, wherein selectively releasing the aerosol precursor composition from the reservoir with the valve comprises directing the aerosol precursor composition from the reservoir in the cartridge through the valve in the control body.

15 20. The method of any one of Claims 15 and 16, wherein an internal pressure within the reservoir is substantially equal to an ambient pressure, and

wherein controlling dispensing of the aerosol precursor composition comprises producing the pressure differential between the first pressure within the reservoir and the second pressure proximate the atomizer with a flow restrictor.

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21. The method of Claim 20, further comprising delivering the aerosol precursor composition through a fluid delivery tube to the heating element during application of the pressure differential and otherwise resisting flow of the aerosol precursor composition to the heating element.

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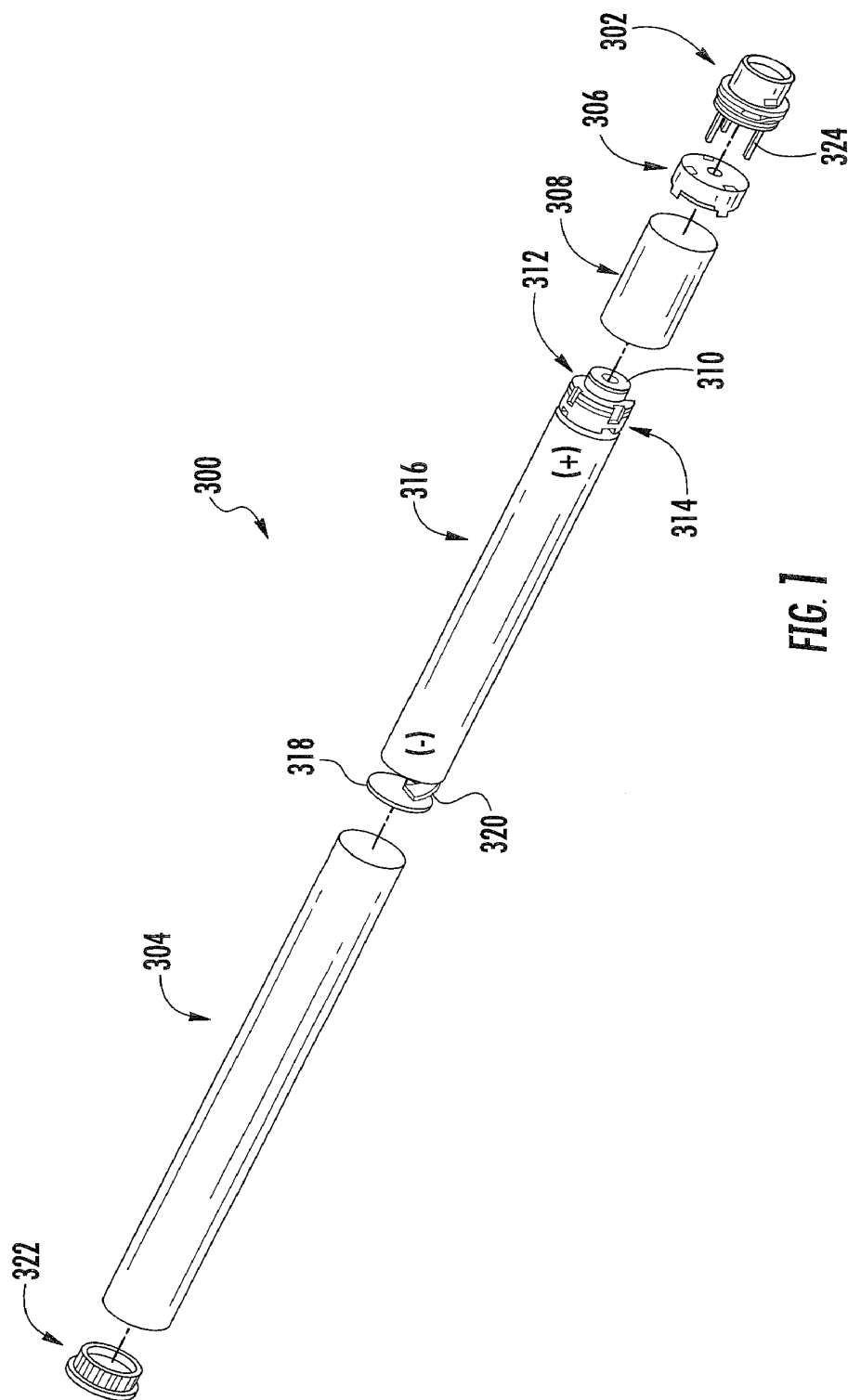
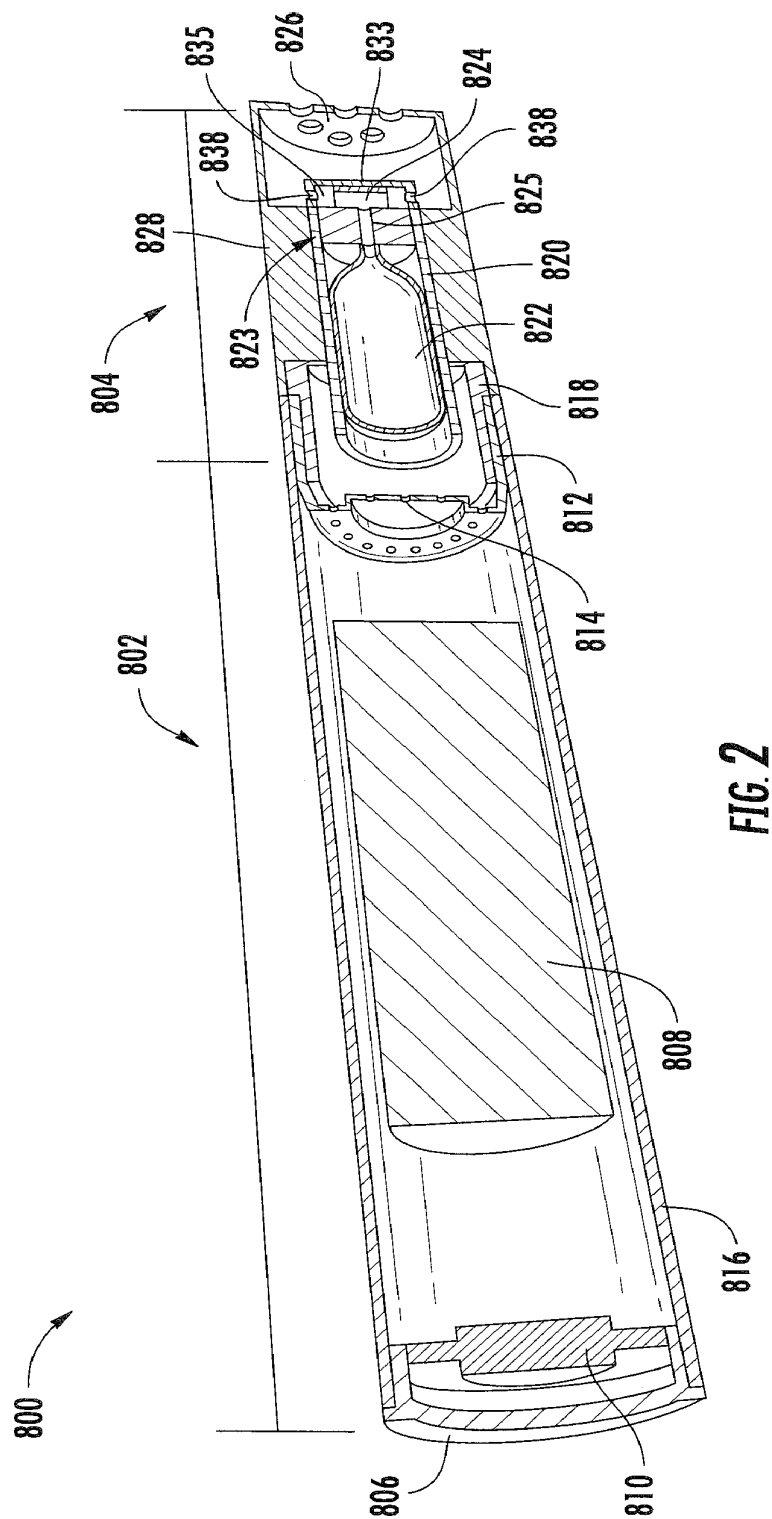


FIG. 1

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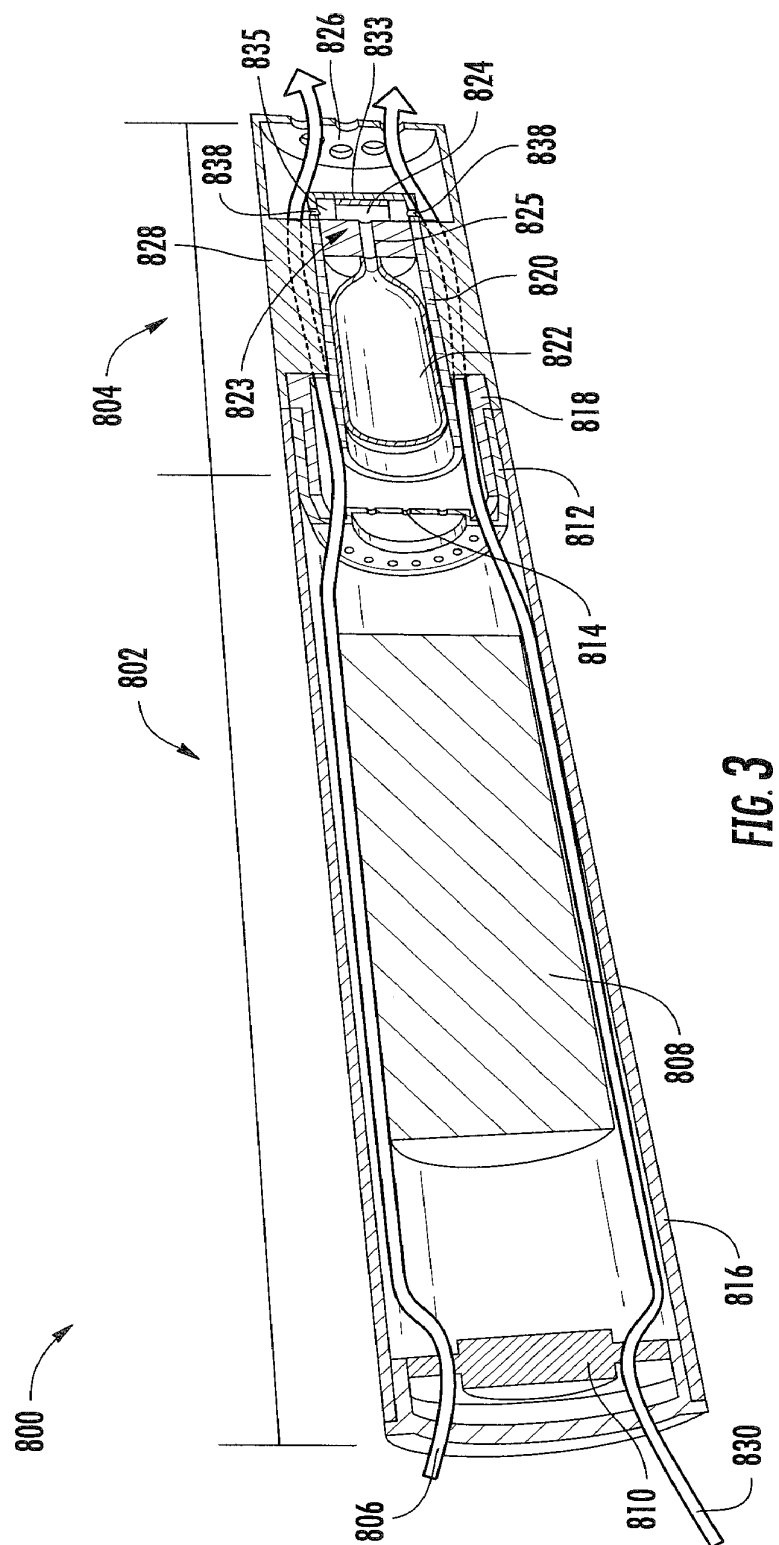
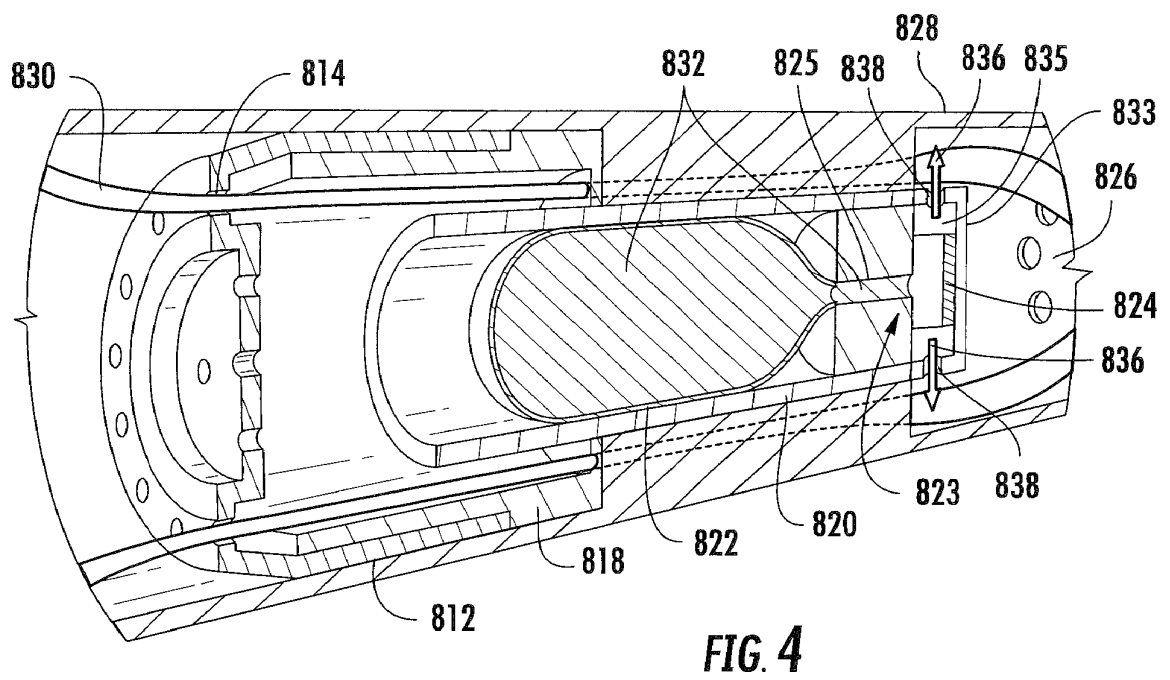


**FIG. 3**



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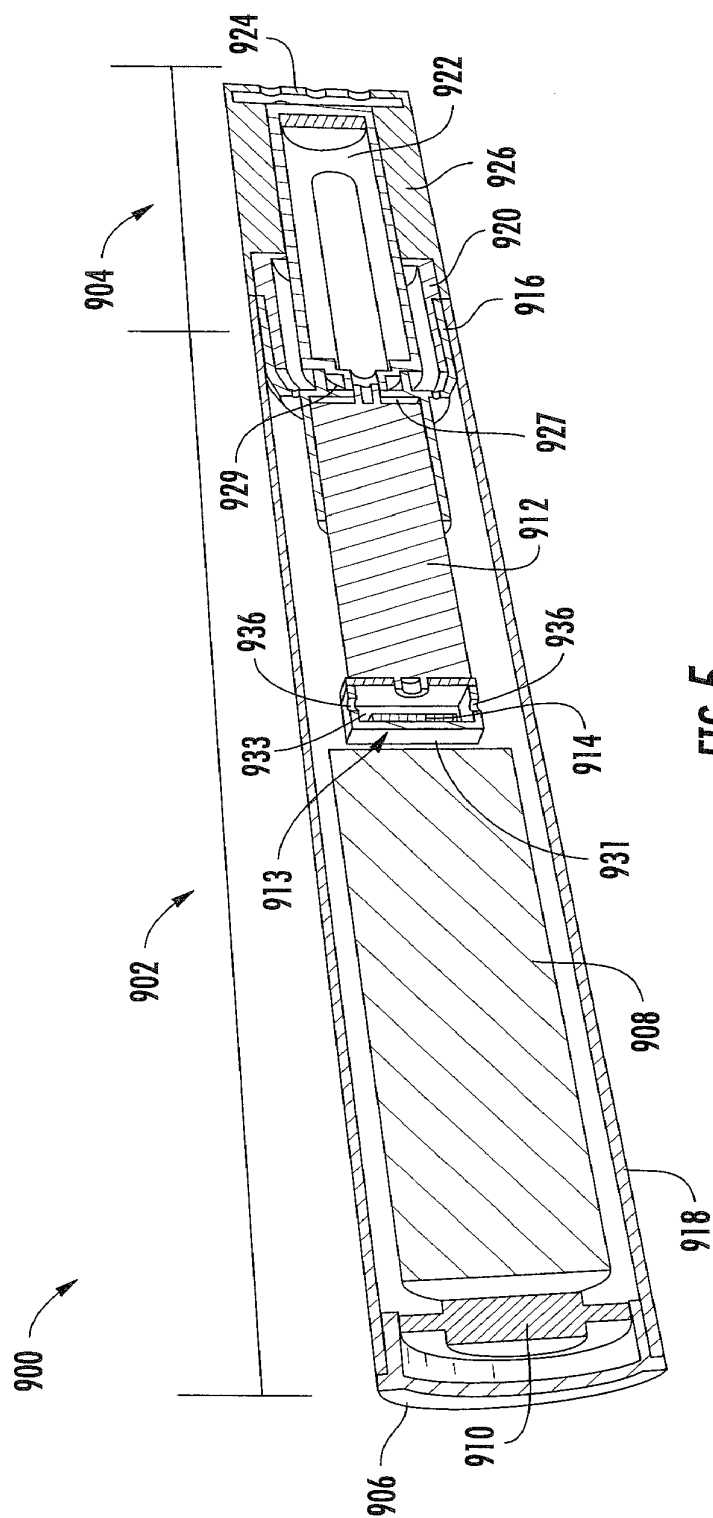


FIG. 5

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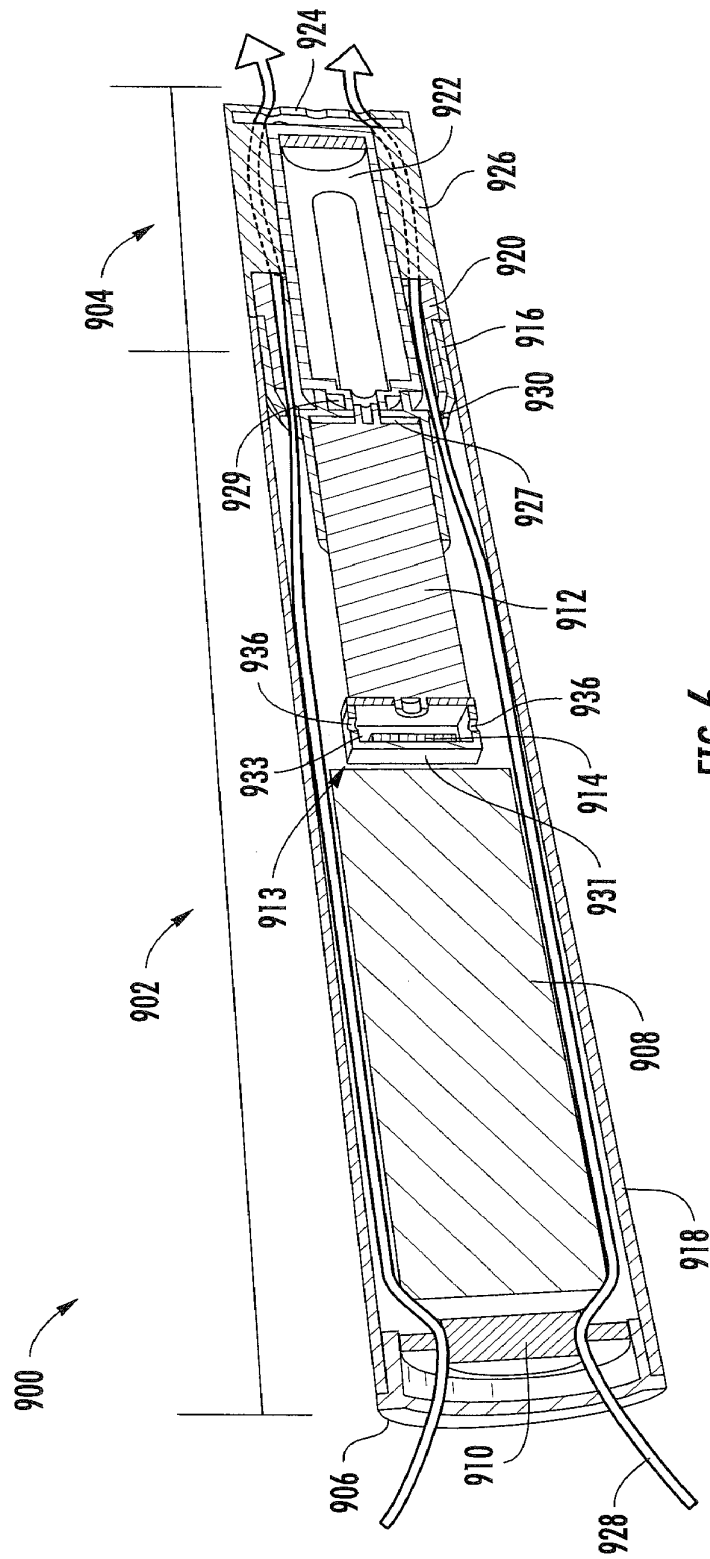


FIG. 6

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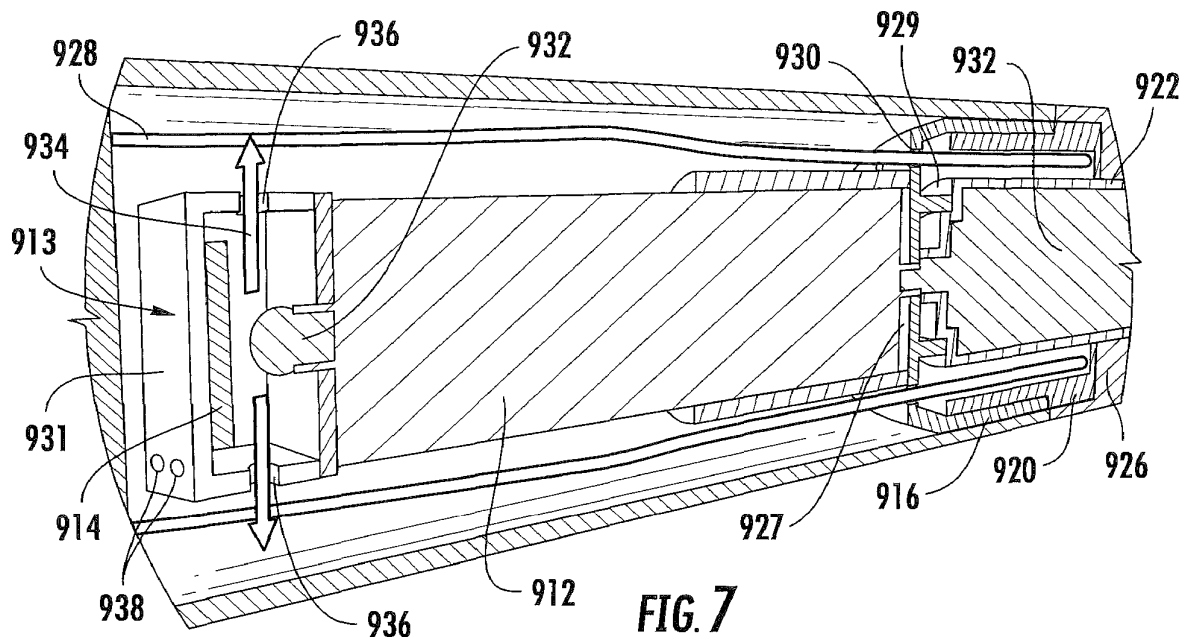


FIG. 7

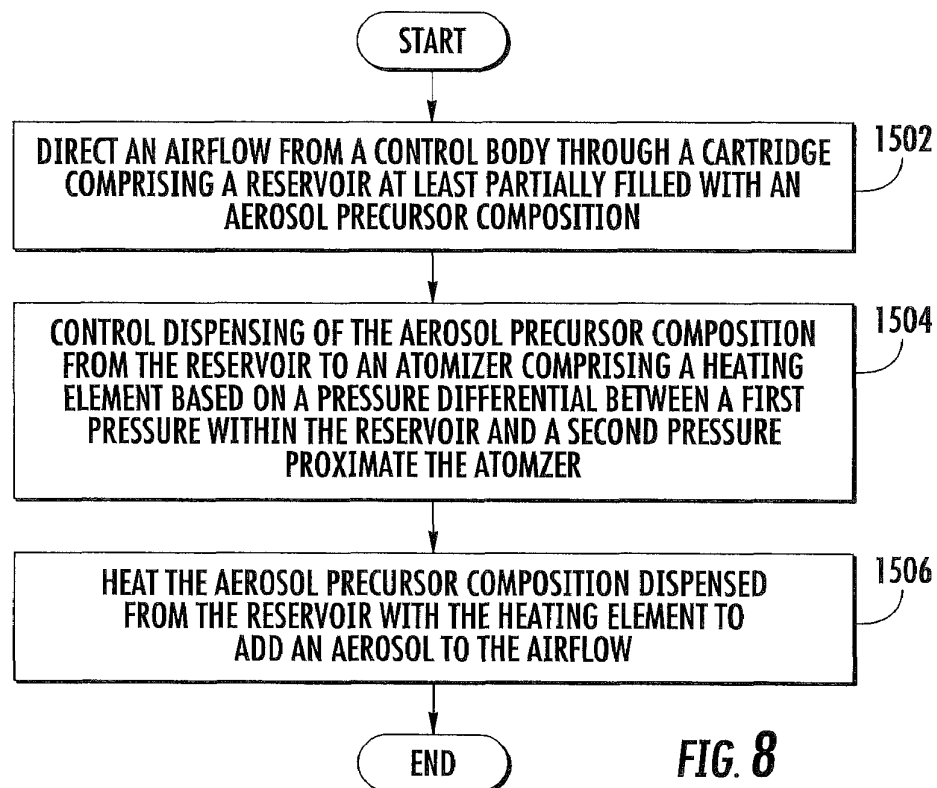


FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/062835

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

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

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| X         | WO 2005/120614 A1 (ALEXZA MOLECULAR<br>DELIVERY CORP [US]; CROSS STEVEN D [US];<br>HERBETTE MAT)<br>22 December 2005 (2005-12-22)<br>paragraphs [0045] - [0056]; figures 1-3<br>----- | 1-3,15,<br>16         |



Further documents are listed in the continuation of Box C.



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

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"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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

2 February 2015

Date of mailing of the international search report

10/02/2015

Name and mailing address of the ISA/

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Authorized officer

Kock, Søren

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/062835

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- (51) **International Patent Classification:** Not classified
- (21) **International Application Number:** PCT/IB2014/003007
- (22) **International Filing Date:** 5 November 2014 (05.11.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:** 61/900,598 6 November 2013 (06.11.2013) US
- (71) **Applicant:** SIS RESOURCES, LTD. [IL/IL]; P.O. Box 674, 99000 Beit Shemesh (IL).
- (72) **Inventors:** COHEN, Shai; 99 Druk Street, 9743614 Jerusalem (IL). GAVRIELOV, Shmuel; P.O. Box 674, 99000 Beit Shemesh (IL). MALAMUD, Alex; 109 Harav Pardes, 9747133 Jerusalem (IL).
- (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, 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, KN, KP, KR, 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:**

- *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*



WO 2015/068044 A2

(54) **Title:** ELECTRONIC CIGARETTE OVERHEATING PROTECTION

(57) **Abstract:** An electronic cigarette comprises a battery portion including a battery operable to power the electronic cigarette, and a cartomizer coupled with the battery portion. The cartomizer comprises a heating element that aerosolizes a liquid, and a temperature sensor operable to measure a temperature within the electronic cigarette during operation thereof and prevent further operation of the electronic cigarette when the measured temperature exceeds a predetermined threshold.

## **ELECTRONIC CIGARETTE OVERHEATING PROTECTION**

### **CROSS REFERENCE TO RELATED APPLICATION**

**[0001]** This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Application No. 61/900,598, filed on November 6, 2013, the entire content of which is incorporated herein by reference thereto.

### **BACKGROUND**

**[0002]** An electronic cigarette ("e-cigarette" or "e-Cig") is a device that emulates tobacco cigarette smoking, by producing smoke replacement that may be similar in its physical sensation, general appearance, and sometimes flavor (i.e., with tobacco fragrance, menthol taste, added nicotine etc.). A battery portion of the e-Cig includes a controller and battery for powering the device, and a cartomizer portion of the e-Cig generates an aerosol mist (i.e. e-smoke or vapor) that is a replacement for cigarette smoke. In particular, the cartomizer may use heat, ultrasonic energy, or other means to aerosolize/vaporize an "e-Liquid" solution (e.g. based on propylene glycol, or glycerin, for example including taste and fragrance ingredients) into an aerosol mist. The aerosolization may be similar to nebulizer or humidifier vaporizing solutions for inhalation. The aerosolization may be caused by a heating element that heats the e-Liquid to generate the mist/vapor/e-smoke. The heating element may become quite hot in order to properly heat the e-Liquid and depending on the duration of usage of the e-Cig. Excessive heat within the e-Cig may cause burning of the internal components of the e-Cig and result in problems for the e-Cig user.

### **SUMMARY**

**[0003]** Disclosed herein is an electronic cigarette which comprises a battery portion including a battery operable to power the electronic cigarette, and a cartomizer coupled with the battery portion. The cartomizer comprises a heating element that aerosolizes a liquid, and a temperature sensor operable to measure a temperature within the electronic cigarette during operation thereof and prevent further operation of the electronic cigarette when the measured temperature exceeds a predetermined threshold.

**[0004]** Also disclosed herein is an electronic cigarette which comprises a battery portion and a cartomizer coupled with the battery portion. The battery portion comprises a controller,



and a battery operable to power the electronic cigarette. The cartomizer comprises a heating element that aerosolizes a liquid, and a temperature sensor operable to measure a temperature within the electronic cigarette during operation thereof.

[0005] Further disclosed herein is a method for electronic cigarette operation. The method comprises monitoring an ambient temperature of the electronic cigarette, and switching off power to the electronic cigarette when the ambient temperature exceeds a predetermined threshold temperature.

[0006] Additionally disclosed herein is a method for electronic cigarette operation. The method comprises breaking a circuit of a thermal fuse within the electronic cigarette when an ambient temperature of the electronic cigarette exceeds a rated temperature of the thermal fuse.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0007] The systems and methods disclosed herein may be better understood with reference to the following drawing and description. Non-limiting and non-exhaustive embodiments are described with reference to the following drawing. The components in the drawing are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the embodiments as disclosed herein.

[0008] Figure 1 is a diagram of an electronic cigarette including a temperature sensor.

#### **DETAILED DESCRIPTION**

[0009] By way of introduction, an e-Cig may include a temperature sensor coupled with or near a heating element operable to aerosolize e-Liquid. The temperature sensor of the e-Cig may shut down power to the e-Cig when an internal temperature exceeds a predetermined threshold. Depending on the temperature sensed by the temperature sensor, the shutdown may be temporary. In one embodiment, the sensor is a thermal fuse that triggers a switch to shut down power in the e-Cig when the temperature exceeds a predetermined threshold.

[0010] Other systems, methods, features and advantages will be, or will become, apparent to one with skill in the art upon examination of the following figure and detailed description.

It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the embodiments disclosed herein, and be protected by the following claims. Nothing in this section should be taken as a limitation on those claims. Further aspects and advantages are discussed below.

**[0011]** Subject matter will now be described more fully hereinafter with reference to the accompanying drawings, which form a part hereof, and which show, by way of illustration, specific example embodiments. Subject matter may, however, be embodied in a variety of different forms and, therefore, covered or claimed subject matter is intended to be construed as not being limited to any example embodiments set forth herein; example embodiments are provided merely to be illustrative. Likewise, a reasonably broad scope for claimed or covered subject matter is intended. Among other things, for example, subject matter may be embodied as methods, devices, components, and/or systems. Accordingly, embodiments may, for example, take the form of hardware, software, firmware or any combination thereof (other than software per se). The following detailed description is, therefore, not intended to be taken in a limiting sense.

**[0012]** Throughout the specification and claims, terms may have nuanced meanings suggested or implied in context beyond an explicitly stated meaning. Likewise, the phrase "in one embodiment" as used herein does not necessarily refer to the same embodiment and the phrase "in another embodiment" as used herein does not necessarily refer to a different embodiment. It is intended, for example, that claimed subject matter include combinations of example embodiments in whole or in part.

**[0013]** In general, terminology may be understood at least in part from usage in context. For example, terms, such as "and", "or", or "and/or," as used herein may include a variety of meanings that may depend at least in part upon the context in which such terms are used. Typically, "or" if used to associate a list, such as A, B or C, is intended to mean A, B, and C, here used in the inclusive sense, as well as A, B or C, here used in the exclusive sense. In addition, the term "one or more" as used herein, depending at least in part upon context, may be used to describe any feature, structure, or characteristic in a singular sense or may be used to describe combinations of features, structures or characteristics in a plural sense. Similarly, terms, such as "a," "an," or "the," again, may be understood to convey a singular usage or to convey a plural usage, depending at least in part upon context. In addition, the term "based

on" may be understood as not necessarily intended to convey an exclusive set of factors and may, instead, allow for existence of additional factors not necessarily expressly described, again, depending at least in part on context.

**[0014]** Figure 1 is a diagram of an electronic cigarette 100 (i.e. e-Cig). The "smoke" (i.e. aerosol mist) produced by an e-Cig 100 is created by turning an e-Liquid into mist and some vapor with an aerosol generating component 112. The e-Liquid may be stored in a liquid container. A cartomizer 113 may include the aerosol generating component 112 and the e-Liquid. The cartomizer 113 may also be referred to as a cartridge throughout this disclosure and may be disposable. A temperature sensor 110 is also part of the cartomizer 113 as well as a heating element 111. In one embodiment, the temperature sensor 110 comprises a thermal circuit breaker fuse that breaks a circuit within the cartomizer 113 when an ambient temperature within the e-Cig 100 exceeds a rated temperature of the fuse. The fuse (i.e. temperature sensor 110) is located adjacent the heating element 111 for a more accurate measurement of internal temperature of the e-Cig 100 and a quicker identification of a potential overheating issue. The e-Liquid can be aerosolized via air flow 108, generated by the inhalation of an individual (i.e. the smoker or consumer or vaper). In order to reduce the viscosity, to a level enabling aerosolization, external heat may be applied through the heating element 111, which may include a heating coil and a wick that is soaked in or includes a portion of the e-Liquid. In other words, the heating element 111 may be a coil in one embodiment that wraps around the wick in order to heat the e-Liquid on the wick. Local viscosity may be reduced via heating, while inhalation occurs, enabling aerosolization in the inhalation generated flow of air 108. The e-Liquid may be heated via an electric current flowing through the heating element 111 and may then be aerosolized and evaporated through the e-Cig and may contain tastes and aromas that create a smoking sensation.

**[0015]** A controller 102 may be activated due to air flow 108 (from the inhaled air) passing a flow sensor 104. The flow sensor 104 may be activated by a pressure drop across the flow sensor 104 and may directly switch the battery 106 power on, or be used as an input for the controller 102 that then switches the battery 106 current on. Although illustrated as separate from the e-Cig, the controller 102 may be a part of the e-Cig (e.g. along with the battery 106). The battery 106 may be a separate/removable assembly. The battery 106 may include one or more electronic chips controlling and communicating from it. It may connect with the

cartomizer 113, which can be replaced or changed (e.g. when a new/different e-Liquid is desired).

**[0016]** The e-Cig 100 may include two parts. The first part is often just referred to as the battery or battery portion (i.e. battery enclosure) and it includes the battery 106, the air flow sensor 104, and the controller 102. The second part is the cartridge (i.e. cartomizer 113). The cartridge 113 includes the e-Liquid that is required for aerosol and flavor generation. The battery portion and the cartridge may be connected by metal connectors. An airflow tube of the battery enclosure and an airflow tube of the cartridge 113 may enable an individual to puff through the e-Cig 100 and activate the airflow sensor 104 inside the battery portion. This may trigger the controller 102 and cause the heating element 111 inside the cartridge 113 to get hot, evaporate the e-Liquid that is in the cartridge 113 and causes aerosol (i.e. vapor) to form. Although not shown in Figure 1, the e-Cig 100 may include connections (i.e. connectors or electrical connections) that are used for power delivery to the heating element 111 and for charging the battery 106.

**[0017]** The temperature sensor 110 may operate to shut down or shut off power delivery from the battery 106 when the heating element 111 begins to overheat. The shutdown may be the result of a broken circuit when the temperature sensor 110 comprises a thermal fuse. The thermal fuse may be one-time use in one embodiment, such that the entire cartridge 113 should be replaced if the thermal fuse is triggered and breaks the circuit within the e-Cig 100. Alternatively, the thermal fuse (i.e. temperature sensor 110) may be able to temporarily break the circuit at certain temperatures, but re-connect the circuit at normal temperature levels.

**[0018]** Alternatively, the controller 102 may be operable to receive a temperature measurement from the temperature sensor 110, and operable to control the power output from the battery 106 to the heating element 111 depending on the temperature measured by the temperature sensor 110. In one embodiment, there may be multiple levels of temperature measurement thresholds such that a lower threshold of temperature measurement may result in power being shut off for a short period of time (i.e. when the measured temperature reaches that threshold). A maximum temperature threshold level may result in permanent shut down of the power for that cartridge 113 if the internal measured temperature reaches that maximum temperature threshold level. For example, the controller 102 can have a maximum temperature threshold wherein the controller shuts off power when the measured

temperature reaches the maximum temperature threshold, and the controller 102 can have a second temperature threshold which is lower than the maximum temperature threshold wherein the controller 102 temporarily shuts off the power when the measured temperature reaches the second temperature threshold. Preferably, the power is turned on when the measured temperature returns to a normal operating temperature or falls below the second temperature threshold.

**[0019]** The controller 102 of the e-Cig 100 may include a controller chip that connects the battery 106 to the heating coil 111 when an individual puffs (i.e. draws or inhales) on the e-Cig 100 and disconnects the battery 106 from the heating coil 106 when the individual stops inhaling (end of the "puff").

**[0020]** In some cases, there can be a failure (e.g. a short circuit in the switch) wherein the battery 106 gets stuck in the connected state, regardless of whether or not an individual is inhaling. When such a failure occurs, the temperature inside the e-Cig 100 starts rising and the e-Liquid eventually runs out, causing a rise in temperature inside the e-Cig 100. In e-Cigs with a plastic barrel, this may cause the plastic to burn and/or melt, exposing the e-Cig's internal components that are hot.

**[0021]** The temperature sensor 110 may be included adjacent to or coupled with the heating element 111 to monitor the temperature inside the e-Cig 100. In order to accurately measure the temperature, the temperature sensor 110 must be small enough to fit inside the e-Cig 100 and be adjacent or coupled with the heating element 111 for accurate temperature measurement. In one embodiment, the temperature sensor 110 is a thermal fuse that switches off the current when the ambient temperature inside the e-Cig 100 reaches the rated temperature (i.e. a predetermined temperature) of the thermal fuse. The thermal fuse may be referred to as a thermal circuit breaker fuse. In an embodiment, the thermal circuit breaker fuse can be coupled in series with a switch that stops the power to the electronic circuit when the thermal circuit breaker fuse is broken.

**[0022]** In one embodiment, the thermal fuse may be a one-time use device such that when the thermal fuse is broken (the electric current in the e-Cig 100 is stopped), it prevents further usage of the cartridge (i.e. cartomizer) 113. In this case, the cartridge 113 is disposable, so a

replacement cartridge 113 includes a new thermal fuse. In other words, the triggering of the thermal fuse prevents future usage of that cartridge 113.

**[0023]** The illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various embodiments. The illustrations are not intended to serve as a complete description of all of the elements and features of apparatus and systems that utilize the structures or methods described herein. Many other embodiments may be apparent to those of skill in the art upon reviewing the disclosure. Other embodiments may be utilized and derived from the disclosure, such that structural and logical substitutions and changes may be made without departing from the scope of the disclosure. Additionally, the illustrations are merely representational and may not be drawn to scale. Certain proportions within the illustrations may be exaggerated, while other proportions may be minimized. Accordingly, the disclosure and the figures are to be regarded as illustrative rather than restrictive.

## WE CLAIM:

1. An electronic cigarette comprising:  
a battery portion including a battery operable to power the electronic cigarette; and  
a cartomizer coupled with the battery portion, the cartomizer comprising:  
a heating element that aerosolizes a liquid; and  
a temperature sensor operable to measure a temperature within the electronic cigarette during operation thereof and prevent further operation of the electronic cigarette when the measured temperature exceeds a predetermined threshold.
2. The electronic cigarette of claim 1, wherein the cartomizer is disposable.
3. The electronic cigarette of claim 2, wherein the temperature sensor comprises a thermal fuse.
4. The electronic cigarette of claim 3, wherein the thermal fuse includes a rated temperature at which a circuit supplying power to the heating element within the cartomizer is broken.
5. The electronic cigarette of claim 4, wherein the predetermined threshold is the rated temperature of the thermal fuse.
6. The electronic cigarette of claim 1, wherein the cartomizer is interchangeable with different battery portions.
7. The electronic cigarette of claim 1, wherein the battery portion further comprises a controller.
8. The electronic cigarette of claim 7, wherein the controller is electrically coupled with the temperature sensor and operable to receive an indication when the measured temperature exceeds the predetermined threshold.

9. The electronic cigarette of claim 8, wherein the controller stops the supply of power from the battery to the heating element upon receiving the indication from the temperature sensor.
10. The electronic cigarette of claim 8, wherein the temperature sensor is operable to provide a plurality of predetermined temperature measurement thresholds to the controller such that different temperature measurement thresholds result in different amounts of shut off time for the supply of power from the battery.
11. The electronic cigarette of claim 1, wherein the heating element comprises a heating coil wrapped around a wick.
12. An electronic cigarette comprising:  
a battery portion comprising:  
a controller; and  
a battery operable to power the electronic cigarette;  
a cartomizer coupled with the battery portion, the cartomizer comprising:  
a heating element that aerosolizes a liquid; and  
a temperature sensor operable to measure a temperature within the electronic cigarette during operation thereof.
13. The electronic cigarette of claim 12, wherein the controller receives the measured temperature from the temperature sensor.
14. The electronic cigarette of claim 13, wherein the controller comprises a maximum temperature threshold such that the controller shuts off the power when the measured temperature reaches the maximum temperature threshold.
15. The electronic cigarette of claim 14, wherein the controller comprises a second temperature threshold lower than the maximum temperature threshold, wherein the controller temporarily shuts off the power when the measured temperature reaches the second temperature threshold, and further wherein the power is turned on when the measured temperature returns to a normal operating temperature.



16. The electronic cigarette of claim 12, wherein the temperature sensor comprises a thermal circuit breaker fuse.
17. The electronic cigarette of claim 16, wherein the thermal circuit breaker fuse is coupled in series with a switch that stops the power to the electronic circuit when the thermal circuit breaker fuse is broken.
18. The electronic cigarette of claim 17, wherein the thermal circuit breaker fuse is permanently broken when the measured temperature exceeds a rated temperature of the thermal circuit breaker fuse.
19. A method for electronic cigarette operation comprising:  
monitoring an ambient temperature of the electronic cigarette; and  
switching off power to the electronic cigarette when the ambient temperature exceeds a predetermined threshold temperature.
20. The method of claim 19, wherein the temperature sensor comprises a thermal fuse.
21. The method of claim 20, wherein the switching off the power comprises breaking of a circuit, wherein the predetermined threshold temperature comprises a rated temperature of the thermal fuse.
22. A method for electronic cigarette operation comprising:  
breaking a circuit of a thermal fuse within the electronic cigarette when an ambient temperature of the electronic cigarette exceeds a rated temperature of the thermal fuse.

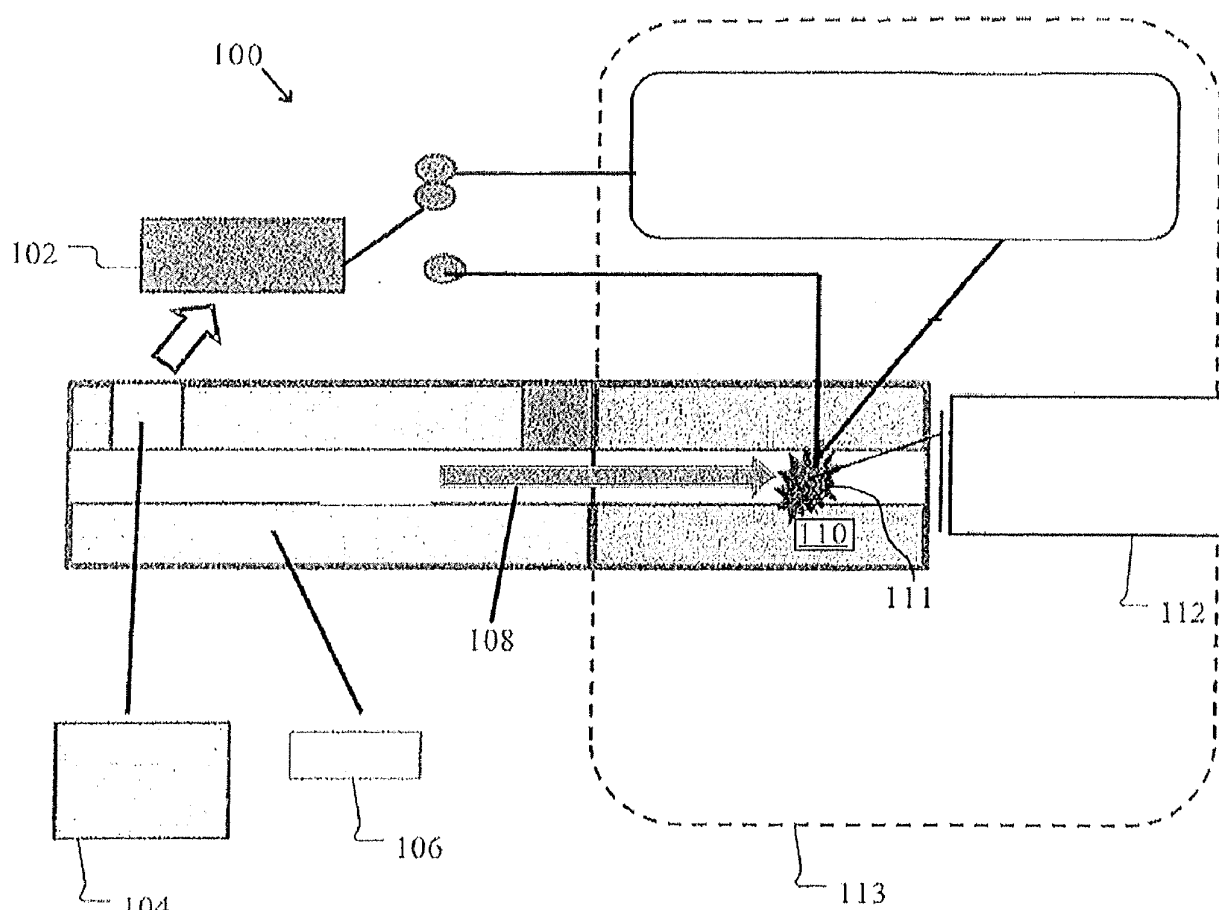


Figure 1



(51) International Patent Classification:  
A24F 47/00 (2006.01)

(21) International Application Number:  
PCT/IB2014/003007

(22) International Filing Date:  
5 November 2014 (05.11.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
61/900,598 6 November 2013 (06.11.2013) US

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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, 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, KN, KP, KR, 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))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:  
12 November 2015

(54) Title: ELECTRONIC CIGARETTE OVERHEATING PROTECTION

(57) Abstract: An electronic cigarette (100) comprises a battery portion including a battery (106) operable to power the electronic cigarette, and a cartomizer (113) coupled with the battery portion. The cartomizer comprises a heating element (111) that aerosolizes a liquid, and a temperature sensor (110) operable to measure a temperature within the electronic cigarette during operation thereof and prevent further operation of the electronic cigarette when the measured temperature exceeds a predetermined threshold.



WO 2015/068044 A3

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2014/003007

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/008

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)

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         | WO 2013/034459 A1 (BRITISH AMERICAN TOBACCO CO [GB]; EGOYANTS PETR [RU]; VOLOBUEV DMITRY)<br>14 March 2013 (2013-03-14) | 1,2,<br>6-10,12,<br>13 |
| A         | page 18, line 11 - page 19, line 10;<br>figures 1-4,10                                                                  | 3-5,<br>14-18          |
| X         | WO 2013/098398 A2 (PHILIP MORRIS PROD [CH]) 4 July 2013 (2013-07-04)                                                    | 1,2,<br>6-10,12,<br>13 |
| A         | page 16, line 7 - page 17, line 10;<br>figures 1-6<br>page 21, line 34 - page 22, line 7                                | 3-5,14,<br>15,19-22    |



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents:

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Date of the actual completion of the international search

26 August 2015

Date of mailing of the international search report

17/09/2015

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/003007

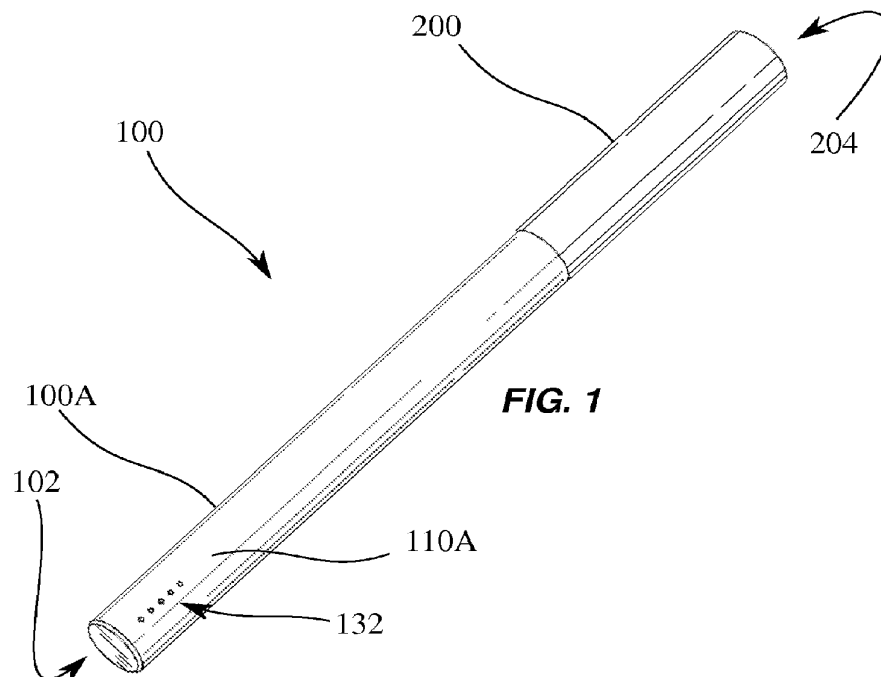
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| -----                                     |                     |                            |                     |



- (51) International Patent Classification:  
A24F 25/00 (2006.01) B05B 17/00 (2006.01)  
A24F 47/00 (2006.01)
- (21) International Application Number:  
PCT/US2014/065971
- (22) International Filing Date:  
17 November 2014 (17.11.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
61/905,093 15 November 2013 (15.11.2013) US
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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, 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, KN, KP, KR, 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,

[Continued on next page]

(54) Title: VAPORIZER WITH COVER SLEEVE



[Continued on next page]



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**  
GW, KM, ML, MR, NE, SN, TD, TG).

— with international search report (Art. 21(3))

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**(57) Abstract:** A vaporizer may include a battery portion, a cartomizer connectable with the battery portion, and a sleeve fitable over the cartomizer. The sleeve and an outer shell of the battery portion may have the same or complimentary colors or patterns. The battery portion may further include a plurality of illuminable indicators, which may illuminate to indicate, for instance, remaining voltage of a battery housed within the battery portion.

## **VAPORIZER WITH COVER SLEEVE**

### **CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Provisional Application No. 61/905,093 filed November 15, 2013, the disclosure of which is hereby incorporated herein by reference in its entirety.

### **FIELD OF THE DISCLOSURE**

[0002] This disclosure relates generally to the field of vaporizers, which may also be referred to as electronic cigarettes.

### **BACKGROUND**

[0003] Electronic cigarettes have recently emerged as a new product for providing nicotine through a smokeless inhalation process. Typically, implementations consist of a power supply (typically a battery) and an atomizing device. In reusable electronic cigarettes the two items are separated into a battery and a cartomizer, to allow the disposal and replacement of a nicotine containing fluid cartomizer while preserving the more costly battery and associated circuitry (microcontroller, switch, etc.) for additional use. In disposable electronic cigarettes, the two items are combined to integrate the functions into one unit that is discarded after either the battery energy or the nicotine containing liquid is exhausted.

[0004] The electronic cigarette liquid used to vaporize ingredients such as nicotine is generally a solution of propylene glycol (PG), vegetable glycerin (VG), or polyethylene glycol 400 (PEG400), as well as their mixtures to which a flavor and/or nicotine has been added. The solution is often sold in a bottle (for refilling by the user) or in disposable cartridges or cartomizers. Many different flavors are incorporated into these liquids, including those that resemble the taste of regular tobacco, menthol, vanilla, coffee, cola and/or various fruits. Various nicotine concentrations are also available, and nicotine-free solutions are also common.

### **BRIEF SUMMARY OF THE DISCLOSURE**

[0005] The following presents a simplified summary of the disclosure in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is intended to neither identify key or critical elements of the invention nor delineate the scope of the invention. Its sole purpose is to present some



concepts of the invention, in accordance with the disclosure, in a simplified form as a prelude to the more detailed description that is presented later.

**[0006]** In one embodiment of the disclosure, a vaporizer may include a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, and internal components housed within the outer shell. The internal components may include a battery, a printed circuit board, including a microcontroller for operating a program to control the vaporizer, a pressure switch operable to detect a pressure differential generated when the airflow is established, at least one illuminable indicator which illuminates in association with charge remaining of the battery, and electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator. The vaporizer may further include a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell. The internal cartomizer components may include a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current is passed along the heating element, a storage component for holding a vaporizable fluid, and a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell.

**[0007]** An additional embodiment of a vaporizer may include a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, a retaining ring provided externally on an area of the outer shell, and internal components housed within the outer shell. The internal components may include a battery, a printed circuit board, including a microcontroller for operating a program to control the vaporizer, a pressure switch operable to detect a pressure differential generated when the airflow is established, a plurality of light emitting diodes which illuminate in association with charge remaining of the battery, and electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator. The vaporizer may further include a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell

diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell. The internal cartomizer components may include a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current is passed along the heating element, a storage component for holding a vaporizable fluid, and a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell. The vaporizer may also include a sleeve having dimensions conforming with the cartomizer, the sleeve fittable over the cartomizer, the sleeve including an air hole alignable with the mouthpiece of the cartomizer when the sleeve is fitted the cartomizer, the retaining ring contacting an internal surface of the vaporizer sleeve when the vaporizer sleeve is placed over the cartomizer and the cartomizer is connected with battery portion.

#### **BRIEF DESCRIPTION OF THE FIGURES**

**[0008]** The following description and the annexed drawings set forth certain illustrative aspects of the invention. These aspects are indicative, however, of but a few of the various ways in which the principles of the invention may be employed and the present invention is intended to include all such aspects and their equivalents. Other advantages and novel features of the invention will become apparent from the following description when considered in conjunction with the drawings.

**[0009]** FIG. 1 illustrates a perspective view of an embodiment of a vaporizer with a vaporizer sleeve in accordance with the disclosure;

**[00010]** FIG. 2 illustrates a front view of the vaporizer with the vaporizer sleeve of FIG. 1;

**[00011]** FIG. 3 illustrates a rear view of the vaporizer with the vaporizer sleeve of FIG. 1;

**[00012]** FIG. 4 illustrates an exploded side view of a vaporizer, without a vaporizer sleeve, in accordance with the disclosure, with the outer shell of the vaporizer transparent thereby illustrating the internal components of the vaporizer; and

**[00013]** FIG. 4A illustrates a reverse side view of the printed circuit board of the vaporizer shown in FIG. 4.

**DETAILED DESCRIPTION**

**[00014]** The following detailed description and the appended drawings describe and illustrate some embodiments of the invention for the purpose of enabling one of ordinary skill in the relevant art to make and use the invention. As such, the detailed description and illustration of these embodiments are purely illustrative in nature and are in no way intended to limit the scope of the invention, or its protection, in any manner. It should also be understood that the drawings are not to scale and in certain instances details have been omitted, which are not necessary for an understanding of the present invention, such as details of fabrication and assembly. In the accompanying drawings, like numerals represent like components.

**[00015]** In one embodiment of the disclosure, a vaporizer may include a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, and internal components housed within the outer shell. The internal components may include a battery, a printed circuit board, including a microcontroller for operating a program to control the vaporizer, a pressure switch operable to detect a pressure differential generated when the airflow is established, at least one illuminable indicator which illuminates in association with charge remaining of the battery, and electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator. The vaporizer may further include a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell. The internal cartomizer components may include a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current is passed along the heating element, a storage component for holding a vaporizable fluid, and a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell.

**[00016]** Embodiments of a vaporizer may further include at least one illuminable indicator comprises a plurality of light emitting diodes, and wherein the PCB operates to illuminate a predetermined number of light emitting diodes after determining the battery voltage. The plurality of light emitting diodes may include five light emitting diodes, and all five diodes

may illuminate if the battery has at least first predetermined level of volts, four diodes may illuminate if the battery has at least a second predetermined level of volts, three diodes may illuminate if the battery has at least a third predetermined level of volts, two diodes may illuminate if the battery has at least a fourth predetermined level of volts, one diode may illuminate if the battery has at least a fifth predetermined level of volts, and no diode may illuminate if the battery has less than the fifth predetermined level of volts. The vaporizer may include a sleeve having dimensions conforming with the cartomizer, the sleeve fittable over the cartomizer. The sleeve may include an air hole alignable with the mouthpiece of the cartomizer when the sleeve is fitted the cartomizer. An outer surface of the sleeve may include a pattern or color which is the same or complimentary as a pattern or color provided on an outer surface of battery portion. The battery portion further include a retaining ring provided on external area of the outer shell of the battery portion, the retaining ring may contact an internal surface of the vaporizer sleeve when the vaporizer sleeve is placed over the cartomizer and the cartomizer is connected with battery portion. The retaining ring may be provided in a recess of the outer shell of the battery portion. The pressure switch may be encapsulated in an elastic material in order to prevent air flow around the pressure switch.

**[00017]** An additional embodiment of a vaporizer may include a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, a retaining ring provided externally on an area of the outer shell, and internal components housed within the outer shell. The internal components may include a battery, a printed circuit board, including a microcontroller for operating a program to control the vaporizer, a pressure switch operable to detect a pressure differential generated when the airflow is established, a plurality of light emitting diodes which illuminate in association with charge remaining of the battery, and electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator. The vaporizer may further include a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell. The internal cartomizer components may include a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current

is passed along the heating element, a storage component for holding a vaporizable fluid, and a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell. The vaporizer may also include a sleeve having dimensions conforming with the cartomizer, the sleeve fitable over the cartomizer, the sleeve including an air hole alignable with the mouthpiece of the cartomizer when the sleeve is fitted the cartomizer, the retaining ring contacting an internal surface of the vaporizer sleeve when the vaporizer sleeve is placed over the cartomizer and the cartomizer is connected with battery portion.

**[00018]** In further embodiments of the vaporizer, the retaining ring may be provided in a recess of the outer shell of the battery portion. The pressure switch may be encapsulated in an elastic material in order to prevent air flow around the pressure switch. The plurality of light emitting diodes may include five light emitting diodes, and all five diodes may illuminate if the battery has at least first predetermined level of volts, four diodes may illuminate if the battery has at least a second predetermined level of volts, three diodes may illuminate if the battery has at least a third predetermined level of volts, two diodes may illuminate if a the battery has at least a fourth predetermined level of volts, one diode may illuminate if the battery has at least a fifth predetermined level of volts, and no diode may illuminate if the battery has less than the fifth predetermined level of volts.

**[00019]** With reference now to the figures, an embodiment of a vaporizer 100 with a removable vaporizer sleeve 200 are illustrated. Vaporizer 100 may include a battery portion 100A and a cartomizer 100B. In some embodiments, cartomizer 100B may share a common housing with battery portion 100A, however the illustrated embodiment shows battery portion 100A as removably connectable with cartomizer 100B.

**[00020]** Battery portion may have a first distal end 102 and a second proximate end 104. Cartomizer may have a first battery-side end 106 and a second mouthpiece-side end 108, and battery portion 100A and cartomizer 100B may be connectable at proximate end 104 and battery-side end 106. Battery portion 100A and cartomizer 100B may be connectable by an known or to be developed connectors, including as illustrated matable male and female threading. Battery portion 100A may include an outer battery shell 110A having a diameter similar, or nearly identical, as the diameter of an outer cartomizer shell 110B. Accordingly, when battery portion 100A and cartomizer 100B are mated, vaporizer 100 may be substantially elongate and cylindrical. In some embodiments, the diameter of vaporizer 100 is approximately 9mm.

**[00021]** Battery portion 100A may include a variety of components housed within outer shell 110A. One such component may be a rechargeable battery 112, which in one embodiment is a lithium-ion battery. A pressure switch 114 and a printed circuit board (PCB) 116 may also be housed within outer shell 110A. Electronic circuitry may be further provided in order to electrically connect battery 112, pressure switch 114, and PCB 116 as part of the operation of vaporizer 100. At least one air hole 118 may be provided on outer shell 110, proximate to either end of battery portion 100A, with at least one additional air hole (not illustrated) provided on or proximate to proximate end 104 in order to establish internal air flow through battery portion 100A. The at least one additional air hole may be in fluid communication with at least one battery-side air hole (not illustrated) provided on cartomizer 100B, which in turn may be fluidly communicable with a tube 122 passing through cartomizer 100B. The tube may terminate at a mouthpiece 124 provided at or proximate to the mouthpiece-side end 108 of cartomizer 124. Accordingly, when a user inhales through mouthpiece 124, an air flow is generated from air hole 118, through the at least one additional air holes and battery-side end air holes, and further through tube 122, terminating at mouthpiece. Upon establishing this airflow, pressure switch 114 may identify a pressure differential generated from this airflow, which may in turn activate vaporizer 100. In order to facilitate pressure switch 114 in detecting a pressure differential, pressure switch 114 may be held or encapsulated in an compressible or elastic material 126, which in one embodiment is rubber or an elastomer, thereby preventing air from flowing around pressure switch 114.

**[00022]** After detecting a pressure differential, pressure switch 114 may communicate with PCB 116 in order to activate vaporizer 100. As may be controlled by a program operating on PCB 116, upon detection of a pressure differential a current may be sent through the electronic circuitry to a heating element 128 provided in cartomizer 100B. Heating element 128 may be any known or to be discovered material which elevates in temperature once a current passed through the material, and in one embodiment heating element 128 may be substantially composed of nichrome wire. Heating element may be provided within proximity to a storage component 130 for a vaporizable substance, such that heating element may elevate the temperature of a vaporizable substance stored in the storage component 130 to a vaporization temperature, at which point the vaporizable substance may become a gaseous form inhalable by the user through tube 122 and mouthpiece 124. In some embodiments, storage component includes a porous material, such as fiber bating, which may be soaked with a liquid vaporizable fluid. A wick, connected with or otherwise in communication with

storage component 130, may be intertwined with heating element 128 in order to facilitate delivery of vaporizable fluid to heating element 128.

**[00023]** PCB 116 may include a series of illuminable indicators 132, which in some embodiments may be light emitting diodes (LED). In the illustrated embodiment, a series of five (5) LED indicators 132 are provided. A series of holes in outer shell 110A may be provided so that indicators 132 are externally viewable. PCB 116 may further operate to detect voltage remaining of battery 112, such that the LED lights 132 may illuminate depending on the voltage remaining. For instance, if battery 112 operates with 4.1V or more, all five indicators 132 may illuminate, however as the voltage drops only a subset of indicators may illuminate. In some embodiments, if battery 112 has less than 4.1V, only four indicators illuminate; if less than 3.9V, only three indicators illuminate; if less than 3.7V, only two indicators illuminate; if less than 3.5V, only one indicator illuminates; and if less than 3.3V, no indicators illuminate. Other pre-determined voltage levels may be used depending on factors, such as battery type and power required to operate vaporizer 100. Further components of PCB 116 may include a microcontroller for executing one or more control programs, output transistor and various passive components, embodiments of which are illustrated in FIG. 4A on a side opposite of indicators 132. In addition to operating indicators 132, PCB 116 may further include a time operation, such that when vaporizer 100 has been active for longer than a pre-set time period, the PCB 116 may automatically stop the vaporizer's functioning by ceasing current to heating element 128. This cutoff time mechanism may improve the safety of vaporizer 100. The cutoff time may be, for example, ten (10) seconds of continued activation of vaporizer 100. Furthermore, PCB 116 may detect when battery portion 100a is connected to a charger (not illustrated) in order to recharge battery 112. The charger may include threading mateable with the threading of the battery portion 100A provided proximate to end 104. Upon detection of a charging state, PCB 116 may operate to illuminate one or more indicators 132 in order to visually indicate to a user of vaporizer 100 that it was entered into the charging state. Once battery 112 is recharged to an optimum voltage capacity, the PCB 116 may adjust indicators 132 in order to emit an alternative visualization to the user indicating a charged state. In one embodiment, as the battery voltage capacity increase during charging, indicators 116 may be sequentially illuminated as charge returns the battery, until all indicators 116 all illuminated in order to indicate that vaporizer 100 has reached a charged state.

**[00024]** Vaporizer sleeve 200 may be dimensioned to conform with the dimensions of cartomizer 100B such that sleeve 200 may slide over and cover cartomizer 100B. Sleeve 200 may be slightly longer than cartomizer 100B and, as such, may be held into place by retaining ring 134 provided about battery portion 110A at or near proximate end 104. Retaining ring 134 may operate to press against the inner surface of sleeve 200, thereby holding sleeve 200 in place from frictional force. Retaining ring 134 may be embedded in a recess in outer shell 110A, thereby maintaining the position of retaining ring 134. Sleeve 200 may further include a mouthpiece hole 206 which may be aligned with mouthpiece 124 once sleeve 200 is placed over cartomizer 100B. In some embodiments, sleeve 200 and outer shell 110A may include a complimentary motif or design. Examples of such a design are illustrated in U.S. Design App. No. 29/487,413, the entire contents of which are herein incorporated by reference in their entirety.

**[00025]** The descriptions set forth above are meant to be illustrative and not limiting. Various modifications of the invention, in addition to those described herein, will be apparent to those skilled in the art from the foregoing description. Such modifications are also intended to fall within the scope of the concepts described herein. The disclosures of each patent, patent application and publication cited or described in this document are hereby incorporated herein by reference, in their entireties.

**[00026]** The foregoing description of possible implementations consistent with the present disclosure does not represent a comprehensive list of all such implementations or all variations of the implementations described. The description of some implementation should not be construed as an intent to exclude other implementations. For example, artisans will understand how to implement the invention in many other ways, using equivalents and alternatives that do not depart from the scope of the invention. Moreover, unless indicated to the contrary in the preceding description, none of the components described in the implementations are essential to the invention. It is thus intended that the embodiments disclosed in the specification be considered as illustrative, with a true scope and spirit of the invention being indicated by the following claims



What is claimed:

1. A vaporizer comprising:

a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, and internal components housed within the outer shell, the internal components including

a battery,

a printed circuit board, including a microcontroller for operating a program to control the vaporizer,

a pressure switch operable to detect a pressure differential generated when the airflow is established,

at least one illuminable indicator which illuminates in association with charge remaining of the battery, and

electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator; and

a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell, the internal cartomizer components including

a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current is passed along the heating element,

a storage component for holding a vaporizable fluid, and

a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell.

2. The vaporizer of claim 1, wherein the at least one illuminable indicator comprises a plurality of light emitting diodes, and wherein the PCB operates to illuminate a predetermined number of light emitting diodes after determining the battery voltage.

3. The vaporizer of claim 2, wherein the plurality of light emitting diodes includes five light emitting diodes, and

wherein all five diodes illuminate if the battery has at least first predetermined level of volts, four diodes illuminate if the battery has at least a second predetermined level of volts,

three diodes illuminate if the battery has at least a third predetermined level of volts, two diodes illuminate if the battery has at least a fourth predetermined level of volts, one diode illuminates if the battery has at least a fifth predetermined level of volts, and no diode illuminates if the battery has less than the fifth predetermined level of volts.

4. The vaporizer of claim further comprising a sleeve having dimensions conforming with the cartomizer, the sleeve fitable over the cartomizer.

5. The vaporizer of claim 4, wherein the sleeve includes an air hole alignable with the mouthpiece of the cartomizer when the sleeve is fitted the cartomizer.

6. The vaporizer of claim 4, wherein an outer surface of the sleeve includes a pattern or color which is the same or complimentary as a pattern or color provided on an outer surface of battery portion.

7. The vaporizer of claim 4, wherein the battery portion further comprises a retaining ring provided on external area of the outer shell of the battery portion, the retaining ring contacting an internal surface of the vaporizer sleeve when the vaporizer sleeve is placed over the cartomizer and the cartomizer is connected with battery portion.

8. The vaporizer of claim 7, wherein the retaining ring is provided in a recess of the outer shell of the battery portion.

9. The vaporizer of claim 1, wherein the pressure switch is encapsulated in an elastic material in order to prevent air flow around the pressure switch.

10. A vaporizer comprising:

a battery portion including an outer shell having an outer shell diameter, a plurality of holes thereby permitting airflow to be established through at least a section of the battery portion, a retaining ring provided externally on an area of the outer shell, and internal components housed within the outer shell, the internal components including

a battery,

a printed circuit board, including a microcontroller for operating a program to control the vaporizer,

a pressure switch operable to detect a pressure differential generated when the airflow is established,

a plurality of light emitting diodes which illuminate in association with charge remaining of the battery, and

electronic circuitry housed within the outer shell, the electronic circuitry electrically connecting the battery, the printed circuit board, the pressure switch, and the at least one illuminable indicator;

a cartomizer including a cartomizer outer shell having a cartomizer outer shell diameter substantially similar to the outer shell diameter, the cartomizer connectable with the battery portion, the cartomizer including internal cartomizer components housed within the outer cartomizer shell, the internal cartomizer components including

a heating element electrically connected with the electronic circuitry of the battery portion when the cartomizer and the battery portion are connected, the heating element operable to heat to a vaporization temperature when a current is passed along the heating element,

a storage component for holding a vaporizable fluid, and

a tube in fluid communication between the airflow of the battery portion and a mouthpiece provided on the cartomizer outer shell; and

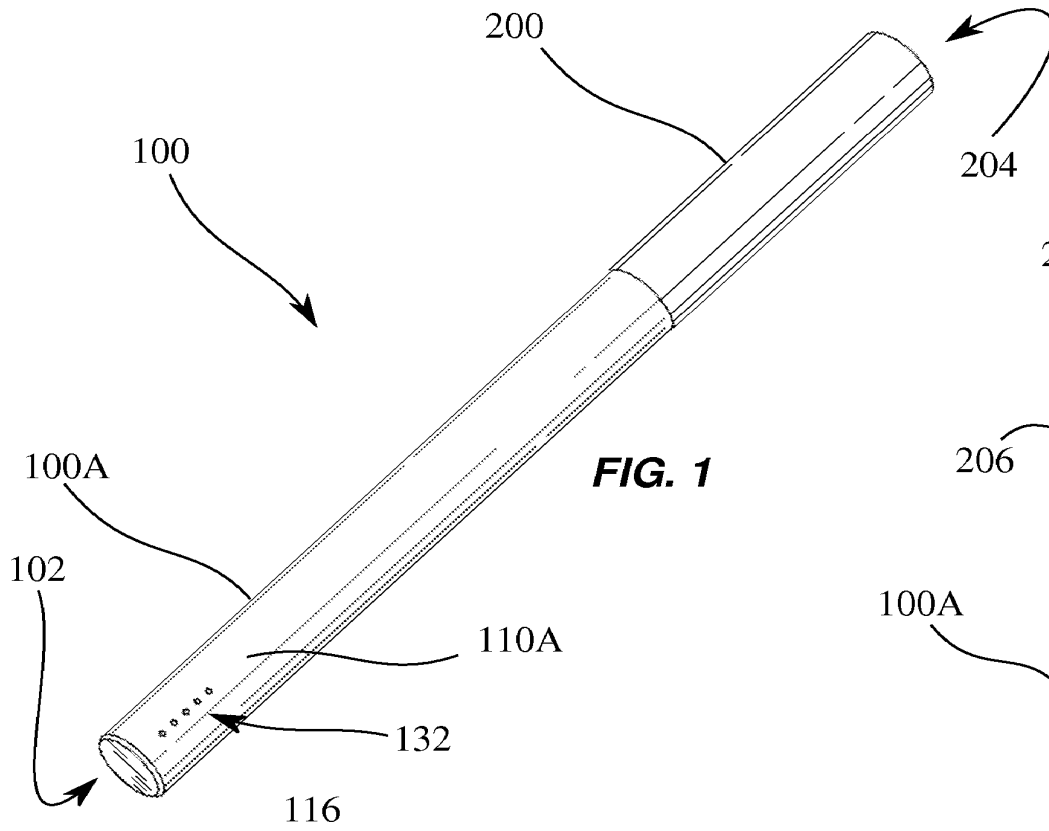
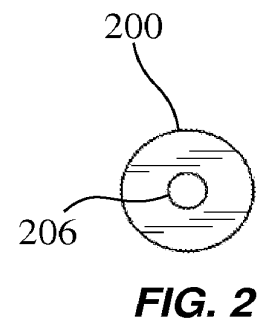
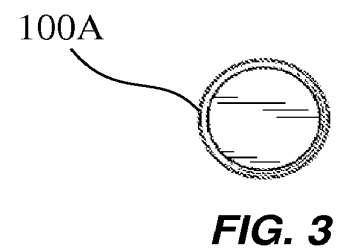
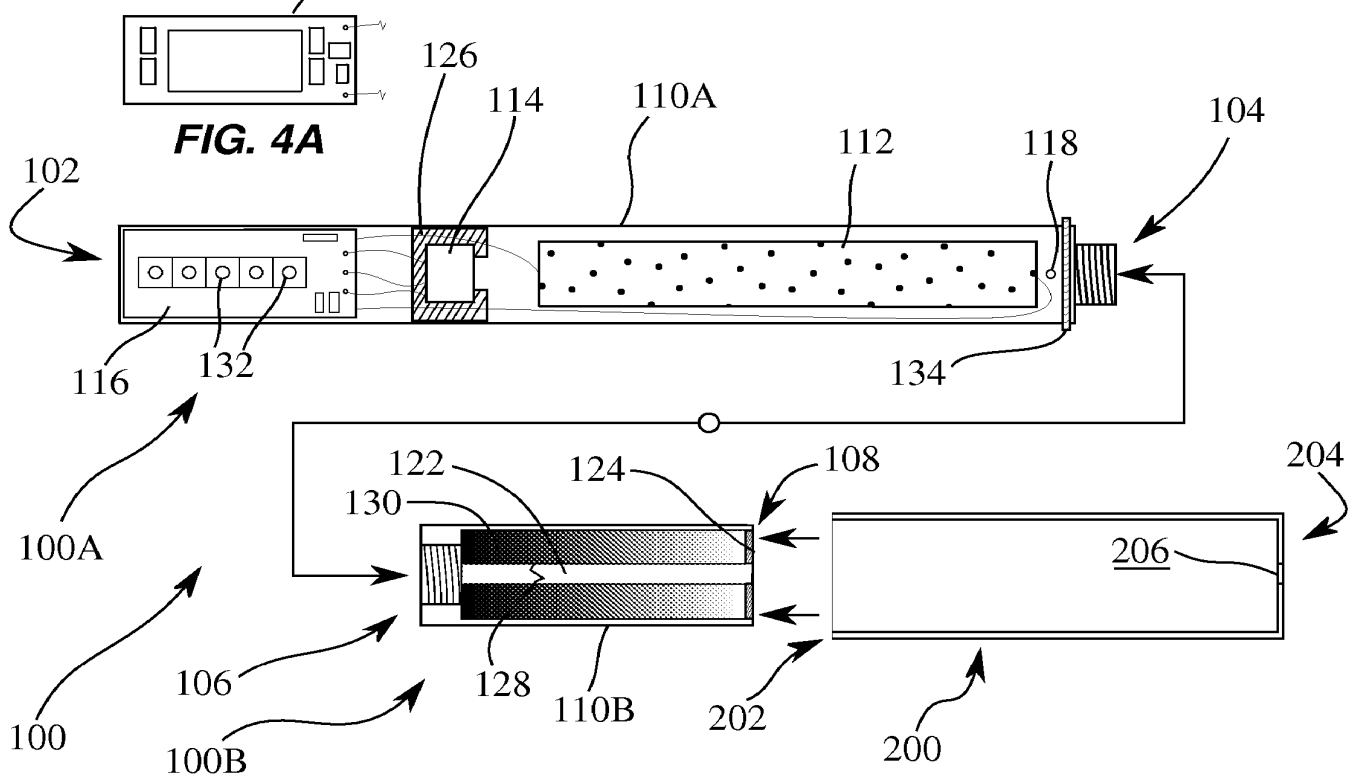
a sleeve having dimensions conforming with the cartomizer, the sleeve fittable over the cartomizer, the sleeve including an air hole alignable with the mouthpiece of the cartomizer when the sleeve is fitted the cartomizer, the retaining ring contacting an internal surface of the vaporizer sleeve when the vaporizer sleeve is placed over the cartomizer and the cartomizer is connected with battery portion.

11. The vaporizer of claim 10, wherein the retaining ring is provided in a recess of the outer shell of the battery portion.

12. The vaporizer of claim 10, wherein the pressure switch is encapsulated in an elastic material in order to prevent air flow around the pressure switch.

13. The vaporizer of claim 10, wherein the plurality of light emitting diodes includes five light emitting diodes, and

wherein all five diodes illuminate if the battery has at least first predetermined level of volts, four diodes illuminate if the battery has at least a second predetermined level of volts, three diodes illuminate if the battery has at least a third predetermined level of volts, two diodes illuminate if a the battery has at least a fourth predetermined level of volts, one diode illuminates if the battery has at least a fifth predetermined level of volts, and no diode illuminates if the battery has less than the fifth predetermined level of volts.



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US14/65971

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A24F 25/00, 47/00; B05B 17/00 (2015.01)

CPC - A24F 47/008; A61M 11/041, 15/06

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classification(s): A24F 25/00, 47/00; B05B 17/00 (2015.01)

CPC Classification(s): A24F 47/008; A61M 11/041, 15/06

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)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google Scholar; IEEE; ESPACENET

Keywords used: vaporizer; e-cigarette; LED; vaporizable fluid; cartomizer; sleeve

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                        | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | US 2012/0318882 A1 (ABEHASERA, B) December 20, 2012; figures 1-4, 11-12; paragraphs [0055]; [0063-0064]; [0081-0082]; [0086]                              | 1-2, 4-8, 10-11       |
| Y         | US 2013/0298905 A1 (UPTOKE, LLC.) November 14, 2013; figures 5A-5B; paragraphs [0010]; [0052]                                                             | 1-2, 4-8, 10-11       |
| Y         | WO 2013/116567 A1 (ALTRIA CLIENT SERVICES INC.) August 08, 2013; figures 1-3, 25; paragraphs [0005]; [0041] [0110]                                        | 4-8, 10-11            |
| A         | US 2005/0017685 A1 (REES, G et al.) January 27, 2005; figures 1-5; paragraphs [0053]; [0079-0080]; [0082]                                                 | 3, 13                 |
| A         | WO 2012/072762 A1 (PHILIP MORRIS PRODUCTS) June 07, 2012; page 2, lines 6-15; page 6, lines 20-38; page 7, lines 1-6 and lines 21-30; page 13, lines 5-11 | 9, 12                 |

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

\* Special categories of cited documents:

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Date of the actual completion of the international search

17 January 2015 (17.01.2015)

Date of mailing of the international search report

11 FEB 2015

Name and mailing address of the ISA/US

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(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织  
国际局



(43) 国际公布日:  
2004年9月23日(23.09.2004)

PCT

(10) 国际公布号:  
WO 2004/080216 A1

(51) 国际分类号: A24B 15/16  
(21) 国际申请号: PCT/CN2004/000183  
(22) 国际申请日: 2004年3月8日(08.03.2004)  
(25) 申请语言: 中文  
(26) 公布语言: 中文  
(30) 优先权:  
03111173.4 2003年3月14日(14.03.2003) CN  
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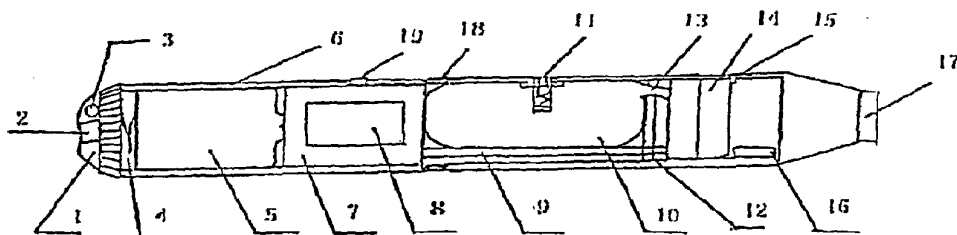
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(54) Title: A NON-SMOKABLE ELECTRONIC AEROSOL CIGARETTE

(54) 发明名称: 一种非可燃性电子雾化香烟



(57) Abstract: The invention relates to a non-smokable electronic aerosol cigarette which only comprises nicotine without harmful tar. The features of the invention are: the air flow sensor which is located in the smoking-mouth of the cigarette end is connected to the circuit -plate to start the atomiser high frequency vibrator which connects with the nicotine solution storing via the spray pipes, the high frequency vibrator is connected to the count routes and the display screen, there is an end shield in the front of the cigarette with cells and light diodes. This device may imitate the traditional smoking pattern and effect, the smokers would feel smoking, and it has no side effect, it realizes "smoking without harm".

[见续页]



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(57) 摘要

本发明涉及一种不含有害焦油，只含烟碱(尼古丁)的非可燃性电子雾化香烟。本发明的特点是，构成香烟尾端烟嘴处设置的气流传感器连至电路板上用于启动经供液管与贮存烟碱溶液相接的雾化器高频振荡器，高频振荡器接计数线路和显示屏，香烟前端为装有电池并带有发光二极管的端罩。该装置可逼真的模拟传统的吸烟方式和效果，使吸烟者有吸烟的感觉，而且无副作用，可实现“吸烟无害健康”。

## 一种非可燃性电子雾化香烟

### 技术领域

本发明涉及一种不含有害焦油，只含烟碱(尼古丁)的非可燃性电  
5 子雾化香烟。

### 背景技术

在当今“吸烟有害健康”已成为常识的情况下，全世界目前仍有  
10 亿人吸烟，而且每年这个数字还在扩大，2003 年 3 月 1 日世界卫生  
组织（WHO）通过的第一个国际禁烟协定《烟草控制框架公约》，据  
WHO 提供的数字表明，吸烟每年造成 490 万人死亡，尽管吸烟可导  
致严重的呼吸系统疾病和癌症，要吸烟者完全戒烟是一桩极端困难的  
事。

香烟的有效成分是烟碱(尼古丁)，吸烟时烟碱随着香烟燃烧时产  
15 生的大量焦油雾滴进入肺泡后迅速吸收，烟碱吸收入血后作用于中  
枢神经系统的受体上，引起类似兴奋剂的“陶醉感”，如吸烟者所经  
历的头晕目眩或飘飘然的感觉。

烟碱是小分子生物碱，在小剂量下对人体基本无害，而且在血液  
中的半衰期极短。烟草的有害物质主要是焦油，烟草焦油是由数百种  
20 成分组成。其中有数种成分内是致癌物。目前证实二次吸烟对不吸  
烟者的危害更大。

为了寻找只含烟碱而不含有害焦油的香烟代用品，有许多发明



是用较纯的烟碱制成诸如“戒烟贴”、“烟碱含漱水”、“包装有抛射剂的高压气罐喷雾剂”、“烟碱口香糖”等产品，这些产品虽然没有焦油的危害，但因烟碱吸收缓慢，在血液中不能建立有效的高峰浓度，不能解决需要烟碱“过瘾”的感觉，同时也剥夺了吸烟者已经养成的

5 “抽”、“吸”的习惯，因而类似的产品不能真正的作为戒烟用品或香烟代用品。

## 发明内容

本发明的目的是克服避免了上述缺点，提供一种可模拟吸烟并有吸烟效果，更接近真实的人性化电子雾化香烟。

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本发明的特点是，构成香烟的尾端烟嘴初设置的气流传感器连至电路板上用于启动经供液管与贮存烟碱溶液相接的雾化器高频振荡器，高频振荡器接计数电路和显示屏，香烟前端为装有电池并带有发光二极管的端罩。它的基本工作原理是当把烟嘴放在嘴上吸气时，

15 气流传感器输出电信号启动电路，装置在电路板上的高频振荡电路启动向雾化器提供驱动电压，另一组直流渐变信号供给红色发光二极管发出渐变的红光。雾化器上的双压电片发射超声波用于雾化，贮存于塑胶容器中的烟碱溶液经供液管输入雾化器中，经微喷雾化成直径为  $1-15\mu\text{m}$  的液滴，其中 75% 的液滴直径在  $6\mu\text{m}$  以下，与进气

20 孔的空气流混合后，能到达细支气管和肺泡中，每次的供液量在  $3-50\mu\text{l}$  之间，这样就能在 10 分钟之内使烟碱在血液中的浓度达到  $30\text{ng/ml}$  左右，通过液晶显示屏可分别显示出烟碱溶液的消耗量，每

天吸烟的次数,对使用者提供警示信息。使用者可通过单向阀补充烟碱溶液。

该装置可逼真的模拟传统的吸烟方式和效果,使吸烟者有吸烟的感觉。而且还无副作用,可实现“吸烟无害健康”。

5

## 附图说明

图 1 为本发明的结构示意图。

图 2 为本发明的结构框图。

图 3 为本发明的雾化器结构示意图。

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## 具体实施方式

本发明将烟碱的水、醇溶液微喷雾化,经口吸入肺中吸收,该装置包括壳体、高频发生器、烟碱贮液及容器、微喷雾化器、气流传感器及附件组成的整体。壳体外形是直管状,也可以略有曲线形,还可以是通常的烟嘴形,笔形或其他艺术品形象。壳体一端装有红色塑料帽状装饰物,内置红色二极发光管,电池是可充电锂电池,也可是镍氢电池。高频振荡器是集成电路与功放管组成的三点式电容振荡器、三点式电感振荡器或变压器式振荡电路,频率在 35KHZ 至 2.2MHZ,电路中带有频率自动微调电路与压电片谐振,液晶显示器显示该装置启动次数和贮液量。塑胶容器由硅橡胶制成,不被烟碱浸入的高分子化合物也可使用。注液单向阀是由球状物或锥状物在弹簧压力下密封的。气流传感器是由薄膜状热敏电阻阵列或硅芯片制成的。该装置包

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含一片粘合了一个环形径向极化压电片的中间有微喷孔阵列的雾化膜片，微喷孔阵列的外周有一圆形波纹环。与该雾化膜片对应的振动膜片上粘合一个圆形单层或多层纵向极化压电片，此振动膜片上开有凹槽或加入垫圈以同雾化膜片组成液体腔。该液体腔边缘开一小孔以

5 连接具有阻尼作用的供液管。该装置是由交流电信号分别驱动两个压电片形成纵向压力波和径向振动波将液体从微喷孔处挤出并雾化。两个压电片各有两个压电信号输入端，压电信号的频率可以不同或一致。两个压电片是同 PZT、PMN、PNN、PSN、PMN-PT、PNN-PT、PSN-PT、PZN-PT 之一，并具有单层结构或者是不同成分的叠层结构。

10 振动膜片和雾化膜片是由单晶硅片加工成的，也可用耐腐蚀金属或合金制成，如镍片、镍钴合金片、镍钯合金片、镍镉钴铑合金片等。振动膜片和雾化膜片粘合后组成液体腔，液体腔中有由天然纤维或合成纤维制作的供液纤维团。烟碱（尼古丁）溶液是由烟碱、水、乙醇、丙三醇、薄荷醇、烟草香精、抗氧剂、氨水组成。烟碱来自烟草总提

15 取物中的 4 种烟碱的混合物，也可称为烟草总生物碱，尼古丁是最多的一种，所以用纯尼古丁也可代替烟碱。烟碱（尼古丁）浓度在 0.1%-30% 之间。该装置可用于经口腔和鼻腔对肺内输送药物或药物前体，提供一种便携式雾化给药装置。

图 1 是这种电子香烟的结构图。图中的 1 是红色有机玻璃，2 是

20 充电插孔，3 是红色发光二极管，4 是弹簧，5 是锂电池，6 是带有旋口 18 的壳体，7 是电路板，8 是液晶显示屏，9 是信号传输导线，10 是塑胶容器，11 是连接到塑胶容器口的注液单向阀，12 是密封

隔板, 13 是供液管, 14 是雾化器, 15 是进气孔, 16 是气流传感器, 17 是烟嘴, 19 是电源开关。

参照图 1 所示组装各部件成为总体, 其中电路板 7 中的电路设计方框图在图 2 中标出, 其高频振荡器中带有频率自动微调的目的是使压电片始终处于谐振点, 雾化器 14 是由双压电片构成的微喷和雾化两种作用, 其结构在图 3 中示出, 其工作原理是利用两个压电片分别驱动组成供液腔的振动膜片和雾化膜片, 圆形压电片与振动膜片粘合后组成压电换能器, 在液体喷出方向提供高速纵向压力波以使液体经微喷孔处高速喷出。环行压电片与带有微喷孔的雾化膜片粘合组成另一压电换能器。向即将离开微喷孔的液滴提供径向振动波, 使液滴进一步破碎。在振动膜片与雾化膜片组成的供液腔中加入一疏松纤维团可改善微喷孔阵列中各微喷孔的能量及液体分配, 使之趋于平均, 振动膜片和雾化膜片可用单晶硅片或耐腐蚀金属合金制成。改变环行压电片和圆形压电片的驱动电压和频率可获得不同直径的雾滴分布曲线。在微喷孔直径在  $4-10\ \mu\text{m}$  时, 雾滴直径在  $1-15\ \mu\text{m}$  的范围内, 经调试后充入烟碱溶液即可使用。

图 3 中的 141 为环型压电片, 142 为雾化膜片, 143 为波纹槽, 144 为纤维团, 145 为振动膜片, 146 为圆形压电片, 147 为供液腔, 148 为微喷口, 149 为压电片引线, 1410 为供液管, 1411 为垫圈, 1412 为凹槽。

烟碱溶液的配制:

用在烟草中提取的 95% 以上的液态烟碱依次加入水、乙醇、丙三醇、薄荷醇、烟草香精、抗氧剂后加氨水调整 PH 值在 7.5-11 之间, 烟

碱浓度可在 1%-30%之间变动, 浓度太高使误差增大, 水的加入量可在 20%-80%之间变动, 乙醇的加入量可在 20%-80%之间变动, 丙三醇的最高浓度应在 45%以下, 抗氧剂为丁基化的羟基茴香醚。

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## 权利要求书

1. 一种非可燃性电子雾化香烟,其特征是构成香烟的尾端烟嘴处设置的气流传感器连至电路板上用于启动经供液管与贮存烟碱溶液相接的雾化器高频振荡器,高频振荡器接计数电路和显示屏,香烟前端为装有电池并带有发光二极管的端罩。

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2. 按照权利要求 1 所述的电子雾化香烟,其特征是壳体外形是直管状,也可以略有曲线形,还可以是通常的烟嘴形,笔形或其他艺术品形象。
3. 按照权利要求 1 所述的电子雾化香烟,其特征是高频振荡器的振荡频率在 35KHZ 至 2.2MHZ,电路中带有频率自动微调电路与压电片谐振。

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4. 按照权利要求 1 所述的电子雾化香烟,其特征是塑胶容器由硅橡胶制成,注液单向阀是由球状物或锥状物在弹簧压力下密封的,气流传感器是由薄膜状热敏电阻阵列或硅芯片制成的。

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5. 按照权利要求 1 所述的电子雾化香烟,其特征是与该雾化膜片对应的振动膜片上粘合一个圆形单层或多层纵向极化压电片,此振动膜片上开有凹槽或加入垫圈以同雾化膜片组成液体腔,该液体腔边缘开一个小孔以连接具有阻尼作用的供液管。
6. 按照权利要求 1 所述的电子雾化香烟,其特征是两个压电片各有两个压电信号输入端,压电信号的频率可以不同或一致。

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7. 按照权利要求 1 所述的电子雾化香烟,其特征是振动膜片和

雾化膜片是由单晶硅片加工成的，也可以用耐腐蚀金属或合金制成，如镍片、镍钴合金片、镍钯合金片、镍铬钴镍铈合金片。

8. 按照权利要求 1 所述的电子雾化香烟，其特征是振动膜片和雾化膜片粘合后组成液体腔，液体腔中有由天然纤维或合成纤维制作的供液纤维团。

9. 按照权利要求 1 所述的电子雾化香烟，其特征是烟碱(尼古丁)溶液是由烟碱、水、乙醇、丙三醇、薄荷醇、烟草香精、抗氧化剂、氨水组成。

10. 按照权利要求 1 所述的电子雾化香烟，其特征是烟碱(尼古丁)浓度在 0.1%-30%之间。

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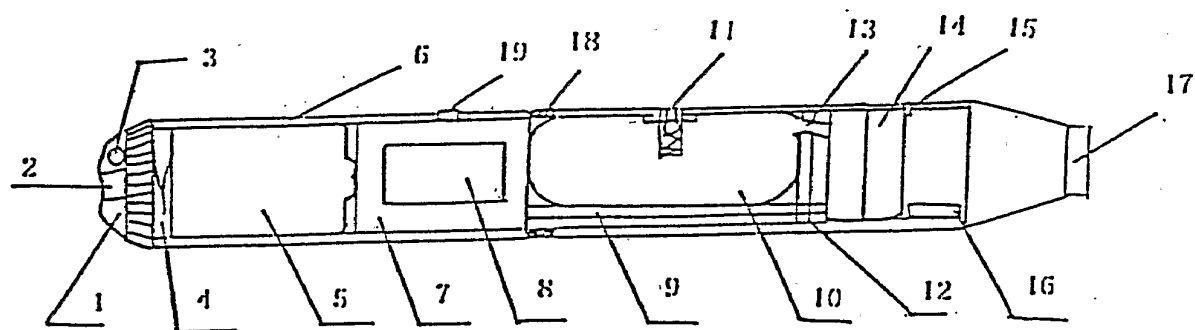


图 1.



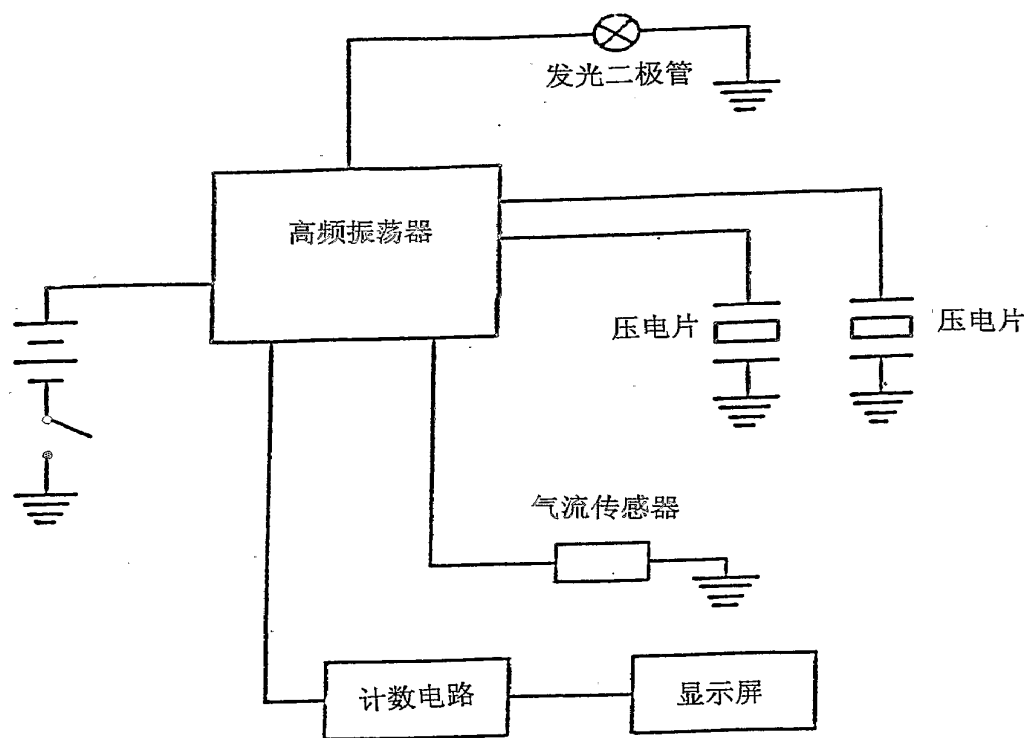


图 2

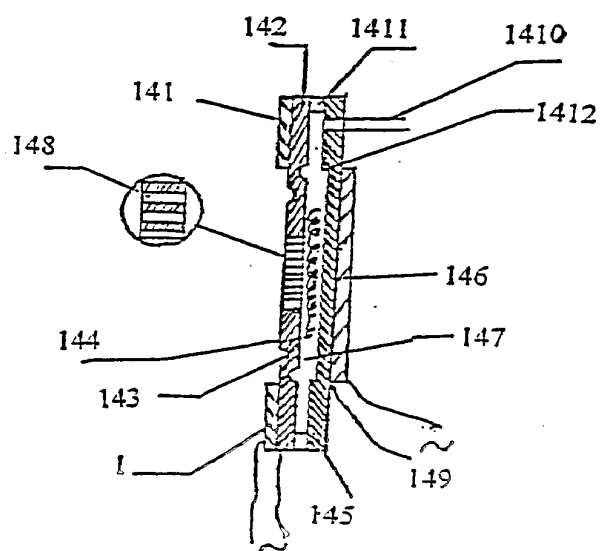


图 3

替换页 (细则第 26 条)

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CN2004/000183

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7:A24815/16

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)

IPC7:A24B15/16

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

IPC7:A24B+,A24C+,A24D+,A24F+

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

EPODOC,PAJ,WPI,CNPAT nicotine,cigarette+,electronic+

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| A         | WO,A2,00/49901(WEBER-QUITZAU,et al),31.Aug.2004,the whole document                 | 1-10                  |
| A         | US,A,5190060(B.A.Cigarettenfabriken GmbH),02.Mar.1993,the whole document           | 1-10                  |
| A         | CN,U,2047485(ZHAO yuzhong),15.Nov.1989,the whole document                          | 1-10                  |

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

|                                                                                                                                                                          |                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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|                                                                                                                                                   |                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Date of the actual completion of the international search<br>25.May 2004(25.05.2004)                                                              | Date of mailing of the international search report<br>10 JUN 2004 (10.06.2004) |
| Name and mailing address of the ISA/CN<br>6 Xitucheng Rd.,Jimen Bridge,Haidian District,<br>100088 Beijing,China<br>Facsimile No. (86-10)62019451 | Authorized officer<br>Telephone No. (86-10)62-85763                            |

Form PCT/ISA/210 (second sheet) (January 2004)

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

International application No.  
PCT/CN2004/000183

| Cited documents | published date | families      | published date |
|-----------------|----------------|---------------|----------------|
| WO0049901A2     | 31.Aug. 2000   | CA2360852A    | 31.Aug. 2000   |
|                 |                | EP1178741A    | 13.Feb. 2002   |
|                 |                | JP2003500008T | 07.Jan. 2003   |
| US5190060A      | 02.Mar. 1993   | DE3910899A    | 11.Oct. 1990   |
| CN2047485U      | 15.Nov. 1989   | None          |                |

# 国际检索报告

国际申请号

PCT/CN2004/000183

## A. 主题的分类

IPC7: A24B15/16

按照国际专利分类表(IPC)或者同时按照国家分类和 IPC 两种分类

## B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC7: A24B15/16

包含在检索领域中的除最低限度文献以外的检索文献

IPC7: A24B+,A24C+,A24D+,A24F+

在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用))

EPODOC,CNPAT,WPI,PAJ

Nicotine,cigarette+,electronic+

## C. 相关文件

| 类 型* | 引用文件, 必要时, 指明相关段落                                              | 相关的权利要求 |
|------|----------------------------------------------------------------|---------|
| A    | WO,A2,00/49901(WEBER-QUITZAU,et al),2000 年 8 月 31 日, 全文        | 1-10    |
| A    | US,A,5190060(B.A.T.Cigarettenfabriken GmbH),1993 年 3 月 2 日, 全文 | 1-10    |
| A    | CN,U,2047485(赵玉忠), 1989 年 11 月 15 日, 全文                        | 1-10    |

☐ 其余文件在 C 栏的续页中列出。

☒ 见同族专利附件。

\* 引用文件的具体类型:

“A” 认为不特别相关的表示了现有技术一般状态的文件

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“&” 同族专利的文件

国际检索实际完成的日期

25.5 月 2004 (25.05.2004)

国际检索报告邮寄日期

10.6月2004 (10.06.2004)

中华人民共和国国家知识产权局(ISA/CN)

中国北京市海淀区蓟门桥西土城路 6 号 100088

传真号: (86-10)62019451

授权官员 边昕 章昕

电话号码: (86-10)62085763

国际检索报告  
关于同族专利的信息

国际申请号  
PCT/CN2004/000183

| 检索报告中引用的<br>专利文件 | 公布日期         | 同族专利          | 公布日期         |
|------------------|--------------|---------------|--------------|
| WO0049901A2      | 31.8 月 2000  | CA2360852A    | 31.8 月 2000  |
|                  |              | EP1178741A    | 13.2 月 2002  |
|                  |              | JP2003500008T | 07.01 月 2003 |
| US5190060A       | 02.03 月 1993 | DE3910899A    | 11.10 月 1990 |
| CN2047485U       | 15.11 月 1989 | None          |              |

(19) 世界知识产权组织  
国际局

(43) 国际公布日:

2004年9月23日(23.09.2004)

PCT

(10) 国际公布号:

WO 2004/080216 A1

(51) 国际分类<sup>7</sup>: A24B 15/16

(21) 国际申请号: PCT/CN2004/000183

(22) 国际申请日: 2004年3月8日(08.03.2004)

(25) 申请语言: 中文

(26) 公布语言: 中文

(30) 优先权:  
03111173.4 2003年3月14日(14.03.2003) CN(71) 申请人(对除美国以外的所有指定国): BEST  
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Beaufort House, P.O. Box 438, Road Town, Tortola,  
Virgin Islands (GB).

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SCIENCE PATENT & TRADEMARK AGENT  
LTD); 中国北京市海淀区王庄路1号清华同方科技大  
厦B座15层, Beijing 100083 (CN)。(81) 指定国(除另有指明, 要求每一种可提供的国家保护):  
AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW,  
BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM,DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,  
MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL,  
PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,  
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ZM, ZW(84) 指定国(除另有指明, 要求每一种可提供的地区保护):  
ARIPO(BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ,  
TZ, UG, ZM, ZW), 欧亚专利(AM, AZ, BY, KG, KZ,  
MD, RU, TJ, TM), 欧洲专利(AT, BE, BG, CH, CY,  
CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT,  
LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI(BF,  
BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,  
NE, SN, TD, TG)

本国际公布:

— 包括国际检索报告。

(48) 更正本的公布日期:

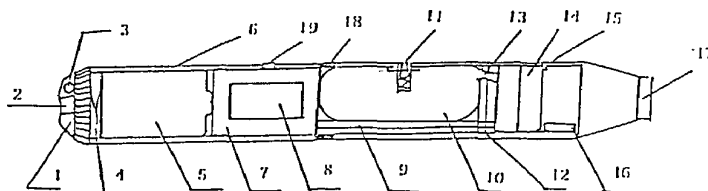
2005年2月24日(24.02.2005)

(15) 有关更正的内容:

见2005年2月24日(24.02.2005)所公布的第08/2005号  
PCT公报第二章所引用双字母代码和其它缩写符号, 请参考刊登在每期  
PCT公报期刊起始的“代码及缩写符号简要说明”。

(54) Title: A FLAMELESS ELECTRONIC ATOMIZING CIGARETTE

(54) 发明名称: 一种非可燃性电子雾化香烟



(57) Abstract: The invention relates to a non-smokable electronic aerosol cigarette which only comprises nicotine without harmful tar. The features of the invention are: the air flow sensor which is located in the smoking-mouth of the cigarette end is connected to the circuit -plate to start the atomizer high frequency vibrator which connects with the nicotine solution storing via the spray pipes, the high frequency vibrator is connected to the count routes and the display screen, there is an end shield in the front of the cigarette with cells and light diodes. This device may imitate the traditional smoking pattern and effect, the smokers would feel smoking, and it has no side effect, it realizes "smoking without harm".

[见续页]



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(57) 摘要

本发明涉及一种不含有害焦油，只含烟碱(尼古丁)的非可燃性电子雾化香烟。本发明的特点是，构成香烟尾端烟嘴处设置的气流传感器连至电路板上用于启动经供液管与贮存烟碱溶液相接的雾化器高频振荡器，高频振荡器接计数线路和显示屏，香烟前端为装有电池并带有发光二极管的端罩。该装置可逼真的模拟传统的吸烟方式和效果，使吸烟者有吸烟的感觉，而且无副作用，可实现“吸烟无害健康”。

# (12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织  
国际局



PCT

(43) 国际公布日  
2008 年 7 月 3 日 (03.07.2008)

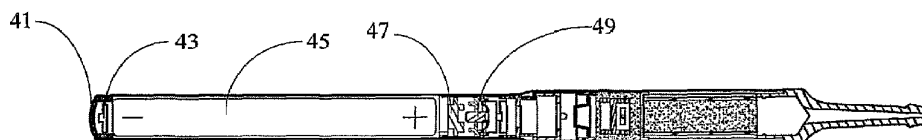
(10) 国际公布号  
WO 2008/077271 A1

- (51) 国际专利分类号:  
A24F 47/00 (2006.01) A61M 15/06 (2006.01)
- (21) 国际申请号: PCT/CN2006/003562
- (22) 国际申请日: 2006 年 12 月 25 日 (25.12.2006)
- (25) 申请语言: 中文
- (26) 公布语言: 中文
- (71) 申请人及
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- (84) 指定国 (除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧洲 (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

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(54) Title: A COMPUTERIZED HEALTHY SMOKING DEVICE

(54) 发明名称: 计算机化健康吸烟装置



(57) Abstract: . A computerized healthy smoking device includes a cigarette nozzle (10), a battery (45), a pneumatic switch (49), a liquid chamber (73) and an atomizing chamber (75). In use, a user inhales the smoking device, which causes its air pressure to change, so the pneumatic switch (49) is closed and switched on. The smoking device is electrified, and the liquid which flows into the atomizing chamber (75) from the liquid chamber is atomized and dispersed through the cigarette nozzle (10). The smoking device also includes a controller having a safety time, and the liquid usage is controlled through adjusting the safety time.

(57) 摘要:

一种计算机化健康吸烟装置, 包括烟嘴(10)、电池(45)、气动开关(49)、液体室(73)以及雾化室(75)。使用时, 用户抽吸烟装置使其内部的气压发生变化, 使气动开关(49)闭合导通, 所述吸烟装置通电, 液体室内的液体进入雾化室(75)雾化后由烟嘴(10)散出。该吸烟装置还包括一控制装置, 该控制装置设置有一安全时间, 通过调节该安全时间的长短来控制上述液体的消耗量。





本国际公布：

— 包括国际检索报告。

## 第 IV 栏 摘要正文(接第 1 页第 5 项)

一种计算机化健康吸烟装置, 包括烟嘴(10)、电池(45)、气动开关(49)、液体室(73)以及雾化室(75)。使用时, 用户抽吸吸烟装置使其内部的气压发生变化, 使气动开关(49)闭合导通, 所述吸烟装置通电, 液体室内的液体进入雾化室(75)雾化后由烟嘴(10)散出。该吸烟装置还包括一控制装置, 该控制装置设置有一安全时间, 通过调节该安全时间的长短来控制上述液体的消耗量。

## 计算机化健康吸烟装置

## 技术领域

本发明涉及一种健康吸烟装置，特别是一种能控制烟液量从而达到控制吸烟量目的的计算机化健康吸烟装置。

## 背景技术

目前，吸烟有害健康已成为一般的健康常识。数据表明，每年因吸烟造成的死亡人数多达 490 万。但是，全世界现在仍有 10 亿烟民，并且这个数字还在不断扩大中。

香烟的主要有效成份是烟碱（尼古丁），吸烟时烟碱随着香烟燃烧时产生的大量焦油雾滴进入肺泡后被迅速吸收，引起类似兴奋剂的陶醉感，使吸烟者因追求快感而上瘾。因此，尽管吸烟可导致严重和呼吸系统疾病和癌症，但要吸烟者完全戒烟是一桩极其困难的事。

烟碱是小分子生物碱，在小剂量下对人体基本无害，且在血液中的半衰期极短。烟草的有害物质主要是焦油，烟草焦油是由数百种成份组成，其中的数十种是致癌物。因此，出现了许多只含烟碱而不含焦油等有害物质的香烟代用品，如“戒烟贴”、“烟碱漱口水”、“烟碱口香糖”、“烟碱饮料”等，多是采用较纯的烟碱制成。这些产品虽然没有焦油的危害，但是未能迎合吸烟者养成依旧的“抽”、“吸”等习惯，因而难以成为真正的戒烟用品或香烟的代用品。

针对上述问题，现有技术中提供了一些仿真的香烟产品，如中国专利申请第 200420031182.0 号中所述的一种雾化电子烟，其包括壳体及吸嘴，壳体的外壁上开有进气孔，壳体内依次设有电子线路板、常压腔、传感器、气液分离器、雾化器、供液瓶；其中电子线路板由电子开关电路及高频发生器组成；在传感器的一侧开有传感器气流通道，传感器内设有负压腔；雾化器与供液瓶相接触，在雾化器的内部设有雾化腔；供液瓶的一侧与壳体之间设有锁定供液瓶的挡圈，供液瓶的另一侧开有雾汽通道；进气孔、常压腔、气液分离器、雾化器、雾汽通道、导气孔、吸嘴依次相连通。该雾化电子烟可以使用户有吸烟的兴奋感觉，但无法控制烟液量从而达到控制吸烟量的目的，难以达到健康吸烟的目的。

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确 认 本

## 发明内容

本发明所要解决的技术问题在于提供一种健康吸烟装置，特别是一种能控制烟液量从而达到控制吸烟量目的的计算机化健康吸烟装置。

为解决上述技术问题，本发明所采用的技术方案是：一种计算机化健康吸烟装置，该计算机化健康吸烟装置包括烟嘴、电池、气动开关、液体室以及雾化室，用户通过烟嘴抽吸该计算机化健康吸烟装置，聚合物锂电池用于为该计算机化健康吸烟装置供电，气动开关其在气压作用下使所述计算机化健康吸烟装置通电，该液体室内存储有待雾化液体，雾化室用于对待雾化液体进行雾化。使用时，用户抽吸计算机化健康吸烟装置使其内部的气压发生变化，使气动开关闭合导通，计算机化健康吸烟装置通电，液体室内的液体进入雾化室雾化后由烟嘴散出。该计算机化健康吸烟装置还包括一控制装置，该控制装置设置有一安全时间，通过调节该安全时间的长短来控制上述液体的消耗量。

由于本发明的计算机化健康吸烟装置内充入的是 0.2% - 3.8% 烟碱溶液，充分雾化后产生大量的雾气类似烟雾，在吸烟过程中并不产生焦油等有害物质，不会对人体产生危害，并且还在此基础上通过计算机化微控制芯片的控制，进一步控制了吸烟量，因此真正达到了健康吸烟的目的。

## 附图说明

图 1 是本发明计算机化健康吸烟装置的外观示意图。

图 2 是本发明计算机化健康吸烟装置的内部结构示意图。

图 3 是本发明计算机化健康吸烟装置的雾化室的结构示意图。

图 4 是本发明计算机化健康吸烟装置的导液机构与液体室、雾化室的连接结构示意图。

图 5 是本发明计算机化健康吸烟装置的药液雾化过程示意图。

图 6 是本发明计算机化健康吸烟装置的微控制芯片示意图。

## 具体实施方式

下面结合附图对本发明作进一步的描述。

请一并参阅图 1 与图 2，本发明的计算机化健康吸烟装置包括烟嘴 10、烟杆 40、烟仓 70 三个部分。烟嘴 10 内设有气流通道，其外部套设软硅胶，外形采用流线型设计，以保

证该计算机化健康吸烟装置具有较好的口感，安全无毒。烟嘴 10 的材料选用仿真普通通过滤嘴香烟型，其烟嘴外套增加烟草香味或其他特殊味道，能让吸烟者更加具有吸烟的感觉。在烟杆 40 顶部设有透明的仿形烟头 41，该仿形烟头 41 上开设有一隐蔽的通气孔。

烟杆 40 内部主要包括指示灯 43、电池 45、微控制芯片 47 以及气动开关 49。该电池 43 为聚合物锂电池或防爆锂电池，该指示灯 43 设置于仿形烟头 41 下方，其为一发光二极管，当计算机化健康吸烟装置通电后进入使用状态，指示灯 43 会缓慢点亮，灯光透过仿形烟头以模拟香烟点燃的火光。微控制芯片 45 用于根据用户抽吸的频率来控制烟液量，从而达到控制吸烟量的目的。该气动开关 49 采用镀金或镀银处理，其导电性能良好。在气动开关 49 内设有一薄膜，该薄膜将烟杆 40 与烟仓 70 分成两个相对独立的腔室。

请参阅图 3 至图 5，该烟仓 70 内部主要包括发热部件 71、液体室 73、雾化室 75 和导液机构 79。液体室 73 用于存储待雾化的烟碱溶液，其内设置有多孔体 731，烟碱溶液存储于多孔体 731 内。在本实施例中，多孔体 731 可由聚丙烯纤维、涤纶纤维或尼龙纤维充填。

该雾化室 75 包括外层的油嘴支架 751 和内部的油嘴座 753。发热部件 71 固定在雾化室 75 内，其为用铂丝、镍铬合金或含有稀土元素的铁铬铝合金制成的丝状体或片状体。在雾化室 75 的外侧固定有陶瓷雾化片 81（超声波振荡片）。在油嘴座 753 上开设有喷射孔 755，该喷射孔 755 连通雾化室 75 内外。此外，油嘴支架 751 上也开有通气孔。

导液机构 79 为多层泡沫镍网，也可以采用不锈钢纤维毡、高分子多聚物发泡体及泡沫陶瓷制成，其外周设有密封圈。该导液机构 79 包裹在油嘴支架 751 和油嘴座 753 的外面，凸起端与液体室 73 中的多孔体 731 接触。导液机构 79 通过毛细浸润将烟液导至雾化室 75 进行雾化，在发热部件 71 的作用下进一步雾化。雾化后的大直径微滴在涡流的作用下附壁，经雾化室 75 上的溢流孔被导液机构 79 重吸收；小直径微滴悬浮在气流中形成气溶胶，经雾气通道再由烟嘴 10 吸出。烟液的雾化过程如图 5 所示。

本发明计算机化健康吸烟装置的工作过程如下：当用户抽吸时，气流经过发热部件 71、雾化室 75，最后由烟嘴 10 吸出。在用户抽吸时，烟仓 70 侧的气流流向烟嘴 10，从而使烟杆 40 独立腔室的气压低于正常大气压。这样在烟杆 40 一侧负气压的作用下，气动开关 49 闭合导通电流。

以下参阅图 6 来说明微控制芯片 45 对烟液用量的控制作用：当用户吸气时，气动开关 49 闭合，使微处理器 IC3 的 7 脚电位被拉低，微处理器 IC3 进入工作状态。此后微处

理器 IC3 的 8 脚向 Q2 输送触发信号使 Q2 导通工作, Q2 工作后随即拉动雾化头工作使烟液雾化, 同时微处理器 IC3 的第 1 脚同时发出脉宽调制信号触发指示灯 43 点亮工作。当用户停止抽吸后, 气动开关 49 断开, 微处理器 IC3 停止工作, 进入睡眠状态。发热部件 71 经过一段时间 T 后停止发热, 在本实施方式中, 该时间 T 设定为 7.5 秒。此后发热部件 71 进入睡眠状态, 由此即可有效控制烟液量从而达到控制吸烟量的目的。同时, 也可根据上述时间 T 来控制指示灯 43 延时熄灭, 以进一步增加计算机化健康吸烟装置的拟真性。

此外, 该微处理器 IC3 具有记数锁存功能和低电压提示功能, 当开关动作到 1500 次时微处理器会发出清洗指令, 让雾化头自动清洗 8 秒钟; 当电池电压过低时, 指示灯会连续闪烁 20 秒钟提示电压过低, 以提醒用户充电。

### 工业应用性

由于在液体室 73 内充入的是 0.2%—3.8% 的医药级模拟烟碱溶液, 充分雾化后产生大量的雾气类似烟雾, 但在吸烟过程中不产生焦油等有害物质, 不会对人体产生危害。而本发明的计算机化健康吸烟装置还可在此基础进一步控制烟液量从而达到控制吸烟量的目的, 因此真正达到了健康吸烟的目的。本发明的计算机化健康吸烟装置也可以通过改变液体室 73 的结构来装入常规药物, 作为肺内给药装置使用。

## 权利要求

- 1、一种计算机化健康吸烟装置，所述计算机化健康吸烟装置包括：  
烟嘴，用户通过所述烟嘴抽吸所述计算机化健康吸烟装置；  
电池，用于为所述计算机化健康吸烟装置供电；  
气动开关，其在气压作用下使所述计算机化健康吸烟装置通电；  
液体室，其内存储有待雾化液体；  
雾化室，用于对所述液体进行雾化；  
使用时，用户抽吸所述计算机化健康吸烟装置使其内部的气压发生变化，使气动开关闭合导通，所述计算机化健康吸烟装置通电，所述液体室内的液体进入所述雾化室雾化后由所述烟嘴散出；  
其特征在於，所述计算机化健康吸烟装置还包括一控制装置，所述控制装置设置有一安全时间，通过调节所述安全时间的长短来控制所述液体的消耗量。
- 2、如权利要求 1 所述的计算机化健康吸烟装置，其特征在於，所述控制装置为一微控制芯片，其在所述安全时间内控制所述雾化室工作。
- 3、如权利要求 2 所述的计算机化健康吸烟装置，其特征在於，所述微控制芯片包括一微处理器，所述微处理器具有记数锁存功能，其在开关动作到一定次数时发出清洗指令，让所述雾化头自动清洗。
- 4、如权利要求 3 所述的计算机化健康吸烟装置，其特征在於，所述微处理器在开关动作到 1500 次时发出清洗指令。
- 5、如权利要求 3 所述的计算机化健康吸烟装置，其特征在於，所述雾化头自动清洗 8 秒钟。
- 6、如权利要求 3 所述的计算机化健康吸烟装置，其特征在於，所述微处理器具有低电压提示功能，当电池电压过低时，指示灯会连续闪烁以提醒用户充电。
- 7、如权利要求 6 所述的计算机化健康吸烟装置，其特征在於，所述指示灯连续闪烁 8 秒钟。
- 8、如权利要求 1 所述的计算机化健康吸烟装置，其特征在於，所述计算机化健康吸烟装置还包括一发光元件，所述元件为红色或橙色发光二极管，其在电路接通时点亮，以

仿真真正的吸烟过程。

9、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述烟嘴呈流线型，其外部套设有软性硅胶。

10、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述烟嘴材料选用仿真普通过滤嘴香烟型，其烟嘴外套增加烟草香味或其他特殊味道。

11、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述雾化室进一步包括一加热元件。

12、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述计算机化健康吸烟装置还包括一导液机构，所述导液机构一端与所述液体室接触。

13、如权利要求 1 所述的液体室具有的设计结构能够充分储液及快速放液。

14、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述电池为聚合物锂电池。

15、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述电池为防爆锂电池。

16、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述气动开关元件采用镀金或镀银处理。

17、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述待雾化液体为模拟烟碱溶液。

18、如权利要求 17 所述的计算机化健康吸烟装置，其特征在于，所述模拟烟碱溶液为 0.2%—3.8%的医药级模拟烟碱溶液。

19、如权利要求 1 所述的计算机化健康吸烟装置，其特征在于，所述待雾化液体为含有某种特定成分药液，用户需要时采用所述装置用于呼吸道系统给药或辅助治疗。



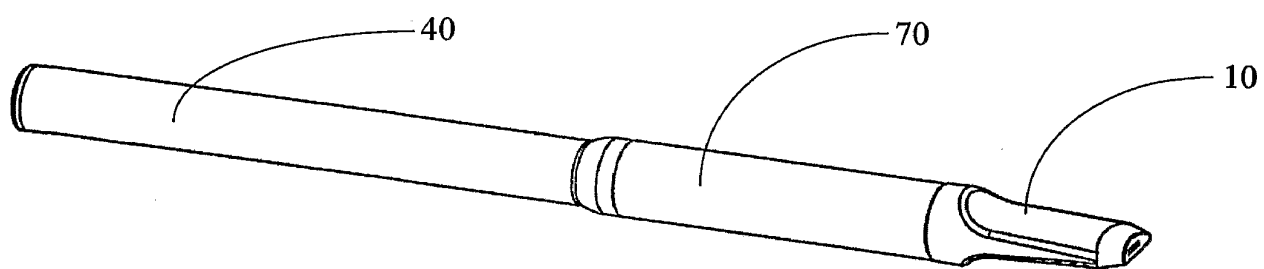


图 1

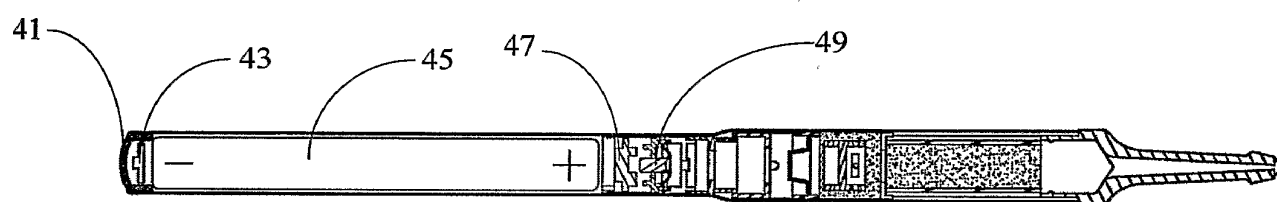


图 2

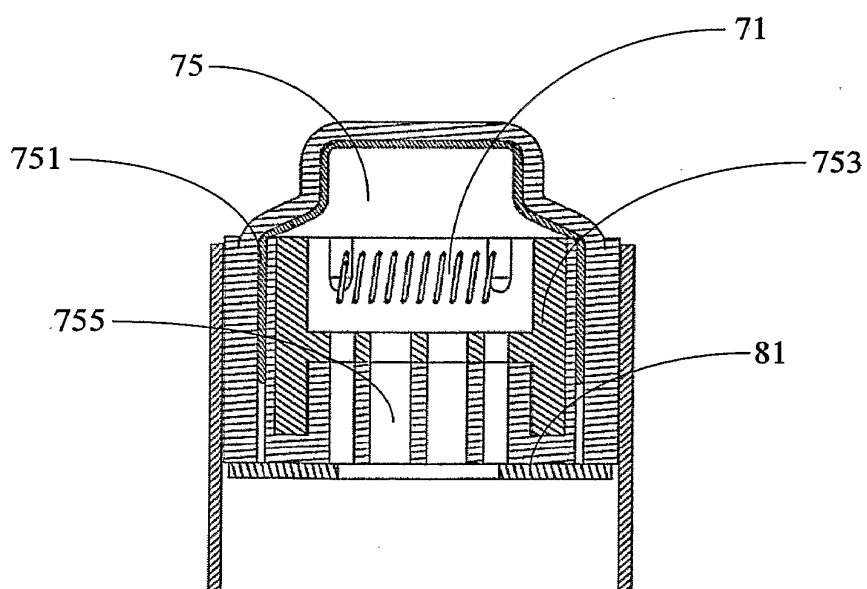


图 3

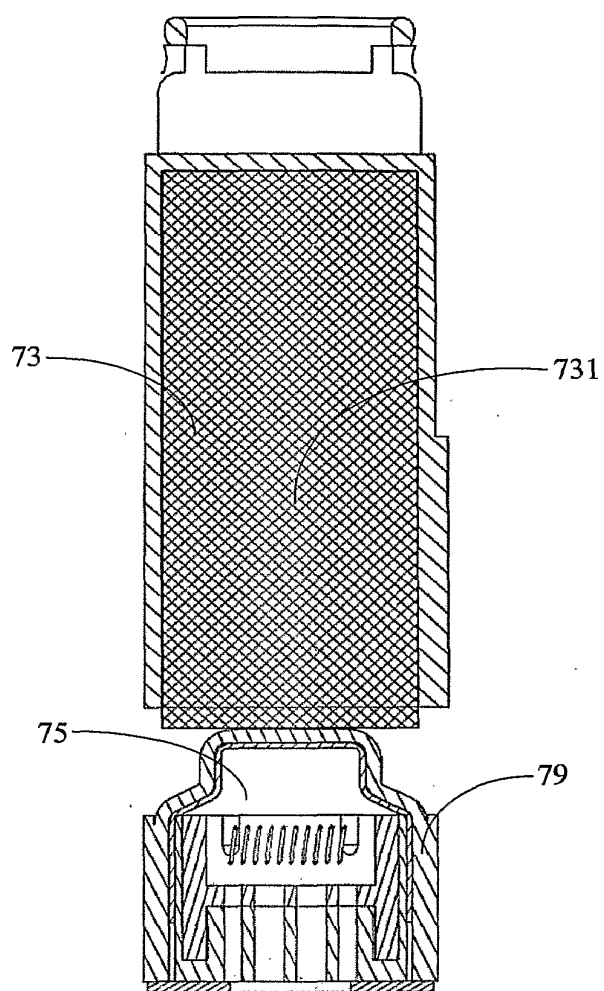


图 4

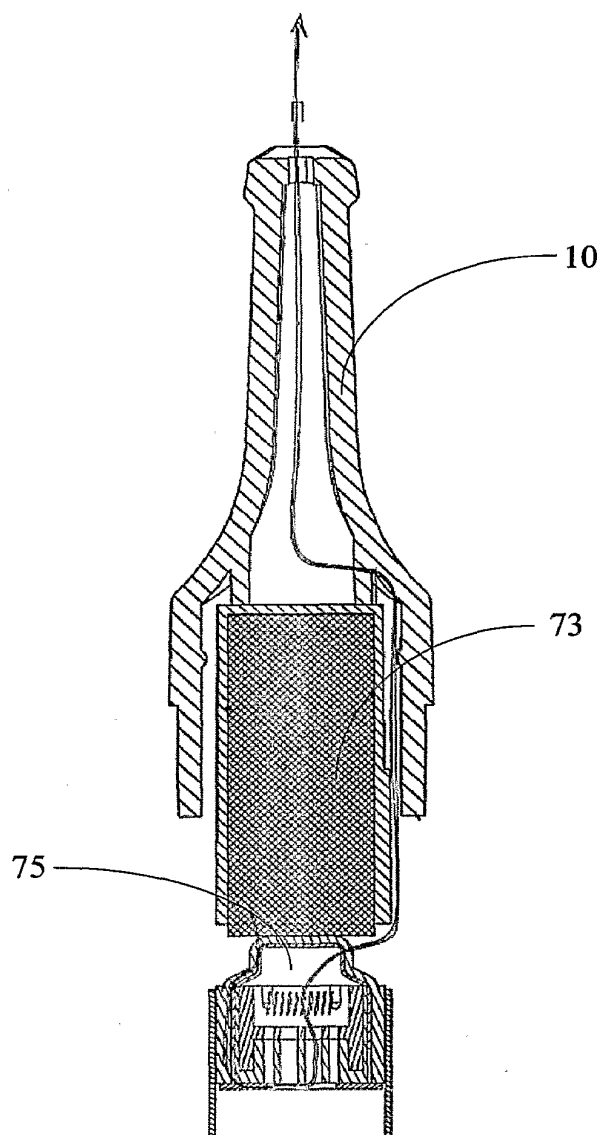


图 5

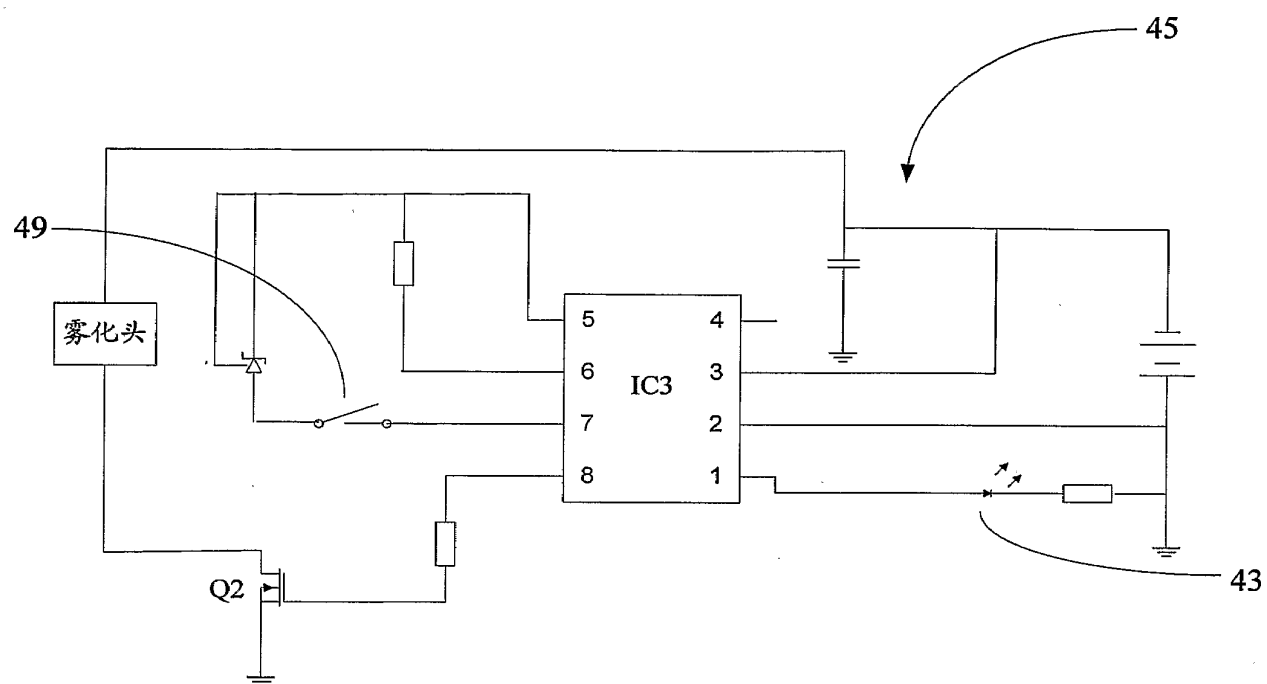


图 6

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2006/003562

## A. CLASSIFICATION OF SUBJECT MATTER

see extra sheet

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A24F,A61M

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)

WPI&EPODOC&PAJ Chinese patent (1985~) atomi+, aerosol, vapor+

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                   | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | CN2719043Y(HAN Li)24 Aug.2005 (24.08.2005)<br>page 6, paragraph 5,6<br>page 7, first and last paragraph; page 5, paragraph 5; page 8, last paragraph | 1-19                  |
| Y         | CN1127983A(VOGES INNOVATION PTY LTD)31 Jul.1996 (31.07.1996)<br>page10, paragraph 3                                                                  | 1-19                  |
| A         | CN1541577A(HAN Li)03 Nov.2004 (03.11.2004) the whole document                                                                                        | 1-19                  |

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

☒ 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  
27 Aug.2007(27.08.2007)

Date of mailing of the international search report

18 · OCT 2007 (18 · 10 · 2007)

Name and mailing address of the ISA/CN  
The State Intellectual Property Office, the P.R.China  
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Facsimile No. 86-10-62019451

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2006/003562

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

A24F47/00(2006.01)i

A61M15/06(2006.01)i

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/CN2006/003562

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                               |                       |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages            | Relevant to claim No. |
| A                                                     | US4945929A (BRITISH-AMERICAN TOBACCO CO., LTD.)<br>07 Aug.1990(07.08.1990) the whole document | 1-19                  |
| A                                                     | CN1575673A(SEIKO EPSON COR) 09 Feb.2005(09.02.2005) the whole document                        | 1-19                  |

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

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

International application No.

PCT/CN2006/003562

| Patent Documents referred<br>in the Report | Publication Date | Patent Family | Publication Date |
|--------------------------------------------|------------------|---------------|------------------|
| CN2719043Y                                 | 24 Aug.2005      | AU2005232354A | 27 Oct.2005      |
|                                            |                  | WO2005099494A | 27 Oct.2005      |
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|                                            |                  | EP1736065A    | 27 Oct.2006      |
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|                                            |                  | CA2165961A    | 12 Jan.1995      |
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|                                            |                  | JP8511966T    | 17 Dec.1996      |
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|                                            |                  | DK706352T     | 15 Jul.2002      |
|                                            |                  | PT706352T     | 31 Jul.2002      |
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|                                            |                  | RU2005115958A | 10 Nov.2005      |
|                                            |                  | EP1618803A    | 25 Jan.2006      |
|                                            |                  | BRPI0407944A  | 07 Mar.2006      |
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|                                            |                  | US2006196518A | 07 Sep.2006      |
|                                            |                  | JP2006524494T | 02 Nov.2006      |

Form PCT/ISA/210 (patent family annex) (April 2007)



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

International application No.

PCT/CN2006/003562

| Patent Documents referred<br>in the Report | Publication Date | Patent Family  | Publication Date |
|--------------------------------------------|------------------|----------------|------------------|
| US4945929A                                 | 07 Aug.1990      | GB2191718A     | 23 Dec.1987      |
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Form PCT/ISA/210 (patent family annex) (April 2007)

## 国际检索报告

国际申请号

PCT/CN2006/003562

## A. 主题的分类

参见附加页

按照国际专利分类表(IPC)或者同时按照国家分类和 IPC 两种分类

## B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC:A24F,A61M

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用))

WPI&amp;EPODOC&amp;PAJ 中国专利文献(1985~) 雾化, atomi+, aerosol, vapor+

## C. 相关文件

| 类 型* | 引用文件, 必要时, 指明相关段落                                                                     | 相关的权利要求 |
|------|---------------------------------------------------------------------------------------|---------|
| Y    | CN2719043Y(韩力)24.8 月 2005 (24.08.2005)<br>说明书第六页第五、七段, 第七页第一、最后一段,<br>第五页第五段, 第八页最后一段 | 1-19    |
| Y    | CN1127983A(沃盖斯新技术有限公司)31.7 月 1996 (31.07.1996)<br>说明书第十页第三段, 第九页第四段                   | 1-19    |
| A    | CN1541577A(韩力)03.11 月 2004 (03.11.2004) 全文                                            | 1-19    |
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| A    | CN1575673A(精工爱普生株式会社)09.2 月 2005 (09.02.2005) 全文                                      | 1-19    |

☐ 其余文件在 C 栏的续页中列出。☒ 见同族专利附件。

\* 引用文件的具体类型:

“A” 认为不特别相关的表示了现有技术一般状态的文件

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“L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇  
引用文件的公布日而引用的或者因其他特殊理由而引  
用的文件

“O” 涉及口头公开、使用、展览或其他方式公开的文件

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结合并且这种结合对于本领域技术人员为显而易见时,  
要求保护的发明不具有创造性

“&amp;” 同族专利的文件

国际检索实际完成的日期

27.8 月 2007 (27.08.2007)

国际检索报告邮寄日期

18.10月 2007 (10.18.2007)

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传真号: (86-10)62019451

受权官员

孙春梅

电话号码: (86-10) 62085751

按照国际专利分类表(IPC)或者同时按照国家分类和 IPC 两种分类:

A24F47/00(2006.01)i

A61M15/06(2006.01)i

国际检索报告  
关于同族专利的信息

国际申请号  
PCT/CN2006/003562

| 检索报告中引用的<br>专利文件 | 公布日期         | 同族专利           | 公布日期         |
|------------------|--------------|----------------|--------------|
| CN2719043Y       | 24.8 月 2005  | AU2005232354A  | 27.10 月 2005 |
|                  |              | WO2005099494A  | 27.10 月 2005 |
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|                  |              | EP1736065A     | 27.10 月 2006 |
|                  |              | CN1942114A     | 04.4 月 2007  |
|                  |              | BRPI0506780A   | 22.5 月 2007  |
|                  |              | CA2165961A     | 12.1 月 1995  |
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|                  |              | AU7063294A     | 24.1 月 1995  |
|                  |              | EP0706352A     | 17.4 月 1996  |
| CN1127983A       | 31.7 月 1996  | BR9406968A     | 06.8 月 1996  |
|                  |              | JP8511966T     | 17.12 月 1996 |
|                  |              | AU677081B      | 10.4 月 1997  |
|                  |              | US5894841A     | 20.4 月 1999  |
|                  |              | AT214575T      | 15.4 月 2002  |
|                  |              | DE69430196D    | 25.4 月 2002  |
|                  |              | DK706352T      | 15.7 月 2002  |
|                  |              | PT706352T      | 31.7 月 2002  |
|                  |              | ES2171455T3    | 16.9 月 2002  |
|                  |              | DE69430196T    | 31.10 月 2002 |
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|                  |              | CA2518174A     | 11.11 月 2004 |
|                  |              | WO2004095955A  | 11.11 月 2004 |
|                  |              | AU2004234199A  | 11.11 月 2004 |
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|                  |              | EP1618803A     | 25.1 月 2006  |
|                  |              | BRPI0407944A   | 07.3 月 2006  |
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|                  |              | CN1284493C     | 15.11 月 2006 |

PCT/ISA/210 表(同族专利附件) (2007 年 4 月)



(51) International Patent Classification:  
*F22B 1/28* (2006.01)  
(21) International Application Number:  
PCT/IB2012/052044

(22) International Filing Date:  
23 April 2012 (23.04.2012)

(25) Filing Language: English  
(26) Publication Language: English

(30) Priority Data:  
13/044,355 9 March 2011 (09.03.2011) US  
61/478,460 22 April 2011 (22.04.2011) US

(71) Applicant (for all designated States except US): **CHONG CORPORATION** [—/US]; 5550 Nicollet Avenue, Minneapolis, Minnesota 55419 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GOODMAN, Jack** [US/US]; 3228 Cottontail Drive, Ann Arbor, Michigan 48105 (US). **O'NEILL, William** [US/US]; 16866 79th Place N, Maple Grove, Minnesota 55311 (US). **CHONG, Alexander ChinHak** [US/US]; 2744 Raleigh Ave., St. Louis Park, Minnesota 55416 (US). **BARTKOWSKI, William P.** [US/US]; 5223 Malibu Drive, Edina, Minnesota 55436 (US). **KOVACH, Peter Joseph** [US/US]; 211 Rice Creek Terrace NE, Fridley, Minnesota 55432

(US). **LINDE, Larry Gawain** [US/US]; 17595 Partridge Street NW, Andover, Minnesota 55304 (US). **BERG, Randy Eugene** [US/US]; 1631 99th Ave. Northwest, Coon Rapids, Minnesota 55433 (US).

(74) Agent: **VEREGGE, Peter S.**; Cislo & Thomas LLP, 1333 2nd Street, Suite No. 500, Santa Monica, California 90401 (US).

(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, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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,

[Continued on next page]

(54) Title: MEDICANT DELIVERY SYSTEM

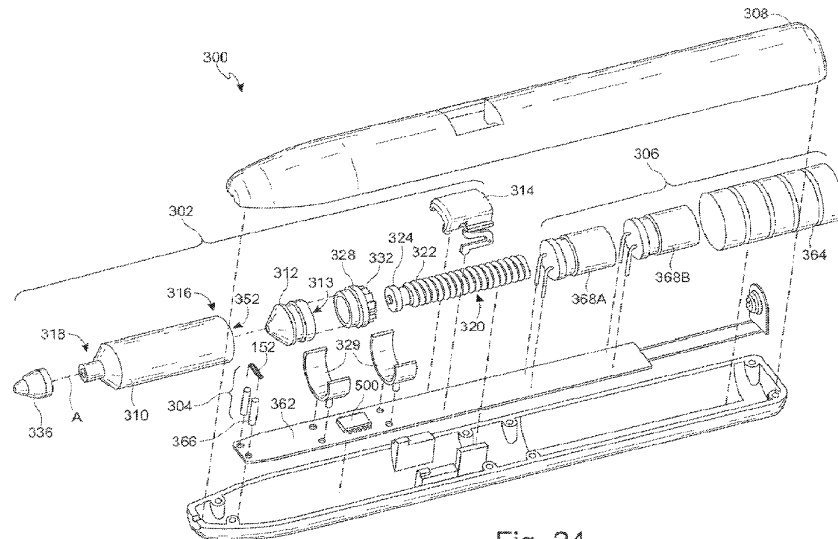


Fig. 24

(57) Abstract: An improved medicant delivery system 100 is disclosed wherein the carrier for the medicant is a fluid that can be atomized or vaporized by exposure to heat. The system provides for repeatable dose of medicant, can be stored in any orientation, and/or has an ability to maximize energy efficiency.



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

— *the filing date of the international application is within two months from the date of expiration of the priority period (Rule 26bis.3)*

**Published:**

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

## MEDICANT DELIVERY SYSTEM

## TECHNICAL FIELD

**[0001]** This invention relates to devices and methods for vaporizing a liquid for inhalation. More specifically, the invention relates to providing a device and method for controlling, metering and measuring precise volumes of fluid vaporized and the vapor produced by a hand-held vaporizing device each time the device is engaged by its user that is reliable and safer to use than current devices relying on lithium ion chemistry.

## BACKGROUND

**[0002]** Various hand-held, personal vaporizing devices are currently available. Some of these have been specifically designed to produce a nicotine-infused vapor for the purpose of serving, as an alternative to smoking, a traditional tobacco cigarette wherein the tobacco is ignited and the user inhales the smoke and its constituents- including the nicotine-a naturally occurring constituent of tobacco. Devices used for the purpose of cigarette alternatives produce a vapor devoid of most of the 4000+ chemicals and byproducts of tobacco smoke and, therefore, deliver nicotine to the user, through ingestion of the vapor, without most of the harm normally associated with tobacco smoke.

**[0003]** Unfortunately, disadvantages still remain in the design and performance of these vaporizing devices. For example, some devices are bulky or cumbersome to use as a transportable, hand-held device.

**[0004]** Other vaporizing devices are incapable of delivering precise, consistent, and reliable metered doses of the medicant. Current electronic atomization cigarettes do not provide for a method to control the consistency of the volume of liquid vaporized nor the

volume of vapor produced and, as a result, cannot produce a measurable amount of nicotine on a per vaporization basis. There are certain circumstances and situations, including those where regulations might dictate, where it may well be required that these devices be capable of delivering vapor and its nicotine constituent in a manner that enables the amount of nicotine present in the vapor be measurable and consistently repeated with each and every engagement by the user. In addition to or in lieu of nicotine, a vaporizer might be used to deliver other substances to the user, including medicants. Similarly, a precise measured “dose” may be desired, or even required for these substances.

**[0005]** In addition, because some of the devices on the market use a liquid storage unit that is “open” to the atmosphere, some devices leak or fail to perform reliably unless the vaporizing device is maintained in an upright position during use, or during the packaging, shipping, and storage of the device. Furthermore, with such devices, the liquid may be subject to contamination, adulteration and/or evaporation under certain conditions.

**[0006]** Finally, most, if not all, current commercially available products use lithium chemistry batteries as their power source. This is primarily due to three factors: 1) the useful life of the battery; 2) the power needed to vaporize the fluid; and, 3) the requirement for a small compact device roughly the size of traditional tobacco products- i.e. cigarettes and cigars, or in non-tobacco or nicotine formulations, the need for compactness in order to be discretely employed by the user in circumstances where discretion is appropriate. Lithium chemistry batteries, however, are volatile, hazardous (both in that they can release noxious vapors as well as potential for explosion under certain conditions) and environmentally challenging with respect to storage, reliability, and disposability.

**[0007]** It is anticipated that the lithium chemistry power source of hand-held portable devices will become an issue for U.S. regulators, distributors, retailers, and



consumers as the current product gets more widely distributed and used and as more uses for the devices are identified, manufactured, distributed, sold and consumed.

**[0008]** Therefore, there is still a need for a device and method for providing an improved hand-held vapor delivery system that reliably and consistently produces a repeatable metered dose of a medicant in a safe, efficient, and effective manner.

## SUMMARY

**[0009]** In one aspect, a method and device for improving hand-held vapor delivery devices to generate reliable, consistent, repeatable metered doses of a medicament or medicant comprises a power control system utilizing an integrated circuit capable of determining and delivering the precise amount of power for the precise duration of time that is just enough to completely vaporize a predetermined volume of a liquid.

**[0010]** In another aspect, the method and device for an improved hand-held vapor delivery device may comprise a fluid delivery system, a vaporizing or atomizing system, and a power control system contained in a housing, wherein the fluid delivery system consistently, repeatably, and reliably delivers a precise metered dose to the atomizing system, and the power delivery system supplies just enough electrical power to the atomizing system to completely atomize or vaporize the exact volume of liquid delivered to the atomizing system.

**[0011]** In another aspect, the hand-held vapor delivery device has an ability to operate independent of orientation, and/or an ability to deliver a repeatable dose of medicant, and/or an ability to be stored in any orientation, and/or an ability to maximize energy efficiency.

**[0012]** In another aspect, the invention provides a device and method that enables vapor

delivery devices to use more stable, more reliable, less environmentally hazardous, and safer sources of battery chemistry without significantly affecting the portability and discreteness of the devices.

#### BRIEF DESCRIPTION OF DRAWINGS

[0013] Figure 1 is a perspective view of an embodiment of a medicant delivery device of the present invention.

[0014] Figure 2 is a top view of the device shown in Figure 1.

[0015] Figure 3 is a section view taken along line 3-3 of Figure 2.

[0016] Figure 4 is an enlarged detail section view of the upper section of the device shown in Figure 3.

[0017] Figure 5 is an exploded perspective view of the device shown in Figures 1-4.

[0018] Figure 6 is an enlarge perspective view of elements of the device shown in Figures 3-5.

[0019] Figure 7 is a perspective view of another embodiment of the present invention with the housing removed for purpose of illustration.

[0020] Figure 8 is an exploded perspective view of the embodiment shown in Figure 7.

[0021] Figure 9 is an enlarged side view showing details of elements shown in Figures 7 and 8.

[0022] Figures 10-13 are side views of the device shown in Figures 7-9 illustrating sequential steps of operation.

[0023] Figure 14 is an enlarged perspective view of the vaporizing system shown in Figures 7-9.

**[0024]** Figure 15 is a schematic diagram of a “one-shot” circuit that may be used in an embodiment of the power control system of the present invention.

**[0025]** Figure 16 and Figure 17 are schematic diagrams of similar modified circuits that may be used in an embodiment of the power control system.

**[0026]** Figure 18 is an enlarged side view of an embodiment of a vaporizing element.

**[0027]** Figure 19 is a perspective view of another embodiment of the vaporizing device.

**[0028]** Figure 20 is a section view of the vaporizing device shown in Figure 19.

**[0029]** Figure 21 is an exploded perspective view of the vaporizing device shown in Figures 19 and 20.

**[0030]** Figure 22 is an enlarged perspective view of elements shown in Figure 20.

**[0031]** Figure 23 is an isometric view of another embodiment of the medicant delivery device.

**[0032]** Figure 24 is an exploded view of the device shown in Figure 23.

**[0033]** Figure 25 is close-up isometric view of an embodiment of a fluid delivery system shown in Figure 24.

**[0034]** Figure 26 is a section view through line 26-26 of the fluid delivery system shown in Figure 25.

**[0035]** Figure 27 is a close-up isometric view of an embodiment of a plunger of the fluid delivery system shown in Figure 28.

**[0036]** Figure 28 is a close-up isometric view of an embodiment of a drive nut of the fluid delivery system shown in Figure 24.

**[0037]** Figure 29 is a close-up isometric view of an embodiment of the outlet cap and vaporizing system of the medicant delivery device shown in Figure 24.

[0038] Figure 30 is a close-up isometric view of an embodiment of a fluid discharge actuator of the medicant delivery device shown in Figure 24.

[0039] Figure 31A is a close-up isometric view of a proximal end of the fluid delivery system of the medicant delivery device shown in Figure 24.

[0040] Figure 31B is the medicant delivery device shown in Figure 31A with the bottom depressed.

[0041] Figure 32 is an isometric view of an embodiment of an anti-rotation feature of the fluid delivery system shown in Figure 24.

[0042] Figure 33 is an isometric view of another embodiment of the delivery device.

[0043] Figure 34 is an isometric view of the delivery device shown in Figure 33 with the housing removed.

[0044] Figure 35 is a close up view of the top of the delivery device shown in Figure 33 showing the vaporization system.

[0045] Figure 36 is a block diagram of an embodiment of the power control system.

#### DETAILED DESCRIPTION OF THE INVENTION

[0046] The detailed description set forth below in connection with the appended drawings is intended as a description of presently-preferred embodiments of the invention and is not intended to represent the only forms in which the present invention may be constructed or utilized. The description sets forth the functions and the sequence of steps for constructing and operating the invention in connection with the illustrated embodiments. It is to be understood, however, that the same or equivalent functions and sequences may be accomplished by different embodiments that are also intended to be encompassed within the spirit and scope of the invention.

**[0047]** To improve the ability to meter a precise dose of a medicant in vapor form for inhalation from a vapor delivery device, the vapor delivery device requires either a power control system that can control the amount and duration of heat applied to a liquid form of the medicant, or a fluid delivery system that can accurately, consistently, and repeatably discharge a precise volume of a medicant. These two methods: (a) controlling the amount of heat applied to the liquid, and (b) controlling the volume of liquid to be vaporized, can be used alone or in combination to improve the accuracy of the medicant “dose” provided by the vaporizer. As used in the claims, the term “medicant” means a medicament, medication, medicine, pharmaceutical, drug, and the like used for healing, treating, altering, improving, restoring, relieving, and/or curing a particular condition, disease, or mental or physical state, which includes the active ingredient or combination of active ingredients and inactive ingredients infused into an expedient or dissolved in some other carrier.

**[0048]** The amount and duration of the heat applied correlates with the amount of power supplied to the vapor delivery device. Therefore, in order to improve the functionality of current vapor delivery devices, the current devices must be implemented with a power control system that comprises a means for providing a precise amount of power from a power source to heat a heating element to a minimum required temperature that completely vaporizes a predetermined volume of a liquid. Based on the properties of a medicant, in particular, the expedient or carrier, the minimum required temperature to completely vaporize a predetermined volume can be calculated. By knowing the minimum temperature required to vaporize a predetermined volume of a medicant, energy resources can be conserved by not using more energy than is necessary, which is one of the problems with current devices.

**[0049]** The means for providing a precise amount of power from a power source to heat a heating element to a minimum required temperature to completely vaporize a predetermined volume of a liquid comprises a control circuit or integrated circuit **82** having a processor **500** that controls the power sent to a heating element **152** to ensure that only the necessary amount of power is provided to vaporize the specific volume discharged. Since the amount of power supplied to a heating element **152** correlates with the resistance through the heating element, the processor **500** may be programmed to monitor the resistance of the heating element **152** as a proxy for the amount of power being supplied to the heating element **152**. Knowing the resistance, the processor **500** can govern the amount of power to supply to the heating element **152**. Measuring the resistance at the heating element has several advantages. First, power may be accurately measured and maintained. Second, it measures the resultant voltage from the circuit, rather than measuring it from the battery, which conserves battery life. Third, it insures that vaporization remains constant, allowing for measured dosages irrespective of the life cycle of the battery and degradation of the heating element.

**[0050]** In some embodiments, the means for providing a precise amount of power may also comprise a boost converter that is a switched DC/DC converter, in conjunction with supercapacitors **368a**, **368b**. The boost converter uses a charge converter that functions with an H bridge and inductor/capacitor system. By using the boost converter the charge current is limited to preserve the batteries and a much higher discharge current from the supercap is allowed, but for a shorter duration. By way of example only, it make take 3-5 seconds to charge but only 0.5 second to discharge. Thus, the battery may only see 100-200mA load, but the capacitor might see 1A or more. By utilizing this system, alkaline batteries **364** can be used, thereby improving the safety of this device.

[0051] A supercapacitor (“supercap”) **368a, 368b** is an electrochemical capacitor with relatively high energy density. Its energy density is typically hundreds of times greater than conventional electrolytic capacitors. A supercap **368a, 368b** can store up to two orders of magnitude the capacitance a standard electrolytic capacitor can maintain.

[0052] The described invention circuitry charges a supercap **368a, 368b** from a set of alkaline batteries **364** using a DC/DC boost converter. When charging a supercap **368a, 368b**, numerous parameters must be taken into consideration. For illustrative purposes, a 300 farad capacitor bank that is to be charged to 6V DC, using a 6V power source (4 - 1.5V AA batteries) capable of sourcing 1.2A MAX current could be used. Note that a resistor can be used in this circuit to limit the current to a maximum amperage – e.g. 1A, etc., as an additional control of the heating circuit.

[0053] To define how the invention charging circuitry works, the Ohm’s law equation is used - Charge resistor value =  $6V / 1A = 6 \text{ Ohms}$ . This is determined using Ohm's law:  $R=E/I$ , where R is the resistance in ohms, E is the energy in volts, and I is the current in amps.

[0054] To determine what it takes to charge the capacitor bank, ‘Power’ is utilized, which electrically is described as ‘Wattage’. This Power equation is described as:

[0055] Resistor Power =  $6V \times 1A = 6W$  (Power = Voltage x Current)

[0056] Thus, in order to charge a 6V capacitor bank at 1A with a 6V power supply (4 AA/AAA batteries), a 6 Ohm resistor with a wattage rating of 6W or higher is needed. In certain designs, fewer batteries, such as one, two, or three, can be used to supply sufficient power.

[0057] Using this approach, this invention solves the standard problem of battery life issues that current electronic cigarettes (e-cigarettes) have. Additionally, this approach

provides the ability to maintain sufficient power to vaporize the liquid using standard alkaline chemistry batteries, which current e-cigarette devices are incapable of utilizing.

[0058] Figure 37 shows a block diagram of the process. There is an energy or power source **600** that supplies the input power. This source can be one of several types but in general fits in two types. Type 1 may be a low power source not capable of the higher current to function directly. This type of power source requires additional conditioning to support full function, thus requires a power conversion stage **602** and a power storage stage **608**. Type 2 may be a high current source that allows a direct drive of the vaporization element.

[0059] State or control logic **604**, which may be dedicated logic or a processor, supplies the control, measurement and drive functions. One embodiment may use a Texas Instrument MSP430 processor, but this could be any processor or ASIC-like device. GPIO and A/D functions may also be used to allow the measurement of either the current flow (direct drive) or voltage in the power storage (supercap). When all conditions are met, the control logic **604** activates the discharge switch **610** to heat the vaporization element **612**.

[0060] The ability to accurately measure and meter the power that energizes the vaporization element **612** allows the accurate metering of the vapor phase transition and dosage amounts. In the direct drive system the current and time of drive are used to compute and meter the energy that is used to heat the vaporization element **612**. In the stored energy system the formula  $\frac{1}{2}CV^2$  is used to compute the energy in the system and the desired end voltage to meter the energy used to heat the vaporization element **612**, where C is the capacitance and V is the voltage.

[0061] An alternative to controlling the amount power would be to control the amount of time the heating element is energized as the power source begins to dissipate. The



processor **500** can be configured to monitor the resistance and adjust the time the heating element remains on so as to completely vaporize a given volume of medicant.

[0062] In some embodiments, a flow switch **614** may be used to signal the requested start of a vaporization phase. When implemented into a vaporization device, the device may have a fluid delivery system (discussed below). The fluid delivery system deposits a required amount of fluid on the vaporization element **612** prior to activation of the flow switch **614**.

[0063] In some embodiments, a fluid discharge activator **616** may be used to “wake up” the processor **604** and charge **606** the supercap **608** (in the stored energy system). In the direct drive system, the fluid discharge activator would be used to “wake” the processor **604** from an ultra-low power sleep mode. The fluid discharge actuator **616** may be a mechanical device to activate the system, such as a turn switch, a button, knob, lever, and the like.

[0064] In some embodiments, diodes **618**, **620** may be used to indicate to the operator the status of the system operation. For example, one diode may be an LED **618** to signal when the vaporization element **612** is being driven. Another LED **620** may be used to blink specified patterns to indicate system status, e.g. power up, low battery, exhausted fluid state, or other system specific status states (i.e. max dosage per unit time, etc...). In other embodiments, a display, such as an LCD screen, may be used to show the system status or other information, such as the type of substance or medicant contained in the delivery device, the amount and/or doses remaining, the battery level, a user ID in case the device is lost, etc. A button or similar device could be used to actuate and scroll through the display.

**[0065]** In a Type 1 configuration (low current, alkaline batteries etc.) the charge current may be limited to preserve the battery lifecycle. In many batteries, if large amounts of current are drawn, it will significantly reduce the battery life or state of charge. Therefore, using the lower current draw from the batteries and the power storage stage **608** allows for a high current event without unduly draining the batteries.

**[0066]** In a Type 2 configuration, the power storage **608** can be used to extend the life of the battery (lithium polymer, lithium-ion) if desired. The power storage **608** also makes it easier to very accurately meter the precise amount of energy into the vaporization element **612** with a simple voltage measurement. Accurately metering precise amounts of energy into the vaporization element can be done with a voltage and current measurement but it is harder to accurately measure current than to measure voltage. Thus, it may be advantageous to use a simpler-voltage only process.

**[0067]** An additional power saving feature that is shared with the control logic **604** and the power conversion **602**, namely, the power state (on switch) of the system. This power saving feature with the power state can be accomplished via either an ultra-low power mode of the conversion/cpu or a power disconnect/latch function. This is used to extend the operation life of the device after the first use.

**[0068]** The energy required to completely vaporize a predetermined volume of liquid is a function of the amount of power and the duration of time the power is present. Therefore, the power control system **306** may also comprise a means for controlling a precise duration of time to supply the precise amount of power to completely vaporize the predetermined volume of liquid at the required temperature. The means for controlling a precise duration of time to supply the power may comprise a “one-shot” control circuitry **170**, **172**, or **174** that can be integrated with the circuit for controlling the amount of power

described above. Examples of “one-shot” circuits **170**, **172**, or **174** are shown in Figures 15-17 and described below in more detail. A “one-shot” circuit may be used to limit the electric current delivery time interval regardless of how long the user holds the lever down. The power control system **306** is completely “off” in between uses; therefore, there is no drain on the battery during idle time. As a result, battery life is prolonged.

[0069] In some embodiments, the integrated circuit may be configured to actuate the power source a predetermined number of times. This number should be low enough such that each actuation results in the same amount of power each time. In some embodiments, the integrated circuit may be configured to monitor the battery life and not actuate the power when a predetermined amount of battery life has been detected.

[0070] This power control system **306** can be implemented in existing vapor delivery devices. For example, the control system **306** can be installed into handles of current vapor delivery devices to be implemented with existing heating systems to improve the energy efficiency and accuracy of dosing of current devices.

[0071] Besides, or in addition to, controlling the amount and duration of the power to significantly improve the efficiency and effectiveness of metering precise doses from vaporization devices, a means for consistently metering a precise volume of a liquid to be vaporized can be used as an alternative or additional layer of precision. Therefore, an efficient medicant delivery device may comprise a power control system **34** utilizing various embodiments of the circuitry described above to control the efficient and effective use of power, and/or a fluid delivery system **30**, **302**, or **402** as a means for consistently metering a precise volume of a liquid from the fluid reservoir to precisely control the volume of the liquid discharged for vaporization. Various combinations of these systems may be used to achieve the desired level of accuracy. An atomization or vaporization

system **32** may also be required to vaporize the medicant. In this application, atomization and vaporization are referred to interchangeably to indicate that the state of the medicant is a form that can be inhaled and absorbed by the lungs.

**[0072]** The precise volume of liquid that can be completely vaporized at a given temperature and duration of exposure can be calculated. Therefore, the precise volume required to be discharged from a fluid delivery system may be predetermined because the temperature of the wire and the duration the wire is energized can be fixed. Alternatively, in some embodiments, the precise volume may vary depending on the temperature of the wire and how long the wire remains energized at that temperature.

**[0073]** The embodiments of the power control system described above offer an advantageous way for more precisely metering a specific dose of a medicant. Controlling the volume of the medicant discharged also improves the metering accuracy. Examples of devices for controlling the volume of medicants to a heating element for vaporization are described below. These devices can be used alone or in combination with the power control system to further improve the accuracy of metered doses of medicants.

**[0074]** In one embodiment, as shown in Figures 1 and 2, a medicant delivery device **20** has an elongated housing **22** with a mouthpiece **24** and a lever **28** adjacent to a back or top end of the housing. A mouthpiece opening **26** extends into the mouthpiece **24**. Referring further to Figures 3-5, an embodiment of the device **20** includes a fluid or liquid delivery system **30** as the means for consistently metering a precise volume of a liquid to precisely control the volume of the liquid discharged for vaporization, and a vaporizing system **32**, as well as an electrical power control system **34**. The electrical power control system **34** may include batteries **44** within a battery compartment **42** of the housing **22**, and with the batteries electrically connected to a flexible circuit board **82** via a spring **46** and contacts

**48.** As shown in Figure 5, the housing may be provided with left and right sides, in a clamshell design. The lever **28** may be attached to the housing **22** at a pivot **58**.

**[0075]** As shown in Figure 4, a means for consistently metering a precise volume of a liquid from a fluid reservoir to precisely control the volume of the liquid discharged for vaporization is achieved by the liquid delivery system **30**, in the example shown, which includes a resilient or flex wall liquid chamber or reservoir **64** connected via a tube **66** to a lever valve **70**. The reservoir **64** may be a thin walled flexible pouch made of polyethylene film. The reservoir **64** is positioned between two rigid surfaces, with a plate **62** on one side and an inner wall of the housing **22** on the other side. Springs **60** within the housing **22** press on a plate **62**, which in turn presses on the reservoir **64**. This pressurizes the liquid in the reservoir.

**[0076]** A tube **66** extends from the reservoir **64** to a lever valve **70** which may include a valve post **74**, a valve spring **72** and valve washer **76**. A valve section **80** of the tube **66** in this design extends through an opening the valve post **74**, as shown in Figure 6. The valve spring **72** urges the valve washer **76** against the valve section **80** of the tube pinching it closed.

**[0077]** Referring to Figures 4-6, an embodiment of the vaporizing system **32** includes a heater **150** which is electrically connected to the electrical power control system **34**. The vaporizing system **32** is also connected to, and receives liquid from, the liquid delivery system **30**. The heater **150** may be an electrical resistance heater formed by an open coil of wire **152**, such as ni-chrome wire. In this design, the electric current is supplied to the coil wire **152** via connectors **156** on, or linked to, the flexible circuit board **82**, which in turn is connected to the batteries **44**. Figure 14 shows the connectors **156** for providing electrical power to the heating element.

[0078] An outlet segment **154** of the tube **66** extending out of the lever valve **70** towards the mouthpiece or back end of the device is inserted into the front end of a wire coil **152**. Referring momentarily to Figure 14, solid wire inserts **159** may be inserted into the ends of the wire coil **152** and the outlet segment **154** to provide internal support, so that they do not distort or collapse when pressed down into connectors **156**. The outlet segment **154** at the front end of wire coil heater **152** provides liquid into the bore of coil with each actuation of the device **20**.

[0079] The tube **66** is connected to the reservoir **64** with a liquid-tight connection so that liquid can only flow from the reservoir only through tube **66**. The tube **66** may be a resilient, flexible material such that its inner lumen can in general be completely flattened when compressed, and then generally fully recover to its original shape when released. A lever segment **67** of the tube **66** is positioned beneath the lever **28** and a fixed rigid surface inside of the housing, which optionally may be part of the circuit board **82** on which power management circuitry is located. Locating features **112** may be provided in, on, or through the circuit board **82** to ensure desired positioning is maintained. The lever **28** is retained by lever pivot **116** and can pivot through a controlled range of motion.

[0080] In use, the mouthpiece **24** is placed into the mouth and the user presses or squeezes the lever **28**. The tube **66** is pre-filled or primed with liquid during manufacture. Referring to Figure 4, as the lever **28** pivots down about the pivot **58**, a pincher **86** pinches the lever segment **67** of the tube **66** against an inside surface of the housing **20**, adjacent to the pivot **58** and the reservoir **64**. This temporarily closes off the tube **66** at the pincher **86**. As the lever **28** continues to pivot down (or inward towards the centerline of the device) a ramp surface **88** of the lever **28** progressively squeezes the lever segment **67** of the tube **66** between the pincher **86** and the lever valve **70**. This creates a squeegee type of

movement which pumps liquid towards the lever valve **70** using a peristaltic action. As the lever **28** continues to pivot inwardly, posts on the lever press the valve washer **76** down against the force of the valve spring **72**. This temporarily opens the lever valve **70** by allowing the valve section **80** of the tube **66** to open. With the valve section **80** of the tube open, and with liquid in the tube being pumped via the ramp surface **88**, a bolus of liquid flows through the valve section **80** and the outlet segment **154** and into the wire coil **152**.

[0081] The constant positive pressure exerted on the reservoir **64** by the springs **60** pressurizes the liquid in the tube **66**. However, since the tube **66** is pinched closed by the pincher **86**, no liquid flows out of the reservoir when the lever is depressed and the lever valve is opening. Rather, the liquid already present in the tube **66** between the pincher **86** and the lever valve **70** provides the measured bolus which is uniformly delivered to the wire coil.

[0082] The downward movement of the lever **28** also closes a switch **158** linked to or located on the circuit board **82**. Electric current then flows from the batteries **44**, or other power source, to the wire coil **152**. The wire coil heats up causing the liquid to vaporize. The current supplied to the wire coil, and the temperature of the wire coil when operating, may be regulated by the circuit board, depending on the liquid used, the desired dose, and other factors. The switch **158** may be positioned to close only when the lever **28** is fully depressed. This avoids inadvertently heating the wire coil. It also delays heating the wire coil until the bolus of liquid is moved into the wire coil via the pivoting movement of the lever, to help prolong battery life. A “one-shot” control circuit **170**, for example, as shown in Figure 15 described below, may be used to limit the electric current delivery time interval regardless of how long the user holds the lever down. The power is completely “off” in between uses. There is no drain on the battery during idle time. As a result,

battery life is prolonged.

**[0083]** As is apparent from this description, the liquid delivery system **30**, using a linear peristaltic pumping action, delivers a consistent, fixed, repeatable bolus of liquid to vaporizing system **32** with each actuation of the device **20**. The liquid delivery system **30** further seals the reservoir **64** between actuations via the pincher **86**, maintains the contents of the reservoir in a pressurized state, and controls electric power delivery to the vaporizing system **32**. The liquid delivery system is designed so that as liquid is used, air is not introduced into the system.

**[0084]** The diameter and length of the wire coil **152** forms a cylindrical volume within the inside diameter of the coil that is sufficient to capture a single expressed dose of liquid from the liquid delivery system. The adjacent loops of wire of the wire coil **152** may also be positioned so that liquid surface tension holds the liquid within the bore of the coil. This allows the device **20** to be used in any orientation, since gravity is not needed to keep the released dose of liquid in place.

**[0085]** The use of an open coil offers the further advantage that the vapor may be generated and escape anywhere along the length of the coil, without inadvertently affecting vaporization of the balance of the bolus of liquid in the coil. The wire coil also provides a large surface area for heat transfer and minimizes energy loss resulting from heating ancillary components.

**[0086]** Upon application of electric power, liquid in the coil vaporizes and passes through gaps between coils. The coil can be sized and shaped and positioned in the housing so that the vapor generated can be entrained into an air stream drawn through the device **20** when the user inhales on the mouthpiece. “Inhale” here means drawing the vapor at least into the mouth.



[0087] Figures 7-13 show a second device embodiment **100** which may be similar to the device **20**, but with the following differences. In the device **100**, the means for consistently metering a precise volume of a liquid from the fluid reservoir to precisely control the volume of the liquid discharged for vaporization comprises a foam pad **106** that is compressed and inserted between a reservoir **64** and one of the rigid walls of the housing. Force exerted on the reservoir **64** by the foam trying to recover to its relaxed state exerts compressive force on the reservoir which maintains the liquid in the reservoir under pressure. The foam pad **106** may be used in place of the springs **60** shown in Figure 4. The reservoir may alternatively be pressurized using a syringe with a spring-biased plunger. With any of these designs, the reservoir may optionally be provided as a replaceable cartridge.

[0088] As shown in Figure 8, in the device **100**, a lever valve **118** is provided (in place of the pincher **86** in the device **20**) to compress the front end of the tube **66**, preventing liquid from flowing out from the pressurized reservoir in between uses. The lever valve **118** may be a stamped sheet metal form soldered to a rigid circuit board **114** containing the same or similar circuitry as described above for the power control system **34**.

[0089] Figures 10-13 show additional features that can be used for a means for consistently metering a precise volume of a liquid from the fluid reservoir to precisely control the volume of the liquid discharged for vaporization, specifically, the pumping action of the liquid delivery system in the device **100**. When a dose of vapor is desired, the user places the mouthpiece in the mouth and inhales while pressing a button **109** on the lever **110**, causing the lever to rotate downward (counter-clockwise). As the lever **110** initially rotates as shown in Figure 10, a lever pinch projection **132** clamps or pinches the tube **66** closed at a pinch point **140**, closing off the pressurized liquid reservoir. Continued

rotation of lever **110** causes the lever **110** to flex at a flex point **124** having reduced thickness, as shown in Figure 11. This allows over-travel rotation of the lever while the tube **66** remains closed off at the pinch point **140**, without crushing the tube.

[0090] Further rotation of lever **110** then compresses the lumen of the pump segment **68** of the tube **66**. This pumps liquid from the pump segment **68** towards the lever valve **118**. This movement also moves projections on the lever which push valve flanges **120** down, deflecting and opening the lever valve **118**, and allowing a pressurized bolus of liquid to move through the tube and into the vaporizing system **32**. The dotted lines in Figure 12 show the lever valve **118** deflected down and away from the bottom surface of the circuit board **114**, to open the valve. Lastly, at end of the lever stroke, a lever switch protrusion contacts a switch **158**, switching the power delivery system on.

[0091] When lever **110** is released, it pivots back up to its original position. As the lever returns, the lever valve **118** reseats first, sealing the back end of pump segment **68** of the tube **66** and preventing air from being drawn back into the pump segment. As the lever **110** continues to rotate clockwise, the pump segment **68** decompresses, creating a negative pressure within the tube lumen. Lastly, at pinch point **140** the tube **66** reopens, allowing pressurized liquid from the reservoir to enter, refilling pump segment **68** with liquid to provide the next dose.

[0092] The volume of liquid expressed with each stroke can be controlled by selection of desired pump segment **68** tube diameter and length. Maintenance of a positive pressure on the liquid reservoir ensures that the system always stays primed with liquid, and that “short shots” resulting from air bubbles in the tube do not occur. Furthermore, sealing of the vaporizer system with a valve such as the valve **70** or **118** that is only actuated at the time of delivery, and positive pressure dispensing prevents inadvertent leakage of liquid

irrespective of orientation of the device during storage or use, thereby providing a means for consistently metering a precise volume of a liquid from the fluid reservoir to precisely control the volume of the liquid discharged for vaporization.

**[0093]** Figure 15 is a schematic diagram for a “one-shot” circuit **170** for the power control system that delivers a fixed time interval of electric current to the heater **150** regardless of how long the lever is depressed by the user. In Figure 15, CD4047 is a CMOS low power monostable/astable multivibrator available for example from Texas Instruments. U1 is a common CD4047 which operates from a 12V battery voltage with very low quiescent current drain. When pushbutton SW1 is depressed, U1 is triggered, Q (pin 10) goes high and C1 is rapidly charged to near the supply voltage through a FET within U1. At the same time, resistor R1 is switched to a logical “0” state and immediately begins discharging capacitor C1 with the time constant of  $1/RC$ .

**[0094]** A wide range of pulse durations may be selected. Using a typical ni-chrome wire coil, pulse durations ranging from approximately 0.2 to 2 seconds are sufficient to fully vaporize the bolus of liquid. When the voltage on pin 3 reaches the threshold for logic “0” ( $\sim 1/3$  supply voltage), the logic levels switch and Q (pin 10) returns to a logic low level. Q2 is an emitter follower that provides current amplification to enable Q1 to be fully saturated during the desired current pulse. D1 and R4 provide a visual indication of the heater current. R2 is a “pull down” resistor for SW1, and C2 prevents induced noise from falsely triggering the circuit. Other choices of IC may be employed, such as the Toshiba TC7WH123, depending upon battery voltage, package size, and cost.

**[0095]** The battery voltage gradually decreases over the lifespan of the device. For many applications, the circuit described in Figure 15 provides the necessary control. However, more precise metering of the medicant may be accomplished by increasing the

current pulse duration as the current decreases over the discharge life of the battery. In the circuit **172** shown in Figure 16, an additional OP amp IC serves as a voltage controlled current source for the power control system. The input voltage is sampled from Pin 10 of U1. A constant current is generated in Q3 and used to discharge the timing capacitor, C1, at a constant rate. Once the voltage across C1 reaches the logic threshold, CD 4047 trips and the output pulse width is complete. As the battery voltage decreases the constant current generated in Q3 decreases, causing the time to discharge C1 to increase. This lengthens the output pulse to maintain a relatively constant heater power per inhalation cycle as the battery voltage declines over the lifetime of the device. The various current setting and sense resistor values may be adjusted to provide optimal performance. Other circuits may be employed to provide the same function such as voltage to frequency converters.

**[0096]** Figure 17 shows another circuit **174** for the power control system where a voltage regulator U2 is inserted between the output transistor Q1 and the heater filament. This keeps the filament voltage constant throughout the battery life. The regulated voltage may be chosen to optimize the heater operation near end of life. A low dropout regulator is desired to maximize the lifespan before regulation is no longer maintained. A simple linear regulator is shown, but a high efficiency, switching regulator may also be employed to improve efficiency. The pulse duration is maintained as described above or an equivalent “one shot” circuit and the heater current is kept constant by the voltage regulator.

**[0097]** In another alternative design, the electrical power control system **34** may be configured to provide consistent power by timing the power to provide the minimum energy needed to vaporize the liquid. The power control system **34** may also be

programmed to do this. For example, the electrical power control system **34** may be programmed to power the source down to the voltage required to vaporize the liquid, so as to extend its useful life. Here, the power source may include a capacitor that builds, retains and provides a charge necessary to vaporize the liquid to be vaporized, again, so as to extend the useful life of the power source. In some embodiments, supercapacitors may be employed as discussed above to further enhance the functionality of the power source.

**[0098]** In an additional alternative design shown in Figure 18, the liquid to be atomized is delivered into a small diameter tube **180** via capillary action, as distinct from providing the liquid via pressure into the heating coil, where it is stabilized for vaporization due to surface tension. The tube **180** can be glass, polyaniline or metal, e.g., stainless steel. A heating element such as ni-chrome wire can be coiled around the tube, coiled into the tube or inserted into a tube in a V-shape so as to heat the entire volume of liquid at the same time.

**[0099]** Figures 19-22 show an alternative vaporizing device **200** having a housing formed from a base **202** including a mouthpiece **206**, and a cover **204** attached to the base **202**. Pivot arms **209** on a button **208** are pivotally attached to pivot posts **226** on a bridge **224**, as shown in Figure 21 to provide another means for consistently metering a precise volume of a liquid from the fluid reservoir **234** to precisely control the volume of the liquid discharged for vaporization. The radius **244** of the pincher **238** can flex when the tube **236** is compressed. The bridge **224** has pins for securely attaching it to the base **202**. The positive electrode of each battery **44** is held into contact with center contact **212** by a spring **46**. A positive conductor strip **214** connects the center contact to a printed circuit board **216**.

**[00100]** Referring to Figure 22, a wick **220** extends from the printed circuit board **216**

(containing the same or similar circuitry as described above for the power control system 34) up to a vaporizing coil **222** and optionally over a raised wall **240**. The wick may be a strip or sheet of ceramic tape **220** that serves as a wick and a heat sink. The wick **220** is positioned between the heating element, such as the vaporizing coil **222**, and the outlet of the tube **236**. The wick **200** may rest on top of the heating element, or be positioned adjacent to it, and the tube outlet may also be on top of the heating element and the wick **220** (when the device **200** is in the upright position, with the button **208** on top).

[00101] Brass posts **218** or similar contacts are attached to the printed circuit board **216** and to opposite ends of the coil **222**. The button **208** has a pincher arm **209** positioned to pinch and close off flow in a tube **236** connecting a liquid reservoir to an outlet location on, adjacent to or overlying the wick **220**. The tube **236** may be held in place by molded in tube clips **240** on the bridge **224**. Arms **233** on a normally closed pinch valve **232** extend up through openings in the bridge **224**. A valve spring **230** around a post **228** holds the valve **232** into the normally closed position. A bottom surface of the valve **232** may act as a switch with the printed circuit board **216**, or actuate a separate switch on the printed circuit board **216**, to switch on electrical current to the coil **222** when the button **208** is pressed.

[00102] In use, the vaporizing device **200** operates on the same principals as described above, with the following additions. A slot **210** may be provided in the housing to accommodate an insulating tab. The insulating tab is installed during manufacture and prevents electrical contact between the center contact **212** and the batteries. As a result, the device cannot be inadvertently turned on during shipping and storage. Battery life is therefore better preserved. Before operating the vaporizing device **200** for the first time, the user pulls the tab out of the slot **210**. As shown in Figures 19 and 20, the mouthpiece

is round. The dimension LL in Figure 20 between the coil **222** and the mouthpiece tip may be minimized to 15, 10 or 5 mm. The liquid reservoir may have a volume exceeding 0.8 or 1.0 ml to allow foam compression to pressurize the pump. In the device **200**, the liquid supplied from the reservoir via the tube **236** is not delivered into the coil **222**. Rather the liquid is delivered onto the wick **220**. The heating coil **222** abuts the wick **220** and heats the wick, which then vaporizes substantially all of the liquid on or in the wick.

**[00103]** In each of the vaporizing devices described above, the open coil heater **152** or **222** of e.g., ni-chrome wire may be encased in a porous ceramic material, so that the vapor produced when the fluid is atomized must pass through the ceramic material in order to be ingested or inhaled. The ceramic material can be manufactured with techniques that control the size of the pores through which the vapor will pass. This can help to regulate the size of the vapor molecules or droplets produced for inhalation. By controlling the amount of electrical power and the duration of power to the coil heater, the heater continues to vaporize the fluid at the heater until the vapor droplets or particles are small enough to pass through the ceramic material, effectively utilizing all the fluid delivered to the coil and controlling the dose in addition to regulating the molecule size. By regulating the size of the vapor molecule produced, the vaporizing devices can be used with more precision and with fluids and medicants that require carefully controlled dosages particle sizes. In some cases, smaller molecules may be advantageous as they can be inhaled more deeply into the lungs, providing better a more effective delivery mechanism.

**[00104]** The wire coil heater may alternatively be encased in a heat resistant fabric-like material, such as Kevlar®, so that the vapor must pass through the fabric to be ingested. The fabric can be manufactured with a desired mesh opening size, to regulate the size of the vapor particles and/or molecules delivered by the vaporizer. By controlling the amount

of electrical power and the duration of power to the heater, the heater continues to vaporize the fluid delivered to the heater until the vapor particles are small enough to pass through the mesh of the fabric. Containing the fluid inside the fabric with the heater until the particles are sufficiently small enough to pass through the fabric can help to effectively atomize and deliver all the fluid delivered to the heater, with little or no waste, in turn controlling the dose.

**[00105]** Although the switch **158** is described above as a mechanical contact switch, other forms of switches may optionally be used, including switches that optically or electrically sense the movement of position of an element, or a switch that senses the presence of liquid in the heater **150**. In addition, though the lever and pinch valves are shown as clamping type of valves, other forms of mechanically or electrically operated valves may be used. Similarly, the peristaltic pumping action created by the pivoting movement of the lever may be optionally replaced with alternative forms of pumping or fluid movement. Various types of equivalent heating elements may also be used in place of the wire coils described. For example, solid state heating elements may be used. The heating element may also be replaced by alternative vaporizing elements, such as electro-hydrodynamic or piezo devices that can convert liquid into a vapor without heating.

**[00106]** In another embodiment, a delivery device **300** utilizes a plunger-style liquid delivery system **302** as another means for consistently metering a precise volume of a liquid from a fluid reservoir to precisely control the volume of the liquid discharged for vaporization. As shown in Figure 23, the delivery device **300** comprises a new liquid delivery system **302**, but utilizes the same or similar an atomization or vaporization system **32** and power control system **34** described above, all contained in a housing **308**, preferably cylindrical in shape to mimic a cigarette or cigar.



[00107] The fluid delivery system **302** has a fluid reservoir **310** to contain the medicant and a pressure generator, such as a piston **312** that indexes forward inside the fluid reservoir **310** in a consistent, fixed, repeatable amount every time fluid discharge actuator, such as a button **314**, is pressed or actuated. Preferably, the fluid reservoir **310** is cylindrical in shape, and more preferably, shaped like a syringe. The delivery device **300** is completely sealed between applications such that the medicant cannot evaporate during storage or between actuation cycles.

[00108] The fluid reservoir **310** has a proximal end **316** and a distal end **318**. The proximal end **316** is configured to accept the piston **312** which forms a hydraulic seal against the walls of the reservoir **310**, such that the medicant cannot leak past the piston **312**. The piston **312** may have a hollow core **313**. A plunger **320** is provided to couple with the piston **312** to drive the piston **312** forward in a controlled and step-like manner. The plunger **320** comprises a shaft **322** having a head **324** at one end. In a preferred embodiment, the head **324** is flanged. The head **324** is configured to engage with mating geometry on the inside of the piston **312**, securing the piston **312** to the plunger **320**. The shaft **322** of the plunger is configured with a male screw thread **326**, preferably, for its entire length.

[00109] A drive nut **328** is disposed at the proximal end **316** of the reservoir **310**. Various features of the housing **308** and reservoir **310** constrain the position of the drive nut **328** such that it is free to move rotationally concurrent to the axis **A** of the plunger **320**, but prevent translation in any other direction. The drive nut **328** has a mating female screw thread **330** to the plunger **320** and is threaded onto the plunger **320**. The drive nut **328** is further configured with ratchet teeth **332**, which interact with a pawl **334** on a button **314**

described later such that during operation, the drive nut **328** will rotate in a single direction.

**[00110]** A cap **336** is disposed at the distal end **318** of reservoir **310**. The cap **336** may be an elastomeric component with an outlet **338** comprising a self-collapsing slit/hole. Preferably, the cap **336** is made of silicone. The outlet **338** is responsive to pressure from the medicant within the reservoir **310** such that when the medicant is at a higher pressure than the ambient pressure outside of the reservoir **310**, the outlet **338** will open **338A**, allowing medicant to escape the reservoir **310**. Once enough medicant has escaped the reservoir **310** to equilibrate with ambient pressure, the outlet **338** will automatically collapse, sealing the remaining contents of the reservoir **310** from ambient, thereby, preventing loss of medicant to evaporation. So, the measured dose is determined by proper calibration of the pressure needed to properly form and maintain a droplet of the medicant at the outlet **338** until vaporization is initiated. The nature of seal is such that pressure changes external to the device will not cause the reservoir to come "unsealed" the external pressure changes would not be focused enough nor forceful enough to "unseal." And, the natural elasticity of the reservoir would cause the seal to "re-seal" irrespective of external pressure changes.

**[00111]** Based on the surface tension of the liquid medicant, the volume of the medicant discharged from the outlet **338** should be small enough that it forms a droplet at the outlet **338** that adheres to the outlet **338** without dropping or dripping off from the cap **336**. The distance from the outlet **338** to the coiled wire **152** should also be small enough that a droplet of the liquid formed at the outlet bridges the gap between the outlet **338** and the coiled wire **152** thereby allowing the droplet to transfer to the coiled wire **152** or the wick

**360** within the coiled wire **152**. This configuration allows the vapor delivery device **300** to be used in any orientation; thereby, improving the versatility over current devices.

[00112] As shown in Figure 30, the button **314** functions to provide controlled rotational indexing of the drive nut **328**. The button **314** includes a control surface **340** protruding through the upper housing for the user to actuate the button **314**. In its neutral (home) position, the button **314** is normally protruding slightly from the housing **308**. The button **314** is constrained such that it can translate in a direction normal to the control surface **340** when it is pressed. The button **314** is configured with two spring elements **341a**, **341b** which bias the button back to its neutral position in the absence of pressure on the control surface **340**. The spring elements **341a**, **341b** are designed to deform under pressure on the load surface and return to their original shape upon release of that pressure. The range of button travel motion is limited by a stop **342** having an upper surface **343a** and a lower surface **343b**. The stop surfaces **343a**, **343b** engage opposing surfaces on lower and upper housings at limits of button travel, creating a fixed range of displacement for the button **314** when it is pressed/released. The button **314** is further configured with a pawl **334** to engage ratchet teeth **332** on the drive nut **328**. When the button **314** is depressed, the pawl **334** engages ratchet teeth **332**, causing the drive nut **328** to rotate. Upon release, a sloped surface **344** of a pawl **334** and an opposing surface **346** of the ratchet **332** oppose one another, deflecting the pawl **334** at a web allowing the pawl **334** to ride over the adjacent ratchet tooth and the button **314** to return to its neutral position. In this manner, the ratchet **332** allows the drive nut **328** to rotate in a single direction.

[00113] In some embodiments, the button **314** may function to initiate the delivery of power to the heating system **304** synchronous to the delivery of a bolus of medicant to the vaporization system **32**. As shown in Figures 31A and 31B a contact pin **348** is provided

spanning the button spring elements **341a**, **341b**. Deflection of the spring elements **341a**, **341b** during actuation of the button **314** lowers the contact pin **348** relative to contacts **350a**, **350b**, closing the circuit across the contacts **350a**, **350b**, as shown in Figure 31B. This closure serves to initiate a power cycle to the vaporization system **32** as described later. In some embodiments, the contacts **350a**, **350b** may be directly under the spring elements **341a**, **341b**. The underside of the spring elements **341a**, **341b** may have independent contact pins **348** to connect with the contacts **350a**, **350b** to close the circuit. In some embodiments, a single contact pin **348** and a single contact **350a** may be used.

**[00114]** The pitch of thread **326** is selected in consideration of the bore **352** of the reservoir **310**, and controlled angular indexing of the drive nut **328** to displace the desired bolus of medicant from the reservoir **310** with each indexing of the drive nut **328**. All of the rotational motions of the drive nut **328** are converted to linear motion on the plunger **320** to provide a consistent, fixed, and repeatable dose of the medicant. To ensure that the plunger **320** does not spin with the rotating drive nut **328**, the plunger **320** is further provided with a groove **354** running down its length, said groove **354** accepting anti-rotation tang **356** protruding from the lower portion of the housing **308**, as shown in Figure **32**.

**[00115]** The atomization or vaporization system **32**, similar to what was described above, comprises a tightly coiled wire heater element **152** positioned adjacent to the fluid delivery system outlet **338**. In the preferred embodiment, the coiled wire **152** is a nichrome wire. In some embodiments, the nichrome wire coil **152** may be wound around a high temperature fiber wicking element **360** to distribute the received medicant dose across the coil **152**.

**[00116]** The power control system **34** comprises a circuit board **362** (containing the same or similar circuitry as described above) and associated battery **364** that delivers a fixed and precise amount of power to the nichrome wire **152** with each actuation, the amount of power delivered being that necessary to atomize or vaporize the precise volume of delivered bolus of the medicant. For optimal system efficiency, it is desirable to maximize energy density of the heater. Thus the coils of the heater are ideally spaced as close together as possible. Furthermore, it is desirable to distribute the dose of medicant that is to be vaporized as uniformly as possible across the heater elements. To that end, the heater coils **152** are wrapped around a wick **360** comprising material tolerant of high temperature, said material compelling the medicant to distribute evenly throughout the wick **360**. The coil **152** is connected to the power control system **34** via crimp connectors **366**. In the preferred embodiment, the circuit board **362** comprises a one-shot circuit (similar to or same as the circuitry described above) that delivers a fixed and precise amount of power to the nichrome heater **152** with each actuation, the amount of power delivered being that necessary to atomize the delivered bolus of medicant.

**[00117]** In some embodiments, to further provide a means for delivering a precise amount of power to the vaporization system **32**, the power control system may comprise one or more supercaps **368a**, **368b** connected to the power source and the circuit. Using supercaps **368a**, **368b** prevents the vaporization system **32** from receiving varying amounts of power as the batteries **364** approach their end. In particular, supercaps **368a**, **368b** prevent the power to the vaporization system **32** from decreasing as the batteries die. Without the circuitry to precisely control the power, decreased battery power would lead to a lower temperature wire **152** for a given activation. In such case, if the volume of the medicant remains the same, then there may be incomplete vaporization of the medicant.

[00118] Figures 33-35 show another embodiment of a delivery device **400**. Figure 34 shows the delivery device **400** with the housing **408** removed. Delivery device **400** comprises the same or similar vaporization system **32** and power control system **34** as described above with another embodiment of a fluid delivery system **402** as a means for consistently metering a precise volume of a liquid from a fluid reservoir. The housing **408** of delivery device **400** also differs from that of delivery device **300**. The housing **408** generally has an elongated box-like configuration. The housing **408** can take on other shapes as well, such as a cylinder or any shape or size desired for a particular application. The housing **408** has a top end **410** and a bottom end **412** opposite the top end **410**. The top end **410** comprises a cover **414**.

[00119] Protruding from the top end **410** is an inhaler tube **416**. The inhaler tube **416** is operatively connected to the fluid delivery system **402**. Medicants from the fluid delivery system **402** are vaporized by the vaporization system **32** and the vapors flow through the inhaler tube **416** and into the user's mouth. The cover **414** is used to protect the inhaler tube **416** when not in use. Figure 33 shows a sliding cover; however, the cover **414** can be flip top, detachable, slidable, and the like. As the cover **414** is pushed back, away, off, or otherwise removed from the top end, the inhaler tube **416** is released and rotates upward. The user can then begin the process of inhaling through the inhaler, which starts the heating process by activating a flow sensor.

[00120] At the bottom end **412** of the housing **408** is a knob **418** to deliver a precise volume of medicant from the fluid delivery system **402** to the vaporization system **32**. Like the button **314** of device **300**, the knob **418** at the bottom **412** of device **400** is used to advance a plunger (not shown) through a syringe (not shown) repeatedly in a step-like manner to deliver a precise, fixed, and consistent volume of a medicant from the syringe

and deposit it onto the coiled wire **152** of the vaporization system **32**. Each rotation of the knob **418** advances an exact, metered amount of drug with a consistently repeatable volume.

[00121] Like the previous versions, the device **400** utilizes a circuit board **420** (containing the same or similar circuitry as described above for the power control system **34**) with associated processor (not shown), super caps **368a**, **368b**, and other electronic components utilized to deliver a consistent, precise and sufficient amount of power to the heating system to vaporize or atomize a predetermined volume of a liquid. The circuit board **420** is located at the top end **410** adjacent to the fluid delivery system **402** and the vaporization system **32**. A through-hole **430** is provided to allow the inhaler tube **416** to be passed through the circuit board **420** allowing the fluid reservoir **422** to be attached to this inhaler tube **416** and present the inhaler tube **416** to the user.

[00122] Below the circuit board **420**, the fluid delivery system **402** is mounted. This assembly provides a secure, tamper resistant chamber for retaining the fluid. The fluid delivery system **402** is then connected to a gear reduction assembly **424** that allows the linear syringe actuator to be advanced through the reservoir **422** in a consistent amount for each rotation of the knob **418**.

[00123] The vaporization system **32** is placed into the path of the fluid that is delivered via the fluid delivery system **402** each time the knob **418** is rotated. The vaporization **32** comprises a heating coil **152**. In some embodiments, the heating coil **152** may be wrapped around a wick **360**, which helps retain the liquid after it has been discharged from the fluid delivery system **402**. After the fluid is advanced, the fluid wets the wick **428** that is placed inside the heating coil assembly **152**. Once this wick **360** is wetted, the coil **152** can be heated once the user begins to inhale (suck) on the inhaler tube **416**. To trigger the heating

mechanism, a flow sensor (not shown) is placed in the inhalation path, which is the path between the inlet of the inhaler tube **416** and the outlet **417** of the inhaler tube **416**.

**[00124]** As flow is sensed when the user begins to inhale/suck on the inhaler tube **416**, the coil heating is begun by applying voltage to the coil **152**. The power applied to the coil wire **152** is supplied via the supercap assembly **368a**, **368b**, which is charged via the device batteries **364**.

**[00125]** To further improve the delivery and efficacy of the medicant delivered by the present invention, plume chemistry of the medicant delivered to the lungs must be analyzed. Depending on the size of the vapor product released by the vapor delivery device, the medicant may have effects at various places; thereby dictating the effectiveness and speed with which the medicant can work on a user. For example, the larger vapor products are more likely to get caught inside the mouth, which would result in the medicant travelling through the digestive track. Small vapor products can be inhaled into the lungs, but may get caught in the upper lungs. Even finer vapor products can reach the lower lungs where absorption of the medicant is more effective and faster.

**[00126]** Again, to control the size of the vapor product, a permeable membrane of ceramic, fabric, or the like may be placed between the heating system and the mouthpiece. The heating element allows the medicant to vaporize; however, prior to exiting through the mouthpiece, the vapor product is filtered through the permeable membrane to govern the size of the vapor product delivered to the user. The membrane should be made of a material that is resilient to heat, such as ceramic or Kevlar® material.

**[00127]** Due to the consistent, reliable, and precise control of dosage offered by the present invention, its application goes far beyond just as a substitute for tobacco products. The device can be used to deliver dietary supplements, sleep aids, weight loss products,



pain killers, and many other prescription or over-the-counter pharmaceutical products where precise dosing is required. The present invention can even be implemented in a non-pharmaceutical context, such as for dispensing liquid candies for consumption, breath fresheners, room fresheners, and any other application where vaporization of a liquid in consistent, reliable, and precise doses are needed.

**[00128]** While the system and device have been described in terms of what are presently considered to be the most practical and effective embodiments, it is to be understood that the disclosure need not be limited to the disclosed embodiments. It is intended that all permutations, enhancements, equivalents, combinations, and improvements thereto that are apparent to those skilled in the art upon a reading of the specification and a study of the drawings are included within the true spirit and scope of the present invention. The scope of the disclosure should thus be accorded the broadest interpretation so as to encompass all such modifications and similar structures. It is therefore intended that the application includes all such modifications, permutations and equivalents that fall within the true spirit and scope of the present invention. Thus, multiple embodiments and methods have been shown and described. Various modifications and substitutions may of course be made without departing from the spirit and scope of the invention. The invention, therefore, should not be limited except by the following claims and their equivalents.

#### INDUSTRIAL APPLICABILITY

**[00129]** This invention may be industrially applied to the development, manufacture, and use of a medicant delivery system that can consistently, reliably, and repeatably deliver a precise dose of a medicant to a user in vapor form in an energy efficient manner. The delivery system comprises a power control system, a vaporization system, and a fluid delivery system. The power control system utilizes a circuitry that allows the system to

deliver just enough power to vaporize or atomize a known volume of a medicant. To avoid changes in the current due to power drainage, the control system utilizes supercapacitors connected to the circuitry. The power source and/or the resistance at the heating element can be monitored so that the system knows how much power needs to be supplied to efficiently vaporize the known volume of medicant. The fluid delivery system utilizes a reservoir and dispensing mechanism that dispenses the same volume of medicant with each actuation. The heating system utilizes a nichrome wire.

## CLAIMS

What is claimed is:

1. A control system for a hand-held vapor delivery device, comprising: a circuit configured to provide a precise amount of power from a power source to heat a heating element to a minimum required temperature to completely vaporize a predetermined volume of a liquid, and control a precise duration of time to supply the precise amount of power to completely vaporize the predetermined volume of liquid at the required temperature.
2. The control system of claim 1, wherein the circuit comprises a one-shot circuit.
3. The hand-held vaporizing device of claim 1, wherein the circuit further comprises a processor programmed to monitor a resistance of the heating element and adjust the amount of power to a level sufficient to heat the heating element to the required temperature.
4. The control system of claim 1, wherein the circuit comprises a DC/DC boost converter and a supercapacitor operatively connected to the power source to adjust the amount of power to the level sufficient to heat the heating element to the required temperature.
5. The hand-held vaporizing device of claim 1, wherein the circuit is configured to actuate the power source a predetermined number of times.
6. A hand-held medicant delivery device, comprising:
  - a. a housing having a first end and a second end;
  - b. a mouthpiece attached to the first end;
  - c. a fluid delivery system;

- d. a vaporization system , comprising a heating element in between the mouthpiece and the fluid reservoir; and
  - e. a power control system, comprising a circuit configured to provide a precise amount of power from a power source to heat the heating element to a required temperature to completely vaporize the precise volume of the liquid, and control a precise duration of time to supply the precise amount of power to completely vaporize the precise volume of the liquid at the required temperature.
- 7. The hand-held medicant delivery device of claim 6, wherein the control system comprises a one-shot circuit.
  - 8. The hand-held medicant delivery device of claim 6, wherein the circuit comprises a processor that is programmed to monitor a resistance of the heating element and adjust the power until the heating element reaches the required temperature.
  - 9. The hand-held medicant delivery device of claim 6, wherein the control system comprises a DC/DC boost converter operatively connected to a supercapacitor.
  - 10. The hand-held medicant delivery device of claim 6, wherein the circuit comprises a processor programmed to actuate the power source a predetermined number of times.
  - 11. The hand-held medicant delivery device of claim 6, wherein the power source is an alkaline battery.
  - 12. The hand-held medicant delivery device of claim 6, wherein the fluid delivery system, comprises:
    - a. a fluid reservoir inside the housing, the fluid reservoir having a first end and a second end; and

- b. a pressure generator positioned inside the fluid reservoir at the second end and configured to advance towards the first end at a fixed and discrete distance to consistently meter a precise volume of a liquid from the fluid reservoir.
- 13. The hand-held medicant delivery device of claim 12, wherein the fluid delivery system further comprises a cap in fluid communication with the fluid reservoir at the first end, the cap having an outlet opposite the fluid reservoir, wherein the liquid stored inside the fluid reservoir can exit through the outlet when a positive pressure is applied to the fluid reservoir to form a droplet at the outlet.
- 14. The hand-held medicant delivery device of claim 13, wherein the outlet and the heating element are separated by a distance smaller than the droplet, such that the droplet can contact the heating element while still on the outlet.
- 15. The hand-held medicant delivery device of claim 13, wherein the pressure generator comprises:
  - a. a piston housed inside the fluid reservoir configured to push the liquid out through the cap; and
  - b. a fluid discharge actuator operatively connected to the piston, wherein actuation of the fluid discharge actuator causes the piston to advance the fixed and discrete distance towards the first end.
- 16. The hand-held medicant delivery device of claim 12, further comprising a permeable membrane positioned between the mouthpiece and the heating element, wherein the permeable membrane is permeable to vapor molecules of a predetermined size.
- 17. A hand-held medicant delivery device, comprising:
  - a. a housing having a first end and a second end;

- b. a mouthpiece attached to the first end;
  - c. a fluid delivery system, comprising:
    - i. a fluid reservoir inside the housing, the fluid reservoir having a first end and a second end, and
    - ii. a pressure generator positioned inside the fluid reservoir at the second end and configured to advance towards the first end in at a fixed and discrete distance to consistently meter a precise volume of a liquid from the fluid reservoir;
  - d. a vaporization system , comprising a heating element in between the mouthpiece and the fluid reservoir; and
  - e. a control system to deliver power to the vaporization system.
18. The hand-held medicant delivery device of claim 17, wherein the fluid delivery system further comprises a cap in fluid communication with the fluid reservoir at the first end, the cap having an outlet opposite the fluid reservoir, wherein the liquid stored inside the fluid reservoir can exit through the outlet when a positive pressure is applied to the fluid reservoir to form a droplet at the outlet.
19. The hand-held medicant delivery device of claim 18, wherein the outlet and the heating element are separated by a distance smaller than the droplet, such that the droplet can contact the heating element while still on the outlet at the opening.
20. The hand-held medicant delivery device of claim 18, wherein the pressure generator comprises:
- a. a piston housed inside the fluid reservoir configured to push the liquid out through the cap; and

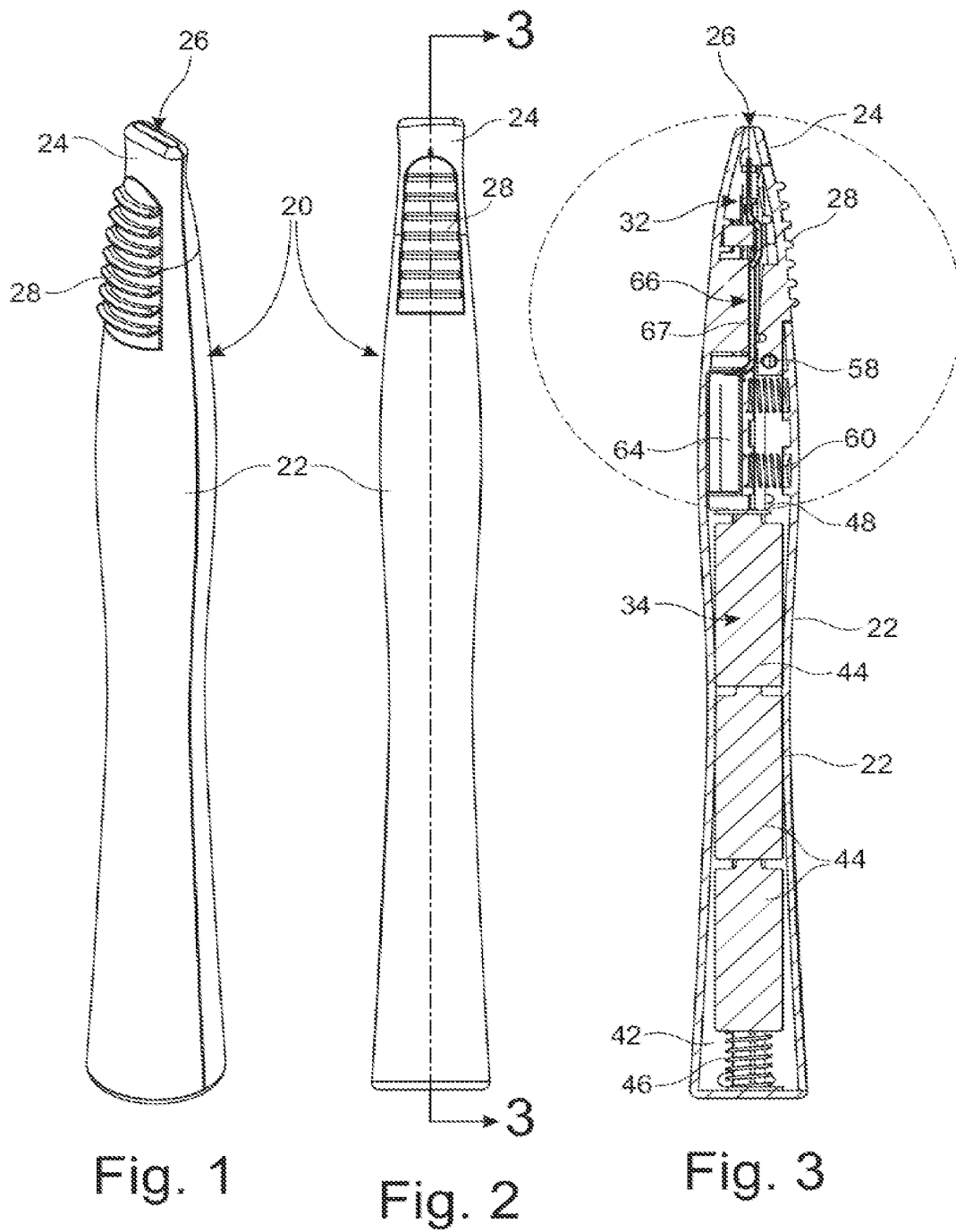
- b. a fluid discharge actuator operatively connected to the piston, wherein actuation of the fluid discharge actuator causes the piston to advance the fixed and discrete distance towards the first end.
21. The hand-held medicant delivery device of claim 17, further comprising a permeable membrane positioned between the mouthpiece and the heating element, wherein the permeable membrane is permeable to vapor molecules of a predetermined size.
22. A method of efficiently and consistently vaporizing a precise amount of a liquid medicant from a hand-held device, comprising:
- a. consistently metering a precise volume of a liquid to a heating element; and
  - b. supplying a precise amount of power from a power supply to heat the heating element for a precise duration of time such that the combination of the precise amount of power and the precise duration of time heats the heating element to a minimum required temperature for a minimum required time to completely vaporize the precise volume of the liquid.
23. The method of claim 22, wherein metering a precise volume of the liquid, comprises:
- a. storing the liquid in a fluid reservoir; and
  - b. applying a precise amount of positive pressure inside the fluid reservoir to discharge the precise volume of fluid from the fluid reservoir.
24. The method of claim 23, wherein the precise amount of positive pressure is applied by advancing a plunger a predetermined distance within the fluid reservoir.
25. The method of claim 24, wherein advancing the plunger the predetermined distance is achieved by turning a drive nut a fixed rotational movement.

26. The method of claim 25, wherein turning the drive nut is achieved by actuating a button that turns the drive nut the fixed rotational movement each time the button is actuated.
27. The method of claim 22, wherein supplying the precise amount of power is achieved by programming a processor to permit actuation of the power supply a predetermined number of times.
28. The method of claim 22, wherein supplying the precise amount of power, comprises:
- a. monitoring a temperature of the heating element while the power is being supplied;
  - b. comparing the temperature of the heating element to a predetermined temperature; and
  - c. adjusting the precise duration of time the precise amount of power is supplied based on the comparison.
29. The method of claim 22, wherein supplying the precise amount of power, comprises:
- a. monitoring a temperature of the heating element while the power is being supplied;
  - b. comparing the temperature of the heating element to a predetermined temperature; and
  - c. adjusting the amount of power supplied based on the comparison.
30. The method of claim 29, wherein monitoring the temperature of the heating element is achieved by measuring the resistance in the heating element.



31. The method of claim 29, further comprising a supercapacitor operatively connected to the power supply and the processor to adjust the amount of power supplied.
32. The method of claim 31, wherein the power supply is an alkaline battery.
33. The method of claim 22, wherein supplying the power is activated by creating an airflow at a mouthpiece of the hand-held device.
34. The method of claim 33, further comprising controlling a size of a vapor molecule of the vaporized liquid by placing a permeable membrane between the heating element and the mouthpiece, wherein the permeable membrane is permeable only to vapor molecules of a predetermined size.
35. A control system for a hand-held vapor delivery device, comprising:
  - a. a means for providing a precise amount of power from a power source to heat a heating element to a minimum required temperature to completely vaporize a predetermined volume of a liquid; and
  - b. a means for controlling a precise duration of time to supply the precise amount of power to completely vaporize the predetermined volume of liquid at the required temperature.

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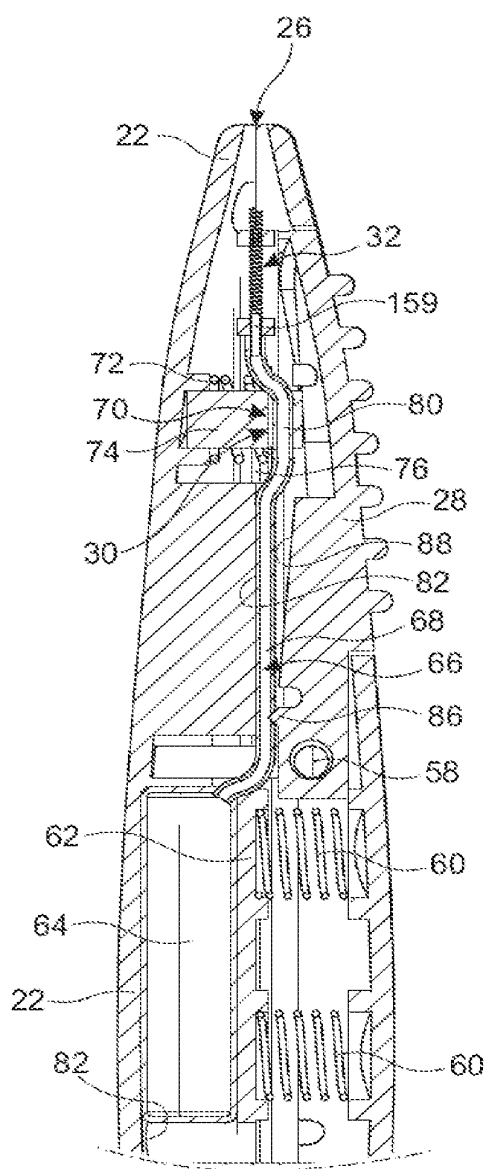


Fig. 4

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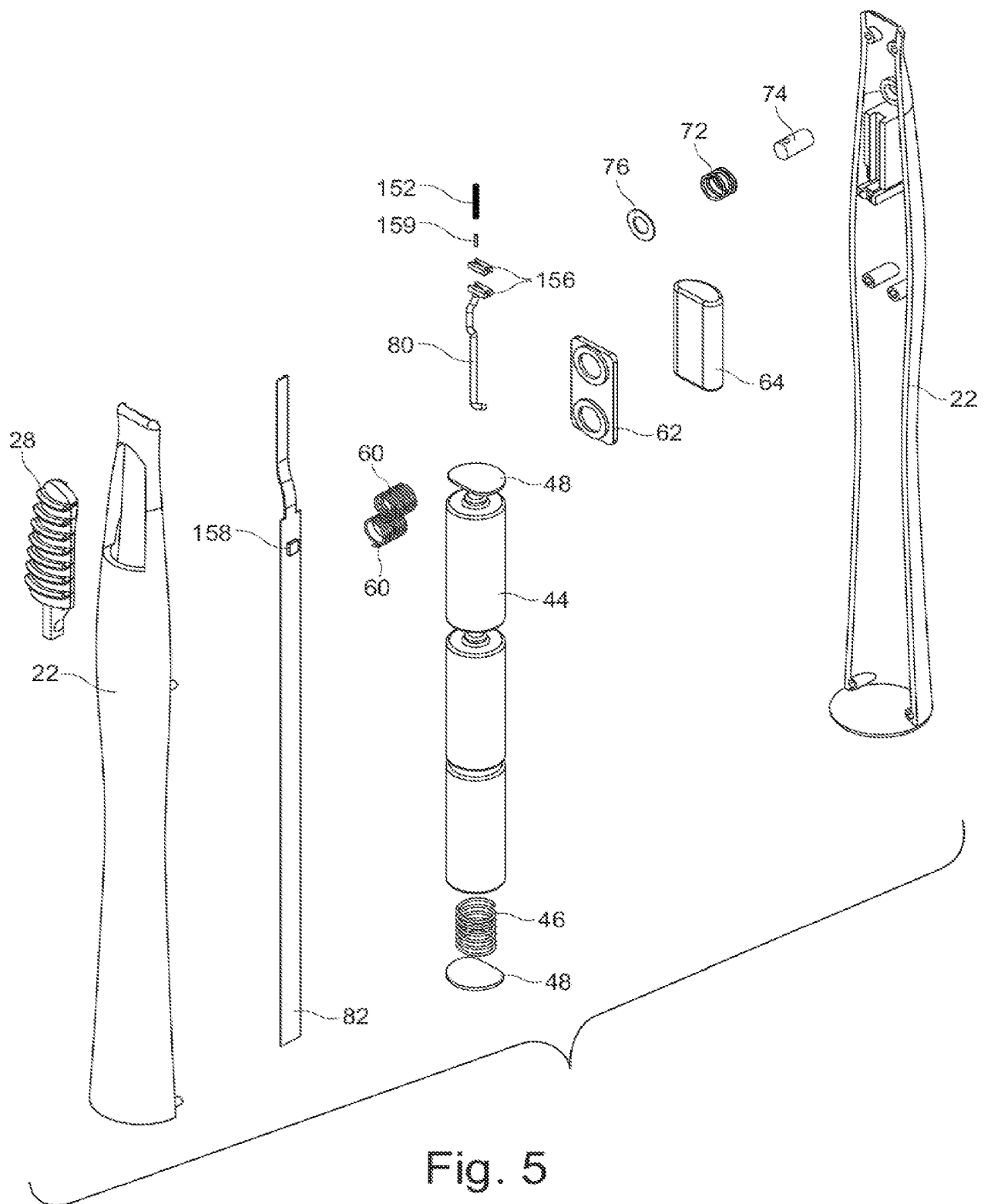


Fig. 5

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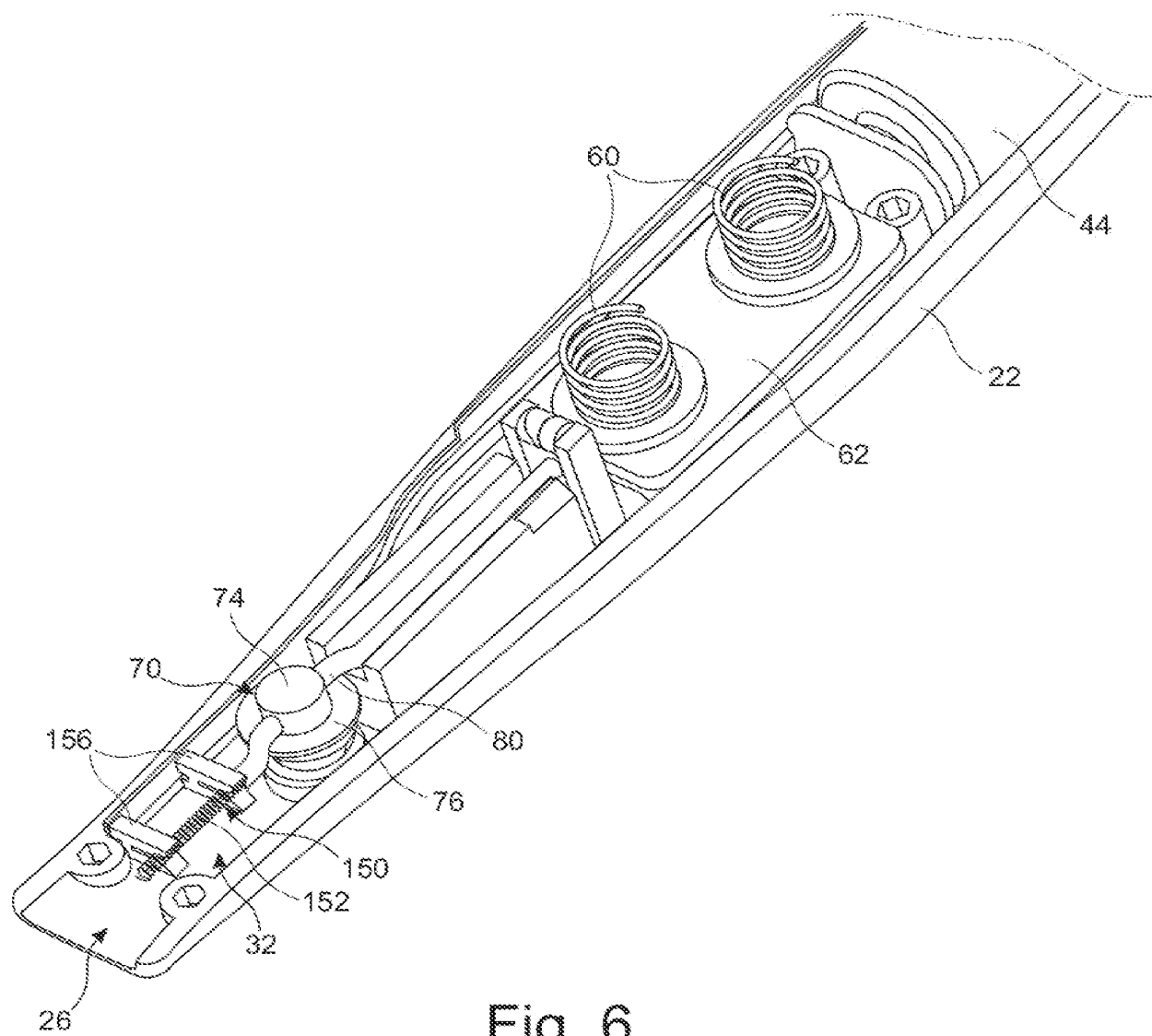


Fig. 6

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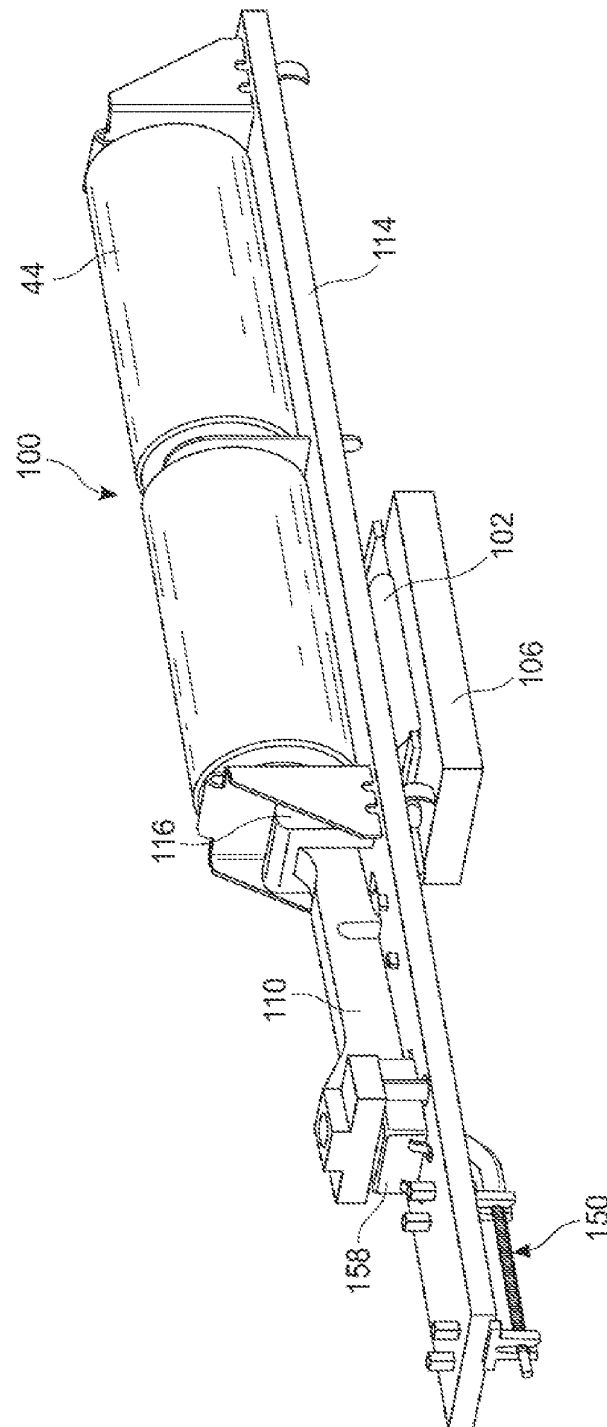


Fig. 7

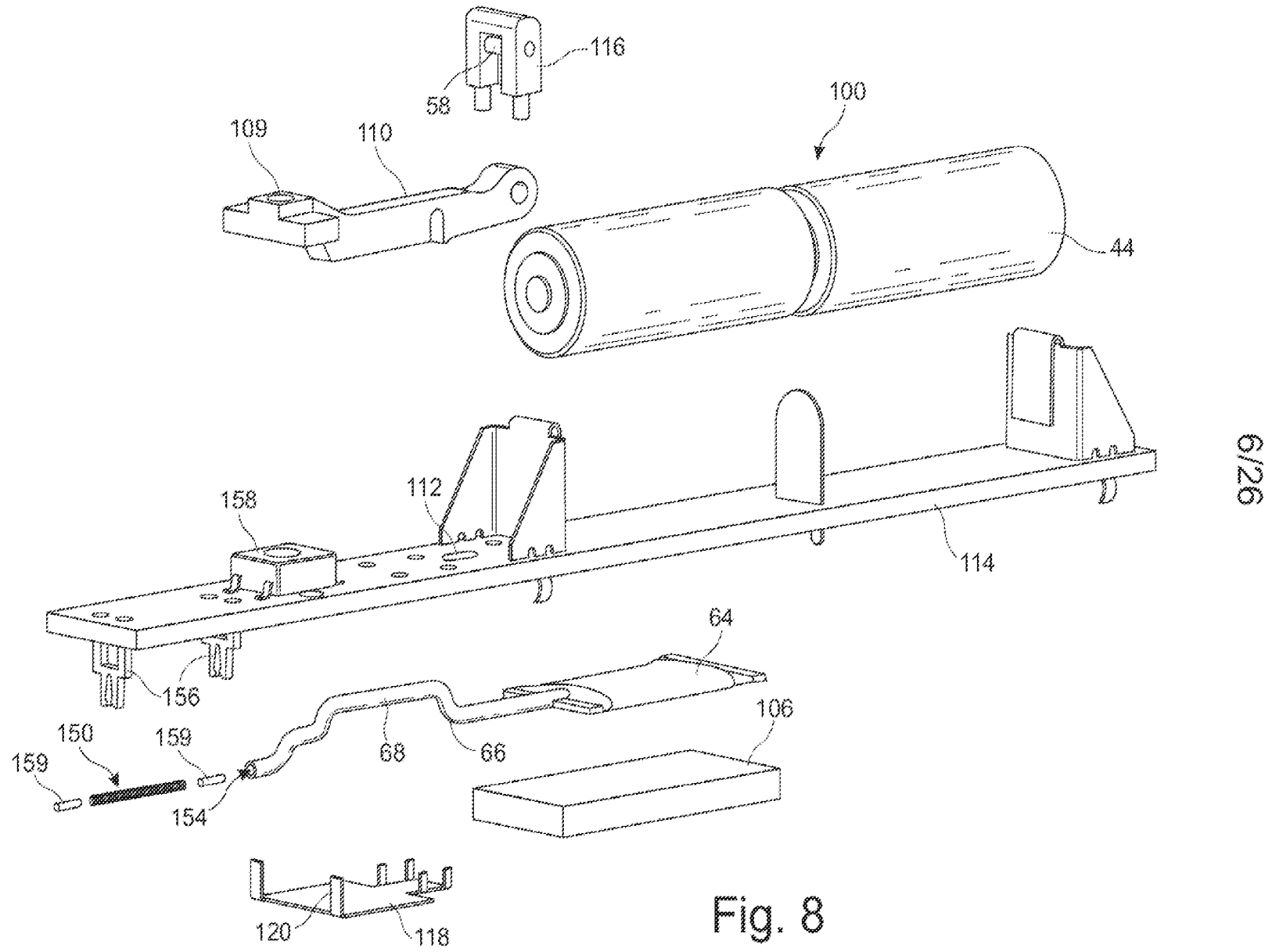
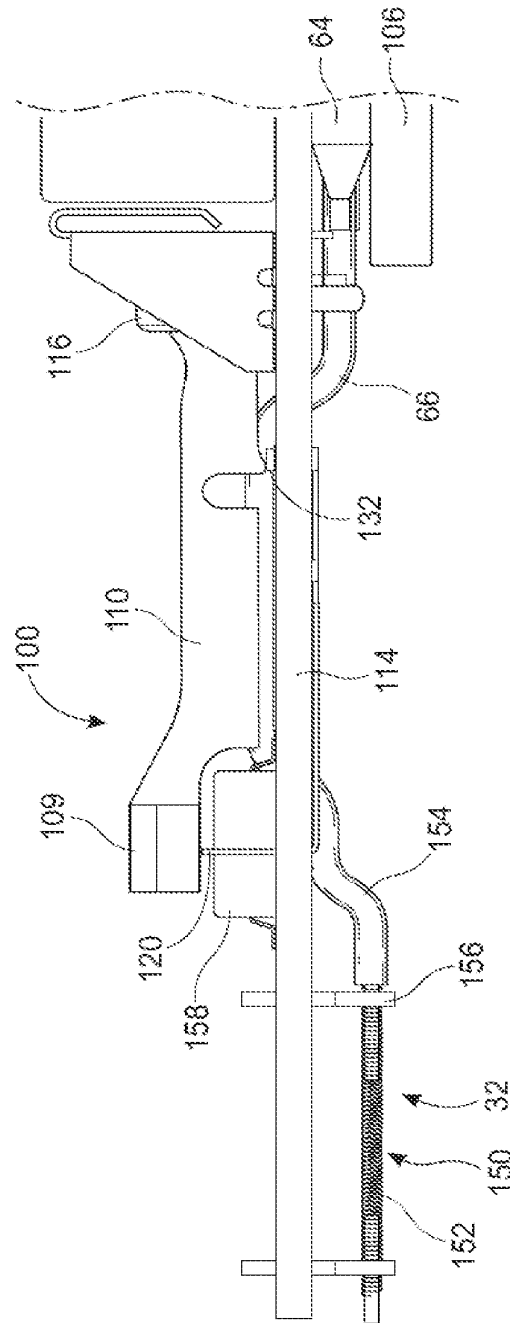


Fig. 8

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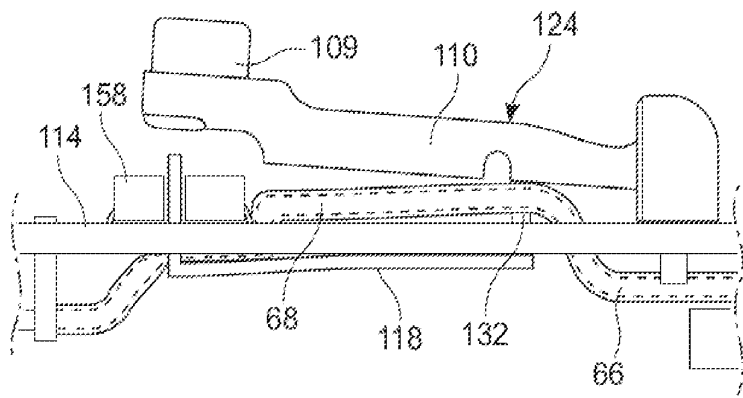


Fig. 10

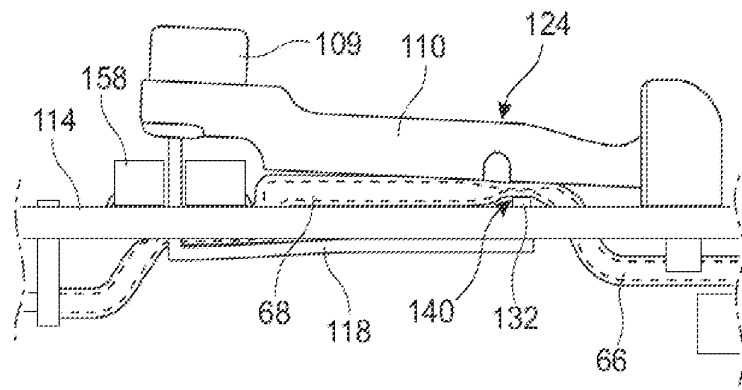


Fig. 11

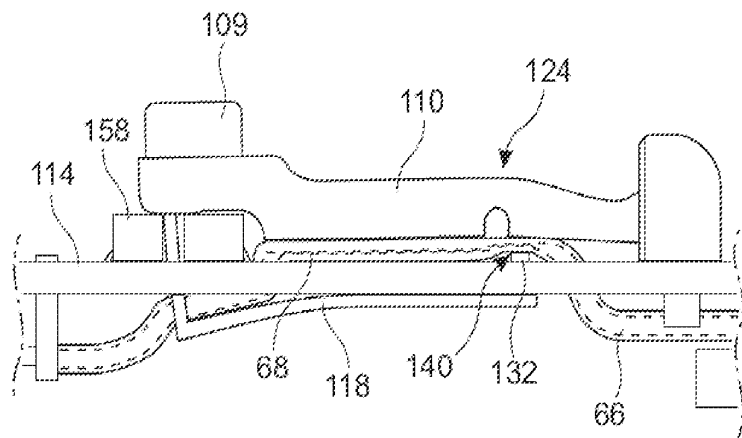


Fig. 12

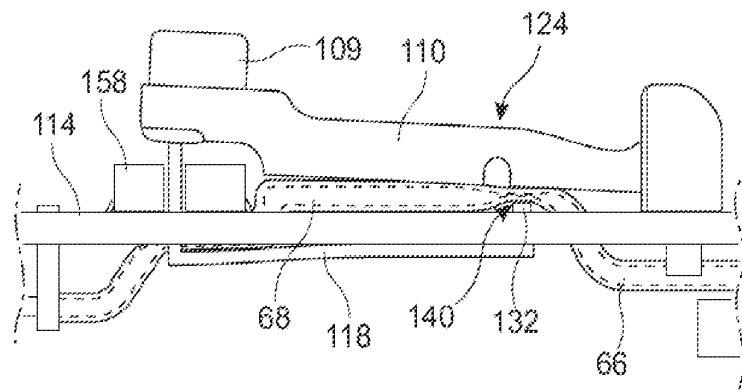
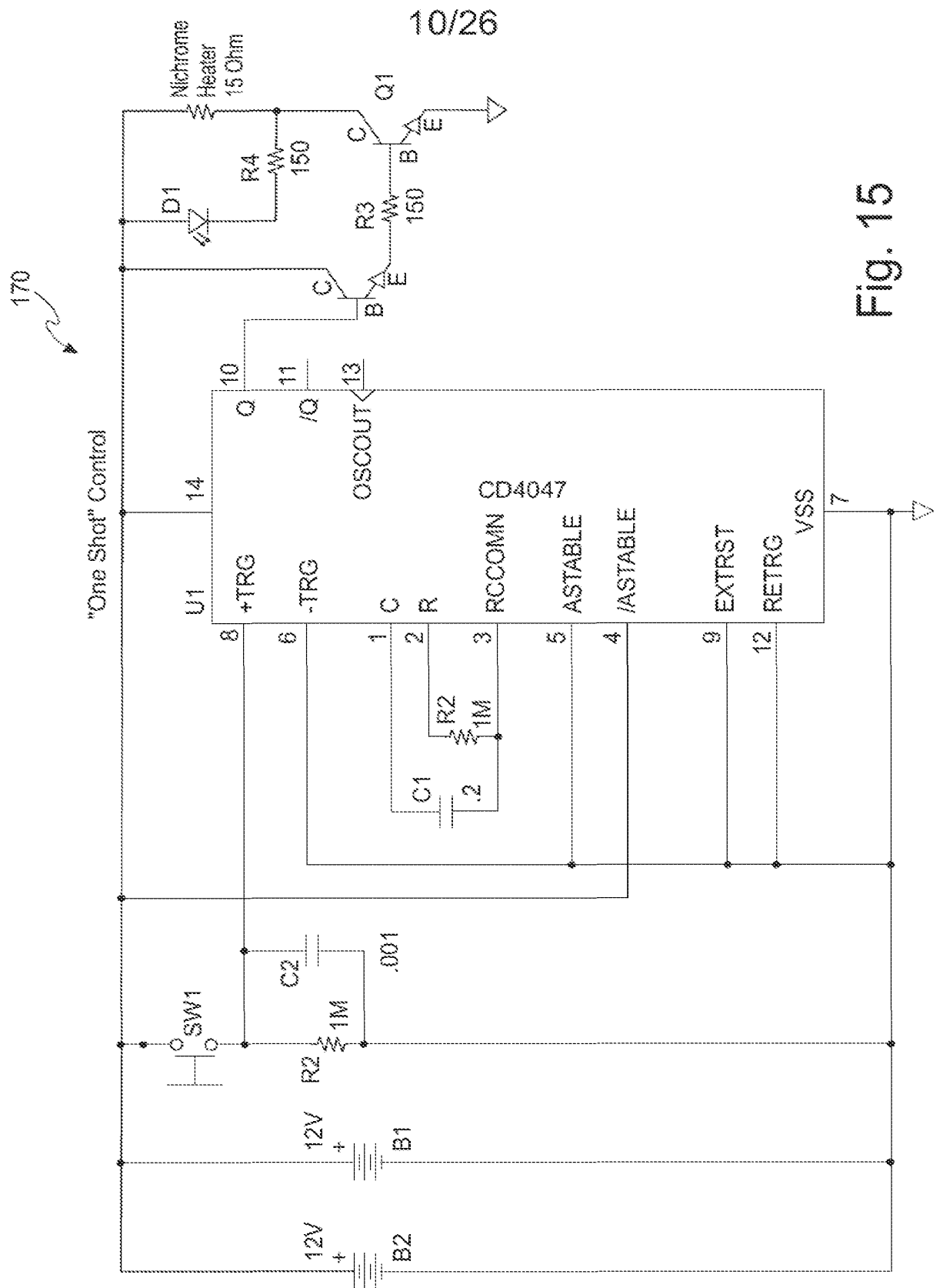


Fig. 13





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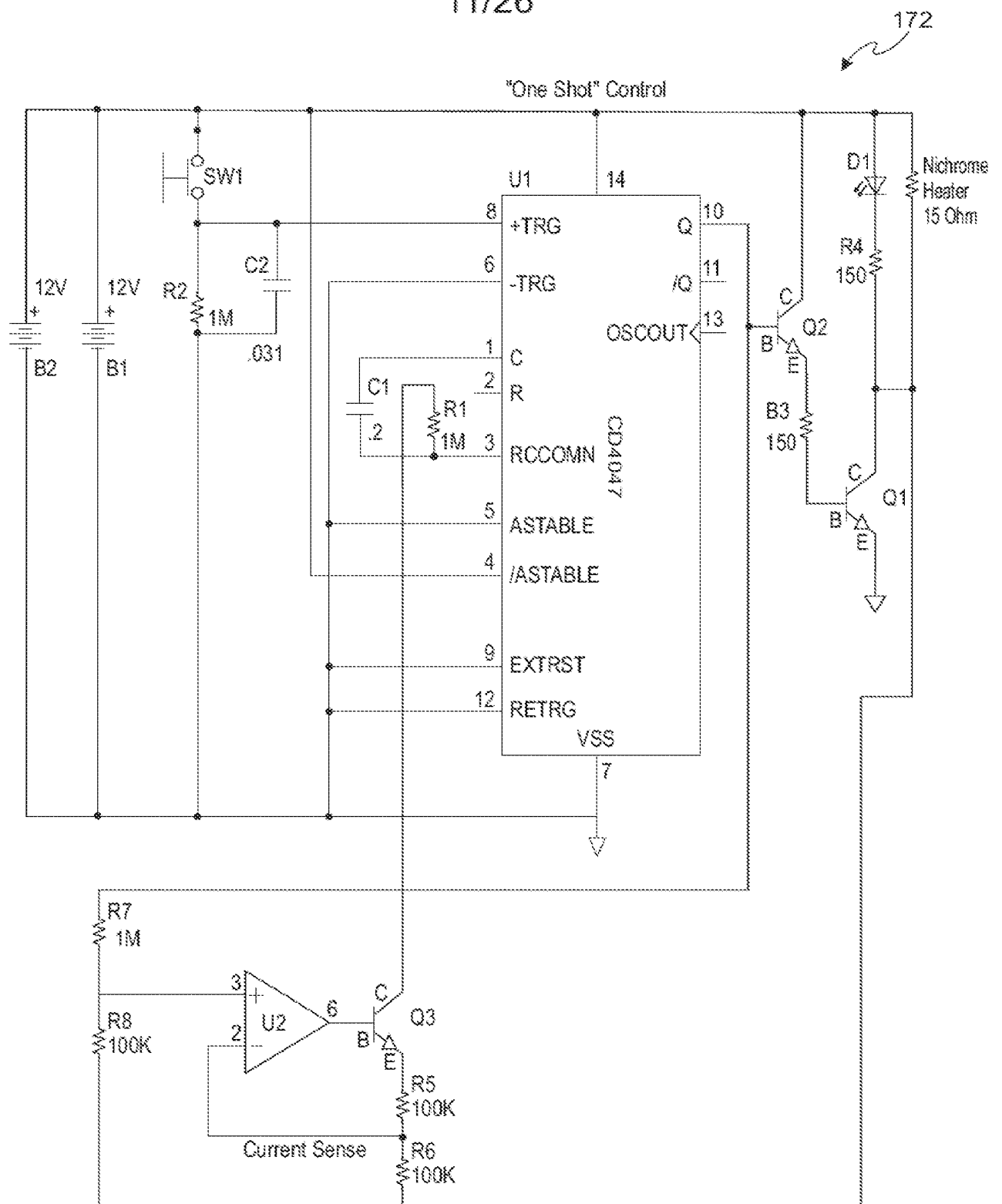


Fig. 16

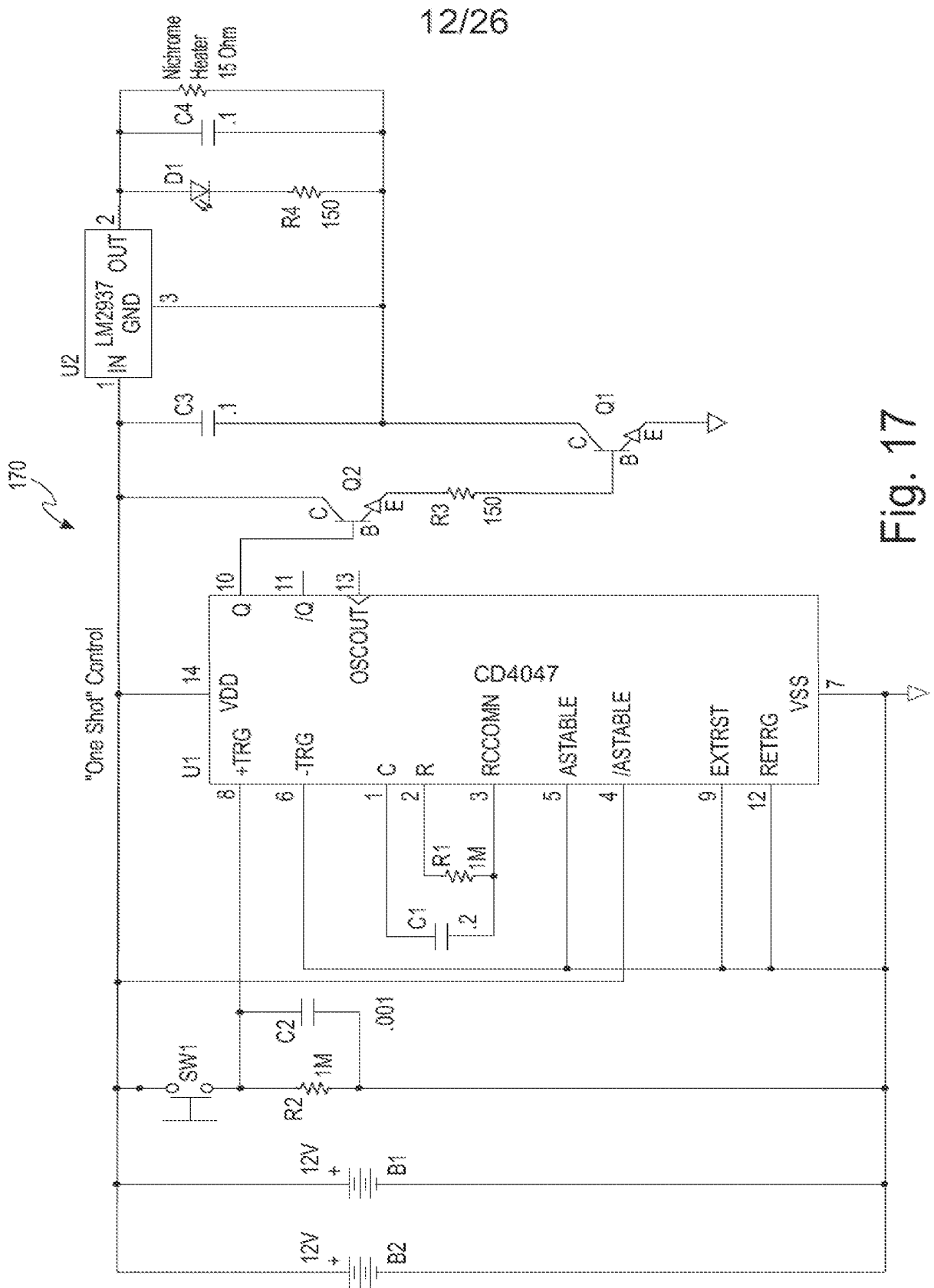


Fig. 17

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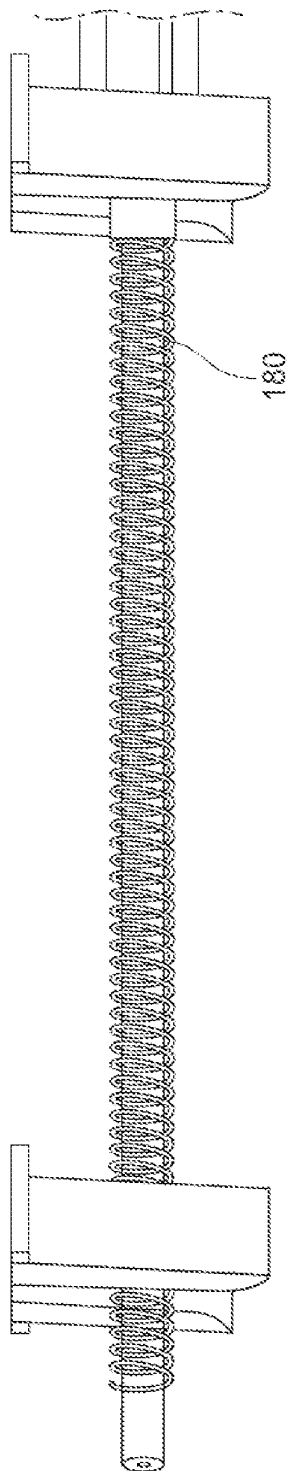


Fig. 18

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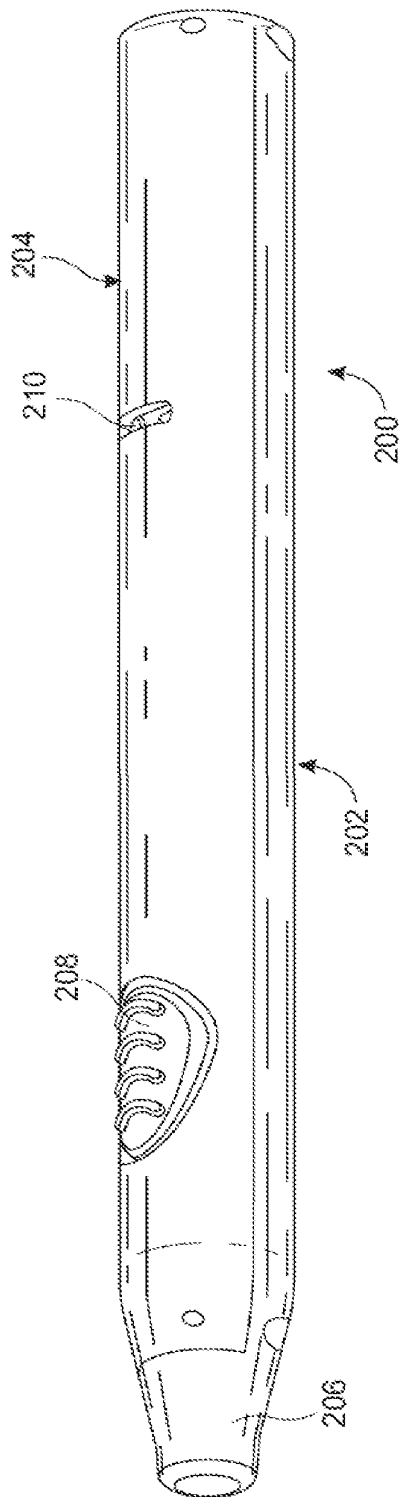


Fig. 19

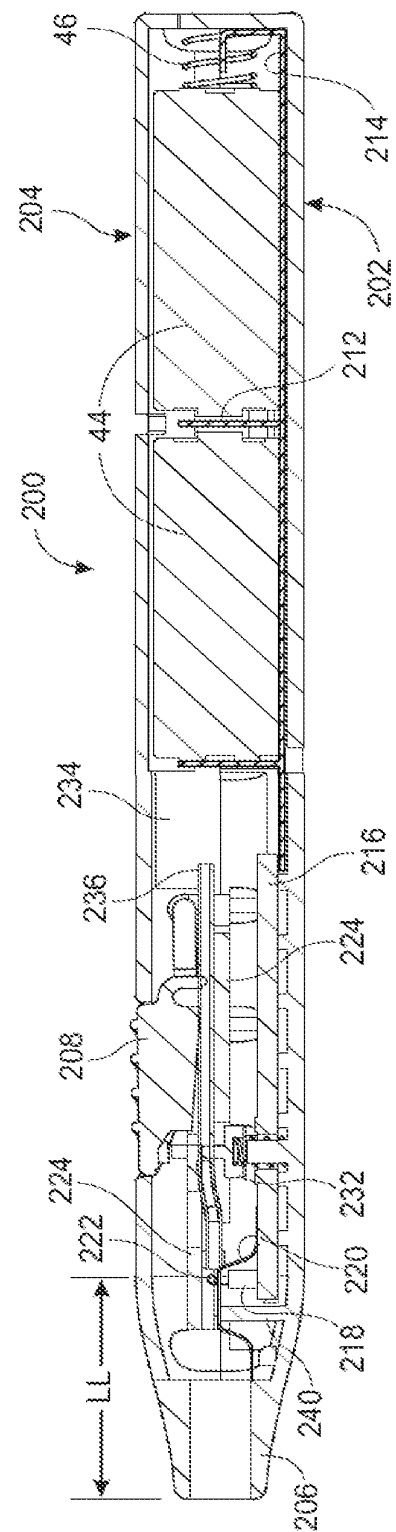
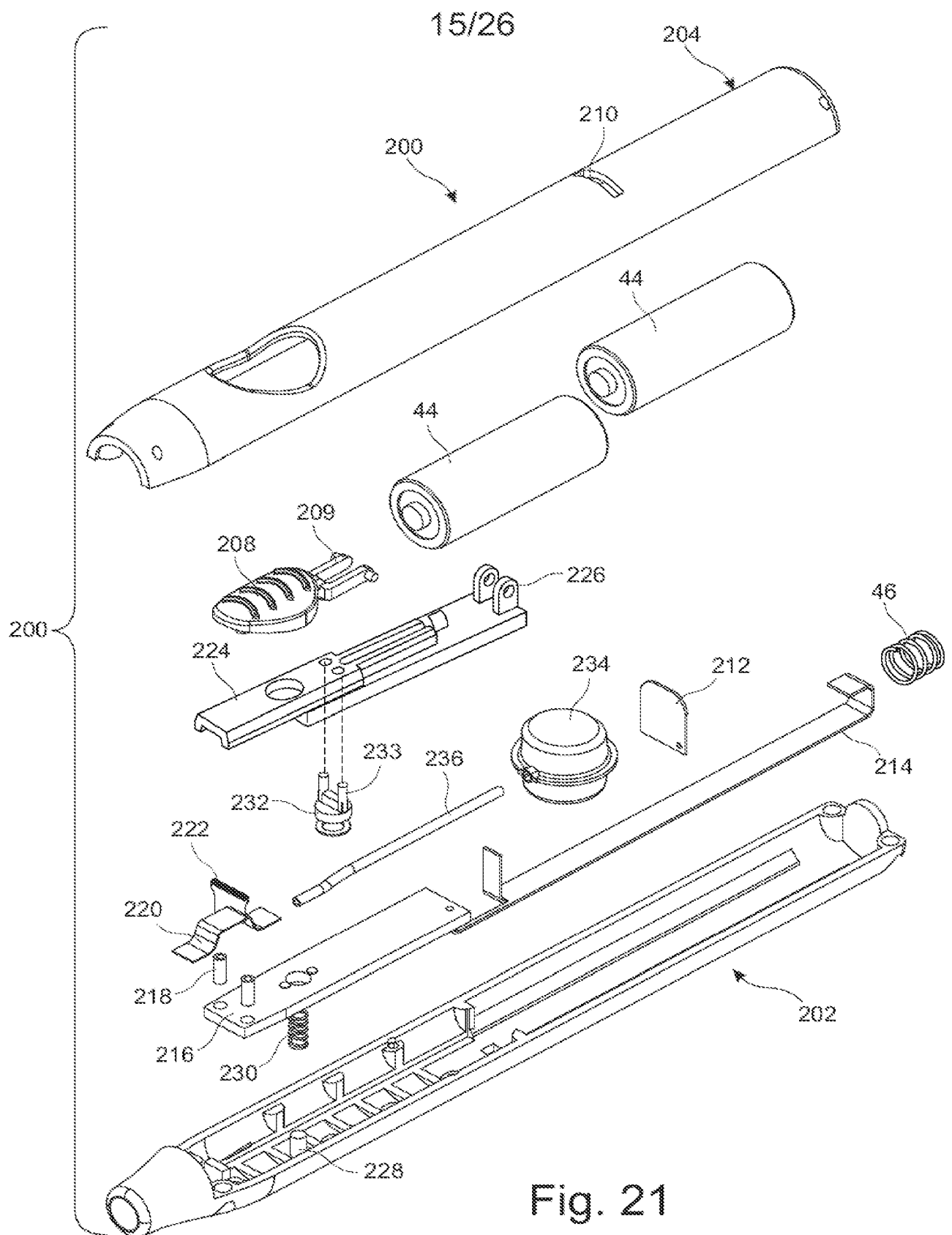


Fig. 20





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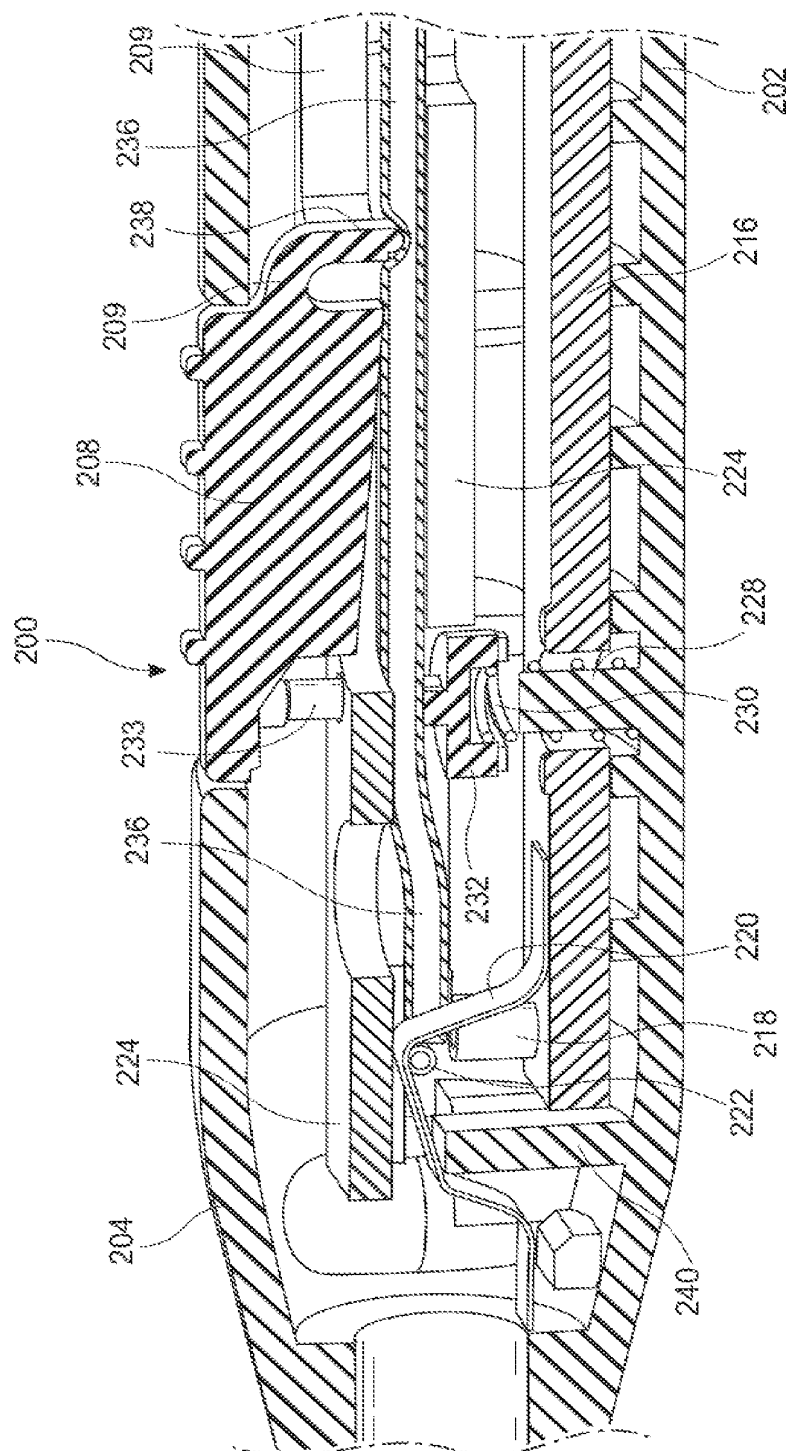


Fig. 22

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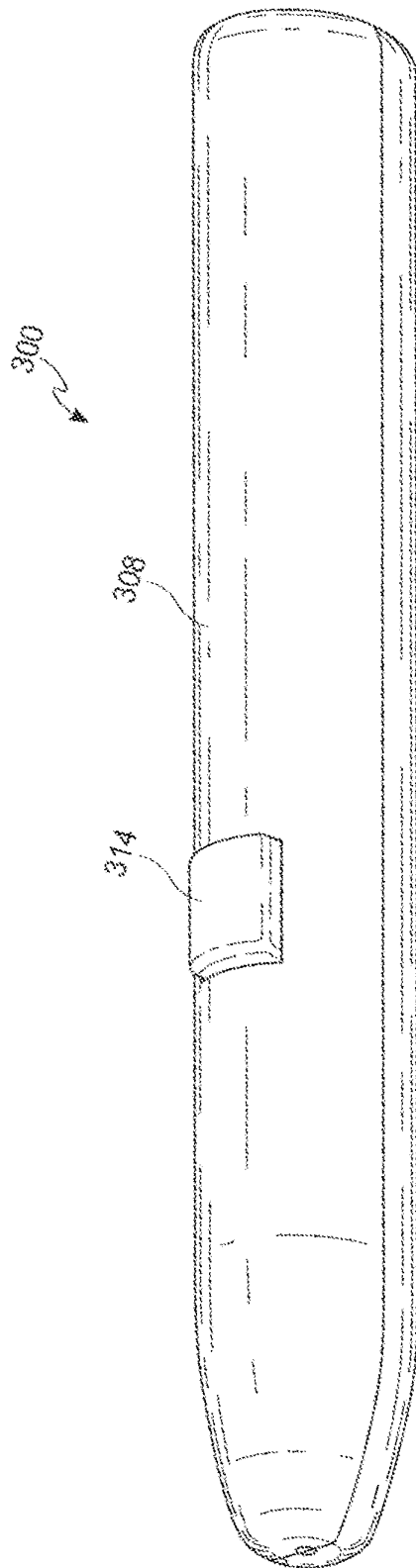
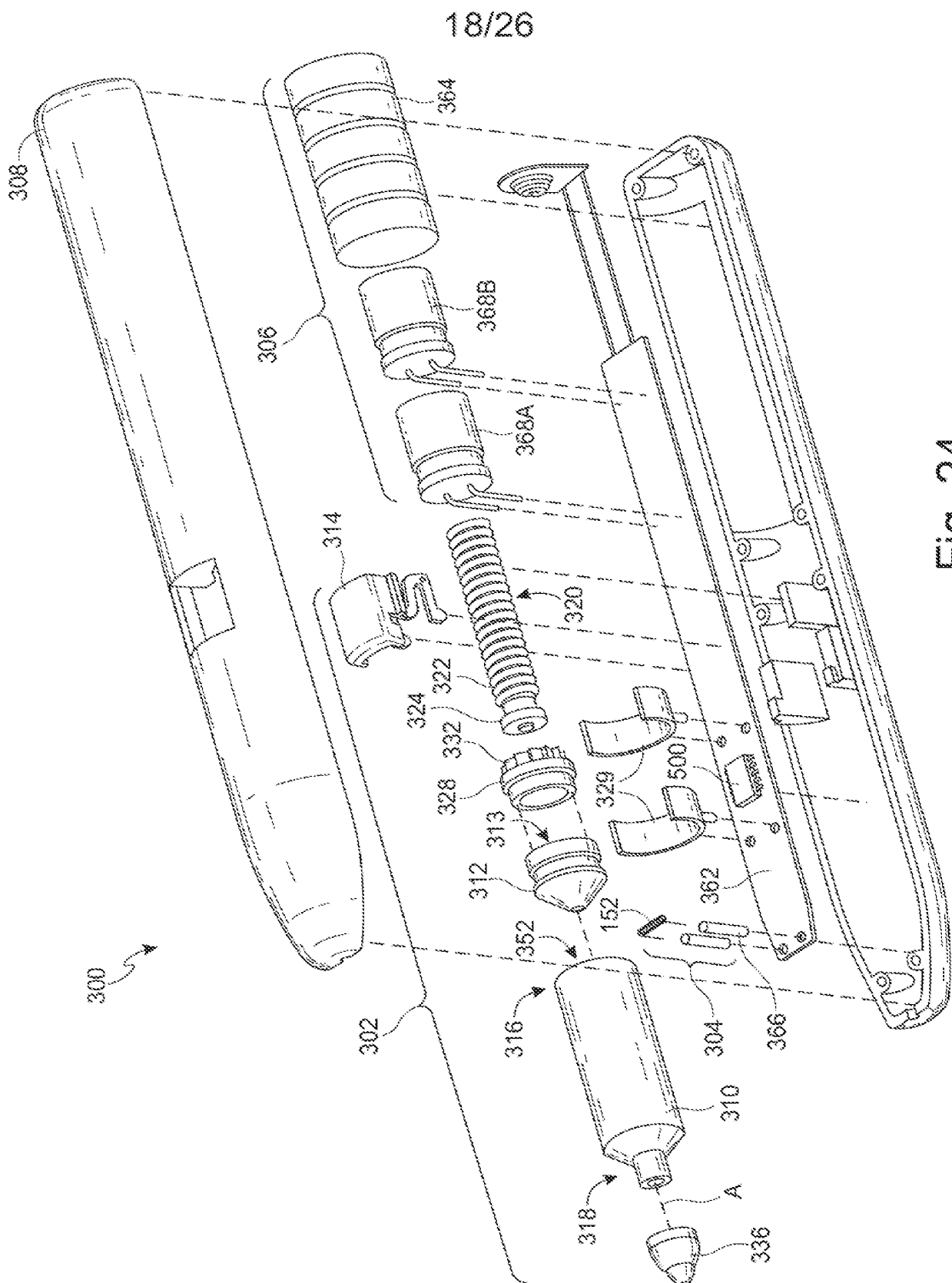


Fig. 23



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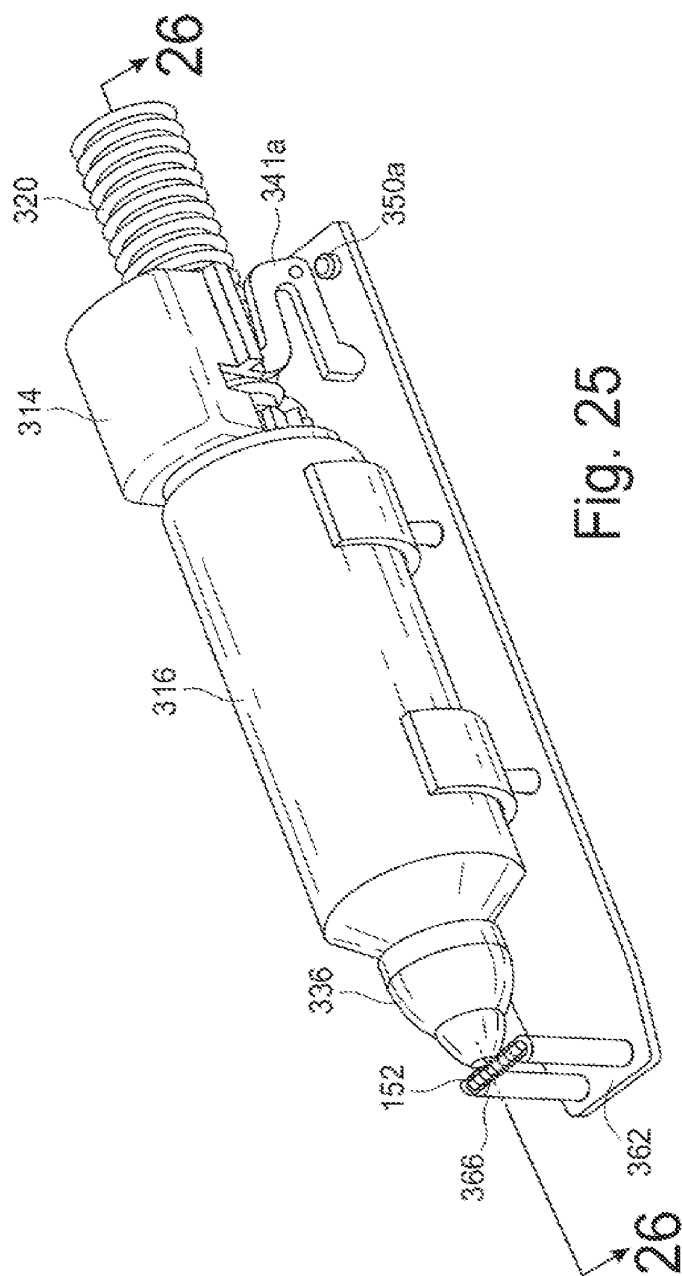


Fig. 25

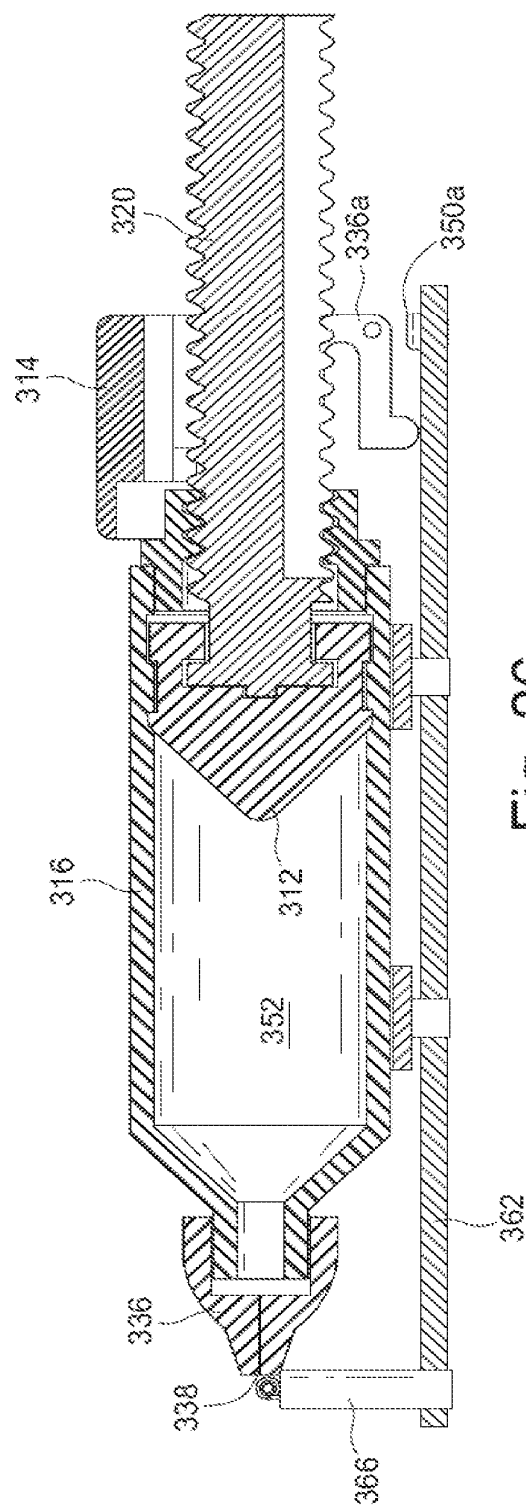


Fig. 26

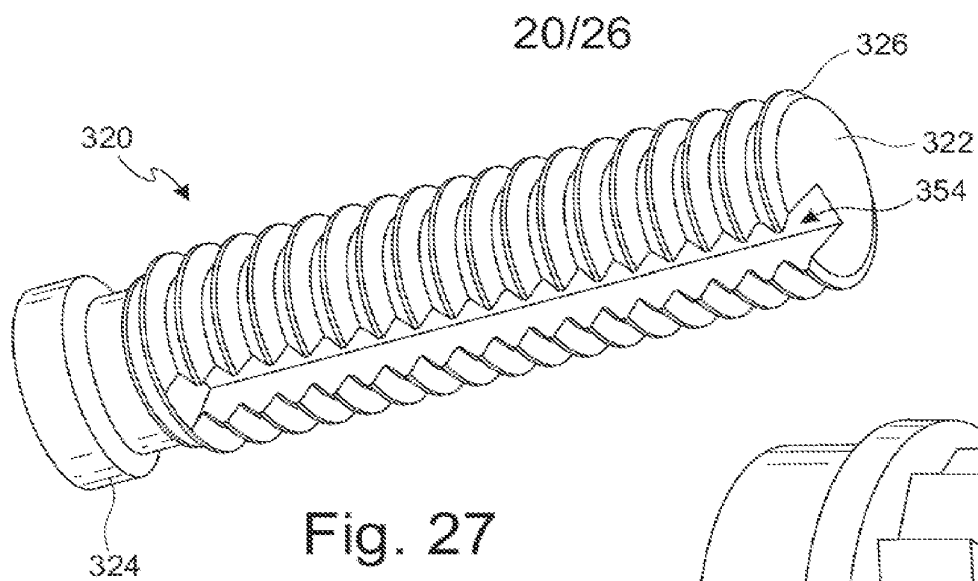


Fig. 27

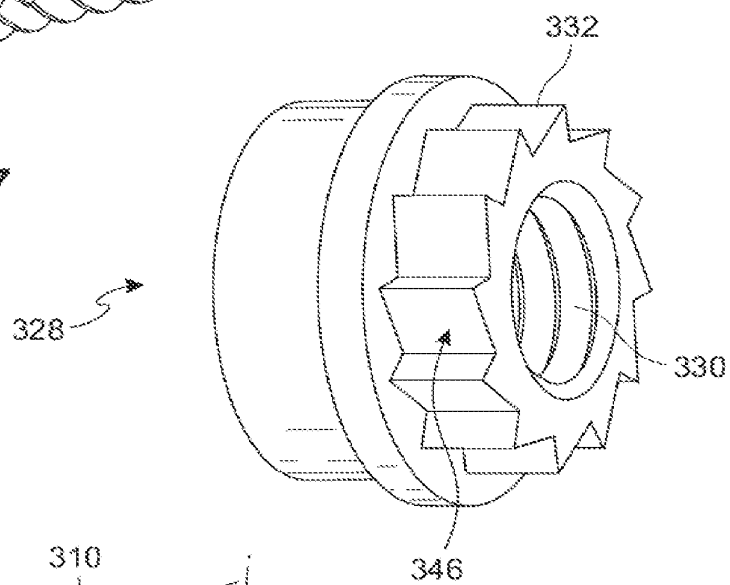


Fig. 28

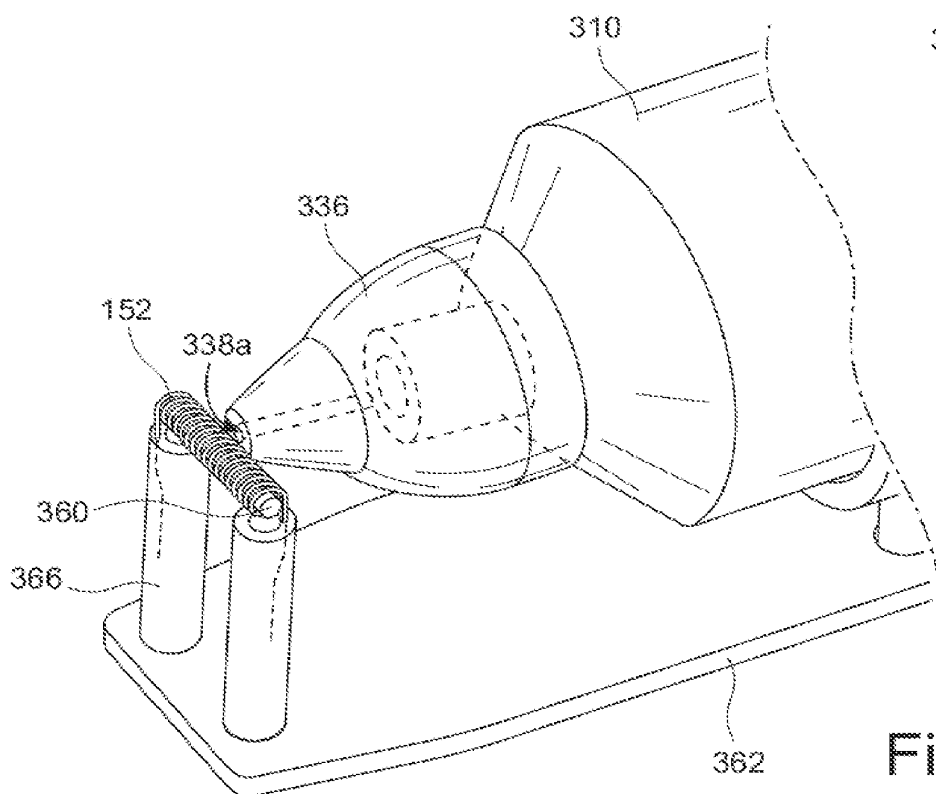


Fig. 29

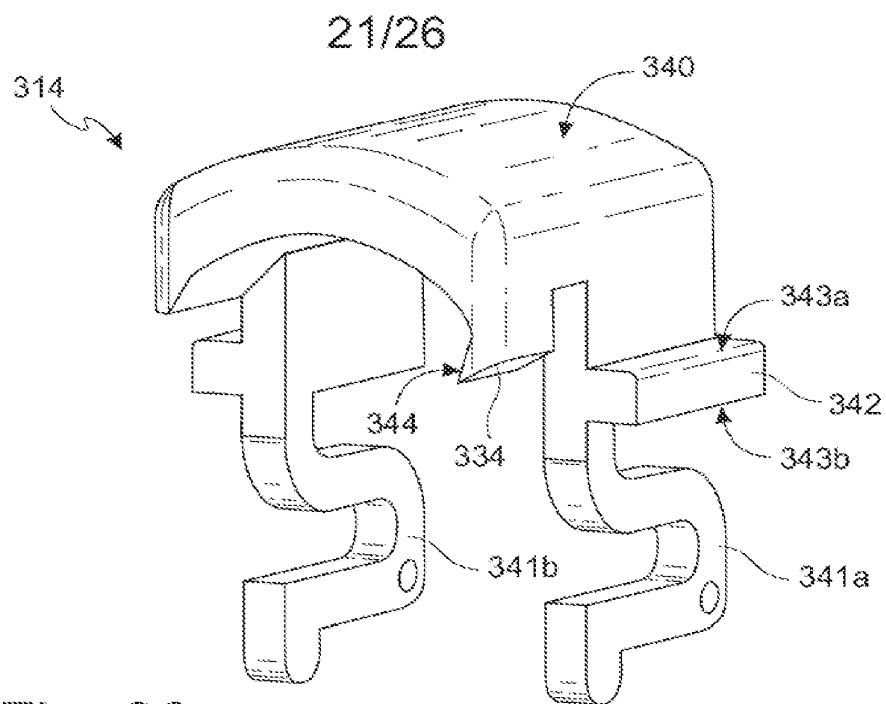


Fig. 30

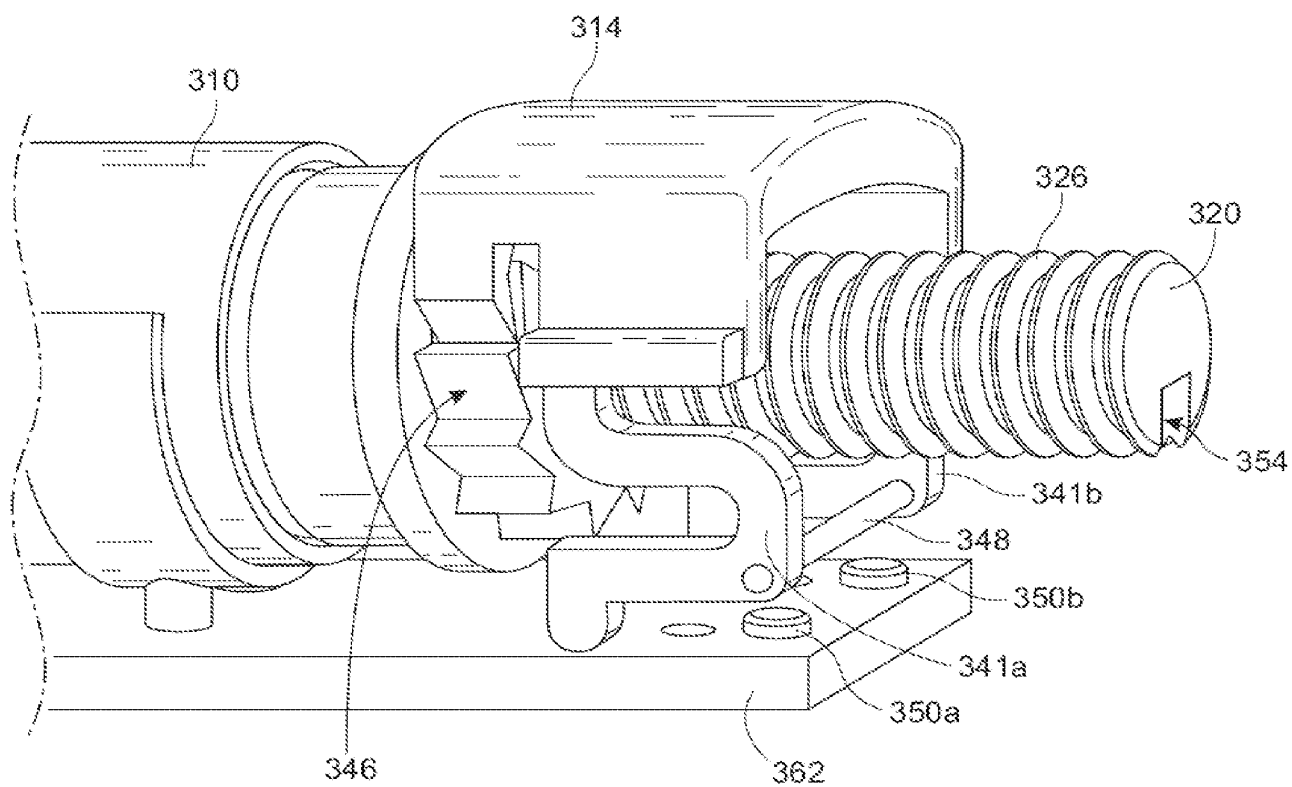


Fig. 31A

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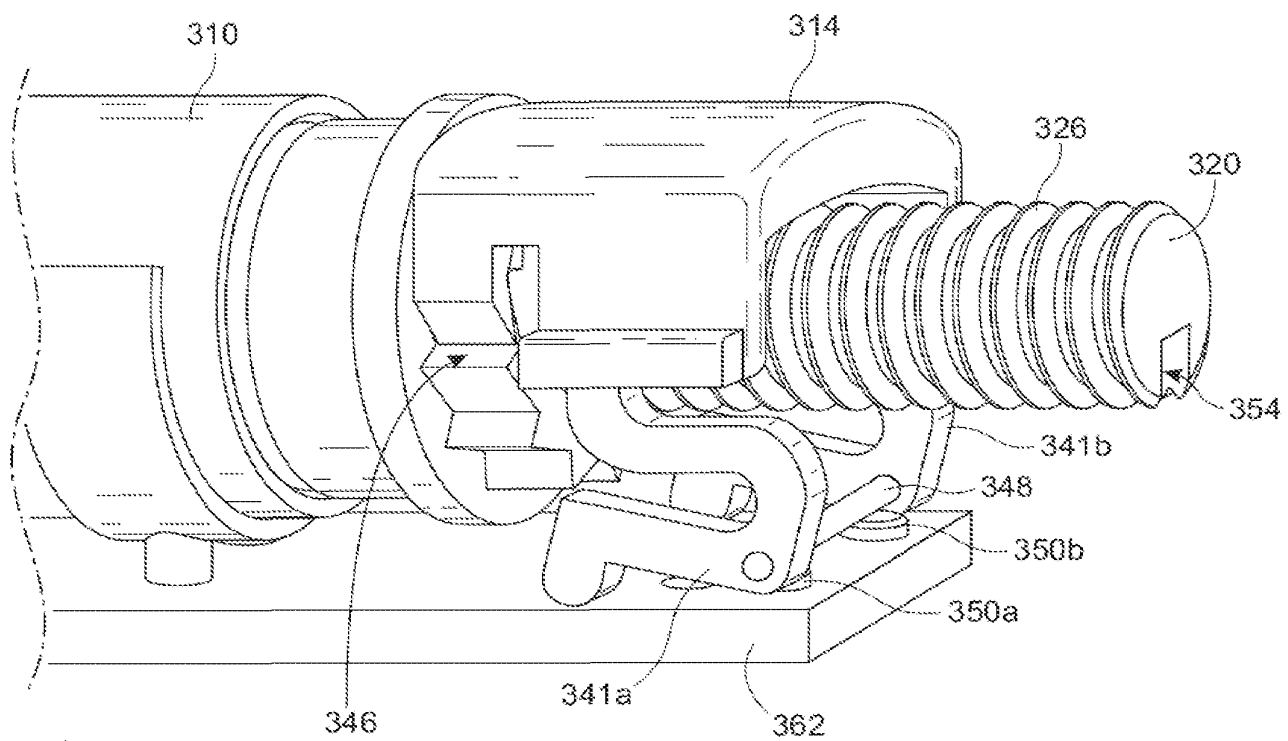


Fig. 31B

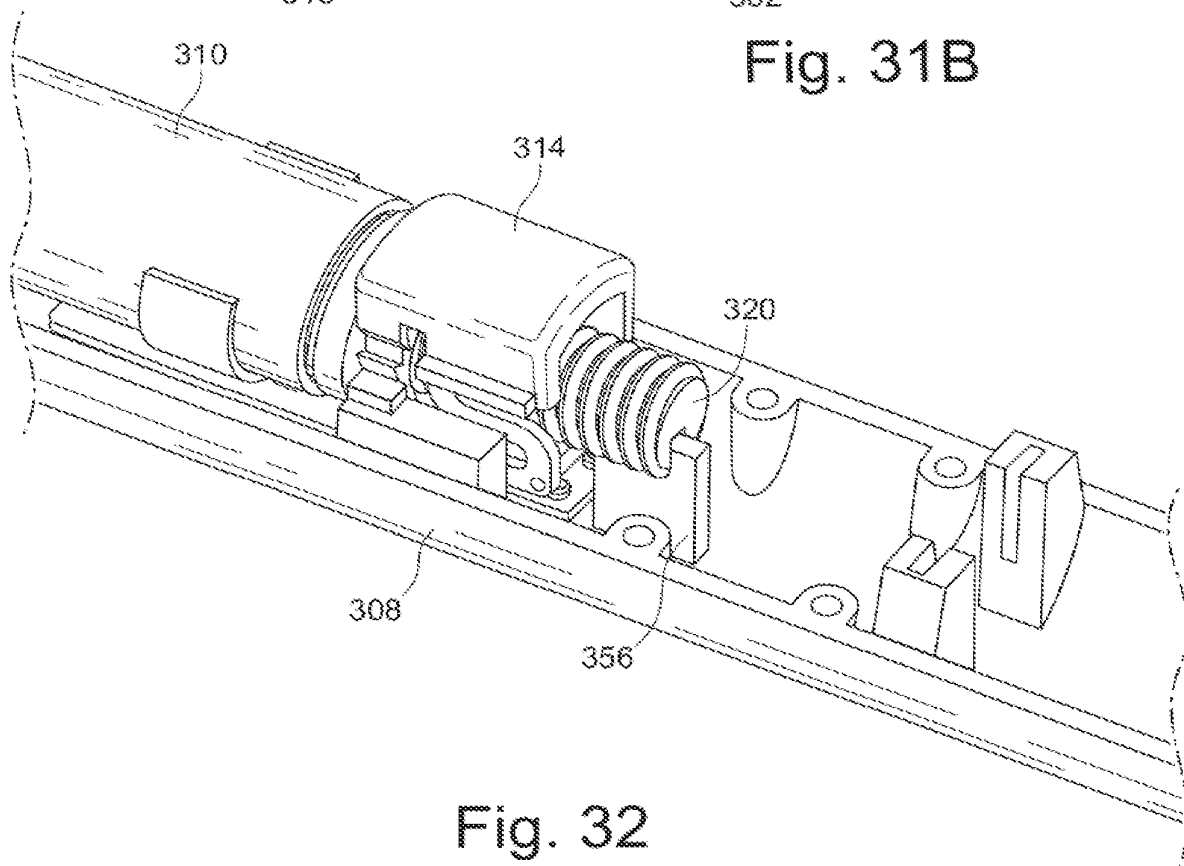


Fig. 32

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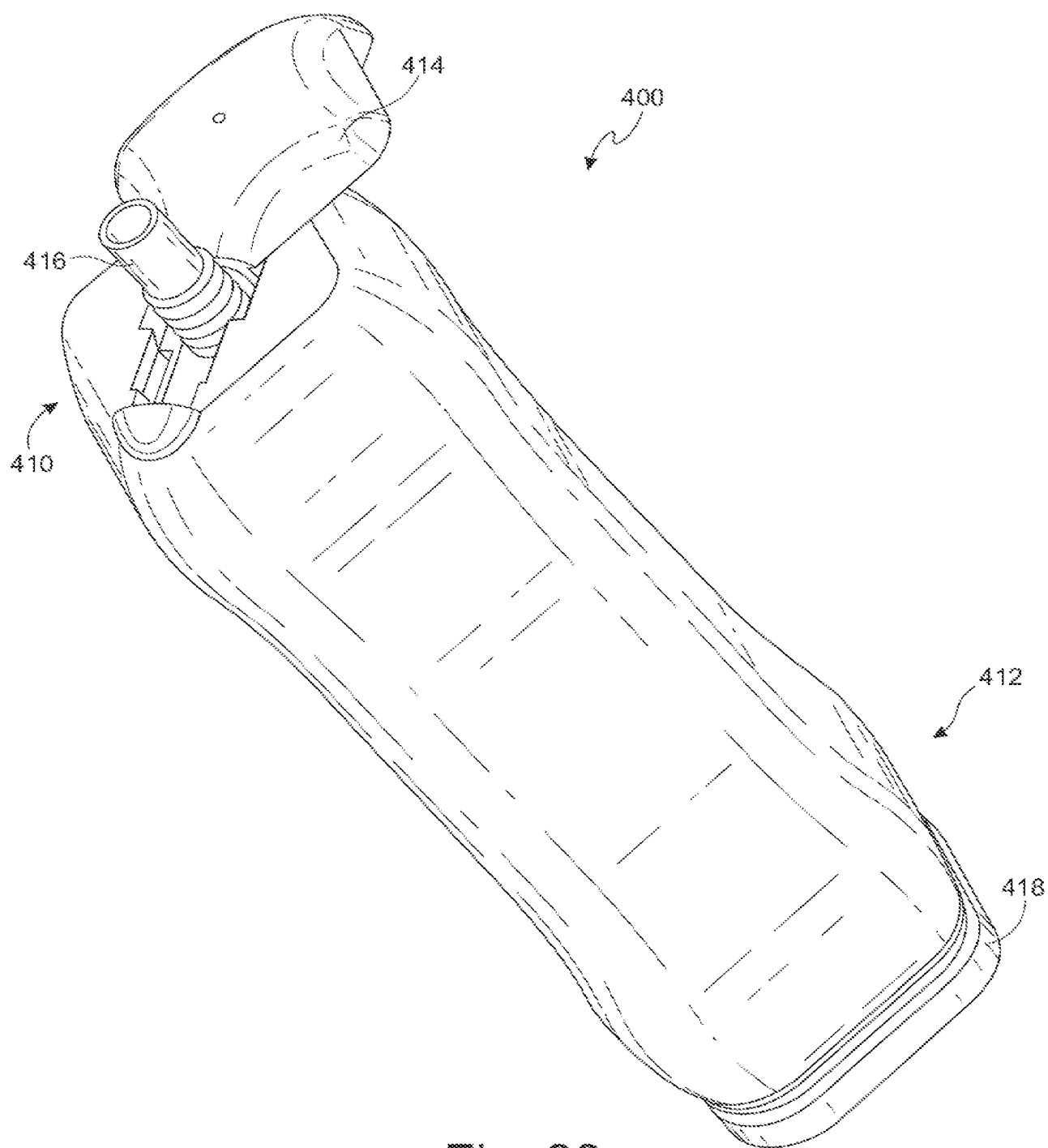


Fig. 33



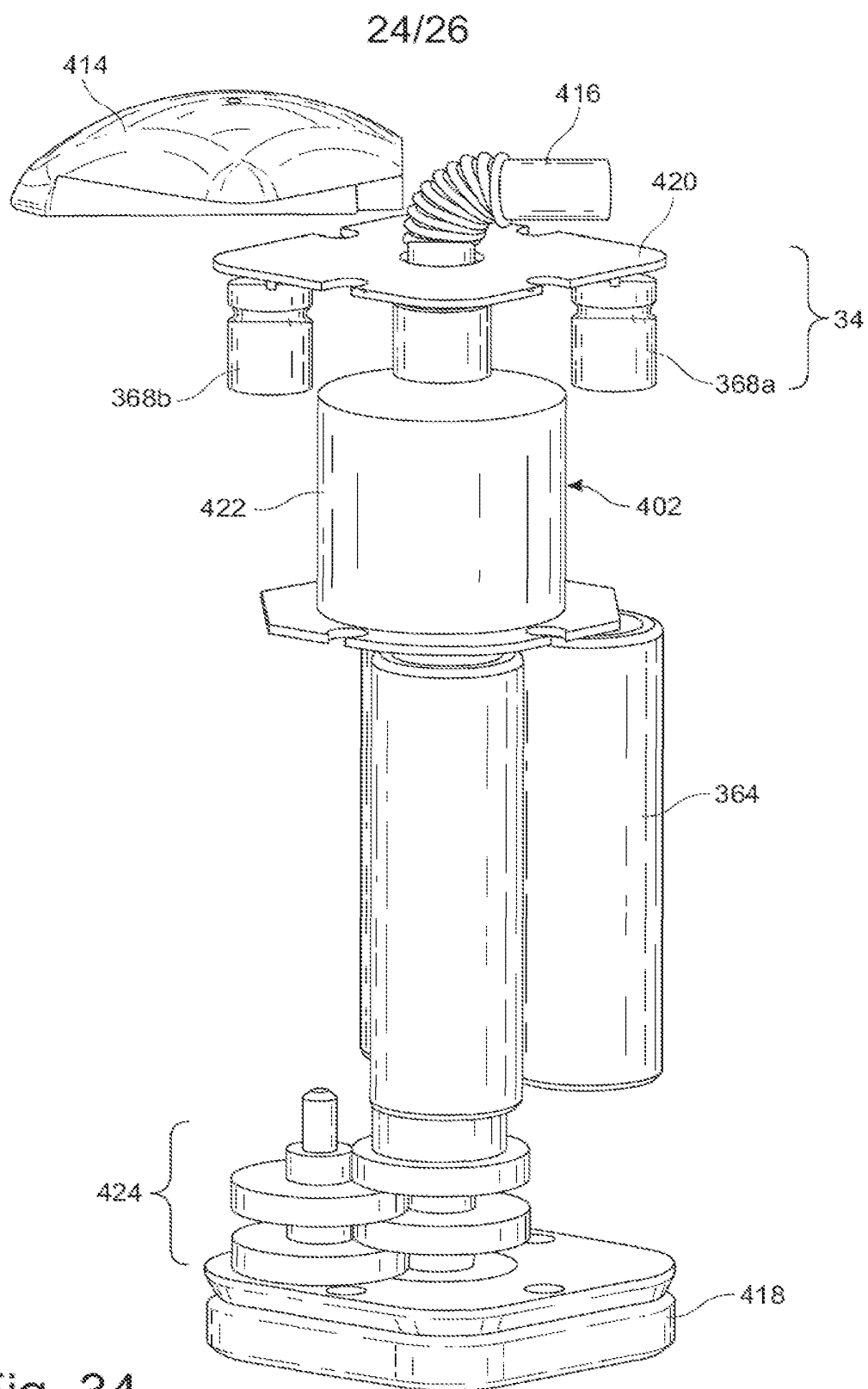


Fig. 34

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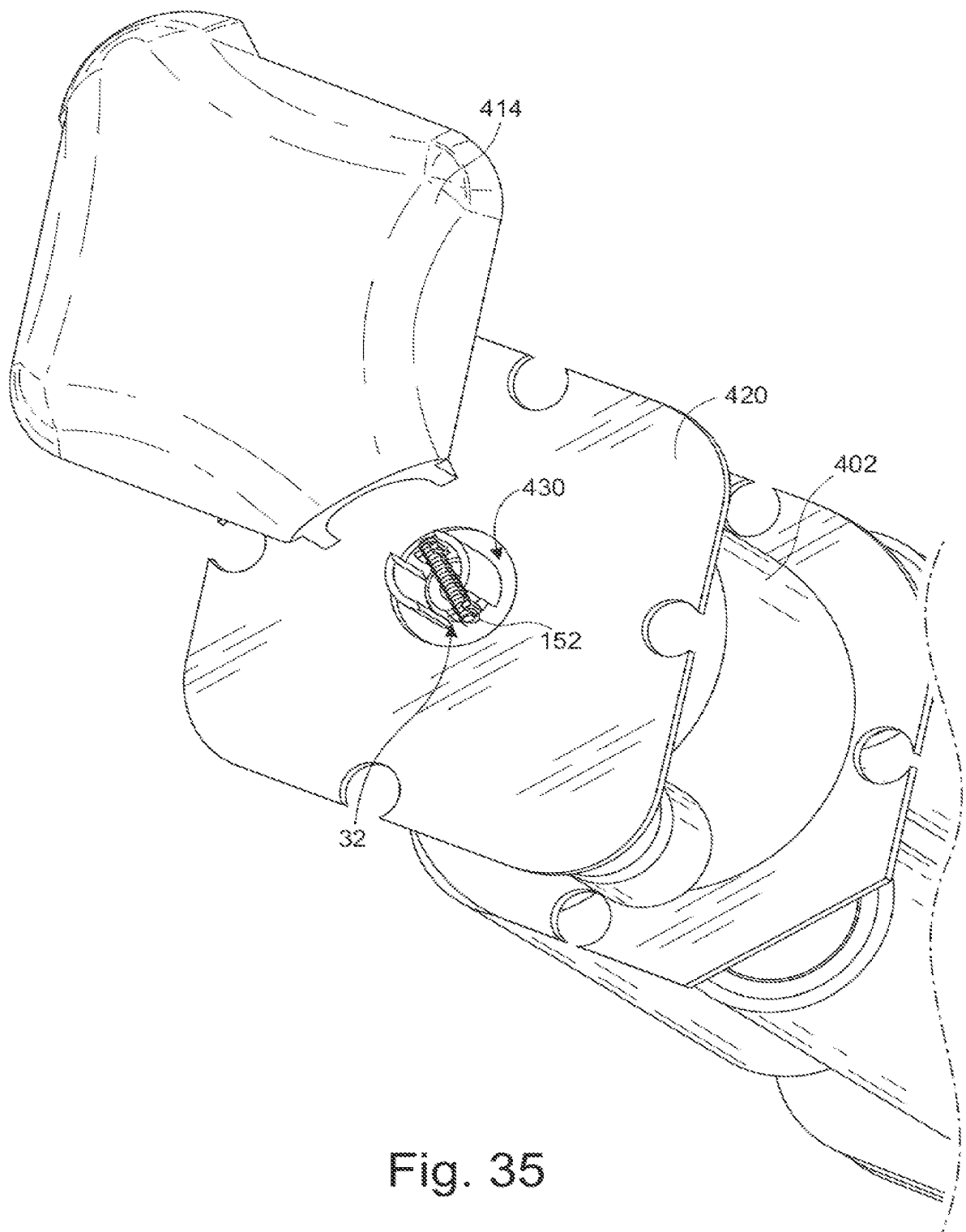


Fig. 35

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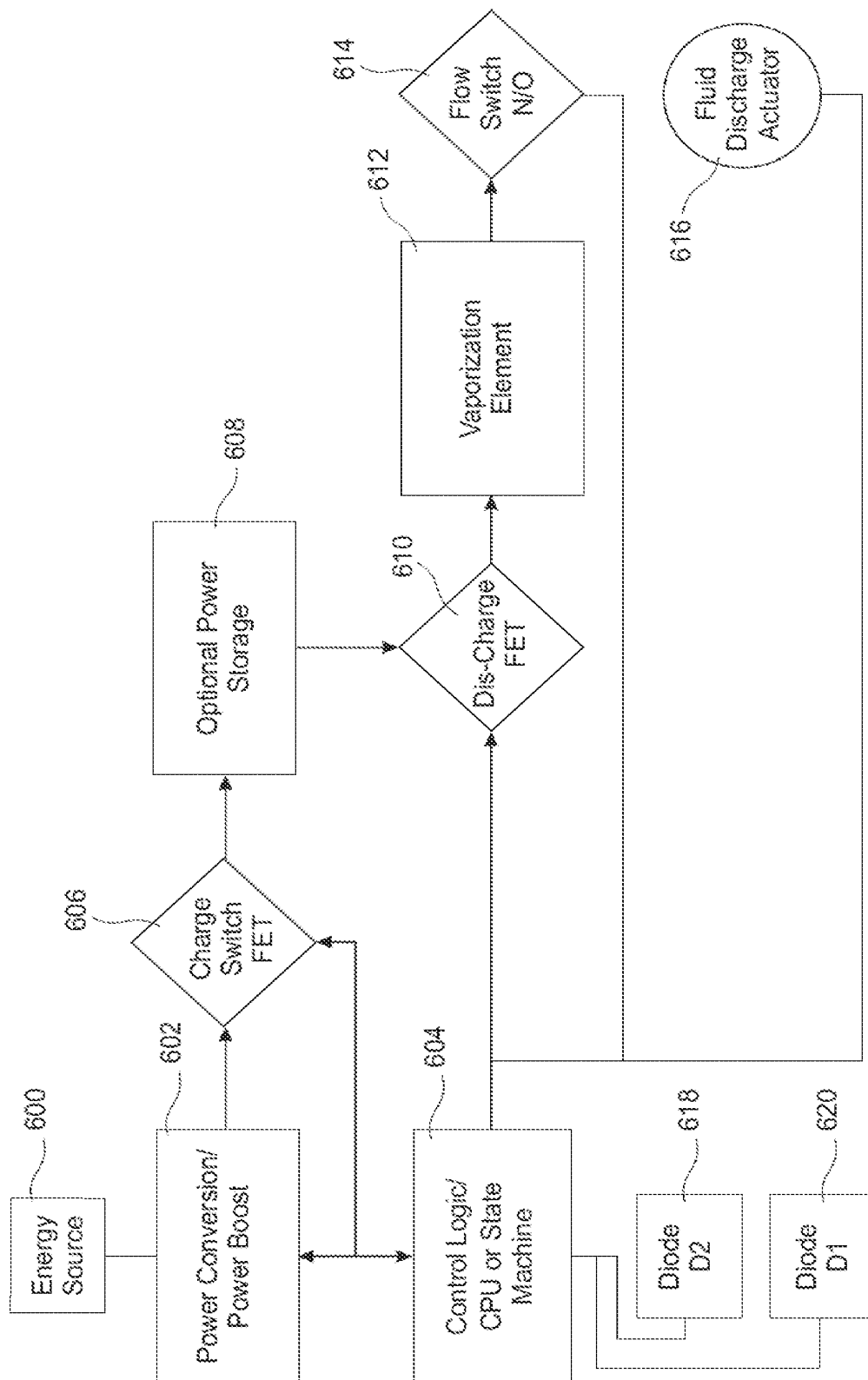


Fig. 36



## (51) International Patent Classification:

A61M 11/00 (2006.01) A61M 15/06 (2006.01)  
A61M 11/02 (2006.01) A61M 16/10 (2006.01)  
A61M 11/04 (2006.01) A61M 16/16 (2006.01)

## (21) International Application Number:

PCT/IB2012/052044

## (22) International Filing Date:

23 April 2012 (23.04.2012)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

13/044,355 9 March 2011 (09.03.2011) US  
61/478,460 22 April 2011 (22.04.2011) US

(71) Applicant (for all designated States except US): **CHONG CORPORATION** [—/US]; 5550 Nicollet Avenue, Minneapolis, Minnesota 55419 (US).

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(75) Inventors/Applicants (for US only): **GOODMAN, Jack** [US/US]; 3228 Cottontail Drive, Ann Arbor, Michigan 48105 (US). **O'NEILL, William** [US/US]; 16866 79th Place N, Maple Grove, Minnesota 55311 (US). **CHONG, Alexander ChinHak** [US/US]; 2744 Raleigh Ave., St. Louis Park, Minnesota 55416 (US). **BARTKOWSKI, William P.** [US/US]; 5223 Malibu Drive, Edina, Min-

nesota 55436 (US). **KOVACH, Peter Joseph** [US/US]; 211 Rice Creek Terrace NE, Fridley, Minnesota 55432 (US). **LINDE, Larry Gawain** [US/US]; 17595 Partridge Street NW, Andover, Minnesota 55304 (US). **BERG, Randy Eugene** [US/US]; 1631 99th Ave. Northwest, Coon Rapids, Minnesota 55433 (US).

(74) Agent: **VEREGGE, Peter S.**; Cislo & Thomas LLP, 1333 2nd Street, Suite No. 500, Santa Monica, California 90401 (US).

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## (54) Title: MEDICANT DELIVERY SYSTEM

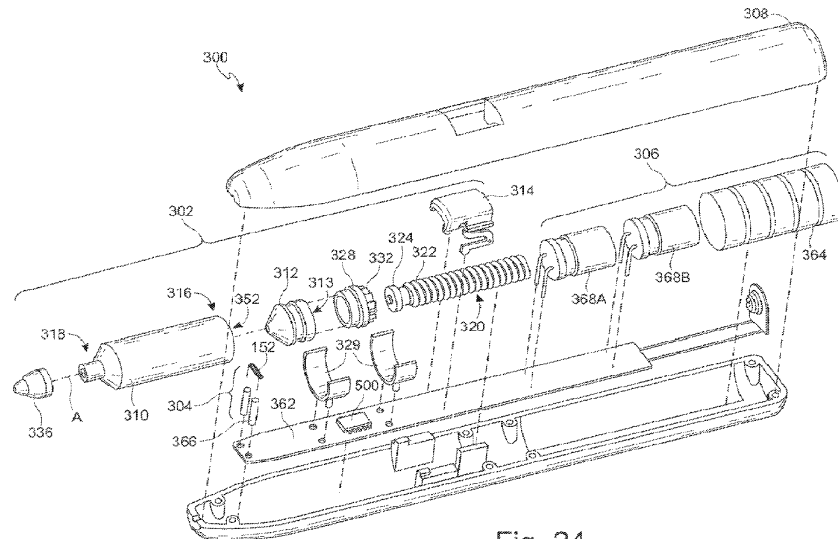


Fig. 24

(57) **Abstract:** An improved medicant delivery system 100 is disclosed wherein the carrier for the medicant is a fluid that can be atomized or vaporized by exposure to heat. The system provides for repeatable dose of medicant, can be stored in any orientation, and/or has an ability to maximize energy efficiency.



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, ML, MR, NE, SN, TD, TG).

**(88) Date of publication of the international search report:**  
17 January 2013

**Published:**

- *with international search report (Art. 21(3))*
- *with information concerning request for restoration of the right of priority in respect of one or more priority claims (Rules 26bis.3 and 48.2(b)(vii))*

**(15) Information about Correction:**

**Previous Correction:**  
see Notice of 29 November 2012

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB12/52044

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61M 11/00, 11/02, 11/04, 15/06, 16/10, 16/16 (2012.01)

USPC - 128/200.14, 203.27, 203.26, 204.17; 131/202, 273, 360

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC (8): A61M 11/02, 11/04, 11/00, 15/06, 16/10, 16/16 (2012.01)

USPC: 128/200.14, 203.27, 203.26, 204.17; 131/202, 273, 360

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)

MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google Scholar; Pubmed; Science Direct; simulated, imitated, substitute, electronic, cigarette, smoking, inhaler, atomizer, nebulizer, disperse, vaporize, evaporate, CPU, processor, controller, circuit, microprocessor, one-shot, monostable, capacitor, supercapacitor, resistor, outlet, exit, nozzle, orifice, DC/D

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category*   | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                | Relevant to claim No.                                                        |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| X<br>—<br>Y | US 2011/0036346 A1 (COHEN, SA et al.) February 17, 2011; figure 9; paragraphs [0003], [0018], [0020], [0028], [0031], [0032], [0039]-[0043]                                                                       | 1, 5, 6, 10, 22, 27-29, 33, 35<br>-----<br>2-4, 7-9, 11-21, 23-26, 30-32, 34 |
| Y           | US 5928189 A (PHILLIPS, RE et al.) July 27, 1999; figure 6; column 1, lines 5-10; column 4, lines 65-68; column 5, lines 1-5                                                                                      | 2, 7                                                                         |
| Y           | US 6845216 B2 (SHUSTER, JA et al.) January 18, 2005; column 4, lines 15-17; column 7, lines 54-68; column 10, lines 60-65; column 13, lines 25-35; column 13, lines 30-40; column 15, line 66; column 15, line 68 | 3, 8, 30                                                                     |
| Y           | US 2008/0315829 A1 (JONES, SMR et al.) December 25, 2008; figure 11; paragraphs [0008], [0031], [0041], [0050], [0052], [0072], [109]                                                                             | 11-21, 23-26, 31, 32                                                         |
| Y           | EP 1731228 B1 (GOODCHILD, MS) August 11, 201; paragraphs [0001], [0017], [0024]; figure 1                                                                                                                         | 4, 9                                                                         |
| Y           | US 2006/0196518 A1 (HON, L) September 7, 2006; paragraph [0021]                                                                                                                                                   | 14, 19                                                                       |
| Y           | US 2006/0260626 A1 (LUAN, Z et al.) November 23, 2006; figure 2; paragraphs [0004], [0022], [0039]                                                                                                                | 16, 21, 34                                                                   |
| Y           | US 2010/0186739 A1 (KRONESTEDT, V et al.) July 29, 2010; figures 1, 2; paragraphs [0001], [0063], [0068], [0075], [0078], [0079]                                                                                  | 25, 26                                                                       |

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"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

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Date of the actual completion of the international search

01 October 2012 (01.10.2012)

Date of mailing of the international search report

16 OCT 2012

Name and mailing address of the ISA/US

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P.O. Box 1450, Alexandria, Virginia 22313-1450  
Facsimile No. 571-273-3201

Authorized officer:

Shane Thomas

PCT Helpdesk: 571-272-4300

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**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/IB12/52044

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                    |                       |
|-------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y                                                     | US 2010/0268171 A1 (MOLLER, CS) October 21, 2010; figures 2, 3; Claim 1            | 26                    |

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## CORRECTED VERSION

(19) World Intellectual Property  
Organization  
International Bureau



WIPO | PCT



(10) International Publication Number

**WO 2012/120487 A8**

(43) International Publication Date  
13 September 2012 (13.09.2012)

(51) International Patent Classification:  
*F22B 1/28* (2006.01)

(21) International Application Number:  
PCT/IB2012/052044

(22) International Filing Date:  
23 April 2012 (23.04.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
13/044,355 9 March 2011 (09.03.2011) US  
61/478,460 22 April 2011 (22.04.2011) US

(71) Applicant (for all designated States except US): **CHONG CORPORATION** [—/US]; 5550 Nicollet Avenue, Minneapolis, Minnesota 55419 (US).

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(54) Title: MEDICANT DELIVERY SYSTEM

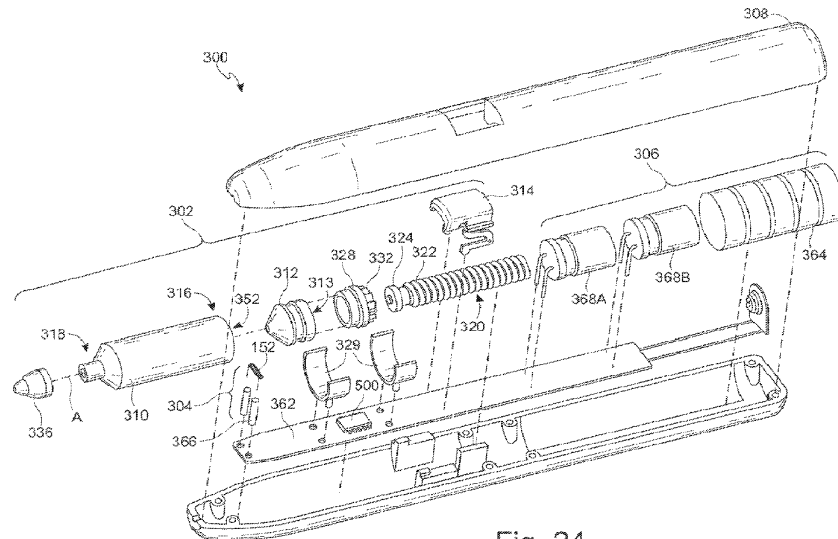


Fig. 24

(57) Abstract: An improved medicant delivery system 100 is disclosed wherein the carrier for the medicant is a fluid that can be atomized or vaporized by exposure to heat. The system provides for repeatable dose of medicant, can be stored in any orientation, and/or has an ability to maximize energy efficiency.

WO 2012/120487 A8





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, ML, MR, NE, SN, TD, TG).

— *with information concerning request for restoration of the right of priority in respect of one or more priority claims (Rules 26bis.3 and 48.2(b)(vii))*

**Published:**

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

**(48) Date of publication of this corrected version:**

29 November 2012

**(15) Information about Correction:**  
see Notice of 29 November 2012

## CORRECTED VERSION

**(10) International Publication Number**  
**WO 2012/120487 A8**

nesota 55436 (US). **KOVACH, Peter Joseph** [US/US]; 211 Rice Creek Terrace NE, Fridley, Minnesota 55432 (US). **LINDE, Larry Gawain** [US/US]; 17595 Partridge Street NW, Andover, Minnesota 55304 (US). **BERG, Randy Eugene** [US/US]; 1631 99th Ave. Northwest, Coon Rapids, Minnesota 55433 (US).

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[Continued on next page]

**(54) Title:** MEDICANT DELIVERY SYSTEM

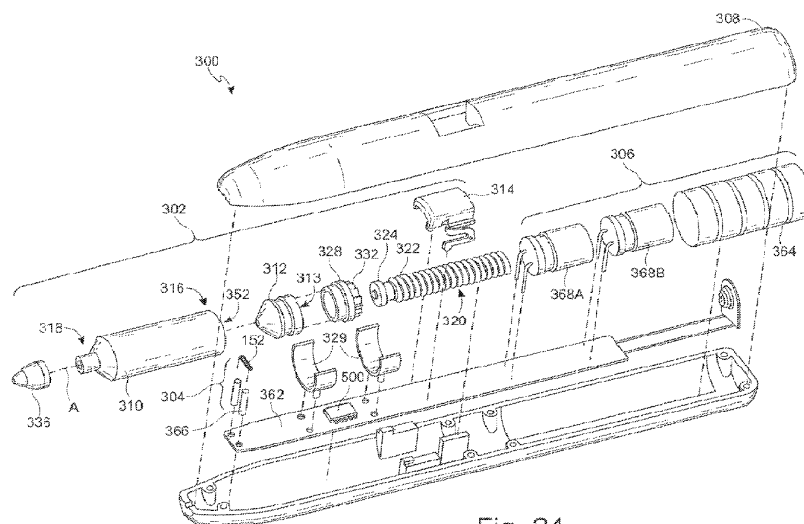


Fig. 24

**(57) Abstract:** An improved medicant delivery system 100 is disclosed wherein the carrier for the medicant is a fluid that can be atomized or vaporized by exposure to heat. The system provides for repeatable dose of medicant, can be stored in any orientation, and/or has an ability to maximize energy efficiency.



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, ML, MR, NE, SN, TD, TG).

— *with information concerning request for restoration of the right of priority in respect of one or more priority claims (Rules 26bis.3 and 48.2(b)(vii))*

**Published:**

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

**(48) Date of publication of this corrected version:**

29 November 2012

**(15) Information about Correction:**

see Notice of 29 November 2012



(51) International Patent Classification:

A24F 47/00 (2006.01) A24D 1/18 (2006.01)  
A24F 13/00 (2006.01) A61M 15/06 (2006.01)

(21) International Application Number:

PCT/MY2011/000249

(22) International Filing Date:

30 December 2011 (30.12.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PI 2011006111 15 December 2011 (15.12.2011) MY

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Block C, Jalan Dataran SD 1, Dataran SD PJU 9, Bandar  
Sri Damansara, Kuala Lumpur 52200 (MY).

(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, BR, BW, BY, BZ,  
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,  
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, ML, MR, NE, SN, TD, TG).

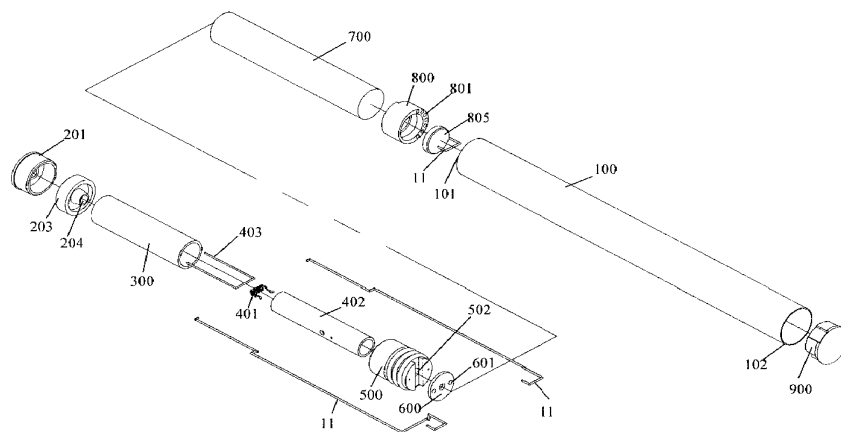
Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a  
patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))

(54) Title: AN ELECTRONIC VAPORISATION CIGARETTE



(57) Abstract: The present invention relates to an electronic vaporisation cigarette, comprising: a shell (100); a mouthpiece including a cap (201) and a ring (203), detachably attached at an anterior end (101) of the shell (100); an absorbent means (300) having liquid absorbed therein; a vaporiser including a heating element (401) and an insulator for vaporising the liquid when said vaporiser is electrically heated, wherein the vaporiser is in proximity with the absorbent means (300); a battery (700) to supply electrical energy for heating the heating element (401); a switch base (800) connected to the battery (700) to switch on the battery (700); and a cover (900) detachably attached at a posterior end (102) of the shell (100); characterised in that: a liquid segregate base (500) and a plate (600) are in proximity with the vaporiser for preventing leakage of the liquid; the cover (900) has a plurality of air inlets (901); and the switch base (800) is in proximity with the cover (900) and has a plurality of holes (801) to receive wires (11) and allow from the plurality of air inlets (901) to the vaporiser.

## AN ELECTRONIC VAPORISATION CIGARETTE

### Background of the Invention

#### Field of the Invention

- 5 This invention relates to an electronic vaporisation cigarette, and more particularly to an improved electronic vaporisation cigarette resembling to a normal cigarette that offers convenience and satisfaction to users.

#### Description of Related Arts

- 10 A cigarette is a roll of finely cut tobacco leaves wrapped in a cylinder of thin paper for smoking. It works by ignition at one end and is allowed to smoulder wherein the smoke is inhaled from the other end through the mouth and usually into the smoker's lungs. The creation of the tobacco blend in the cigarette is often made up to 600 ingredients. During the ignition of the cigarette, the burning process which  
15 burns over 4000 chemicals including tar, carbon monoxide, and other carcinogenic substances are harmful to the smoker and secondary smoker.

- The smoke produced from the cigarette will cause air pollution and is not environmental friendly as the smoker tends to dispose used cigarette anywhere on  
20 the floor. Due to such tendency, it could be hazardous as the butt of the cigarette may still light up when it is thrown on the floor and may consume other flammable items around. It is also a hassle for the smokers as they need to be dependent on lighter when there is a need to smoke. The smoker could not smoke indoors as some areas prohibit smoking. There is a distinctive way to identify smokers as they  
25 usually have stained or yellowish teeth due to the chemicals in the cigarette and they usually have tobacco and ash smell on them and their belongings. This could therefore separate the smokers from the anti-smoke society and when the situation gets worse, it could lead to social problem. This therefore has led to revolution in cigarette industry to find a solution to reduce the risk of smoking.  
30 There is a need to find a solution that contains less harmful chemicals, no second

hand smoke, convenient and able to smoke in traditional "no smoking" areas, and reduced overall physical aesthetics.

5 In the market currently, there exist many electronic cigarettes to replace the normal cigarette. These electronic cigarettes provide a battery-powered device that allows user to inhale nicotine and flavour by way of a vaporised solution. It is a non-flammable device without having to face the risk of fire, flame, and other harmful chemical compounds such as tar and carbon monoxide. However, although the inhaling and the taste of using the electronic cigarette resembles a  
10 normal cigarette, users are still not satisfied as the physical appearance of the electronic cigarette is different in terms of size and diameter. Therefore, there is a need to improve on the existing electronic cigarette so that it does not just provide the same sensation but also satisfaction in the resemblance of the physical appearance.

15

Cited herein is US 2011/0168194 A1 which disclosed an electronic atomization cigarette which includes a shell and a mouthpiece. The external wall of the shell has an air inlet. An electronic circuit board, a normal pressure cavity, a sensor, a vapour-liquid separator, an atomizer, a liquid-supplying bottle is sequentially  
20 provided within the shell, wherein the electronic circuit board comprises an electronic switching circuit and a high frequency generator. The use of a liquid-supplying bottle is a disadvantage as leakage may occur and caused inconvenience to the users.

25 US Publication No. 2011/0036346 A1 disclosed a personal inhalation device including an outer shell having an orifice formed therein and containing a medium having one or more deliverables and an atomizing unit disposed within the shell. The device includes three principal components: an electronics section, an atomising unit, and a cartridge. The electronic section is connected to one end of  
30 the atomizing unit by means of a screw-on connection, and the cartridge is connected to the other end of the atomizing unit by an interference fit. This could be a disadvantage and inconvenience to the users when using it. There is a need

to improve the cited patent which offers a single integral piece device which contains all the principal components.

Accordingly, it can be seen in the prior arts that there exists a need to provide an improved electronic vaporisation cigarette for the convenience and satisfaction of users when holding and smoking the electronic vaporisation cigarette.

### Summary of Invention

It is an objective of the present invention to provide an improved electronic vaporisation cigarette that physically resembles a normal king-size cigarette.

It is also an objective of the present invention to provide an improved electronic vaporisation cigarette having a new location of air inlets for the convenience of users when holding the electronic vaporisation cigarette.

It is yet another objective of the present invention to provide an improved electronic vaporisation cigarette that has the same length and weight as the normal king-size cigarette.

It is a further objective of the present invention to provide an improved electronic vaporisation cigarette that increases user's satisfaction during puffing and reduced risk of liquid leakage.

It is another objective of the present invention to provide an improved electronic vaporisation cigarette that increases user's sensation in feeling, touching, and tasting of the electronic vaporisation cigarette during puffing.

Accordingly, these objectives may be achieved by following the teachings of the present invention. The present invention relates to an electronic vaporisation cigarette, comprising: a shell; a mouthpiece including a cap and a ring, detachably attached at an anterior end of the shell; an absorbent means having a liquid absorbed therein; a vaporiser including a heating element and an insulator for

vaporising the liquid when said vaporiser is electrically heated, wherein the vaporiser is in proximity with the absorbent means; a battery to supply electrical energy for heating the heating element; a switch base connected to the battery to switch on the battery; and a cover detachably attached at a posterior end of the shell; characterised in that: a liquid segregate base and a plate are attached to the vaporiser for preventing leakage of the liquid; the cover has a plurality of air inlets; and the switch base is in proximity with the cover and has a plurality of holes to receive wires (11) and allow air passage from the plurality of air inlets to the vaporiser.

10

### **Brief Description of the Drawings**

The features of the invention will be more readily understood and appreciated from the following detailed description when read in conjunction with the accompanying drawings of the preferred embodiment of the present invention, in which:

15

Figure 1 is a drawing showing an electronic vaporisation cigarette.

Figure 2 is a drawing showing a wiring of the electronic vaporisation cigarette.

Figure 3 is a drawing showing cross-section view of a cap.

Figure 4 is a drawing showing perspective view of the cap.

20 

Figure 5 is a drawing showing cross-section view of a ring.

Figure 6 is a drawing showing perspective view of the ring.

Figure 7 is a drawing showing side view of a liquid segregate base.

Figure 8 is a drawing showing cross-section view of the liquid segregate base.

Figure 9 is a drawing showing perspective view of the liquid segregate base.

25 

Figure 10 is a drawing showing posterior view of the liquid segregate base.

Figure 11 is a drawing showing top view of a plate.

Figure 12 is a drawing showing cross-section view of a switch base.

Figure 13 is a drawing showing posterior view of the switch base with an electronic board.

30 

Figure 14 is a drawing showing perspective view of the switch base.

Figure 15 is a drawing showing side view of a cover.

Figure 16 is a drawing showing perspective view of the cover.



Figure 17 is a drawing showing a shell of the electronic vaporisation cigarette.

Figure 18 is a drawing showing an exploded view of the electronic vaporisation cigarette.

## 5 Detailed Description of the Invention

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted  
10 as limiting but merely as a basis for claims. It should be understood that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the invention is to cover all modification, equivalents and alternatives falling within the scope of the present invention as defined by the appended claims. As used throughout this application,  
15 the word "may" is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words "include," "including," and "includes" mean including, but not limited to. Further, the words "a" or "an" mean "at least one" and the word "plurality" means one or more, unless otherwise mentioned. Where the abbreviations or technical terms  
20 are used, these indicate the commonly accepted meanings as known in the technical field. For ease of reference, common reference numerals will be used throughout the figures when referring to the same or similar features common to the figures. The present invention will now be described with reference to Figure 1-18.

25

The present invention relates to an electronic vaporisation cigarette, comprising:

a shell (100);

a mouthpiece including a cap (201) and a ring (203), detachably attached at  
an anterior end (101) of the shell (100);

30

an absorbent means (300) having a liquid absorbed therein;

a vaporiser including a heating element (401) and an insulator (403) for vaporising the liquid when said vaporiser is electrically heated, wherein the vaporiser is in proximity with the absorbent means (300);

5 a battery (700) to supply electrical energy for heating the heating element (401);

a switch base (800) connected to the battery (700) to switch on the battery (700); and

a cover (900) detachably attached at a posterior end (102) of the shell (100);

10

characterised in that:

a liquid segregate base (500) and a plate (600) are in proximity with the vaporiser for preventing leakage of the liquid;

15 the cover (900) has a plurality of air inlets (901); and

the switch base (800) is in proximity with the cover (900) and has a plurality of holes (801) to receive wires (11) and allow air passage from the plurality of air inlets (901) to the vaporiser.

20 The principal components of the electronic vaporisation cigarette of the present invention are the shell (100), the mouthpiece, the absorbent means (300), the vaporiser, the liquid segregate base (500), the plate (600), the battery (700), the switch base (800), and the cover (900).

25 In a preferred embodiment of the present invention, the cover (900) is detachably attached to the posterior end (102) of the shell (100). The cover (900) may be in proximity with the switch base (800). In a preferred embodiment of the present invention, by order from the posterior end (102) of the shell (100), the switch base (800), the battery (700), the plate (600), the liquid segregate base (500), and the  
30 vaporiser are vertically arranged and connected accordingly in proximity. The switch base (800), the battery (700), the plate (600), the liquid segregate base (500), and the vaporiser may be connected electronically via wires (11). In a

preferred embodiment of the present invention, the vaporiser is in proximity with the mouthpiece. In a preferred embodiment of the present invention, the mouthpiece is detachably attached to the anterior end (101) of the shell (100).

In a preferred embodiment of the present invention, the liquid contains nicotine.

5

In a preferred embodiment of the present invention, the shell (100) has a length of 84.00mm and a diameter of 8.00mm.

10 In a preferred embodiment of the present invention, the shell (100) is a single, integral piece.

In a preferred embodiment of the present invention, the insulator comprises a tube (402) and a filamentous fibre (403).

15 In a preferred embodiment of the present invention, the heating element (401) is coiled around the filamentous fibre (403).

In a preferred embodiment of the present invention, the filamentous fibre (403) traverses the tube (402) and extends outward from the tube (402).

20

In a preferred embodiment of the present invention, the heating element (401) is received in the tube (402).

25 In a preferred embodiment of the present invention the insulator is enclosed by the absorbent means 9300).

In a preferred embodiment of the present invention, the liquid segregate base (500) has base openings (501) for allowing air to flow to the vaporiser.

30 In a preferred embodiment of the present invention, the plate (600) has plate openings (601) for allowing air to flow to the vaporiser.

In a preferred embodiment of the present invention, the switch base (800) has the plurality of holes (801) for wires (11) and to allow air passage.

In a preferred embodiment of the present invention, the plurality of holes (801) on the switch base (800) is co-axial with the plurality of air inlets (901) on the cover (900).

5

In a preferred embodiment of the present invention, the switch base (800) is embedded with an electronic board (805).

10 In a preferred embodiment of the present invention, the switch base (800) comprises an air sensor (802), a light emitting means (803), and an electronic circuit (804).

15 In a preferred embodiment of the present invention, the air sensor (802), the light emitting means (803) and the electronic circuit (804) are included in the electronic board (805).

In a preferred embodiment of the present invention, the light emitting means (803) is switched on when the air sensor (802) detects air flow.

20 In a preferred embodiment of the present invention, the cover (900) has a convex, concave, flat, or frosted surface

25 The term "inhale" used herein refers to a person drawing in a substance typically via mouth but is also possible via the nose, and can include, but does not necessarily require, the substance entering lungs of the person.

The term "vapour" used herein refers to both a substance in the gaseous state and a suspension of finely divided solid particles or liquid droplets in a gas including aerosols, mists and the like.

30

The cover (900) is detachably attached to the posterior end (102) of the shell (100). The cover (900) is in proximity with the switch base (800). By order from the

posterior end (102) of the shell (100), the switch base (800), the battery (700), the plate (600), the liquid segregate base (500), and the vaporiser are vertically arranged in proximity (referring to figure 1, 2, and 18). The switch base (800), the battery (700), the plate (600), the liquid segregate base (500), and the vaporiser are connected electronically via wires (11). The vaporiser is in proximity with the mouthpiece. The mouthpiece is detachably attached to the anterior end (101) of the shell (100).

Below is an example of a best mode to assemble the electronic vaporisation cigarette from which the advantages of the present invention may be more readily understood. It is to be understood that the following example is for illustrative purpose only and should not be construed to limit the present invention in any way.

### **Example**

The present invention is best to be carried out with the following example describing the measurement of each component.

#### Shell (100).

Both the anterior end (101) and the posterior end (102) may have a diameter of 8.00mm. The shell (100) may have a length resembling to a normal king-size cigarette that is 84.00mm. Referring to figure 17, the physical appearance of the shell (100) may resemble a normal king-size cigarette, having an orange-coloured portion and a white-coloured portion. The orange-coloured portion may have a length of 27.50mm and the white coloured portion may have a length of 56.5mm.

#### Mouthpiece

In a preferred embodiment, the cap (201) has a diameter of 8.05 – 8.15mm and a width of 4.00mm. In a preferred embodiment, the cap (201) has a diameter of 8.10mm.

Referring to figure 3 and 4, the cap (201) has an anterior aperture (202) with a diameter of 3.00mm and a width of 2.50 mm. The anterior aperture (202) is for the

vapour produced from vaporisation of the liquid, to flow into the user's mouth. The anterior aperture (202) is physically visible on the anterior end (101) of the shell (100). In a preferred embodiment, the cap (201) is made of polypropylene.

- 5 The ring (203) has a diameter of 8.05 – 8.15mm and a width of 2.50 mm. In a preferred embodiment the ring has a diameter of 8.10mm. Referring to figure 5 and 6, the ring (203) may have a posterior aperture (204) with a diameter of 3.30mm and a width of 3.50mm. In a preferred embodiment, the ring (203) is made of silica gel and is translucent.

10

In a preferred embodiment, the cap (201) and the ring (203) are in proximity. The anterior aperture (202) and the posterior aperture (204) are aligned together to form air passage for vapour to flow from the tube (402) of the vaporiser into the user's mouth.

15

The shape of the anterior aperture (202) of the cap (201) can be modified by a person, to be in a shape of, not limiting to, star, flower, rectangular, oval, or triangle.

20 Absorbent means (300)

In a preferred embodiment, the absorbent means (300) is wool.

The 'wool' described herein refers to a textile fibre, usually obtained from sheep and other certain animals. The fibres contained in the wool are hydrophilic, thus  
25 are ready to absorb moisture.

In a preferred embodiment, the wool is refractory wool.

"Refractory" described herein refers to material that has high melting point and  
30 maintains its structural properties at a high temperatures. Refractory wool is preferably used in the present invention to withstand high temperature caused by the heating element (401). Wool has a lower rate of flame spread, low heat release,

low heat of combustion, and does not melt or drip, it forms a char which is insulating and self-extinguishing, and contributes less to toxic gases and smoke.

In a preferred embodiment, there are two absorbent means (300) used in the present example, both of which are wools. The two absorbent means (300) are preferably used to prevent excessive liquid from entering into the vaporiser through the tube (402) or the filamentous fibre (403). The two absorbent means (300) are also preferably used so that better insulation can be achieved and to prevent the shell (100) from overheating due to the heating of liquid by the heating element (401).

In a preferred embodiment of the present invention, the absorbent means (300) have absorbent and insulation property.

The absorbent means (300) has a width of 18.00mm and a length of 30.00mm. The thickness is 2.00mm.

#### Vaporiser

In a preferred embodiment of the present invention, the tube (402) has a length of 25.00mm and a diameter of 4.00mm.

Referring to figure 1, the tube (402) is inserted into the liquid segregate (500) base at a certain depth. The length of the tube (402) embedded inside the liquid segregate base (500) maybe 7.00mm.

Referring to figure 2, the filamentous fibre (403) traverses the tube (402) and extends outward from the tube (402). The heating element (401) in the tube (402) is coiled around the filamentous fibre (403). The heating element (401) is connected to the electronic circuit (804) via wires (11). The point of connection between the heating element (401) and the wires (11) is preferably on the external of the tube (402).

In a preferred embodiment, the filamentous fibre (403) is made from glass fibre.

In a preferred embodiment of the present invention, the heating element (401) comprises copper heating element.

5

Liquid segregate base (500)

In a preferred embodiment, the liquid segregate base (500) has a diameter of 7.20mm - 08.20mm and a length of 10.40mm (referring to figure 7 and 8). In a preferred embodiment, the liquid segregate base (500) has a diameter of 7.95mm and a length of 10.40mm.

10

In a preferred embodiment, the liquid segregate base (500) has a depth of 3.50mm for the tube (402) to rest on the liquid segregate base (500) and also to accumulate liquid should any leakage occur. Figure 8 shows the cross-section view of the liquid segregate base (500) which shows the depth of the liquid segregate base (500) and the base openings (501).

15

Referring to figure 8, in a preferred embodiment of the present invention, the liquid segregate base (500) has an inner aperture (502) for air to flow from the plurality of air inlets (901) into the vaporiser. In a preferred embodiment of the present invention, the inner aperture (502) has a diameter of 3.55mm – 3.65mm, preferably at 3.6 mm and a length of 10.4 mm. In a preferred embodiment, the length of the inner aperture (502) is longer than the length of the liquid segregate base (500) (referring to figure 9).

20

25

In a preferred embodiment of the present invention, each of the plurality of base openings (501) has a diameter of 0.80mm and a length of 0.15mm for allowing wires (11) from the switch base (800) to pass through the liquid segregate base (500) and connect to the heating element (401) outside the tube (402) (referring to figure 2 and 10).

30



In a preferred embodiment of the present invention, the liquid segregate base (500) is made from silica gel.

#### Plate (600)

5 In a preferred embodiment of the present invention, the plate (600) has a diameter of 6.40mm and a thickness of 0.60mm.

In a preferred embodiment, the plurality of plate openings (601) has a diameter ranging from 1.00mm – 1.50mm.

10 Referring to figure 2 and 11, in a preferred embodiment, there are two plate openings (601) measuring at diameter of 1.00mm for allowing wires (11) to pass through from the switch base (800) to the base openings (501) of the liquid segregate base (500). The distance of each of the plate openings (601) is 4.40mm.

15 Referring to figure 11, in a preferred embodiment, there is one plate opening (601) measuring at diameter of 1.50mm at the centre of the plate (600) for allowing air to flow from the plurality of air inlets (901) into the inner aperture (502) of the liquid segregate base (500).

20 In a preferred embodiment, the plate (600) is made from polypropylene.

In the present invention, the plate (600) serves a purpose of preventing the liquid, should there be any leakage, from flowing through the battery (700) and eventually  
25 the switch base (800).

#### Battery (700)

In a preferred embodiment of the present invention, the battery (700) has a length of 40.00mm. The battery (700) used in the present invention is preferably 75400  
30 Li-ion battery.

Switch base (800)

Referring to figure 13, in a preferred embodiment, the switch base (800) is embedded with the electronic board (805). In a preferred embodiment, the air sensor (802), the light emitting means (803), and the electronic circuit (804) are included in the electronic board (805) (referring to figure 13). In a preferred embodiment, the electronic board (805) has the electronic circuit (804) that contains control electronics for controlling operation of the present invention. In a preferred embodiment of the present invention, the electronic circuit (804) is connected to one or more components of the electronic vaporisation cigarette such as the battery (700), the heating element (401), and the light emitting means (803) through wires (11). Referring to figure 13, in a preferred embodiment, the electronic board (805) is embedded under the switch base (800) and faces the posterior end (102) of the shell (100). The electronic board (805) is in proximity with the cover (900).

15

In a preferred embodiment of the present invention, the switch base (800) has a diameter of 8.00mm and a width of 3.90mm - 4.50mm (referring to figure 12). The diameter of the switch base (800) may be similar or smaller than the diameter of the shell (100).

20

Referring to figure 14, in a preferred embodiment, the plurality of holes (801) is located circumferentially along the rim of the switch base (800).

The plurality holes (801) are configured to a size to receive wires (11) for connecting the electronic circuit (804) to one or more components of the electronic vaporisation cigarette. In a preferred embodiment of the present invention, each of the plurality of holes (801) has a diameter of 0.60mm.

In a preferred embodiment of the present invention, the switch base (800) has a minimum of seven holes (801), wherein three of the plurality of holes (801) are used for the wires (11) to pass through from the electronic board (805) to the respective components.

30

In a preferred embodiment, four of the plurality of holes (801) are used for air to flow from the plurality of air inlets (901) into the vaporiser. As the diameter of the switch base (800) may be similar to the diameter of the shell (100), there is very little or no space left for the air from the plurality of air inlets (901) to flow into the vaporiser. As air is crucial in the heating and vaporisation of the liquid, the plurality of holes (801) creates an avenue for air to flow from the plurality of air inlets (901) into the vaporiser.

The user may trigger the air sensor (802) by sequentially inhaling and/or exhaling through the mouthpiece in various patterns or combinations.

In a preferred embodiment of the present invention, the light emitting means (803) is a light emitting diode. In a preferred embodiment, the light emitting means (803) lights up when the user puffs on the electronic vaporisation cigarette which may indicate the electronic vaporisation cigarette is operating. The light emitting means (803) can be a single colour or multi-colour light. If it is multi-colour light, the light emitting means (803) can be operated so as to produce a different colour depending on the liquid for example the light could be red for nicotine, and blue for caffeine.

20

In a preferred embodiment of the present invention, the switch base (800) is made from polyethylene.

#### Cover (900)

Referring to figure 15 and 16, in a preferred embodiment of, the cover (900) has a diameter of 8.00mm-8.10mm, preferably at 8.05mm and a width of 5.00mm. In a preferred embodiment, the surface of the cover (900) has a diameter of 8.50mm (referring to figure 15).

The surface of the cover (900) may have a bigger diameter compared to the diameter of the shell (100) to ensure the posterior end (102) of the shell (100) is completely tighten with the cover (900).

In a preferred embodiment, the surface of the cover (900) has a frosty surface that resembles to a normal tobacco cigarette butt during burning.

In a preferred embodiment, the plurality of air inlets (901) comprises a minimum of  
5 four air inlets (901). The four air inlets (901) complement to the preferred embodiment of four holes (801) of the switch base (800) for the air to flow.

In a preferred embodiment, the plurality of air inlets (901) is very tiny and cannot be seen by naked eyes. In a preferred embodiment, the plurality of air inlets (901)  
10 is made at each corner of the cover (900).

In a preferred embodiment of the present invention, the cover (900) is made from polyvinyl chloride.

#### Operation of the electronic vaporisation cigarette

15 In operation, a user inhales vapour from the mouthpiece by puffing through the cap (201) at the anterior end (101) of the shell (100). This causes external air to be drawn into the shell (100) from the plurality of air inlets (901) at the posterior end (102) of the shell (100). Specifically, air is drawn in through the plurality of air inlets (901) of the cover (900) and passes through the plurality of holes (801) of the  
20 switch base (800), the plate openings (601) of the plate (600), the base openings (501) of the liquid segregate base (500) and into the vaporiser. The air that flows through the switch base (800) triggers the air sensor (802), thereby switching on the battery (700) which power up the light emitting means (803) and the vaporiser. The air that flows into the vaporiser is heated as it flows over the heating element  
25 (401). The heated air then passes over the insulator causing the liquid absorbed in the absorbent means (300) to be vaporised, creating a vapour containing the liquid from the absorbent means (300). The vapour flows around the vaporiser and is discharged through the mouthpiece into the user's mouth. Each instance of the user drawing or puffing on the electronic vaporisation cigarette is referred to herein  
30 as a "puff".

Inhaling a vapour containing nicotine may preclude tar and other harmful effects of a normal tobacco cigarette. The vapour, which dissipates quickly, reduces the hazards of second-hand smoke or passive smoking among bystanders. As there is also no actual combustion involved (as only electric heating involving heating  
5 element (401) is required in the present invention), the present invention avoid fire hazard and environmental problems associated with the normal tobacco cigarette.

Although the present invention has been described with reference to specific  
embodiments, also shown in the appended figures, it will be apparent for those  
10 skilled in the art that many variations and modifications can be done within the scope of the invention as described in the specification and defined in the following claims.

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Description of the reference numerals used in the accompanying drawings according to the present invention:

| Reference Numerals | Description           |
|--------------------|-----------------------|
| 100                | Shell                 |
| 101                | Anterior end          |
| 102                | Posterior end         |
| 201                | Cap                   |
| 202                | Anterior aperture     |
| 203                | Ring                  |
| 204                | Posterior aperture    |
| 300                | Absorbent means       |
| 401                | Heating element       |
| 402                | Tube                  |
| 403                | Filamentous fibre     |
| 500                | Liquid segregate base |
| 501                | Base openings         |
| 502                | Inner aperture        |
| 600                | Plate                 |
| 601                | Plate openings        |
| 700                | Battery               |
| 800                | Switch base           |
| 801                | Holes                 |
| 802                | Air sensor            |
| 803                | Light emitting means  |
| 804                | Electronic circuit    |
| 805                | Electronic board      |
| 900                | Cover                 |
| 901                | Air inlets            |
| 11                 | Wire                  |

**Claims**

I/We claim:

1. An electronic vaporisation cigarette, comprising:
  - 5 a shell (100);
  - a mouthpiece including a cap (201) and a ring (203), detachably attached at an anterior end (101) of the shell (100);
  - an absorbent means (300) having a liquid absorbed therein;
  - a vaporiser including a heating element (401) and an insulator for vaporising the liquid when said vaporiser is electrically heated, wherein the vaporiser is in proximity with the absorbent means (300);
  - 10 a battery (700) to supply electrical energy for heating the heating element (401);
  - a switch base (800) connected to the battery (700) to switch on the battery (700); and
  - 15 a cover (900) detachably attached at a posterior end (102) of the shell (100);
- characterised in that:
  - 20 a liquid segregate base (500) and a plate (600) in proximity with the vaporiser for preventing leakage of the liquid;
  - the cover (900) has a plurality of air inlets (901); and
  - the switch base (800) is in proximity with the cover (900) and has a plurality of holes (801) along the rim of the switch base (800) to receive wires (11) and allow air passage from the plurality of air inlets (901) to the vaporiser.
2. The electronic vaporisation cigarette according to claim 1, wherein the liquid contains nicotine.
- 30

3. The electronic vaporisation cigarette according to claim 1, wherein the shell (100) has a length of 84.00mm and a diameter of 8.00mm.
4. The electronic vaporisation cigarette according to claim 1, wherein the shell (100) is a single, integral piece.
5. The electronic vaporisation cigarette according to claim 1, wherein the insulator comprises a tube (402) and a filamentous fibre (403).
6. The electronic vaporisation cigarette according to claim 1 and claim 6, wherein the heating element (401) is coiled around the filamentous fibre (403).
7. The electronic vaporisation cigarette according to claim 5, wherein the filamentous fibre (403) traverses the tube (402) and extends outward from the tube (402).
8. The electronic vaporisation cigarette according to claim 1, wherein the heating element (401) is received in the tube (402).
9. The electronic vaporisation cigarette according to claim 1, wherein the insulator is enclosed by the absorbent means (300).
10. The electronic vaporisation cigarette according to claim 1, wherein the liquid segregate base (500) has base openings (501) for allowing air to flow into the vaporiser.
11. The electronic vaporisation cigarette according to claim 1, wherein the plate (600) has plate openings (601) for allowing air to flow into the base openings (501).
12. The electronic vaporisation cigarette according to claim 1, wherein the plurality of holes (801) on the switch base (800) is co-axial with the plurality of air inlets (901) on the cover (900).



13. The electronic vaporisation cigarette according to claim 1, wherein the switch base (800) is embedded with an electronic board (805).
- 5 14. The electronic vaporisation cigarette according to claim 1, wherein the switch base (800) comprises an air sensor (802), a light emitting means (803), and an electronic circuit (804).

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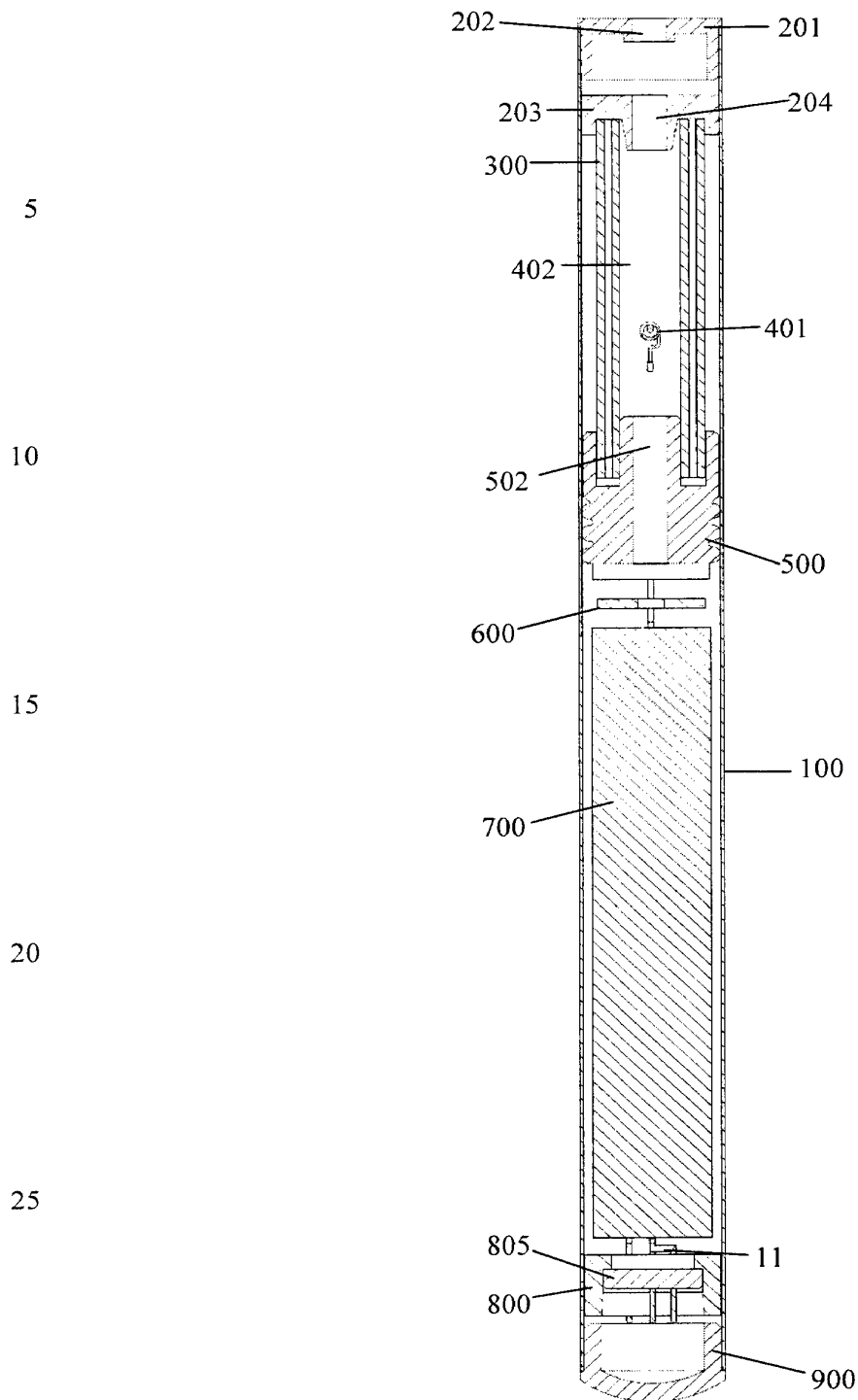
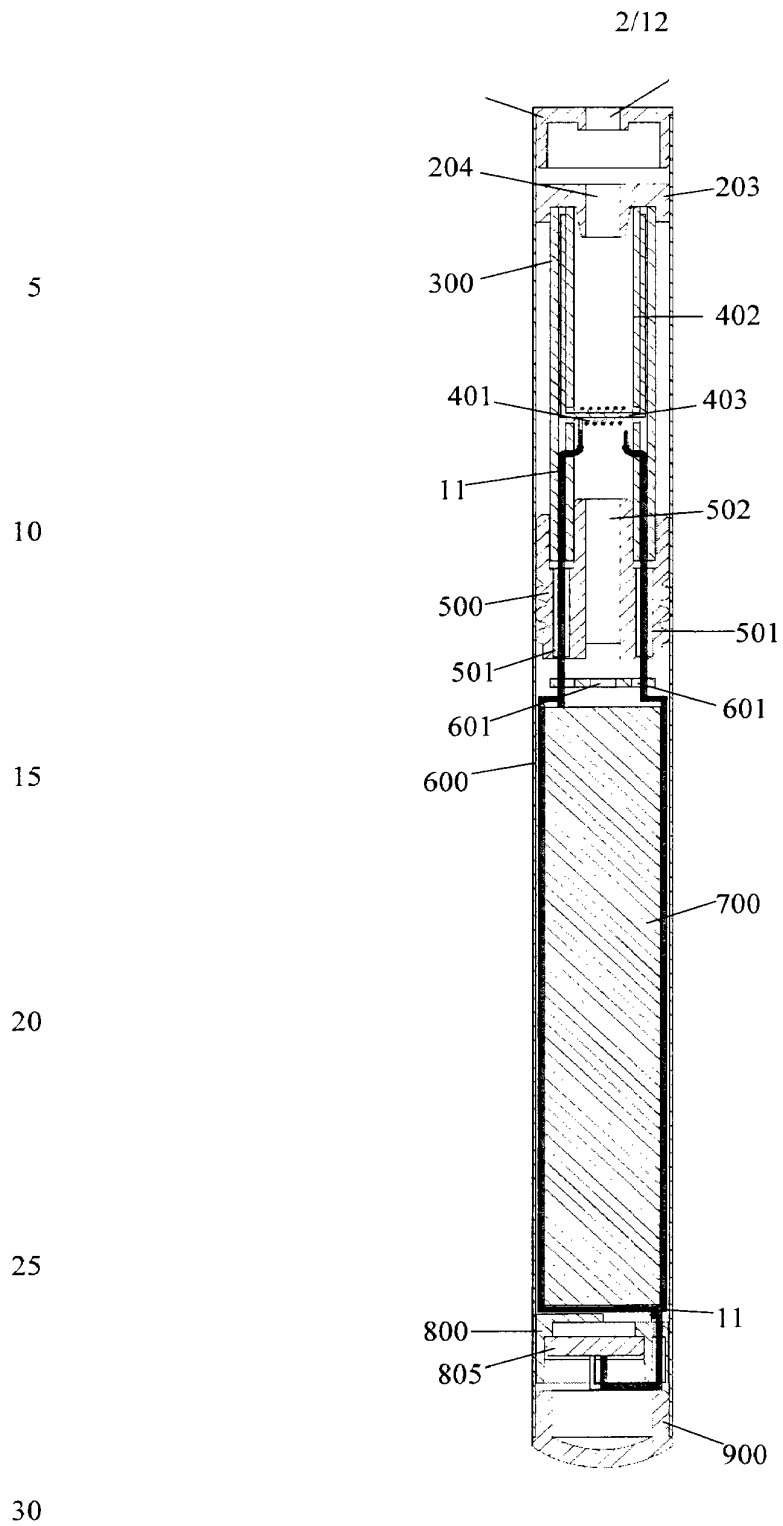


Figure 1

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**Figure 2**

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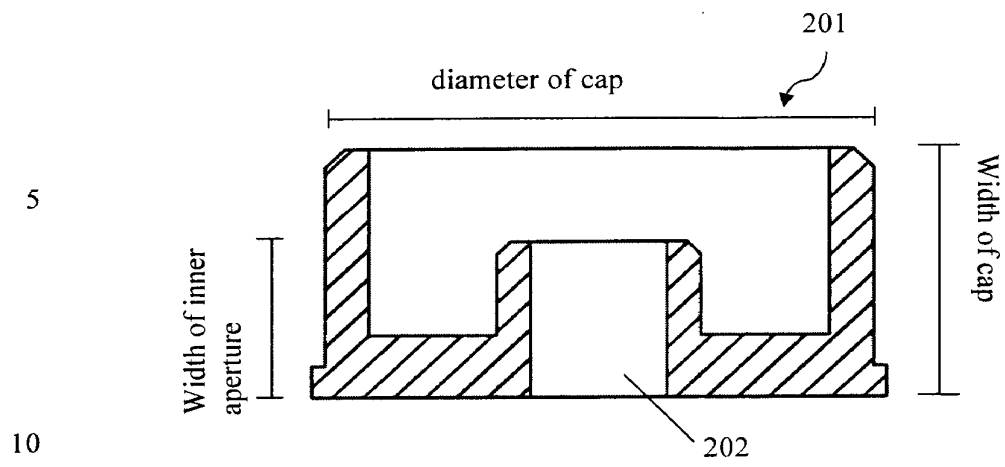


Figure 3

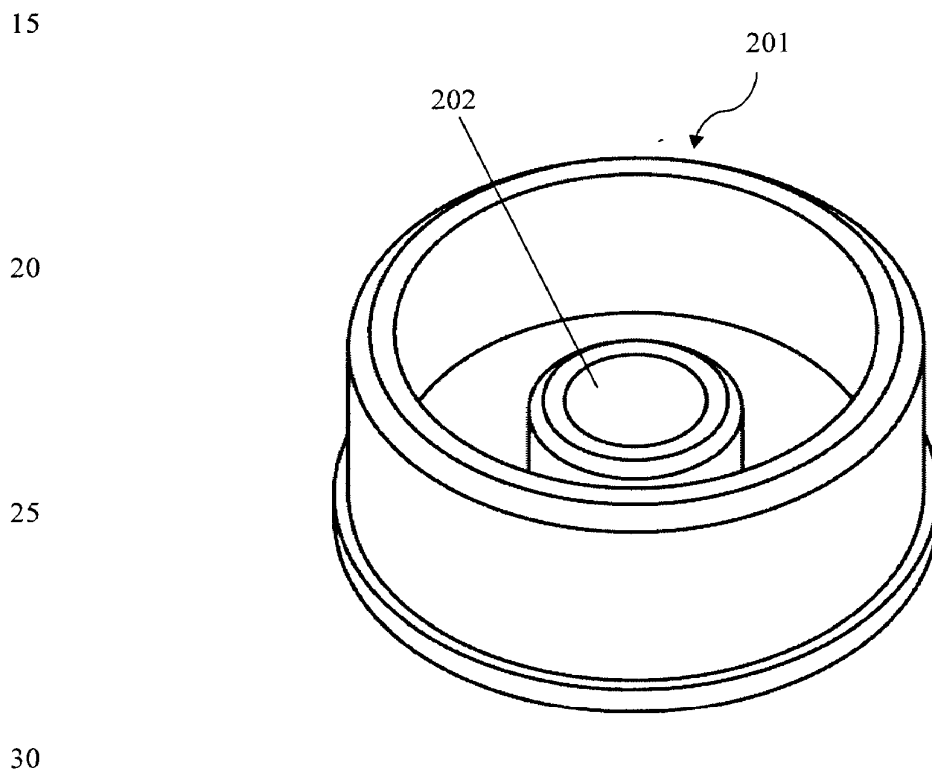


Figure 4

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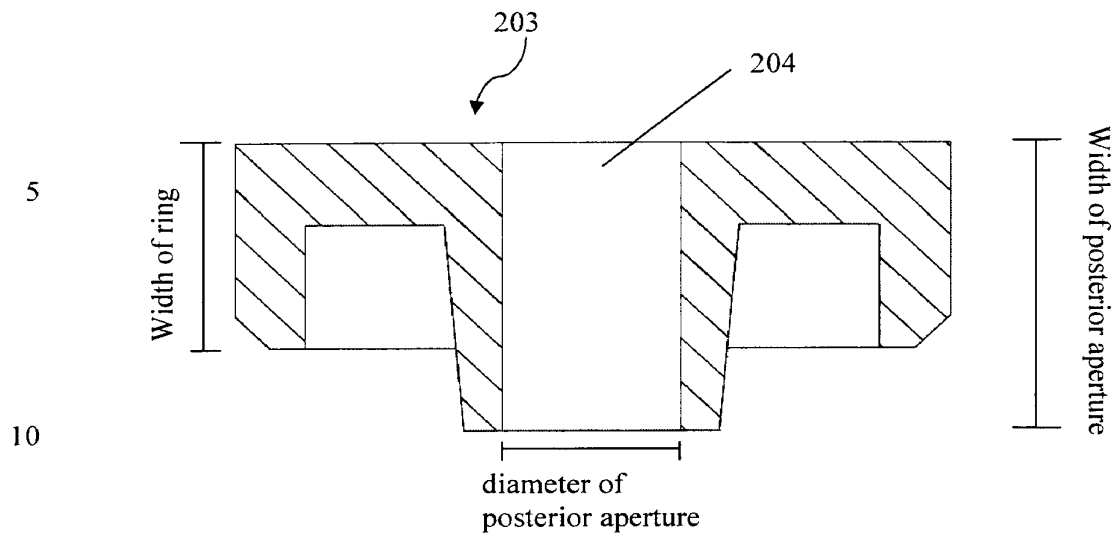


**Figure 5**

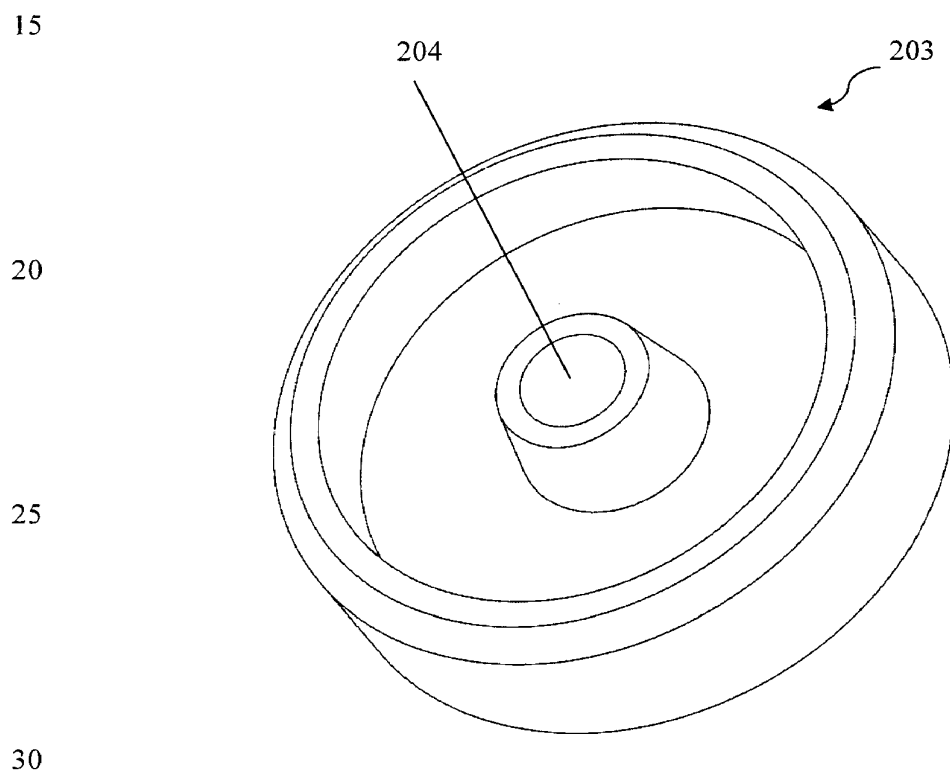


**Figure 6**

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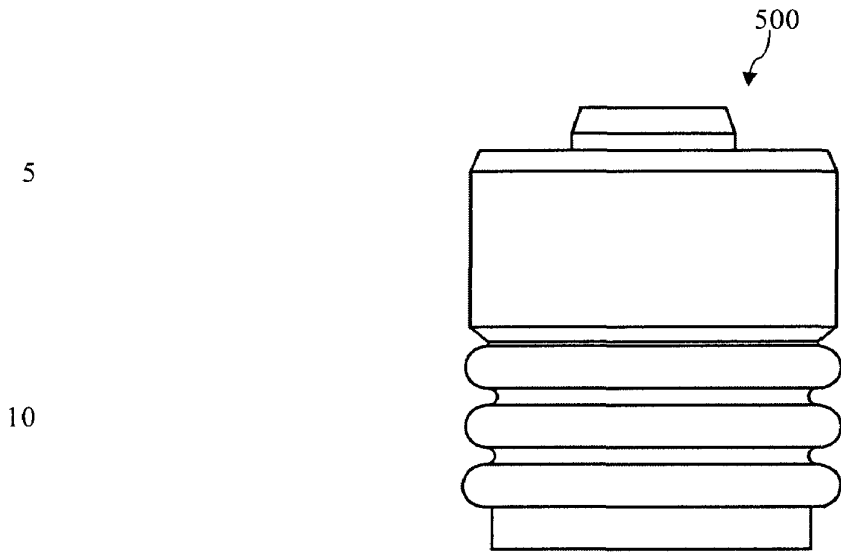


Figure 7

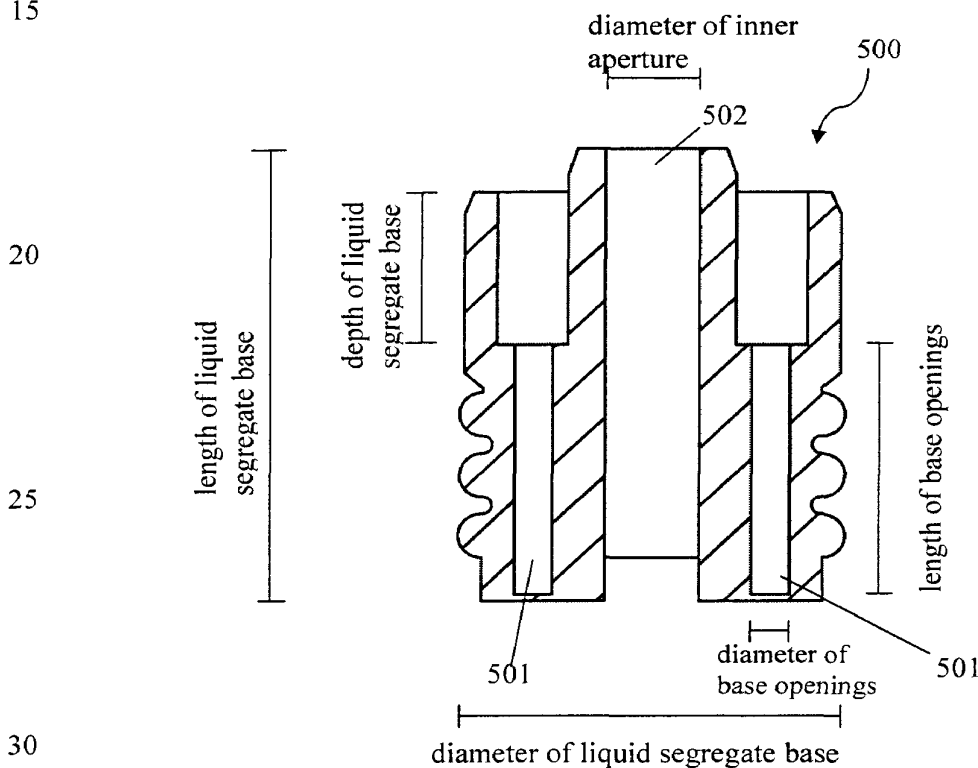


Figure 8

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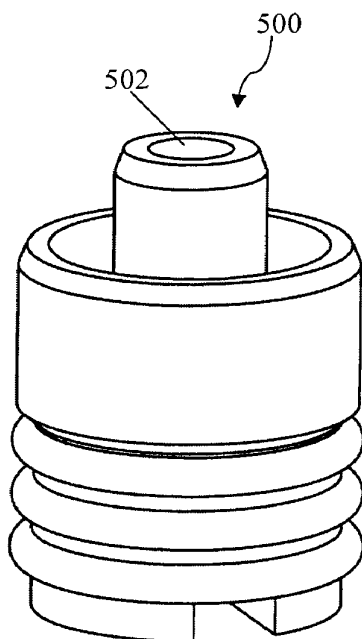


Figure 9

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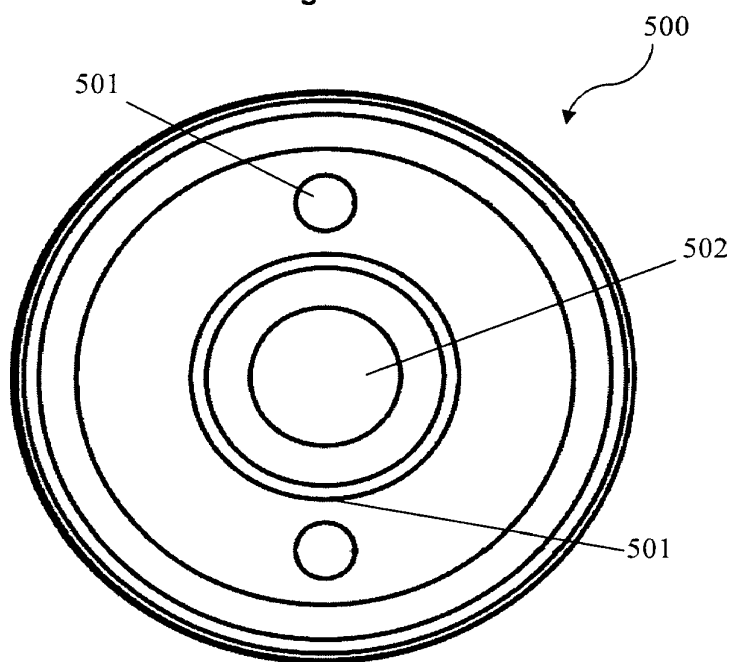


Figure 10

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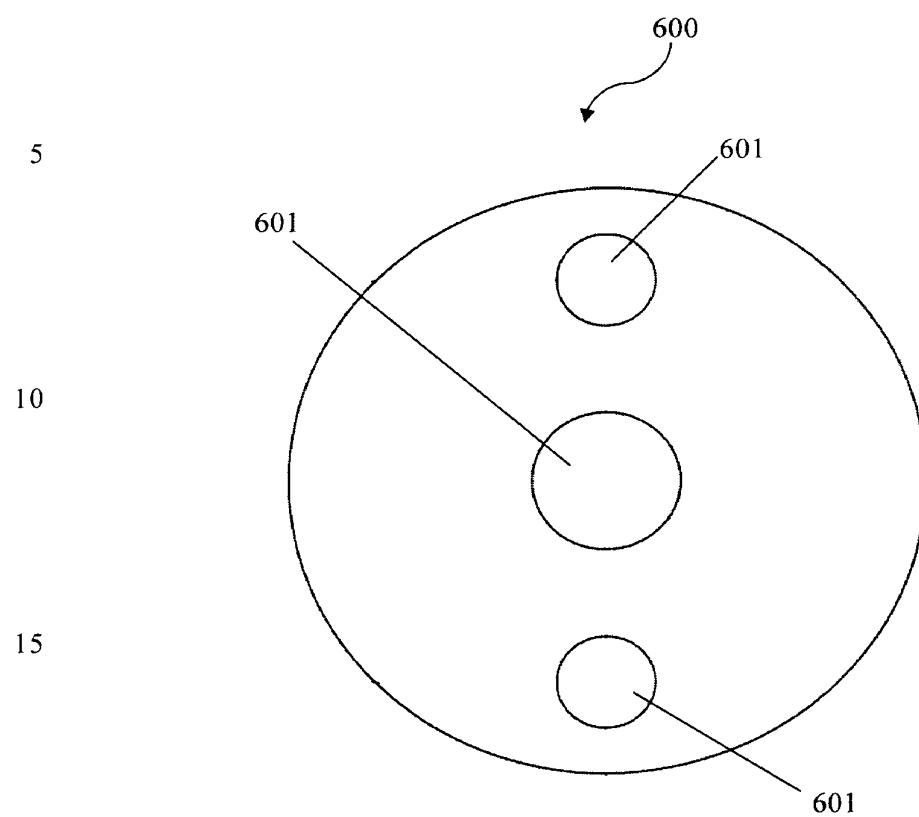


Figure 11



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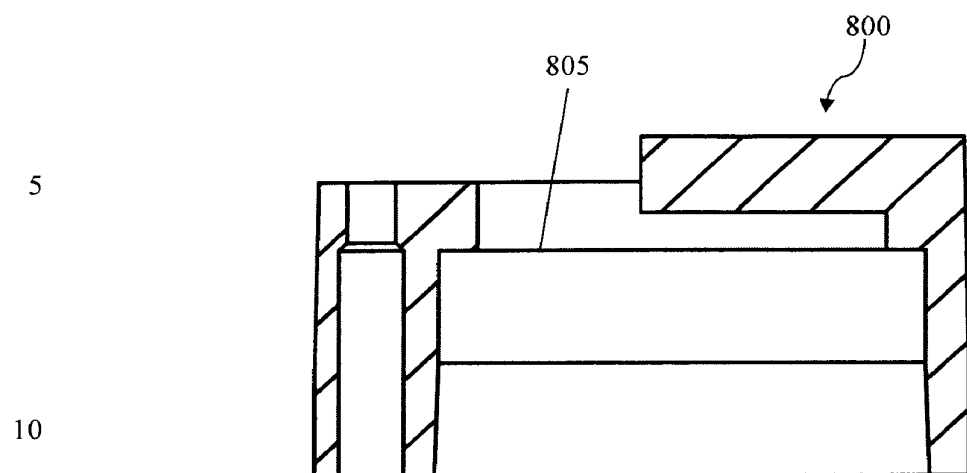


Figure 12

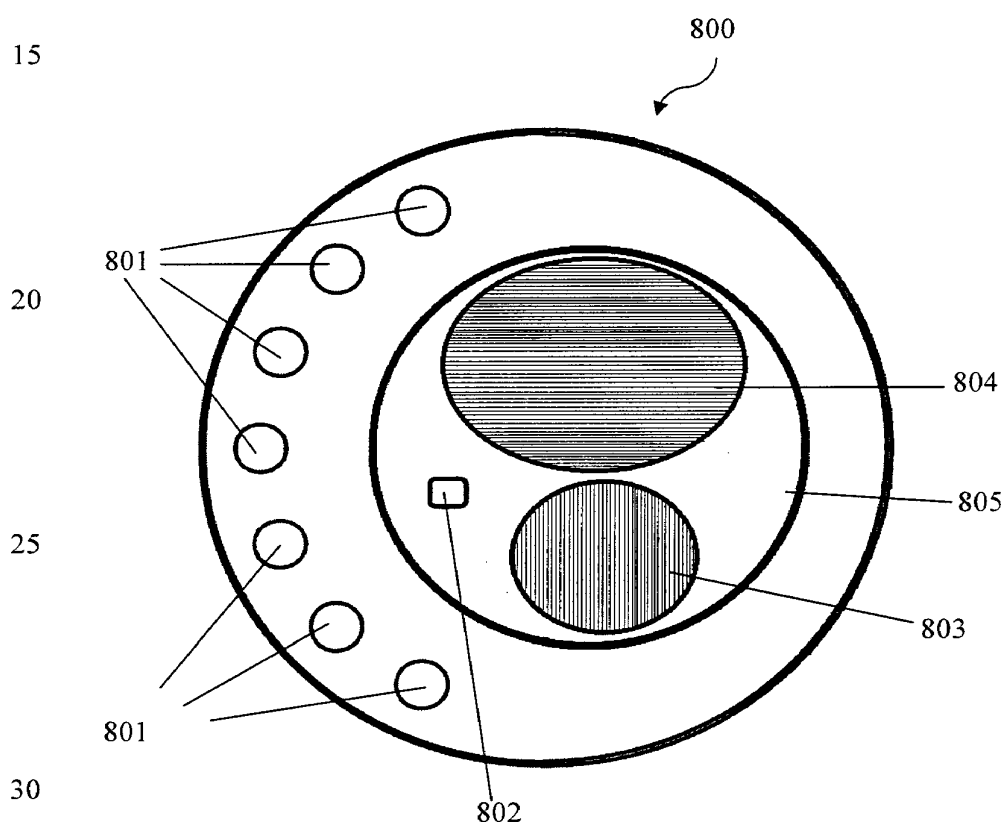


Figure 13

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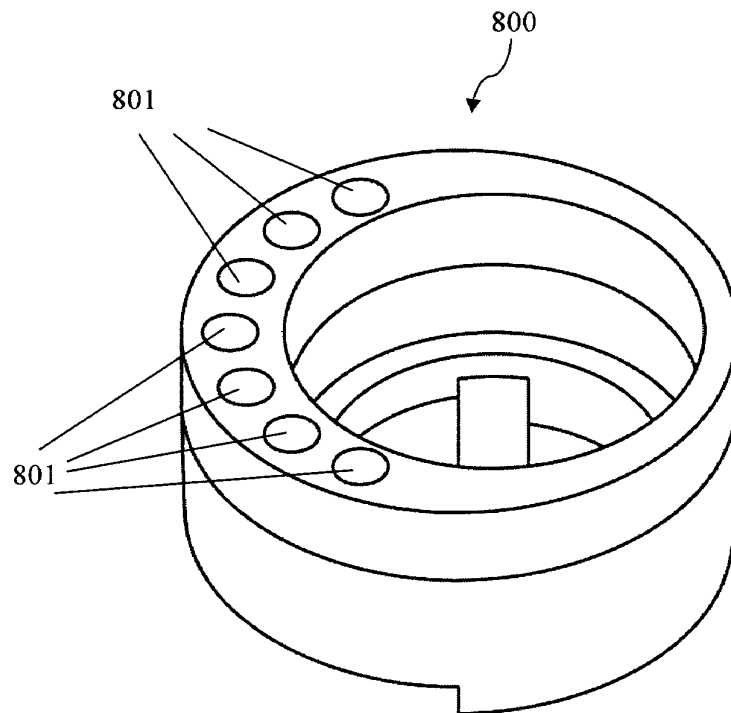


Figure 14

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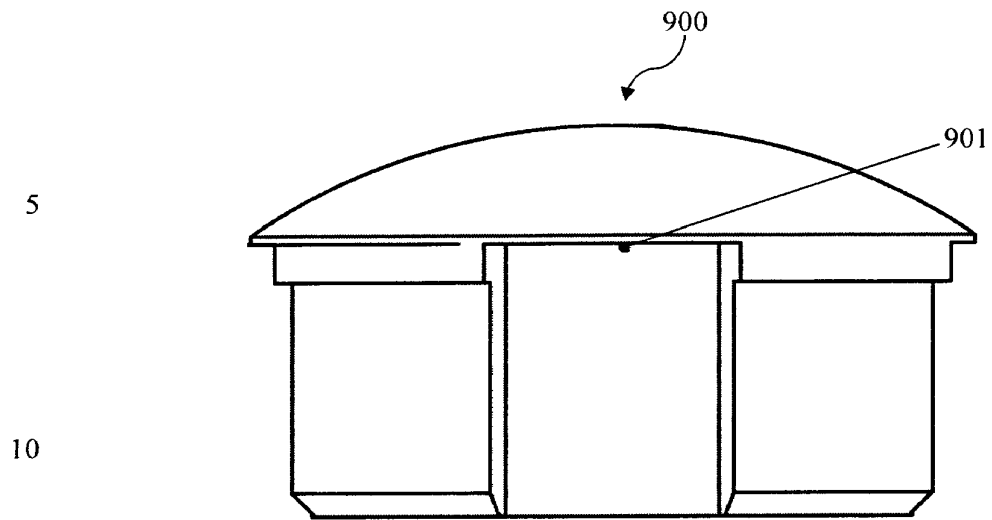


Figure 15

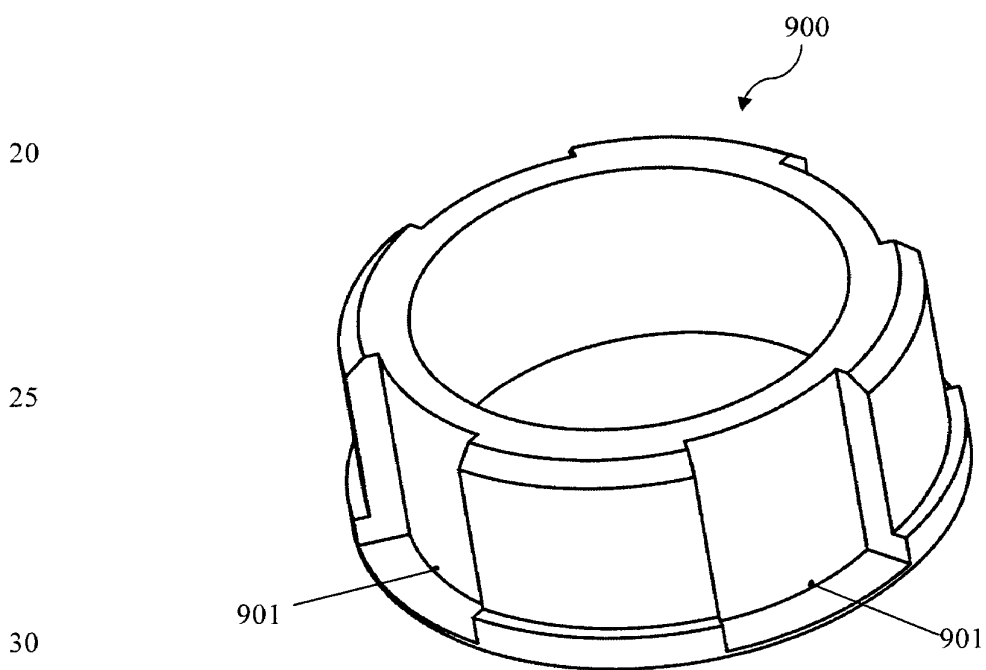


Figure 16

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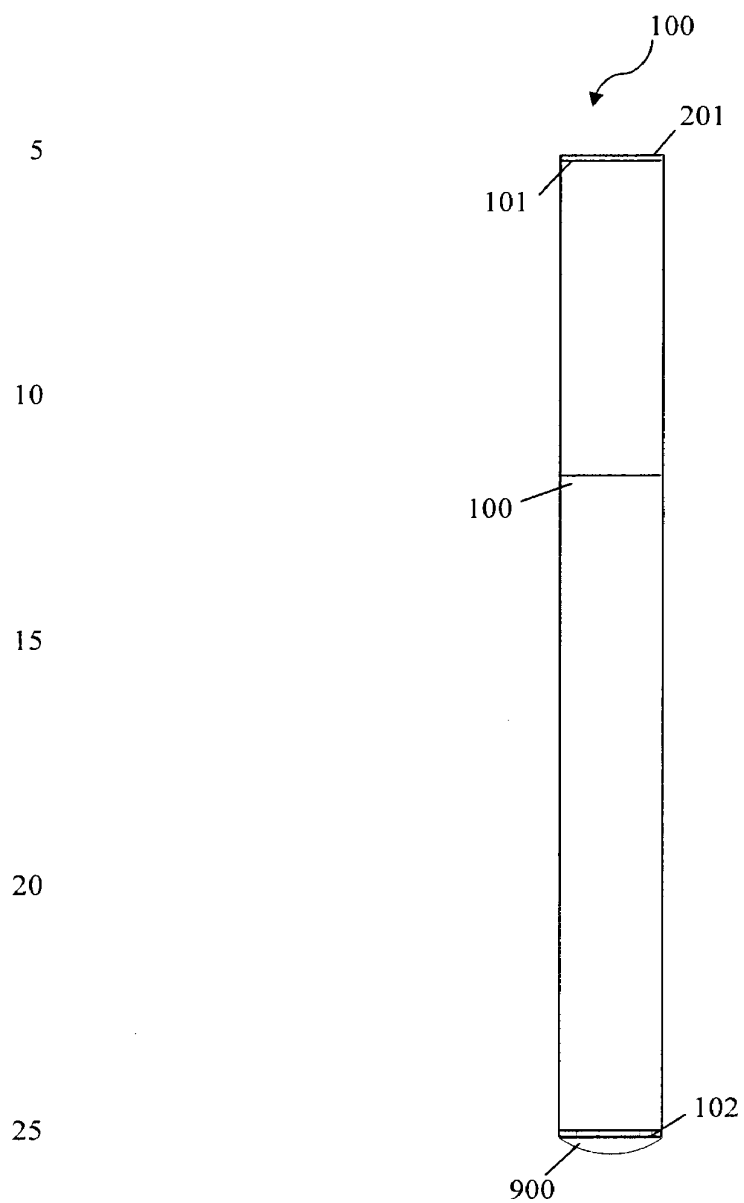


Figure 17

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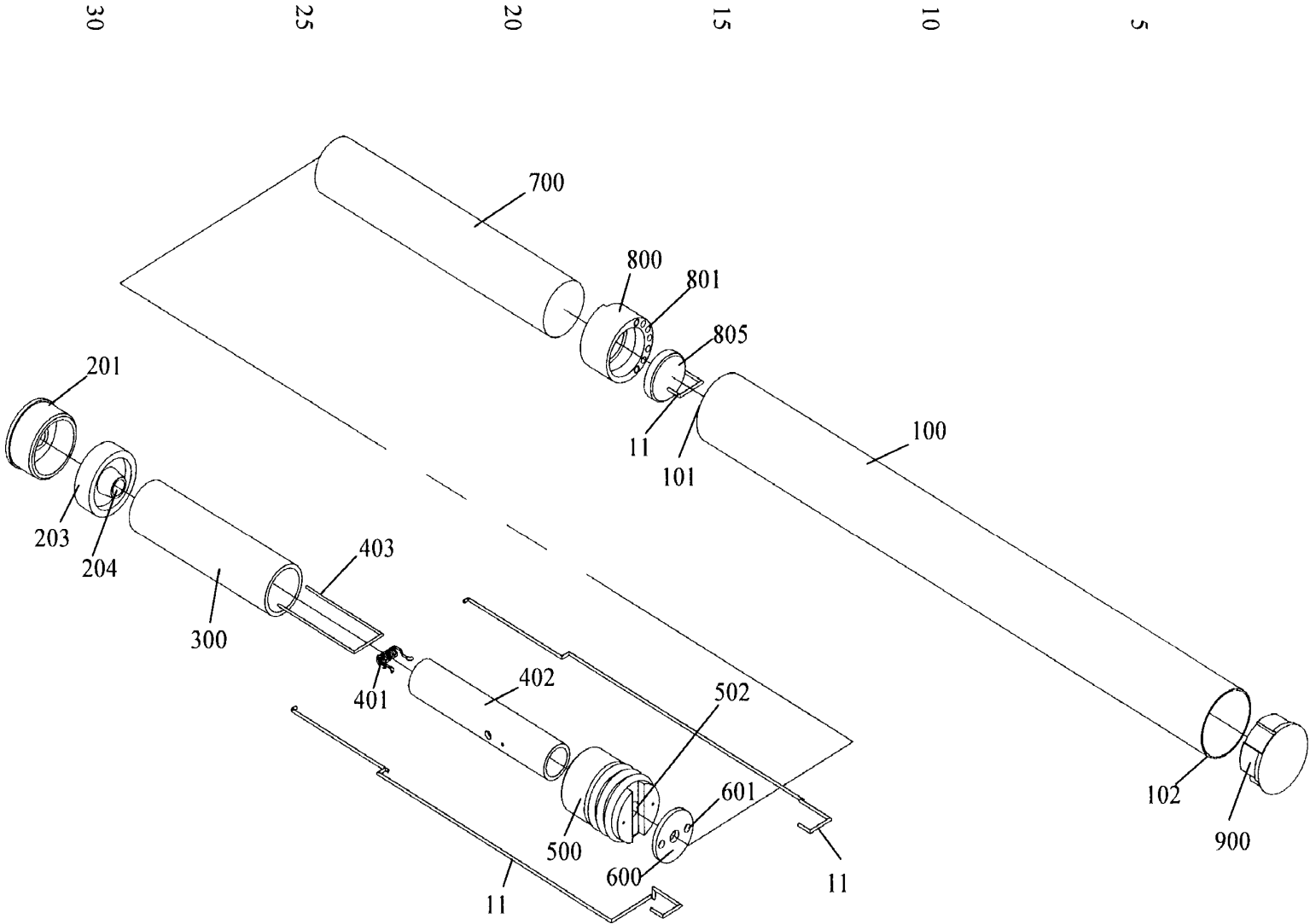


Figure 18

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/MY2011/000249

## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A24F 47/00 (2006.01)

A24F 13/00 (2006.01)

A24D 1/18 (2006.01)

A61M 15/06 (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)

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)

EPODOC and WPI: A61M15/IC/EC, A24F/IC/EC, A24D/IC/EC; Keywords: smoke, tobacco, nicotine, cigarette, battery, electronic, vapour, atomise, heat, inhale, puff, liquid, substance, absorb, air inlet, segregate, seal, leakage; and like terms

ESpace: A24F47/00B2E; Keywords: vapour; and like terms

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                            | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | CN 101228969 A (LONG) 30 July 2008<br>Fig. 1 & 2; page 4, lines 3, 24-25; page 7, lines 11-12; page 8, line 2 | 1-14                  |
| Y         | CN 201018927 Y (WANG) 13 February 2008<br>Fig. 1; page 3, line 13; page 4, lines 5-6, 23                      | 1-14                  |
| Y         | CN 202014573 U (SHENZHEN HEDONGYUAN TECHNOLOGY CO LTD) 26 October 2011<br>Fig. 2                              | 5-6, 8-9              |
| Y         | EP 2022349 A1 (HAN) 11 February 2009<br>Fig. 1, 17, 18; column 7, lines 50-54                                 | 5-8, 14               |



Further documents are listed in the continuation of Box C



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                                                                | "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                                              |
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| "P" document published prior to the international filing date but later than the priority date claimed                                                                  |                                                                                                                                                                                                                                                  |

Date of the actual completion of the international search

3 April 2012

Date of mailing of the international search report

4 April 2012

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2011/000249

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in<br>Search Report                                                                                 |           | Patent Family Member |             |    |             |    |             |
|---------------------------------------------------------------------------------------------------------------------------|-----------|----------------------|-------------|----|-------------|----|-------------|
| CN                                                                                                                        | 101228969 | NONE                 |             |    |             |    |             |
| CN                                                                                                                        | 201018927 | NONE                 |             |    |             |    |             |
| CN                                                                                                                        | 202014573 | NONE                 |             |    |             |    |             |
| EP                                                                                                                        | 2022349   | AU                   | 2007250367  | AU | 2007250368  | BR | PI0711395   |
|                                                                                                                           |           | BR                   | PI0711401   | CA | 2647212     | CA | 2647234     |
|                                                                                                                           |           | EA                   | 200802045   | EA | 200802046   | EP | 2022350     |
|                                                                                                                           |           | EP                   | 2359705     | JP | 2009537119  | JP | 2009537120  |
|                                                                                                                           |           | KR                   | 20090005139 | KR | 20090018039 | KR | 20110131320 |
|                                                                                                                           |           | KR                   | 20120002555 | MX | 2008013526  | MX | 2008013527  |
|                                                                                                                           |           | NZ                   | 572309      | NZ | 572310      | US | 2009095311  |
|                                                                                                                           |           | US                   | 2009126745  | US | 2011209717  | WO | 2007131449  |
|                                                                                                                           |           | WO                   | 2007131450  | ZA | 200809062   | ZA | 200809063   |
| Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. |           |                      |             |    |             |    |             |
| END OF ANNEX                                                                                                              |           |                      |             |    |             |    |             |

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES  
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges  
Eigentum

Internationales Büro

(43) Internationales  
Veröffentlichungsdatum  
20. März 2014 (20.03.2014)



(10) Internationale Veröffentlichungsnummer  
**WO 2014/040915 A1**

(51) Internationale Patentklassifikation:  
A24F 47/00 (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2013/068426

(22) Internationales Anmeldedatum:  
6. September 2013 (06.09.2013)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:  
10 2012 108 477.7  
11. September 2012 (11.09.2012) DE

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(81) Bestimmungsstaaten (soweit nicht anders angegeben, für  
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AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW,  
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DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
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TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,  
ZW.

(84) Bestimmungsstaaten (soweit nicht anders angegeben, für  
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GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ,  
TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ,  
RU, TJ, TM), europäisches (AL, AT, BE, BG, CH, CY,

[Fortsetzung auf der nächsten Seite]

(54) Title: MOUTHPIECE SEAL FOR A MOUTHPIECE OF AN ELECTRONIC CIGARETTE

(54) Bezeichnung : MUNDSTÜCKVERSCHLUSS FÜR EIN MUNDSTÜCK EINER ELEKTRISCHEN ZIGARETTE

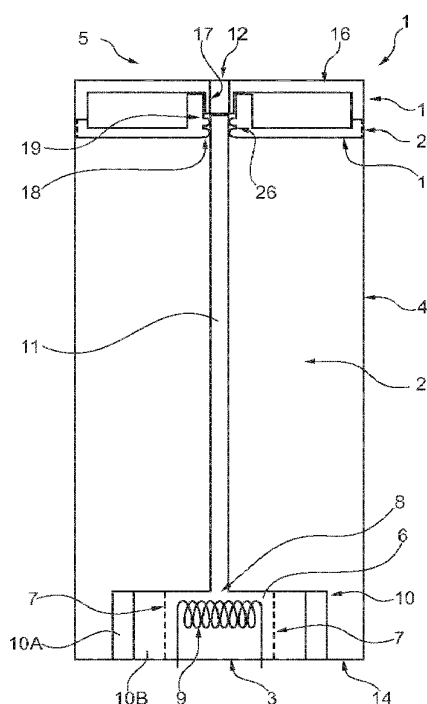


Fig. 1

(57) Abstract: The invention relates to a mouthpiece seal for a mouthpiece of an electronic cigarette which has a housing that has a vaporizer and a container for the liquid, said container being connected to said vaporizer and being situated between the vaporizer and the mouthpiece. The vaporizer is connected to the mouthpiece for the discharge of vapor. In order to improve the seal tightness of the mouthpiece, the mouthpiece seal comprises a sealing element facing the container and a mouthpiece element facing toward the outside, said sealing element and said mouthpiece element being designed to sealingly engage into each other in the assembled state.

(57) Zusammenfassung: Die Erfindung betrifft einen Mundstückverschluss für ein Mundstück einer elektrischen Zigarette, die ein Gehäuse mit einem Verdampfer und einem mit dem Verdampfer verbundenem Depot für das Liquid zwischen Verdampfer und Mundstück umfasst, wobei der Verdampfer mit dem Mundstück für den Dampfaustritt verbunden ist. Zum Verbessern der Dichtigkeit des Mundstücks umfasst der Mundstückverschluss ein dem Depot zugewandtes Dichtelement und ein nach außen gewandtes Mundstückelement, die im Einbauzustand dicht ineinander greifend ausgestaltet sind.

WO 2014/040915 A1





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).

**Veröffentlicht:**

- mit internationalem Recherchenbericht (Artikel 21 Absatz 3)
- vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eingehen (Regel 48 Absatz 2 Buchstabe h)

## Mundstückverschluss für ein Mundstück einer elektrischen Zigarette

Die Erfindung betrifft einen Mundstückverschluss für ein Mundstück einer elektrischen Zigarette, die ein Gehäuse mit einem Verdampfer und einem mit dem Verdampfer  
5 verbundenem Depot für das Liquid zwischen Verdampfer und Mundstück umfasst, wobei der Verdampfer mit dem Mundstück für den Dampfaustritt verbunden ist.

Elektrische Zigaretten sind seit längerem bekannt. Im Prinzip bestehen diese elektronischen Zigaretten aus einem Verdampfer, auch Atomizer genannt, in dem  
10 eine nikotinhaltige oder nikotinfreie meist aromatisierte Flüssigkeit, Liquid genannt, in Dampf verwandelt wird. Dazu enthält der Verdampfer eine Heizwendel, die über eine Stromversorgung, meist ein Akku, mit Energie versorgt wird. Das Liquid wird in einem Depot vorgehalten. Weiterhin ist ein Mundstück zum Inhalieren vorgesehen und ein  
15 Schalter, der die Stromversorgung des Verdampfers regelt. Der Schalter kann entweder manuell oder über Unterdruck, der beim Inhalieren (Ziehen) entsteht, betätigt werden. Meist weisen die elektronischen Zigaretten eine langgestreckte zylindrische Form auf, die derjenigen einer konventionellen Zigarette nach empfunden ist.

20 Der Dampf, der im Verdampfer durch Aufheizen des Liquids entsteht, wird beim Inhalieren zu sich genommen.

Zentraler Bestandteil der elektronischen Zigaretten ist der Verdampfer, der üblicherweise eine Heizwendel umfasst, die aus einem Draht mit elektrischem  
25 Widerstand besteht, der sich beim Durchfluss von Strom erhitzt. Zum Schutz der Heizwendel ist dies meist mit einem Drahtgeflecht oder Metallnetz bedeckt oder in einer weitestgehend abgeschlossenen Brennkammer enthalten, die lediglich kleine Eintrittsöffnungen für das Liquid aufweist.

30 Das Liquid ist in dem Depot vorgehalten und wird von diesem nach und nach an den Verdampfer abgegeben. Das Depot besteht aus einer Hülle und ist meist mit einem Speicherstoff aus Watte, Glasfasern, Vlies etc. gefüllt, in dem das Liquid schwammartig gespeichert ist. Ist der Atomizer zusammen mit dem Depot ausgestaltet, spricht man von einem Cartomizer (Cartridge + Atomizer).

35

Aus der US 2011/0303231 ist z.B. eine elektrische Zigarette bekannt, bei der der Verdampfer aus einem Glasfaser-Rohr, einem Garn aus Glasfasern, eine Heizspirale, ein Baumwolltuch Schicht und eine synthetische Faser Schicht besteht, wobei das Garn aus Glasfasern in die Heizspirale eingefügt ist, die sich innerhalb s Glasfaser-  
5 Rohrs befindet. Die Enden des Glasfasergarns und zwei Drähte, die verwendet werden, um die Heizspirale elektronisch mit den Anschlüsse zu verbinden, sind nach außen durch das Glasfaser Rohr geführt.

Die Baumwolltuch-Schicht umhüllt die Außenwand des Glasfaser-Rohrs und presst  
10 die Enden des Garns dicht gegen das Glasfaser-Rohr. Die synthetische Faser-Schicht zwischen dem Baumwolltuch Schicht und der Befestigungshülse speichert das Liquid und dient als eigentliches Depot.

Aus der EP 2 404 515 A1 ist z.B. eine elektrische Zigarette bekannt, bei der die Hülle  
15 einen zusätzlichen Hilfs- Lufteinlass aufweist. Die elektrische Heizung weist eine Durchgangsbohrung auf und das mit Vlies etc. gefüllte Depot hat einen Kanal zwischen Mundstück und Verdampfer bzw. Durchgangsbohrung. Ein Unterdruck-Sensor ist mit der Durchgangsbohrung und dem Kanal verbunden und bildet einen Luftstrompfad mit dem Hilfslufteinlass aus, um aktiviert zu werden. Das im Vlies  
20 gespeicherte Liquid dringt durch eine zwischen Depot und Heizung angeordnete permeable Komponente und gelangt direkt auf die elektrische Heizung.

Daneben sind Tanksysteme bekannt, in denen das Liquid ohne Watte etc. im Depot gespeichert und über eine Membran etc. an den Verdampfer abgegeben wird. Dabei  
25 kommt meist eine hohle Nadel zum Einsatz, die die Membran durchstößt und mit dem Verdampfer kommuniziert.

Problematisch an allen bekannten Systemen ist die gleichmäßige Zufuhr bzw. Versorgung des Verdampfers mit Liquid, wobei gleichzeitig ein Auslaufen oder  
30 Ansaugen von nicht verdampftem Liquid verhindert werden muss, da z.B. das unverdampfte Nikotin extrem giftig ist. Daher ist wichtig, dass die Benutzer das unverdampfte Liquid nicht über das Mundstück ansaugen.

Dabei muss das Mundstück einerseits das Depot dicht verschließen und andererseits  
35 eine angenehme Haptik (und auch Optik) aufweisen.

Aufgabe der Erfindung ist es daher, einen Mundstückverschluss für das Mundstück einer elektronischen Zigarette bereitzustellen, bei dem kein Auslaufen stattfindet und das gleichzeitig der Haptik Genüge tut.

5

Diese Aufgabe wird durch den in Anspruch 1 wiedergegebenen Mundstückverschluss für ein Mundstück einer elektrischen Zigarette gelöst.

Erfindungsgemäß ist erkannt worden, dass wenn der Mundstückverschluss ein dem Depot zugewandtes Dichtelement und ein nach außen gewandtes Mundstückelement umfasst, die im Einbauzustand dicht ineinander greifend ausgestaltet sind, sowohl die Abdichtung verbessert und gleichzeitig die Haptik für den Benutzer eingehalten werden kann.

Der Mundstückverschluss weist also zwei Teile auf, nämlich das das Depot abdichtende Dichtelement und das dem Benutzer zugewandte Mundstückelement. Die Teile greifen beim Zusammenbau und dem Einsatz im Gehäuse ineinander, wobei sie einerseits eine Abdichtung zur Gehäusewandung bewirken und andererseits eine Abdichtung zum Depot und natürlich untereinander ebenso.

20

Somit wird zuverlässig mit nur zwei Teilen ein Auslaufen des unverdampften Liquids verhindert.

Vorzugsweise kann vorgesehen sein, dass einerseits das Mundstückelement eine Öffnung und damit kommunizierend ein Durchbruchrohr aufweist und andererseits das Dichtelement eine Öffnung und damit kommunizierend ein Durchbruchrohr aufweist, wobei das Durchbruchrohr des Mundstückelements einen ersten Außendurchmesser derart aufweist, dass es beim Ineinandergreifen im Durchbruchrohr des Dichtelements mit Passsitz dichtend aufgenommen ist, so dass die Dichtigkeit der Teile zueinander gewährleistet ist. Sinnvollerweise weist das Durchbruchrohr des Dichtelements einen Innendurchmesser abgestimmt auf den Außendurchmesser des Durchbruchrohrs des Mundstückelements auf und nimmt dieses im Einbauzustand dichtend auf.

Das Mundstückelement und das Dichtelement werden also quetschend aufeinander aufgedrückt, was möglich wird, da das Dichtelement vorzugsweise aus einem

35

Elastomer, wie einem Silikonmaterial, einstückig hergestellt ist und das Mundstückelement vorzugsweise aus Hartplastik, wie einem Thermoplaste oder Duroplaste, einstückig hergestellt ist.

- 5 Die so bewirkte Abdichtung untereinander wird noch verbessert, wenn das Mundstückelement kappenartig zur teilweisen Aufnahme des Dichtelements ausgebildet ist.

- 10 Um das Aneinanderanliegen zu verbessern, können zu dem radial nach Innen von dem Kappenrand vorstehende Stege vorgesehen sein, die im zusammengesetzten Zustand des Mundstückverschlusses das elastische Durchbruchrohr des Dichtelements gegen das umgriffene Durchbruchrohr des Mundstückelements drängen bzw. ein Ausweichen verhindern.

- 15 Um den Zusammenbau und den Zusammenhalt der Teile zu verbessern, kann vorgesehen sein, dass das Dichtelement in Richtung des Mundstückelements vorstehende Arme aufweist, die in entsprechende Ausnehmungen im Kappenrand eingreifen.

- 20 Zum Abdichten gegenüber dem Gehäuse ist es sinnvoll, wenn das Dichtelement radial umlaufend beabstandete Dichtlippen am Außenumfang aufweist.

- Die als Cartomizer bezeichnete Einheit aus Depot und Verdampfer, die in einer zylindrischen Hülle oder Gehäuse enthalten sind, weist also an einem Ende das
- 25 Mundstück auf, das über ein Inhalationsrohr mit dem Verdampfer kommunizierend verbunden ist. Das Inhalationsrohr ist dabei vom dem Depot umgeben bzw. erstreckt sich von dem Verdampfer durch das Depot hindurch zum Mundstück. Der Mundstückverschluss muss also auch das Inhalationsrohr in einer Weise aufnehmen bzw. dessen Anschluss erlauben, die eine Abdichtung zum Depot gewährleistet. Dazu
- 30 kann das Dichtelement radial umlaufende beabstandete Dichtlippen am Innenumfang des Durchbruchrohrs aufweisen, Somit kann das Inhalationsrohr zum einfachen Zusammenbau in das Durchbruchrohr eingeschoben werden und die Dichtigkeit ist durch die Dichtlippen gewährleistet. Es versteht sich, dass der Innendurchmesser des Durchbruchrohrs und der Außendurchmesser des Inhalationsrohrs aufeinander
- 35 abgestimmt sind.

Der Mundstückverschluss wird also stopfenartig nach dem Zusammensetzen in das Gehäuse eingeschoben.

- 5 Weitere Einzelheiten der Erfindung ergeben sich aus der nachfolgenden Beschreibung der Zeichnung. Es zeigen:

Fig. 1 einen schematischen Längsschnitt durch einen Cartomizer einer elektrischen Zigarette;

10

Fig. 2 eine perspektivische Ansicht eines Mundstückverschlusses mit einem Mundstückelement und einem Dichtelement von schräg oben;

Fig. 3 eine perspektivische Ansicht eines Mundstückverschlusses von schräg unten;

15

Fig. 4 eine perspektivische Ansicht des Mundstückelements der Figur 2 und

Fig. 5 eine perspektivische Ansicht des Dichtelements der Figur 2.

- 20 In der Figur 1 ist von einer als Ganzes mit 1 bezeichneten elektrischen Zigarette nur der sogenannte Cartomizer, also die Einheit aus Depot 2 und Verdampfer 3 gezeigt, der in einer zylindrischen Hülle 4 enthalten ist, die gleichzeitig an einem Ende als Mundstück 5 dient und am anderen Ende auf ein nicht gezeigten Teil aufschraubbar ist, der die Stromversorgung (Akku) und weitere Elektronik, wie dem Druckschalten  
25 etc. umfasst.

Dieser grundlegende Aufbau ist weitestgehend bekannt.

- 30 Der Verdampfer 3 ist als weitestgehend abgeschlossene Brennkammer 6 ausgeführt ist, die lediglich kleine Eintrittsöffnungen 7 für das Liquid und eine Austrittsöffnung 8 für den Dampf aufweist und eine Heizwendel 9 umfasst, die aus einem Draht mit elektrischem Widerstand besteht.

- 35 Die Eintrittsöffnungen 7 erstrecken über die gesamte Höhe der Außenwandung der Brennkammer 6 und sind umlaufend gleichmäßig verteilt. Die Austrittsöffnung 8 ist

zentral oberhalb der Heizwendel 9 angeordnet.

Das Depot 2 ist als speicherstofffreier Tank ausgebildet. Es füllt im Wesentlichen die  
gesamt Hülle 4 aus. Lediglich zwischen Tank und Brennkammer 6 ist ein Liquid  
5 durchlässiges Vlies-Gewebe 10 aus Glasfasern angeordnet, das um die kleinen  
Eintrittsöffnungen 7 gelegt ist.

Das durchlässige Gewebe 10 weist einen Bereich 10A höherer Durchlässigkeit und  
einen Bereich 10B niedrigerer Durchlässigkeit auf, wobei der Bereich 10B niedrigerer  
10 Durchlässigkeit an die Eintrittsöffnungen 7 angrenzt. Der Bereich 10B niedrigerer  
Durchlässigkeit ist also radial um die Brennkammer 6 angeordnet und von dem  
Bereich 10A höherer Durchlässigkeit umgeben.

Es wird so ein Gradient für die Liquidzufuhr in dem Gewebe 10 bewirkt.  
15

Zwischen der Austrittsöffnung 8 der Brennkammer 6 für den Dampf und dem  
Mundstück 5 ist zum Mundstück hin sich erstreckendes Inhalationsrohr 11  
angeordnet.

20 Zwischen dem dem Mundstück zugewandten Ende des Inhalationsrohrs 11 und der  
eigentlichen Ansaugöffnung 12 im Mundstück 5 ist ein Mundstückverschluss 13  
vorgesehen, dass das Depot bzw. den Tank zur Ansaugöffnung 12 hin dichtet.

Die Dichtung am anderen Ende der Hülle 4, d.h. im Bereich des Verdampfers 3  
25 übernimmt ein Kragen 14. Dieser kann einstückig mit der Brennkammer 6 und dem  
Inhalationsrohr 11 ausgestaltet sein, so dass diese als Baugruppe in die gemeinsame  
Hülle 4 eingesetzt werden, wobei das Inhalationsrohr 11 in den ebenfalls als  
Baugruppe ausgebildeten Mundstückverschluss 13 gedrückt wird, um das zwischen  
den abschließenden Kragen 14 und Mundstückverschluss 13 gebildeten Depot 2  
30 abzuschließen.

Somit fließt das Liquid aus dem Depot 2 durch die zwei Schichten 10A, B des  
Gewebes 10 durch die Eintrittsöffnungen 7 gleichmäßig in die Brennkammer und wird  
dort an der Heizwendel 9 verdampft, sobald die Stromzufuhr vom Akku aufgrund  
35 eines Unterdrucks in dem entsprechenden Unterdruckschalter geschaltet wird.

Der Dampf wird dann über die Austrittsöffnung 8 durch das Inhalationsrohr 11 und dem Mundstückverschluss 13 über die Ansaugöffnung 12 abgegeben bzw. inhaliert (gedampft).

5

In den Figuren 2 bis 5 ist der in den zuvor beschriebenen elektrischen Zigaretten 1 verwendete Mundstückverschluss 13 im Detail dargestellt.

Der Verschluss 13 ist als fertige Baugruppe zum Einsetzen in die Hülle 4 zusammengesetzt und besteht aus einem Dichtelement 15 aus Silikon und einem Mundstückelement 16 aus Hartplastik besteht.

Der Mundstückverschluss 13 umfasst also ein dem Depot 2 zugewandtes Dichtelement 15 und ein nach außen gewandtes Mundstückelement 16, die im Einbauzustand dicht ineinander greifend ausgestaltet sind.

Das Mundstückelement 16 weist die Ansaugöffnung 12 und damit kommunizierend ein Durchbruchrohr 17 auf und das Dichtelement 15 eine Öffnung 18 und damit kommunizierend ebenfalls ein Durchbruchrohr 19 auf, wobei das Durchbruchrohr 17 des Mundstückelements 16 einen ersten Außendurchmesser derart aufweist, dass es beim Ineinandergreifen im Durchbruchrohr 19 des Dichtelements 15 mit Passsitz dichtend aufgenommen ist, so dass die Dichtigkeit der Teile zueinander gewährleistet ist. Dabei weist das Durchbruchrohr 19 des Dichtelements 15 einen Innendurchmesser abgestimmt auf den Außendurchmesser des Durchbruchrohrs 17 des Mundstückelements 16 auf und nimmt dieses im Einbauzustand dichtend auf.

Das Mundstückelement 16 und das Dichtelement 15 werden also quetschend aufeinander aufgepresst, was möglich wird, da das Dichtelement aus einem Elastomer (Silikon) einstückig hergestellt ist und das Mundstückelement 16 aus Hartplastik einstückig hergestellt ist.

Die so bewirkte Abdichtung untereinander wird noch verbessert, da das Mundstückelement 16 kappenartig zur teilweisen Aufnahme des Dichtelements 15 ausgebildet ist.

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Um das Aneinanderanliegen zu verbessern, sind zu dem radial nach Innen von dem Kappenrand 20 vorstehende Stege 21 vorgesehen, die im zusammengesetzten Zustand des Mundstückverschlusses 13 das elastische Durchbruchrohr 19 des Dichtelements 15 gegen das umgriffene Durchbruchrohr 17 des Mundstückelements 5 16 drängen bzw. ein Ausweichen verhindern.

Um den Zusammenbau und den Zusammenhalt der Teile zu verbessern, weist das Dichtelement 15 in Richtung des Mundstückelements vorstehende Arme 22 auf, die in entsprechende Ausnehmungen 23 im Kappenrand 20 eingreifen.

10

Zum Abdichten gegenüber dem Gehäuse weist das Dichtelement 15 radial umlaufend beabstandete Dichtlippen 24 am Außenumfang 25 auf.

Die als Cartomizer bezeichnete Einheit aus Depot 2 und Verdampfer 3, die in einer zylindrischen Hülle 4 enthalten sind, weist also an einem Ende das Mundstück 5 auf, das über ein Inhalationsrohr 11 mit dem Verdampfer 3 kommunizierend verbunden ist. Das Inhalationsrohr 11 ist dabei vom dem Depot 2 umgeben bzw. erstreckt sich von dem Verdampfer 3 durch das Depot 2 hindurch zum Mundstück 5.

20 Der Mundstückverschluss 13 muss also auch das Inhalationsrohr 11 in einer Weise aufnehmen bzw. dessen Anschluss erlauben, die eine Abdichtung zum Depot gewährleistet. Dazu weist das Dichtelement 15 radial umlaufende beabstandete Dichtlippen 26 am Innenumfang des Durchbruchrohrs 19 auf.

25 Somit kann das Inhalationsrohr zum einfachen Zusammenbau in das Durchbruchrohr 19 eingeschoben werden und die Dichtigkeit ist durch die Dichtlippen 26 gewährleistet. Es versteht sich, dass der Innendurchmesser des Durchbruchrohrs 19 und der Außendurchmesser des Inhalationsrohrs 11 aufeinander abgestimmt sind.

30 Der Mundstückverschluss 13 wird also stopfenartig nach dem Zusammensetzen in das Gehäuse bzw. Hülle 4 eingeschoben.

## Patentansprüche

1. Mundstückverschluss für ein Mundstück einer elektrischen Zigarette, die ein Gehäuse mit einem Verdampfer und einem mit dem Verdampfer verbundenem Depot für das Liquid zwischen Verdampfer und Mundstück umfasst, wobei der Verdampfer mit dem Mundstück für den Dampfaustritt verbunden ist, dadurch gekennzeichnet, dass der Mundstückverschluss ein dem Depot zugewandtes Dichtelement und ein nach außen gewandtes Mundstückelement umfasst, die im Einbauzustand dicht ineinander greifend ausgestaltet sind.
2. Mundstückverschluss nach Anspruch 1, dadurch gekennzeichnet, dass das Mundstückelement eine Öffnung und damit kommunizierend ein Durchbruchrohr aufweist.
3. Mundstückverschluss nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass das Dichtelement eine Öffnung und damit kommunizierend ein Durchbruchrohr aufweist.
4. Mundstückverschluss nach Anspruch 3, dadurch gekennzeichnet, dass das Durchbruchrohr des Mundstückelements einen ersten Außendurchmesser derart aufweist, dass es beim Ineinandergreifen im Durchbruchrohr des Dichtelements mit Passsitz dichtend aufgenommen ist.
5. Mundstückverschluss nach Anspruch 3 oder 4, dadurch gekennzeichnet, dass das Durchbruchrohr des Dichtelements einen Innendurchmesser abgestimmt auf den Außendurchmesser des Durchbruchrohrs des Mundstückelements aufweist und dieses im Einbauzustand dichtend aufnimmt.
6. Mundstückverschluss nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass das Mundstückelement kappenartig zur teilweisen Aufnahme des Dichtelements ausgebildet ist.
7. Mundstückverschluss nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass das Dichtelement radial umlaufend beabstandete Dichtlippen

am Außenumfang aufweist.

8. Mundstückverschluss nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass das Dichtelement radial umlaufende beabstandete Dichtlippen am Innenumfang des Durchbruchs aufweist.

9. Mundstückverschluss nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass das Dichtelement aus einem Elastomer, wie einem Silikonmaterial, einstückig hergestellt ist.

10

10. Mundstückverschluss nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass das Mundstückelement aus Hartplastik, wie einem Thermoplaste oder Duroplaste, einstückig hergestellt ist.

15

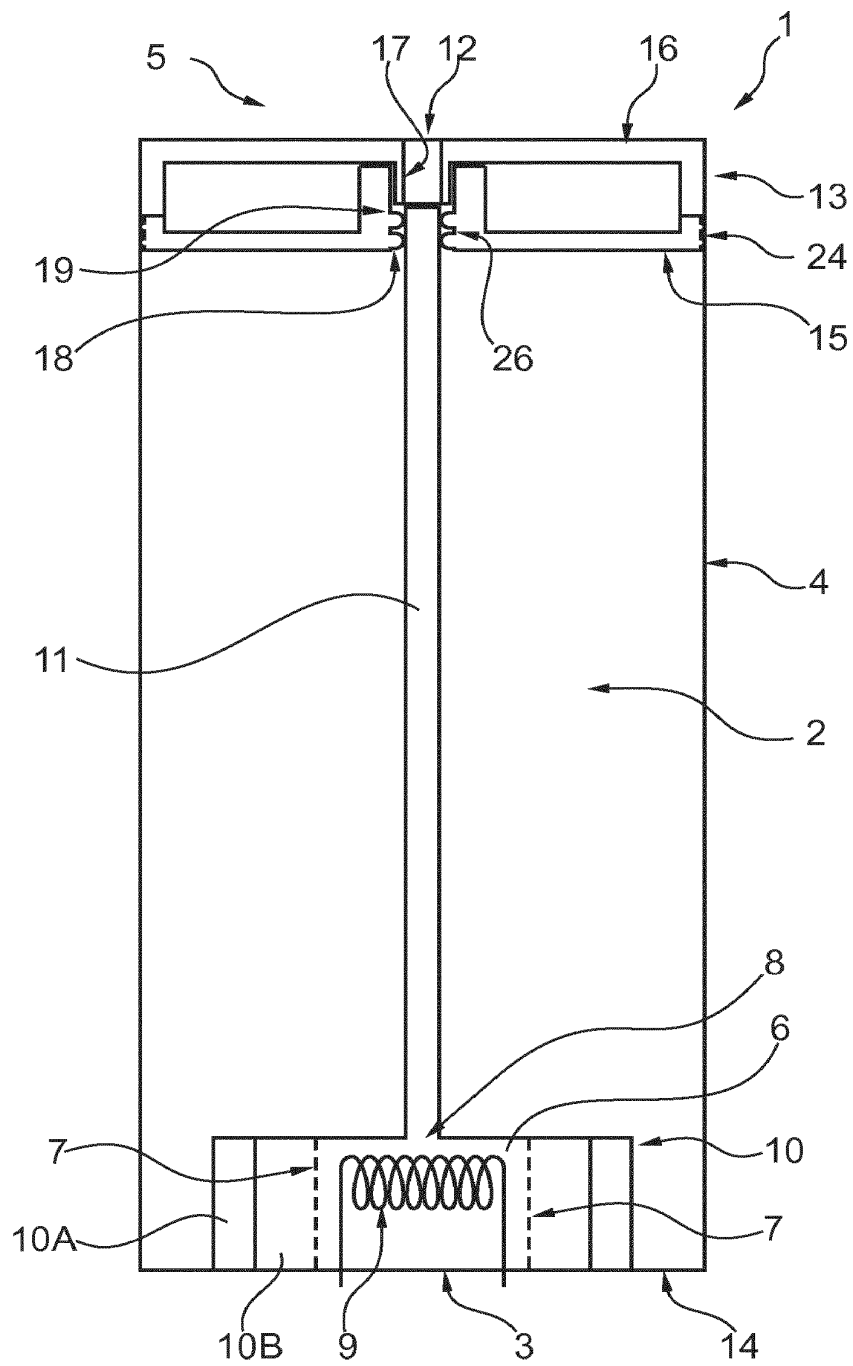


Fig. 1

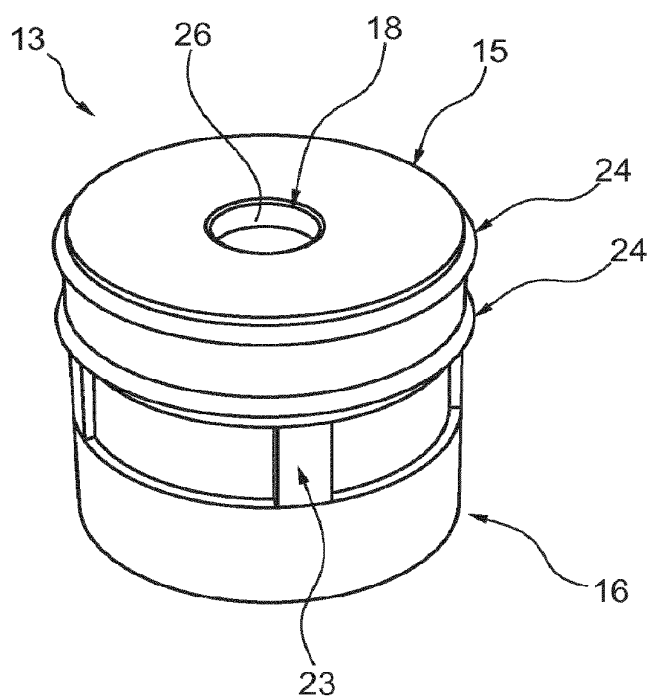


Fig. 3

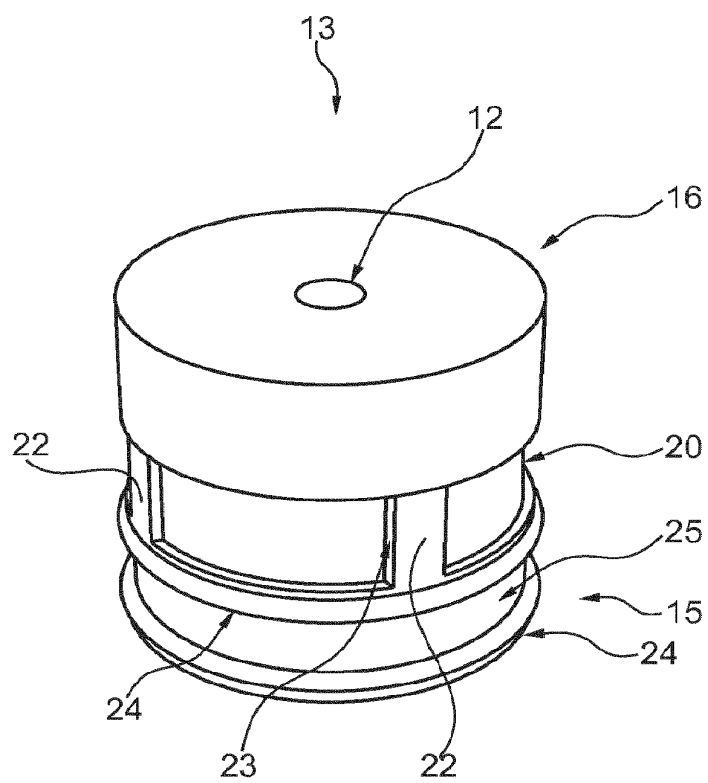


Fig. 2

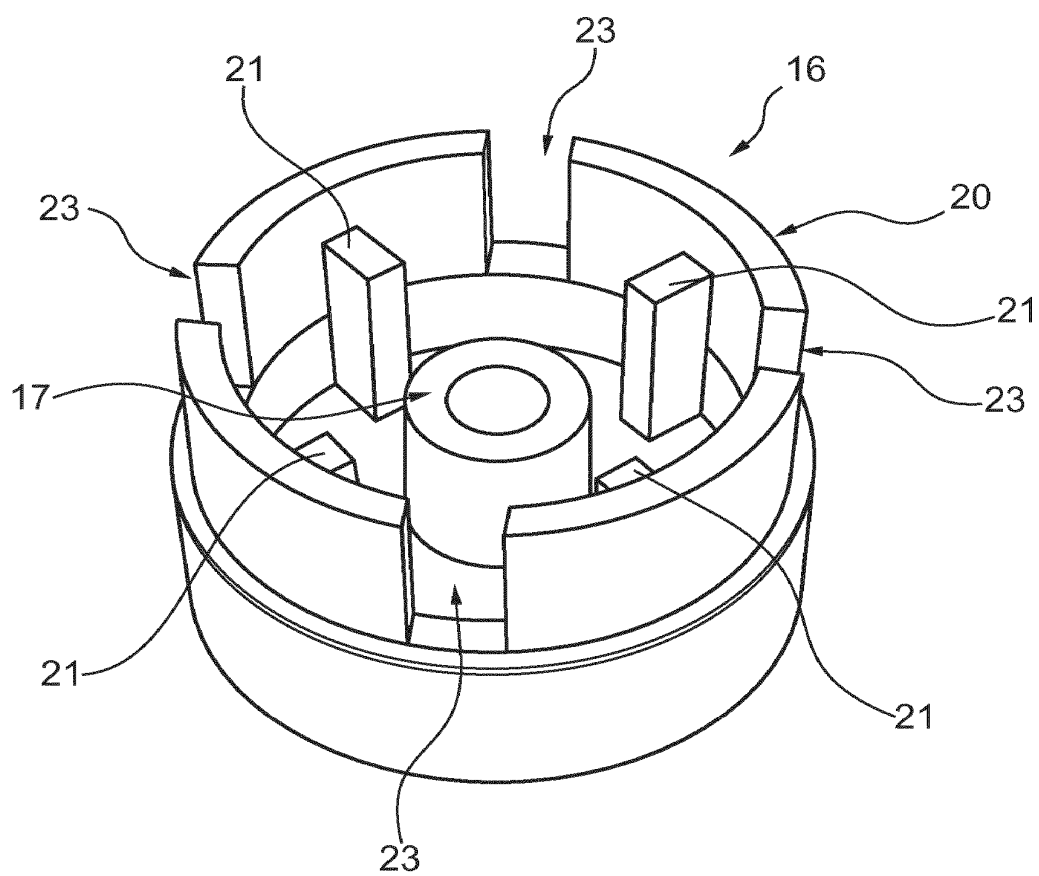


Fig. 4

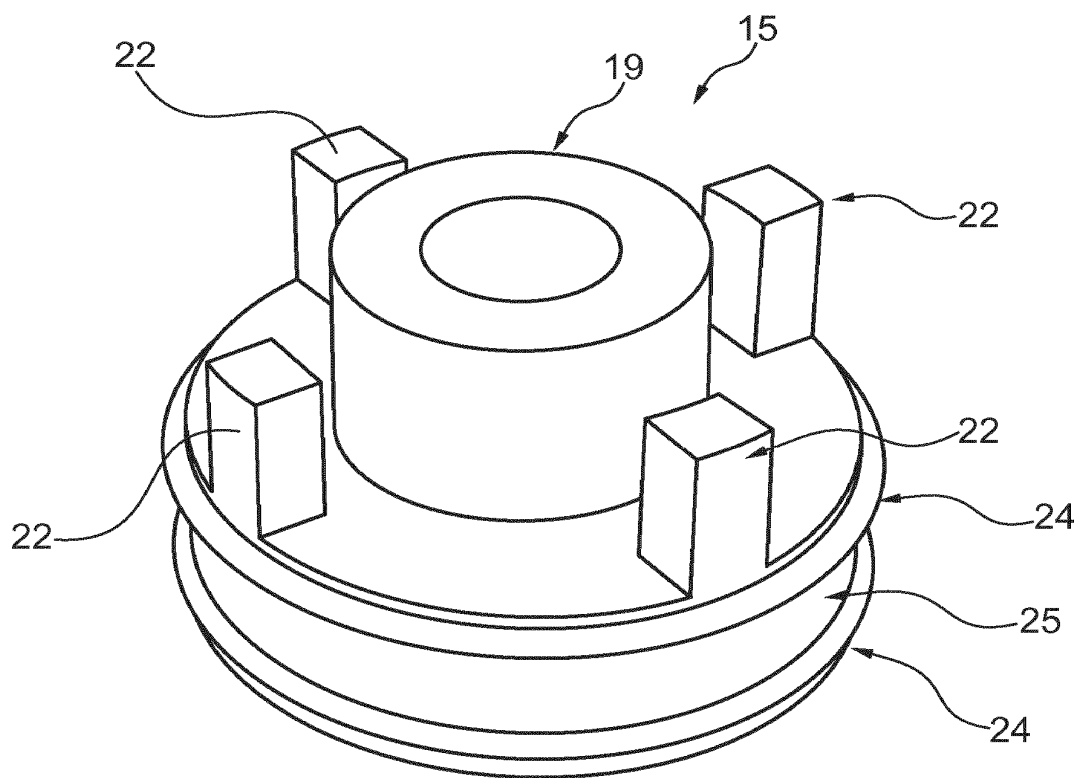


Fig. 5

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/068426

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

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. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 2011/303231 A1 (LI YONGHAI [CN] ET AL)<br>15 December 2011 (2011-12-15)<br>cited in the application<br>paragraph [0023]; figures 1,3<br>----- | 1-10                  |
| A         | US 2012/145169 A1 (WU YANGYANG [CN])<br>14 June 2012 (2012-06-14)<br>paragraphs [0006], [0015]; figures<br>-----                                 | 1-10                  |
| A         | CA 2 641 869 A1 (XIA HAO RAN [CN])<br>6 May 2010 (2010-05-06)<br>page 15, lines 15-17; figure 5<br>-----                                         | 1-10                  |
| A         | CN 201 900 065 U (GONGYUN LONG)<br>20 July 2011 (2011-07-20)<br>figure 4<br>-----                                                                | 1-10                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

3 February 2014

Date of mailing of the international search report

11/02/2014

Name and mailing address of the ISA/

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP2013/068426

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
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| -----                                     |    |                     | -----                      |                     |
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| -----                                     |    |                     | -----                      |                     |
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| -----                                     |    |                     | -----                      |                     |

## A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES

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A24F

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Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)

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## C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

| Kategorie* | Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile                                                 | Betr. Anspruch Nr. |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
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| A          | US 2012/145169 A1 (WU YANGYANG [CN])<br>14. Juni 2012 (2012-06-14)<br>Absätze [0006], [0015]; Abbildungen<br>-----                                 | 1-10               |
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| A          | CN 201 900 065 U (GONGYUN LONG)<br>20. Juli 2011 (2011-07-20)<br>Abbildung 4<br>-----                                                              | 1-10               |



Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen



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Datum des Abschlusses der internationalen Recherche

3. Februar 2014

Absendedatum des internationalen Recherchenberichts

11/02/2014

Name und Postanschrift der Internationalen Recherchenbehörde

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Bevollmächtigter Bediensteter

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**INTERNATIONALER RECHERCHENBERICHT**

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen

PCT/EP2013/068426

| Im Recherchenbericht<br>angeführtes Patentdokument | Datum der<br>Veröffentlichung | Mitglied(er) der<br>Patentfamilie | Datum der<br>Veröffentlichung |
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|                                                    |                               | US 2012145169 A1                  | 14-06-2012                    |
| -----                                              |                               | -----                             |                               |
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| -----                                              |                               | -----                             |                               |
| CN 201900065 U                                     | 20-07-2011                    | KEINE                             |                               |
| -----                                              |                               | -----                             |                               |



(43) International Publication Date  
3 July 2014 (03.07.2014)

(51) International Patent Classification:  
A24F 47/00 (2006.01)

(21) International Application Number:  
PCT/CN2013/090235

(22) International Filing Date:  
23 December 2013 (23.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
201220736918.9 28 December 2012 (28.12.2012) CN

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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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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: ELECTRONIC ATOMIZING INHALATION DEVICE

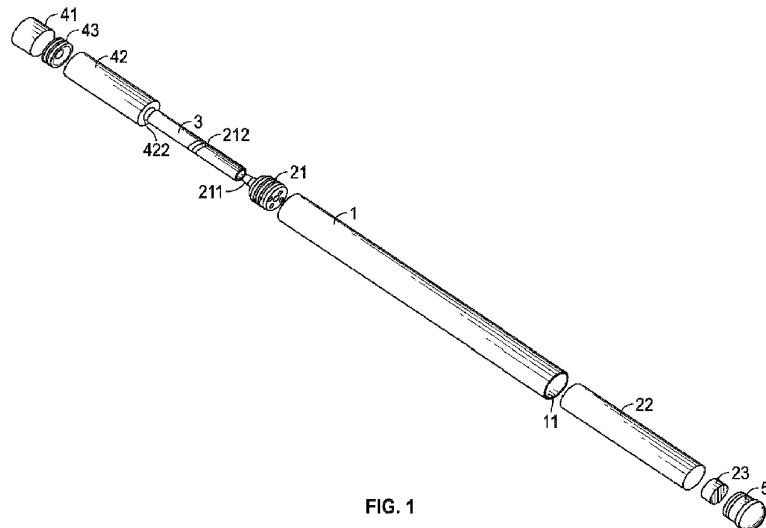


FIG. 1

(57) Abstract: An electronic atomizing inhalation device, includes: a shell (1), the shell (1) including a hollow cavity (11) which includes a hollow pipe (3); an atomizing part and a filtering part arranged in the hollow cavity (11). The atomizing part includes a heating body fixed on the hollow pipe (3), and a liquid storage part (42) wound outside the hollow pipe (3). The filtering part is sleeved on one side of the atomizing part. And the filter body (41) of the filtering part is fastened on an open end of the shell (1) through a sealing bracket (43). The electronic atomizing inhalation device can filter the harmful substances in the smoke it generates; and the electronic atomizing inhalation device is simple in structure, and is safe, reliable, attractive and original.

WO 2014/101734 A1

## Description

### Title of Invention: ELECTRONIC ATOMIZING INHALATION DEVICE

[1]       **【FIELD OF THE INVENTION】**

[2]       The present disclosure relates to the field of electronic atomizing inhalation devices, particularly relates to an electronic atomizing inhalation device having a filtering function.

[3]       **【BACKGROUND OF THE INVENTION】**

[4]       The nozzle of a conventional electronic cigarette does not have any filtering function in general, and is in communication with the inside of the electronic cigarette. When a user smokes an electronic cigarette, nicotine, nicotinamide, and tobacco tar in smoke generated inside the electronic cigarette can enter the oral cavity of the user directly via the nozzle, threatening the user's health.

[5]       Furthermore, the nozzle of the conventional electronic cigarette differs greatly from that of a cigarette nozzle in structure, affecting user experience and is aesthetically unattractive.

[6]       **【SUMMARY OF THE INVENTION】**

[7]       The present disclosure aims to provide an electronic atomizing inhalation device, which is capable of filtering harmful substances in produced smoke and lowering the probability of harmful substances harming human health; and the electronic atomizing inhalation device is simple in structure, and is safe, reliable, attractive, and original.

[8]       In order to solve the abovementioned technical problems, the embodiments of the present disclosure can provide an electronic atomizing inhalation device, including, for example:

[9]       A shell including a hollow cavity which includes a hollow pipe therein.

[10]      An atomizing part and a filtering part arranged in the hollow cavity, the atomizing part including a heating body fixed on the hollow pipe, and a liquid storage part wound outside the hollow pipe.

[11]      The filtering part can be sleeved on one side of the atomizing part; and include a filtering body fastened on an open end of the shell through a sealing bracket.

[12]      Preferably, the filtering body can be processed from multiple threadlike cotton bodies.

[13]      Preferably, the filtering part can further include an oil absorbing body, wherein the sealing bracket can be fastened on the inner wall of the open end of the shell; and one end of the sealing bracket can be pressed against the oil absorbing body, and the other opposite end can support the filtering body.

- [14] Preferably, the oil absorbing body can be provided with a through hole for accommodating the hollow pipe, wherein one end part of the hollow pipe can be positioned outside the through hole, and in butt joint with the sealing bracket.
- [15] Preferably, the sealing bracket can be annular, and the periphery of the sealing bracket can be hermetically connected with the inner wall of the hollow cavity.
- [16] Preferably, the heating body can include a heating wire, a heating seat fastened at one end of the hollow pipe, and a battery and a control switch arranged in the hollow cavity, wherein the control switch, the battery, the heating seat and the heating wire can be connected in sequence.
- [17] Preferably, the heating seat can be provided with a bump for being inserted into the pipe orifice of the hollow pipe, wherein the bump can be hermetically connected with the hollow pipe.
- [18] Preferably, the periphery of the heating seat can be hermetically connected with the inner wall of the hollow cavity.
- [19] Regarding the electronic atomizing inhalation device disclosed in the embodiments in this disclosure, the filtering part can be provided with a filtering body fastened at one open end of the shell, and can be processed from multiple threadlike cotton bodies, thus nicotine, nicotinamide, and tobacco tar in the smoke generated in the electronic atomizing inhalation device can be filtered, and the probability of harmful substances harming human health can be lowered; furthermore, the filtering body can have certain elasticity and be similar to a cigarette nozzle, thus improving user experience; and the electronic atomizing inhalation device is simple in structure, and is safe, reliable, attractive, and original.
- [20] **【BRIEF DESCRIPTION OF THE DRAWINGS】**
- [21] In order to more clearly illustrate the embodiments of the disclosure, drawings needed for describing the embodiments are introduced briefly below. It should be noted that the drawings in the following description correspond only to certain embodiments of the disclosure. For those skilled in the art, other drawings can further be obtained according to these drawings without any inventive efforts.
- [22] Fig. 1 is a schematic diagram illustrating an exploded view of the structure of an electronic atomizing inhalation device, according to an embodiment of the present disclosure.
- [23] Fig. 2 is a schematic diagram illustrating a sectional view of the assembly of an electronic atomizing inhalation device, according to an embodiment of the present disclosure.
- [24] Fig. 3 is a schematic diagram illustrating a section view of the assembly of an electronic atomizing inhalation device, according to another embodiment of the present disclosure.

- [25] Fig. 4 is a schematic diagram illustrating a section view of the assembly of an electronic atomizing inhalation device, according to yet another embodiment of the present disclosure.
- [26] Fig. 5 is a schematic diagram illustrating a section view of the assembly of a heating seat including a sealing portion and a fixed base, according to yet another embodiment of the present disclosure.
- [27] Fig. 6 provides a prospective view of the assembly of the heating seat illustrated in Fig. 5, according to an embodiment of the present disclosure.
- [28] **【DETAILED DESCRIPTION OF THE EMBODIMENTS】**
- [29] The preferred embodiments of the present disclosure are described in reference to the drawings below.
- [30] Fig. 1 and Fig. 2 illustrate a first embodiment of the electronic atomizing inhalation device of the present disclosure.
- [31] Fig. 1 is a schematic diagram illustrating an exploded view of the electronic atomizing inhalation device, according to one embodiment of the present disclosure. In this embodiment, the electronic atomizing inhalation device can include:
- [32] A shell 1, which can include a hollow cavity 11, which can include a hollow pipe 3 therein.
- [33] An atomizing part and a filtering part arranged in the hollow cavity 11, wherein the atomizing part can include a heating body fixed on the hollow pipe 3, and a liquid storage part 42 wound outside the hollow pipe 3.
- [34] The filtering part can be sleeved on one side of the atomizing part; and the filtering body 41 of the filtering part can be fastened on an open end of the shell 1 through a sealing bracket 43.
- [35] The shell 1 can have a hollow pipe body structure with two open ends, and the hollow cavity 11 of the shell 1 can be used for mounting and accommodating the atomizing part, the hollow pipe 3, and the filtering part. In this embodiment, the shell can be made of plastic, such as an ABS (Acrylonitrile Butadiene Styrene) material via a polishing process.
- [36] The atomizing part can be arranged in the hollow cavity 11, have the liquid solution stored therein heated to generate smoke, and can be fastened at the bottom (shown in the drawing) of the hollow cavity 11.
- [37] In this embodiment, the atomizing part can include a heating body and a liquid storage part (e.g., an oil absorbing body) 42, wherein the heating body can be fixed on the hollow pipe 3; and the liquid storage part 42 can be wound outside the hollow pipe 3, and the liquid storage part can include a cotton core for storing liquid/solution.
- [38] The heating body can include: a heating wire 212, a heating seat 21 fastened at one end of the hollow pipe 3, and a battery 22 and a control switch 23 arranged in the

- hollow cavity 11, wherein the control switch 23, the battery 22, the heating seat 21 and the heating wire 212 can be connected in sequence.
- [39] Specifically, the battery 22 can be used for supplying power, and heat produced by the heating seat 21 can be used for heating the liquid solution in the hollow cavity 11 via the heating wire 212. The liquid solution can be stored in the liquid storage part 42. In this embodiment, the heating wire can be wound around the hollow pipe 3, between the hollow pipe 3 and the liquid storage part 42, as shown in Fig. 1.
- [40] In this embodiment, the control switch 23 can be connected with a top cover 5, and switched on or off by pressing the top cover 5. When a circuit is switched on, the battery 22 can be used for supplying power, the heating seat 21 can function, and the heating wire 212 can be used for heating the liquid solution in the hollow cavity 11 to produce smoke.
- [41] Wherein, the hollow pipe 3 can be a structural part for conveying smoke, can be provided with openings at the two ends, and can be hollow. In this embodiment, the heating seat 21 can be provided with a bump 211 for being inserted into the pipe orifice of the hollow pipe 3, and the bump 211 can be hermetically connected with the hollow pipe 3.
- [42] The formed bump 211 can keep the end side on the hollow pipe 3 sealed.
- [43] In a preferred embodiment, the periphery of the heating seat 21 can be hermetically connected with the inner wall of the hollow cavity 11.
- [44] Specifically, the heating seat 21 can be used for separating and sealing, on one side, the cavity housing parts such as the battery 22, the control switch 23, etc., and, on the other side, the cavity including the hollow pipe 3. Therefore, smoke produced on one side of the hollow pipe 3 can be prevented from being diffused from the tail end of the pipe, and thus enhancing the sealing performance of the electronic atomizing inhalation device. Furthermore, a clamping structure can be formed by the bump 211 formed on the heating seat 21 and the hollow pipe 3 to prevent the above-described situation of smoke diffusion from occurring. In some embodiment, as will be discussed below in view of Figs. 4-6, the heating seat can include, for example, a sealing portion and a fixed base.
- [45] The filtering part can have a structure for filtering, for example, nicotine, nicotinamide, and tobacco tar in the smoke generated in the electronic atomizing inhalation device, and can include the filtering body 41 and a sealing bracket 43, wherein the sealing bracket 43 can be fastened on the inner wall of the open end of the shell; and one end of the sealing bracket can be pressed against the liquid storage part (e.g., oil absorbing body) 42, and the other opposite end can be used for supporting the filtering body 41.
- [46] The oil absorbing body 42 can be sleeved outside the hollow pipe 3 and the bump



211 on the heating seat 21, and can be provided with a through hole 422 for accommodating the hollow pipe 3.

- [47] After the heating seat 21 is assembled together with the hollow pipe 3 with the abovementioned method, the oil absorbing body 42 can be sleeved. After assembly, the top end (shown in the drawing) of the hollow pipe 3 may not be totally wrapped by the oil absorbing body 42, and the exposed part can be in butt joint with the sealing bracket 43, thus the leak tightness of an air path can be ensured, and smoke can be prevented from leaking outwards.
- [48] In some embodiments, the oil absorbing body 42 can play a role in assisting in absorbing, for example, nicotine, nicotinamide, and tobacco tar in the smoke generated in the electronic atomizing inhalation device.
- [49] The sealing bracket 43 can be annular, and the periphery of the sealing bracket 43 can be hermetically connected with the inner wall of the hollow cavity 11. The sealing bracket 43 can be pressed against the oil absorbing body 42 on one hand, and can be used for supporting the filtering body 41 on the other hand. The effect of hermetically connecting the periphery of the sealing bracket 43 with the inner wall of the hollow cavity 11 can be the same as the effect of hermetically connecting the periphery of the heating seat 21 with the inner wall of the hollow cavity 11.
- [50] The filtering body 41 can be fastened at the open end of the shell 1, and processed from multiple threadlike cotton bodies. This structure can allow the filtering body 41 to have high elasticity and provide the same touch feel as an ordinary cigarette nozzle, and thus improving user experience.
- [51] Furthermore, the filtering body 41 including multiple threadlike cotton bodies can be used for adsorbing particles in the produced smoke so as to realize the filtering function. The filtering body 41 can be used for filtering, for example, nicotine, nicotinamide, and tobacco tar in the smoke, contributing to reducing the harm caused by the above-described harmful substances on human health.
- [52] According to the electronic atomizing inhalation device provided in the embodiments of the present disclosure, a filtering body 41 of the filtering part can be fastened at one open end of the shell, and be processed from multiple threadlike cotton bodies, thus nicotine, nicotinamide, and tobacco tar in the smoke generated in the electronic atomizing inhalation device can be filtered, and thus, reducing the probability of the harmful substances harming human health; furthermore, the filtering body can have certain elasticity and be closer to a cigarette nozzle, thus improving user experience; and the electronic atomizing inhalation device can be simple in structure, and safe, reliable, attractive, and original.
- [53] Fig. 3 illustrates a second embodiment of the electronic atomizing inhalation device of the present disclosure. The electronic atomization inhalation device illustrated in

Fig. 3 is similar to the one illustrated in Fig. 2. In particular, the heating body in this embodiment can also include: a heating wire 212', a heating seat 21 fastened at one end of the hollow pipe 3, and a battery 22 and a control switch 23 arranged in the hollow cavity 11, wherein the control switch 23, the battery 22, the heating seat 21 and the heating wire 212' can be connected in sequence, as illustrated in the figure.

[54] In this embodiment, however, the heating wire 212' is not wound around the hollow pipe 3, but can, instead, be wound around a fiber rope 10, which can be mounted inside (e.g., across) the hollow pipe 3. The control switch 23 can be connected with a top cover 5, and switched on or off by pressing the top cover 5. When the circuit is switched on, the battery 22 can be used for supplying power to the heating seat 21, which can heat up the heating wire 212', which, in turn, can be used for heating the liquid solution in the hollow cavity 11 to produce smoke.

[55] Fig. 4 illustrates a third embodiment of the electronic atomizing inhalation device of the present disclosure. The electronic atomization inhalation device illustrated in Fig. 4 is similar to the one illustrated in Fig. 3. In this embodiment, the heating seat can include a sealing portion 33 and a fixed base 37 (shown in Figs. 5 and 6), the heating seat placed in the hollow cavity 11 between the battery chamber 48 and the atomizing part 49, separating the battery chamber 48 and the atomizing part 49. The sealing portion 33 can be hermetically connected with the inner wall of the hollow cavity 11. The heating seat can connect the battery 22 and the heating wire 212' mounted in the hollow pipe 3.

[56] In this embodiment, the sealing portion 33 can sleeve, at least partially, on the fixed base 37 which can support the atomizing part 49 of the device. The sealing portion 33 can provide one or more air inlets 12 that can allow air to flow from outside of the shell 1 into the hollow cavity 11 and then into the hollow pipe 3 through a central passage 38 in the fixed base. The illustrated structure of Fig. 3, in particular, the sealing portion 33, can prevent liquid stored in the atomizing part (e.g., the liquid storage part 42) from entering the battery chamber 48. In addition, by having one or more air inlets between the battery chamber 48 and the atomizing part 49, the device of this embodiment can provide a more consistent air flow into the hollow pipe 3 than conventional devices with air inlets near the switch 5 end of the device. In the conventional devices, air enters the device near the switch 5 end of the device and has to travel around and along the length of the battery. As such, the air flow may not be uniform within a device and/or among different devices, depending on the installation of the battery.

[57] Fig. 5 illustrates in detail the exemplary structure of the heating seat including the sealing portion 33 of Fig. 4. The sealing portion 33 can include a top portion 34 and a bottom portion 35. Between the top portion 34 and the bottom portion 35 of the sealing

portion 33 can form an annular groove. When the sealing portion 33 can be sleeved on the fixed base 37 and placed in the hollow cavity 11, an annular cavity can form between the annular groove and the inner wall of the hollow cavity 11. The air inlet 12 can allow air to enter into the annular cavity and then the central passage 38 of the fixed base 37 through inlet 39, eventually reaching the hollow pipe 3.

[58] In this embodiment, the bottom portion 35 of the sealing portion 33 can be provided with a bump 31 for preventing liquid from the atomizing part of the device to enter into the battery chamber below. The bump 31 can optionally include an air flow sensing hole 32 for activating the switch of the device in response to sensing a small amount of air flow.

[59] Fig. 6 provides a prospective view of the assembly of the heating seat illustrated in Fig. 5. As illustrated in Fig. 6, the top portion 34 and the bottom portion 35 of the sealing portion 33 are sleeved on the fixed base 37, which includes an air inlet 12 that allows air from outside of the device to flow through the central passage 38 of the fixed base 37 and into the hollow pipe (not shown in Fig. 6.)

[60] In one or more of the embodiments, the electronic atomizing inhalation device can be an electronic cigarette.

[61] The embodiments disclosed above are only the preferred embodiments of the present disclosure, and of course, not to be used to limit the scope of the claims of the present disclosure. Therefore, equivalent changes made to the claims according to the present disclosure are to be covered by the scope of the present disclosure.

## Claims

- [Claim 1] An electronic atomizing inhalation device, characterized by comprising:  
a shell including a hollow cavity which includes a hollow pipe arranged therein;  
an atomizing part and a filtering part arranged in the hollow cavity, the atomizing part including a heating body fixed on the hollow pipe, and a liquid storage part wound outside the hollow pipe, the heating body configured to atomize a liquid solution stored in the liquid storage part; wherein the filtering part is sleeved on one end of the atomizing part; and includes a filtering body fastened on an open end of the shell through a sealing bracket, the filtering body configured to filter the atomized liquid solution passing through the hollow pipe.
- [Claim 2] The electronic atomizing inhalation device as claimed in claim 1, wherein the filtering body is processed from multiple threadlike cotton bodies.
- [Claim 3] The electronic atomizing inhalation device as claimed in claim 1, wherein the liquid storage part further comprises an oil absorbing body, and wherein the sealing bracket is fastened on the inner wall of the open end of the shell, one end of the sealing bracket pressed against the oil absorbing body, and an opposite end supporting the filtering body.
- [Claim 4] The electronic atomizing inhalation device as claimed in claim 3, wherein the oil absorbing body is provided with a through hole for accommodating the hollow pipe, wherein one end part of the hollow pipe is positioned outside the through hole, and is in butt joint with the sealing bracket.
- [Claim 5] The electronic atomizing inhalation device as claimed in claim 3, wherein the sealing bracket is annular, and a periphery of the sealing bracket is hermetically connected with an inner wall of the hollow cavity.
- [Claim 6] The electronic atomizing inhalation device as claimed in claim 1, wherein the heating body comprises a heating wire, a heating seat fastened at one end of the hollow pipe, and a battery and a control switch arranged in the hollow cavity, wherein the control switch, the battery, the heating seat, and the heating wire are connected in sequence.
- [Claim 7] The electronic atomizing inhalation device as claimed in claim 6,

wherein the heating seat is provided with a bump for being inserted into the pipe orifice of the hollow pipe, wherein the bump is hermetically connected with the hollow pipe.

- [Claim 8] The electronic atomizing inhalation device as claimed in claim 7, wherein the periphery of the heating seat is hermetically connected with the inner wall of the hollow cavity.
- [Claim 9] The electronic atomizing inhalation device as claimed in claim 6, wherein the heating wire comprises a coil wrapped around the hollow pipe.
- [Claim 10] The electronic atomizing inhalation device as claimed in claim 6, wherein the heating wires comprises a coil wrapped around a fiber rope mounted across the hollow pipe.
- [Claim 11] The electronic atomizing inhalation device as claimed in claim 6, wherein the heating seat comprises:  
a sealing portion sleeved on the fixed base, the sealing portion and the fixed base placed in the hollow cavity and separating the atomizing part and the filtering part from a battery chamber.
- [Claim 12] The electronic atomizing inhalation device as claimed in claim 11, wherein the sealing portion includes a top portion and a bottom portion forming an annular groove.
- [Claim 13] The electronic atomizing inhalation device as claimed in claim 11, wherein the heating seat comprises a fixed base including an air inlet configured to allow air into the hollow pipe; and wherein the sealing portion is sleeved, at least partially, on the fixed base.
- [Claim 14] The electronic atomizing inhalation device as claimed in claim 13, wherein the fixed base includes a central air passage connecting the air inlet with the hollow pipe.
- [Claim 15] The electronic atomizing inhalation device as claimed in claim 11, wherein the sealing portion includes an air flow sensing hole configured for activating a switch in response to sensing an air flow.
- [Claim 16] The electronic atomizing inhalation device as claimed in claim 1, wherein the electronic atomizing inhalation device comprises an electronic cigarette.

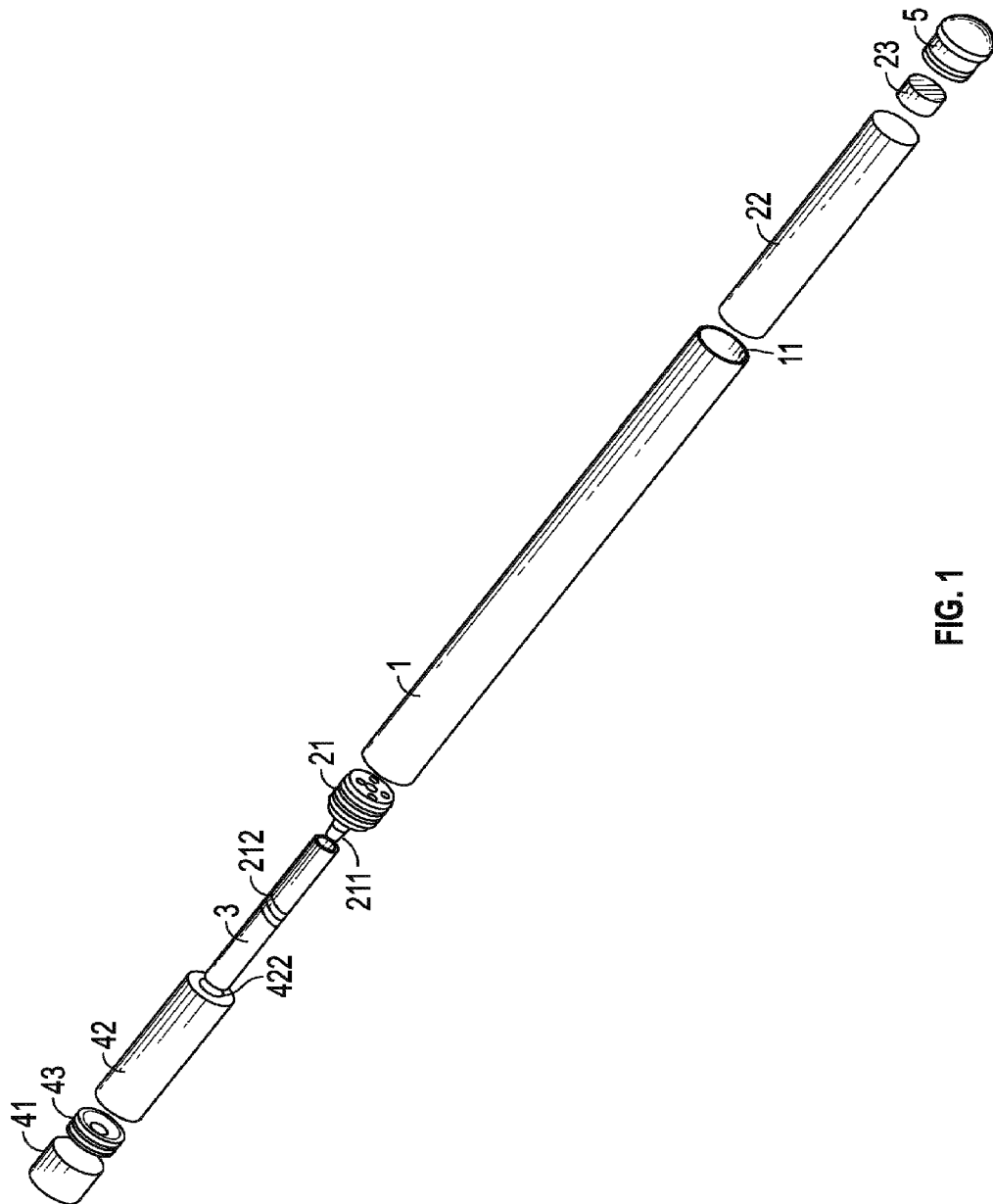


FIG. 1

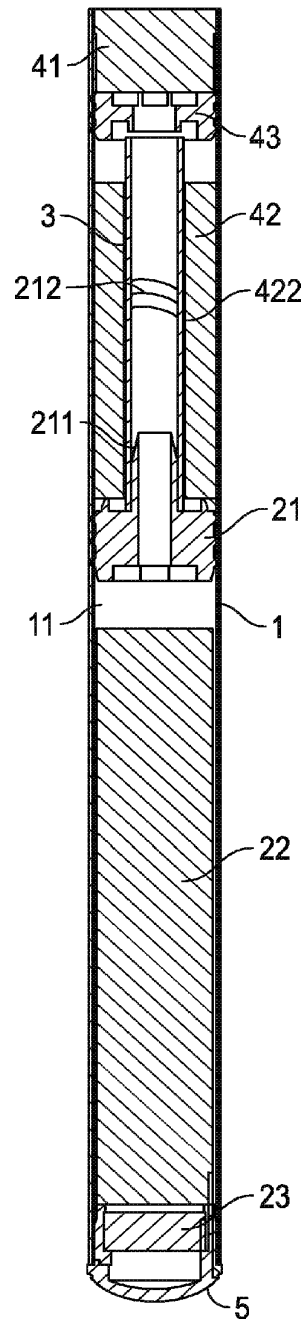


FIG. 2

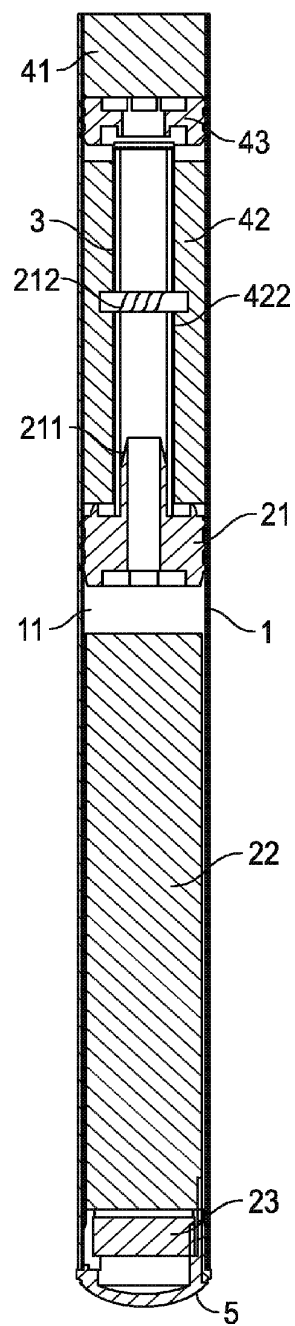


FIG. 3



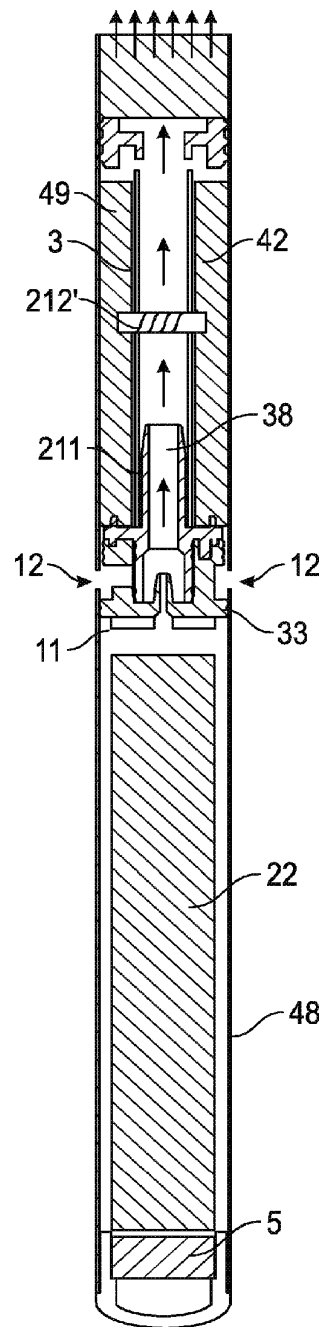


FIG. 4



**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/CN2013/090235

**A. CLASSIFICATION OF SUBJECT MATTER**

A24F 47/00 (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)

IPC: A24F 47

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)

VEN, CNABS, CNTXT: 陈志平, 烟, 电子, 仿真, 模拟, 雾化, 替代, 虚拟, 通孔, 气孔, 过滤, 吸油, electronic, electrical, simulate, imitate, substitute, atomizer, cigar, cigarette, tobacco, screw thread, air hole?, air pore?, inlet, outlet, filter+, wire, heat+

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                          | Relevant to claim No. |
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| Y         |                                                                                                                                             | 10, 12-14             |
| Y         | CN 202262413 U (LI Y et al.) 6 June 2012 (06.06.2012) see claims 1-4, paragraph [0022] and figures 1                                        | 10                    |
| Y         | CN 201750712 U (CHEN Z) 23 February 2011 (23.02.2011) see claims 1-16, paragraphs[0043], [0052], [0058]-[0061] and figures 1-3, 6           | 12-14                 |
| A         | CN 201127292 Y (ZHENGZHOU TOBACCO INST CHINA TOBACCO COR) 8 October 2008 (08.10.2008) see the whole document                                | 1-16                  |

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

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“&amp;”document member of the same patent family

Date of the actual completion of the international search

7 March 2014 (07.03.2014)

Date of mailing of the international search report

**03 Apr. 2014 (03.04.2014)**

Name and mailing address of the ISA/CN

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Form PCT/ISA /210 (second sheet) (July 2009)

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/CN2013/090235

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages          | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------|-----------------------|
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| A         | CN 201197360 Y (CHEN Z) 25 February 2009 (25.02.2009) see the whole document                | 1-16                  |
| A         | EP 2443947 A1 (JAPAN TOBACCO INC. et al.) 25 April 2012 (25.04.2012) see the whole document | 1-16                  |

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

International application No.

PCT/CN2013/090235

| Patent Documents referred<br>in the Report | Publication Date | Patent Family    | Publication Date |
|--------------------------------------------|------------------|------------------|------------------|
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| CN 201750712 U                             | 23.02.2011       | None             |                  |
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| CN 201197360 Y                             | 25.02.2009       | None             |                  |
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|                                            |                  | TW 201100029 A   | 01.01.2011       |
|                                            |                  | WO 2010146693 A1 | 23.12.2010       |



(43) International Publication Date  
25 September 2014 (25.09.2014)

(10) International Publication Number  
**WO 2014/150704 A2**

- (51) International Patent Classification: Not classified
- (21) International Application Number:  
PCT/US2014/024029
- (22) International Filing Date:  
12 March 2014 (12.03.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
61/798,966 15 March 2013 (15.03.2013) US
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- (74) Agent: **SKIFF, Peter K.**; Buchanan Ingersoll & Rooney  
PC, P.O. Box 1404, Alexandria, Virginia 22313-1404  
(US).
- (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, 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, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, 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, 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:**

— *without international search report and to be republished  
upon receipt of that report (Rule 48.2(g))*



**WO 2014/150704 A2**

(54) Title: AN ELECTRONIC SMOKING ARTICLE

(57) Abstract: An electronic smoking article and a method of preventing unauthorized use of an electronic smoking article are disclosed. The smoking article includes a power supply operable to apply voltage to a heater for heating a liquid; a lock-out feature configured to prevent unauthorized use of the smoking article, which disables the power supply to the heater until the lock-out feature is unlocked by an authorized user; a mixing chamber downstream of the heater; and at least one air inlet operable to deliver air drawn into the mixing chamber, the air being mixed with the volatilized liquid material in the mixing chamber to form an aerosol.

## AN ELECTRONIC SMOKING ARTICLE

### RELATED APPLICATION(S)

**[0001]** The present application claims priority under 35 U.S.C. 119 to U.S. Provisional Patent Application No. 61/798,966, filed on March 15, 2013, the entire content of which is hereby incorporated by reference.

### WORKING ENVIRONMENT

**[0002]** Electronic smoking articles, such as electronic cigarettes and aerosol generators can include a capillary tube and/or capillary wick designed to deliver liquid material from a liquid reservoir to a heater. Such devices can be activated by a consumer drawing on a mouthpiece to deliver an aerosol to the user.

### SUMMARY

**[0003]** In accordance with an exemplary embodiment, an electronic smoking article is disclosed, the electronic smoking article comprising: a power supply operable to apply voltage to a heater for heating a liquid; a lock-out feature configured to prevent unauthorized use of the smoking article, which disables the power supply to the heater until the lock-out feature is unlocked by an authorized user; a mixing chamber downstream of the heater; and at least one air inlet operable to deliver air drawn into the mixing chamber, the air being mixed with the volatilized liquid material in the mixing chamber to form an aerosol.

**[0004]** In accordance with another exemplary embodiment, a method of preventing unauthorized use of an electronic smoking device is disclosed, the method comprising: disabling a power supply to a heater of an electronic smoking article with a lock-out feature on the smoking article, and wherein the power supply is operable to apply voltage to a heater for heating a liquid to form an aerosol; and enabling the power supply only upon receipt of an activation code from an authorized user, and wherein the activation code unlocks the lock-out feature and enables the power supply to the heater.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0005]** The disclosure is explained below with reference to the exemplary embodiments shown in the drawings. In the drawings:

**[0006]** FIG. 1 is a cross-sectional view of an electronic smoking article in accordance with an exemplary embodiment having an input activation panel;

**[0007]** FIG. 2 is a cross-sectional view of an electronic smoking article in accordance with an exemplary embodiment having a biometric panel for detecting an authorized user; and

**[0008]** FIG. 3 is a cross-sectional view of an electronic smoking article in accordance with an exemplary embodiment having a proximity or a location based sensor within the smoking article.

#### **DETAILED DESCRIPTION**

**[0009]** In accordance with an exemplary embodiment, a lock-out feature for an electronic smoking article, such as an electronic cigarette is disclosed, which can provide access to the use of the device to only an intended adult smoker and/or owner of the device. In accordance with an exemplary embodiment, the lock-out features can be implemented, which can be easy to learn and operate for the user of the electronic smoking article.

**[0010]** FIG. 1 shows an electronic smoking article 100 in accordance with an exemplary embodiment. As shown in FIG. 1, the electronic smoking article 100 includes a housing 110 having a mouth end 112 and a body end 114. In the body end 114, there is provided an electric power supply in the form of power supply 120 and electric circuitry in the form of circuitry 122 and a puff detection system 130. In accordance with an exemplary embodiment, the detection system 130 can be combined with the circuitry 122 and located an upstream end of the device 100. In the mouth end 112, the smoking article 100 includes a cartridge 140, a heater 144, and a capillary wick (or capillary tube) 146. The cartridge delivers a liquid material 152 from a liquid supply reservoir (or fluid reservoir) 150 to the capillary wick 146, which is surrounded by the heater 144. In accordance with an exemplary embodiment, one end of the capillary wick 146 extends to the cartridge 140 and the other end of the capillary wick 146 is surrounded by the heater 144. The heater 144 is connected to the electric circuitry 122 via connections (not shown). The housing 110 also includes an air inlet 160, an air outlet 162 at the mouth end 112, and an aerosol forming chamber 170.



**[0011]** In use, the liquid material 152 is supplied from the fluid reservoir 150 to the capillary wick 146, which as shown in FIG. 1 is surrounded by the heater 144. When a user draws on the electronic smoking article 100 at the air outlet 162, ambient air is drawn through air inlet 160. In accordance with an exemplary embodiment, the electronic smoking article 100 can include a puff detection system 130, which senses the puff and activates the heater 144 and supplies the liquid material to the capillary wick 146. The power supply 120 supplies pulses of energy to the heater 144 to heat the end of the capillary wick 146 surrounded by the heater 144. The liquid material 152 in the outlet end 147 of the capillary wick 146 can be vaporized by the heater 144 to create a supersaturated vapor. At the same time, the liquid material 152 being vaporized is replaced by additional liquid material 152 moving along the capillary wick 146.

**[0012]** In accordance with an exemplary embodiment, the supersaturated vapor created can be mixed with and carried in the air flow from the air inlet 160. In the aerosol forming chamber 170, the vapor condenses to form an inhalable aerosol, which is carried towards the outlet 162 and into the mouth of the user. The circuitry 122 and the puff detection system 130 are preferably programmable. In accordance with an exemplary embodiment, the circuitry 122 and puff detection system 130 can be used to manage the operation of the electronic smoking article 100.

**[0013]** In use, once the capillary wick 146 is heated, the liquid material contained within a heated portion of the capillary wick 146 is volatilized and ejected out of the outlet 147 where it expands and mixes with air and forms an aerosol in a mixing chamber 170. The electronic smoking article 100 also includes at least one air inlet 160 operable to deliver air to the mixing chamber 170. Preferably, the air inlets 160 to the mixing chamber 170 are arranged downstream of the capillary wick 146 so as to minimize drawing air along the capillary and thereby avoid cooling of the capillary wick 146 during heating cycles.

**[0014]** In use, the volatilized material expands out of the wick 146 and into the mixing chamber 170 where the volatilized material can mix with air to form an aerosol which is then drawn through the air outlet 162. In the exemplary embodiment, the at least one air inlet 160 includes one or two air inlets 160. Alternatively, the air inlets 160 can be

three, four, or five or more. In accordance with an exemplary embodiment, the size and number of air inlets 160 can also aid in establishing the resistance to draw of the electronic smoking article 100.

**[0015]** In accordance with an exemplary embodiment, the electronic smoking article 100 can include a capillary tube (not shown) rather than a capillary wick 146. The capillary tube has an inlet end in fluid communication with an outlet of the liquid supply reservoir and an outlet end operable to expel volatilized liquid material from the capillary tube. In accordance with an exemplary embodiment, the capillary tube can have an internal diameter of 0.01 to 10 mm, preferably 0.05 to 1 mm, and more preferably 0.05 to 0.4 mm.

**[0016]** The power supply 120 can be a Lithium-ion battery or one of its variants, for example a Lithium-ion polymer battery. Alternatively, the power supply 120 may be a Nickel-metal hydride battery, a Nickel cadmium battery, a Lithium-manganese battery, a Lithium-cobalt battery or a fuel cell. In accordance with an exemplary embodiment, the electronic smoking article 100 is usable by a smoker until the energy in the power supply is depleted. Alternatively, the power supply 120 may be rechargeable and include circuitry (not shown) allowing the battery to be chargeable by an external charging device. For example, the circuitry 122, when charged, provides power for a pre-determined number of puffs, after which the circuitry must be re-connected to an external charging device. The electronic smoking article 100 also includes control circuitry 122, which can be on a printed circuit board. In accordance with an exemplary embodiment, the control circuitry 122 preferably includes memory and an operating system or circuitry, which can be programmed as set forth herein to control access to the electronic smoking article 100.

**[0017]** In accordance with an exemplary embodiment as shown in FIG. 1, the smoking article 100 includes an input activation panel 190. The input activation panel 190 is preferably located on an outer surface 116 of the housing 110 of the smoking article 100 and is configured to receive an activation code from an authorized user of the smoking article 100. In accordance with an exemplary embodiment, the input activation panel 190 is preferably connected to the circuitry 122 of the smoking article 100. The panel 190 can include two or more numbered buttons 192, which can be pressed with a

finger, a touch screen pad, or any other suitable panel, which is configured to receive a relatively easy to remember code and can generate a customizable code, which unlocks the smoking article 100.

**[0018]** In accordance with an exemplary embodiment, the customizable code enables the power supply 120 to be activated. Once the electronic smoking article 100 has been enabled, the user can operate the device 100, for example, in accordance with an activation switch (not shown) or a puff detection system 130, which senses the puff, enables the heater 144, and supplies the liquid material 152 to the capillary wick 146.

**[0019]** FIG. 2 is a cross-sectional view of an electronic smoking article 100 in accordance with an exemplary embodiment having a biometric panel 200 for detecting an authorized user. In accordance with an exemplary embodiment, the biometric panel 200 detects distinctive and measurable characteristics of an individual, for example, fingerprints and/or voice recognition. In accordance with an exemplary embodiment, the biometric panel 200 is able to detect a user based on a fingerprint, voice or other biometric, and upon said detection unlocks the lock-out feature of the smoking article 100, which enables the power supply 120 within the smoking article 100 to be activated.

**[0020]** FIG. 3 is a cross-sectional view of an electronic smoking article 100 in accordance with an exemplary embodiment having a proximity or location based sensor 210 within the smoking article 100, which can detect wireless devices 212, for example, hotspots, WiFi at home, favorite coffee shops with wireless access, routers, and/or computers having a computer program (not shown), which can provide access to the sensor 210. In accordance with an exemplary embodiment, the sensor 210 can be configured to detect a corresponding sensor and/or transponder, which is housed, for example, within a wireless device 212, an authorized user's cell phone 214, and/or in a fob 216 (for example, a mechanical device with built-in authentication mechanism). For example, the fob 216 can be on a key chain of an authorized user. The smoking article 100 is preferably configured or programed to unlock and/or enable the power supply 120 within the electronic smoking article 100 upon the detection of the corresponding sensor and/or transponder 212, 214, 216. In accordance with an exemplary embodiment, the corresponding sensor and/or transponder 212, 214, 216 is preferably included within and/or part of a programmable device and/or apparatus 212, 214, 216.

**[0021]** In accordance with an exemplary embodiment, the control circuitry 122 can also include a heater activation light at an upstream end (not shown) operable to glow when the heater 144 is activated. The control circuitry 122 can also include a timer operable to limit the time for which power is supplied to the heater 144. The time-period of the electric current supply to the heater 144 may be pre-set depending on the amount of liquid desired to be vaporized. For example, the control circuitry 122 can be programmable for this purpose.

**[0022]** In accordance with an exemplary embodiment, when enabled, the heater 144 heats a portion of the wick 146 for less than about 10 seconds, more preferably less than about 7 seconds. Thus, the power cycle (or maximum puff length) can range in period from about 1 second to about 10 seconds.

**[0023]** In accordance with an exemplary embodiment, the liquid material 152 includes a tobacco-containing material including volatile tobacco flavor compounds which are released from the liquid upon heating. The liquid material 152 may also be a tobacco flavor containing material or a nicotine-containing material. Alternatively, or in addition, the liquid material 152 may include a non-tobacco material. For example, the liquid material 152 may include water, solvents, ethanol, plant extracts and natural or artificial flavors. Preferably, the liquid material 152 further includes an aerosol former. Examples of suitable aerosol formers are glycerine and propylene glycol.

**[0024]** In an exemplary embodiment, the electronic smoking article 100 is about the same size as a conventional cigarette. In some embodiments, the electronic smoking article 100 can be about 80 mm to about 88 mm long and about 7 mm to about 8 mm in diameter. The outer cylindrical housing 110 of the electronic smoking article 100 may be formed of any suitable material or combination of materials. Examples of suitable materials include metals, alloys, plastics or composite materials containing one or more of those materials, or thermoplastics that are suitable for food or pharmaceutical applications, for example polypropylene, polyetheretherketone (PEEK), ceramic, and polyethylene.

**[0025]** In an exemplary embodiment, the heater 144 can include a coil of wire at least partially surrounding the capillary wick 146. In an exemplary embodiment, the heater

144 is a metal wire and/or a metal alloy wire. The heater 144 can be a coil, which can extend fully or partially along the length of the capillary wick 146.

**[0026]** The electronic smoking article 100 can include a puff indicator (not shown) for indicating when the heater 144 is activated or enabled. In the embodiment in which the electric circuitry 122 includes a sensor to detect air flow indicative of a user taking a puff, the indicator may be activated when the sensor senses air flow indicative of the user taking a puff. In an exemplary embodiment in which the electric circuitry 122 includes a manually operable switch, the indicator may be activated by the switch.

**[0027]** The teachings herein are adaptable to all forms of electronic smoking articles, such as electronic cigarettes, cigars, pipes, hookahs, and other, regardless of their size and shape.

**[0028]** When the word "about" is used in this specification in connection with a numerical value, it is intended that the associated numerical value include a tolerance of  $\pm 10\%$  around the stated numerical value. Moreover, when reference is made to percentages in this specification, it is intended that those percentages are based on weight, i.e., weight percentages.

**[0029]** Moreover, when the words "generally" and "substantially" are used in connection with geometric shapes, it is intended that precision of the geometric shape is not required but that latitude for the shape is within the scope of the disclosure. When used with geometric terms, the words "generally" and "substantially" are intended to encompass not only features, which meet the strict definitions but also features, which fairly approximate the strict definitions.

**[0030]** It will now be apparent that a new, improved, and nonobvious electronic smoking article has been described in this specification with sufficient particularity as to be understood by one of ordinary skill in the art. Moreover, it will be apparent to those skilled in the art that numerous modifications, variations, substitutions, and equivalents exist for features of the electronic smoking article, which do not materially depart from the spirit, and scope of the invention. Accordingly, it is expressly intended that all such modifications, variations, substitutions, and equivalents, which fall within the spirit and scope of the invention as defined by the appended claims, shall be embraced by the appended claims.

**What is Claimed is:**

1. An electronic smoking article comprising:  
a power supply operable to apply voltage to a heater for heating a liquid;  
a lock-out feature configured to prevent unauthorized use of the smoking article, which disables the power supply to the heater until the lock-out feature is unlocked by an authorized user;  
a mixing chamber downstream of the heater; and  
at least one air inlet operable to deliver air drawn into the mixing chamber, the air being mixed with the volatilized liquid material in the mixing chamber to form an aerosol.
2. The smoking article of claim 1, wherein the lock-out feature is an input activation code, which is input into the smoking article via a key pad.
3. The smoking article of claim 1, wherein the lock-out feature is a biometric panel, which detects biometrics of a user of the smoking article and upon detection of an authorized user, unlocks the lock-out feature of the smoking article.
4. The smoking article of claim 1, wherein the lock-out feature is a location based detection system located within the smoking article and upon detection of a corresponding wireless device unlocks the lock-out feature of the smoking article.
5. The smoking article of claim 4, wherein the location based detection system is programmed to provide access to a user at only known locations.
6. The smoking article of claim 1, wherein the lock-out feature is a proximity detector and upon detection of a corresponding sensor and/or transponder, and wherein the corresponding sensor and/or transponder unlocks the lock-out feature on the smoking article.
7. The smoking article of claim 6, wherein the corresponding sensor and/or transponder is a cell phone of a user.

8. The smoking article of claim 6, wherein the corresponding sensor and/or transponder is a fob on a key chain.

9. The smoking article of claim 1, comprising  
a capillary wick for holding the liquid; and  
wherein the heater is operable to heat the capillary wick to a temperature sufficient to at least initially volatilize the liquid material contained within the capillary wick.

10. The smoking article of claim 1, comprising:  
a capillary tube; and  
wherein the heater is operable to heat the capillary tube to a temperature sufficient to at least initially volatilize the liquid material contained within the capillary tube.

11. The smoking article of claim 1, comprising:  
an outer cylindrical housing extending in a longitudinal direction; and  
a liquid material contained within a liquid supply reservoir, which is supplied through an outlet of the supply reservoir into a capillary wick and/or a capillary tube.

12. The smoking article of claim 1, comprising:  
a mouth end having at least one outlet, wherein the mouth end is in fluid communication with the mixing chamber so as to deliver an aerosol to a smoker; and  
wherein the power supply includes a battery and the heater is connected to the battery by two spaced apart electrical connections.

13. The smoking article of Claim 1, comprising:  
control circuitry operable to control supply of power to the heater.

14. The smoking article of Claim 10, wherein the at least one air inlet is located upstream of the capillary tube.

15. A method of preventing unauthorized use of an electronic smoking article, comprising:

disabling a power supply to a heater of an electronic smoking article with a lock-out feature on the smoking article, and wherein the power supply is operable to apply voltage to a heater for heating a liquid to form an aerosol; and

enabling the power supply only upon receipt of an activation code from an authorized user, and wherein the activation code unlocks the lock-out feature and enables the power supply to the heater.

16. The method of claim 15, comprising:  
inputting the activation code using a key pad configured; and  
unlocking the lock-out feature by repeating the input activation code into the key pad.

17. The method of claim 15, comprising:  
inputting the activation code using a biometric panel; and  
unlocking the lock-out feature by detection of a biometric indicator of the authorized user on the biometric panel.

18. The method of claim 15, comprising:  
configuring the activation code to receive a wireless signal from a known wireless device; and  
unlocking the lock-out feature by detection of the wireless signal.

19. The method of claim 18, comprising:  
programming the location based detection system to provide access to the authorized user at only known locations.



20. The method of claim 18, comprising:  
configuring the activation code to detect a signal from a sensor and/or transponder; and  
unlocking the lock-out feature upon detection of the signal from the sensor and/or transponder.

21. The method of claim 20, wherein the corresponding sensor and/or transponder is a cell phone of the authorized user.

22. The method of claim 20, wherein the corresponding sensor and/or transponder is a fob on a key chain of the authorized user.

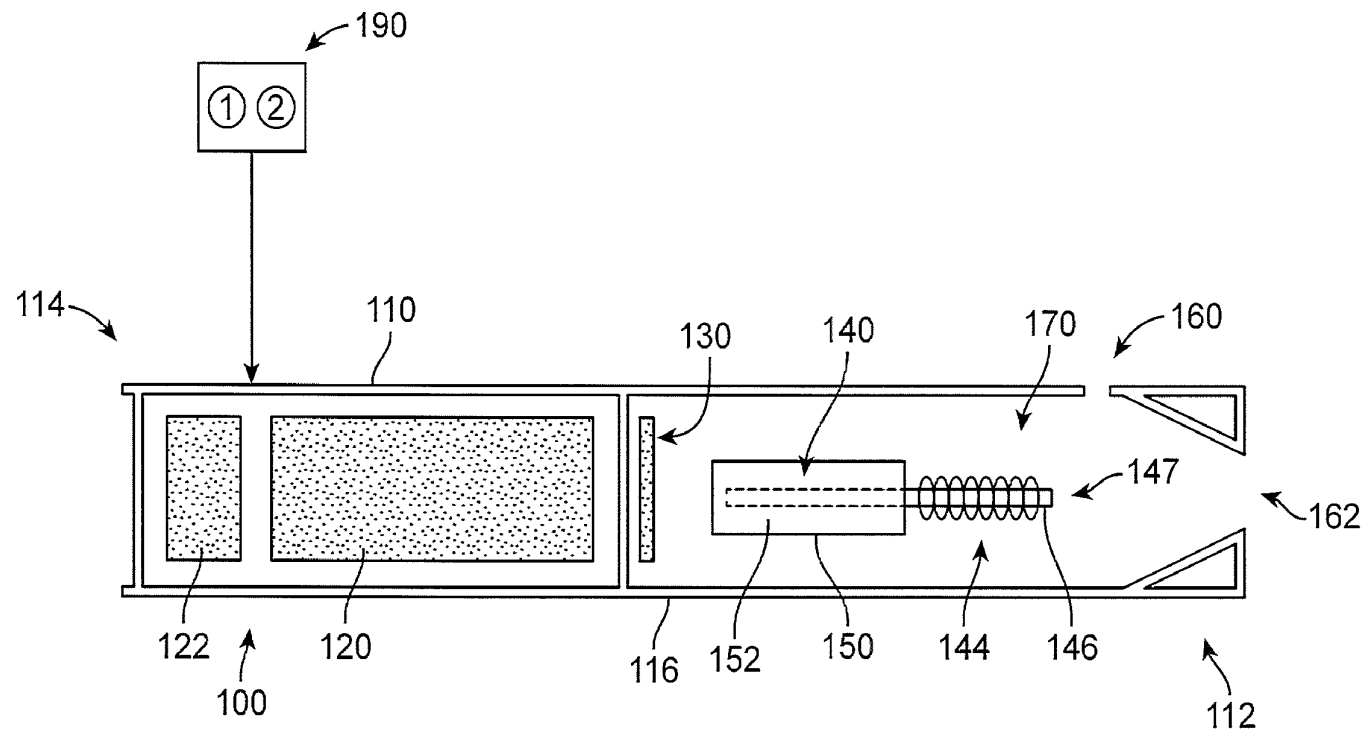


FIG. 1

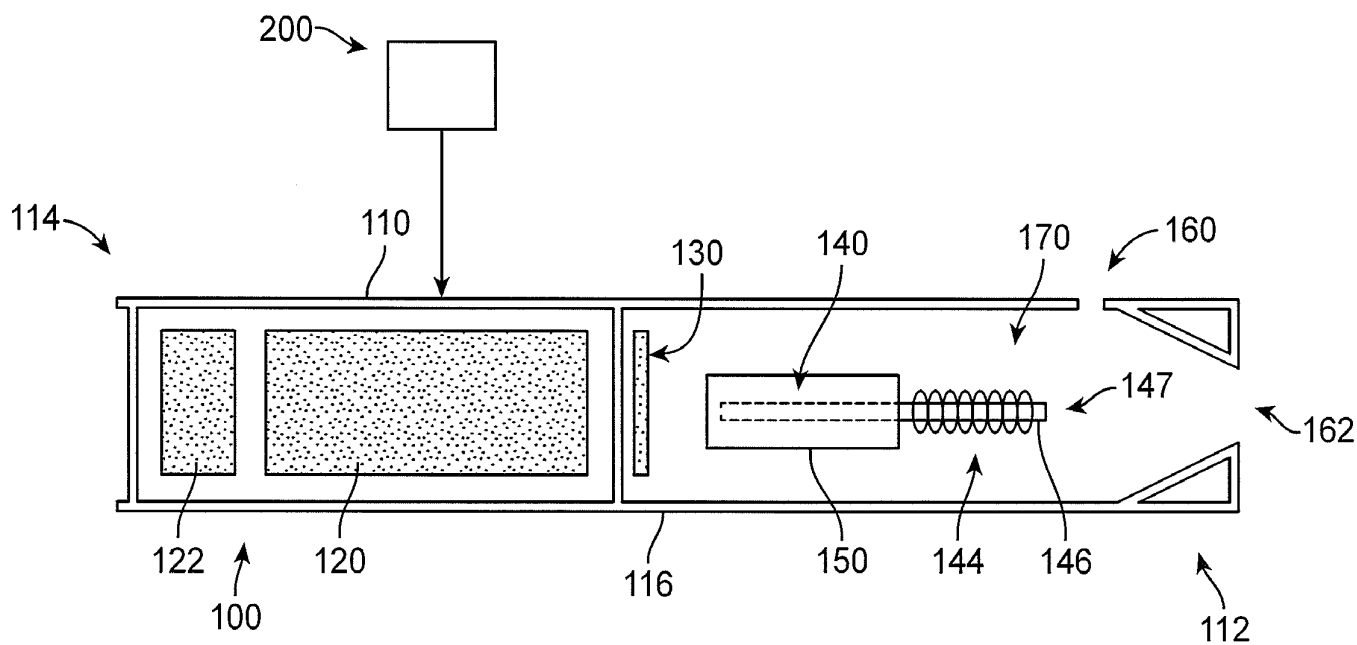
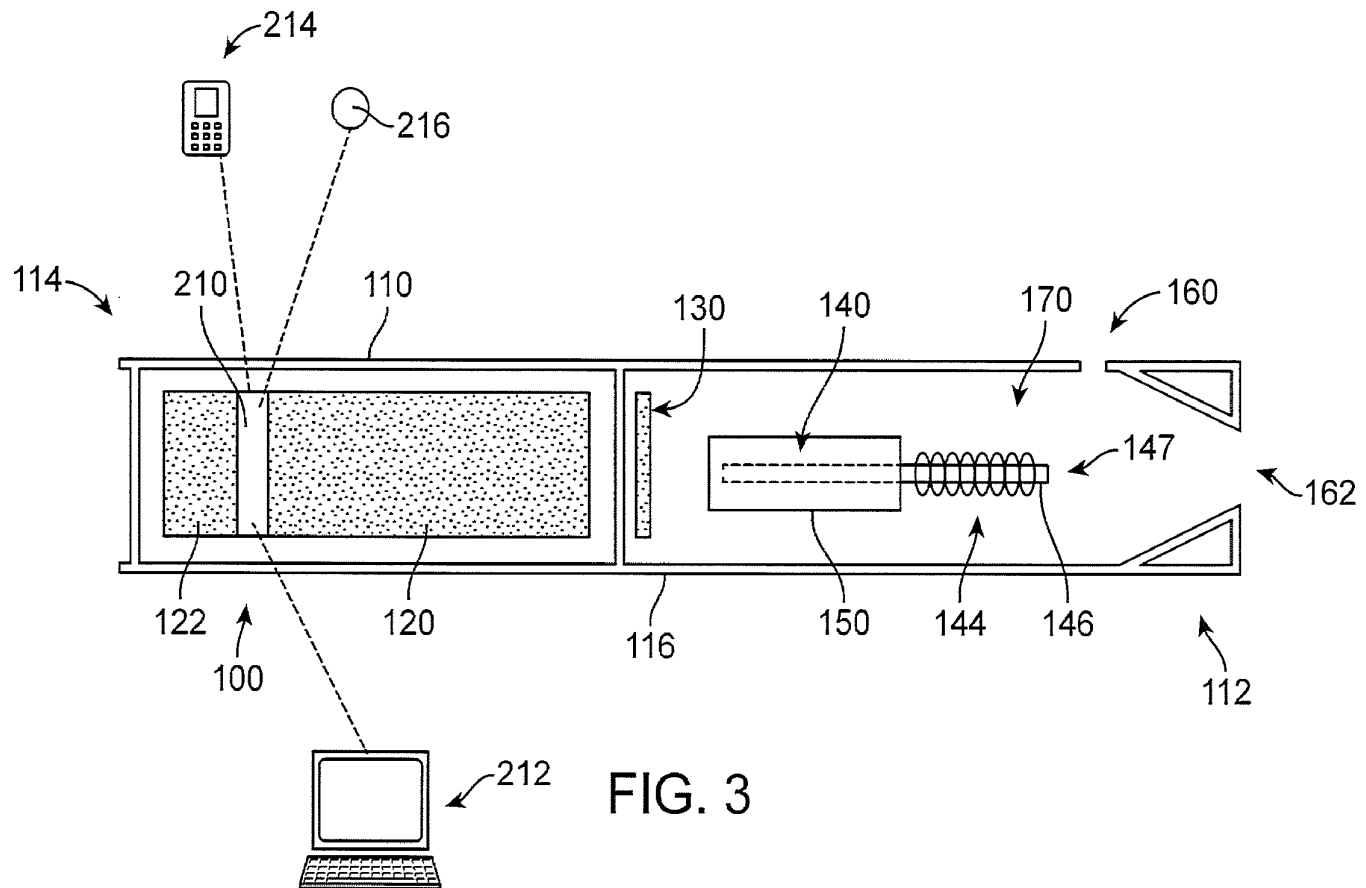


FIG. 2



(51) International Patent Classification:  
A24F 47/00 (2006.01)(21) International Application Number:  
PCT/US2014/024029(22) International Filing Date:  
12 March 2014 (12.03.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
61/798,966 15 March 2013 (15.03.2013) US(71) Applicant: **ALTRIA CLIENT SERVICES INC.**  
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23230 (US).(72) Inventor: **SHAFER, Ken H.**; 15880 Meagher Street,  
Fountain Valley, California 92708 (US).(74) Agent: **SKIFF, Peter K.**; Buchanan Ingersoll & Rooney  
PC, P.O. Box 1404, Alexandria, Virginia 22313-1404  
(US).(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, 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, KN, KP, KR,  
KZ, LA, LC, LK, LR, LS, LT, 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, 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))
- before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))

(88) Date of publication of the international search report:  
20 November 2014

(54) Title: AN ELECTRONIC SMOKING ARTICLE

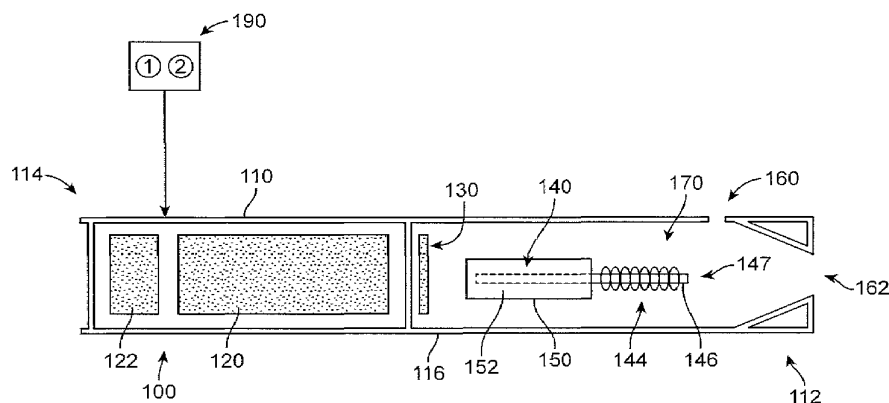


FIG. 1

(57) **Abstract:** An electronic smoking article (100) and a method of preventing unauthorized use of an electronic smoking article (100) are disclosed. The smoking article includes a power supply (120) operable to apply voltage to a heater (144) for heating a liquid; a lock-out feature configured to prevent unauthorized use of the smoking article (100), which disables the power supply to the heater (144) until the lock-out feature is unlocked by an authorized user; a mixing chamber (170) downstream of the heater (144); and at least one air inlet (160) operable to deliver air drawn into the mixing chamber (170), the air being mixed with the volatilized liquid material in the mixing chamber (170) to form an aerosol.

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/024029

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

H04W 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

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

16 September 2014

Date of mailing of the international search report

26/09/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
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Fax: (+31-70) 340-3016

Authorized officer

Marzano Monterosso

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/024029

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

PCT/US2014/024029

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(51) International Patent Classification:  
*G06F 1/00* (2006.01)

(21) International Application Number:

PCT/US2014/043253

(22) International Filing Date:

19 June 2014 (19.06.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/836,923

19 June 2013 (19.06.2013)

US

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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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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,

[Continued on next page]

(54) Title: DEVICE AND METHOD FOR SENSING MASS AIRFLOW

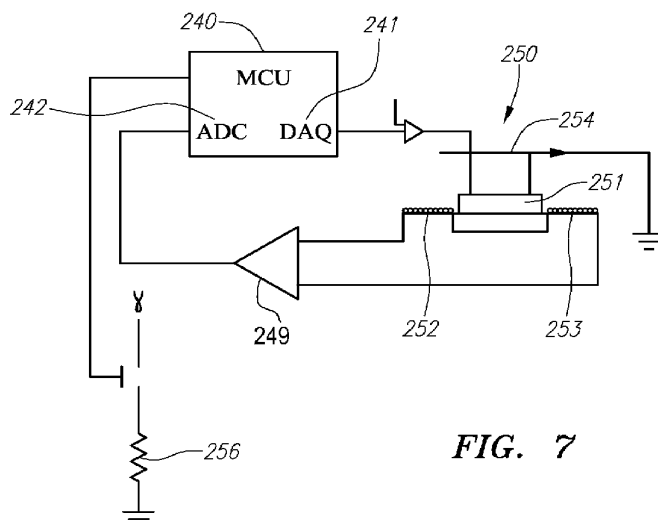


FIG. 7

(57) Abstract: A system, a method, a device and a computer program are provided for detecting and monitoring medium flow. The device comprises a flow sensor (350) that includes a thermopile (352), wherein the thermopile (352) may include a first thermocouple and a second thermocouple. The device can further comprise a microcontroller (340) that can be configured to generate a reference baseline and can further be configured to compare an output of the mass airflow sensor to the reference baseline (503). The heater element may comprise a heater resistor.



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).

— *before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))*

**Published:**

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

## DEVICE AND METHOD FOR SENSING MASS AIRFLOW

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of United States provisional application no. 61/836,923, filed 19 June 2013, which is hereby incorporated by reference as though fully set forth herein.

## FIELD OF THE DISCLOSURE

**[0002]** The present disclosure relates to a system, a method, a device, and a computer program for detecting and monitoring medium flow, including, e.g., gas flow, liquid flow, aerosol flow, or the like.

## BACKGROUND OF THE DISCLOSURE

**[0003]** Electronic cigarettes, also known as e-cigarette (eCigs) and personal vaporizers (PVs), are electronic inhalers that vaporize or atomize a liquid solution into an aerosol mist that may then be delivered to a user. A typical eCig has two main parts – a battery part and a cartomizer. The battery part typically includes a rechargeable lithium-ion (Li-ion) battery, a light emitting diode (LED), and a pressure sensor. The cartomizer typically includes a liquid solution, an atomizer and a mouthpiece. The atomizer typically includes a heating coil that vaporizes the liquid solution.

**[0004]** In prior art eCigs, the pressure sensor is configured to sense a user's draw on the eCig and transmit an activation signal to the heating coil to vaporize the liquid solution. However, these pressure sensors can be large and costly. An unfulfilled

need exists for a sensor that is capable of detecting a user's draw on an eCig, but which is small and uses little battery energy to operate.

**[0005]** The present disclosure provides a system, a method, a device and a computer program that meet the unfulfilled need, providing a small, low energy consumption device.

#### SUMMARY OF THE DISCLOSURE

**[0006]** According to one non-limiting example of the disclosure, a system, a method, a device and a computer program are provided for detecting and monitoring medium flow. The device comprises a flow sensor that includes a thermopile, wherein the thermopile may include a first thermocouple and a second thermocouple. The flow sensor may further include a reference element and a heater element. The reference element may comprise a reference resistor. The heater element may comprise a heater resistor.

**[0007]** The system comprises the flow sensor and a microcontroller. The microcontroller may comprise a microcomputer, a memory and an interface. The microcontroller may further comprise a real-time clock (RTC). The microcontroller may comprise an application specific integrated circuit (ASIC). The microcontroller is configured to receive sensor signals from the flow sensor and detect medium flow in a predetermined region. The microcontroller may be configured to monitor the medium flow as a function of time. The microcontroller may be configured to log medium flow data, including time and date data associated with the medium flow data. The medium may comprise an aerosol, a gas (e.g., air), a liquid, or the like. The microcontroller may be configured not only to turn ON/OFF a heater based on data,

but to also adjust control parameters such as, e.g., a heater pulse width modulation (PWM) drive signal and/or an amount of liquid solution dispensed onto a heating surface. The control may be done proportionally to the flow data or according to an algorithm where flow data is a parameter. Additionally, the microcontroller may use flow data to determine flow direction and restrict or limit false activation of a heater, e.g., in case the user accidentally blows into the device.

**[0008]** The method may be implemented to detect medium flow in or proximate to a predetermined region. The method comprises receiving sensor signals, detecting changes in a temperature, and identifying a threshold-exceeding activity. The threshold-exceeding activity may comprise a shift in a temperature profile in the flow sensor above a predetermined threshold value.

**[0009]** The computer program may be provided on a computer-readable medium that, when executed on a computer, causes the method of detecting medium flow to be carried out. The computer-readable medium may comprise one or more code sections or segments that are configured to carry out the steps of the processes described herein, including the method of detecting medium flow.

**[0010]** In one embodiment, an electronic cigarette can comprise a body, an atomizer within the body, a microcontroller, a power supply within the body and electrically connected to the microcontroller and the atomizer, and a mass air flow sensor electrically connected to the microcontroller.

**[0011]** In another embodiment, an electronic cigarette can comprise a first housing and a second housing, an atomizer within the first housing, a microcontroller within the second housing and comprising a data acquisition circuit and an analog-to-

digital converter, a power supply within the second housing and configured to be electrically connected to the microcontroller and the atomizer, and a flow sensor electrically connected to the microcontroller, wherein the first housing is configured to be coupled to the second housing.

**[0012]** In yet another embodiment, an electronic cigarette can comprise a housing, an atomizer within the housing, a microcontroller comprising a data acquisition circuit and an analog-to-digital converter, a power supply electrically connected to the microcontroller and the atomizer, and a flow sensor comprising a thermopile and a heater, and wherein the flow sensor is electrically connected to the microcontroller.

**[0013]** Additional features, advantages, and embodiments of the disclosure may be set forth or apparent from consideration of the detailed description and drawings. Moreover, it is to be understood that the foregoing summary of the disclosure and the following detailed description and drawings are exemplary and intended to provide further explanation without limiting the scope of the disclosure as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0014]** The accompanying drawings, which are included to provide a further understanding of the disclosure, are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the detailed description serve to explain the principles of the disclosure. No attempt is made to show structural details of the disclosure in more detail than may be necessary for a fundamental understanding of the disclosure and the various ways in which it may be practiced. In the drawings:

[0015] FIG. 1 shows an example of an eCig that is constructed according to an aspect of the disclosure;

[0016] FIG. 2 shows an example of a microcontroller that is constructed according to an aspect of the disclosure;

[0017] FIG. 3 shows an example of a flow sensor that is constructed according to an aspect of the disclosure;

[0018] FIGs. 4A and 4B show examples of temperature profiles as a function of airflow movement;

[0019] FIG. 5 shows an example of a flow channel according to the principles of the disclosure; and

[0020] FIGS. 6A & 6B show an example of signal amplification and filtering through a single amplifier or multiple amplifiers.

[0021] FIG. 7 is an electrical diagram of an eCig comprising a first and second thermopile.

[0022] FIG. 8 is an electrical diagram of an eCig comprising one thermopile.

[0023] FIGS. 9-11 are graphs of an embodiment of the output of a reference signal and an airflow sensor according to the disclosure.

[0024] FIG. 12 is a flowchart illustrating one embodiment of a process for interpreting signals according to the disclosure.

[0025] The present disclosure is further described in the detailed description that follows.

## DETAILED DESCRIPTION OF THE DISCLOSURE

**[0026]** The disclosure and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments and examples that are described and/or illustrated in the accompanying drawings and detailed in the following. It should be noted that the features illustrated in the drawings are not necessarily drawn to scale, and features of one embodiment may be employed with other embodiments as the skilled artisan would recognize, even if not explicitly stated herein. Descriptions of well-known components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments of the disclosure. The examples used herein are intended merely to facilitate an understanding of ways in which the disclosure may be practiced and to further enable those of skill in the art to practice the embodiments of the disclosure. Accordingly, the examples and embodiments herein should not be construed as limiting the scope of the disclosure. Moreover, it is noted that like reference numerals represent similar parts throughout the several views of the drawings.

**[0027]** FIG. 1 shows an example of an eCig 10 that is constructed according to an aspect of the disclosure. The eCig 10 comprise a cartridge 14 and an eCig body 18. The cartridge 14 comprises an opening 12 through which aerosol may be delivered to a user. The cartridge 14 comprises a flavorant (not shown) and an atomizer (not shown). The flavorant may include, e.g., a liquid solution, a gel, a solid, or a gas that comprises molecules to be delivered in an aerosol to a user. The eCig body 18 includes a power supply (e.g., a rechargeable Li-ion battery) (not shown) and an LED (not shown). The eCig 10 includes a flow sensor device (not shown), which may



include a microcontroller 20 (shown in FIG. 2) and a flow sensor 30 (shown in FIG. 3).

**[0028]** FIG. 2 shows an example of the microcontroller 20 constructed according to an aspect of the disclosure. The microcontroller 20 comprises a microcomputer 26, a memory 24 and an interface 28. The microcontroller 20 may include a driver 22 that drives an atomizer (not shown). The driver 22 may include, e.g., a pulse-width modulator (PWM) or signal generator. The microcomputer 20 is configured to execute a computer program, which may be stored externally or in the memory 24, to control operations of the eCig (e.g., eCig 10, shown in FIG. 1), including activation (and deactivation) of the heating element. The memory 24 includes a computer-readable medium that may store one or more segments or sections of computer code to carry out the processes described in the instant disclosure. Alternatively (or additionally) code segments or code sections may be provide on an external computer-readable medium (not shown) that may be accessed through the interface 28.

**[0029]** It is noted that the microcontroller 20 may include an application specific integrated circuit (IC), or the like, in lieu of the microcomputer 26, driver 22, memory 22, and/or interface 28.

**[0030]** The microcontroller may be configured to log medium flow data, including mass flow, volume flow, velocity data, time data, date data, flow duration data, and the like, that are associated with the medium flow. The medium may comprise an aerosol, a gas (e.g., air), a liquid, or the like. The microcontroller may be configured not only to turn ON/OFF a heater based on such data, but to also adjust

control parameters such as heater PWM or amount of liquid solution dispensed onto a heating surface. This control may be done proportionally to the flow data or according to an algorithm where flow data is a parameter. In addition, the microcontroller may use flow data to determine flow direction and restrict or limit false activation of the heater in case the user accidentally blows into the eCig 10.

**[0031]** FIG. 3 shows an example of a flow sensor 30 that is constructed according to an aspect of the disclosure. The flow sensor 30 comprises a substrate 31 and a thermopile (e.g., two or more thermocouples), including an upstream thermopile (or thermocouple) 32 and a downstream thermopile (or thermocouple) 33. The substrate 31 may include a thermal isolation base. The flow sensor 30 may comprise a heater element 34. The flow sensor 30 may comprise a reference element 35. The heater element 34 may include a heater resistor. The reference element 35 may include a reference resistor.

**[0032]** As seen in FIG. 3, the thermopiles 32, 33 may be symmetrically positioned upstream and downstream from the heater element 34. The heater element 34 heats up the hot junctions of the thermopiles 32, 33. In response, each of the thermopiles 32, 33 generates an output voltage that is proportional to the temperature gradient between its hot and cold junctions (the “Seebeck” effect). The hot junctions of the thermopiles 32, 33 and the heater element 34 may reside on the thermal isolation base. Mass air flow sensor signal conditioning may be composed of various forms of filters or gain amplifiers. Filters may be used to eliminate noise before or after signal amplification, thereby reducing sensitivity to unwanted environmental noises or pressure changes. Filtering can be accomplished using low pass, high pass, band pass, or a combination thereof. Signal gain amplification may be accomplished by

employing electronic amplification on the upstream or downstream thermopile signals, or a combination thereof. Amplification of upstream or downstream thermopile signals may use a single state or multiple cascaded stages for each signal, or combination of these signals to form a sum or difference. The amplifier circuit may include means to introducing a signal offset. The amplifier may include transistors, operational amplifiers, or other integrated circuits.

**[0033]** FIGs. 4A and 4B show examples of temperature profiles 41, 42 as a function of airflow movement

**[0034]** Referring to FIGs. 3, 4A and 4B, during operation, when the medium is static, the temperature profile 41 upstream and downstream from the heating element 34 is substantially symmetric (shown in FIG. 4A). When the medium (e.g., aerosol) flows, the temperature profile 42 skews in the flow direction due to heat transport of the flowing medium, causing changes in the outputs of the thermopiles 32, 33. Heat transport is proportional to mass flow and heat capacity of the medium. Therefore, the flow sensor 30 measures the mass flow of the medium.

**[0035]** The reference element 35 may be placed next to the cold junction of the upstream thermopile 32 to provide data for temperature compensation.

**[0036]** Referring to FIGs. 1 - 3, the microcontroller 20 and flow sensor 30 may be provided in the cartridge 14 or the body 18 of the eCig 10. The eCig 10 may include multiple microcontrollers 20 and/or flow sensors 30. The flow sensor 30 may be positioned in a medium flow channel in the eCig 10, so as to detect and measure medium flow (e.g., air flow, aerosol flow, liquid flow, or the like) when a user puffs (or draws) on the mouthpiece of the eCig 10. For instance, a flow sensor 30 may be

placed near the air inlet, near the aerosol outlet, in an air channel, or the like, in the eCig 10.

**[0037]** In order to minimize battery drain during operation, the microcontroller 20 may perform an adaptive algorithm that senses medium flow in the region of the flow sensor 30 by, e.g., driving and heating the heating element 34 in short bursts, using infrequent intervals and receiving the sensor signals from the thermopiles 32, 33, and, then, when a puff is detected (e.g., medium flowing above a predetermined threshold), switching to a more frequent cycle of driving the heating element 34 and receiving the sensor signals from the thermopiles 32, 33. By way of example, an infrequent cycle may comprise a 10 ms pulse every second and a frequent cycle may comprise a 10 ms pulse every 50 ms.

**[0038]** The eCig 10 may include an ON/OFF sensor, such as, for example: a capacitive sensor (not shown) that detects when a user contacts the cartridge 14 (e.g., user's finger or lips) and/or body 18 (e.g., user's fingers); a temperature sensor (not shown) that detects user contact (e.g. finger or lips) of the cartridge 14 and/or body 18; a pressure sensor (not shown) that detects a force applied to cartridge 14 and/or body 18 (e.g., squeeze by fingers or lips); an inertia sensor (not shown) that senses movement of the eCig 10; and the like. In response to an ON signal from the ON/OFF sensor, the microcontroller 20 may be awoken (e.g., from a sleep mode) to drive the flow sensor 20 at a higher frequency cycle (e.g., a 50 ms cycle) so as to minimize any delay between user draw on the eCig 10 and delivery of the aerosol. In response to an OFF signal from the ON/OFF sensor, or after a predetermined time of inactivity, the microcontroller 20 may be set to a sleep mode to save battery life. In

the sleep mode, the flow sensor may 20 may be driven at a low frequency cycle (e.g., a 1 sec cycle).

**[0039]** The flow sensor 30 is suitable for measurement of liquid flow, gas flow, and differential pressure applications. The flow sensor 30 is sensitive at very low flow rates and pressure levels and does not have significant offset or offset drift due to its differential nature. The flow sensor 30 provides for fast response and is resistant to vibration and pressure shock. The sensor 30 is resistant to corrosive gases/liquids and abrasive wear. The flow sensor 30 allows for implementation of simplified signal conditioning circuits (FIGS. 6A & 6B) in, e.g., the eCig 10 (shown in FIG. 1).

**[0040]** According to an aspect of the disclosure, the thermopiles and heater may be used to determine temperature. For example, when there is no air flow, the heater may be turned ON in order to generate a known signal. The thermopiles would respond to the known heater input. This response would be impacted by the ambient temperature and may be determined. In this regard, rather than looking at a differential signal, one would look at the signal from only one of the thermopiles.

**[0041]** FIG. 5 shows an example of a flow channel according to the principles of the disclosure. As seen in FIG. 5, the flow channel may be shaped in the vicinity of the sensor so as to direct a majority of flow over the sensing surface, thus increasing the sensitivity of the system. As illustrated in FIG. 5, the housing 120 of a normal cross-section is mostly open. In the cross-section near a sensor 131, a housing 130 is restricted such that a pcb 132 and the sensor 131 are positioned so that a majority of the flow moves over the sensor 131.

[0042] As an alternative way to determine ambient temperature, a thermistor or other temperature measuring sensor could be placed in the airflow. The signal from this sensor could be used alone or in conjunction with a MAF in order to adjust the heater control signal or disable the eCig in response to temperature limits. One may choose to disable the eCig, for example, if high temperatures may cause juice spoilage or if battery safety/performance is impacted by temperature extremes.

[0043] It is noted that a reference resistor can be used to determine ambient environment and either adjust the heater via PWM or disable the heater when storage/operation temperature limits are exceeded.

[0044] Because operating the mass airflow sensor may place an electrical current demand on the battery, it may be desirable to include a secondary means by which to initiate the operation of the mass airflow sensor. One such means of accomplishing this is possible in the rechargeable configuration of the eCig, a configuration where the liquid and heater are housed in a separate and detachable housing from the sensor and the battery. When the unit housing, the liquid, and the heater are connected to the portion housing the sensor and the battery, this connection event may be detected by the microcontroller, which may also be housed with the sensor. By way of example, the heater, which electronically behaves as a resistor, may complete a circuit that triggers an interrupt signal to be caused on an input pin of the microcontroller. This interrupt event could then cause the microcontroller to activate the previously inactive mass airflow sensor and begin to take readings using the mass airflow sensor. When the portion housing the liquid and the heater are detached from the portion housing the sensor and the battery, the microcontroller may then deactivate the mass airflow sensor.

**[0045]** As mentioned in the previous example, the initiation of the mass airflow sensor could be accomplished by using the heater resistance to complete a circuit, however, this is not the only means to accomplish such a trigger event. Other ways of accomplishing such a trigger event include incorporating a dedicated physical connection or trace that completes a circuit, a capacitor that discharges or charges when the connection is made, and an integrated circuit that establishes communication with the microcontroller when the connection is made.

**[0046]** FIGS. 6A and 6B illustrate an example of a single amplifier with a filter 164 and a difference amplifier and filters for upstream and downstream, with offset 180. As shown in the single amplifier with a filter 164 in FIG. 6A, the airflow signal 160 passes through a filter 161 and a gain amplifier 162 before a signal output 163 is transmitted. The difference amplifier and filters for upstream and downstream, with offset 180 shown in FIG. 6B comprises an upstream airflow signal 170 and a downstream airflow signal 171. The upstream airflow signal 170 passes through a first filter 172 and the downstream airflow signal passes through a second filter 173. The outputs of the first and second filters 171, 172 then enter a difference amplifier 174. A signal is then output from the difference amplifier 174 and enters a gain amplifier 175 along with an offset 175. The gain amplifier 175 then outputs a signal output 177.

**[0047]** FIG. 7 illustrates an electrical diagram of an embodiment of the disclosure comprising a first thermopile 252 and a second thermopile 253. The eCig depicted in FIG. 7 comprises a microcontroller 240, a mass airflow sensor 250, an amplifier 249, and a heater 256. The mass airflow sensor 250 comprises a mass airflow heater 251, a first thermopile 252, and a second thermopile 253. The electrical diagram further

illustrates the direction of airflow 254 over the mass airflow heater 251 and the first and second thermopiles 252, 253. The microcontroller 240 can comprise a data acquisition circuit 241, and an analog-to-digital converter 242. The data acquisition circuit 241 can log and transmit data such as temperature of the heater 256, the number of times the heater 256 has been activated in a certain time, the length of time the heater 256 had been activated, and other information. A more detailed description of data acquisition and transmission can be found in commonly assigned U.S. Provisional Application No. 61/907,239 filed 21 November 2013, the entire disclosure of which is hereby incorporated by reference as though fully set forth herein. The analog-to-digital converter 242 can output information about the eCig to the microcontroller 240, the data acquisition circuit 241, and other devices and sensors that may be present on the microcontroller 240 or otherwise connected to the eCig.

**[0048]** FIG. 8 illustrates an electrical diagram of another embodiment of the disclosure comprising one thermopile 352. The eCig depicted in FIG. 8 comprises a microcontroller 340, a mass airflow sensor 350, an amplifier 349, and a heater 356. The mass airflow sensor 350 comprises a mass airflow heater 351 and a thermopile 352. The electrical diagram further illustrates the direction of airflow over the heater 354 and the thermopile 352. The microcontroller 340 can comprise a data acquisition circuit 341, and an analog-to-digital converter 342. The data acquisition circuit 341 can log and transmit data such as temperature of the heater 356, the number of times the heater 356 has been activated in a certain time, the length of time the heater 356 had been activated, and other information. The analog-to-digital converter 342 can output information about the eCig to the microcontroller 340, the data acquisition



circuit 341, and other devices and sensors that may be present on the microcontroller 340 or otherwise connected to the eCig. In one embodiment, the eCig can also comprise feedback and gain resistors 357, 358.

**[0049]** FIGS. 9-11 illustrate graphical representations of the outputs of the reference signal and the mass air-flow sensor as discussed throughout the disclosure. In the illustrated embodiment a reference signal 460 is normalized to a baseline of 2.0 volts. In other embodiments, the reference signal 460 can be normalized to a different baseline. The reference signal 460 is composed of a moving average of the airflow signal when no airflow is present. This can establish a no-flow baseline condition. The output of the mass air flow sensor in relation to the reference signal 461 can then be conditioned to output a baseline of 2.0 volts. When the output of the mass airflow sensor changes under a predetermined threshold, the reference signal 460 will normalize that change to the baseline. This can allow for subtle changes to occur in the environment, such as temperature change or battery depletion, without the output of the mass air flow sensor in relation to the reference signal 461 to drift. When the output signal changes above a predetermined threshold, the reference signal 460 will stay at the previously normalized baseline and the output of the mass air flow sensor in relation to the reference signal 461 will change proportionally to the amount of fluid flowing over the sensor. When a fluid flow moves over the mass air flow sensor, the output of the mass air flow sensor can then change proportionally to the volume or velocity of the fluid moving past the sensor.

**[0050]** When the reference baseline is stressed, the output of sensor can change, but at a rate below the predetermined threshold, and can cause the microcontroller to normalize the reference signal 460 and the output of the mass air flow sensor in

relation to the reference signal 461 to the desired baseline. The stress to the mass airflow sensor can be either electrical or mechanical in nature. The stress to the mass airflow sensor can also occur because of a change in the ambient temperature of the fluid flowing over the mass air flow sensor. In some embodiments, by determining the amount of fluid or air flow over the sensor, the microcontroller can vary the power output to the atomizer or heater coil. By varying the power output, the microcontroller can better control the temperature of the atomizer or heater coil. In one embodiment, the microcontroller can use the data from the flow sensor to run the eCig heater at a constant temperature over varying rates of flow. This constant temperature can result in a better experience for a user, as the flavorant or juice within the cartomizer or eCig will be vaporized at a constant temperature.

**[0051]** FIG. 12 illustrates a flow-chart of the process by which the microcontroller or other component can interpret signals from the mass airflow sensor or other device. In step 500 a microcontroller can monitor a sensor signal sent from the mass airflow sensor. When the microcontroller monitors a change in the sensor signal that is being monitored in step 500, the microcontroller can determine if the change in the sensor signal is below a programmed threshold 501. If the change in the sensor signal over a length of time is below the programmed threshold the microcontroller or other component can alter a reference signal and a relation signal to a predetermined baseline 502. In one embodiment the reference signal can be set to a baseline reading of 2.0 volts. The microcontroller then continues to monitor the mass airflow sensor for a change in the sensor signal 500. If the change in the sensor signal over time is above a programmed threshold 501, then the microcontroller or other component reads the difference between the reference signal and the relation signal 503. In step

504, the microcontroller or other component can operate a device, sensor, or other component according to the difference between the reference signal and the relation signal. The process then goes back to step 500 and the microcontroller or other component continues to monitor the mass airflow sensor for a change in the sensor signal over time.

**[0052]** In one embodiment, the microcontroller can determine an amount of air flow that is passing over the mass airflow sensor by the difference between the reference signal and the relation signal. In another embodiment, the microcontroller can determine an amount of air flow that is passing through the body by the difference between the reference signal and the relation signal. Once the microcontroller determines or estimates an amount of air flow that is passing over the mass airflow sensor or through the body, the microcontroller can then vary the output of energy that is sent to the atomizer or heater. The microcontroller can vary the output of energy to keep the temperature of the atomizer or heater at a constant temperature or to otherwise control an aspect of the atomizer or heater.

**[0053]** The instant disclosure may be implemented to measure and monitor mass flow, differential pressure, and/or air velocity in applications such as, e.g., heating ventilation and air conditioning (HVAC), automotive, medical respirators, medical ventilators, diesel generators and engines (e.g., to monitor fuel consumption), drug delivery, biomedical analytical tools, and the like.

**[0054]** A “computer” or “microcomputer,” as used in this disclosure, means any machine, device, circuit, component, or module, or any system of machines, devices, circuits, components, modules, or the like, which are capable of manipulating data

according to one or more instructions, such as, for example, without limitation, a processor, a microprocessor, a central processing unit, a general purpose computer, or the like, or an array of processors, microprocessors, central processing units, general purpose computers, or the like.

**[0055]** A “computer-readable medium,” as used in this disclosure, means any medium that participates in providing data (for example, instructions) which may be read by a computer. Such a medium may take many forms, including non-volatile media, volatile media, and transmission media. Non-volatile media may include, for example, optical or magnetic disks and other persistent memory. Volatile media may include dynamic random access memory (DRAM). Transmission media may include coaxial cables, copper wire and fiber optics, including the wires that comprise a system bus coupled to the processor. Transmission media may include or convey acoustic waves, light waves and electromagnetic emissions, such as those generated during radio frequency (RF) and infrared (IR) data communications. Common forms of computer-readable media include, for example, a flexible disk, hard disk, magnetic tape, any other magnetic medium, any other optical medium, a RAM, a PROM, an EPROM, a FLASH-EEPROM, any other memory chip or cartridge, a carrier wave as described hereinafter, or any other medium from which a computer can read.

**[0056]** Various forms of computer readable media may be involved in carrying sequences of instructions to a computer. For example, sequences of instruction (i) may be delivered from a RAM to a processor, (ii) may be carried over a wireless transmission medium, and/or (iii) may be formatted according to numerous formats, standards or protocols known in the art as of the date of this writing.

**[0057]** The terms “including,” “comprising” and variations thereof, as used in this disclosure, mean “including, but not limited to,” unless expressly specified otherwise.

**[0058]** The terms “a,” “an,” and “the,” as used in this disclosure, means “one or more,” unless expressly specified otherwise.

**[0059]** Devices that are in communication with each other need not be in continuous communication with each other, unless expressly specified otherwise. In addition, devices that are in communication with each other may communicate directly or indirectly through one or more intermediaries.

**[0060]** Although process steps, method steps, algorithms, or the like, may be described in a sequential order, such processes, methods and algorithms may be configured to work in alternate orders. In other words, any sequence or order of steps that may be described does not necessarily indicate a requirement that the steps be performed in that order. The steps of the processes, methods or algorithms described herein may be performed in any order practical. Further, some steps may be performed simultaneously.

**[0061]** When a single device or article is described herein, it will be readily apparent that more than one device or article may be used in place of a single device or article. Similarly, where more than one device or article is described herein, it will be readily apparent that a single device or article may be used in place of the more than one device or article. The functionality or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality or features.

## CLAIMS

What is claimed is:

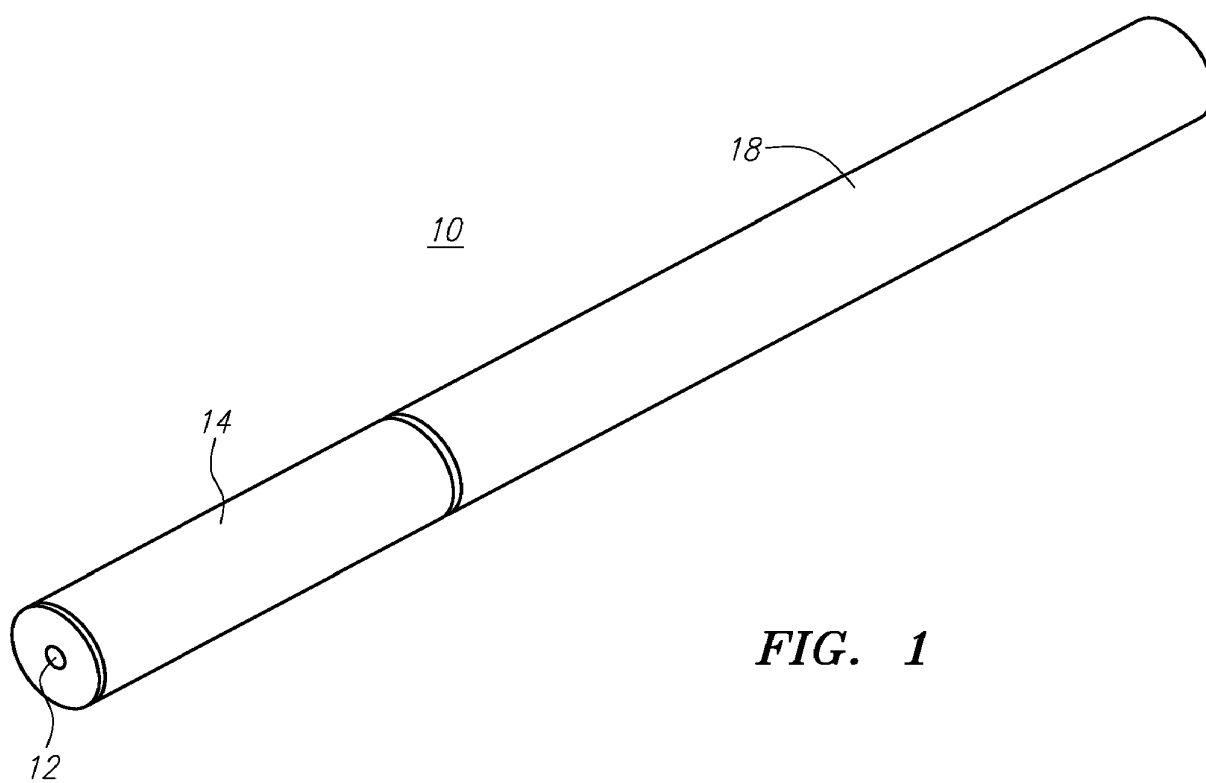
1. An electronic cigarette comprising:  
a body;  
an atomizer within the body;  
a microcontroller;  
a power supply within the body and electrically connected to the microcontroller and the atomizer; and  
a mass air flow sensor electrically connected to the microcontroller.
2. The electronic cigarette according to claim 1, wherein the microcontroller is configured to generate a reference baseline.
3. The electronic cigarette according to claim 2, wherein the microcontroller is further configured to compare an output of the mass airflow sensor to the reference baseline.
4. The electronic cigarette according to claim 1, wherein the atomizer comprises a heater.
5. The electronic cigarette according to claim 1, wherein the microcontroller comprises a microcomputer, a memory, and an interface.
6. The electronic cigarette according to claim 1, wherein the microcontroller is configured to use flow data to determine flow direction.
7. The electronic cigarette according to claim 6, wherein the microcontroller is further configured to limit activation of a heater based off of the direction of airflow.

8. The electronic cigarette according to claim 1, wherein the microcontroller is configured to log medium flow data.
9. The electronic cigarette according to claim 1, wherein the microcontroller is configured to use flow data to determine the amount of air flowing through the body.
10. The electronic cigarette according to claim 9, wherein the microcontroller is further configured to vary an output of power to the atomizer based off the amount of air flowing through the body.
11. An electronic cigarette comprising:
  - a first housing and a second housing;
  - an atomizer within the first housing;
  - a microcontroller within the second housing and comprising a data acquisition circuit and an analog-to-digital converter;
  - a power supply within the second housing and configured to be electrically connected to the microcontroller and the atomizer; and
  - a flow sensor electrically connected to the microcontroller,wherein the first housing is configured to be coupled to the second housing.
12. The electronic cigarette according to claim 11, wherein the microcontroller is configured to generate a reference baseline.
13. The electronic cigarette according to claim 12, wherein the microcontroller is further configured to compare an output of the mass airflow sensor to the reference baseline.
14. The electronic cigarette according to claim 11, wherein the atomizer comprises a heater.

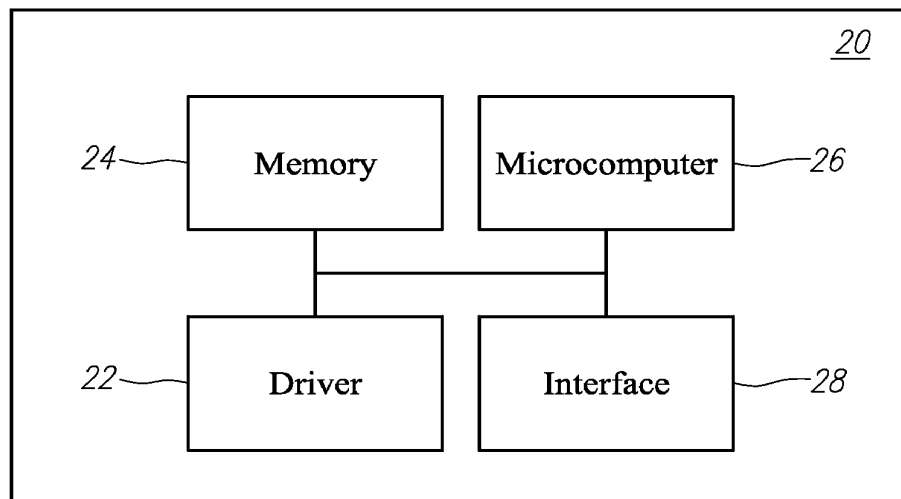
15. The electronic cigarette according to claim 11, wherein the microcontroller comprises a microcomputer, a memory, and an interface.
16. The electronic cigarette according to claim 11, wherein the microcontroller is configured to used flow data to determine flow direction.
17. The electronic cigarette according to claim 11, wherein the mass air flow sensor comprises a substrate and a thermopile.
18. An electronic cigarette comprising:  
a housing;  
an atomizer within the housing;  
a microcontroller comprising a data acquisition circuit and an analog-to-digital converter;  
a power supply electrically connected to the microcontroller and the atomizer; and  
a flow sensor comprising a thermopile and a heater, and wherein the flow sensor is electrically connected to the microcontroller.
19. The electronic cigarette according to claim 18, wherein the atomizer comprises a heater.
20. The electronic cigarette according to claim 18, wherein the microcontroller comprises a microcomputer, a memory, and an interface.



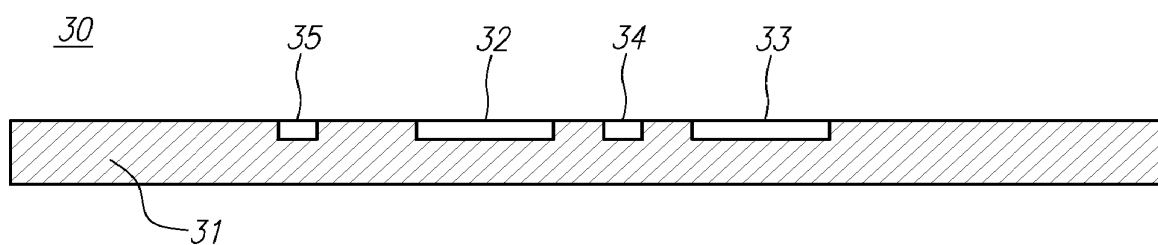
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**FIG. 1**

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*FIG. 2*

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**FIG. 3**

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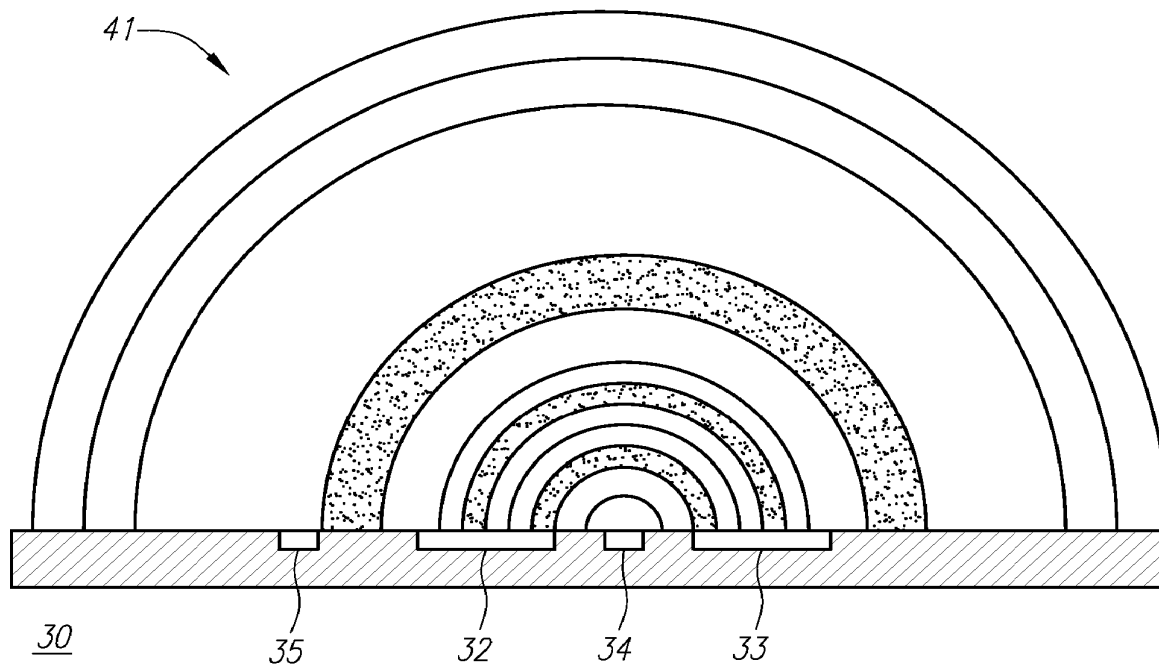


**FIG. 4A**

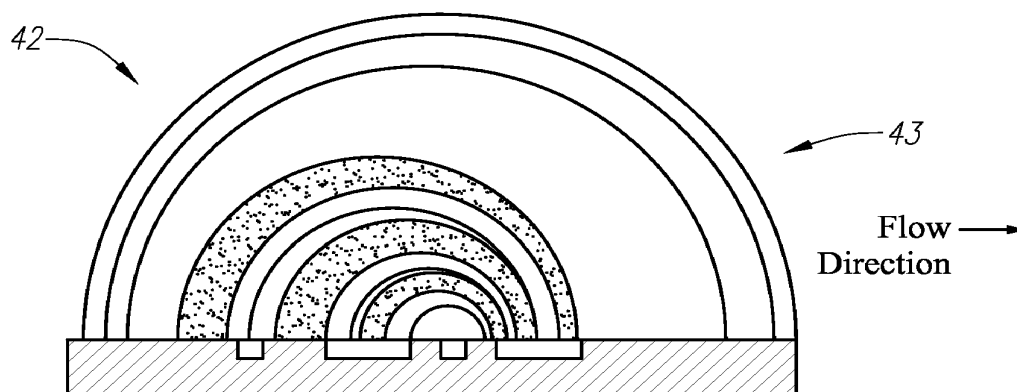
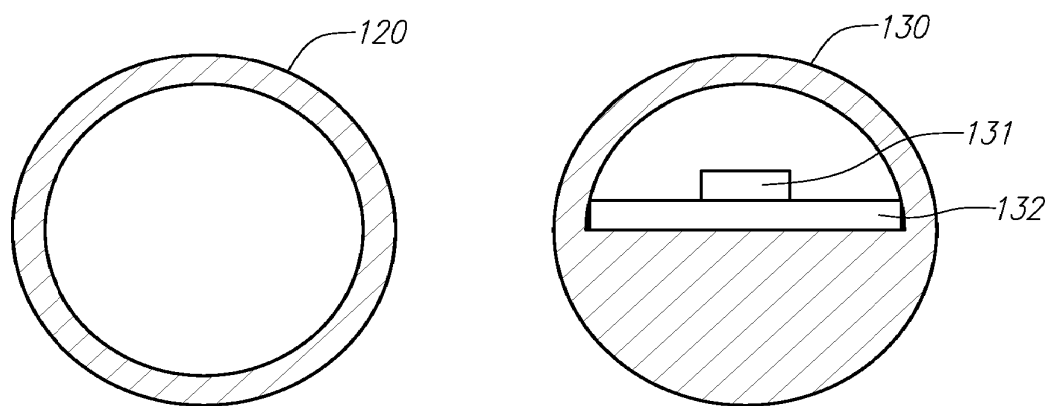
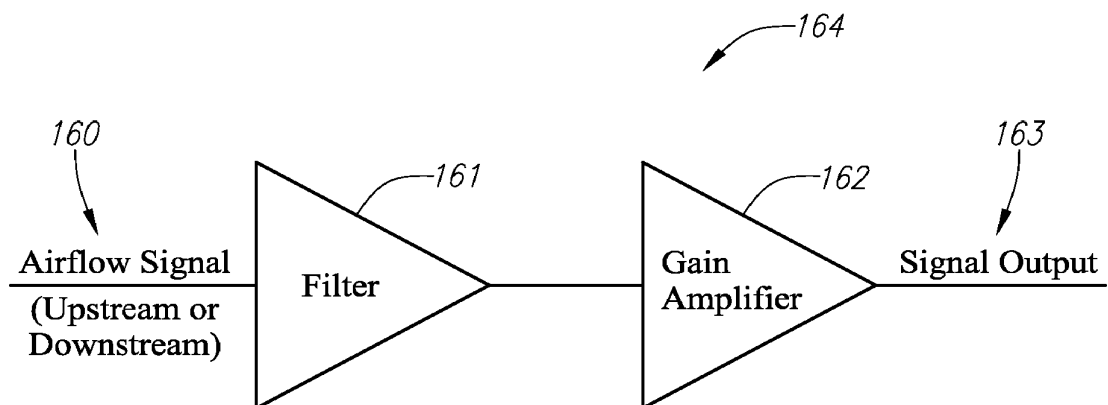
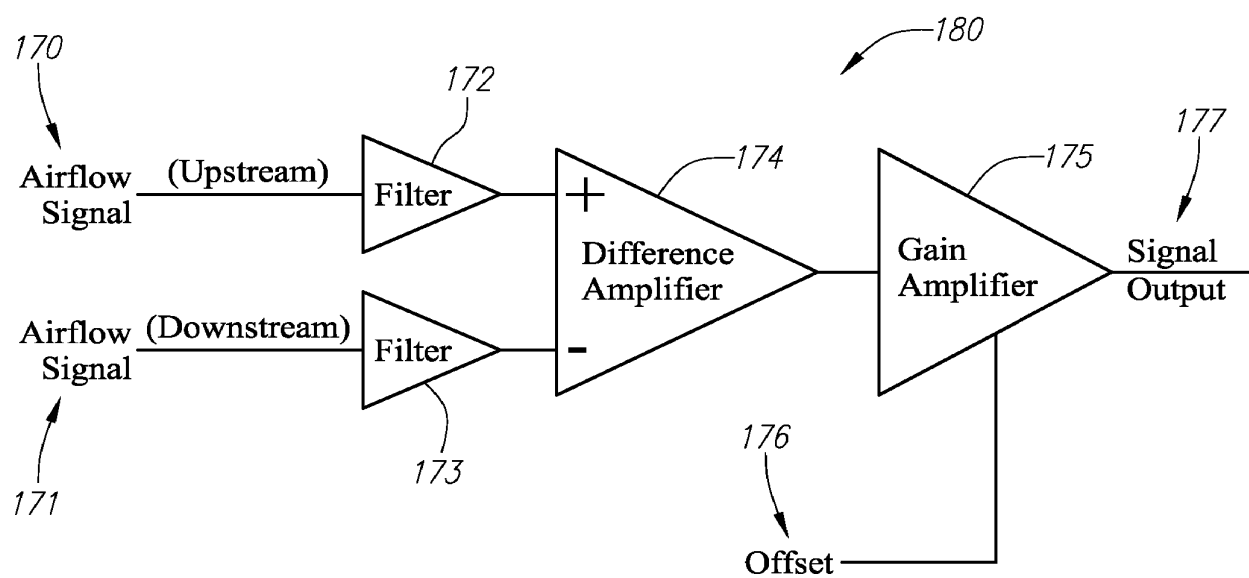


**FIG. 4B**

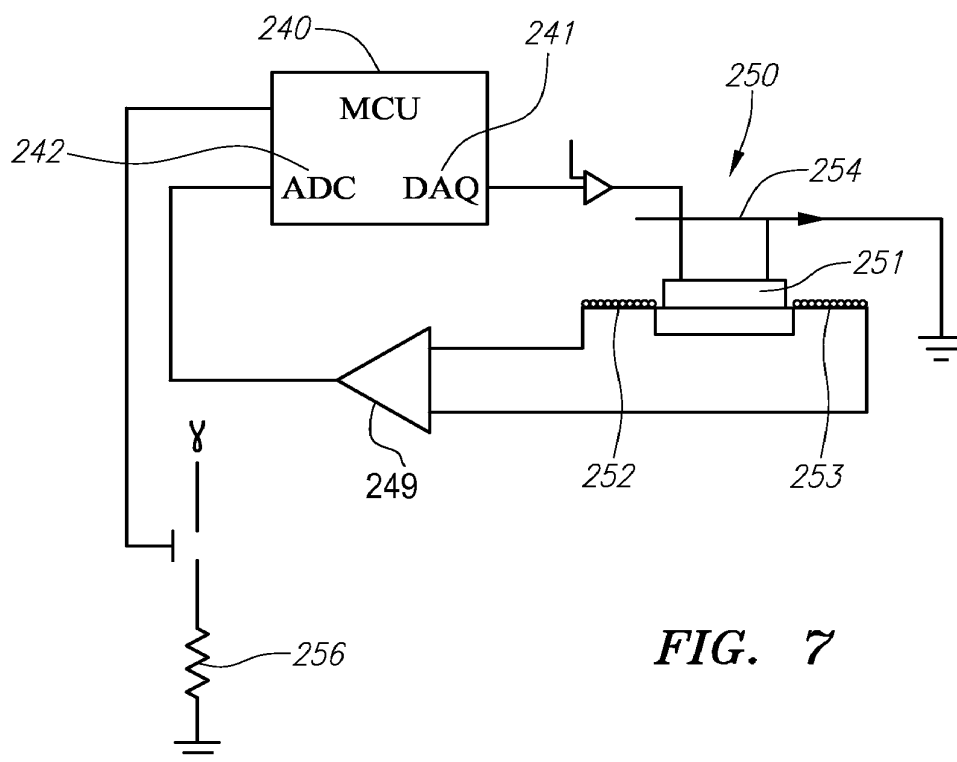
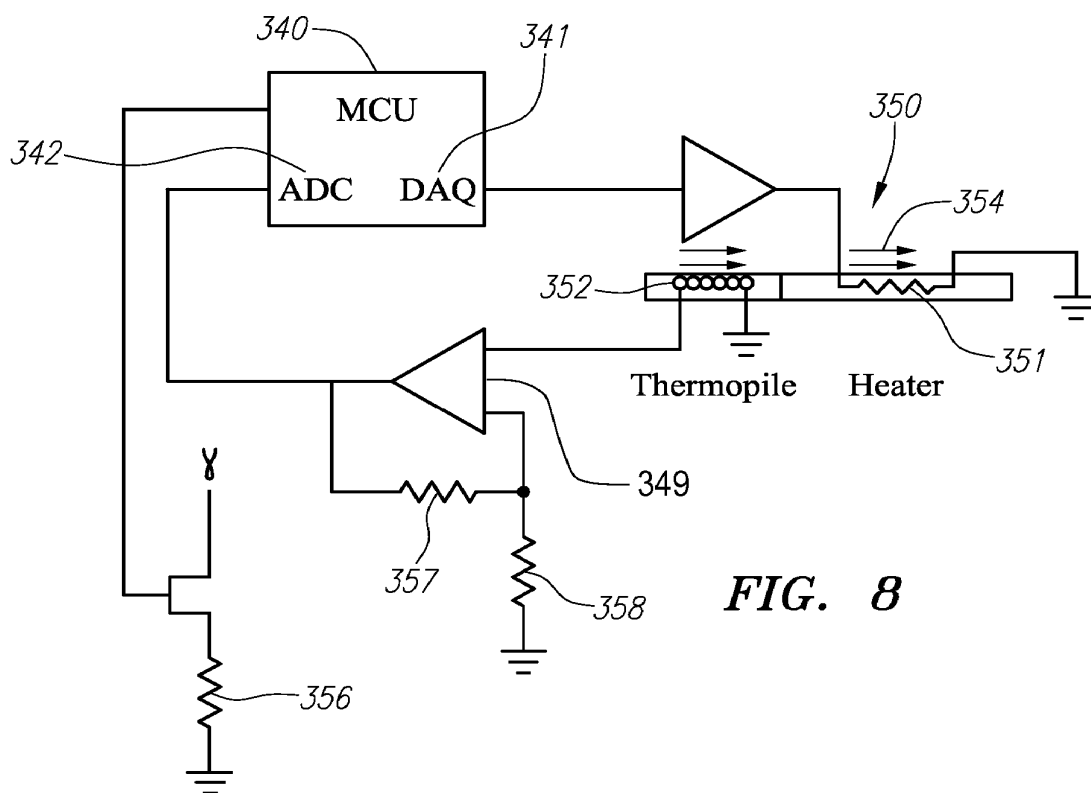
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*FIG. 5*

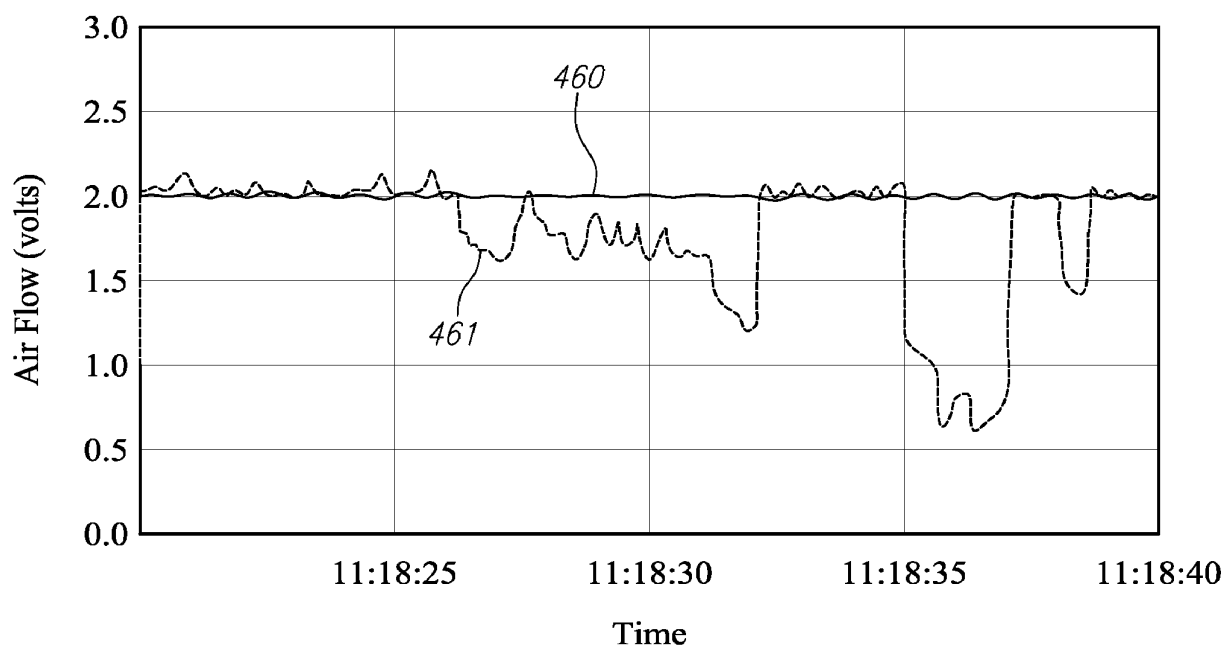
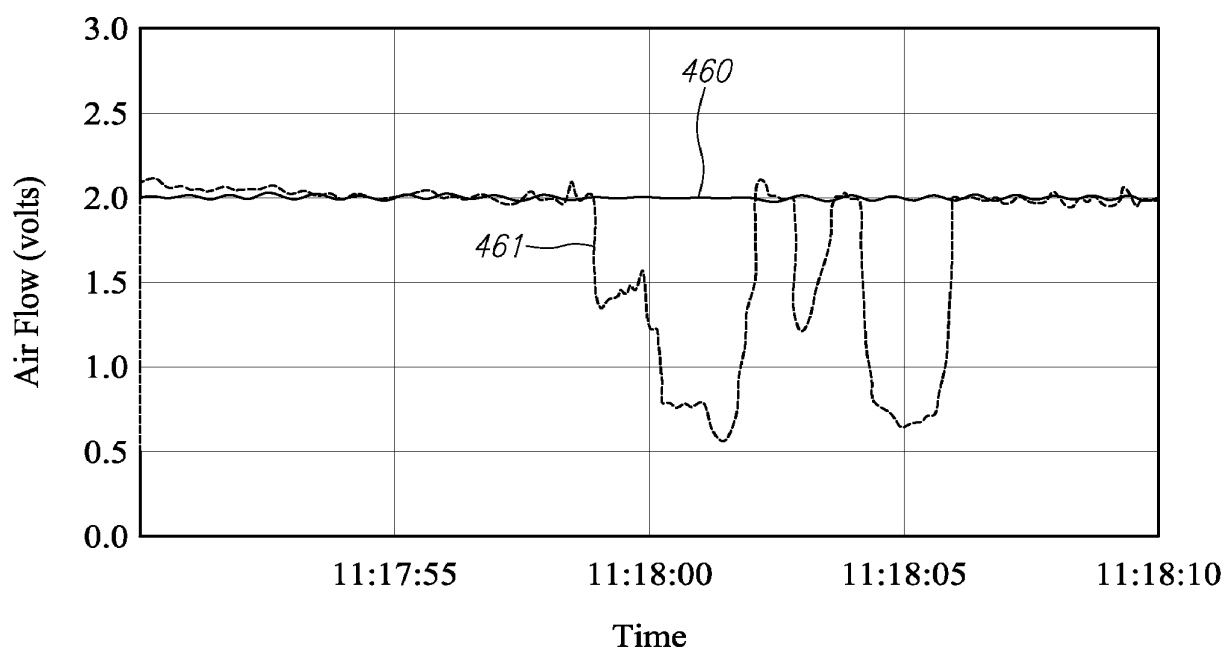
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*FIG. 6A**FIG. 6B*

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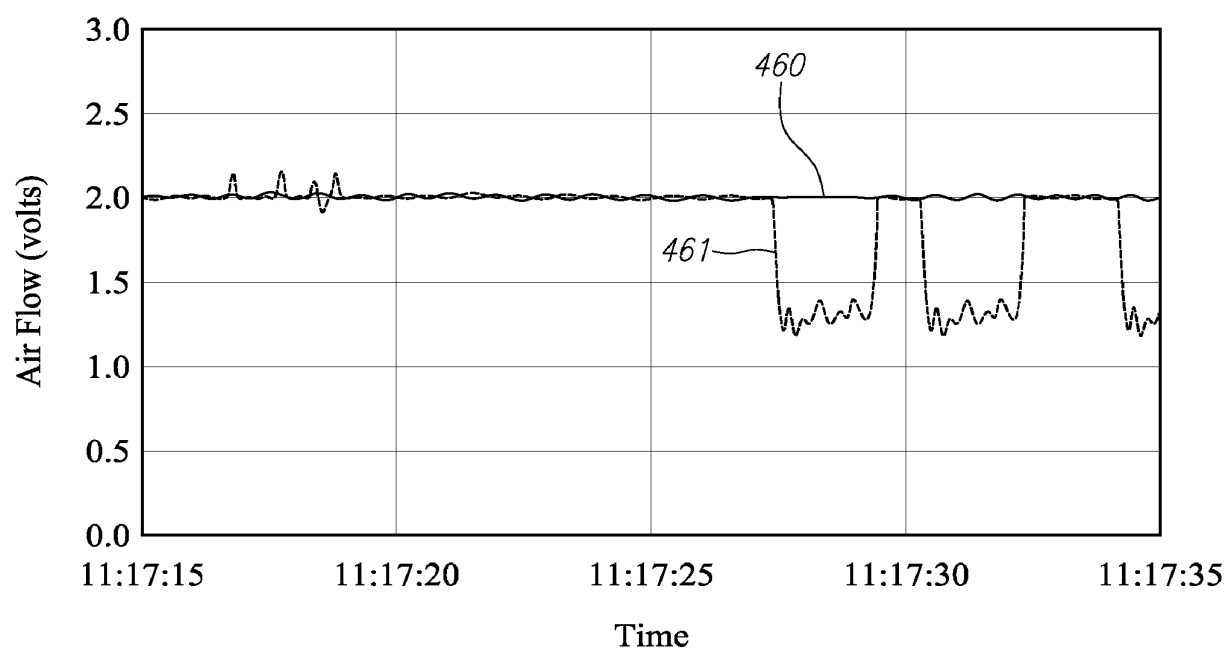
**FIG. 7****FIG. 8**

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**FIG. 9****FIG. 10**



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**FIG. 11**

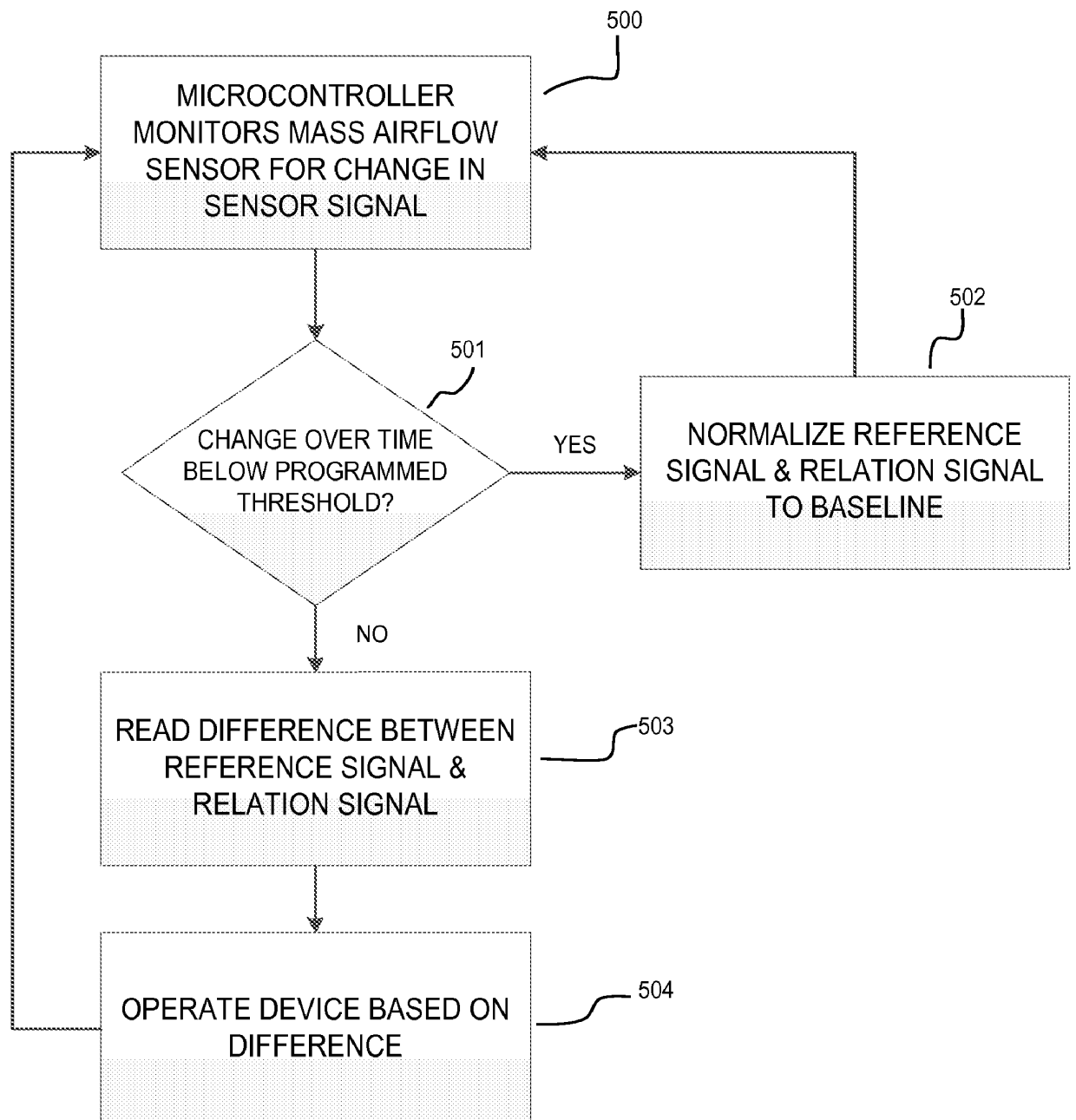


FIG. 12

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/43253

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 1/00 (2014.01)

CPC - G01F 1/8436

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)

CPC: G01F 1/8436

IPC(8): G06F 1/00

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

CPC: G01F 25/0007 G01F 15/024, G01F 1/74, G01F 1/6965; G01F 1/8436

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

Patbase; Google Patents; Google Scholar; Google Web

Search Terms Used: E-cigarette, electronic, smoking, atomizer, controller, microcontroller, processor, airflow, air, flow, baseline, reference, heater, ADC, analog to digital, memory, thermopile

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                            | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | US 2012/0199146 A1 (MARANGOS) 09 August 2012 (09.08.2012), para [0029], [0038], [0040]-[0042], [0046], [0054] | 1-10                  |
| Y         | US 2012/0048266 A1 (ALELOV) 01 March 2012 (01.03.2012), para [0018]-[0019], [0025], [0028]-[0031]             | 11-20                 |
| Y         | US 2011/0226236 A1 (BUCHBERGER) 22 September 2011 (22.09.2011), para [0152]-[0153]                            | 1-10, 12-13           |
| Y         | US 2010/0242974 A1 (PAN) 30 September 2010 (30.09.2010), para [0036]                                          | 7                     |
| Y         | WO 2011/160788 A1 (THORENS et al.) 29 December 2011 (29.12.2011), pg 10, ln 16-20, pg 22, ln 26-32            | 11-20                 |

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

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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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"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

18 September 2014 (18.09.2014)

Date of mailing of the international search report

29 OCT 2014

Name and mailing address of the ISA/US

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Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300  
PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)



## (51) International Patent Classification:

G07F 13/02 (2006.01) G07F 13/10 (2006.01)  
G07F 13/06 (2006.01)

## (21) International Application Number:

PCT/GB2014/052626

## (22) International Filing Date:

29 August 2014 (29.08.2014)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

1315499.2 30 August 2013 (30.08.2013) 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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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: APPARATUS AND METHOD FOR DISPENSING LIQUIDS INTO A CONTAINER

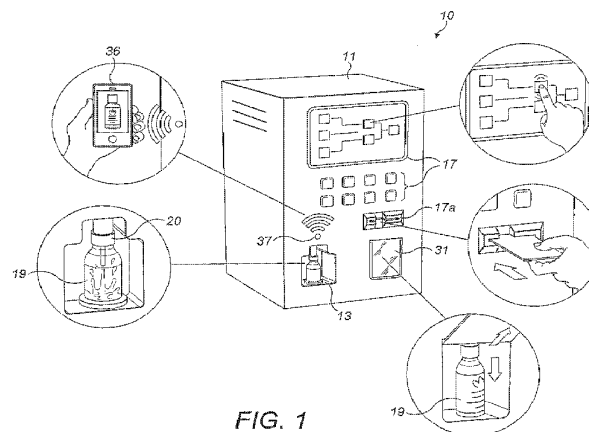


FIG. 1

(57) **Abstract:** A machine for dispensing a vaporisable liquid into a container for use in an electronic inhalation device is disclosed. The machine comprises a reservoir of liquid, a dispensing port to receive an empty container to be filled, and a dispensing mechanism fluidly connected to the reservoir for dispensing a quantity of liquid from the reservoir to a container received in the dispensing port. The machine also comprises a controller connected to the dispensing mechanism to control operation thereof, and a user-operable interface connected to the controller for a user to actuate the machine. Also disclosed is a method of operation of such a machine and a system of a plurality of such machines.

**APPARATUS AND METHOD FOR DISPENSING LIQUIDS INTO A CONTAINER****Technical Field**

This specification relates to an apparatus and method for dispensing liquids into a container.

**Background**

Electronic cigarettes ("e-cigarettes") may comprise a reservoir of liquid which is vaporised or atomised by the device for inhalation by a user. Once the liquid supply is exhausted, the reservoir must be replaced by a new full reservoir of liquid, in the case of disposable reservoirs, or must be refilled, in the case of reusable reservoirs.

**Summary**

In this specification there are described embodiments of an apparatus or machine for dispensing a vaporisable liquid into a container for use in an electronic inhalation device, the machine comprising a reservoir for containing liquid, a dispensing port to receive an empty container to be filled, a dispensing mechanism fluidly connected to the reservoir for dispensing a quantity of liquid from the reservoir to a container received in the dispensing port, a controller connected to the dispensing mechanism to control operation thereof, and a user-operable interface connected to the controller for a user to actuate the machine.

In this specification there is also described a method of operating an apparatus or machine for dispensing a vaporisable liquid into a container for use in an electronic inhalation device, the method comprising receiving a dispensing instruction via a user-operable interface connected to a controller, the controller actuating a dispensing mechanism to dispense a quantity of liquid from a reservoir of the machine to a dispensing port and into a container held in the dispensing port.

**Brief Description of the Drawings**

Figure 1 shows a perspective view of a vending machine of a first embodiment;

Figure 2 shows a functional schematic view of the vending machine shown in Figure 1;

Figure 3 shows an operational flow chart of the vending machine of Figures 1 and 2;

Figure 4 shows a schematic cross-sectional view of a portion of the dispensing mechanism of the vending machine shown in Figures 1 – 2, with a cartomizer held in the dispensing port;

Figures 5A and 5B respectively show views of a cartomizer and dispensing head of a second embodiment, separately and in engagement;

Figures 6A and 6B respectively show views of a cartomizer and dispensing head of a third embodiment, separately and in engagement;

Figure 7 shows a first exemplary data flow diagram of the vending machine shown in Figures 1 – 2;

Figure 8 shows a second exemplary data flow diagram of the vending machine shown in Figures 1 – 2 including network components; and

Figure 9 shows an exemplary logic flow diagram of operation of the vending machine shown in Figures 1 – 2.

### Detailed Description

Referring to Figures 1 and 2, there is shown a vending machine 10 according to a first embodiment for dispensing liquid for use in electronic vapour inhalation devices such as e-cigarettes (hereinafter referred to as e-liquid). The vending machine 10 comprises a housing 11 within which is provided a plurality of e-liquid reservoirs 12. Each reservoir 12 may contain a different formulation of e-liquid, although alternatively, the same e-liquid may be contained in each reservoir 12.

The vending machine 10 comprises a dispensing port 13 configured to receive an e-liquid container of an electronic vapour inhalation device (known as a “cartomizer”) and a dispensing mechanism 14 associated with the dispensing port 13 and configured to fill a cartomizer 19 received in the dispensing port 13 with e-liquid from one or more of the reservoirs 12. The dispensing mechanism 14 is fluidly connected to each of the reservoirs 12 by supply pipes 15 and each supply pipe 15 includes a supply valve 16 to control the flow of e-liquid from the respective reservoir 12 to the dispensing mechanism 14 and out of the dispensing port 13.

The vending machine 10 includes a user interface 17 and a controller 18 connected to the user interface 17. A memory unit 26 is also connected to the controller 18. The user interface 17 is operable by a user to initiate an e-liquid dispensing operation and to select, if appropriate, a choice of e-liquid formulation from the options available from the vending machine 10. The user interface 17 may also be operable to take payment from a user by means of card payment device, a pre-paid card reader, or other wireless or otherwise payment means 17a. Furthermore, the user interface may also be configured to perform an age-verification function to determine that the user is authorised to use the vending machine. This may be by input of a user-specific code or a user-ID recognition device such as a RFID tag and receiver, or user-ID card reader. It is also intended that the vending machine 10 may be operated by input or reading of a “smart” token, via the user interface 17, 17a that can only be bought from a licensed retailer upon proof of minimum age of the purchaser, to ensure age-verification. Such token may also only be usable in combination with password/pass code to further ensure secure operation and prevent unauthorised use.

The controller 18 is connected to the supply valves 16 and to the dispensing mechanism 14 and is configured to control these in response to input from a user via the user interface 17 to effect dispensing of e-liquid into a cartomizer received in the dispensing port 13. The dispensing port 13 is configured to receive an empty cartomizer 19 and to seal around an open end of the cartomizer 19. The cartomizer 19 may be held within the dispensing port 13 by a screw thread, bayonet fitting or other releasable coupling. The dispensing mechanism 14 comprises a dispensing head 20 which includes an e-liquid supply duct 21 and a vacuum duct 22. The liquid supply duct 21 is fluidly connected to the supply pipes 15, and the vacuum duct 22 is connected to a vacuum pump 23. When

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a cartomizer 19 is held in the dispensing port 13, the ends of the liquid supply duct 21 and vacuum duct 22 are in fluid communication with the inside of the cartomizer 19. The liquid supply duct 21 may extend further into the interior of the cartomizer 19 than the vacuum supply duct 22 and the latter terminating adjacent the open end of the cartomizer 19, as can be seen in Figure 4.

The vending machine 10 includes a sterilising device 24 which is configured to clean and sterilise user-supplied cartomizers 19 prior to being filled with e-liquid. The sterilising device comprises an ultrasonic emitter which is disposed proximate the dispensing port 13 and positioned such that it is close to a cartomizer 19 when received therein, and which is configured to emit ultrasonic sound waves to the cartomizer 19. The sterilising device 24 may emit sound waves in the frequency range of 20 – 400 kHz for optimum sterilising efficacy.

The vending machine 10 includes a cartomizer marking mechanism 25 which is configured to print information on a cartomizer 19 received in the dispensing port 13 relating to the details and formulation of the e-liquid dispensed into the cartomizer. For example, this information may comprise the time, date and location of dispensing, the ingredient levels or formulation of the e-liquid, such as nicotine content and/or flavour information, health warning or other regulatory information, and any associated branding, logo or trade mark. This information may be printed directly onto a side wall of a cartomizer 19 whilst being held in the dispensing port 13 by a printing head 27, such as an ink-jet printer head. However, in an alternative embodiment, the information could be printed onto an adhesive label which may either be automatically applied to the side of a cartomizer 19 by an automated labelling mechanism (not shown) whilst the cartomizer 19 is held in the dispensing port 13, or could be separately supplied from a label dispenser (not shown) on the vending machine 10 for a user to manually adhere to the filled cartomizer 19 of e-liquid once filled.

The controller 18 is connected to both the sterilisation device 24 and the marking mechanism 25 to control the operation of both.

Although the vending machine 10 is configured to receive user-supplied cartomizers 19 and refill them, the vending machine also includes a cartomizer supply mechanism 28 whereby, if a user does not have an empty cartomizer 19 to be refilled, the vending machine 10 can provide a new empty cartomizer 19 to be filled. The cartomizer supply mechanism 28 includes a magazine 29 to hold a stock of new empty cartomizers 19 and supply device 30 to feed an empty cartomizers 19 from the magazine 29 to a cartomizer dispensing aperture 31, from which a user may retrieve the dispensed cartomizer and manually insert it into the dispensing port 13. Embodiments are envisaged in which the supply device 30 may alternatively, or also, be configured to supply empty cartomizers 19 directly from the magazine 29 to the dispensing port 13 and automatically fit the cartomizer therein ready to be filled with the dispensed e-liquid.

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A mode of operation of the vending machine 10 will now be described, with reference to the operational flow chart of figure 3. The user may initially operate the user interface 17 to initiate an e-liquid dispensing procedure, at step S1. The user would use the user interface 17 to pass the age verification security check, either by entry of a specific code, reading of an identity card or detection of a RFID identity tag, or other appropriate means, at step S2, and the controller 18 determines at step S3 whether the age verification check is valid or not. If not, the controller operates a display portion of the user interface 17 to indicate age verification error (step S4) and requests the user to re-confirm the age verification check. If the vending machine is configured with different e-liquids in the various reservoirs 12, the user may input via the user interface 17 their choice of e-liquid formulation to be dispensed into the cartomizer 19 at step S5.

At step S6, the user then operates the user-interface 17 and payment means 17a to effect payment for dispensing of the selected e-liquid.

At step S7, the controller queries whether the user has their own used cartomizer to be refilled, or requires a new cartomizer to be provided by the vending machine 10. If the user indicates via the user interface 17 that a new cartomizer is required, the controller operates the cartomizer supply mechanism 28 so that the supply device 30 collects a cartomizer 19 from the magazine 29 and provides it to the dispensing aperture 31 (step S8). The user may then insert their empty cartomizer 19, or newly provided cartomizer 19, into the dispensing port 13 and secure it in place as appropriate by the screw thread, bayonet fitting, or other fitment, so that the dispensing head 20 seals over the opening in the cartomizer 19.

It will be appreciated that if a user requires a new cartomizer to be dispensed, this will have an additional cost than if a user supplies their own used cartomizer. As such, the user may, at earlier step S5, input via the user interface 17 whether they have their own used cartomizer to be refilled or require a new cartomizer to be provided by the vending machine 10 and then, at payment step S6, payment may be taken to include payment for a new cartomizer if necessary. In such a process, at step S7, the vending machine 10 queries whether the user has selected at step S5, and paid for at step S6, a new cartomizer to be supplied. This information as to whether a new cartomizer is required may be stored in the memory 26 and queried by the controller 18 at step S7.

The controller 18 then determines, at step S9, whether the cartomizer 19 is fitted into the dispensing port 13. If not, it loops back to repeat the enquiry until it detects a cartomizer in place.

At step S10, the controller 18 activates the sterilising device 24 to sterilise the cartomizer 19 held within the dispensing port 13 prior to initiating a filling operation. The sterilising device may comprise an ultrasonic emitter actuated by the controller 18 to emit ultrasonic sound waves at the device. Alternatively, or in addition, the sterilising device 24 may comprise a sterilising fluid supply means fluidly connected to the dispensing head 20 by a sterilising fluid duct, configured to introduce a



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sterilising liquid or gas into the cartomizer 19, and subsequently evacuate the sterilising fluid, before a filling operation occurs. Such sterilising fluid may comprise water, liquid chemical disinfectant, or a sterilising gas. In an embodiment, sterilising fluid is used in combination with an ultrasonic emitter for enhanced sterilising efficacy. Yet further, the dispensing port 13 may be provided with a drying  
5 device, such as an infra-red heater or an air duct to blow flushing, possibly heated, clean air into the cartomizer, to dry the interior thereof and flush out/evaporate any residual sterilising fluid, before a filling operation commences.

Following completion of the sterilising procedure, the controller 18 actuates the dispensing  
10 mechanism 14 to dispense e-liquid into the cartomizer 19 at step S11. The controller 18 operates respective supply valve 16 to allow the chosen e-liquid to flow from the reservoir 12 through the supply pipe 15 to the dispensing head 20 of the dispensing mechanism 14. The controller also actuates the vacuum pump 23 so that air is drawn out of the cartomizer 19 through the vacuum duct  
15 22 to create a reduced pressure within the cartomizer 19. This draws the e-liquid through the supply pipe 15, through the supply duct 21 in the dispensing head 20 and into the cartomizer 19.

The vending machine 10 may include a flow meter in the supply duct 21 or supply pipe 15 and, for example, which is or may be connected to the controller 18, to measure the amount of e-liquid dispensed and to control the supply valve 16 to shut and the vacuum pump 23 to stop when the  
20 required volume of e-liquid has been dispensed to fill the cartomizer 19. In an alternative embodiment however, the supply duct 21 may not extend fully into the bottom of the cartomizer 19 but may terminate at a predetermined fill level within the cartomizer 19. The supply duct may include a pressure-sensing valve that senses a back pressure in the duct when the liquid level in the cartomizer reaches the pre-determined fill level and then closes to prevent any more e-liquid being dispensed  
25 into the cartomizer 19. At step S12, the vending machine 10 determines whether the cartomizer 19 is filled with e-liquid, by either detecting a fill level of the e-liquid within the cartomizer, or by detecting when a pre-determined volume of e-liquid has been dispensed, or when a pressure sensing valve in the supply duct 21 closes. At step S13, the controller 18 stops dispensing e-liquid if it is detected at step S12 that the cartomizer has been filled.

30 After (or during) the cartomizer filling process, at step S14, the controller 18 operates the marking mechanism 25 to print information from the print head 27 onto the side wall of the cartomizer held in the dispensing port 13. The controller 18 may operate the print head to print information relating to the dispensed e-liquid such as that listed above.

35 Once the cartomizer 19 has been filled with e-liquid and printed, the dispensing process finishes at step S15, and the user may then remove the cartomizer 19 from the dispensing port 13 and insert it into an electronic vapour inhalation device, such as an e-cigarette. The controller 18 may actuate an indicator 32, such as an LED, a message on a display screen, or an audible signal, to confirm that the  
40 filling operation is complete and that a user may remove the filled cartomizer 19 from the dispensing

port 13, as part of the process end step S15. The LED, display screen or audible signal of the indicator 32 may be part of the overall user interface 17 or may be a separate component.

In an embodiment, the dispenser may be configured to receive and refill different configurations of cartomizers 19, for example, those of different e-cigarette manufacturers. The user could use the user interface 17 to select the type of cartomizer to be refilled and the memory 26 may store volume information for each known cartomizer so as to be able to dispense the correct measured volume of e-liquid into the cartomizer dependent on which cartomizer the user selected.

In an embodiment, it is intended that the vending machine 10 may be able to provide a blend of e-liquids contained in the respective reservoirs 12. This may be achieved by the controller 18 operating more than one of the supply valves 16 in the supply pipes 15 so that e-liquid is drawn from more than one reservoir 12 during the cartomizer filling process described above. The separate supply pipes 15 may combine at a manifold into a single supply duct 21 within the dispensing head 20, or alternatively, the supply pipes 15 may terminate in separate respective supply ducts 21 within the dispensing head 20. The blend of e-liquids may be selected to provide e-liquids of, for example, varying nicotine content, flavour strength or flavour blends. The vending machine 10 may provide a user with a pre-programmed selection of e-liquid blends, the respective details of which may be stored in the memory 26, such as volume ratios of the liquids required from the each of the respective reservoirs 12 to create the chosen blend. Alternatively, the vending machine may be operable to create a completely bespoke blend following a user's selection input via the user interface 17.

The vending machine 10 described above includes one dispensing port to receive cartomizers 19 to be filled with e-liquid. However, alternative embodiments may comprise a plurality of dispensing ports, each configured to receive a different configuration of cartomizer 19. This would allow the vending machine to accept and refill cartomizers of a number of different manufacturers. In such an embodiment, each dispensing port may comprise a cartomizer sensor connected to the controller 18 so that the controller 18 can detect which dispensing port has a cartomizer 19 coupled thereto and control the dispensing head 20 in the correct dispensing port to perform a dispensing operation.

Again, the memory 26 may store volume information relating to a cartomizer associated with each dispensing port so that the correct volume of e-liquid is dispensed depending on which dispensing port a cartomizer is inserted into.

The vending machine 10 described above is configured to print information relating to the dispensed e-liquid directly onto the cartomizer 19. However, in an alternative embodiment, the marking mechanism may print the relevant information on a separate label which may then be either automatically adhered to the cartomizer 19 whilst being held in the dispensing port 13 by a label applicator of the marking mechanism or, may be provided out of the vending machine 10 for a user to manually adhere to the cartomizer 19 once removed from the dispensing port 13.

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In an embodiment, it may be desirable for cartomizers received in, and filled by, the vending machine 10, to include a seal such that once the cartomizer has been refilled the e-liquid is sealed within the cartomizer until the cartomizer is inserted into an e-cigarette. Such an embodiment is shown in Figure 5A and 5B, in which the cartomizer 19 comprises an elastomeric cover 33 over the opening in the top, and the supply duct 21 and vacuum duct 22 may terminate as syringe needles 21a, 22a which, when the cartomizer 19 is fitted into the dispensing port 13, pierce the elastomeric cover 33 to allow the e-liquid to be introduced into, and air evacuated from, the interior of the cartomizer 19. Once the cartomizer has been filled, the needles are retracted out of the cartomizer, and the resilience of the elastomeric cover 33 seals the needle holes, thereby sealing the cartomizer opening.

In an alternative embodiment, shown in Figures 6A and 6B, the cartomizer may be provided with connector 34 in its open end having one or more valves therein, which is configured to engage with, and be opened by, a corresponding coupling 35 in the dispensing head 20 when the cartomizer 19 is fitted within the dispensing port 13. Therefore, e-liquid may be introduced into the cartomizer through an open valve in the connector 34, and once filled, the cartomizer 19 is removed from the dispensing port 13, the valve in the connector 34 automatically closes, sealing the cartomizer 19. Furthermore, an e-cigarette into which the cartomizer may be intended to be inserted, may comprise a corresponding coupling to engage with the connector 34 to open the valve therein when the cartomizer is fitted within the e-cigarette.

In an embodiment, the vending machine 10 may be capable of wirelessly receiving a user's 'order' from a smart phone 36 or other portable electronic device via a receiver 37 within the vending machine 10 and connected to the controller 18. In such an embodiment, a suitable application may be loaded on the smart phone 36 which stores a user's previous or favoured e-liquid formulations, and a user may select a particular formulation on the smart phone 36 which is then transmitted to the receiver 37 of the vending machine 10 to initiate a dispensing operation as described above. In such an embodiment, payment may be able to also be made wirelessly for the vending operation via the smart phone 36 or other portable electronic device.

It will be appreciated that the vending machine 10 of the above-described embodiments provides regulated vending of e-liquids of known formulations and with a range of strengths and flavours which may be pre-made or may be bespoke mixtures created on-demand by individual users. Although in the embodiment of vending machine 10 described above, three reservoirs 12 are shown, in alternative embodiments, more reservoirs may be provided to enable a greater variety of bespoke e-liquid blends to be created and dispensed. Known e-cigarette liquids may comprise nicotine, flavourant and a dilutant. Dilutents may comprise Propylene Glycol, Vegetable Glycol or Aqueous Glycerine. The vending machine may include a single nicotine reservoir, a plurality of flavourant reservoirs and a plurality of dilutant reservoirs with different dilutents such as those listed above. The vending machine 10 may be configured to dispense a range of e-liquids within set-limits determined by a manufacturer or regulatory demands by combining different volumes of nicotine, flavourant and

dilutent. For example, e-liquids with a nicotine content from zero to a maximum regulatory limit may be dispensed, with a range of user-selected flavours and concentrations. In order to provide a greater variety of e-liquid blends, the vending machine 10 may include a plurality of flow meters in the respective supply pipes 15 from each reservoir, all connected to the controller 18. The controller may  
5 be able to control the supply valve 16 of each supply pipe 15 to close when a desired quantity of liquid from the respective reservoir 12 is dispensed, as detected by the respective flow meter and in accordance with the specific blend ratios of the e-liquid formulation selected by the user.

It is intended the embodiments of the vending machine 10 may comprise one or more mass flow  
10 controllers, which may be part of the dispensing mechanism 14 or may be positioned within each of the supply pipes 15, to measure and control the flow rate of e-liquid therethrough. The or each mass flow controller may be connected to the controller 18. The mass flow controllers may generally comprise a mass flow sensor connected to a valve which the mass flow controller controls to maintain the flow rate at a desired level, the value of which may be received from the controller 18. Therefore,  
15 a desired quantity of e-liquid can be accurately dispensed since the e-liquid flow rate is accurately controlled.

Figure 7 shows a first exemplary data flow diagram for the vending machine 10, and how the various data flows between the components of the machine and devices operable with the machine. The  
20 wireless receiver 37 may be configured to receive data from a remote electronic device such as a smart phone 36, possibly via a dedicated app, relating to the user's order and selection of e-liquid to be dispensed, or e-liquid blend, and also to effect payment for use of the vending machine. The data may also comprise age verification data, such as date of birth or a registered user reference. This information is passed to the controller (which may comprise one or more processors). The vending  
25 machine may additionally include a wireless transmitter such that the operation status and/or payment status of the user's order may be relayed to the portable device to be displayed to the user.

The user interface 17 may comprise a display unit, keypad and payment device 17a. The payment device may send payment instructions and signals to the controller 18. The keypad may be used to  
30 select the desired e-liquid choice or blend and whether a new cartomizer 19 is required. The data may also comprise age verification data, such as date of birth or a registered user reference. Data relating to confirmation of the order, operational status and/or payment status may be transmitted to the display unit for display to the user.

The memory 26 may comprise RAM, ROM, a database and/or cache memory. It may store  
35 information relating to specific known cartomizer dimensions and volumes, to be accessed by the controller 18 during operation of the vending machine. It may also store current machine status data such as volumes of e-liquid in the respective reservoirs, which it may receive via the controller from level sensors in the reservoirs. The memory may also store all activity history of the vending machine  
40 over a predetermined time period, such as number of cartomizers refilled, total volume of e-liquid

dispensed, a count of new cartomizers dispensed from the machine, and how many are remaining. It may also store information on users of the vending machine, including preferred choices, blends, user ID references, and frequency of use.

- 5 If the apparatus comprises one or more mass flow controllers, data relating to the desired flow rate, which may be stored in the memory for different cartomizer refilling processes, may be provided to the mass flow controller and data relating to the flow rate control, and total flow may be relayed back from the mass flow controller to the controller 18 and may be stored in the memory 26. Also, if the apparatus comprises one or more flow meters, data from these relating to the flow rate of e-liquid will  
10 be fed to the controller 18, and may be stored in the memory 26.

It is intended that a plurality of vending machines 10 may be provided and connected to each other as a networked e-liquid vending machine system. In such a system, the various vending machines would be connected to a remote server, and real-time data may be collected from the vending  
15 machines 10 within the network, analysed and stored on the server. The data collected could include type and volume of e-liquid dispensed and remaining reservoir levels in individual vending machines within the network, to enable an efficient maintenance schedule to be created so that vending machines within the network can have their reservoirs refilled before they are fully empty. The consumption levels of the different e-liquid formulations within the network of vending machines may  
20 also be stored and analysed, including preferred blend ratios of e-liquids selected by users. The collected data could also relate to individual customer profiles, if available through a dispensing operation (e.g. from age/ID verification data input, or smart-phone connection via a personalised user account), for such data to be used for marketing purposes. This data may be transmitted to the server in real time or alternatively, may be stored in the memory 26 and transferred to the server at  
25 regular intervals or on demand.

Figure 8 shows a second exemplary data flow diagram for the vending machine 10 and its data flow within a network of such vending machines and between a remote electronic device operable with the vending machine. Figure 9 shows an exemplary logic flow diagram for operation of the vending  
30 machine 10 within a network of vending machines and in conjunction with a remote electronic device operable with the vending machine. Referring to Figure 8, in some implementations, a client 1100 such as a user's portable device may become "aware" of a nearby e-liquid vending machine (e.g., via "autohandshake," radio frequency identification (RFID), near-field communication (NFC), and/or the like) and generate an e-liquid vending options request, e.g., 1102, for example containing a security  
35 certificate and/or credentials (e.g., username and password) to authenticate a user's identity, age, etc., along with user preference information stored on the client (e.g., preferred formulation(s), preferred flavour(s), cartomizer/device type, etc.) and/or user location information (e.g., GPS coordinates and/or the like). For example, the client 1100 may provide an e-liquid vending options request 1102 in the form of a (Secure) Hypertext Transfer Protocol ("HTTP(S)") POST message  
40 including data formatted according to the eXtensible Markup Language ("XML"). An example e-liquid

vending options request 1102, substantially in the form of a HTTP(S) POST message including XML-formatted data, is provided below:

```

5   POST /orderrequest.php HTTP/1.1
   Host: www.bat.com/e-liquid_dispense
   Content-Type: Application/XML
   Content-Length: 484
   <?XML version = "1.0" encoding = "UTF-8"?>
10  <e-liquid_vending_options_request>
      <request_ID>1126515</request_ID>
      <timestamp>yyyy-mm-dd hh:mmE:ss</timestamp>
      <user_ID>JDoe@gmail.com</user_ID>
      <credentials>
15      <password>secret123</password>
      <access_key>Fort7992</access_key>
      <GPS_coord>Latitude_Longitude_Elevation</GPS_coord>
      <preference_details>
      <formulation_ID>150</formulation_ID>
      <flavor_ID>menthol</flavor_ID>
20      <cartomizer_type>100</cartomizer_type>
      <refill_amount>15mL</refill_amount>
      ...
      </preference_details>
      <client_details>
25      <client_IP>192.168.23.122</client_IP>
      <client_type>smartphone</client_type>
      <client_model>HTC Hero</client_model>
      <OS>Android 2.2</OS>
      <app_installed_flag>true</app_installed_flag>
30      ...
      </client_details>
   </e-liquid_vending_options_request>

```

35 In other embodiments, the e-liquid vending options request 1102 may be generated as a result of a user manually requesting, e.g., via a website or application running on the client 1100, information pertaining to nearby vending options for refilling his/her e-cigarette. The e-liquid vending options request 1102, in some embodiments, may be transmitted to a nearby e-liquid vending machine, e.g., 1200, or to multiple e-liquid vending machines via an e-liquid vending machine network.

40 The e-liquid vending machine may, in some embodiments, send an e-liquid user preferences request 1105 to an e-liquid vending server (e.g., 1121). In some implementations, the e-liquid vending server 1121 may receive a (Secure) Hypertext Transfer Protocol ("HTTP(S)") POST message including data formatted according to the eXtensible Markup Language ("XML"). An example e-liquid user preferences request 1104, substantially in the form of a HTTP(S) POST message including XML-formatted data, is provided below:

```

50  POST /sample_user_preference_query.php HTTP/1.1
   Host: www.bat.com/e-liquid_dispense
   Content-Type: Application/XML
   Content-Length: 484
   <?XML version = "1.0" encoding = "UTF-8"?>
   <sample_query_request>

```

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```

<request_ID>1126515</request_ID>
<timestamp>yyyy-mm-dd hh:mmE:ss</timestamp>
<user_ID>JDoe@gmail.com</user_ID>
<credentials>
5     <password>secret123</password>
      <access_key>Fort7992</access_key>
      <GPS_coord>Latitude_Longitude_Elevation</GPS_coord>
<sample_user_preference_query name="e-liquid_user_profile">
      <query num=1>
10      Select CartomizerType.Number, Formulation.Pref from
      eLiquid_User_Profiles where UserAccountNum=JDoeAccountNum
      ...
      </query>
      <query>
15      ...
      </query>
</sample_user_preference_query>
</sample_query_request>

```

20 The e-liquid vending server 1121 may perform the requested query (e.g., via user account preference query 1105) on user account database 1122 to determine user preference information (e.g., preferred formulation(s), preferred flavour(s), cartomizer/device type(s) owned/used, preferred filling location(s), etc.). The e-liquid vending server 1121 may, as a result of the query, return an e-liquid user preferences response 1107 to the e-liquid vending machine 1200.

25 The e-liquid vending machine may, at 1108, compile information obtained from one or both of the user client device and the user account database (e.g., via the e-liquid vending server 1121) in order to generate an e-liquid vending options response 1109 including one or more of the following: user authentication verification, location(s) of vending machine(s), formulation levels available within the machine(s), available flavourants, cartomizer/device types accommodated, payment methods  
30 accepted, etc., and may display the available e-liquid vending options to the user, e.g., via client 1100 and/or via a user interface on the e-liquid vending machine 1200. A user may then choose to physically proceed to the location of the vending machine and complete the remainder of the e-liquid refill/purchase transaction via a user interface which is built into the vending machine itself.

35 Alternatively, a user may make a purchase/refill selection via his/her mobile device, e.g., at 1111 or 1112, from among the available e-liquid vending options, and an e-liquid order selection 1113/1114 may be sent to the e-liquid vending machine 1200. In some embodiments, a checkout page for completing the purchase/refill transaction may be transmitted from the e-liquid vending machine 1200 to the client 1100, e.g. presenting a variety of payment options from which the user may choose and  
40 authorize via a payment election confirmation message 1117, while in other embodiments a user may complete and pay for a purchase/refill transaction via a user interface on the e-liquid vending machine 1200, for example via touch screen, keyboard, mouse, magnetic stripe reader, and/or the like.

The e-liquid vending machine 1200 may, at 1118, execute the e-liquid order fulfilment, for example by  
45 refilling e-liquid into an already-installed cartomizer/device, by dispensing an empty cartomizer/device to be refilled, by dispensing a pre-filled cartomizer/device, and/or by requesting (via a user interface

on the e-liquid vending machine 1200 or via the client 1100) mechanical insertion of the cartomizer/device to be refilled on the front of the vending machine and subsequently refilling once insertion has been verified, etc. In some embodiments, the cartomizer/device may contain its own memory storage, from which case the e-liquid vending machine 1200 may retrieve information  
 5 relevant to the purchase/refill transaction, such as the model of the device, the age/usage history of the device, filling capacity, etc. The vending machine may further be capable, upon insertion of the device, of detecting a fill level within the device and/or properties of the formulation contained therein. The vending machine may further be equipped to indicate when the cartomizer/device refilling process has been completed, for example by rendering a message on the e-liquid vending machine  
 10 1200 user interface, transmitting a message (e.g., by rendering a webpage, sending an email message/SMS text) to a client 1100, emitting a tone, flashing a light, etc.

In one implementation, the order fulfilment may include generation of transaction data 1119 including, for example, the user's selected formulation type and quantity, cartomizer/device type, GPS-derived  
 15 location information, etc. An example of transaction data 1119 formatted in XML is provided below:

```

    <order_fulfillment_transaction_data>
      <request_ID>1126515</request_ID>
      <timestamp>yyyy-mm-dd hh:mm:ss</timestamp>
      <user_ID>JDoe@gmail.com</user_ID>
      <formulation_ID>150</formulation_ID>
      <flavor_ID>menthol</flavor_ID>
      <cartomizer_type>100</cartomizer_type>
      <refill_amount>15mL</refill_amount>
    </order_fulfillment_transaction_data>
  
```

Transaction data 1119 may, in some embodiments, be transmitted to the e-liquid vending server 1121 and/or to client 1100, for example as an addition/update to the record(s) contained therein (e.g., user account database 1121 and smart phone memory, respectively).

The logic flow diagram of Figure 9 illustrates the step-wise transactional process between a client 2100, the vending machine 2101 and the server 2102 of a network of vending machines. The respective steps of the logic flow diagram are explained within the logic step boxes of Figure 9 and so a detailed description of the respective steps in the process will not be repeated in detail here.

The housing 11 is intended to be a secure casing for the vending machine to resist being broken into or tampered with. As such, it is preferably made from a strong material such as steel, and includes a secure locking means so that only authorised personnel may access the interior of the vending machine 10. Furthermore, the housing 11 may include an alarm (not shown) that activates if the  
 40 housing 11 is interfered with or opened by an unauthorised person. Such alarm may be connected to the controller 18 and be configured to lock the dispensing function of the vending machine 10 until the alarm is reset. These tamper-resistant measures, plus the age-verification measures mentioned above, enhance the security of the vending machine 10. In addition, if the vending machine 10 or



housing 11 has been tampered with such that an alarm of the machine activates, this activation may be communicated to the server of the network so that appropriate servicing can be scheduled.

In an embodiment, the dispensing mechanism 14 may include a seal label applicator which is configured, upon completion of a dispensing operation, to apply a seal-label over the top of the filled cartomizer which is to be peeled off by a user before use in an inhalation device. Such a seal label may include tamper-evident features so that if the cartomizer is not for immediate use in an inhalation device, it will be apparent if the cartomizer has been interfered with since it was last filled.

The refilling of empty used cartomizers with e-liquid provides environmental benefits of reducing waste.

Although the embodiments described above have generally related to a vending machine, in the sense that some type of payment made be made in order to operate the machine, the approach described herein may be utilised with a machine or apparatus for dispensing a vaporisable liquid that does not involve any form of vending or payment to the machine. One possibility, for example, is that the machine is located in an establishment (hotel, club, etc), where any payment is handled by a separate transaction, e.g. at a till. A user may then be permitted to use the machine, for example, by allowing the user to obtain physical access to the machine, by providing the user with some appropriate token (e.g. key or smart card) that allows operation of the machine, by an operator sending a control instruction to the machine (by wired or wireless communication) to permit user operation, etc. The above approaches (and other potential mechanisms) may be used in combination with one another if so desired).

In some cases the machine may be maintained behind a counter, and is therefore operated on behalf of a user by an appropriate staff member of the establishment. The operator may have some appropriate token (e.g. password, key or smart card) that allows operation of the machine.

In some cases the machine may be provided as a home use apparatus, so that it can be located in a domestic setting. It may be more economical for a user to run such a home-use dispensing machine than to purchase individual e-cigarettes or individual cartridges (cartomisers) containing e-liquids for such devices. Furthermore, the machine 10 allows the e-liquid containers to become re-usable (rather than disposable) devices. In addition, the machine offers the user greater control over the content, e.g. flavouring, for any given container re-fill, rather than being limited to the particular options available for individually purchased containers.

Such a home use apparatus will generally be smaller than a commercial vending machine, and typically will not incorporate any form of payment mechanism in the user interface 17. However, it may still have some appropriate access control facility, e.g. by a passcode, key or smart card, to help prevent undesired usage of the machine. Such a home use apparatus may include the various

features of a dispensing machine described above in relation to Figures 1-9, as appropriate depending upon the particular circumstances of the apparatus.

In order to address various issues and advance the art, the entirety of this disclosure shows by way of illustration various embodiments in which the claimed invention(s) may be practiced and provide for superior liquid dispensers, methods and systems thereof. The advantages and features of the disclosure are of a representative sample of embodiments only, and are not exhaustive and/or exclusive. They are presented only to assist in understanding and teach the claimed features. It is to be understood that advantages, embodiments, examples, functions, features, structures, and/or other aspects of the disclosure are not to be considered limitations on the disclosure 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 and/or spirit of the disclosure. Various embodiments may suitably comprise, consist of, or consist essentially of, various combinations of the disclosed elements, components, features, parts, steps, means, etc. In addition, the disclosure may include other inventions not presently claimed, but which may be claimed in future.

**Claims**

1. A machine for dispensing a vaporisable liquid into a container for use in an electronic inhalation device, the machine comprising a reservoir for containing liquid, a dispensing port to  
5 receive an empty container to be filled, a dispensing mechanism fluidly connected to the reservoir for dispensing a quantity of liquid from the reservoir to a container received in the dispensing port, a controller connected to the dispensing mechanism to control operation thereof, and a user-operable interface connected to the controller for a user to actuate the machine.
- 10 2. A machine according to claim 1 wherein the user-operable interface is operable by a user to affect payment for supply of a quantity of the liquid from the reservoir and the machine is configured to dispense a quantity of liquid from the reservoir in response to a payment operation by a user via the user-operable interface.
- 15 3. A machine according to claim 1 or claim 2 further comprising a magazine of empty liquid containers and a delivery mechanism configured to deliver an empty container from the magazine for subsequent insertion into the dispensing port and filling with liquid.
- 20 4. A machine according to claim 3 wherein the delivery mechanism is configured to delivery an empty container from the magazine into the dispensing port.
- 25 5. A machine according to any preceding claim, further comprising a cleaning mechanism configured to clean a container received in the dispensing port prior to filling the container with liquid from the reservoir.
6. A machine according to claim 5 wherein the cleaning mechanism comprises an ultrasonic emitter.
7. A machine according to any preceding claim, wherein the dispensing port is configured to  
30 receive and fill containers of varying configurations.
8. A machine according to any preceding claim comprising a plurality of dispensing ports configured to receive and fill containers having different configurations.
- 35 9. A machine according to any preceding claim comprising a plurality of reservoirs containing different liquids, wherein the dispensing mechanism is configured to selectively dispense liquid from the plurality of reservoirs to the dispensing port.

10. A machine according to claim 9 wherein the dispensing mechanism is configured to mix liquid from two or more of the plurality of reservoirs and dispense the mixed liquid to the dispensing port.

11. A machine according to claim 10 comprising at least three reservoirs respectively containing nicotine, a diluent, and a flavourant, and wherein the dispensing mechanism is configured to mix different ratios of the nicotine, diluent, and flavourant as the mixed liquid to be dispensed.

12. A machine according to any preceding claim further comprising a container marking mechanism configured to mark a container filled with liquid from the dispensing mechanism with information related to the dispensed liquid.

13. A machine according to claim 12 wherein the marking mechanism comprises a label printer configured to print a label with information relating to the dispensed liquid and adhere the label to the container.

14. A machine according to claim 12 wherein the marking mechanism comprises a printer configured to print information relating to the dispensed liquid directly onto the container.

15. A machine according to any preceding claim further comprising a container detector associated with the dispensing port and connected to the controller, and configured to detect whether a container is received within the dispensing port, and the controller is configured to control the dispensing mechanism not to dispense liquid if no container is received in the dispensing port.

16. A machine according to claim 15 wherein the container detector is configured to determine a type of container received within the dispensing port and the controller is configured to control the dispensing mechanism to dispense an appropriate amount of liquid in dependence on the detected container type.

17. A machine according to any preceding claim wherein the dispensing mechanism comprises a first duct configured to draw air out of the container to create a reduced pressure therein, and a second duct through which liquid from the reservoir is conveyed into the container and is drawn into the container by the vacuum created therein.

18. A machine according to any preceding claim wherein the dispensing mechanism comprises a flow meter connected to the controller and wherein the controller is configured to control the dispensing mechanism to dispense a pre-determined quantity of liquid as measured by the flow meter.

19. A machine according to claim 9 or any of claims 10 to 18 when dependent on claim 9, wherein each of the reservoirs is fluidly connected to the dispensing mechanism by a supply pipe, and

wherein each supply pipe includes a flow meter connected to the controller, and wherein the controller is configured to control the dispensing mechanism to dispense specific quantities of liquid from the reservoirs as measured by the flow meters.

- 5 20. A machine according to any preceding claim further comprising a wireless receiver connected to the controller and configured to receive a signal transmitted from a user-operated wireless device, and wherein the controller is configured to control the dispensing mechanism in response to the received signal.
- 10 21. A machine according to any preceding claim wherein the controller is configured only to control the dispensing mechanism to dispense liquid from the reservoir to a container upon verification of at least one user identification criterion.
- 15 22. A machine according to claim 21 wherein the controller is configured only to control the dispensing mechanism to dispense liquid from the reservoir to a container upon verification of minimum age information for a user.
- 20 23. A machine according to any preceding claim further comprising a seal label applicator configured to automatically apply a seal label over an opening in a container after being filled with liquid.
24. A machine according to claim 23 wherein the seal labels applied by the seal label applicator are tamper-evidencing seal labels.
- 25 25. A machine according to any preceding claim further comprising a memory unit connected to the controller.
- 30 26. A method of operating a machine for dispensing a vaporisable liquid into a container for use in an electronic inhalation device, the method comprising receiving a dispensing instruction via a user-operable interface connected to a controller, the controller actuating a dispensing mechanism to dispense a quantity of liquid from a reservoir of the machine to a dispensing port and into a container held in the dispensing port.
- 35 27. A method according to claim 26 comprising using the user-operable interface to affect payment for supply of a quantity of the liquid from the reservoir and dispensing a quantity of liquid from the reservoir in response to a payment operation.
28. A method according to claim 26 or claim 27 further comprising actuating of a delivery mechanism to deliver an empty container from a magazine of empty liquid containers for subsequent

insertion into the dispensing port and filling with liquid.

29. A method according to claim 28 wherein the delivery mechanism delivers an empty container from the magazine into the dispensing port.

5

30. A method according to any of claims 26 to 29, further comprising cleaning a container received in the dispensing port by actuation of a cleaning mechanism, prior to filling the container with liquid from the reservoir.

10

31. A method according to claim 30 comprising performing the cleaning operation by means of an ultrasound generating device.

15

32. A method according to any of claims 26 to 31, wherein the machine comprises a plurality of reservoirs containing different liquids, wherein the method comprises dispensing liquid from the plurality of reservoirs to the dispensing port according to a user selection.

33. A method according to claim 32 comprising mixing liquid from two or more of the plurality of reservoirs and dispensing the mixed liquid to the dispensing port.

20

34. A method according to claim 33 wherein the machine comprises at least three reservoirs respectively containing nicotine, a diluent, and a flavourant, and wherein the method comprises mixing different ratios of the nicotine, diluent, and flavourant as the mixed liquid to be dispensed.

25

35. A method according to any of claims 26 to 34 further comprising actuating a container marking mechanism to mark a container filled with liquid from the dispensing mechanism with information related to the dispensed liquid.

30

36. A method according to claim 35 wherein the marking mechanism comprises a label printer and the method comprises printing a label with information relating to the dispensed liquid for adherence onto the container.

37. A method according to claim 35 wherein the marking mechanism comprises a printer and the method comprises printing information relating to the dispensed liquid directly onto the container.

35

38. A method according to any of claims 26 to 37 wherein the machine further comprises a container detector associated with the dispensing port and connected to the controller, wherein the method comprises detecting whether a container is received within the dispensing port, and the controller controlling the dispensing mechanism not to dispense liquid if no container is received in the dispensing port.

40

39. A method according to claim 38 comprising determining a type of container received within the dispensing port and the controller controlling the dispensing mechanism to dispense an appropriate amount of liquid in dependence on the detected container type.

40. A method according to any of claims 26 to 39 wherein the dispensing mechanism comprises a first duct and a second duct fluidly connected between the reservoir and the dispensing mechanism, the method comprising drawing air out of the container through the first duct to create a reduced pressure therein, and conveying liquid from the reservoir into the container through the second duct by being drawn into the container by the vacuum created therein.

41. A method according to any of claims 26 to 40 wherein the dispensing mechanism comprises a flow meter connected to the controller and wherein the method comprises controlling the dispensing mechanism to dispense a pre-determined quantity of liquid as measured by the flow meter.

42. A method according to 32 or any of claims 33 to 41 when dependent on claim 32, wherein each of the reservoirs is fluidly connected to the dispensing mechanism by a supply pipe, and wherein each supply pipe includes a flow meter connected to the controller, the method comprising controlling the dispensing mechanism to dispense specific quantities of liquid from the reservoirs as measured by the flow meters.

43. A method according to any of claims 26 to 42 wherein the machine further comprises a wireless receiver connected to the controller, the method comprising receiving a signal transmitted from a user-operated wireless device, and the controller controlling the dispensing mechanism in response to the received signal.

44. A method according to any of claims 26 to 43 comprising verifying a user identification criterion and only dispensing liquid from the reservoir to a container upon verification of at least one user identification criterion.

45. A method according to claim 44 wherein the at least one user identification criterion verification comprises verification of minimum age information for a user.

46. A method according to any of claims 26 to 45 wherein the machine comprises a seal label applicator and the method comprises automatically applying a seal label over an opening in a container after being filled with liquid.

47. A method according to any of claims 26 to 46 comprising applying tamper-evidencing seal labels to a container.

48. A machine according to any of claims 1 to 25, wherein said machine is a vending machine.

49. A method according to any of claims 26 to 47, wherein said machine is a vending machine.

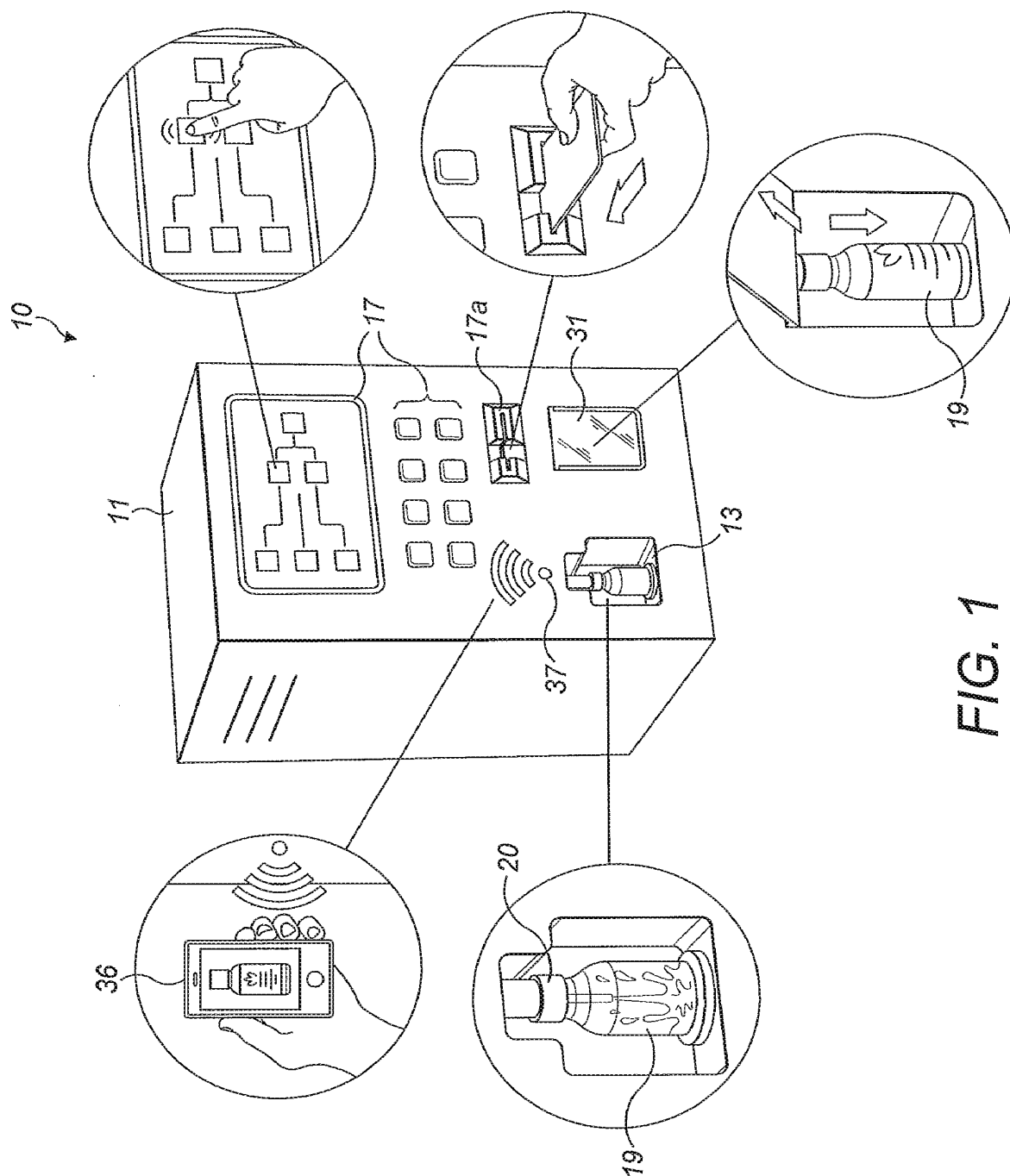
50. A system of a plurality of machines according to any of claims 1 to 25 or 48 all connected to a  
5 server, wherein each of the machines is configured to send data relating to the dispensing operations  
of the respective machine to the server.

51. A system according to claim 50 wherein each machine within the system is configured to  
transmit to the server data relating to the quantity of liquid dispensed from, or remaining in, the  
10 machine reservoir(s).

52. A system according to claim 50 or claim 51 wherein each machine within the system is  
configured to transmit to the server data relating to user selections of liquids to be dispensed.

15





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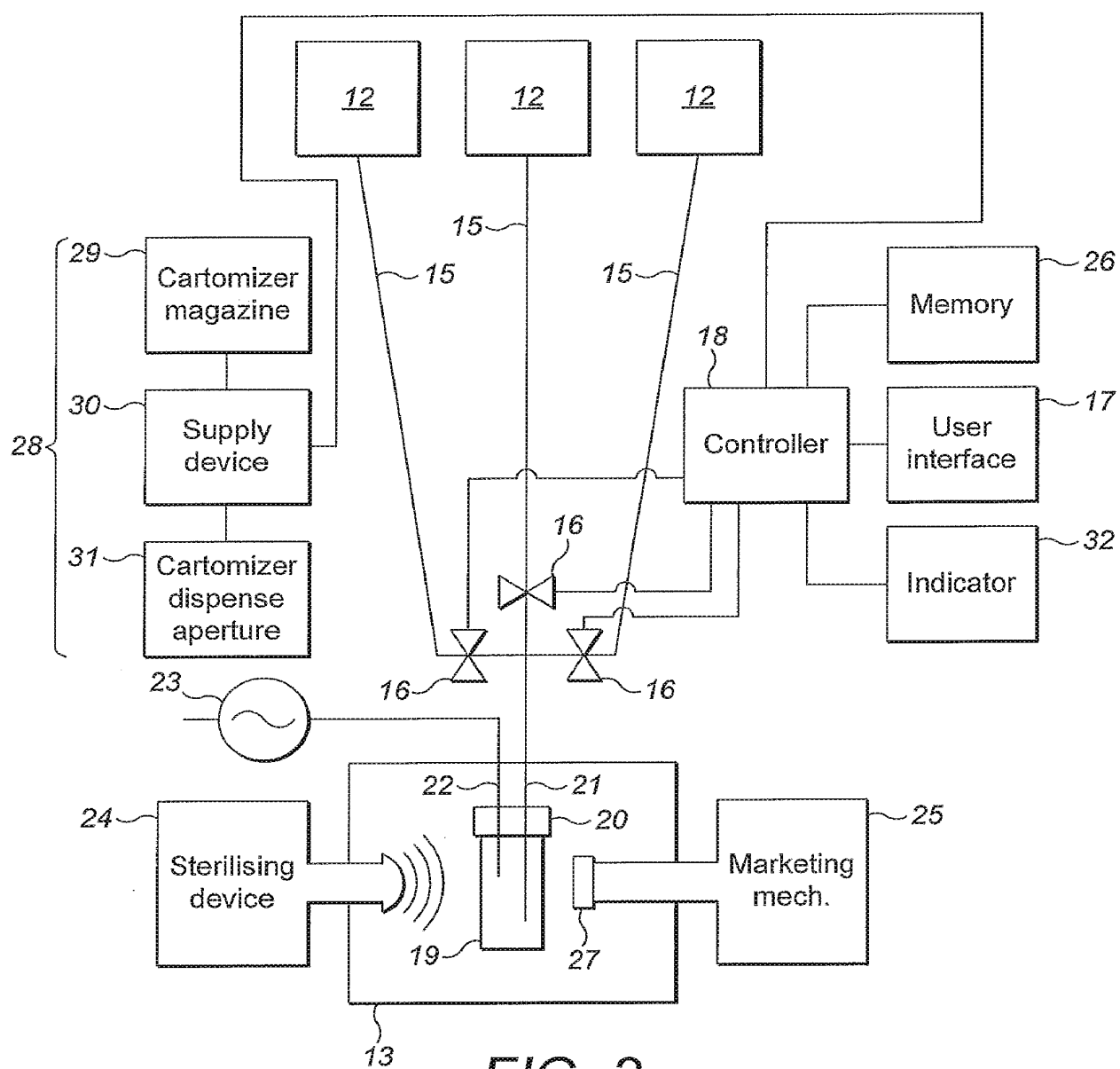


FIG. 2

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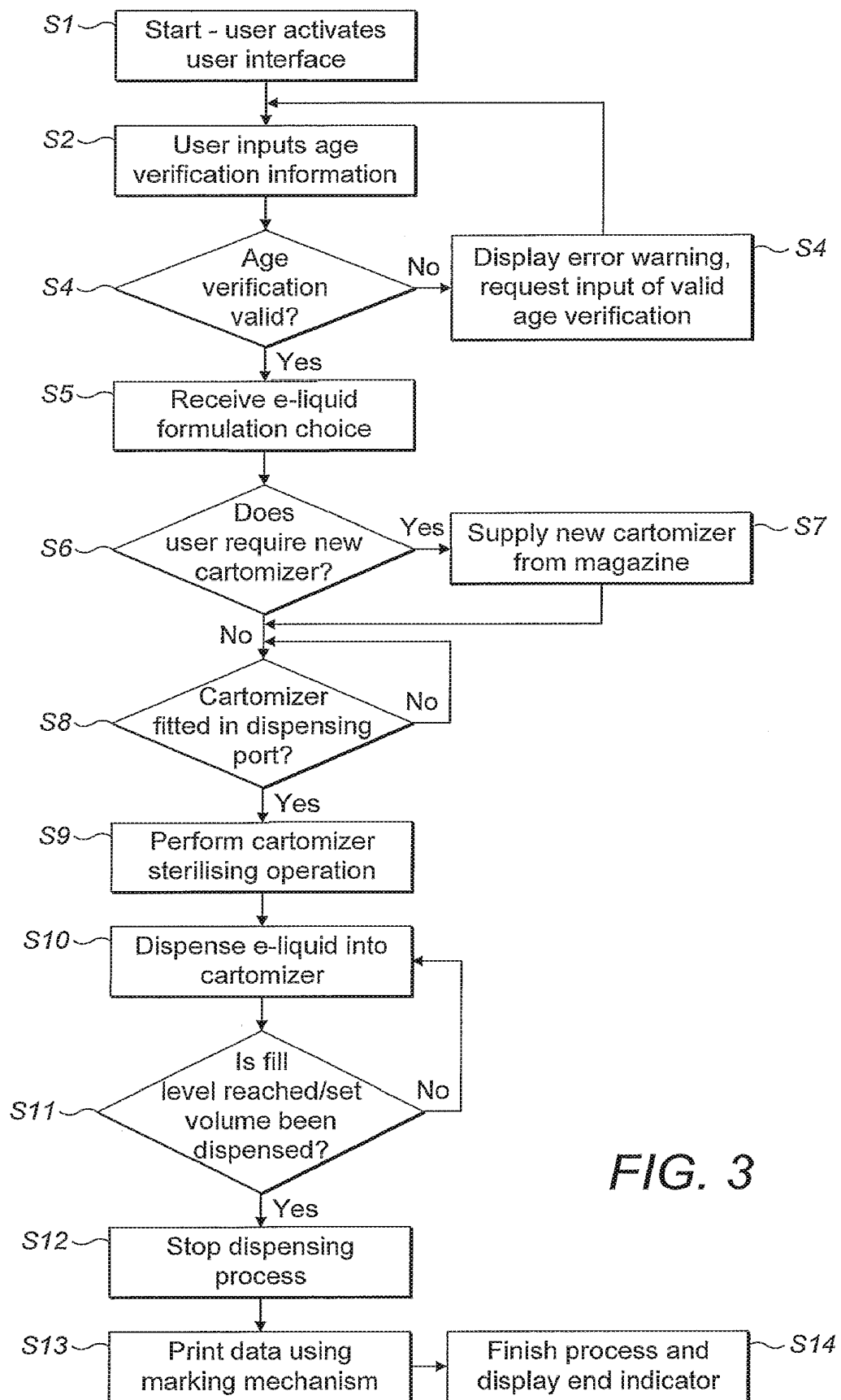
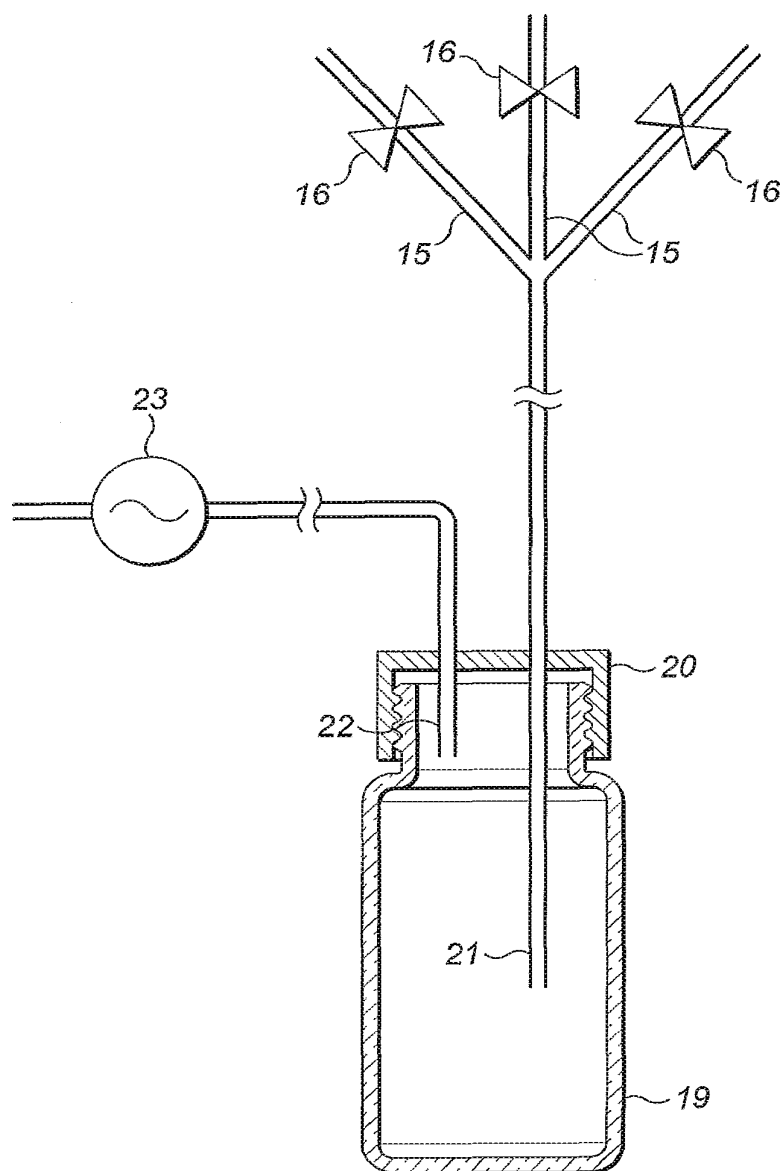
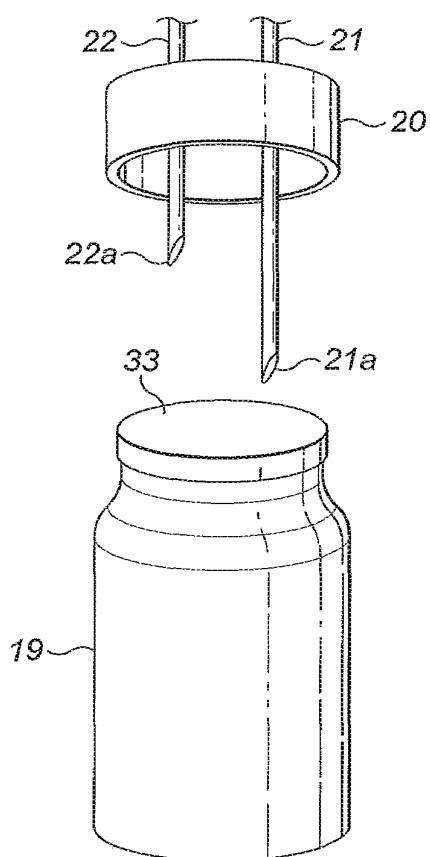
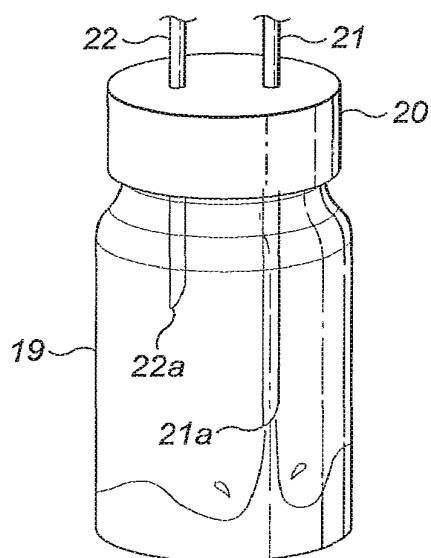


FIG. 3

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**FIG. 4**

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**FIG. 5A****FIG. 5B**

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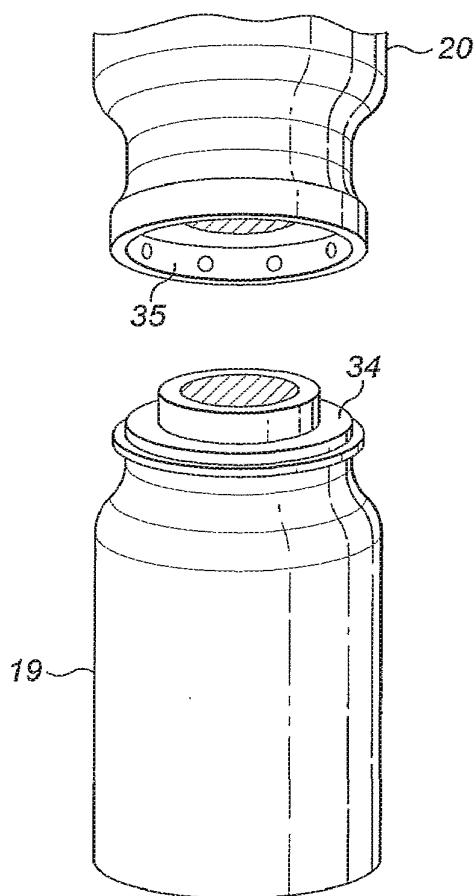


**FIG. 6A**

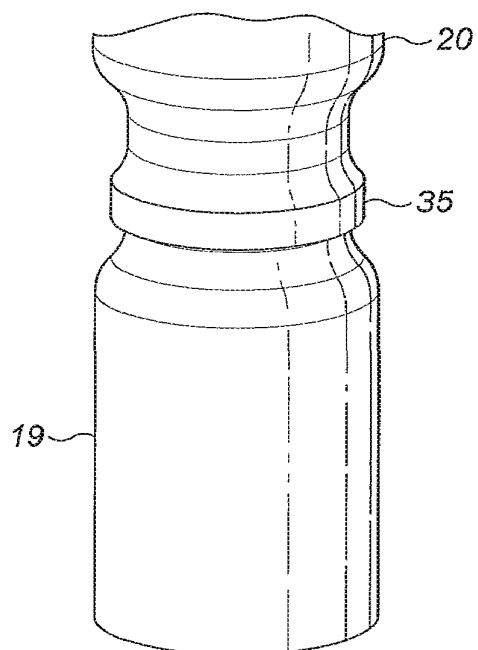


**FIG. 6B**

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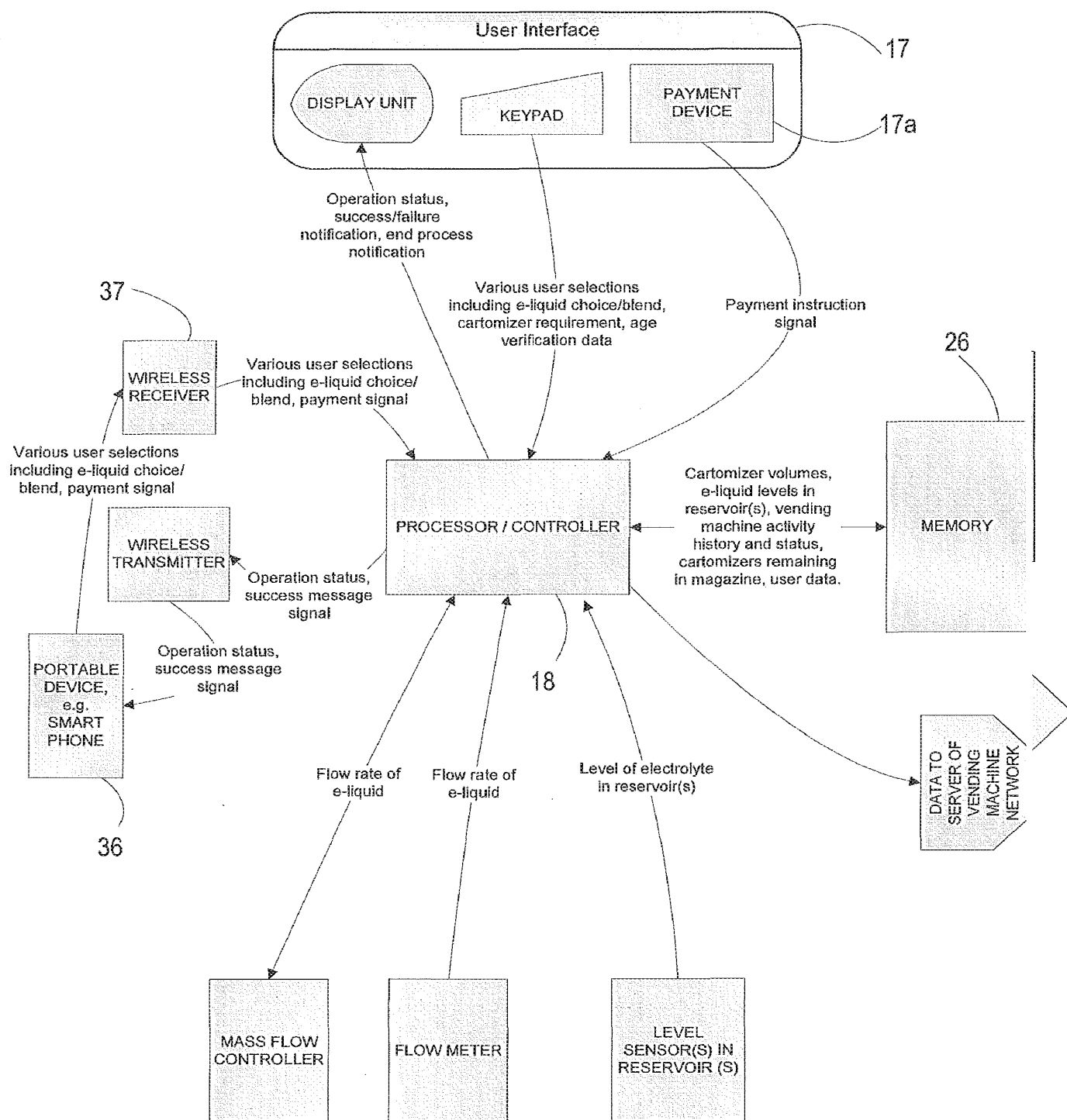
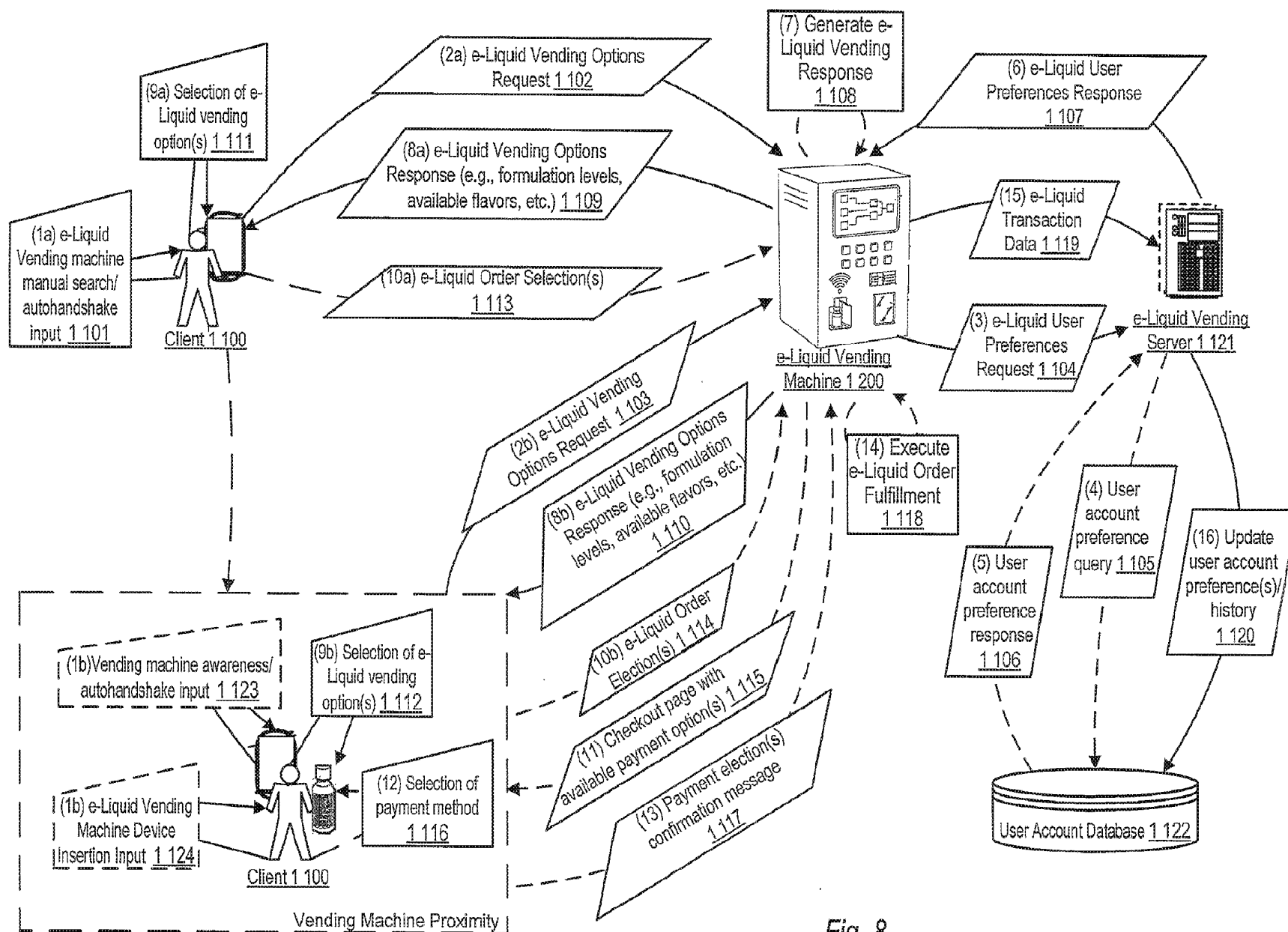


Fig. 7





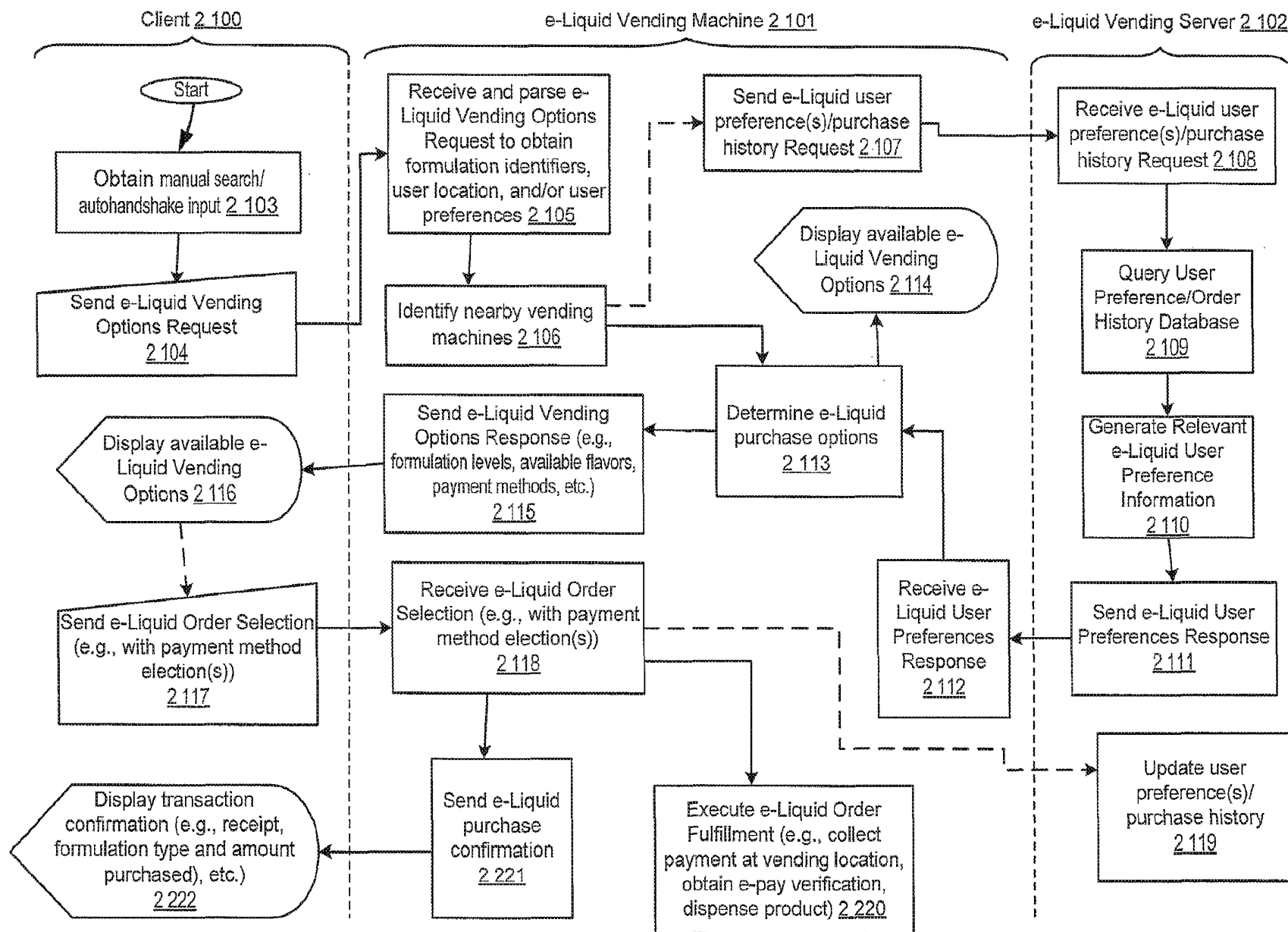


Fig. 9

## INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2014/052626

## A. CLASSIFICATION OF SUBJECT MATTER

INV. G07F13/02 G07F13/06 G07F13/10  
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)

B01L G07F B65D A47J B67D A61J

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         | US 2012/035761 A1 (TILTON DONALD EDWARD [US] ET AL) 9 February 2012 (2012-02-09)<br>abstract; figures<br>paragraph [0005]<br>paragraphs [0027] - [0031]<br>paragraph [0039]<br>paragraphs [0042] - [0044]<br>paragraph [0049]<br>paragraphs [0053] - [0054]<br>paragraphs [0059] - [0061]<br>paragraphs [0063] - [0064]<br>paragraphs [0068] - [0069]<br>claims<br>----- | 1-52                  |
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents :

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Date of the actual completion of the international search

10 November 2014

Date of mailing of the international search report

19/11/2014

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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                              | Relevant to claim No. |
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2014/052626

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## (12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织  
国际局

(43) 国际公布日  
2015 年 4 月 30 日 (30.04.2015)



(10) 国际公布号  
**WO 2015/058387 A1**

- (51) 国际专利分类号:  
*A24F 47/00* (2006.01) *H01M 2/04* (2006.01)
- (21) 国际申请号: PCT/CN2013/085882
- (22) 国际申请日: 2013 年 10 月 24 日 (24.10.2013)
- (25) 申请语言: 中文
- (26) 公布语言: 中文
- (71) 申请人: 吉瑞高新科技股份有限公司 (KIMREE HI-TECH INC.); 英属维尔京群岛托尔托拉岛罗德城奎兹天空大厦邮箱 905 号, Tortola (VG)。
- (72) 发明人: 刘秋明 (LIU, Qiuming); 中国广东省深圳市宝安区西乡兴业路缤纷世界花园 E3 栋 1202, Guangdong 518000 (CN)。
- (74) 代理人: 深圳市顺天达专利商标代理有限公司 (SHENZHEN STANDARD PATENT & TRADE-MARK AGENT LTD.); 中国广东省深圳市福田区深南大道 1056 号银座国际大厦 810-815 室, Guangdong 518040 (CN)。

- (81) 指定国 (除另有指明, 要求每一种可提供的国家保护): 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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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) 指定国 (除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (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)。

### 本国际公布:

- 包括国际检索报告(条约第 21 条(3))。

(54) Title: BATTERY COMPONENT AND ELECTRONIC CIGARETTE

(54) 发明名称: 电池组件和电子烟

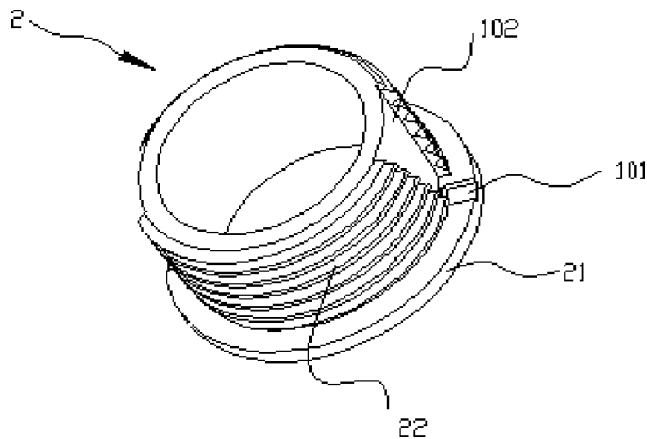


图 3 / FIG. 3

(57) Abstract: Disclosed are a battery component and an electronic cigarette. The battery component is used for being assembled with an atomizing component to form the electronic cigarette. The battery component comprises a sleeve pipe and an end cap provided at one extremity of the sleeve pipe and movably connected to the sleeve pipe. Provided on the end cap is an air inlet channel in communication with an airflow channel within the sleeve pipe. The air inlet area of the air inlet channel increases incrementally as the length of the end cap that protrudes the sleeve pipe increases. Per the present invention, by providing the air inlet channel on the end cap, the air inlet area of the air inlet channel increases incrementally as the end cap protrudes out of the sleeve pipe. A user is allowed to control, on the basis of individual requirements for the volume of airflow, the length of the end cap that protrudes the sleeve pipe, thus controlling the air inlet area and implementing requirements for different airflow effects.

(57) 摘要: 本发明公开了一种电池组件和电子烟, 电池组件用于与雾化组件组合形成电子烟, 所述电池组件包括套管和设置在所述套管一端且与所述套管活动连接的端盖, 所述端盖上设置有与所述套管内气流通道相连通的

的进气通道, 所述进气通道的进气口面积随着所述端盖伸出所述套管的长度的增加而递增。本发明通过在端盖上设置有进气通道, 进气通道的进气口面积随着端盖伸出套管逐渐增加。使用者可以按照个人对通气量的需求, 控制端盖伸出套管长度, 进而控制进气口面积, 实现对不同通气效果的要求。

# 说明书

## 发明名称：电池组件和电子烟

### 技术领域

- [1] 本发明涉及日用电子产品领域，尤其涉及一种电池组件和电子烟。

### 背景技术

- [2] 电子烟包括电池组件和雾化组件，雾化组件用于吸烟的端部设置有吸嘴盖，电池组件远离吸烟端的端部设置灯帽，电池组件的套管内部设置有气流传感器，灯帽上设置有通气孔，使用者通过吸嘴盖吸气时，气流通过通气孔流通至电池组件的套管内部，气流传感器感应到气流信号，电子烟开始工作。
- [3] 由于每个人的肺活量不同，吸烟时对电子烟的通气量要求不同，参考图1，灯帽包括盖体21和连接部22，其进气通道自连接部22远离盖体21的一端起沿套管轴向贯穿连接部22并延伸至盖体21，具体包括两部分：第一部分是侧缺口6，设置在盖体21的朝向连接部22的侧壁并开设至盖体21边缘，第二部分是与缺口6连通的引导部7，引导部7为轴向贯穿连接部22外壁的矩形槽，这种结构的进气通道在自然状态下控制进气通量的结构为缺口6和矩形槽中进气面积最小的结构，即缺口6的横截面和矩形槽的横截面中面积最小的，如果两者面积相等，则无论灯帽处于何种状态，进气通量始终是不变的，如果不等，则仅仅在灯帽抽离套管的瞬间改变进气通量；即使将灯帽旋出套管，由于矩形槽的进气口面积始终为其某个横截面的面积，因此并不能控制连续改变进气通量。
- [4] 现有技术中，通气孔的进气口的大小是固定设置，因此不能满足用户对不同通气效果的要求。
- [5] 因此，现有技术存在缺陷，需要改进。

### 发明内容

- [6] 本发明要解决的技术问题在于，针对现有技术的上述不能满足用户对不同通气效果的要求缺陷，提供一种电池组件和电子烟。
- [7] 本发明解决其技术问题所采用的技术方案是：构造一种电池组件，用于与雾化组件组合形成电子烟，所述电池组件包括套管和设置在所述套管一端且与所述

套管活动连接的端盖，所述端盖上设置有与所述套管内气流通道相连通的进气通道，所述进气通道的进气口面积随着所述端盖伸出所述套管的长度的增加而递增。

- [8] 在本发明所述的电池组件中，所述进气通道包括第一进气通道和第二进气通道，
- [9] 所述第一进气通道的一端直接与外界连通，所述第一进气通道的另一端直接与所述套管内气流通道相连通或者通过所述第二进气通道与所述套管内气流通道相连通；
- [10] 所述第二进气通道的一端直接与所述套管内气流通道相连通，所述第二进气通道的另一端通过所述第一进气通道与外界连通或者在所述端盖伸出所述套管时直接与外界连通，所述第二进气通道的进气口面积随着所述端盖伸出所述套管的长度的增加而递增。
- [11] 在本发明所述的电池组件中，所述端盖包括盖体和沿所述盖体缩径形成的、朝向所述套管轴向延伸的中空的连接部，所述套管套设在所述连接部上，所述盖体盖设在所述套管上，所述第二进气通道在所述连接部上轴向或者径向延伸设置并与所述套管内气流通道相连通。
- [12] 在本发明所述的电池组件中，所述第二进气通道轴向延伸设置并与所述套管内气流通道相连通，
- [13] 所述第二进气通道为自所述连接部靠近所述盖体的一端起开设的沿所述套管轴向贯穿所述连接部外壁且横截面逐渐增大的梯形通气凹槽；
- [14] 所述第一进气通道为设置在所述盖体朝向所述套管的侧壁上与所述梯形通气凹槽相连通的第一通气槽。
- [15] 在本发明所述的电池组件中，所述第二进气通道径向延伸设置并与所述套管内气流通道相连通，
- [16] 所述第二进气通道为自所述连接部靠近所述盖体的一端起开设的沿所述套管轴向贯穿所述连接部外壁的缺口；
- [17] 所述第一进气通道为设置在所述盖体朝向所述套管的侧壁上与所述缺口相连通或者直接与所述套管内气流通道相连通的第二通气槽。

- [18] 在本发明所述的电池组件中，所述第二通气槽正对所述缺口且与所述缺口相连通。
- [19] 在本发明所述的电池组件中，所述第二进气通道径向延伸设置并与所述套管内气流通道相连通，
- [20] 所述第二进气通道为设置在所述连接部上的通孔；
- [21] 所述第一进气通道为与所述通孔连通的第三通气槽，所述第三通气槽自与所述通孔连通的一端起沿所述套管轴向延伸至所述盖体。
- [22] 在本发明所述的电池组件中，所述连接部外壁设置有外螺纹，所述套管内壁设置有与所述外螺纹相匹配的内螺纹。
- [23] 本发明还公开了一种电子烟，包括雾化组件和电池组件，所述电池组件包括套管和设置在所述套管一端且与所述套管活动连接的端盖，所述端盖上设置有与所述套管内气流通道相连通的进气通道，所述进气通道的进气口面积随着所述端盖伸出所述套管的长度的增加而递增。
- [24] 在本发明所述的电子烟中，所述进气通道包括第一进气通道和第二进气通道，
- [25] 所述第一进气通道的一端直接与外界连通，所述第一进气通道的另一端直接与所述套管内气流通道相连通或者通过所述第二进气通道与所述套管内气流通道相连通；
- [26] 所述第二进气通道的一端直接与所述套管内气流通道相连通，所述第二进气通道的另一端通过所述第一进气通道与外界连通或者在所述端盖伸出所述套管时直接与外界连通，所述第二进气通道的进气口面积随着所述端盖伸出所述套管的长度的增加而递增。
- [27] 在本发明所述的电子烟中，所述端盖包括盖体和沿所述盖体缩径形成的、朝向所述套管轴向延伸的中空的连接部，所述套管套设在所述连接部上，所述盖体盖设在所述套管上，所述第二进气通道在所述连接部上轴向或者径向延伸设置并与所述套管内气流通道相连通。
- [28] 在本发明所述的电子烟中，所述第二进气通道轴向延伸设置并与所述套管内气流通道相连通，
- [29] 所述第二进气通道为自所述连接部靠近所述盖体的一端起开设的沿所述套管轴



向贯穿所述连接部外壁且横截面逐渐增大的梯形通气凹槽；

[30] 所述第一进气通道为设置在所述盖体朝向所述套管的侧壁上与所述梯形通气凹槽相连通的第一通气槽。

[31] 在本发明所述的电子烟中，所述第二进气通道径向延伸设置并与所述套管内气流通道相连通，

[32] 所述第二进气通道为自所述连接部靠近所述盖体的一端起开设的沿所述套管轴向贯穿所述连接部外壁的缺口；

[33] 所述第一进气通道为设置在所述盖体朝向所述套管的侧壁上与所述缺口相连通或者直接与所述套管内气流通道相连通的第二通气槽。

[34] 在本发明所述的电子烟中，所述第二通气槽正对所述缺口且与所述缺口相连通。

[35] 在本发明所述的电子烟中，所述第二进气通道径向延伸设置并与所述套管内气流通道相连通，

[36] 所述第二进气通道为设置在所述连接部上的通孔；

[37] 所述第一进气通道为与所述通孔连通的第三通气槽，所述第三通气槽自与所述通孔连通的一端起沿所述套管轴向延伸至所述盖体。

[38] 在本发明所述的电子烟中，所述连接部外壁设置有外螺纹，所述套管内壁设置有与所述外螺纹相匹配的内螺纹。

[39] 实施本发明的电池组件和电子烟，具有以下有益效果：本发明的电池组件包括套管和设置在套管一端的与套管活动连接的端盖，端盖上设置有进气通道，进气通道的进气口面积随着端盖伸出套管逐渐增加。使用者可以按照个人对通气量的需求，控制端盖伸出套管长度，进而控制进气口面积，实现对不同通气效果的要求。

#### 附图说明

[40] 下面将结合附图及实施例对本发明作进一步说明，附图中：

[41] 图1是现有技术中灯帽的结构示意图；

[42] 图2是本发明电池组件的部分结构示意图；

[43] 图3是本发明电池组件的端盖的第一实施例的结构示意图；

[44] 图4是本发明电池组件的端盖的第二实施例的结构示意图；

[45] 图5是本发明电池组件的端盖的第三实施例的结构示意图。

### 具体实施方式

[46] 为了对本发明的技术特征、目的和效果有更加清楚的理解，现对照附图详细说明本发明的具体实施方式。

[47] 为了解决现有技术的上述不能满足用户对不同通气效果的要求缺陷，本发明提供一种电池组件和电子烟。

[48] 参考图2是本发明电池组件的部分结构示意图；

[49] 本发明的电池组件，用于与雾化组件组合形成电子烟，电池组件包括套管1和设置在套管1一端且与套管1活动连接的端盖2，本发明中端盖2具体为灯帽，端盖2上设置有与套管1内气流通道相连通的进气通道，进气通道的进气口面积随着端盖2伸出套管1的长度的增加而递增，套管1内部轴向设置有气流传感器3，气流传感器3用于感应气流，并触发电子烟开始工作。值得注意的是，本发明中进气口不是固定的，而是随着端盖2伸出套管1逐渐变化的。

[50] 本发明中进气通道进气口的变化是设置在端盖2与套管1的活动连接部分，进气通道的进气口面积增加的条件仅仅是端盖2伸出套管1，不用增加其他的机构实现进气通量的变化，结构简单，操作方便，且不会在外观上增加其他复杂的机构。

[51] 其中端盖2与套管1的活动连接包括滑动扣合连接、过盈配合、螺纹连接等，优选的螺纹连接，采用螺纹连接旋出端盖，既简单方便，又不易出现类似滑动扣合连接、过盈配合等因频繁操作会出现的松动问题，且采用螺纹连接可以连续控制端盖2伸出套管1的长度，进而连续改变进气口的面积，更加人性化。

[52] 其中，进气通道包括第一进气通道和第二进气通道：

[53] 第一进气通道的一端直接与外界连通，第一进气通道的另一端直接与套管1内气流通道相连通或者通过第二进气通道与套管1内气流通道相连通；

[54] 第二进气通道的一端直接与套管1内气流通道相连通，第二进气通道的另一端通过第一进气通道与外界连通或者在端盖2伸出套管1时直接与外界连通，第二进气通道的进气口面积随着端盖2伸出套管1的长度增加而递增。

- [55] 第一进气通道主要是用于在正常状态下端盖2没有伸出套管1时引导气流进入，因此第一进气通道的进气端口与外界连通，第二进气通道主要是实现在端盖2伸出套管1后，调节进气口的大小，因此第二进气通道的出气端口直接与套管1内气流通道相连通。第一进气通道的出气端口可以直接与套管1内气流通道相连通，此时第二进气通道的进气口必须在端盖2伸出套管1后直接与外界连通；第一进气通道的出气端口还可以直接与第二进气通道的进气端口直接连通。正常状态下端盖2没有伸出套管1时，第二进气通道的进气端口即为进气口，在端盖2伸出套管1后，第二进气通道的进气端口不能参与气流的控制，进气端口不再相当于进气口，第二进气通道的进气口是第二进气通道与套管1共同封闭形成的结构。
- [56] 下面结合图3-5，详细介绍本发明的几种实现方式，端盖2包括盖设在套管1上的盖体21和沿盖体21缩径形成的、并朝向套管1轴向延伸的中空的连接部22，下面三个实施例中，优选的端盖2和套管1之间通过螺纹结构连接，即连接部22外壁设置有外螺纹，套管1内壁设置有与外螺纹相匹配的内螺纹。本实施中考虑到组装的方便，套管1的内部穿设有一中空的连接件4，连接件4与套管1过盈配合，连接件4的内壁设置该外螺纹。
- [57] 实施例一：
- [58] 参考图3是本发明电池组件的端盖的第一实施例的结构示意图；
- [59] 第一实施例中，第二进气通道在连接部22上轴向延伸设置并与套管1内气流通道相连通，具体的，第二进气通道为自连接部22靠近盖体21的一端起开设的沿套管1轴向贯穿连接部22外壁且横截面逐渐增大的梯形通气凹槽102，梯形通气凹槽102的进气口由套管1的端部和梯形通气凹槽102任一截面构成，其在端盖2旋出套管1时逐渐增大。
- [60] 轴向连通可以减小气流流过的阻力，设计为梯形可以在增加进气口面积时递增连续，即可以连续平稳的改变进气口的面积，且为了使得递增变化不至于过大，梯形优选的等腰梯形，且梯形的底角为15-30°，便于控制进气口大小的增加。
- [61] 进气口的面积主要由进气口的平行于梯形的底部方向的宽度和进气口的深度决定，这里进气口的深度为套管1与端盖2螺纹连接后，梯形通气凹槽102的底部到

套管1的深度，由于进气口的宽度的变化受限于梯形的底角，上面已经阐述，进气口的深度是固定不变的，如果深度过大或者过小，会导致进气口面积的递增量过小或者过大，不够人性化，且受限于连接部22的厚度，进气口的深度不可能过大，优选的进气口的深度为2mm。

[62] 第一进气通道为设置在盖体21朝向套管1的侧壁上与梯形通气凹槽102相连通的沿盖体21径向开设至盖体21边缘的第一通气槽101，第一通气槽101和梯形通气凹槽102相互连通的端口在与气流流动方向垂直的方向上的宽度相等，在盖体21朝向套管1的侧壁完全盖设在套管1端部时，位于盖体21边缘的第一通气槽101的进气端口实现与外界连通。

[63] 本实施例中，正常情况下，端盖2没有伸出套管1时，外部气流首先从位于盖体21边缘的第一通气槽101的进气端口进入，经由第一通气槽101后进入梯形通气凹槽102的进气端口，最后进入套管1内部。此时，梯形通气凹槽102的进气端口即为梯形通气凹槽102的进气口，控制进气通量的是第一通气槽101的进气端口和梯形通气凹槽102的进气端口，当将端盖2连续旋出套管1时，进气端口不能作为进气口，因为其不再控制气流，且第一通气槽101也不再参与气流的引导，此时梯形通气凹槽102的进气口为套管1的端部和梯形通气凹槽102封闭形成，进气口与外界连通，且梯形通气凹槽102的进气口随着套管1的端部的移动而逐渐增大，如此实现通过旋出端盖2，进气口面积逐渐增加，连续增加进气通量以满足不同使用者对不同通气效果的要求。

[64] 实施例二：

[65] 图4是本发明电池组件的端盖的第二实施例的结构示意图；

[66] 第二实施例中，第二进气通道在连接部22上径向延伸设置并套管1内气流通道相连通，径向连通与轴向连通类似，可以减小气流的阻力，具体的，第二进气通道为自连接部22靠近盖体21的一端起开设的沿套管1轴向贯穿连接部22外壁的缺口202；缺口202的进气口为缺口202没有被套管1遮挡的部分，随着端盖2逐渐伸出套管1，缺口202从套管1中裸露出来的部分逐渐增大，本实施例中缺口202优选的矩形缺口，矩形缺口可以连续平稳的改变进气口的面积，便于控制进气通量，如此实现通过旋出端盖2，连续增加进气通量以满足不同使用者对不同通

气效果的要求。

- [67] 第一进气通道为设置在盖体21朝向套管1的侧壁上与缺口202相连通的第二通气槽201。第一进气通道也可以不与第二进气通道连通，而是直接与套管1内部直接连通，此时第一进气通道为现有技术中的结构，参考图5，例如第一进气通道自连接部22远离盖体21的一端起沿套管1轴向贯穿连接部22并延伸至盖体21。本实施例中优选的第二通气槽201正对缺口202且与缺口202相连通，第二通气槽201的结构参见实施例一中的第一通气槽101。
- [68] 本实施例中，第一进气通道相当于一个底部开口的箱体，套管1相当于盖在箱体顶部的顶盖，移动套管1将顶盖逐渐打开，进气口相当于顶盖被打开的部分。而第一实施例中，相当于底部和顶部本来就是开口的，由于顶部的开口是由盒体的四个侧壁构成，套管1相当于其中的一个侧壁，所以当套管1移动时，顶部的开口逐渐移动，由于第一实施例中箱体是梯形所以当套管1构成的侧壁逐渐贴近底部时，顶部的开口必然是逐渐增加的，即进气口是逐渐增加的。无论是哪种方式，都能够实现进气口面积的逐渐增加。
- [69] 实施例三：
- [70] 图5是本发明电池组件的端盖的第三实施例的结构示意图。
- [71] 第二进气通道为设置在连接部22上的通孔302，通孔302沿径向贯穿连接部22；通孔302可以为任何形状，本实施例中优选的圆形，选为圆形同样是基于进气口面积变化的连续性，如果选择其他不规格形状的通孔，进气口面积的变化会出现陡增，不够人性化，且对比实施例二，本实施例中的通孔302并没有轴向贯穿整个连接部22，因此在旋转端盖2与套管1时，端盖2与套管1的螺纹连接不容易受到影响。另，设计圆形通孔，对比实施例一和实施例二，进气口面积增加的趋势是由快速增加到慢速增加，因此在进气通量小的时候可以快速增加进气通量，增加到差不多的时候可以慢速增加进气通量，控制更加方便，人性化。
- [72] 第一进气通道为与通孔302连通的第三通气槽301，第三通气槽301自与通孔302连通的一端起沿套管1轴向延伸至盖体21。具体的，第三通气槽301包括两部分，第一部分设置在连接部22上，为与通孔302连通的引导部，其为由通孔302的部分边缘沿套管1轴向开设至连接部22与盖体21邻接处的凹槽，第二部分设置在

盖体21与连接部22邻接的侧壁上的缺口，缺口与引导部连通并开设至盖体21的侧缘，具体参考实施例一中的第一通气槽101。与实施例二中类似，第一进气通道也可以不与第二进气通道连通，而是直接与套管1内部直接连通。本实施例中优选的第三通气槽301正对通孔302且与通孔302相连通。

[73] 本发明还公开了一种电子烟，包括相互电连接的雾化组件和上述电池组件。其中，所述雾化组件和所述电池组件为一体结构或可拆卸连接结构。吸烟时气流从所述进气通道的进气口进入进气通道后流入气流通道，然后再流入所述雾化组件与烟油的烟雾混合最后进入吸烟者口腔。关于电池组件参见上述介绍，所述雾化组件为现有技术，此处不再赘述。

[74] 综上，本发明的电池组件包括套管和设置在套管一端的与套管活动连接的端盖，通过端盖上设置有进气通道,进气通道的进气口面积随着端盖伸出套管逐渐增加，使用者可以按照个人对通气量的需求，控制端盖伸出套管长度，进而控制进气口面积，实现对不同通气效果的要求。

[75] 上面结合附图对本发明的实施例进行了描述，但是本发明并不局限于上述的具体实施方式，上述的具体实施方式仅仅是示意性的，而不是限制性的，本领域的普通技术人员在本发明的启示下，在不脱离本发明宗旨和权利要求所保护的范围情况下，还可做出很多形式，这些均属于本发明的保护之内。

## 权利要求书

- [权利要求 1] 一种电池组件，用于与雾化组件组合形成电子烟，其特征在于，所述电池组件包括套管（1）和设置在所述套管（1）一端且与所述套管（1）活动连接的端盖（2），所述端盖（2）上设置有与所述套管（1）内气流通道相连通的进气通道，所述进气通道的进气口面积随着所述端盖（2）伸出所述套管（1）的长度的增加而递增。
- [权利要求 2] 根据权利要求1所述的电池组件，其特征在于，所述进气通道包括第一进气通道和第二进气通道，所述第一进气通道的一端直接与外界连通，所述第一进气通道的另一端直接与所述套管（1）内气流通道相连通或者通过所述第二进气通道与所述套管（1）内气流通道相连通；所述第二进气通道的一端直接与所述套管（1）内气流通道相连通，所述第二进气通道的另一端通过所述第一进气通道与外界连通或者在所述端盖（2）伸出所述套管（1）时直接与外界连通，所述第二进气通道的进气口面积随着所述端盖（2）伸出所述套管（1）的长度的增加而递增。
- [权利要求 3] 根据权利要求2所述的电池组件，其特征在于，所述端盖（2）包括盖体（21）和沿所述盖体（21）缩径形成的、朝向所述套管（1）轴向延伸的中空的连接部（22），所述套管（1）套设在所述连接部（22）上，所述盖体（21）盖设在所述套管（1）上，所述第二进气通道在所述连接部（22）上轴向或者径向延伸设置并与所述套管（1）内气流通道相连通。
- [权利要求 4] 根据权利要求3所述的电池组件，其特征在于，所述第二进气通道轴向延伸设置并与所述套管（1）内气流通道相连通，所述第二进气通道为自所述连接部（22）靠近所述盖体（21）的一端起开设的沿所述套管（1）轴向贯穿所述连接部（22）外壁且横截面逐渐增大的梯形通气凹槽（102）；

所述第一进气通道为设置在所述盖体（21）朝向所述套管（1）的侧壁上与所述梯形通气凹槽（102）相连通的第一通气槽（101）。

[权利要求 5] 根据权利要求3所述的电池组件，其特征在于，所述第二进气通道径向延伸设置并与所述套管（1）内气流通道相连通，所述第二进气通道为自所述连接部（22）靠近所述盖体（21）的一端起开设的沿所述套管（1）轴向贯穿所述连接部（22）外壁的缺口（202）；

所述第一进气通道为设置在所述盖体（21）朝向所述套管（1）的侧壁上与所述缺口（202）相连通或者直接与所述套管（1）内气流通道相连通的第二通气槽（201）。

[权利要求 6] 根据权利要求5所述的电池组件，其特征在于，所述第二通气槽（201）正对所述缺口（202）且与所述缺口（202）相连通。

[权利要求 7] 根据权利要求3所述的电池组件，其特征在于，所述第二进气通道径向延伸设置并与所述套管（1）内气流通道相连通，所述第二进气通道为设置在所述连接部（22）上的通孔（302）；所述第一进气通道为与所述通孔（302）连通的第三通气槽（301），所述第三通气槽（301）自与所述通孔（302）连通的一端起沿所述套管（1）轴向延伸至所述盖体（21）。

[权利要求 8] 根据权利要求2所述的电池组件，其特征在于，所述连接部（22）外壁设置有外螺纹，所述套管（1）内壁设置有与所述外螺纹相匹配的内螺纹。

[权利要求 9] 一种电子烟，包括雾化组件和电池组件，其特征在于，所述电池组件包括套管（1）和设置在所述套管（1）一端且与所述套管（1）活动连接的端盖（2），所述端盖（2）上设置有与所述套管（1）内气流通道相连通的进气通道，所述进气通道的进气口面积随着所述端盖（2）伸出所述套管（1）的长度的增加而递增。

[权利要求 10] 根据权利要求9所述的电子烟，其特征在于，所述进气通道包括第



一进气通道和第二进气通道，  
所述第一进气通道的一端直接与外界连通，所述第一进气通道的另一端直接与所述套管（1）内气流通道相连通或者通过所述第二进气通道与所述套管（1）内气流通道相连通；  
所述第二进气通道的一端直接与所述套管（1）内气流通道相连通，所述第二进气通道的另一端通过所述第一进气通道与外界连通或者在所述端盖（2）伸出所述套管（1）时直接与外界连通，所述第二进气通道的进气口面积随着所述端盖（2）伸出所述套管（1）的长度的增加而递增。

[权利要求 11] 根据权利要求10所述的电子烟，其特征在于，所述端盖（2）包括盖体（21）和沿所述盖体（21）缩径形成的、朝向所述套管（1）轴向延伸的中空的连接部（22），所述套管（1）套设在所述连接部（22）上，所述盖体（21）盖设在所述套管（1）上，所述第二进气通道在所述连接部（22）上轴向或者径向延伸设置并与所述套管（1）内气流通道相连通。

[权利要求 12] 根据权利要求11所述的电子烟，其特征在于，所述第二进气通道轴向延伸设置并与所述套管（1）内气流通道相连通，  
所述第二进气通道为自所述连接部（22）靠近所述盖体（21）的一端起开设的沿所述套管（1）轴向贯穿所述连接部（22）外壁且横截面逐渐增大的梯形通气凹槽（102）；  
所述第一进气通道为设置在所述盖体（21）朝向所述套管（1）的侧壁上与所述梯形通气凹槽（102）相连通的第一通气槽（101）。

[权利要求 13] 根据权利要求11所述的电子烟，其特征在于，所述第二进气通道径向延伸设置并与所述套管（1）内气流通道相连通，  
所述第二进气通道为自所述连接部（22）靠近所述盖体（21）的一端起开设的沿所述套管（1）轴向贯穿所述连接部（22）外壁的缺口（202）；

所述第一进气通道为设置在所述盖体（21）朝向所述套管（1）的侧壁上与所述缺口（202）相连通或者直接与所述套管（1）内气流通道相连通的第二通气槽（201）。

[权利要求 14] 根据权利要求13所述的电子烟，其特征在于，所述第二通气槽（201）正对所述缺口（202）且与所述缺口（202）相连通。

[权利要求 15] 根据权利要求11所述的电子烟，其特征在于，所述第二进气通道径向延伸设置并与所述套管（1）内气流通道相连通，所述第二进气通道为设置在所述连接部（22）上的通孔（302）；所述第一进气通道为与所述通孔（302）连通的第三通气槽（301），所述第三通气槽（301）自与所述通孔（302）连通的一端起沿所述套管（1）轴向延伸至所述盖体（21）。

[权利要求 16] 根据权利要求10所述的电子烟，其特征在于，所述连接部（22）外壁设置有外螺纹，所述套管（1）内壁设置有与所述外螺纹相匹配的内螺纹。

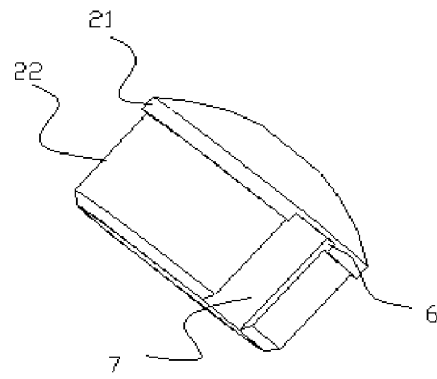


图 1

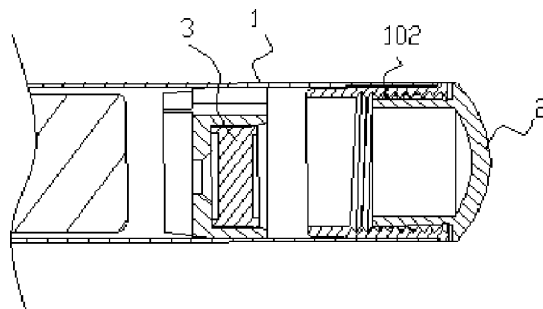


图 2

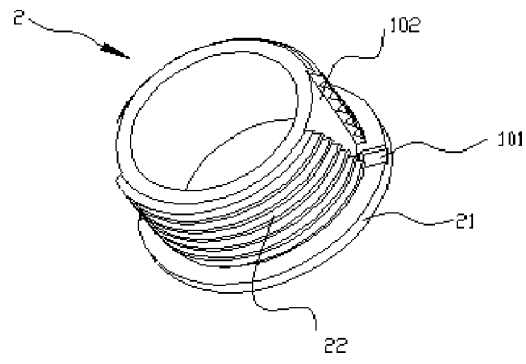


图 3

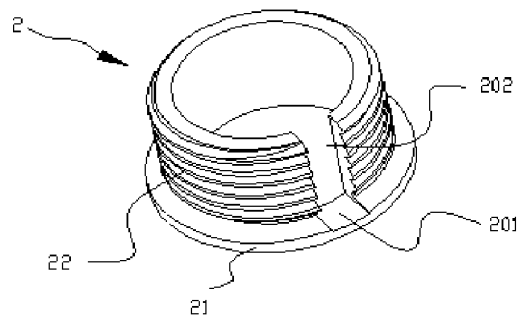


图 4

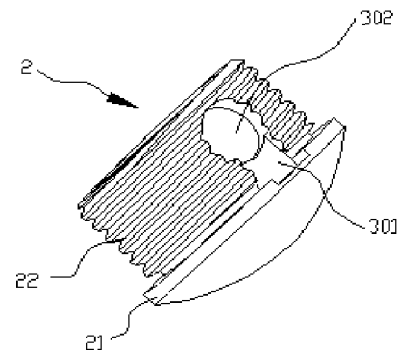


图 5

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CN2013/085882

## A. CLASSIFICATION OF SUBJECT MATTER

A24F 47/00 (2006.01) i, H01M 2/04 (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)

IPC: A24F; H01M

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, CNTXT, CPRSABS, VEN, WPI, EPODOC: battery, electr+, cigarette, sleeve, channel, air, cover, end, area, increase+, end, cap, wind, inlet, intake, notch, slot, hole, opening, length

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                   | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | CN 202873797 U (LIU, Xiang) 17 April 2013 (17.04.2013) description, paragraphs [0001]-[0035], and figures 1-7        | 1-3, 5, 8-11, 13, 16  |
| Y         | CN 202873797 U (LIU, Xiang) 17 April 2013 (17.04.2013) description, paragraphs [0001]-[0035], and figures 1-7        | 2-8, 10-16            |
| Y         | CN 202697716 U (ZHANG, Guangjie) 30 January 2013 (30.01.2013) description, paragraphs [0001]-[0022], and figures 1-4 | 2-8, 10-16            |
| E         | CN 203415639 U (SHENZHEN FIRST UNION TECH CO.) 29 January 2014 (29.01.2014) the whole document                       | 1-6, 9-14             |
| E         | CN 203492795 U (LIU, Qiuming) 26 March 2014 (26.03.2014) the whole document                                          | 1-16                  |

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

☒ 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  
03 July 2014

Date of mailing of the international search report  
30 July 2014

Name and mailing address of the ISA  
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No. 6, Xitucheng Road, Jimenqiao  
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Telephone No. (86-10) 62413266

**INTERNATIONAL SEARCH REPORT**International application No.  
PCT/CN2013/085882

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                     | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------|-----------------------|
| A         | CN 203058299 U (SHENZHEN HANGSEN BIOTECHNOLOGY CO., LTD.) 17 July 2013 (17.07.2013) the whole document | 1-16                  |
| A         | WO 2012142293 A2 (LEVITZ, ROBERT et al.) 18 October 2012 (18.10.2012) the whole document               | 1-16                  |

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

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

International application No.  
PCT/CN2013/085882

| Patent Documents referred<br>in the Report | Publication Date | Patent Family    | Publication Date |
|--------------------------------------------|------------------|------------------|------------------|
| CN 202873797 U                             | 17 April 2013    | None             |                  |
| CN 202697716 U                             | 30 January 2013  | WO 2014023171 A1 | 13 February 2014 |
| CN 203415639 U                             | 29 January 2014  | None             |                  |
| CN 203492795 U                             | 26 March 2014    | None             |                  |
| CN 203058299 U                             | 17 July 2013     | None             |                  |
| WO 2012142293 A2                           | 18 October 2012  | CA 2833132 A1    | 18 October 2012  |
|                                            |                  | WO 2012142293 A3 | 06 December 2012 |
|                                            |                  | CN 103687503 A   | 26 March 2014    |
|                                            |                  | KR 20140047601 A | 22 April 2014    |
|                                            |                  | EP 2696711 A2    | 19 February 2014 |
|                                            |                  | US 2014034071 A1 | 06 February 2014 |



|                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                     |                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------|
| A. 主题的分类<br>A24F 47/00(2006.01)i; H01M 2/04(2006.01)i<br>按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类                                                                                                                                                                                                                                                                                                         |                                                                     |                                    |
| B. 检索领域<br>检索的最低限度文献(标明分类系统和分类号)<br>A24F; H01M<br>包含在检索领域中的除最低限度文献以外的检索文献                                                                                                                                                                                                                                                                                                                        |                                                                     |                                    |
| 在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用))<br>CNABS, CNTXT, CPRSABS, VEN, WPI, EPODOC: 电池, 套管, 盖, 帽, 进气, 孔, 洞, 槽, 通道, 长度, 增加, 面积, 电子 3d 烟, 进风, battery, electr+, cigarette, sleeve, channel, air, cover, end, area, increas+, end, cap, wind, inlet, intake, notch, slot, hole, opening, length                                                                                                        |                                                                     |                                    |
| C. 相关文件                                                                                                                                                                                                                                                                                                                                                                                          |                                                                     |                                    |
| 类 型*                                                                                                                                                                                                                                                                                                                                                                                             | 引用文件, 必要时, 指明相关段落                                                   | 相关的权利要求                            |
| X                                                                                                                                                                                                                                                                                                                                                                                                | CN 202873797U (刘翔) 2013年 4月 17日 (2013 - 04 - 17)<br>说明书第1-35段、图1-7  | 1-3, 5, 8-11, 13, 16               |
| Y                                                                                                                                                                                                                                                                                                                                                                                                | CN 202873797U (刘翔) 2013年 4月 17日 (2013 - 04 - 17)<br>说明书第1-35段、图1-7  | 2-8, 10-16                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                | CN 202697716U (张广杰) 2013年 1月 30日 (2013 - 01 - 30)<br>说明书第1-22段、图1-4 | 2-8, 10-16                         |
| E                                                                                                                                                                                                                                                                                                                                                                                                | CN 203415639U (深圳市合元科技有限公司) 2014年 1月 29日 (2014 - 01 - 29)<br>全文     | 1-6, 9-14                          |
| E                                                                                                                                                                                                                                                                                                                                                                                                | CN 203492795U (刘秋明) 2014年 3月 26日 (2014 - 03 - 26)<br>全文             | 1-16                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                | CN 203058299U (深圳市恒信德馨生物科技有限公司) 2013年 7月 17日 (2013 - 07 - 17)<br>全文 | 1-16                               |
| <input checked="" type="checkbox"/> 其余文件在C栏的续页中列出。 <input checked="" type="checkbox"/> 见同族专利附件。                                                                                                                                                                                                                                                                                                  |                                                                     |                                    |
| * 引用文件的具体类型:<br>“A” 认为不特别相关的表示了现有技术一般状态的文件<br>“E” 在国际申请日的当天或之后公布的在先申请或专利<br>“L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件(如具体说明的)<br>“O” 涉及口头公开、使用、展览或其他方式公开的文件<br>“P” 公布日先于国际申请日但迟于所要求的优先权日的文件<br>“T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件<br>“X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性<br>“Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性<br>“&” 同族专利的文件 |                                                                     |                                    |
| 国际检索实际完成的日期<br>2014年 7月 03日                                                                                                                                                                                                                                                                                                                                                                      |                                                                     | 国际检索报告邮寄日期<br>2014年 7月 30日         |
| ISA/CN的名称和邮寄地址<br>中华人民共和国国家知识产权局(ISA/CN)<br>北京市海淀区蓟门桥西土城路6号<br>100088 中国<br>传真号 (86-10)62019451                                                                                                                                                                                                                                                                                                  |                                                                     | 授权官员<br>宋丽<br>电话号码 (86-10)62413266 |

表 PCT/ISA/210 (第2页) (2009年7月)

| C. 相关文件 |                                                                        |         |
|---------|------------------------------------------------------------------------|---------|
| 类 型*    | 引用文件，必要时，指明相关段落                                                        | 相关的权利要求 |
| A       | WO 2012142293A2 (LEVITZ, ROBERT等) 2012年 10月 18日 (2012 - 10 - 18)<br>全文 | 1-16    |

国际检索报告  
关于同族专利的信息

国际申请号

PCT/CN2013/085882

| 检索报告引用的专利文件 |              | 公布日<br>(年/月/日) | 同族专利 |              | 公布日<br>(年/月/日) |
|-------------|--------------|----------------|------|--------------|----------------|
| CN          | 202873797U   | 2013年 4月 17日   | 无    |              |                |
| CN          | 202697716U   | 2013年 1月 30日   | WO   | 2014023171A1 | 2014年 2月 13日   |
| CN          | 203415639U   | 2014年 1月 29日   | 无    |              |                |
| CN          | 203492795U   | 2014年 3月 26日   | 无    |              |                |
| CN          | 203058299U   | 2013年 7月 17日   | 无    |              |                |
| WO          | 2012142293A2 | 2012年 10月 18日  | CA   | 2833132A1    | 2012年 10月 18日  |
|             |              |                | WO   | 2012142293A3 | 2012年 12月 06日  |
|             |              |                | CN   | 103687503A   | 2014年 3月 26日   |
|             |              |                | KR   | 20140047601A | 2014年 4月 22日   |
|             |              |                | EP   | 2696711A2    | 2014年 2月 19日   |
|             |              |                | US   | 2014034071A1 | 2014年 2月 06日   |

表 PCT/ISA/210 (同族专利附件) (2009年7月)

(51) International Patent Classification:  
A24F 47/00 (2006.01)(21) International Application Number:  
PCT/EP2014/073182(22) International Filing Date:  
29 October 2014 (29.10.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
61/897,149 29 October 2013 (29.10.2013) US

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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, 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, KN, KP, KR, 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))

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

(54) Title: SMOKING CESSATION DEVICE

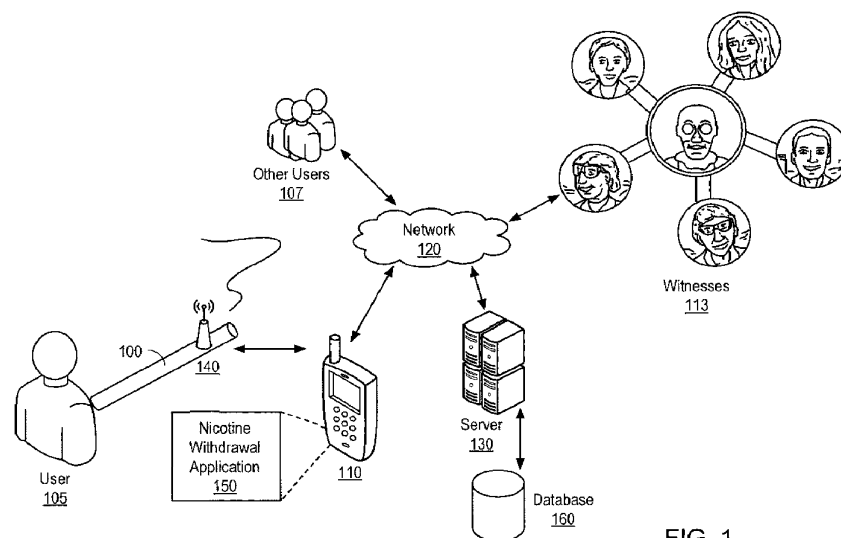


FIG. 1

(57) Abstract: An electronic cigarette with a memory and ability to record the amount and duration of inhalation of nicotine vapor. The electronic cigarette may be integrated with a smart phone application or other software to record usage and provide feedback to the smoker. The application may include an algorithm for the development of a withdrawal schedule for the user to quit smoking or vaping.

**SMOKING CESSATION DEVICE****CROSS REFERENCE TO RELATED APPLICATIONS**

**[0001]** This application claims priority to U.S. Provisional Application No. 61/897,149 filed October 29, 2013, titled SMOKING CESSATION DEVICE the contents of which are incorporated herein by reference.

**Field**

**[0001]** The present disclosure relates to assistants for quitting smoking or vaping, including electronic cigarettes.

**Background**

**[0002]** Cigarette smoke contains over 4,800 chemicals, 69 of which are linked to causing cancer. Smoking cigarettes can lower life expectancy by 13.2 years for men, and 14.5 years for women. In the United States, cigarette smoking causes over 440,000 deaths per year. According to the America Lung Association, smoking is one of the most prevalent sources of preventable death worldwide.

**[0003]** Quitting smoking and vaping is notoriously difficult. It is estimated that 52 percent of smokers try to quit smoking. However, 90 percent of smokers that attempt to quit smoking relapse. Many aids have been developed to quit smoking that are less harmful than cigarettes. For example, nicotine patches and nicotine gum have proven helpful in quitting smoking.

**[0004]** Additionally, electronic cigarettes have been developed as an aid to quit smoking by providing a less harmful source of inhaled nicotine. Instead of burning nicotine and other chemicals like convention cigarettes, electronic cigarettes vaporize a mixture of nicotine and volatile chemicals. This nicotine rich vapor may be inhaled from the cigarette. The vapor does not contain many of the harmful carcinogens that are contained in cigarettes.

**[0005]** However, despite these aids the failure rate of smokers trying to quit smoking is remarkably high, while the death toll is ever increasing. Thus, a profound need exists to implement an improved method to help smokers quit smoking.

### Objects

[0006] It is an object of the disclosure to reduce the relapse rate of smokers attempting to quit smoking or vaping.

5 [0007] It is an object of the present invention to improve the likelihood of quitting smoking or vaping through feedback to a user.

[0008] It is an object of the present invention to increase the support network for smokers to assist them in quitting smoking or vaping.

[0009] It is an object of the present invention to use clinical data to determine optimal weighted nicotine withdrawal schedules.

10 [0010] It is an object of the disclosure to reduce health care spending through reduced healthcare costs.

### Summary

[0011] The likelihood a smoker's attempt to quit smoking will be successful is greatly increased when the psychological aspects of smoking are addressed. Nicotine is a physically  
15 addictive drug and is associated with many social activities, which increase the difficulty of quitting smoking. In fact, studies have shown that while counseling or medication alone increases the chances of quitting smoking, the combination is more effective. For instance, nicotine replacement products can help relieve withdrawal systems when people are quitting smoking. Additionally, individual and group counseling may also increase the likelihood an  
20 attempt to quit smoking will be successful, as it addresses the psychological and behavioral addiction to smoking.

[0012] Unfortunately, the physiological and psychological aids to quit smoking are generally always separate. Therefore, many smokers attempt to quit smoking or vaping using one or the other. Additionally, the lack of integration between the physiological and psychological aids  
25 also reduces the effectiveness of an attempt to quit smoking. This is because, for example, the psychological reinforcement and support is not directly linked to the amount or actual status of the current usage of a smoker. Rather a smoker may discuss his subjective view of his success with the group, leading to dilution of social reinforcement mechanisms. Therefore,

integration of the withdrawal and the group support aspects of quitting smoking would likely increase the success of an attempt to quit smoking.

**[0013]** Furthermore, only some data and studies exist regarding the attributes of people that try to quit smoking and the precise withdrawal schedule that would be successful for each person. Therefore, the ability to record the withdrawal schedule that resulted in successes and failures based on a broad base of data would increase the efficacy the development of a withdrawal schedule that would be effective for a given individual.

**[0014]** To address these difficulties and others, systems and methods have been developed to electronically manage a smoker's attempt to quit smoking. This may include an electronic cigarette with a memory and ability to record the amount and/or duration of inhalation of nicotine vapor. Additionally, the electronic cigarette may be integrated with a smart phone application or other software to record usage and provide feedback to the smoker. The application may include an algorithm for the development of a withdrawal schedule for the user to quit smoking.

**[0015]** In some examples, an electronic cigarette may include a microprocessor, a Bluetooth link, a battery, a vaporization system, an LED, a button, and a memory. The cigarette may include certain software or firmware linked to the microprocessor for executing the logic of the system. The microprocessor may monitor and record the number of puffs of a cigarette, the duration of each puff, the total inhaled time, the amount of nicotine ingested, the flow rate, and other aspects. The microprocessor may store the information locally, and/or send the information over the Bluetooth link to be stored externally.

**[0016]** The process for quitting smoking or vaping may include an application that presents the smoker with a questionnaire relating to the smoker's characteristics including height, weight, age, sex, smoking history, and other characteristics deemed relevant to quitting. The smoker may then select witnesses that provide social support and feedback during the quitting process. The application may then determine an optimal withdrawal schedule based on the smoker's individual characteristics and current usage.

[0017] Additionally, the application may be integrated with a cloud based server that aggregates data using neural networks from many users of the application to determine optimal withdrawal schedules. Furthermore, health care insurance companies may have access or integrate with the application to provide reduction in premiums based on usage or success or determine optimal risk allocation.

#### **Brief Description of the Drawings**

[0018] The accompanying drawings, which are incorporated in and constitute a part of this specification, exemplify the embodiments of the present invention and, together with the description, serve to explain and illustrate principles of the invention. The drawings are intended to illustrate major features of the exemplary embodiments in a diagrammatic manner. The drawings are not intended to depict every feature of actual embodiments nor relative dimensions of the depicted elements, and are not drawn to scale.

[0019] Figure 1 is an overview of a system that implements a nicotine withdrawal program.

[0020] Figure 2 is a diagram of an embodiment of the components of an electronic cigarette according to the present disclosure.

[0021] Figure 3 is a diagram of an embodiment of a system for developing and implementing a nicotine withdrawn program.

[0022] Figure 4 illustrates a step-by-step process for implementing a program to assist a user in a scheduled withdrawal from nicotine according to the present disclosure.

[0023] Figure 5 illustrates an embodiment of a user interface according to the present disclosure.

[0024] Figure 6 illustrates an embodiment of a user interface according to the present disclosure.

[0025] Figure 7 illustrates an embodiment of the electrical components according to the present disclosure.

[0026] Figure 8 illustrates an embodiment of the components of a connected electronic cigarette according to the present disclosure.



[0027] In the drawings, the same reference numbers and any acronyms identify elements or acts with the same or similar structure or functionality for ease of understanding and convenience. To easily identify the discussion of any particular element or act, the most significant digit or digits in a reference number refer to the Figure number in which that element is first introduced.

### Detailed Description

[0028] Various examples of the invention will now be described. The following description provides specific details for a thorough understanding and enabling description of these examples. One skilled in the relevant art will understand, however, that the invention may be practiced without many of these details. Likewise, one skilled in the relevant art will also understand that the invention can include many other obvious features not described in detail herein. Additionally, some well-known structures or functions may not be shown or described in detail below, so as to avoid unnecessarily obscuring the relevant description.

[0029] The terminology used below is to be interpreted in its broadest reasonable manner, even though it is being used in conjunction with a detailed description of certain specific examples of the invention. Indeed, certain terms may even be emphasized below; however, any terminology intended to be interpreted in any restricted manner will be overtly and specifically defined as such in this Detailed Description section.

[0002] In some embodiments, properties such as dimensions, shapes, relative positions, and so forth, used to describe and claim certain embodiments of the invention are to be understood as being modified by the term "about." While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any inventions or of what may be claimed, but rather as descriptions of features specific to particular implementations of particular inventions. Certain features that are described in this specification in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features

may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

5   **[0003]**           Similarly while operations may be depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the  
10   implementations described above should not be understood as requiring such separation in all implementations, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

15   **[0004]**           It should initially be understood that the disclosure herein may be implemented with any type of hardware and/or software, and may be a pre-programmed general purpose computing device. For example, the system may be implemented using a server, a personal computer, a portable computer, a thin client, or any suitable device or devices. The disclosure and/or components thereof may be a single device at a single location, or multiple devices at a single, or multiple, locations that are connected together using any appropriate  
20   communication protocols over any communication medium such as electric cable, fiber optic cable, or in a wireless manner.

25   **[0005]**           It should also be noted that the disclosure is illustrated and discussed herein as having a plurality of modules which perform particular functions. It should be understood that these modules are merely schematically illustrated based on their function for clarity purposes only, and do not necessary represent specific hardware or software. In this regard, these modules may be hardware and/or software implemented to substantially perform the particular functions discussed. Moreover, the modules may be combined together within the disclosure, or divided into additional modules based on the particular function desired. Thus,

the disclosure should not be construed to limit the present invention, but merely be understood to illustrate one example implementation thereof.

**[0006]** The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network.

5 The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. In some implementations, a server transmits data (e.g., an HTML page) to a client device (e.g., for purposes of displaying data to and receiving user input from a user interacting with the client device). Data generated at the client device (e.g., a result of the user interaction) can be  
10 received from the client device at the server.

**[0007]** Implementations of the subject matter described in this specification can be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web  
15 browser through which a user can interact with an implementation of the subject matter described in this specification, or any combination of one or more such back-end, middleware, or front-end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network ("LAN") and a wide area network  
20 ("WAN"), an inter-network (e.g., the Internet), and peer-to-peer networks (e.g., ad hoc peer-to-peer networks).

**[0008]** Implementations of the subject matter and the operations described in this specification can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their  
25 structural equivalents, or in combinations of one or more of them. Implementations of the subject matter described in this specification can be implemented as one or more computer programs, i.e., one or more modules of computer program instructions, encoded on computer storage medium for execution by, or to control the operation of, data processing apparatus.

Alternatively or in addition, the program instructions can be encoded on an artificially-generated propagated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal that is generated to encode information for transmission to suitable receiver apparatus for execution by a data processing apparatus. A computer storage medium  
5 can be, or be included in, a computer-readable storage device, a computer-readable storage substrate, a random or serial access memory array or device, or a combination of one or more of them. Moreover, while a computer storage medium is not a propagated signal, a computer storage medium can be a source or destination of computer program instructions encoded in an artificially-generated propagated signal. The computer storage medium can also be, or be  
10 included in, one or more separate physical components or media (e.g., multiple CDs, disks, or other storage devices).

**[0009]** The operations described in this specification can be implemented as operations performed by a “data processing apparatus” on data stored on one or more computer-readable storage devices or received from other sources.

15 **[0010]** The term “data processing apparatus” encompasses all kinds of apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, a system on a chip, or multiple ones, or combinations, of the foregoing. The apparatus can include special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit). The apparatus can also include,  
20 in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a cross-platform runtime environment, a virtual machine, or a combination of one or more of them. The apparatus and execution environment can realize various different computing model infrastructures, such as web  
25 services, distributed computing and grid computing infrastructures.

**[0011]** A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, declarative or procedural languages, and it can be deployed in any

form, including as a stand-alone program or as a module, component, subroutine, object, or other unit suitable for use in a computing environment. A computer program may, but need not, correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

**[0012]** The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform actions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

**[0013]** Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor for performing actions in accordance with instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. However, a computer need not have such devices. Moreover, a computer can be embedded in another device, e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio or video player, a game console, a Global Positioning System (GPS) receiver, or a portable storage device (e.g., a universal serial bus (USB) flash drive), to name just a few. Devices suitable for storing computer program instructions and data include all forms of

non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

**[0030]** Fig. 1 illustrates the components of an embodiment of a nicotine withdrawal system in accordance with the present disclosure. The system includes an electronic cigarette 100 that may be capable of sensing the number and duration of puffs taken by a user 105. The electronic cigarette 100 may then store this data. The cigarette 100 may also transmit this data through a transceiver 140 or other electronic communication means to a computing device 110 or over a network connection to a computing device 110.

**[0031]** The computing device 110 may include a nicotine withdrawal application 150 that includes program modules for implementing a quit smoking program for a user 105. The nicotine withdrawal application 150 may optimize a nicotine withdrawal schedule based on the user's 105 unique personal attributes and nicotine usage history.

**[0032]** The nicotine withdrawal application 150 may also aggregate input from other users 107 to optimize the nicotine withdrawal programs presented in the nicotine withdrawal application 150. Usage data from other users 107 may be sent over a network 120 to a server 130 and stored in a database 160. The server 130 may then analyze the aggregated usage data and based on medical input and research, determine optimal withdrawal programs based on each user's 105 unique attributes. The withdrawal program may be based on a daily or weekly goal for nicotine consumption that decreases over time. Accordingly, the application 150 will provide feedback to the users on whether their nicotine consumption is under the goal and/or on track to be under the goal. Additionally, FIG.1 illustrates witnesses 113 that may be added to the application 150 to provide social support and feedback to encourage the user 107 to quit smoking or vaping. These witnesses 113 may be added form an application interface as described further herein.

**[0033]** Figure 2 illustrates a connected electronic cigarette 100 according to the present disclosure. The electronic cigarette 100 includes a button or switch 220 for actuating the cigarette 100. The button 220 may be any touch sensitive, or mechanical based button or switch. A user 105 may actuate the button 220 in order to activate the electronic cigarette 100 and inhale the nicotine rich vapor.

**[0034]** Actuation of the button 220 may be sensed by the controller 230 which may then send a signal to energize the heating element 260. The heating element 260 may then begin to vaporize nicotine infused liquid stored in the tank 250 inside of the atomizer 240. Once vaporized, the nicotine rich vapor may then be inhaled by the user 105 through an opening in the end of the cigarette 100. Actuation of the button 220 may also trigger a light 210 to be turned on, mimicking the lighting of a convention cigarette. This represents a single embodiment of a conventional electronic cigarette, but is not intended to be limiting. Accordingly, an electronic cigarette 100 of the present disclosure may function in any other manner using convention electronics as understood by one of skill in the art. For instance, the atomizer 240 may be replaced by other means of vaporizing the nicotine liquid. Additionally, the heating element 260 may be replaced by any other component capable of vaporizing the nicotine liquid for inhalation by a user 105. Additionally a flow sensor may trigger the heating element that indicates a user has begun inhaling in some embodiments.

**[0035]** The cigarette 100 may also record the duration and number of actuations of button 220 in order to determine the amount of nicotine inhaled by a user 105. Specifically, during actuation of the button 220, a controller 230 may record that the button 200 was actuated and may also record the duration of actuation. The actuation data may then be stored in the memory 270 and/or sent over a transceiver 140 to a network, server, smartphone, or other computing device 110. A controller 230 may be any suitable controller, including a microprocessor, microcontroller, a combination of analog processing components, or other computing device(s).

**[0036]** The transceiver 140 may be any device capable of wirelessly transmitting or receiving data over any number of wireless communication modes including Bluetooth, Wi-Fi,

or others. The memory 270 may be any combination of volatile and non-volatile memory including RAM, ROM, cache, hard drive, or other types of memory. The memory 270 may be integrated with the controller 230 and/or a transceiver 140 or may be separate. Additionally, the cigarette may include any suitable battery 200 to power the electronic cigarette, and other appropriate electronics and circuitry. In another embodiment, the cigarette 100 may not include a transceiver 140 and instead may have a data connection. For instance, the cigarette 100 may include a serial or USB connection to allow a computing device 110 to download data from the memory 270.

**[0037]** The electronic cigarette 100 may include instructions or software stored on a computer readable medium that is readable by the controller 230 or other control system. The software may be firmware, software or other types of instructions. The software may be stored on the electronic cigarette, or may run on an applet executing remotely on a server over the network or on a wirelessly linked device, for example a smartphone or computing device 110. The software modules may be stored in the memory 270. The electronic cigarette 100 may include one or more ports for downloading new software or instructions. Additionally, new software may be transferred wirelessly over the transceiver 140.

**[0038]** Figure 3 illustrates a diagram demonstrating an embodiment of the data flow logic of a nicotine withdrawal system in accordance with the present disclosure. A new user 105 seeking to quit smoking may sign up for a nicotine withdrawal application 150. Upon signing up, the user 105 may be prompted to enter their profile 380 in to the nicotine withdrawal application 150. The profile 380 includes characteristics that are relevant to nicotine withdrawal. This may include age, sex, height, weight, smoking history, including the number of cigarettes per day, the time of day of usage, and any other relevant characteristics. For example, the application 150 may request the number of cigarettes smoked per day, the brand of cigarettes, whether the user 105 smokes e-cigarettes. If the user 105 indicates through the interface that they smoke e-cigarettes, the application 150 may additionally request the user provide how long each cartridge is used and the amount of nicotine per cartridge.



**[0039]** Additionally, the user 105 may be prompted by the application 150 to select witnesses 350 that will provide social support through the quitting process. The nicotine withdrawal application 150 may also provide interaction or other means for witnesses to interact and support the user 105. The application 150 may allow the user 105 to post thoughts or feelings on social media sites by direct integration, or within the application 150. For example, the user 105 may be prompted to enter their current feelings, which may include that they are feeling stressed or that they are bored, and they are contemplating smoking a cigarette.

**[0040]** Once the initial data has been entered, the application 150 may determine an optimal nicotine withdrawal schedule 370 based on the user's 105 individual profile 380. That schedule may then be output 360 to the user 105. The output 360 may be in the form of a chart or table or other indication of the amount of cigarettes or puffs recommended for a user 105 for a particular period of time. This may include the number of cigarettes recommended for the day, week, or month, with options to display different time periods. Additionally, the user 105 may be given different options to select the pace of withdrawal from different recommended paces, some being a much faster drop from nicotine use. The output 360 may be displayed on the screen of a computing device 110 or through audio indications from the computing device 110.

**[0041]** In other embodiments, the user may set a daily, weekly, or monthly target nicotine consumption (e.g., in cigarettes, vapes puffs, nicotine, or other amounts) through the application 150. In those embodiments, the user's nicotine use will be compared to the daily target consumption, and provide feedback to encourage the user to smoke less or vape less than the daily target or goal set. In some embodiments, the daily target or goal will be a part of the nicotine withdrawal schedule 370, and a user can set new targets periodically as it becomes easier to hit the target. In some embodiments, the goal or will be not to smoke for a certain number of days, or not to vape for a certain number of days or a month.

**[0042]** In other embodiments, the withdrawal schedule 370 will utilize the same amount of puffs or vapes on an e-cigarette but instead lower the strength of the e-liquid periodically,

so the user effectively consumes less nicotine. In these embodiments, the application 150 may let the user know when they are running low to purchase a lower strength e-liquid.

**[0043]** In some embodiments, the user can choose the type of feedback that they prefer, including harsh, moderate or laid back. For example, an application 150 may ask the user if they want an authoritarian type coach (e.g., drill sergeant) a moderate type coach (e.g., teacher, etc.) or a laid back coach (e.g., hippie). That way, a user may customize the feedback they receive to be optimal for their motivational needs. Accordingly, if a user chooses a more authoritarian type feedback, they may receive harsher messages or more intense audio or visual warnings if they go over their goal amount for the day or are approaching it. Similarly, they may receive greater positive reinforcement for meeting their goal with certain types of feedback settings.

**[0044]** After a user 105 has received the output 360 including a recommended withdrawal schedule 370, the user 105 may then implement the program by taking the appropriate number of puffs from the electronic cigarette 100. The usage 330 will be recorded through actuation of the button 220 as discussed with respect to Figure 2.

**[0045]** Additionally, usage 330 such as puff data 320 may be recorded based on the activation of a flow sensor 340 included in electronic cigarette 100. The controller 230 may determine whether data from the flow sensor 340 indicates a drag has been taken or determine the flow rate. Based on the flow rate and duration of actuation or inhalation, the controller 230 may determine a more accurate estimate of the amount of nicotine inhaled by a user 105. This may be performed through an algorithm including, for example, integration of the flow rate over time for the entire inhalation period. Additionally, in some embodiments, the flow rate may be determined at set time intervals while the flow rate is still above a certain threshold that is indicative of inhalation by a user 105. The flow rate for each time block may then be used to determine an amount of nicotine for each block, and those blocks may be added up over the duration of an inhalation to calculate total nicotine inhaled.

**[0046]** Additionally, the controller 230 may utilize data from a flow sensor 340 to ensure that inadvertent activation of the button 220 is not recorded as puff data 320. This may eliminate

the system from registering false positives. The controller 230 may only record a puff data 320 when activation of the button 220 is accompanied by a sufficient rate and/or duration of airflow recorded by the flow sensor 340.

**[0047]** In other embodiments, actuation of the button 220 for more than a predefined amount of time will indicate usage. This will additionally help eliminate false positives.

**[0048]** Once puff data 320 has been recorded, the controller 230 may route the data to be saved in a memory 270 of the electronic cigarette 100 or be routed to be input 390 to the nicotine withdrawal application 150 or both. The application 150 may then process the puff data 320 to determine progress 375 of the user 105 with respect to the nicotine withdrawal schedule 370 determined by the application 150. In some embodiments, this may be performed on a control system that integrated with the electronic cigarette 100. In other embodiments, this will be performed on a computing device running the application 150. The progress 375 may then be output 360 to the user 105 by an indication on the electronic cigarette 100 or an output to a display on the computing device 110. The output 360 of the progress 375 may include the puff data 320 presented in different forms on a display of a computing device 110, or it may include a comparison of the puff data 320 to the goals encompassed in the withdrawal schedule 370. In some embodiments, this may include a color coded indication of the progress (e.g., red means nicotine use has exceeded that allotted by goal).

**[0049]** Additionally, puff data 320 input 390 into the application 150 may be utilized to modify the nicotine withdrawal schedule 370. The modifications may be based on puff data 230, progress 375, and/or feedback from the user 105 into the application 150. The modified withdrawal schedule 370 may then be output 360 back to the user 105.

**[0050]** Additionally, a purveyor of a nicotine withdrawal application 150 may partner with a liquid nicotine provider. Accordingly, a progress 375 output may be used to determine the price of refills for the tank 250. If the user 105 is making substantially good progress 375, the provider may lower the price of a refill. This will provide an additional economic incentive for the user 105 to quit smoking.

**[0051]** Health insurance providers may also have networks that interface with a nicotine withdrawal application 150. Accordingly, the health care providers may monitor progress 270 data from users 105 and may provide discounts on premiums depending on the success or failure based on the progress 270. Additionally, health insurance providers may be able to calculate risk pools based on puff data 320 and progress 375 data from user 105 and other users 107.

**[0052]** A nicotine withdrawal schedule 370 for a particular user 105 may be optimized through analysis of data from other users 107. The profile 380 data and puff data 320 from other users 107, including their progress 375, may also be input 390 into the application 150. The application 150 may then utilize that data, and compare it to the user's 105 profile 380, puff data 390, and/or progress 375, and determine an optimal nicotine withdrawal schedule 370. For example, users 105 that have similar characteristics may benefit from utilizing a similar withdrawal schedule 370. Additionally, the third party usage progress 375 data will determine the success rate of other users 107 with respect to a particular nicotine withdrawal schedule 370. Accordingly, this can be utilized to predict the success of a particular withdrawal schedule 370 of a unique user 105 based on their profile 380 and/or puff data 320.

**[0053]** For example, a study published in BioMed Central titled Effect of an Electronic Nicotine Delivery Device (e-Cigarette) on smoking reduction and cessation: a prospective 6-month pilot, studied the success rate of e-cigarettes on reducing cigarette smoking. The study grouped participants with similar characteristics including participants smoking at least 15 factory cigarettes per day for at least the past 10 years who did not want to quit smoking. The allowed the participants to smoke up to 4 cartridges of e-cigarettes per day. The study showed a significant decrease in the number of factory cigarettes smoked for each participant from 25 to 5 per day at week 24.

**[0054]** Accordingly, an application 150 in accordance with the present disclosure may group users 105 with profile 380 data similar to the above study and implement a similar reduction program. However, this represents just one mode of reducing smoking. After additional puff

data 320 and progress data 375 is analyzed, more specific grouping and effective smoking cessation programs may be developed.

**[0055]** After analysis of large pools of progress 375 data from other users 107, it might be determined that certain characteristic in a profile 380 would indicate the optimum selection for a particular component of a withdrawal schedule 370. For example, it may be determined that users 105 who are a certain age or weight, may be able to be more successful or achieve better progress 375 from a schedule that has a higher rate of decrease of nicotine usage per week, or month. As another example, specific amounts of prior smoking may require a different rate of withdrawal. Other factors of the withdrawal may be varied in addition to the rate, including potential timing of step downs, the timing of nicotine use throughout the day, and the spacing of nicotine use throughout the day (i.e., many shorter puffs or fewer longer puffs). Additionally, the process of analyzing data from other users 107 may be facilitated through a neural network.

**[0056]** Figure 4 illustrates an embodiment of a process that may be utilized by an application 150 for implementing a withdrawal program 410. First, the application 150 may request a user profile 380. Next, the application may request witnesses 350 to provide social support during the process of quitting smoking. Then the application 150 may determine an optimal nicotine withdrawal schedule 370. Additionally, usage may trigger data input 390 from which the nicotine withdrawal schedule 370 which may be appropriately modified.

**[0057]** In some embodiments, when a user is experiencing a craving, the application 150 may have an interface 510 input that allows to alert witnesses 350 to a craving. This will provide a method of immediate social support to get through a craving. In some embodiments, the coach or motivational person may also provide feedback when a user indicates they are having a craving. This may be in the form of messages from the coach through the application 150 interface 510.

**[0058]** Figures 5 and 6 include example interfaces 510 that the nicotine withdrawal application 150 may present to the user 105 on a mobile device or other computing device 110. One of the major hurdles to quitting smoking is the positive reinforcement experienced

immediately after smoking a cigarette and the delayed negative or uncertain reinforcement as a consequence. Users 105 may not develop lung cancer or other adverse conditions for years after smoking, and the effect or adverse consequences of each individual cigarette are largely uncertain and unknown. Indeed, psychological research has demonstrated that punishment or adverse consequences are more effective motivators when administered immediately after the target behavior than when it is delayed. For example, Alan Kazdin's Behavior Modification in Applied Settings: Seventh Edition, quotes several studies relating to delay of punishment. The studies demonstrate that even brief delays can reduce the effectiveness of punishment. Additionally, adverse feedback or consequences are more effective when the consequences occur every time the behavior occurs.

**[0059]** Accordingly, the present disclosure provides a method of providing near immediate and continual feedback to the user 105 in order to provide further motivation to quit smoking. The feedback is provided through the application 150 by way of the user interface 510. Figures 5 and 6 demonstrate examples of types of feedback that may be provided to a user 105. These include, for example, a usage indicator 520. A usage indicator 520 may display indications of the number of cigarettes smoked, potentially in a red or negative color depending on the progress 375 toward the user's goal or withdrawal schedule 370, the amount of nicotine consumed from the electronic cigarette, for example in mg, or puffs, and a chart showing the nicotine usage statistics selectable for different time periods, including days, weeks, months, and years or other timeframes. The usage indicator may display this information in quantitative or numerical format, or display it in qualitative formats such as bar graphs and color coded usage indicators. In some embodiments, the user may vary the amount of nicotine vaporized by manipulating the voltage control. In some embodiments, the voltage may be increased or decreased by scrolling left or right on the keyboard. This may be implemented by an application interface that allows voltage increase or decrease by a throttle, arrows, joystick, or other representation of a throttle control that will vary the amount of nicotine breathed in for an average puff. In some embodiments, scrolling left less than 1s will increase the voltage 0.1 and scrolling right will decrease the voltage 0.1.

**[0060]** The feedback to user may also include an abstinence timer 530 indicating the amount of time since the last cigarette has smoked, and an option to indicate the user 105 “slipped” and has smoked a cigarette. In some embodiments, and as shown in Figure 6, the feedback through an interface 510 may also include a savings indicator 610 that displays the amount of money saved through abstaining from smoking. This may be calculated and displayed over several different time periods to increase the immediacy and quality of feedback including over the day, week and overall. The application 150 and/or computing device may calculate the amount of money saved by comparing the amount of cigarettes the user was smoking when they started the program with the amount of cigarettes smoked (or effective cigarettes based on nicotine consumption) during the withdrawal schedule 370.

**[0061]** Additionally the application 150 interface 510 may include, based on the nicotine withdrawal schedule 370 and/or the progress 375, a goal progress indicator 540. The progress indicator 540 may include various indications of the user’s 105 progress 375 on meeting the goals of the nicotine withdrawal schedule 370. This may include a bar graph demonstrating the weekly progress, percentage, milligrams, or other indication of how much of the week’s allotted nicotine has been consumed, based on usage of the electronic cigarette 100. In some embodiments, the progress indicator 540 may include color coding indicating, for instance, in red if the user has exceeded their goal or green if they have not. In some embodiments, the progress indicator 540 may be green or yellow if the user has not reached their goal or exceeded their goal number of puffs, mg, cigarettes or other measure of smoking. In some embodiments, it will be blue if a user is on track, or white if there is no goal in process. This goal progress indicator 540 may be provided through the user interface 510, or in some embodiments, may be provided on the light 210 as shown in FIG. 7 as indicating the state of the device. The goal may be a target cigarettes or nicotine per day, week, or month. In some embodiments, the goal will be a weekly or daily consumption amount that will decrease overtime in accordance with a withdrawal schedule 370.

**[0062]** In some embodiments, the application may include “my smokers” that displays their puffs/day or cigs/day. In some embodiments, the interface 510 may include a joystick or other functionality for varying voltage supplied to the

**[0063]** Figure 7 illustrates an example of a circuit diagram of the electronic components of an electronic cigarette 100. The electronic components include a processor or controller 230, a transceiver 140, or a transmitter and a receiver separate from each other, an LED or other light 210, memory 270, battery, 200, charge control, atomizer power supply, voltage control, reference voltage, button, and other components as indicated. Accordingly this only provides an example of the electronic components, and other configurations and components may be implemented in order to provide a connected electronic cigarette 100. The status of the device as indicated by A105, for example may be communicated by the LED light 210 in different colors or flashing patterns that represent for example, charging, vaping, synching, low battery, or other statuses.

**[0064]** Figure 8 illustrates a schematic diagram of an example of the internal components of an electronic cigarette 100 according to the present disclosure. The cigarette 100 includes a battery 200, data interface 820, such as a USB port, and an atomizer connector 830. The connector 830 includes the ability to connect to the refill cartridge containing an atomizer 240 and a tank 250 filled with volatile chemicals and nicotine.

**[0065]** In some embodiments, the device will include a smart buzzer that includes a find me function on the mobile application 150. By pressing find me on the application 150 interface, the buzzer may sound allowing a user to find the e-cigarette.

**[0014]** The various methods and techniques described above provide a number of ways to carry out the invention. Of course, it is to be understood that not necessarily all objectives or advantages described can be achieved in accordance with any particular embodiment described herein. Thus, for example, those skilled in the art will recognize that the methods can be performed in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objectives or advantages as taught or suggested herein. A variety of alternatives are mentioned herein. It is to be



understood that some embodiments specifically include one, another, or several features, while others specifically exclude one, another, or several features, while still others mitigate a particular feature by inclusion of one, another, or several advantageous features.

**[0015]** Furthermore, the skilled artisan will recognize the applicability of various features from different embodiments. Similarly, the various elements, features and steps discussed above, as well as other known equivalents for each such element, feature or step, can be employed in various combinations by one of ordinary skill in this art to perform methods in accordance with the principles described herein. Among the various elements, features, and steps some will be specifically included and others specifically excluded in diverse embodiments.

**[0016]** Although the application has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the embodiments of the application extend beyond the specifically disclosed embodiments to other alternative embodiments and/or uses and modifications and equivalents thereof.

**[0017]** In some embodiments, the terms “a” and “an” and “the” and similar references used in the context of describing a particular embodiment of the application (especially in the context of certain of the following claims) can be construed to cover both the singular and the plural. The recitation of ranges of values herein is merely intended to serve as a shorthand method of referring individually to each separate value falling within the range. Unless otherwise indicated herein, each individual value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (for example, “such as”) provided with respect to certain embodiments herein is intended merely to better illuminate the application and does not pose a limitation on the scope of the application otherwise claimed. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the application.

**[0018]** Certain embodiments of this application are described herein. Variations on those embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. It is contemplated that skilled artisans can employ such variations as appropriate, and the application can be practiced otherwise than specifically described herein.

5 Accordingly, many embodiments of this application include all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the application unless otherwise indicated herein or otherwise clearly contradicted by context.

10 **[0019]** Particular implementations of the subject matter have been described. Other implementations are within the scope of the following claims. In some cases, the actions recited in the claims can be performed in a different order and still achieve desirable results. In addition, the processes depicted in the accompanying figures do not necessarily require the particular order shown, or sequential order, to achieve desirable results.

15 **[0020]** All patents, patent applications, publications of patent applications, and other material, such as articles, books, specifications, publications, documents, things, and/or the like, referenced herein are hereby incorporated herein by this reference in their entirety for all purposes, excepting any prosecution file history associated with same, any of same that is inconsistent with or in conflict with the present document, or any of same that may have a  
20 limiting affect as to the broadest scope of the claims now or later associated with the present document. By way of example, should there be any inconsistency or conflict between the description, definition, and/or the use of a term associated with any of the incorporated material and that associated with the present document, the description, definition, and/or the use of the term in the present document shall prevail.

25 **[0021]** In closing, it is to be understood that the embodiments of the application disclosed herein are illustrative of the principles of the embodiments of the application. Other modifications that can be employed can be within the scope of the application. Thus, by way of example, but not of limitation, alternative configurations of the embodiments of the

application can be utilized in accordance with the teachings herein. Accordingly, embodiments of the present application are not limited to that precisely as shown and described.

**Claims**

1. An electronic cigarette for assisting in a smoking or vaping cessation program comprising:

a controller;

5 a memory in electrical communication with the controller;

a vaporizing chamber;

a heating element integrated with the vaporizing chamber;

a storage tank in fluid communication with the vaporizing chamber;

10 a button in electrical communication with the controller, the button actuating the controller to activate the heating element; and

wherein the controller is configured to record actuation data representing at least one actuation of the button.

15 2. The electronic cigarette of claim 1 wherein the actuation data includes a number and duration of actuations of the button.

3. The electronic cigarette of claim 1 wherein a flow rate sensor is in electrical communication with the controller.

20 4. The electronic cigarette of claim 1 wherein the controller determines if the flow rate detected by the flow sensor reaches a certain threshold.

5. The electronic cigarette of claim 1 wherein the controller continually records the flow rate over during the duration of actuation of the button.

25

6. The electronic cigarette of claim 1 wherein a transceiver is in electrical communication with the controller.

7. The electronic cigarette of claim 6 wherein the transreceiver transmits actuation data.

8. A process for determining a nicotine withdrawal schedule for a user based on a unique user profile to quit smoking or vaping, the process comprising:

5                   inputting profile information from a user relevant to a nicotine withdrawal schedule;

                  comparing the profile information to the progress data from other users;

                  determining a nicotine withdrawal schedule based on the comparison;

                  outputting the nicotine withdrawal schedule to the user;

10               inputting puff data from the user; and

                  outputting a progress of the user based on a comparison of the nicotine withdrawal schedule and the puff data.

9. The process of claim 8 including the step of maintaining a database of progress data  
15               from other users.

10. The process of claim 8 wherein the puff data includes actuation number and duration.

11. The process of claim 8 including the step of modifying the nicotine withdrawal based  
20               on the puff data.

12. A device for providing feedback on nicotine use, the device comprising:

                  a controller system;

                  a memory in electrical communication with the controller control system;

25               a vaporizing chamber;

                  a heating element integrated with the vaporizing chamber;

                  progress indicator that is configured to provide an indication of a user's progress towards a goal;

a storage tank in fluid communication with the vaporizing chamber;

a button in electrical communication with the controller, the button actuating the controller to activate the heating element;

wherein the control system is configured to record actuation data representing

5 at least one actuation of the button; and

wherein the control system is further configured to instruct the progress indicator to display an indication of the user's progress based on at least in part the recorded actuation data.

10 13. The device for providing feedback on nicotine use of claim 12, wherein the progress indicator is a visual indicator.

14. The device for providing feedback on nicotine use of claim 13, wherein the progress indicator is a color coded light source.

15

15. The device for providing feedback on nicotine use of claim 14, wherein the control system is configured to turn the light source colors based on a comparison between the recorded actuation data and a nicotine withdrawal schedule.

20 16. A process for providing a user with an indication of their compliance with a nicotine withdrawal schedule, the process comprising:

recording actuation data based on the time and number of actuations of a vaporizing button on an electronic cigarette;

calculating an amount of nicotine smoked based on the recorded actuation data;

25 comparing the recorded actuation data to a nicotine withdrawal schedule and determining a level of compliance based on the comparison; and

outputting an indication of the determined level of compliance to a user.

17. The process of claim 16, wherein the indication of the determined level of compliance is a color output of a light source.

18. The process of claim 16, wherein the indication of the determined level of compliance  
5 is a textual indication on a display.

19. The process of claim 16, wherein the indication of the determined level of compliance is a color coded symbol on a display.

10 20. The process of claim 16, wherein the indication of the determined level of compliance is a bar graphical representation of the amount smoked in comparison to the withdrawal schedule.

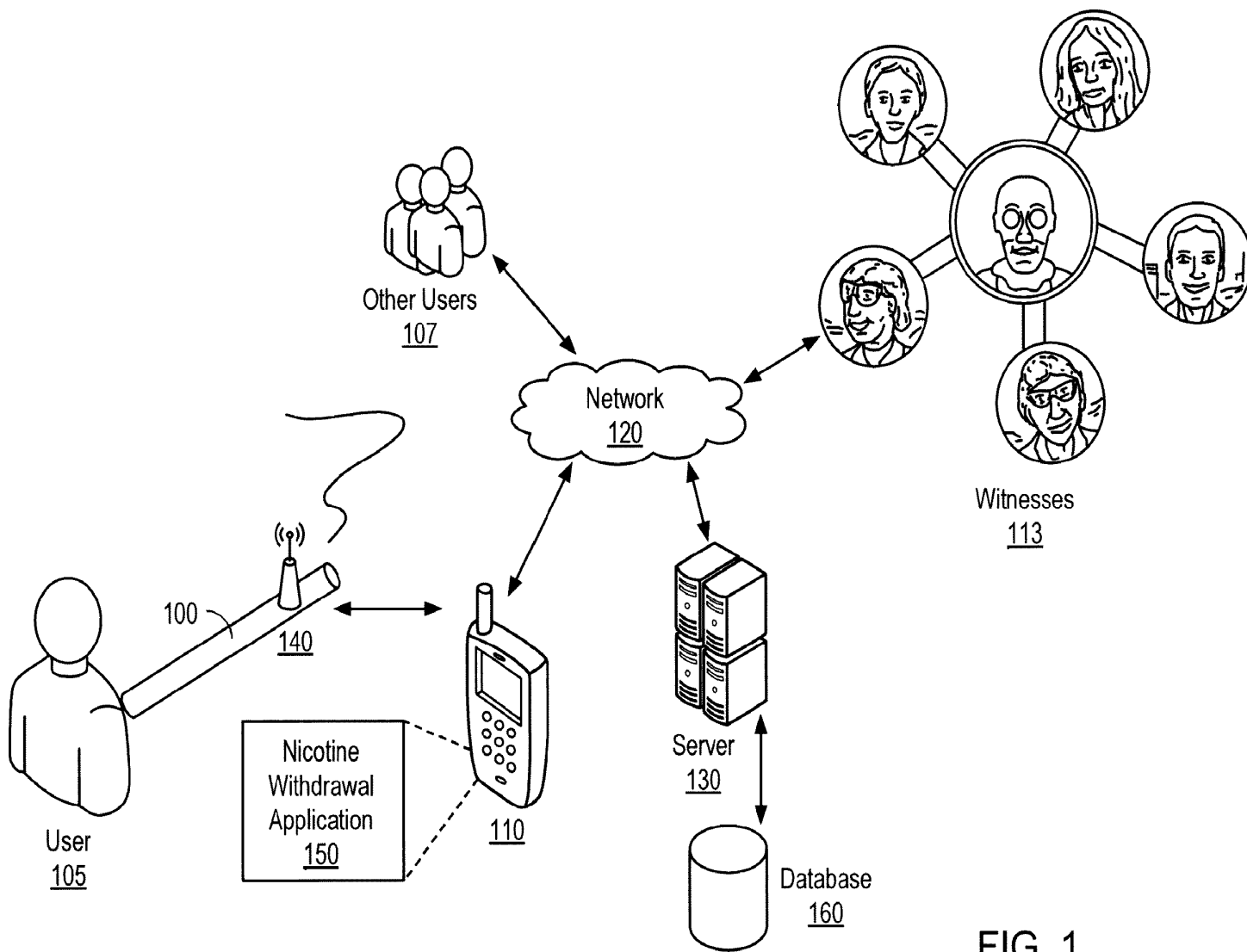


FIG. 1



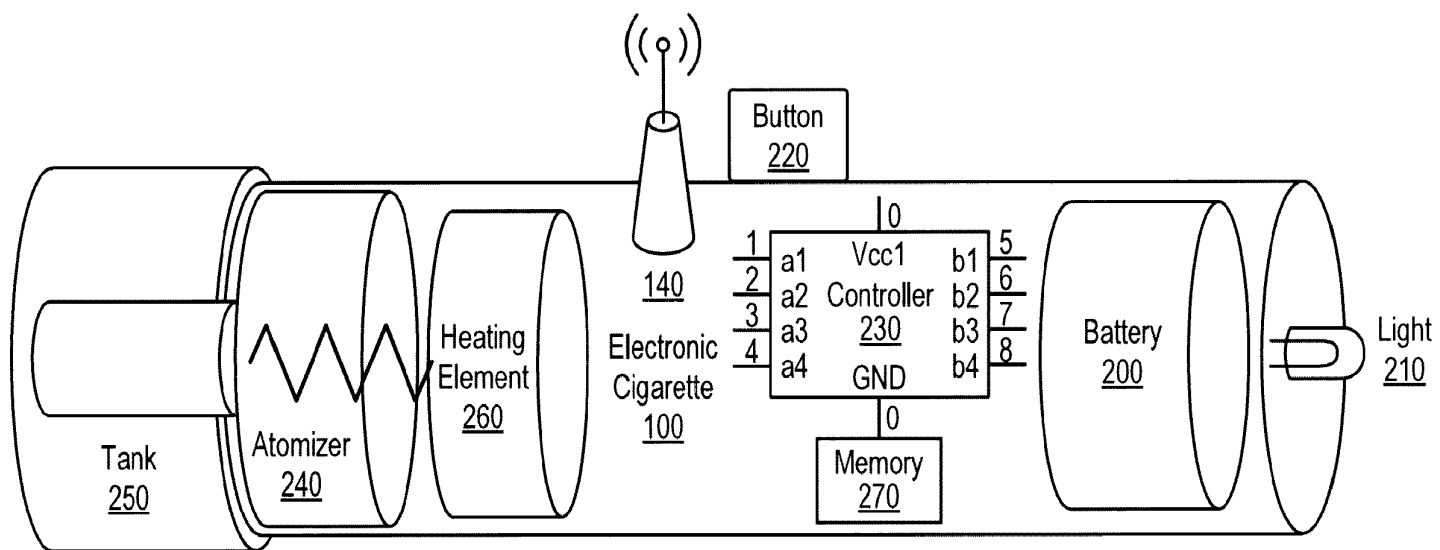


FIG. 2

SUBSTITUTE SHEET (RULE 26)

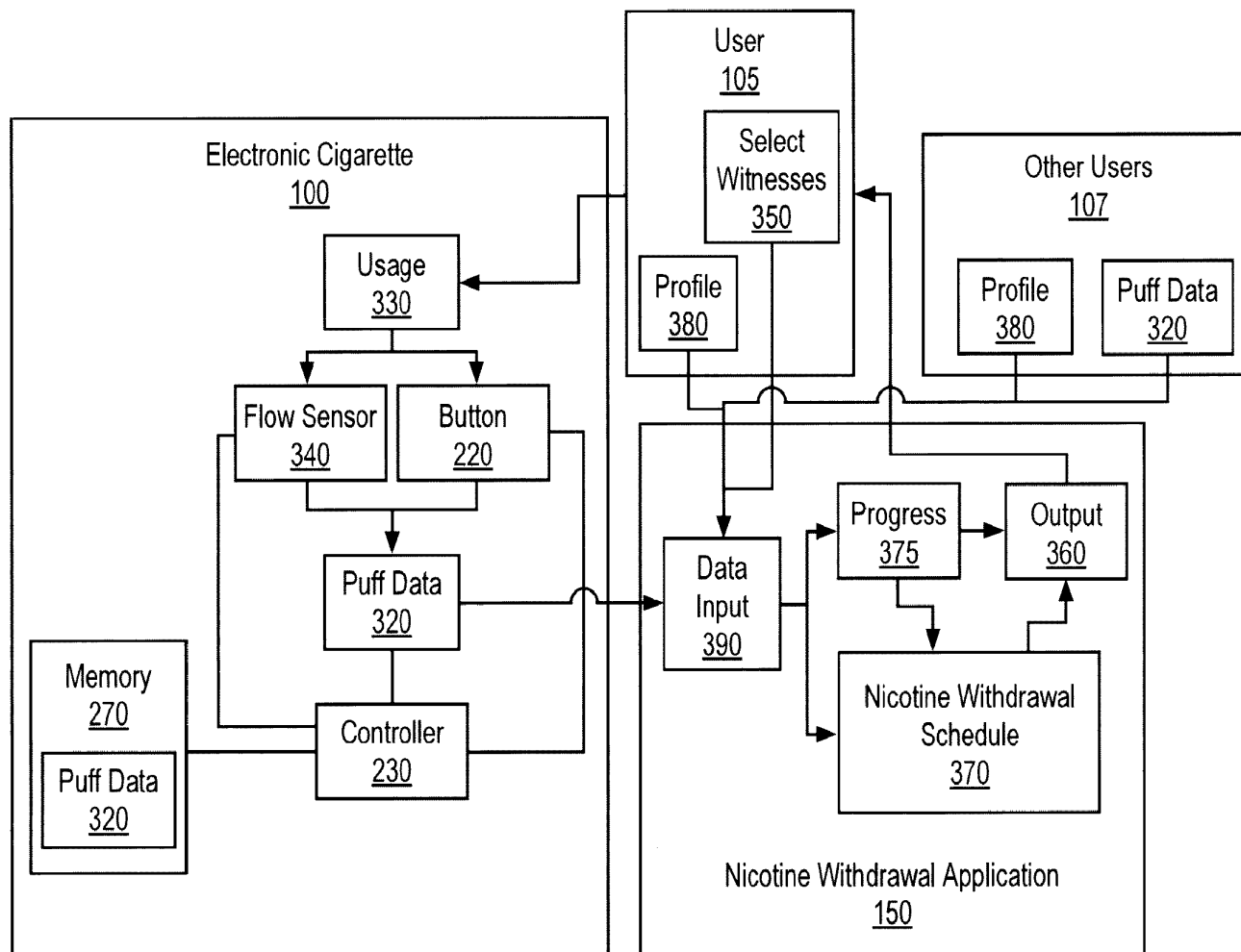


FIG. 3

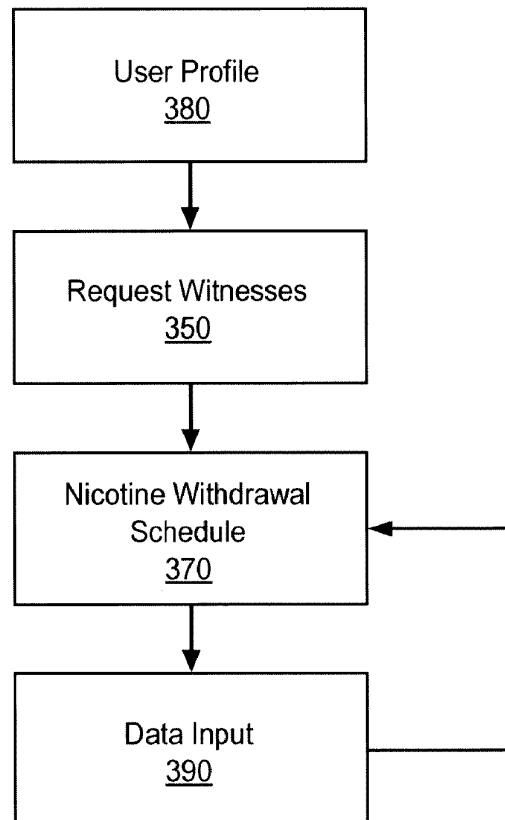


FIG. 4

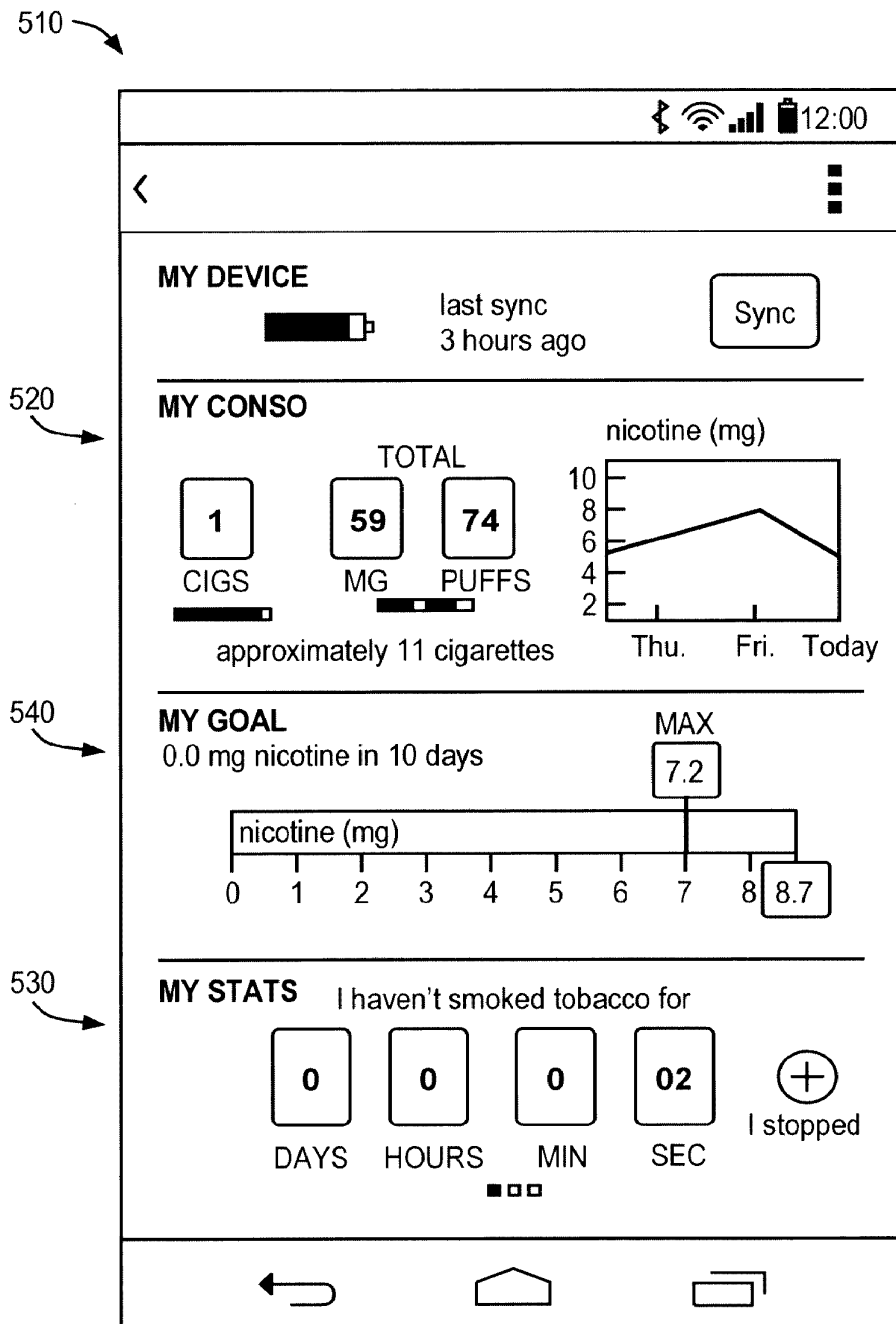
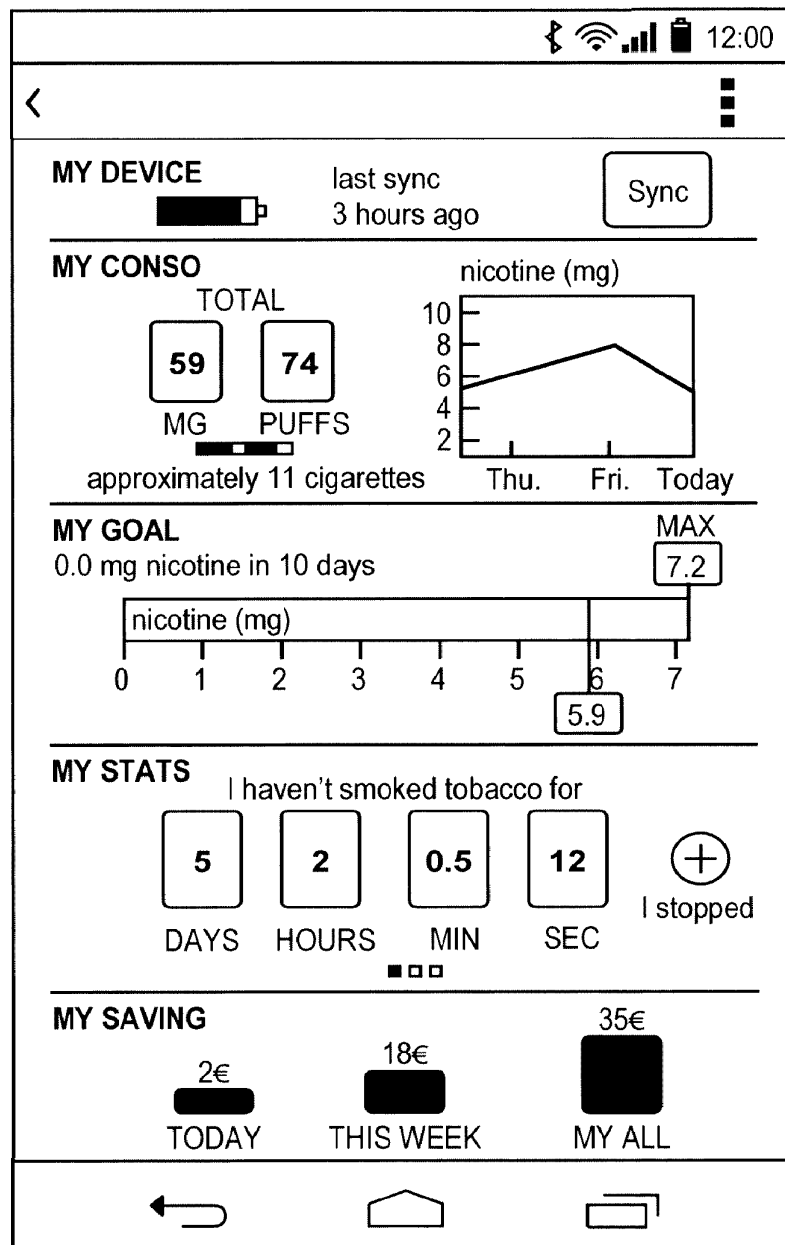


FIG. 5

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510



550

FIG. 6

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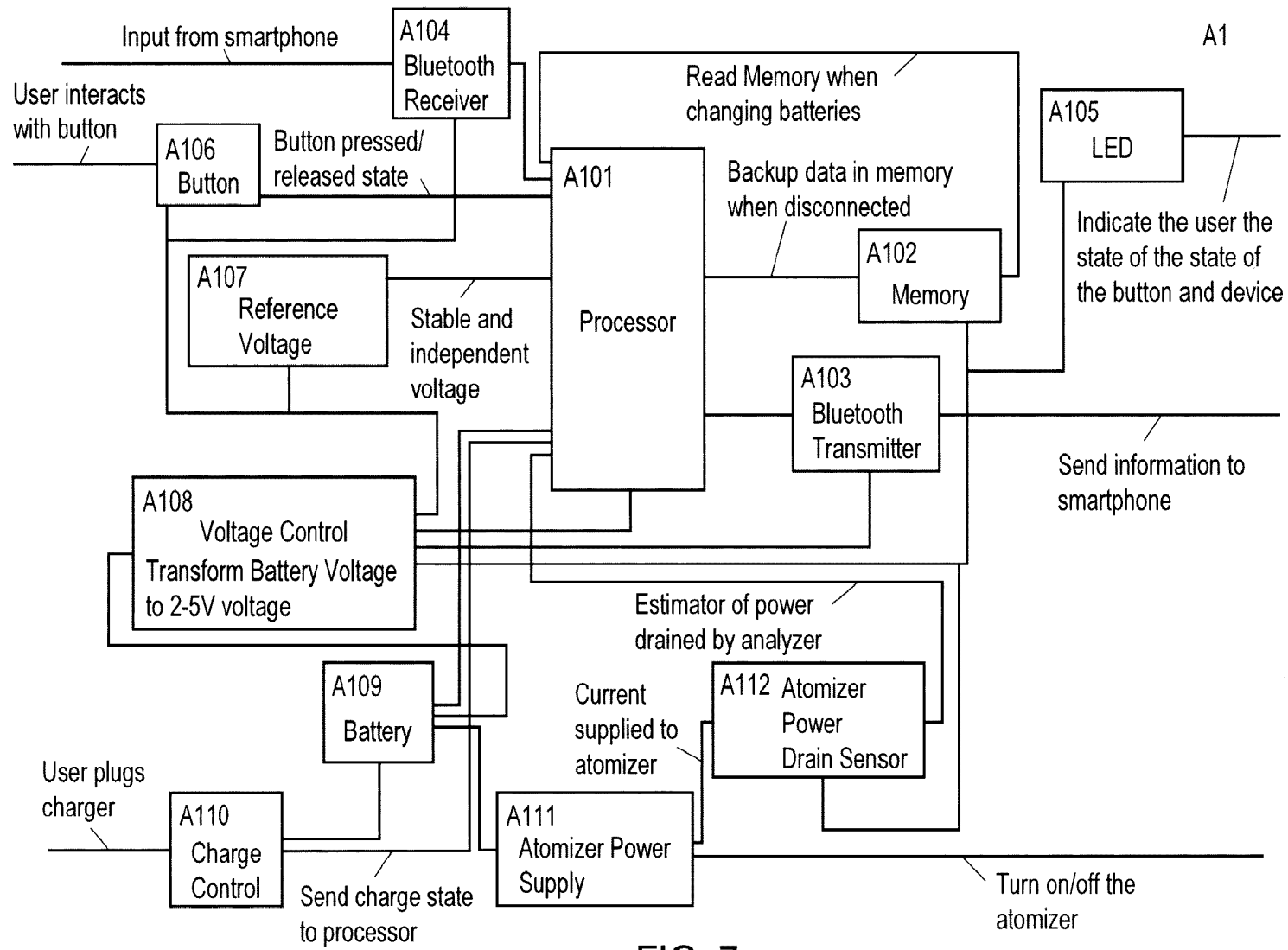


FIG. 7

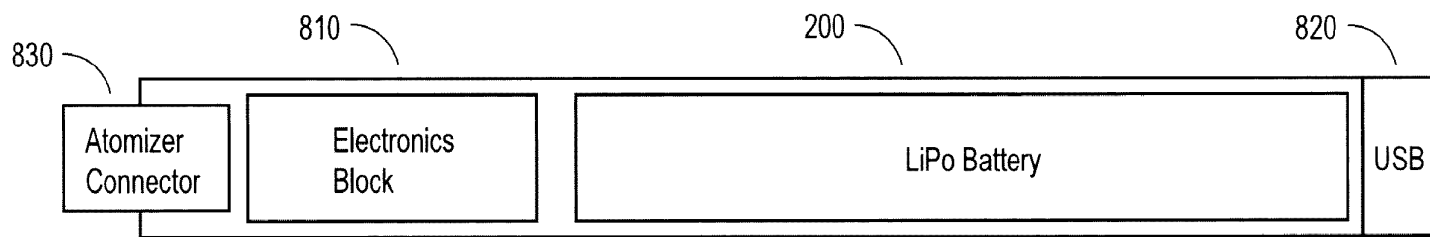


FIG. 8

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/073182

## A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F47/00

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)

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)

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

3 February 2015

Date of mailing of the international search report

11/02/2015

Name and mailing address of the ISA/

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Fax: (+31-70) 340-3016

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## INTERNATIONAL SEARCH REPORT

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## (12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织  
国际局

(43) 国际公布日  
2015 年 6 月 25 日 (25.06.2015)



(10) 国际公布号  
**WO 2015/089711 A1**

(51) 国际专利分类号:  
A24F 47/00 (2006.01)

(21) 国际申请号: PCT/CN2013/089566

(22) 国际申请日: 2013 年 12 月 16 日 (16.12.2013)

(25) 申请语言: 中文

(26) 公布语言: 中文

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(81) 指定国 (除另有指明, 要求每一种可提供的国家保护): 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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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) 指定国 (除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (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)。

本国际公布:

— 包括国际检索报告(条约第 21 条(3))。

(54) Title: ELECTRONIC CIGARETTE CONTROL CIRCUIT, ELECTRONIC CIGARETTE, AND CONTROL METHOD FOR ELECTRONIC CIGARETTE

(54) 发明名称: 电子烟控制电路、电子烟以及电子烟的控制方法

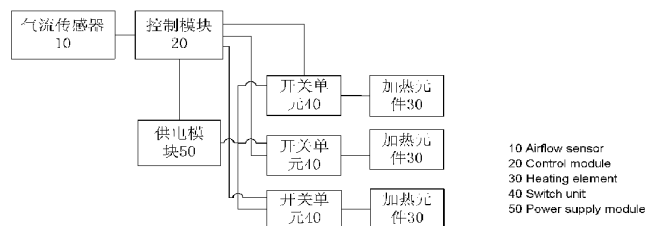


图 1 /Fig. 1

(57) Abstract: An electronic cigarette control circuit, an electronic cigarette, and a control method for the electronic cigarette. The electronic cigarette control circuit is used for controlling the electronic cigarette, comprising at least one airflow sensor (10), a control module (20), at least two switch units (40), and heating elements (30) correspondingly connected to each switch unit (40). The at least two switch units (40) and the at least one airflow sensor (10) respectively are connected to the control module (20). The airflow sensor (10) is used for collecting an airflow signal of each instance of inhalation of the electronic cigarette and for transmitting the airflow signal to the control module (20). The control module (20) is used for comparing the airflow signal of each instance with a predetermined value and for selecting, on the basis of the comparison result, to transmit a conduction signal to at least one switch unit (40) among the at least two switch units (40). The switch units (40) are used for being conducted when the conduction signal is received to allow the corresponding heating elements (30) to heat up. The heating elements (30) are used for heating cigarette oil in corresponding oil-storage elements to atomize the cigarette oil. The present invention provides the beneficial effects of enhanced user experience by allowing changes to smoking taste on the basis of exerted smoking strength.

(57) 摘要:

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WO 2015/089711 A1



一种电子烟控制电路、电子烟以及电子烟的控制方法，电子烟控制电路用于控制电子烟，包括至少一个气流传感器（10）、控制模块（20）、至少两个开关单元（40）以及与每一开关单元（40）对应连接的加热元件（30），至少两个开关单元（40）以及至少一个气流传感器（10）分别与控制模块（20）连接；气流传感器（10）用于采集每次吸入电子烟内的气流信号并将气流信号发送给控制模块（20），控制模块（20）用于将每次的气流信号与预设值进行比较，并根据比较结果选择发送导通信号给至少两个开关单元（40）中的至少一个开关单元（40），开关单元（40）用于在收到导通信号后导通以使得对应的加热元件（30）加热，加热元件（30）用于加热对应储油件中的烟油以使其雾化。本发明具有可以根据吸烟力度改变吸烟口味，提高用户体验的有益效果。

# 说明书

## 电子烟控制电路、电子烟以及电子烟的控制方法

### 技术领域

- [1] 本发明涉及日用电子产品领域，尤其涉及一种控制电路、电子烟以及电子烟的控制方法。

### 背景技术

- [2] 现有技术中，电子烟是由雾化器和电池杆组成。其中雾化器内设置有存储有烟油的储油件以及用于加热烟油的加热元件。当加热元件发热时储油件中的烟油会挥发雾化，变成烟雾从吸嘴处输出，达到抽烟效果。电池杆内有一个空气压力驱动开关和一个供电模块。当抽烟时空气压力驱动开关感应到空气流通形成的压力，触发该供电模块给加热元件供电，该加热元件加热烟油形成烟雾。
- [3] 由于上述技术中，用户在吸烟时无论吸烟力度的大小如何，雾化器烟雾量的多少和口味都一样。因此，用户不能完全体验到抽真烟时轻抽和重抽时的烟雾量的变化，口味单一，不能自动根据吸烟者的抽烟习性进行调味，因而不能满足需要。

### 发明内容

- [4] 本发明要解决的技术问题在于，针对现有技术中用户不能完全体验到抽真烟时烟雾口味随抽烟力度而改变的缺陷，提供一种改进的控制电路、电子烟以及电子烟的控制方法。
- [5] 本发明解决技术问题采用的技术方案是：提供一种控制电路，用于控制电子烟，包括至少一个气流传感器、控制模块、至少两个开关单元以及与每一所述开关单元对应连接的加热元件，所述至少两个开关单元以及所述至少一个气流传感器分别与所述控制模块连接；
- [6] 所述气流传感器用于采集每次吸入所述电子烟内的气流信号并将所述气流信号发送给所述控制模块，所述控制模块用于将每次的所述气流信号与预设值进行比较，并根据比较结果选择发送导通信号给所述至少两个开关单元中的至少一个开关单元，所述开关单元用于在收到所述导通信号后导通以使得对应的加热

元件加热，所述加热元件用于加热对应储油件中的烟油以使其雾化。

- [7] 优选地，所述控制电路还包括供电模块，所述供电模块分别与所述控制模块以及每一所述开关单元连接，所述供电模块用于为所述控制模块、每一所述开关单元以及每一所述加热元件提供供电电源。
- [8] 优选地，所述控制模块为微处理器，所述微处理器包括存储单元、比较单元以及控制单元，所述比较单元分别与所述气流传感器以及所述控制单元连接，所述控制单元分别与所述至少两个开关单元连接，所述存储单元与所述比较单元连接；
- [9] 所述存储单元用于存储所述至少两个预设值，所述比较单元用于将所述气流信号的峰值与每一所述预设值进行比较，选择出所述至少两个预设值中小于所述峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给所述控制单元，所述控制单元根据所述比较结果信号选择发送所述导通信号给所述至少两个开关单元中的一个开关单元。
- [10] 优选地，所述微处理器还包括计时单元，所述计时单元与所述控制单元连接，所述控制单元发送所述导通信号的同时发送一个触发信号给所述计时单元，所述计时单元收到触发信号后开始计时，并在计时预定时间后发送反馈信号给所述控制单元，所述控制单元根据所述反馈信号发送关闭信号给该处于导通状态的开关单元，该处于导通状态的开关单元接收到所述关闭信号后关闭使得对应的加热元件停止加热。
- [11] 优选地，所述控制模块包括至少两路比较控制电路，每一所述比较控制电路的输入端分别与所述气流传感器连接，每一所述比较控制电路的输出端分别对应连接有一所述开关单元，所述至少两路比较控制电路设置依次增加的所述预设值，所述气流信号触发预设值小于所述气流信号的比较控制电路；
- [12] 在一路所述比较控制电路被触发时，该所述比较控制电路的输出端输出所述导通信号；
- [13] 在一路以上的比较控制电路被触发时，所有被触发的比较控制电路按预设值的大小排序，相邻两个比较控制电路中，预设值相对较大的比较控制电路抑制预设值相对较小的比较控制电路使其关闭，预设值最大的所述比较控制电路输出

所述导通信号。

- [14] 优选地，每一所述比较控制电路包括第一比较电路和第二比较电路，所述第一比较电路的比较电压输入端与所述气流传感器连接，所述第一比较电路的基准电压端以所述预设值作为基准电压，相邻两个比较控制电路中的预设值较大的第一比较电路的输出端与预设值较小的第一比较电路对应的第二比较电路的基准电压端连接；所述第二比较电路的比较电压输入端与所述第一比较电路的输出端连接；所述第一比较电路用于将所述气流信号分别与每一所述预设值进行比较，预设值小于该气流信号的所述第一比较电路的输出端输出一个第二电压给所述第二比较电路的比较电压输入端。
- [15] 优选地，所述控制模块还包括至少两个延时单元，所述至少两个延时单元分别一一对应地连接在所述开关单元与所述第二比较电路之间，所述延时单元用于在收到所述第二比较电路输出的导通信号后，在持续地预定时间内向所述开关单元提供导通信号使得所述开关单元在持续的预定时间内导通。
- [16] 优选地，所述控制电路还包括用于将所述气流信号放大的放大单元，所述放大单元连接在所述气流传感器与所述控制模块之间。
- [17] 优选地，所述开关单元为MOS管。
- [18] 本发明还提供了一种电子烟，所述电子烟包括上述所述的控制电路。
- [19] 优选地，所述电子烟包括至少两个用于储存不同烟油的储油件，每一所述加热元件一一对应地设置在所述储油件中。
- [20] 优选地，所述电子烟包括至少两个雾化器，所述至少两个储油件分别设置在所述至少两个雾化器中。
- [21] 优选地，所述电子烟包括一个雾化器，所述至少两个储油件均设置在所述一个雾化器中。
- [22] 优选地，所述电子烟包括至少两个气流传感器，每一所述气流传感器对应设置有不同的工作压力段，并在检测到位于该工作压力段的气流信号时，发送该气流信号给所述控制模块。
- [23] 本发明还提供了一种电子烟的控制方法，包括如下步骤：
- [24] S1：气流传感器采集每次吸入电子烟内的气流信号并将所述气流信号发送给

控制模块；

- [25] S2：所述控制模块将所述气流信号与预设值进行比较，并根据比较结果选择发送导通信号给至少两个开关单元中的至少一个开关单元，该收到所述导通信号的开关单元导通以使得对应的加热元件加热。
- [26] 优选地，所述步骤S2进一步包括如下步骤：
- [27] S2.1：所述控制模块为微处理器，设置至少两个预设值并存储在所述微处理器的存储单元中；
- [28] S2.2：所述微处理器的比较单元将所述气流信号的峰值与分别与每一所述预设值进行比较，选择出所述至少两个预设值中的小于该峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给所述微处理器的控制单元；
- [29] S2.3：所述控制单元根据所述比较结果信号选择发送导通信号给至少两个开关单元中的一个开关单元，该收到所述导通信号的开关单元导通以使得对应的加热元件加热。
- [30] 优选地，在所述步骤S2.3中，所述控制单元根据所述比较结果信号选择发送导通信号给至少两个开关单元中的一个开关单元的同时，发送触发信号给所述微处理器的计时单元，所述计时单元收到所述触发信号时开始计时，并在计时预设时间后发送反馈信号给所述控制单元，所述控制单元根据所述反馈信号发送关闭信号给该处于导通状态的开关单元，该开关单元关闭使得所述加热元件停止加热。
- [31] 优选地，所述步骤S2进一步包括如下步骤：
- [32] 所述控制模块的每一路比较控制电路的分别依次增加地设置所述预设值，所述气流信号触发预设值小于所述气流信号的比较控制电路；
- [33] 在一路所述比较控制电路被触发时，该所述比较控制电路的输出端输出所述导通信号给对应的开关单元；
- [34] 在一路以上的比较控制电路被触发时，所有被触发的比较控制电路按预设值的大小排序，相邻两个比较控制电路中，预设值相对较大的比较控制电路抑制预设值相对较小的比较控制电路使其关闭，预设值最大的所述比较控制电路输出所述导通信号。



- [35] 优选地，在步骤S2中，所述比较控制电路将所述导通信号先发送给延时单元，所述延时单元接收该导通信号后，在预定时间内向对应的开关单元持续提供该导通信号。
- [36] 实施本发明提供的控制电路、电子烟以及电子烟的控制方法具有以下有益效果：本发明提供的控制模块根据气流压强传感器采集的气流信号控制相应的一个或多个开关单元导通，使得该开关单元对应的加热元件加热不同储油件里的烟油，以达到抽烟力度改变烟雾口味以及烟雾量的目的，具有提高用户体验的有益效果；此外，抽烟力度和吸烟口味不同的吸烟者可以实现共用一根电子烟，其在外出旅游等不方便携带较多物品的环境中便利性较为明显，特别给具有多人吸烟的家庭带来较大便利。

#### 附图说明

- [37] 下面将结合附图及实施例对本发明作进一步说明，附图中：
- [38] 图1是本发明一实施例中的控制电路的原理框图；
- [39] 图2是本发明第一实施例中的控制模块的原理框图；
- [40] 图3是本发明第二实施例中的控制电路的原理框图；
- [41] 图4是本发明第二实施例中的控制电路的电路原理图
- [42] 图5是本发明一实施例中的电子烟的控制方法的流程框图；
- [43] 图6是本发明一实施例中的电子烟的控制方法的步骤S2的具体流程框图。

#### 具体实施方式

- [44] 为了解决现有技术中用户不能完全体验到抽真烟时烟雾口味及烟雾量随抽烟力度而改变的缺陷，本发明的创新点在于，可以根据用户实际重抽和轻抽的气流信号与预设值进行比较，对应开启连接在不同加热元件的开关单元，控制该开关单元对应的加热元件加热不同储油件里的烟油，以达到抽烟力度改变烟雾口味及烟雾量的目的。
- [45] 为了对本发明的技术特征、目的和效果有更加清楚的理解，现对照附图详细说明本发明的具体实施方式。
- [46] 如图1所示，一种控制电路，用于控制电子烟，其包括至少一个气流传感器10、控制模块20、至少两个加热元件30、至少两个开关单元40以及供电模块50。

该至少两个开关单元40的控制端、气流传感器10以及供电模块50分别与该控制模块20连接。每一开关单元40分别一一对应地连接在每一加热元件30与供电模块50之间。

[47] 气流传感器10用于采集每次吸入电子烟内的气流信号并将气流信号发送给控制模块20，控制模块20用于将每次的气流信号与预设值进行比较，并根据比较结果选择发送导通信号给至少两个开关单元40中的一个开关单元40，开关单元40用于在收到导通信号后导通以使得对应的加热元件30加热，加热元件30用于加热对应储油件中的烟油以使其雾化。在本实施例中开关单元以及加热元件的个数均为3个。气流传感器的个数为1个。开关单元40可以选用常用开关电路即可。当然，在其它实施例中，所述开关单元40中的多个开关单元40可以同时导通，或者全部开关单元也可以同时导通，以实现自动调出多种味道及改变烟雾量的目的。所述加热元件30中的电阻值可以相同，也可以不同，其根据需要进行设置，在此不作限定。例如，在本实施例中，所述加热元件30之间的电阻值不同，且对应不同的储油件。

[48] 该控制电路控制电子烟使得用户可通过调整每次抽烟的力度来控制对应储油件中的加热元件30发热以达到相应调整吸烟的口味，所述烟雾量也能自动根据吸烟力度进行调整，因而能够提高用户体验，使得该电子烟更加接近真烟；此外，抽烟力度和吸烟口味不同的吸烟者可以实现共用一根电子烟，其在外出旅游等不方便携带较多物品的环境中便利性较为明显，特别给具有多人吸烟的家庭带来较大便利。

[49] 在第一实施例中，该控制模块20采用微处理器。如图2所示，该微处理器包括模数转换单元21、存储单元22、比较单元23以及控制单元24。比较单元23分别与气流传感器10以及控制单元24连接，控制单元24分别与至少两个开关单元40连接，存储单元22与比较单元23连接，模数转换单元21与比较单元23连接。

[50] 模数转换单元21用于将模拟信号转换为数字信号，存储单元22用于存储预先设置的至少两个预设值，比较单元23用于将转换为数字信号后的气流信号的峰值与每一预设值进行比较，选择出至少两个预设值中小于该气流信号的峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给控制单元24，控制单

元24根据比较结果信号选择发送导通信号给至少两个开关单元40中的一个开关单元40。

- [51] 可以理解地，该微处理器还可以包括一个计时单元25，该计时单元25与控制单元24连接，控制单元24在发送导通信号给开关单元40的同时发送一个触发信号给该计时单元25，计时单元25收到触发信号后开始计时，并在计时预定时间后发送反馈信号给控制单元24，控制单元24根据该反馈信号发送关闭信号给该处于导通状态的开关单元40，该处于导通状态的开关单元40接收到关闭信号后关闭使得对应的加热元件30停止加热。
- [52] 该计时单元25通过设定预定时间从而控制每次吸烟时对应开关单元40的导通时间，进而更加精确地控制每次吸烟时的烟雾量。并且，在持续预定时间后自动关闭该开关单元24还可以节约烟油和电能，以免造成不必要的浪费。
- [53] 当该比较单元23在该预定时间以内接收到另一个气流信号，并产生一个比较结果信号传递给控制单元24，也即是两次收到气流信号的间隔小于在计时单元25中设定的预定时间时：
- [54] 如果该后收到比较结果信号与前一次的比较结果信号相同，控制单元24发送一个触发信号给计时单元25，该计时单元25收到该触发信号后清零，并重新开始计时，并在计时预定时间后发送反馈信号给该控制单元24，控制单元24收到反馈信号后再发送关闭信号给处于导通状态的开关单元40使其关闭。
- [55] 如果该后收到的比较结果信号与前一次的比较结果信号不同，控制单元24发送一个关闭信号给处于导通状态的开关单元40使其关闭，同时发送一个导通信号给与该后收到的比较结果信号对应的开关单元40使其导通。并且还发送一个触发信号给计时单元25，该计时单元25清零并重新开始计时，计时预定时间后发送一个反馈信号给控制单元24，控制单元24发送关闭信号给处于导通状态的开关单元40使其关闭。
- [56] 在第二实施例中，如图3所示，控制模块20可以包括至少两路比较控制电路20a，每一比较控制电路20a的输入端分别与气流传感器10连接，每一比较控制电路20a的输出端分别对应与一开关单元40连接。该至少两个预设值分别设置在至少两路比较控制电路20a中，并且该至少两个预设值是依次升高的。该气流信

号触发预设值小于气流信号的比较控制电路20a。在只有一路比较控制电路20a被触发时，该比较控制电路20a的输出端输出导通信号给开关单元40的控制端。当一路以上的比较控制电路20a被触发时，所有被触发的比较控制电路20a按预设值的大小排序，相邻两个比较控制电路20a中，预设值相对较大的比较控制电路20a抑制预设值相对较小的比较控制电路20a使其关闭，预设值最大的比较控制电路20a输出导通信号。

[57] 进一步地，如图4所示，每一比较控制电路20a包括第一比较电路U2和第二比较电路U3。第一比较电路U2以及第二比较电路U3均分别包括比较电压输入端、基准电压端以及输出端。第一比较电路U2以及第二比较电路U3的工作原理为：当比较电压输入端的电压高于基准电压端的电压时，输出端输出一个电压。第一比较电路U2、第二比较电路U3均为运算放大器。并且每一运算放大器的基准电压端和比较电压输入端均连接有一个分压电阻。当然可以理解地，该第一比较电路U2以及第二比较电路U3也可以采用其他方式实现，如芯片或者单片机等。

[58] 第一比较电路U2的比较电压输入端与气流传感器10连接，第一比较电路U2的基准电压端以预设值作为第一比较电路U2的基准电压。相邻两个比较控制电路20a中的预设值较大的第一比较电路U2的输出端与预设值较小的第一比较电路U2对应的第二比较电路U3的基准电压端连接。本文中的'相邻'指的是将该至少两个比较控制电路20a按预设值的大小进行排序时的相邻。第二比较电路U3的比较电压输入端与第一比较电路U2的输出端连接，第二比较电路U3的基准电压端接分压电阻后接地。第一比较电路U2将流信号分别与每一预设值进行比较，预设值小于该气流信号的第一比较电路U2的输出端输出一个第二电压给第二比较电路U3的比较电压输入端。

[59] 当只有一个第一比较电路U2的预设值小于气流信号时，该第二比较电路U3的输出端输出导通信号给对应的开关单元40。当一个以上的第一比较电路U2的预设值小于气流信号时，在所有预设值小于气流信号的第一比较电路U2中，预设值相对最大的第一比较电路U2对应的第二比较电路U3输出导通信号给对应的开关单元40，其余第一比较电路U2对应的第二比较电路U3分别被与该第

二比较电路 U3 的基准电压端连接的第一比较电路 U2 的输出的第二电压抑制从而关闭。

- [60] 作为本实施例的优选方案，控制模块 20 还可以包括至少两个延时单元 200，每一延时单元 200 连接在每一第二比较电路 U3 以及该第二比较电路 U3 对应的开关单元 40 之间。延时单元 200 用于在其收到第二比较电路 U3 的导通信号时，在预定时间内给对应的开关单元 40 持续提高该导通信号，使得开关单元 40 在该持续的预定时间内导通，该预定时间结束后该开关单元 40 自动关闭，对应的加热元件 30 停止加热。
- [61] 优选地，在气流传感器 10 与每一第一比较电路 U2 之间还设置有一个放大单元 U1。该放大单元 U1 用于将气流传感器 10 检测到的气流信号放大，然后将放大后的气流信号分别发送给每一第一比较电路 U2。第一放大单元 U1 可以采用运算放大器，当然也可以采用其他常规放大电路。
- [62] 在本实施中，开关单元 40 可以为 MOS 管或三极管等组成的常见开关电路。
- [63] 本发明还提供了一种电子烟，该电子烟包括上述任一实施例中的控制电路。所述电子烟的雾化器中设置有至少两个用于储存不同烟油的储油件，控制电路的至少两个加热元件 30 分别一一对应地安装在该储油件中，并且该电子烟只有一个气流传感器 10。气流传感器 10 设置在所述电子烟的进气口处。
- [64] 或者，该电子烟还可以包括至少两个雾化器，该控制电路的至少两个加热元件 30 分别一一对应地设置在该至少两个雾化器中。并且，该气流传感器 10 的个数为至少两个，优选为三个。每个气流传感器 10 分别设置有不同的工作压力段。当该气流传感器 10 感应到对应工作压力段的气流信号时，该气流传感器发 10 送该气流信号给控制模块 20。
- [65] 本发明还提供了一种电子烟的控制方法，如图 4 所示，该控制方法的第一实施例中，包括以下步骤：
- [66] S1：气流传感器 10 采集每次吸入电子烟内的气流信号并将气流信号发送给控制模块 20；
- [67] S2：控制模块 20 将气流信号与预设值进行比较，并根据比较结果选择发送导通信号给至少两个开关单元 40 中的至少一个开关单元 40，该收到导通信号的开

关单元40导通以使得对应的加热元件30加热。

[68] 在本发明的所述实施例中，所述气流信号为气流传感器10根据气流变化产生的电压信号，所述预设值为根据气流信号对应设置的电压值。

[69] 进一步地，如图4所示，步骤S2包括如下步骤：

[70] S2.1：控制模块20为微处理器，微处理器的模数转换单元21将模拟信号形式的气流信号转化为数字信号形式的气流信号，预设至少两个不同的预设值，并将该至少两个预设值存储在微处理器的存储单元22中；

[71] S2.2：微处理器的比较单元23将转为数字信号后的气流信号的峰值分别与每一预设值进行比较，选择出至少两个预设值中的小于该峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给微处理器的控制单元24；

[72] S2.3：控制单元24根据比较结果信号选择发送导通信号给至少两个开关单元40中的一个开关单元40，该收到导通信号的开关单元40导通以使得对应的加热元件30加热。

[73] 并且在步骤S2.3中，控制单元24根据比较结果信号选择发送导通信号给至少两个开关单元40中的一个开关单元40的同时，发送触发信号给微处理器的计时单元25。计时单元25收到触发信号时开始计时，并在计时预设时间后发送反馈信号给控制单元24，控制单元24根据反馈信号发送关闭信号给该处于导通状态的开关单元40，该开关单元40关闭使得加热元件30停止加热。

[74] 或者，采用第二实施例中的控制模块20时，该步骤S2可以进一步包括以下步骤：

[75] 控制模块20的每一路比较控制电路20a的预设值分别依次升高，气流信号触发预设值小于气流信号的比较控制电路20a；

[76] 在一路比较控制电路20a被触发时，该比较控制电路20a的输出端输出导通信号给对应的开关单元40，使得对应储油件中的加热元件30发热；

[77] 在一路以上的比较控制电路20a被触发时，所有被触发的比较控制电路20a按预设值的大小排序，相邻两个比较控制电路20a中，预设值相对较大的比较控制电路20a抑制预设值相对较小的比较控制电路20a使其关闭，预设值最大的比较控制电路20a输出所述导通信号。预设值最大的比较控制电路20a输出导通信号给开关

单元40的控制端，其余比较控制电路20a分别被该预设值高于且相近本身的比较控制电路20a关闭。

- [78] 进一步地，当只有一个比较控制电路20a的第一比较电路U2的预设值小于气流信号时，该比较控制电路20a的第二比较电路U3的输出端输出导通信号。当一个以上的所述第一比较电路U2的预设值小于气流信号时，在所有预设值小于气流信号的第一比较电路U2中，预设值相对最大的第一比较电路U2对应的第二比较电路U3输出导通信号给开关单元40的控制端，其余第一比较电路U2对应的第二比较电路U3分别被与该第二比较电路U3的基准电压端连接的第一比较电路U2的输出的第二电压抑制从而关闭。
- [79] 在步骤 S23 中，第二比较电路 U3 先将导通信号先发送给延时单元 200，延时单元 200 接收该导通信号后，在预定时间内向对应的开关单元 40 持续提供该导通信号。开关单元 40 在接收到导通信号的时间段里导通，当没有接收到导通信号时，该开关单元 40 自动关闭。
- [80] 综上所述，本发明的控制模块 20 根据气流传感器 10 采集的气流信号控制对应的发热元件 30 发热，以使得对应 储油件里的烟油雾化，以达到抽烟力度改变烟雾口味的目的。进一步地，该控制模块 20 还可以进一步控制加热元件 30 加热的持续时间，更精确地控制每次吸烟的烟雾产生量，根据各种吸烟人群的吸烟习惯以及喜好，更加合理配置每次吸烟的烟雾量可以使得吸烟效果达到最佳，其还可以节约烟油和电能，防止用户忘记关闭电子烟使得电子烟一直处于工作状态。
- [81] 应当理解的是，对本领域普通技术人员来说，可以根据上述说明加以改进或变换，而所有这些改进和变换都应属于本发明所附权利要求的保护范围。

## 权利要求书

- [权利要求 1] 一种控制电路，用于控制电子烟，其特征在于，包括至少一个气流传感器（10）、控制模块（20）、至少两个开关单元（40）以及与所述每一所述开关单元（40）对应连接的加热元件（30），所述至少两个开关单元（40）以及所述至少一个气流传感器（10）分别与所述控制模块（20）连接；所述气流传感器（10）用于采集每次吸入所述电子烟内的气流信号并将所述气流信号发送给所述控制模块（20），所述控制模块（20）用于将每次的所述气流信号与预设值进行比较，并根据比较结果选择发送导通信号给所述至少两个开关单元（40）中的至少一个开关单元（40），所述开关单元（40）用于在收到所述导通信号后导通以使得对应的加热元件（30）加热，所述加热元件（30）用于加热对应储油件中的烟油以使其雾化。
- [权利要求 2] 根据权利要求1所述的控制电路，其特征在于，所述控制电路还包括供电模块（50），所述供电模块（50）分别与所述控制模块（20）以及每一所述开关单元（40）连接，所述供电模块（50）用于为所述控制模块（20）、每一所述开关单元（40）以及每一所述加热元件（30）提供供电电源。
- [权利要求 3] 根据权利要求2所述的控制电路，其特征在于，所述控制模块（20）为微处理器，所述微处理器包括存储单元（22）、比较单元（23）以及控制单元（24），所述比较单元（23）分别与所述气流传感器（10）以及所述控制单元（24）连接，所述控制单元（24）分别与所述至少两个开关单元（40）连接，所述存储单元（22）与所述比较单元（23）连接；所述存储单元（22）用于存储至少两个预设值，所述比较单元（23）用于将所述气流信号的峰值与每一所述预设值进行比较，选择出所述至少两个预设值中小于所述峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给所述控制单元（24），所述控制单元（24）根据所述比较结



果信号选择发送所述导通信号给所述至少两个开关单元（40）中的一个开关单元（40）。

[权利要求 4]

根据权利要求3所述的控制电路，其特征在于，所述微处理器还包括计时单元（25），所述计时单元（25）与所述控制单元（24）连接，所述控制单元（24）发送所述导通信号的同时发送一个触发信号给所述计时单元（25），所述计时单元（25）收到触发信号后开始计时，并在计时预定时间后发送反馈信号给所述控制单元（24），所述控制单元（24）根据所述反馈信号发送关闭信号给该处于导通状态的开关单元（40），该处于导通状态的开关单元（40）接收到所述关闭信号后关闭使得对应的加热元件（30）停止加热。

[权利要求 5]

根据权利要求1所述的控制电路，其特征在于，所述控制模块（20）包括至少两路比较控制电路（20a），每一所述比较控制电路（20a）的输入端分别与所述气流传感器（10）连接，每一所述比较控制电路（20a）的输出端分别对应连接有一所述开关单元（40），所述至少两路比较控制电路（20a）设置依次增加的所述预设值，所述气流信号触发预设值小于所述气流信号的比较控制电路（20a）；

在一路所述比较控制电路（20a）被触发时，该所述比较控制电路（20a）的输出端输出所述导通信号；

在一路以上的比较控制电路（20a）被触发时，所有被触发的比较控制电路（20a）按预设值的大小排序，相邻两个比较控制电路（20a）中，预设值相对较大的比较控制电路（20a）抑制预设值相对较小的比较控制电路（20a）使其关闭，预设值最大的所述比较控制电路（20a）输出所述导通信号。

[权利要求 6]

根据权利要求5所述的控制电路，其特征在于，每一所述比较控制电路（20a）包括第一比较电路（U2）和第二比较电路（U3），所述第一比较电路（U2）的比较电压输入端与所述气流传感器（1

0) 连接, 所述第一比较电路 (U2) 的基准电压端以所述预设值作为基准电压, 相邻两个比较控制电路 (20a) 中的预设值较大的第一比较电路 (U2) 的输出端与预设值较小的第一比较电路 (U2) 对应的第二比较电路 (U3) 的基准电压端连接; 所述第二比较电路 (U3) 的比较电压输入端与所述第一比较电路 (U2) 的输出端连接; 所述第一比较电路 (U2) 用于将所述气流信号分别与每一所述预设值进行比较, 预设值小于该气流信号的所述第一比较电路 (U2) 的输出端输出一个第二电压给所述第二比较电路 (U3) 的比较电压输入端。

[权利要求 7] 根据权利要求6所述的控制电路, 其特征在于, 所述控制模块 (20) 还包括至少两个延时单元 (200), 所述至少两个延时单元 (200) 分别一一对应地连接在所述开关单元 (40) 与所述第二比较电路 (U3) 之间, 所述延时单元 (200) 用于在收到所述第二比较电路 (U3) 输出的导通信号后, 在持续地预定时间内向所述开关单元 (40) 提供导通信号使得所述开关单元 (40) 在持续的预定时间内导通。

[权利要求 8] 根据权利要求7所述的控制电路, 其特征在于, 所述控制电路还包括用于将所述气流信号放大的放大单元 (U1), 所述放大单元 (U1) 连接在所述气流传感器 (10) 与所述控制模块 (20) 之间。

[权利要求 9] 根据权利要求8所述的控制电路, 其特征在于, 所述开关单元 (40) 为 MOS 管 (Q1)。

[权利要求 10] 一种电子烟, 其特征在于, 所述电子烟包括如权利要求1所述的控制电路。

[权利要求 11] 根据权利要求10所述的电子烟, 其特征在于, 所述电子烟包括至少两个用于储存不同烟油的储油件, 每一所述加热元件 (30) 一一对应地设置在所述储油件中。

[权利要求 12] 根据权利要求 11所述的电子烟, 其特征在于, 所述电子烟包括至少两个雾化器, 所述至少两个储油件分别设置在所述至少两个雾

化器中。

[权利要求 13] 根据权利要求11所述的电子烟，其特征在于，所述电子烟包括一个雾化器，所述至少两个储油件均设置在所述一个雾化器中。

[权利要求 14] 根据权利要求12所述的电子烟，其特征在于，所述电子烟包括至少两个气流传感器（10），每一所述气流传感器（10）对应设置有不同的工作压力段，并在检测到位于该工作压力段的气流信号时，发送该气流信号给所述控制模块（20）。

[权利要求 15] 一种电子烟的控制方法，其特征在于，包括如下步骤：  
S1：气流传感器（10）采集每次吸入电子烟内的气流信号并将所述气流信号发送给控制模块（20）；  
S2：所述控制模块（20）将所述气流信号与预设值进行比较，并根据比较结果选择发送导通信号给至少两个开关单元（40）中的至少一个开关单元（40），收到所述导通信号的开关单元（40）导通以使得对应的加热元件（30）加热。

[权利要求 16] 根据权利要求15所述的电子烟的控制方法，其特征在于，所述步骤S2进一步包括如下步骤：  
S2.1：所述控制模块（20）为微处理器，设置至少两个预设值并存储在所述微处理器的存储单元（22）中；  
S2.2：所述微处理器的比较单元（23）将所述气流信号的峰值与分别与每一所述预设值进行比较，选择出所述至少两个预设值中的小于该峰值的最大预设值，并根据该最大预设值发送一个比较结果信号给所述微处理器的控制单元（24）；  
S2.3：所述控制单元（24）根据所述比较结果信号选择发送导通信号给至少两个开关单元（40）中的一个开关单元（40），该收到所述导通信号的开关单元（40）导通以使得对应的加热元件（30）加热。

[权利要求 17] 根据权利要求16所述的电子烟的控制方法，其特征在于，在所述步骤S2.3中，所述控制单元（24）根据所述比较结果信号选择发

送导通信号给至少两个开关单元（40）中的一个开关单元（40）的同时，发送触发信号给所述微处理器的计时单元（25），所述计时单元（25）收到所述触发信号时开始计时，并在计时预设时间后发送反馈信号给所述控制单元（24），所述控制单元（24）根据所述反馈信号发送关闭信号给该处于导通状态的开关单元（40），该开关单元（40）关闭使得所述加热元件（30）停止加热。

[权利要求 18]

根据权利要求15所述的电子烟的控制方法，其特征在于，所述步骤S2进一步包括如下步骤：

所述控制模块（20）的每一路比较控制电路（20a）分别依次增加地设置所述预设值，所述气流信号触发预设值小于所述气流信号的比较控制电路（20a）；

在一路所述比较控制电路被触发（20a）时，该所述比较控制电路（20a）的输出端输出所述导通信号给对应的开关单元（40）；

在一路以上的比较控制电路（20a）被触发时，所有被触发的比较控制电路（20a）按预设值的大小排序，相邻两个比较控制电路（20a）中，预设值相对较大的比较控制电路（20a）抑制预设值相对较小的比较控制电路（20a）使其关闭，预设值最大的所述比较控制电路（20a）输出所述导通信号。

[权利要求 19]

根据权利18所述的电子烟的控制方法，其特征在于，在步骤S2中，所述比较控制电路（20a）将所述导通信号先发送给延时单元（200），所述延时单元（200）接收该导通信号后，在预定时间内向对应的开关单元（40）持续提供该导通信号。

说明书附图

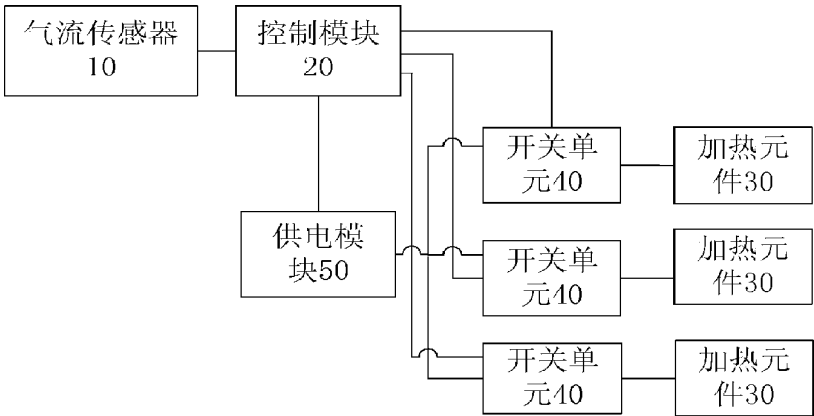


图 1

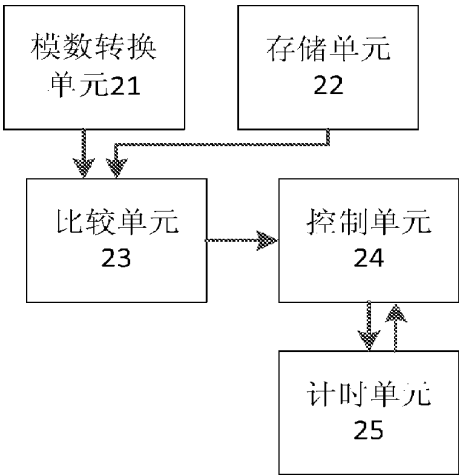


图 2

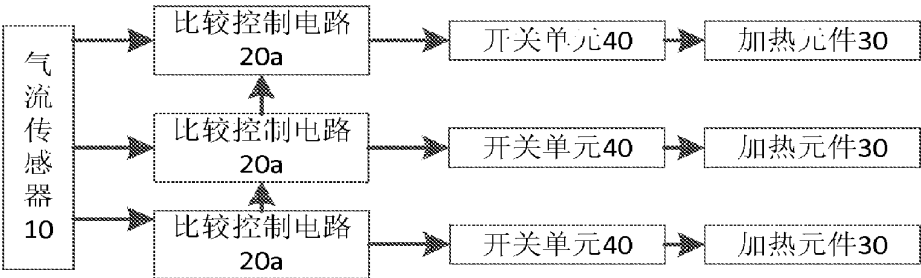


图 3

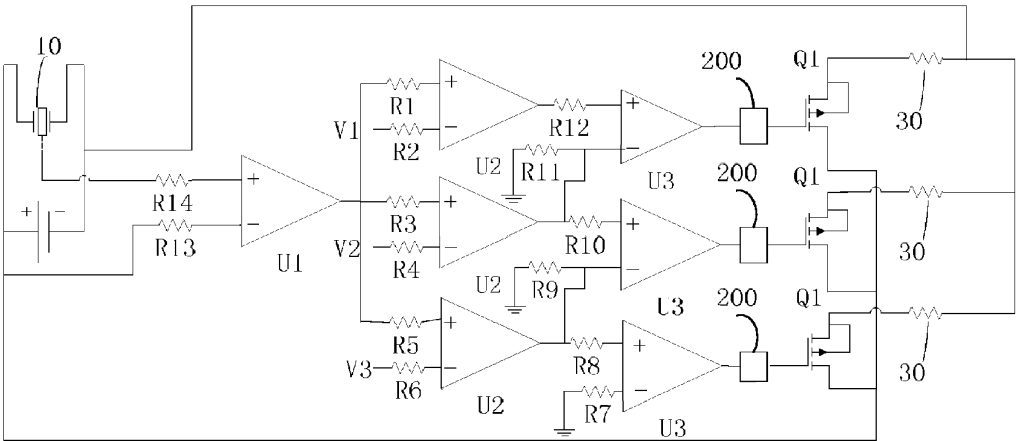


图 4

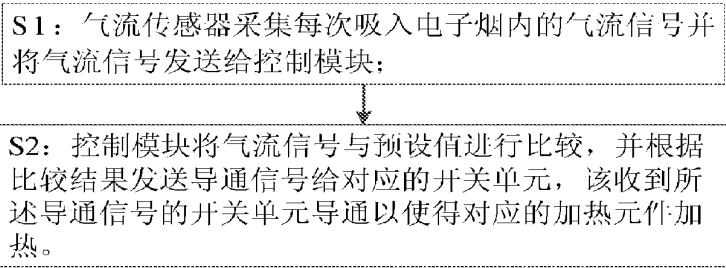


图 5

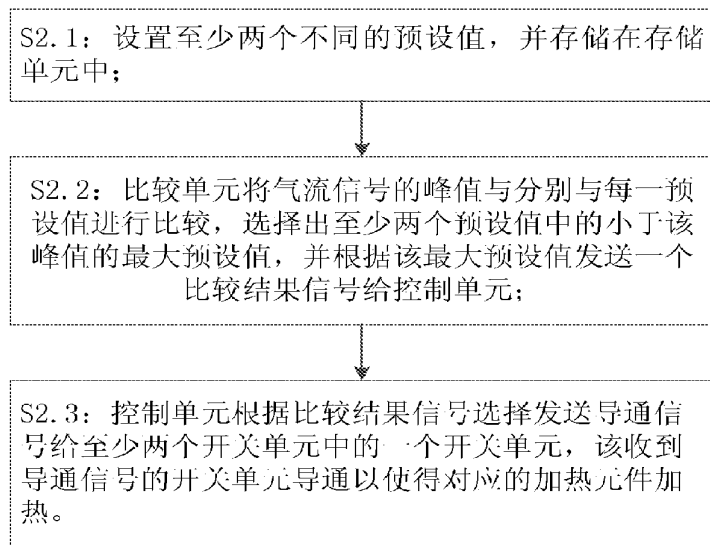


图 6

# INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CN2013/089566**

## A. CLASSIFICATION OF SUBJECT MATTER

A24F 47/00 (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)

A24F A61M

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: control circuit, electronic, electric, atomize, imitate, simulate, substitute, cigar, cigarette, tobacco, circuit

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | CN 101518361 A (BEIJING GREENWORLD TECHNOLOGIES, LTD.), 02 September 2009 (02.09.2009), description, page 5, and figure 1                         | 1, 2, 10-15           |
| Y         | CN 202738816 U (XIE, Yongping), 20 February 2013 (20.02.2013), description, pages 1 and 2, and figures 1 and 2                                    | 1, 2, 10-15           |
| Y         | CN 202445135 U (CHINA TOBACCO HUBEI INDUSTRIAL CO., LTD. et al.), 26 September 2012 (26.09.2012), description, pages 1 and 2, and figures 1 and 2 | 1, 2, 10-15           |
| Y         | CN 103415222 A (CAPUANO, S.), 27 November 2013 (27.11.2013), description, pages 2 and 3                                                           | 1, 2, 10-15           |
| A         | CN 103054196 A (SHENZHEN FIRSTUNION TECHNOLOGY CO., LTD.), 04 April 2013 (24.04.2013), the whole document                                         | 1-19                  |
| A         | CN 201869778 U (LIU, Qiuming), 22 June 2011 (22.06.2011), the whole document                                                                      | 1-19                  |
| A         | US 8499766 B1 (NEWTON, K.D.), 06 August 2013, (06.08.2013), the whole document                                                                    | 1-19                  |

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

☒ See patent family annex.

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

|                                                                                                                                                                                                                    |                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Date of the actual completion of the international search<br>12 September 2014 (12.09.2014)                                                                                                                        | Date of mailing of the international search report<br><b>09 October 2014 (09.10.2014)</b> |
| Name and mailing address of the ISA/CN:<br>State Intellectual Property Office of the P. R. China<br>No. 6, Xitucheng Road, Jimenqiao<br>Haidian District, Beijing 100088, China<br>Facsimile No.: (86-10) 62019451 | Authorized officer<br><b>ZHANG, Yucui</b><br>Telephone No.: (86-10) <b>62084123</b>       |

Form PCT/ISA/210 (second sheet) (July 2009)



**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/CN2013/089566****C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages            | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------|-----------------------|
| A         | WO 2013040193 A2 (PERRIGO L CO. et al.), 21 March 2013 (21.03.2013), the whole document       | 1-19                  |
| A         | CN 103237468 A (PHILIP MORRIS PRODUCTS S.A.), 07 August 2013 (07.08.2013), the whole document | 1-19                  |

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

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

International application No.

**PCT/CN2013/089566**

| Patent Documents referred<br>in the Report | Publication Date  | Patent Family      | Publication Date  |
|--------------------------------------------|-------------------|--------------------|-------------------|
| CN 101518361 A                             | 02 September 2009 | GB 0913768 D0      | 16 September 2009 |
|                                            |                   | DE 102010012600 A1 | 30 September 2010 |
|                                            |                   | US 2010242974 A1   | 30 September 2010 |
|                                            |                   | GB 2468932 A       | 29 September 2010 |
|                                            |                   | GB 2468932 B       | 10 August 2011    |
|                                            |                   | CN 101518361 B     | 06 October 2010   |
|                                            |                   | US 8205622 B2      | 26 June 2012      |
| CN 202738816 U                             | 20 February 2013  | None               |                   |
| CN 202445135 U                             | 26 September 2012 | None               |                   |
| CN 103415222 A                             | 27 November 2013  | US 2013319440 A1   | 05 December 2013  |
|                                            |                   | WO 2012109371 A3   | 08 November 2012  |
|                                            |                   | WO 2012109371 A2   | 16 August 2012    |
|                                            |                   | KR 20140063506 A   | 27 May 2014       |
|                                            |                   | EP 2672848 A2      | 18 December 2013  |
|                                            |                   | JP 2014504886 A    | 27 February 2014  |
| CN 103054196 A                             | 24 April 2013     | None               |                   |
| CN 201869778 U                             | 22 June 2011      | None               |                   |
| US 8499766 B1                              | 06 August 2013    | US 2013284194 A1   | 31 October 2013   |
| WO 2013040193 A2                           | 21 March 2013     | WO 2013040193 A3   | 30 May 2013       |
| CN 103237468 A                             | 07 August 2013    | US 2013340750 A1   | 26 December 2013  |
|                                            |                   | JP 2013545474 A    | 26 December 2013  |
|                                            |                   | SG 190110 A1       | 28 June 2013      |
|                                            |                   | MX 2013006195 A    | 04 November 2013  |
|                                            |                   | WO 2012072790 A1   | 07 June 2012      |
|                                            |                   | EP 2460423 A1      | 06 June 2012      |
|                                            |                   | KR 20130139276 A   | 20 December 2013  |
|                                            |                   | CA 2818076 A1      | 07 June 2012      |
|                                            |                   | EA 201390818 A1    | 28 February 2014  |
|                                            |                   | EP 2645892 A1      | 09 October 2013   |
|                                            |                   | AR 084096 A1       | 17 April 2013     |
|                                            |                   | IL 226009 D0       | 27 June 2013      |

Form PCT/ISA/210 (patent family annex) (July 2009)

## 国际检索报告

国际申请号

PCT/CN2013/089566

|                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                 |                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------|
| A. 主题的分类<br>A24F 47/00(2006.01)i<br><br>按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类                                                                                                                                                                                                                                                                                                                           |                                                                                 |                                     |
| B. 检索领域<br>检索的最低限度文献(标明分类系统和分类号)<br>A24F A61M<br><br>包含在检索领域中的除最低限度文献以外的检索文献<br><br>在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用))<br>CNABS;VEN:电子, 雾化, 仿真, 模拟, 替代, 烟, 控制电路, electronic, electric, atomize, imitate, simulate, substitute, cigar, cigarette, tobacco, circuit                                                                                                                               |                                                                                 |                                     |
| C. 相关文件                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                 |                                     |
| 类 型*                                                                                                                                                                                                                                                                                                                                                                                              | 引用文件, 必要时, 指明相关段落                                                               | 相关的权利要求                             |
| Y                                                                                                                                                                                                                                                                                                                                                                                                 | CN 101518361 A (北京格林世界科技发展有限公司) 2009年 9月 02日 (2009 - 09 - 02)<br>说明书第5页, 附图1    | 1, 2, 10-15                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                 | CN 202738816 U (谢永平) 2013年 2月 20日 (2013 - 02 - 20)<br>说明书第1、2页, 附图1、2           | 1, 2, 10-15                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                 | CN 202445135 U (湖北中烟工业有限责任公司等) 2012年 9月 26日 (2012 - 09 - 26)<br>说明书第1、2页, 附图1、2 | 1, 2, 10-15                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                 | CN 103415222 A (萨米 卡普亚诺) 2013年 11月 27日 (2013 - 11 - 27)<br>说明书第2、3页             | 1, 2, 10-15                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                 | CN 103054196 A (深圳市合元科技有限公司) 2013年 4月 24日 (2013 - 04 - 24)<br>全文                | 1-19                                |
| A                                                                                                                                                                                                                                                                                                                                                                                                 | CN 201869778 U (刘秋明) 2011年 6月 22日 (2011 - 06 - 22)<br>全文                        | 1-19                                |
| A                                                                                                                                                                                                                                                                                                                                                                                                 | US 8499766 B1 (NEWTON KYLE D) 2013年 8月 06日 (2013 - 08 - 06)<br>全文               | 1-19                                |
| <input checked="" type="checkbox"/> 其余文件在C栏的续页中列出。 <input checked="" type="checkbox"/> 见同族专利附件。                                                                                                                                                                                                                                                                                                   |                                                                                 |                                     |
| * 引用文件的具体类型:<br>“A” 认为不特别相关的表示了现有技术一般状态的文件<br>“E” 在国际申请日的当天或之后公布的在先申请或专利<br>“L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件 (如具体说明的)<br>“O” 涉及口头公开、使用、展览或其他方式公开的文件<br>“p” 公布日先于国际申请日但迟于所要求的优先权日的文件<br>“T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件<br>“X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性<br>“Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性<br>“&” 同族专利的文件 |                                                                                 |                                     |
| 国际检索实际完成的日期<br>2014年 9月 12日                                                                                                                                                                                                                                                                                                                                                                       |                                                                                 | 国际检索报告邮寄日期<br>2014年 10月 09日         |
| ISA/CN的名称和邮寄地址<br>中华人民共和国国家知识产权局(ISA/CN)<br>北京市海淀区蓟门桥西土城路6号<br>100088 中国<br>传真号 (86-10)62019451                                                                                                                                                                                                                                                                                                   |                                                                                 | 授权官员<br>张羽鑫<br>电话号码 (86-10)62084123 |

表 PCT/ISA/210 (第2页) (2009年7月)

| C. 相关文件 |                                                                      |         |
|---------|----------------------------------------------------------------------|---------|
| 类 型*    | 引用文件，必要时，指明相关段落                                                      | 相关的权利要求 |
| A       | WO 2013040193 A2 (PERRIGO L CO等) 2013年 3月 21日 (2013 - 03 - 21)<br>全文 | 1-19    |
| A       | CN 103237468 A (菲利普莫里斯生产公司) 2013年 8月 07日 (2013 - 08 - 07)<br>全文      | 1-19    |

表 PCT/ISA/210 (第2页) (2009年7月)

国际检索报告  
关于同族专利的信息

国际申请号

PCT/CN2013/089566

| 检索报告引用的专利文件 |            |    | 公布日<br>(年/月/日) | 同族专利               | 公布日<br>(年/月/日) |
|-------------|------------|----|----------------|--------------------|----------------|
| CN          | 101518361  | A  | 2009年 9月 02日   | GB 0913768 D0      | 2009年 9月 16日   |
|             |            |    |                | DE 102010012600 A1 | 2010年 9月 30日   |
|             |            |    |                | US 2010242974 A1   | 2010年 9月 30日   |
|             |            |    |                | GB 2468932 A       | 2010年 9月 29日   |
|             |            |    |                | GB 2468932 B       | 2011年 8月 10日   |
|             |            |    |                | CN 101518361 B     | 2010年 10月 06日  |
|             |            |    |                | US 8205622 B2      | 2012年 6月 26日   |
| CN          | 202738816  | U  | 2013年 2月 20日   | 无                  |                |
| CN          | 202445135  | U  | 2012年 9月 26日   | 无                  |                |
| CN          | 103415222  | A  | 2013年 11月 27日  | US 2013319440 A1   | 2013年 12月 05日  |
|             |            |    |                | WO 2012109371 A3   | 2012年 11月 08日  |
|             |            |    |                | WO 2012109371 A2   | 2012年 8月 16日   |
|             |            |    |                | KR 20140063506 A   | 2014年 5月 27日   |
|             |            |    |                | EP 2672848 A2      | 2013年 12月 18日  |
|             |            |    |                | JP 2014504886 A    | 2014年 2月 27日   |
| CN          | 103054196  | A  | 2013年 4月 24日   | 无                  |                |
| CN          | 201869778  | U  | 2011年 6月 22日   | 无                  |                |
| US          | 8499766    | B1 | 2013年 8月 06日   | US 2013284194 A1   | 2013年 10月 31日  |
| WO          | 2013040193 | A2 | 2013年 3月 21日   | WO 2013040193 A3   | 2013年 5月 30日   |
| CN          | 103237468  | A  | 2013年 8月 07日   | US 2013340750 A1   | 2013年 12月 26日  |
|             |            |    |                | JP 2013545474 A    | 2013年 12月 26日  |
|             |            |    |                | SG 190110 A1       | 2013年 6月 28日   |
|             |            |    |                | MX 2013006195 A    | 2013年 11月 04日  |
|             |            |    |                | WO 2012072790 A1   | 2012年 6月 07日   |
|             |            |    |                | EP 2460423 A1      | 2012年 6月 06日   |
|             |            |    |                | KR 20130139276 A   | 2013年 12月 20日  |
|             |            |    |                | CA 2818076 A1      | 2012年 6月 07日   |
|             |            |    |                | EA 201390818 A1    | 2014年 2月 28日   |
|             |            |    |                | EP 2645892 A1      | 2013年 10月 09日  |
|             |            |    |                | AR 084096 A1       | 2013年 4月 17日   |
|             |            |    |                | IL 226009 D0       | 2013年 6月 27日   |

表 PCT/ISA/210 (同族专利附件) (2009年7月)

## (12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织  
国际局

(43) 国际公布日  
2015 年 7 月 30 日 (30.07.2015)



(10) 国际公布号  
WO 2015/109616 A1

- (51) 国际专利分类号:  
H02J 7/00 (2006.01) H02J 17/00 (2006.01)
- (21) 国际申请号: PCT/CN2014/072050
- (22) 国际申请日: 2014 年 2 月 13 日 (13.02.2014)
- (25) 申请语言: 中文
- (26) 公布语言: 中文
- (30) 优先权:  
201420049703.9 2014 年 1 月 24 日 (24.01.2014) CN
- (71) 申请人: 吉瑞高新科技股份有限公司 (KIMREE HI-TECH INC.); 英属维尔京群岛托尔托拉岛罗德城奎兹天空大厦邮箱 905 号, Tortola (VG)。
- (72) 发明人: 刘秋明 (LIU, Qiuming); 中国广东省惠州市仲恺高新区和畅西三路 16 号 A 栋三、四、五层, Guangdong 516000 (CN)。
- (74) 代理人: 北京集佳知识产权代理有限公司 (UNITALEN ATTORNEYS AT LAW); 中国北京市朝阳区建国门外大街 22 号赛特广场 7 层, Beijing 100004 (CN)。

- (81) 指定国 (除另有指明, 要求每一种可提供的国家保护): 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, 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, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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) 指定国 (除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (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)。

### 本国际公布:

— 包括国际检索报告(条约第 21 条(3))。

(54) Title: WIRELESS CHARGING SYSTEM FOR ELECTRONIC CIGARETTE

(54) 发明名称: 一种电子烟的无线充电系统

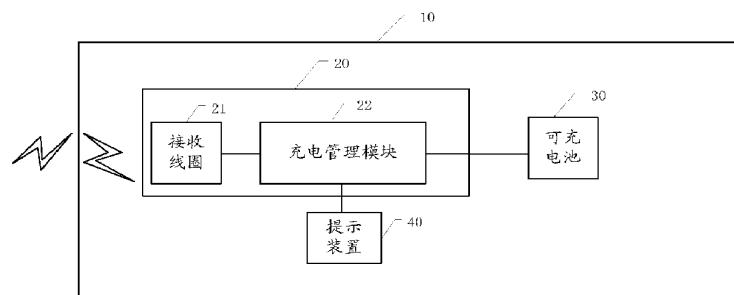


图 2 / FIG. 2

21 RECEIVING COIL  
22 CHARGING MANAGEMENT MODULE

30 RECHARGEABLE BATTERY  
40 PROMPT DEVICE

(57) Abstract: Provided is a wireless charging system for an electronic cigarette, comprising a wireless power receiving device arranged within an electronic cigarette and connected to a rechargeable battery of the electronic cigarette. The wireless power receiving device receives power wirelessly outputted by an external charging device, and outputs the received power to the rechargeable battery, thereby charging the rechargeable battery. Since the wireless power receiving device receives power wirelessly, it is not necessary to connect to the external charging device via electrodes. An electronic cigarette provided with the wireless power receiving device need only be placed within a wireless power transmission range of the external charging device for charging to be performed. The present invention is easy to use, and solves the problem in the prior art that electronic cigarette charging is inconvenient.

(57) 摘要:

[见续页]



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本申请提供了一种电子烟的无线充电系统，包括设置在电子烟内部，且与电子烟的可充电电池相连接的无线电能接收装置，无线电能接收装置能够接收外部的充电设备通过无线方式输出的电能，并将接收到的电能输出到可充电电池，从而对可充电电池进行充电。因为无线电能接收装置是通过无线方式接收电能的，无需通过电极与外部充电设备进行连接，只需将设置无线电能接收装置的电子烟放置在外部充电设备的无线电能发射范围内即可进行充电，使用起来非常方便，能够解决现有的电子烟充电不方便的问题。

## 一种电子烟的无线充电系统

### 技术领域

本申请要求于 2014 年 1 月 24 提交中国专利局、申请号为 201420049703.9、发明名称为“一种电子烟的无线充电系统”的国内申请的优先权，其全部内容通过引用结合在本申请中。

### 背景技术

电子烟是一种香烟的替代品，又名虚拟香烟、电子香烟，主要用于戒烟和替代香烟。它有着与香烟一样的外观、与香烟近似的味道，甚至比一般香烟的口味要多出很多，也像香烟一样能吸出烟、吸出味道跟感觉来。并且没有香烟中的焦油、悬浮微粒等其他有害成分，也没有弥漫或缭绕的二手烟，不会对自己和他人造成危害。

现有电子烟一般包括电池杆和雾化器，当吸烟者吸气时，雾化器内烟液受热蒸发雾化，形成模拟烟气的气雾。

电池杆的电池采用可充电电池，以便能够多次重复使用。在对可充电电池进行充电时一般采用接触式充电，在充电时需要将充电电极与外部充电器的电能输出端紧密接触才能进行充电，虽然广泛使用，但是要求定位精确，使用较为不便，从而造成不好的用户体验。

### 发明内容

有鉴于此，本申请提供一种电子烟的无线充电系统，用于对电池杆内的可充电电池进行充电，以解决充电较为不便的问题。

为了实现上述目的，现提出的方案如下：

一种电子烟的无线充电系统，包括：

无线电能接收装置，设置在电子烟内，用于从外部充电设备通过无线方式接收电能，并将所述电能输出到所述电子烟的可充电电池；

提示装置，与所述无线电能接收装置相连接，用于在所述充电管理模



块输出直流电流时发出提示信号。

优选的，所述无线电能接收装置包括：

接收线圈，设置在所述电子烟内，用于根据所述外部充电设备发出的电磁场输出感应电压；

- 5        充电管理模块，分别与所述接收线圈、所述可充电电池相连接，用于根据所述感应电压输出直流电流，并将所述直流电流输出到所述可充电电池。

优选的，所述充电管理模块包括二极管、整流电容、第一电阻、第二电阻、第三电阻、第四电阻、发光二极管、第一三极管、第二三极管、蜂鸣器和处理器；

- 10       所述接收线圈的一端接地，并分别与所述整流电容的一端、所述发光二极管的负极、所述第一三极管的集电极相连接；

所述接收线圈的另一端与所述二极管的正极、所述整流电容的另一端、所述第一电阻的一端、所述蜂鸣器的一端、所述第二三极管的发射极相连接；

- 15       所述第一电阻的另一端分别与所述发光二极管的正极、所述处理器相连接；

所述蜂鸣器的另一端通过所述第二电阻与所述第一三极管的发射极相连接；

所述第一三极管的基极通过所述第三电阻与所述处理器相连接；

- 20       所述第二三极管的基极通过所述第四电阻与所述处理器相连接；

所述第二三极管的集电极分别与所述处理器、所述可充电电池相连接，用于向所述可充电电池输出直流电流。

优选的，所述充电管理模块包括：

SG88602 芯片。

- 25       优选的，所述提示装置包括：

光电提示单元，用于当进行充电时输出光提示信号；和/或，

声音提示单元，用于当进行充电时输出声音提示信号。

优选的，所述光电提示单元包括：

发光二极管。

优选的，所述生意提示单元包括：

蜂鸣器。

5 优选的，还包括：

无线电能适配器，用于通过无线方式输出电能。

优选的，所述无线电能适配器包括：

发射线圈，用于发出所述电磁波。

10 从上述技术方案可以看出，本申请提供的电子烟的无线充电系统包括设置在电子烟内部，且与电子烟的可充电电池相连接的无线电能接收装置，无线电能接收装置能够接收外部的充电设备通过无线方式输出的电能，并将接收到的电能输出到可充电电池，从而对可充电电池进行充电。因为无线电能接收装置是通过无线方式接收电能的，无需通过电极与外部充电设备进行连接，只需将设置有无线电能接收装置的电子烟放置在外部充电设备的无线电能发射范围内即可进行充电，使用起来非常方便，能够解决现有的电子烟充电不方便的问题。

15

## 附图说明

20 为了更清楚地说明本申请实施例或现有技术中的技术方案，下面将对实施例或现有技术描述中所需要使用的附图作简单地介绍，显而易见地，下面描述中的附图仅仅是本申请的一些实施例，对于本领域普通技术人员来讲，在不付出创造性劳动的前提下，还可以根据这些附图获得其他的附图。

25 图 1 为本申请实施例提供的一种电子烟的无线充电系统的结构图；

图 2 为本申请另一实施例提供的一种电子烟的无线充电系统的结构图；

图 3 为本申请又一实施例提供的一种电子烟的无线充电系统的结构图；  
图 4 为本申请又一实施例提供的一种电子烟的无线充电系统的结构图；  
图 5 为本申请又一实施例提供的一种电子烟的无线充电系统的结构图。

## 5 具体实施方式

下面将结合本申请实施例中的附图，对本申请实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本申请一部分实施例，而不是全部的实施例。基于本申请中的实施例，本领域普通技术人员在没有作出创造性劳动前提下所获得的所有其他实施例，都属于本申请保护的  
10 范围。

### 实施例一

图 1 为本申请实施例提供的一种电子烟的无线充电系统的结构图；

如图 1 所示，本实施例提供的无线充电系统包括无线电能接收装置 20  
15 和提示装置 40。

无线电能接收装置 20 设置在电子烟 10 的内部，并且与电子烟 10 的可  
充电池 30 相连接。该无线电能接收装置 20 能够接收外部的充电设备通过  
无线方式输出的电能，并将接收到的电能输出到可充电池 30，从而对可充  
电池 30 进行充电。

20 提示装置 40 与无线电能接收装置 20 相连接，用于在充电的同时发出  
声音或光电信号，提示充电正在进行。

从上述技术方案可以看出，本实施例提供的电子烟的无线充电系统包  
括设置在电子烟内部，且与电子烟的可充电池相连接的无线电能接收装置，  
无线电能接收装置能够接收外部的充电设备通过无线方式输出的电能，并  
25 将接收到的电能输出到可充电池，从而对可充电池进行充电。因为无线电  
能接收装置是通过无线方式接收电能的，无需通过电极与外部充电设备进行  
连接，只需将设置有无线电能接收装置的电子烟放置在外部充电设备的

无线电能发射范围内即可进行充电，使用起来非常方便，能够解决现有的电子烟充电不方便的问题。

### 实施例二

5 图 2 为本申请另一实施例提供的一种电子烟的无线充电系统的结构图。

如图 2 所示，本实施例提供的无线充电系统包括无线电能接收装置 20，无线电能接收装置设置在电子烟的内部。

其中无线电能接收装置 20 包括接收线圈 21 和充电管理模块 22，接收  
10 线圈 21 与充电管理模块 22 相连接，充电管理模块 22 还与可充电电池 30 相连接。

接收线圈 21 用于接收外部充电设备发出的电磁波，并在电磁波的作用下生产感应电压。充电管理模块 22 接收接收线圈 21 生成的感应电压，并对其进行整流和滤波，生成直流电流，并将直流电流输出到可充电电池 30，  
15 以对可从电池进行充电。

### 实施例三

图 3 为本申请又一实施例提供的一种电子烟的无线充电装置的结构图。

20 如图 3 所示，本实施例中无线电能接收装置 20 包括接收线圈 21 和充电管理模块 22，充电管理模块 22 优选 SG88602 芯片，可充电电池 30 与充电管理模块 22 相连接。

另外，为了使充电管理模块 22 的输出更加平稳，本实施例增设了滤波电容 C，滤波电容 C 与可充电电池 30 并联。

25 同时在充电管理模块 22 连接有发光二极管 D，当对可充电电池 30 进行充电时，充电管理模块 22 控制发光二极管 D 发光，以提示正在进行充电。

#### 实施例四

图 4 为本申请又一实施例提供的一种电子烟的无线充电系统的结构图。

如图 4 所示, 本实施例中无线电能接收模块 20 包括接收线圈 21、二极管 D1、整流电容 C1、第一电阻 R1、第二电阻 R2、第三电阻 R3、第四电阻 R4、发光二极管 D、第一三极管 T1、第二三极管 T2、蜂鸣器 B 和处理器。

接收线圈 21 的一端接地, 并分别与整流电容 C1 的一端、发光二极管 D 的负极、第一三极管 T1 的集电极相连接。接收线圈 21 的另一端与二极管 D1 的正极、整流电容 C1 的另一端、第一电阻 R1 的一端、蜂鸣器 B 的一端、第二三极管 T2 的发射极相连接。

第一电阻 R1 的另一端分别与发光二极管 D 的正极、处理器相连接。蜂鸣器 B 的另一端通过第二电阻 R2 与第一三极管 T1 的发射极相连接。第一三极管 T1 的基极通过第三电阻 R3 与处理器 22 相连接。第二三极管 T2 的基极通过第四电阻 R4 与处理器 22 相连接。第二三极管 T2 的集电极分别与处理器 22、可充电池 30 相连接, 用于向可充电池 30 输出直流电流。

本实施例中的处理器 22 用于对发光二极管 D 和蜂鸣器 B 进行控制, 当对可充电池 30 进行充电时, 分别控制发光二极管 D 发光, 或控制蜂鸣器发出声音。

#### 实施例五

图 5 为本申请又一实施例提供的一种电子烟的无线充电系统的结构图。

如图 5 所示, 本实施例是在实施例二的基础上增设了无线电能适配器 50。

无线电能适配器 50 用于从市电网络获取电能, 经过变压然后通过无线方式输出电能, 即发出电磁波, 当以上实施例提供的电子烟放置在该电磁

波的有效范围内时，就能对电子烟进行充电。

无线电能适配器 50 包括发射线圈 51，用于发射电磁场。

最后，还需要说明的是，在本文中，诸如第一和第二等之类的关系术语仅仅用来将一个实体或者操作与另一个实体或操作区分开来，而不一定要求或者暗示这些实体或操作之间存在任何这种实际的关系或者顺序。而且，术语“包括”、“包含”或者其任何其他变体意在涵盖非排他性的包含，从而使得包括一系列要素的过程、方法、物品或者设备不仅包括那些要素，而且还包括没有明确列出的其他要素，或者是还包括为这种过程、方法、物品或者设备所固有的要素。在没有更多限制的情况下，由语句“包括一个……”限定的要素，并不排除在包括所述要素的过程、方法、物品或者设备中还存在另外的相同要素。

本说明书中各个实施例采用递进的方式描述，每个实施例重点说明的都是与其他实施例的不同之处，各个实施例之间相同相似部分互相参见即可。

对所公开的实施例的上述说明，使本领域专业技术人员能够实现或使用本申请。对这些实施例的多种修改对本领域的专业技术人员来说将是显而易见的，本文中所定义的一般原理可以在不脱离本申请的精神或范围的情况下，在其它实施例中实现。因此，本申请将不会被限制于本文所示的这些实施例，而是要符合与本文所公开的原理和新颖特点相一致的最宽的范围。

## 权 利 要 求

1、一种电子烟的无线充电系统，其特征在于，包括：

无线电能接收装置，设置在电子烟内，用于从外部充电设备通过无线方式接收电能，并将所述电能输出到所述电子烟的可充电电池；

5       提示装置，与所述无线电能接收装置相连接，用于在所述充电管理模块输出直流电流时发出提示信号。

2、如权利要求 1 所述的无线充电系统，其特征在于，所述无线电能接收装置包括：

10       接收线圈，设置在所述电子烟内，用于根据所述外部充电设备发出的电磁场输出感应电压；

充电管理模块，分别与所述接收线圈、所述可充电电池相连接，用于根据所述感应电压输出直流电流，并将所述直流电流输出到所述可充电电池。

3、如权利要求 2 所述的无线充电系统，其特征在于，所述充电管理模块包括二极管、整流电容、第一电阻、第二电阻、第三电阻、第四电阻、  
15       发光二极管、第一三极管、第二三极管、蜂鸣器和处理器；

所述接收线圈的一端接地，并分别与所述整流电容的一端、所述发光二极管的负极、所述第一三极管的集电极相连接；

20       所述接收线圈的另一端与所述二极管的正极、所述整流电容的另一端、所述第一电阻的一端、所述蜂鸣器的一端、所述第二三极管的发射极相连接；

所述第一电阻的另一端分别与所述发光二极管的正极、所述处理器相连接；

所述蜂鸣器的另一端通过所述第二电阻与所述第一三极管的发射极相连接；

25       所述第一三极管的基极通过所述第三电阻与所述处理器相连接；

所述第二三极管的基极通过所述第四电阻与所述处理器相连接；

所述第二三极管的集电极分别与所述处理器、所述可充电电池相连接，

用于向所述可充电电池输出直流电流。

4、如权利要求 2 所述的无线充电系统，其特征在于，所述充电管理模块包括：

SG88602 芯片。

5 5、如权利要求 1 所述的无线充电系统，其特征在于，所述提示装置包括：

光电提示单元，用于当进行充电时输出光提示信号；和/或，

声音提示单元，用于当进行充电时输出声音提示信号。

10 6、如权利要求 5 所述的无线充电系统，其特征在于，所述光电提示单元包括：

发光二极管。

7、如权利要求 5 所述的无线充电系统，其特征在于，所述声音提示单元包括：

蜂鸣器。

15 8、如权利要求 1~7 任一项所述的无线充电系统，其特征在于，还包括：无线电能适配器，用于通过无线方式输出电能。

9、如权利要求 8 所述的无线充电系统，其特征在于，所述无线电能适配器包括：

发射线圈，用于发出所述电磁波。



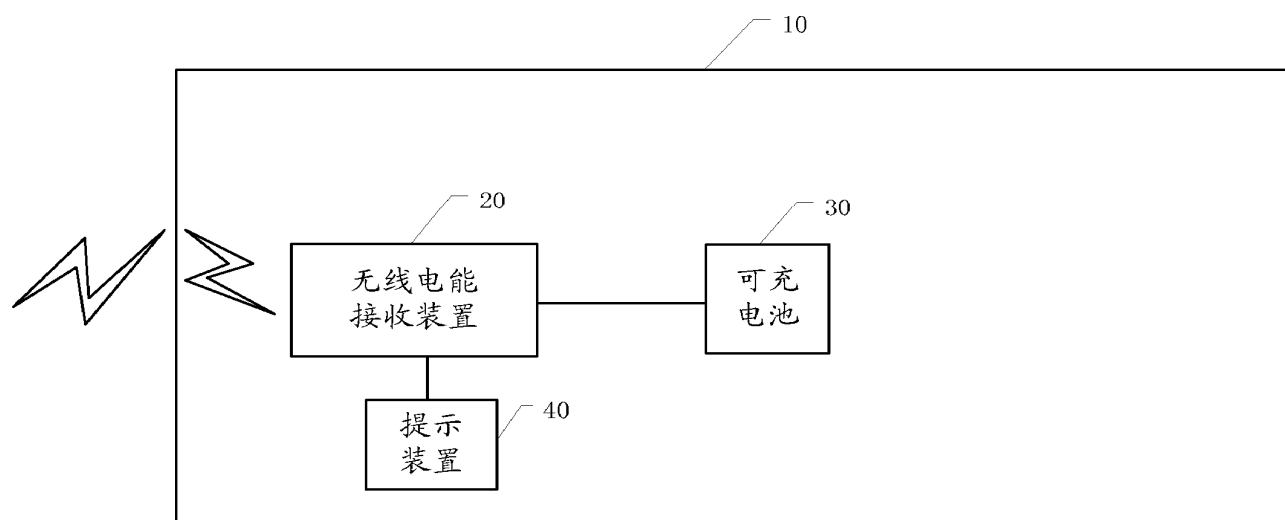


图 1

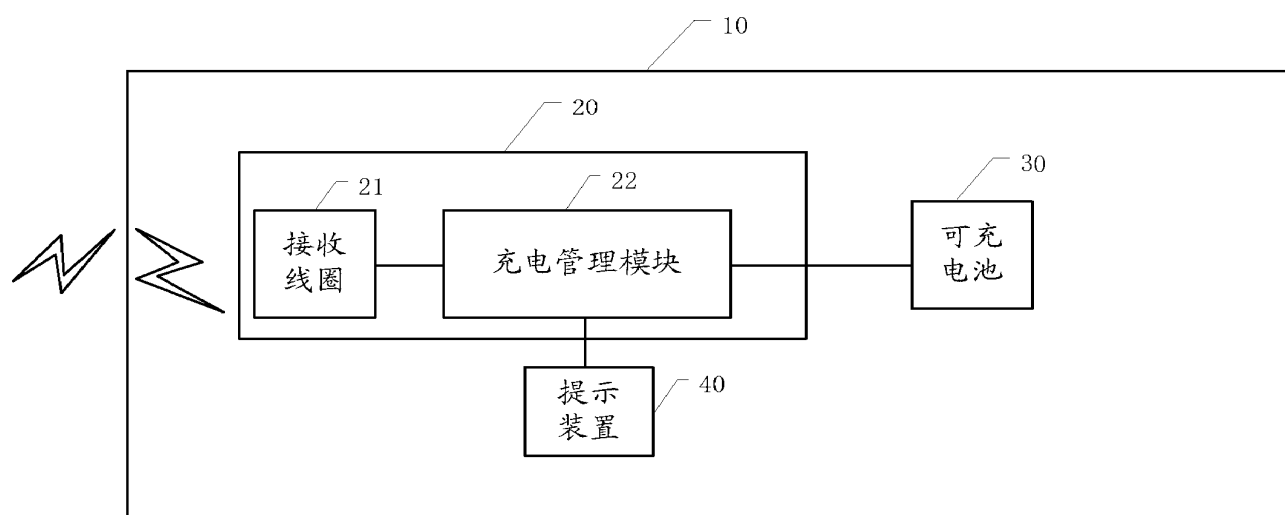


图 2

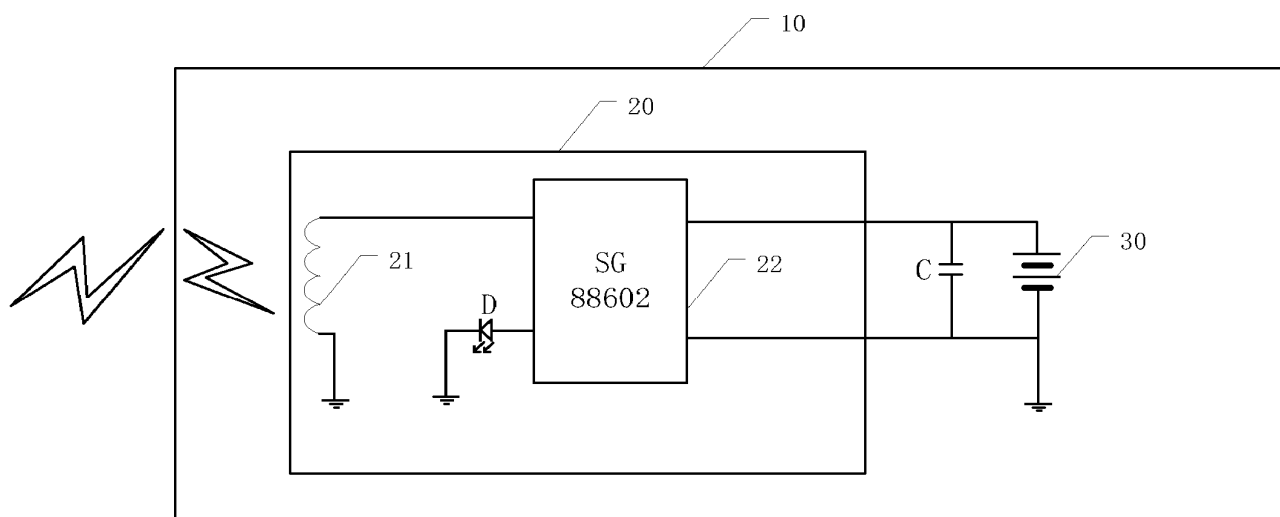


图 3

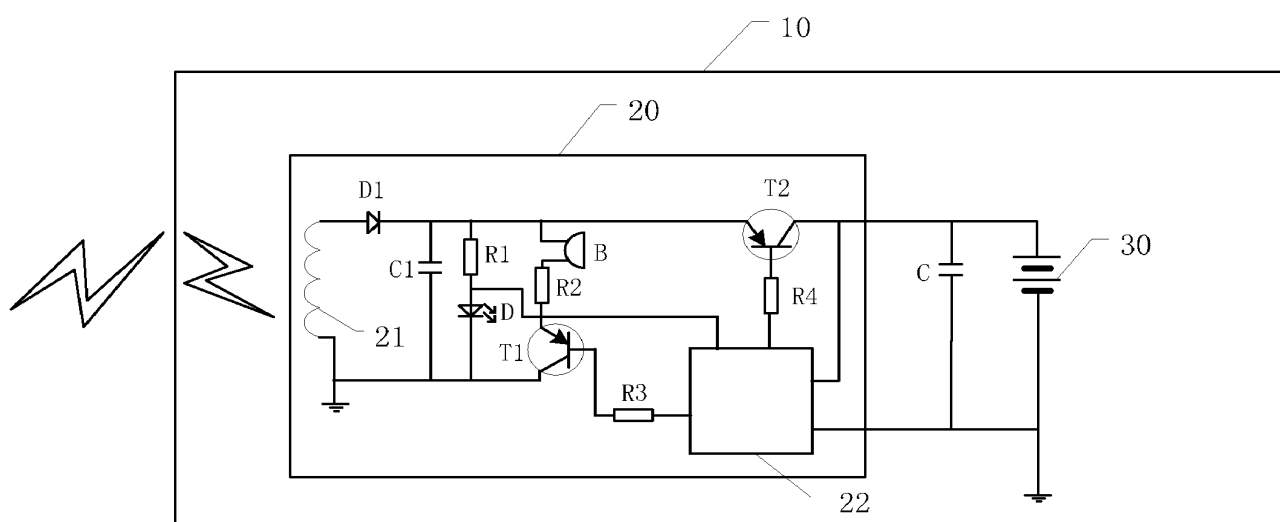


图 4

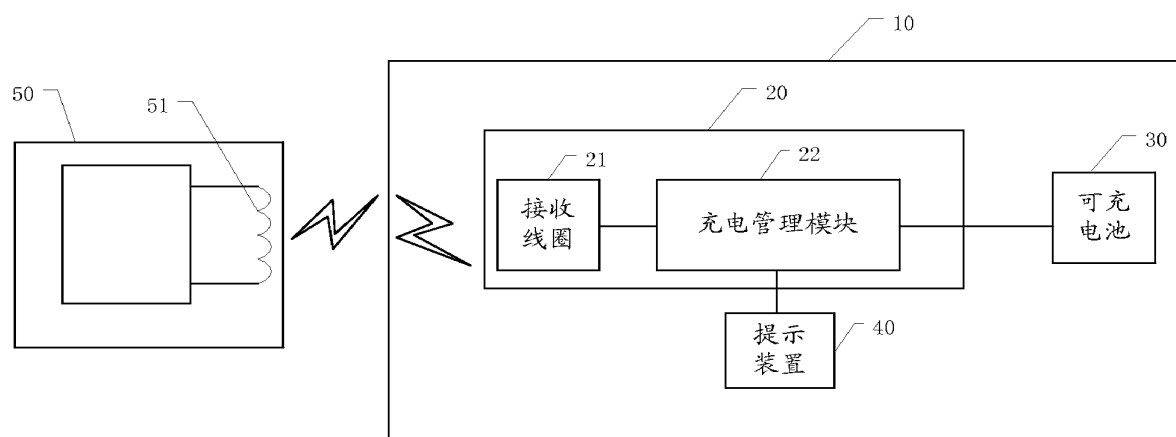


图 5

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/CN2014/072050

## A. CLASSIFICATION OF SUBJECT MATTER

H02J 7/00 (2006.01) i; H02J 17/00 (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)

H02J

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)

VEN; CPRSABS; CNABS: electronic cigarette, wireless, charg+, coil, liuqiuming, non, contact+, inductive, smoke+, cigarette

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                              | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | CN 201910649 U (XIANG, Zhiyong) 27 July 2011 (27.07.2011) description, paragraphs [0018] to [0021] and figures 1 to 5           | 1-9                   |
| X         | CN 102883631 A (XIANG, Zhiyong et al.) 16 January 2013 (16.01.2013) description, paragraphs [0030] to [0033] and figures 1 to 5 | 1-9                   |
| A         | CN 201384062 Y (HUA, Jian) 20 January 2010 (20.01.2010) the whole document                                                      | 1-9                   |
| A         | CN 202774134 U (LIU, Qiuming) 13 March 2013 (13.03.2013) the whole document                                                     | 1-9                   |
| A         | CN 201134682 Y (ZHU, Yubing) 15 October 2008 (15.10.2008) the whole document                                                    | 1-9                   |
| A         | US 2013087160 A1 (GHERGHE, ALEXANDRU) 11 April 2013 (11.04.2013) the whole document                                             | 1-9                   |

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

☒ 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  
16 July 2014

Date of mailing of the international search report  
29 July 2014

Name and mailing address of the ISA  
State Intellectual Property Office of the P. R. China  
No. 6, Xitucheng Road, Jimenqiao  
Haidian District, Beijing 100088, China  
Facsimile No. (86-10) 62019451

Authorized officer  
LAN, Xia  
Telephone No. (86-10) 82245486

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

International application No.  
PCT/CN2014/072050

| Patent Documents referred<br>in the Report | Publication Date | Patent Family    | Publication Date |
|--------------------------------------------|------------------|------------------|------------------|
| CN 201910649 U                             | 27 July 2011     | None             |                  |
| CN 102883631 A                             | 16 January 2013  | WO 2012100430 A1 | 02 August 2012   |
|                                            |                  | EP 2668858 A1    | 04 December 2013 |
|                                            |                  | US 2013298922 A1 | 14 November 2013 |
| CN 201384062 Y                             | 20 January 2010  | None             |                  |
| CN 202774134 U                             | 13 March 2013    | None             |                  |
| CN 201134682 Y                             | 15 October 2008  | None             |                  |
| US 2013087160 A1                           | 11 April 2013    | None             |                  |

## 国际检索报告

国际申请号

PCT/CN2014/072050

|                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                              |                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------|
| A. 主题的分类<br>H02J 7/00(2006.01)i; H02J 17/00(2006.01)i<br><br>按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类                                                                                                                                                                                                                                                                                                     |                                                                              |                                            |
| B. 检索领域<br><br>检索的最低限度文献(标明分类系统和分类号)<br>H02J<br><br>包含在检索领域中的除最低限度文献以外的检索文献<br><br>在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用))<br>VEN;CPRSABS;CNABS:电子烟, 无线, 充电, 线圈, 刘秋明, non, contact+, inductive, smoke+, cigarette, charg+, wireless, coil                                                                                                                                                           |                                                                              |                                            |
| C. 相关文件                                                                                                                                                                                                                                                                                                                                                                                          |                                                                              |                                            |
| 类 型*                                                                                                                                                                                                                                                                                                                                                                                             | 引用文件, 必要时, 指明相关段落                                                            | 相关的权利要求                                    |
| X                                                                                                                                                                                                                                                                                                                                                                                                | CN 201910649U (向智勇) 2011年 7月 27日 (2011 - 07 - 27)<br>说明书第0018-0021段, 附图1-5   | 1-9                                        |
| X                                                                                                                                                                                                                                                                                                                                                                                                | CN 102883631A (向智勇 等) 2013年 1月 16日 (2013 - 01 - 16)<br>说明书第0030-0033段, 附图1-5 | 1-9                                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                | CN 201384062Y (华健) 2010年 1月 20日 (2010 - 01 - 20)<br>全文                       | 1-9                                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                | CN 202774134U (刘秋明) 2013年 3月 13日 (2013 - 03 - 13)<br>全文                      | 1-9                                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                | CN 201134682Y (朱育兵) 2008年 10月 15日 (2008 - 10 - 15)<br>全文                     | 1-9                                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                | US 2013087160A1 (GHERGHE, ALEXANDRU) 2013年 4月 11日 (2013 - 04 - 11)<br>全文     | 1-9                                        |
| <input type="checkbox"/> 其余文件在C栏的续页中列出。 <input checked="" type="checkbox"/> 见同族专利附件。                                                                                                                                                                                                                                                                                                             |                                                                              |                                            |
| * 引用文件的具体类型:<br>“A” 认为不特别相关的表示了现有技术一般状态的文件<br>“E” 在国际申请日的当天或之后公布的在先申请或专利<br>“L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件(如具体说明的)<br>“O” 涉及口头公开、使用、展览或其他方式公开的文件<br>“P” 公布日先于国际申请日但迟于所要求的优先权日的文件<br>“T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件<br>“X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性<br>“Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性<br>“&” 同族专利的文件 |                                                                              |                                            |
| 国际检索实际完成的日期<br><br>2014年 7月 16日                                                                                                                                                                                                                                                                                                                                                                  |                                                                              | 国际检索报告邮寄日期<br><br>2014年 7月 29日             |
| ISA/CN的名称和邮寄地址<br><br>中华人民共和国国家知识产权局(ISA/CN)<br>北京市海淀区蓟门桥西土城路6号<br>100088 中国<br>传真号 (86-10)62019451                                                                                                                                                                                                                                                                                              |                                                                              | 受权官员<br><br>兰霞<br><br>电话号码 (86-10)82245486 |

表 PCT/ISA/210 (第2页) (2009年7月)

国际检索报告  
关于同族专利的信息

国际申请号

PCT/CN2014/072050

| 检索报告引用的专利文件 |              | 公布日<br>(年/月/日) | 同族专利 |              | 公布日<br>(年/月/日) |
|-------------|--------------|----------------|------|--------------|----------------|
| CN          | 201910649U   | 2011年 7月 27日   | 无    |              |                |
| CN          | 102883631A   | 2013年 1月 16日   | WO   | 2012100430A1 | 2012年 8月 02日   |
|             |              |                | EP   | 2668858A1    | 2013年 12月 04日  |
|             |              |                | US   | 2013298922A1 | 2013年 11月 14日  |
| CN          | 201384062Y   | 2010年 1月 20日   | 无    |              |                |
| CN          | 202774134U   | 2013年 3月 13日   | 无    |              |                |
| CN          | 201134682Y   | 2008年 10月 15日  | 无    |              |                |
| US          | 2013087160A1 | 2013年 4月 11日   | 无    |              |                |

表 PCT/ISA/210 (同族专利附件) (2009年7月)

| Electronic Patent Application Fee Transmittal |          |                                                                    |        |                      |
|-----------------------------------------------|----------|--------------------------------------------------------------------|--------|----------------------|
| Application Number:                           |          | 14925968                                                           |        |                      |
| Filing Date:                                  |          | 28-Oct-2015                                                        |        |                      |
| Title of Invention:                           |          | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |        |                      |
| First Named Inventor/Applicant Name:          |          | Adam BOWEN                                                         |        |                      |
| Filer:                                        |          | Richard Douglas Shoop/Brian Flick                                  |        |                      |
| Attorney Docket Number:                       |          | 13211-713.303                                                      |        |                      |
| Filed as Small Entity                         |          |                                                                    |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                                                    |        |                      |
| Description                                   | Fee Code | Quantity                                                           | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                                                    |        |                      |
| Pages:                                        |          |                                                                    |        |                      |
| Claims:                                       |          |                                                                    |        |                      |
| Miscellaneous-Filing:                         |          |                                                                    |        |                      |
| Petition:                                     |          |                                                                    |        |                      |
| Patent-Appeals-and-Interference:              |          |                                                                    |        |                      |
| Post-Allowance-and-Post-Issuance:             |          |                                                                    |        |                      |
| Extension-of-Time:                            |          |                                                                    |        |                      |



| Description                             | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|-----------------------------------------|----------|----------|--------|----------------------|
| Miscellaneous:                          |          |          |        |                      |
| SUBMISSION- INFORMATION DISCLOSURE STMT | 2806     | 1        | 90     | 90                   |
| Total in USD (\$)                       |          |          |        | 90                   |

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 27809803                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Richard Douglas Shoop/Brian Flick                                  |
| <b>Filer Authorized By:</b>                 | Richard Douglas Shoop                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 15-DEC-2016                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 16:32:36                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

|                                          |                             |
|------------------------------------------|-----------------------------|
| Submitted with Payment                   | yes                         |
| Payment Type                             | DA                          |
| Payment was successfully received in RAM | \$ 90                       |
| RAM confirmation Number                  | 121616INTEFSW00003636504050 |
| Deposit Account                          |                             |
| Authorized User                          |                             |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

|                 |                                                     |                                                  |                                          |                  |                  |
|-----------------|-----------------------------------------------------|--------------------------------------------------|------------------------------------------|------------------|------------------|
|                 |                                                     |                                                  |                                          |                  |                  |
| File Listing:   |                                                     |                                                  |                                          |                  |                  |
| Document Number | Document Description                                | File Name                                        | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1               |                                                     | 13211-713-303_IDS_Filing_SupplIDS_12-15-2016.pdf | 766418                                   | yes              | 9                |
|                 |                                                     |                                                  | 3354ebaab33df0a21adf53dd03ed50c1d5fcf7dd |                  |                  |
|                 | Multipart Description/PDF files in .zip description |                                                  |                                          |                  |                  |
|                 | Document Description                                |                                                  | Start                                    | End              |                  |
|                 | Transmittal Letter                                  |                                                  | 1                                        | 3                |                  |
|                 | Information Disclosure Statement (IDS) Form (SB08)  |                                                  | 4                                        | 9                |                  |
| Warnings:       |                                                     |                                                  |                                          |                  |                  |
| Information:    |                                                     |                                                  |                                          |                  |                  |
| 2               | Foreign Reference                                   | EP2856893A1.pdf                                  | 3797855                                  | no               | 17               |
|                 |                                                     |                                                  | 9e9e535e97feb0832fb271b2d51dddc5024ca6   |                  |                  |
| Warnings:       |                                                     |                                                  |                                          |                  |                  |
| Information:    |                                                     |                                                  |                                          |                  |                  |
| 3               | Foreign Reference                                   | EP2908675A1.pdf                                  | 2851612                                  | no               | 26               |
|                 |                                                     |                                                  | 18617c20f28d55bee6be340e76a7896f5f4abb3  |                  |                  |
| Warnings:       |                                                     |                                                  |                                          |                  |                  |
| Information:    |                                                     |                                                  |                                          |                  |                  |
| 4               | Foreign Reference                                   | EP2915443A1.pdf                                  | 3131188                                  | no               | 11               |
|                 |                                                     |                                                  | edc6785026730a393e33a42f16b2c43177494d5d |                  |                  |
| Warnings:       |                                                     |                                                  |                                          |                  |                  |
| Information:    |                                                     |                                                  |                                          |                  |                  |
| 5               | Foreign Reference                                   | EP3062646-WO2015066136.pdf                       | 1920287                                  | no               | 37               |
|                 |                                                     |                                                  | 78ca85cae85f5ab9b5d8561b19d31e643b3dc74e |                  |                  |
| Warnings:       |                                                     |                                                  |                                          |                  |                  |
| Information:    |                                                     |                                                  |                                          |                  |                  |

|              |                   |                            |                                          |    |    |
|--------------|-------------------|----------------------------|------------------------------------------|----|----|
| 6            | Foreign Reference | EP3065581-WO2015068044.pdf | 729371                                   | no | 15 |
|              |                   |                            | db68ce2ef9dae6813f00c055614d9cb7896df474 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 7            | Foreign Reference | EP3068244-WO2015073975.pdf | 797485                                   | no | 16 |
|              |                   |                            | 6548a386aa02b67a4008be4094745bac81b4382d |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 8            | Foreign Reference | WO2004080216A1.pdf         | 749955                                   | no | 18 |
|              |                   |                            | a28bfe15199fdd2375c7ddd887e7bbf63036e369 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 9            | Foreign Reference | WO2008077271A1.pdf         | 827852                                   | no | 21 |
|              |                   |                            | 05b9db2349cb9260c6d037bf6a571ccf0e41be68 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 10           | Foreign Reference | WO2012120487A2.pdf         | 3158287                                  | no | 79 |
|              |                   |                            | ede9fa584af52f2d97df4cbbdaa0708545f1ef31 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 11           | Foreign Reference | WO2013089551A1.pdf         | 1094113                                  | no | 36 |
|              |                   |                            | 33c2a25276d66ea2bff596b18c46f1f606c609d6 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
| Information: |                   |                            |                                          |    |    |
| 12           | Foreign Reference | WO2014040915A1.pdf         | 781426                                   | no | 20 |
|              |                   |                            | b4fca67d78087fa18028b2fd3d734bee21816da5 |    |    |
| Warnings:    |                   |                            |                                          |    |    |
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|              |                   |                    |                                          |    |    |
|--------------|-------------------|--------------------|------------------------------------------|----|----|
| 13           | Foreign Reference | WO2014101734A1.pdf | 728234                                   | no | 18 |
|              |                   |                    | c1d700ac238628f508823cce0ecb737fb652c26  |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 14           | Foreign Reference | WO2014150704A2.pdf | 828026                                   | no | 19 |
|              |                   |                    | 394f7aaf1d89f7d22a7e415029137a7bba8cf56a |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 15           | Foreign Reference | WO2014205263A1.pdf | 1056949                                  | no | 35 |
|              |                   |                    | 6db12fe466b36da318f6c948f7acc69fe1c2eda  |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 16           | Foreign Reference | WO2015028815A1.pdf | 1594036                                  | no | 33 |
|              |                   |                    | 9d638f363ab8782b303dc2a82e54d0bdec971717 |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 17           | Foreign Reference | WO2015058387A1.pdf | 931263                                   | no | 23 |
|              |                   |                    | 341e193f14ba9602ebfd6abe761969c79c44fc8b |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 18           | Foreign Reference | WO2015063126A1.pdf | 1411710                                  | no | 39 |
|              |                   |                    | e0ef616442510431ce0ffff8802d5ad5f81cb1c2 |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |
| 19           | Foreign Reference | WO2015089711A1.pdf | 1209458                                  | no | 27 |
|              |                   |                    | 7e7365e68bb5bc9fe94eafda5fcd512f93a6dcb  |    |    |
| Warnings:    |                   |                    |                                          |    |    |
| Information: |                   |                    |                                          |    |    |

|                              |                       |                                                      |                                           |    |    |
|------------------------------|-----------------------|------------------------------------------------------|-------------------------------------------|----|----|
| 20                           | Foreign Reference     | WO2015109616A1.pdf                                   | 667054                                    | no | 18 |
|                              |                       |                                                      | d3aafca22d01992c54b1a974c2f1d23659d14517  |    |    |
| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| 21                           | Non Patent Literature | Bradley_et_al_ElectronicCigaretteAerosol_2012.pdf    | 5098764                                   | no | 10 |
|                              |                       |                                                      | f8b6e76dddde2d5e4306ba1de5d0ec91180c45a66 |    |    |
| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| 22                           | Non Patent Literature | Bullen_EffectElectronicNicotine_2010.pdf             | 3656275                                   | no | 7  |
|                              |                       |                                                      | dcdaf01d833bb249ef0884fa3718b17416ec42a0  |    |    |
| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| 23                           | Non Patent Literature | Caponnetto_et_al_SuccessfulSmokingCessation_2011.pdf | 2503183                                   | no | 6  |
|                              |                       |                                                      | 756b138489ce9750e025de03abdef56f0d476156  |    |    |
| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| 24                           | Non Patent Literature | Hurt_et_al_TreatingTobaccoDependence_2009.pdf        | 13685927                                  | no | 13 |
|                              |                       |                                                      | a8e5b848e6aac6a987c0fc18291c770e1fd3bc6d  |    |    |
| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| 25                           | Fee Worksheet (SB06)  | fee-info.pdf                                         | 30628                                     | no | 2  |
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| Warnings:                    |                       |                                                      |                                           |    |    |
| Information:                 |                       |                                                      |                                           |    |    |
| Total Files Size (in bytes): |                       |                                                      | 54007356                                  |    |    |

**This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.**

**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

**CERTIFICATE OF TRANSMISSION UNDER 37 CFR 1.8**

I hereby certify that this correspondence is being transmitted to the USPTO via EFS-Web on December 15, 2016.

/Brian Flick/  
Brian Flick

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 14/925,968 Confirmation No.: 2707  
 First Named Inventor : Adam Bowen  
 Filed : October 28, 2015  
 Art Unit : 1747  
 Examiner : Mayes, Dionne Walls  
 Title : NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES  
 AND METHODS THEREOF  
 Customer No. : 66854

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**INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.97 & § 1.98**

Sir:

In accordance with 37 CFR § 1.97-1.98, applicants hereby submit an Information Disclosure Statement, including attached forms(s) PTO/SB/08. A copy of each reference is being submitted herewith, along with a concise explanation in English for those publications in a foreign language.

Applicants respectfully request that the listed information be considered by the Examiner and be made of record in the above-identified application. Applicants further request that the Examiner initial and return a copy of the attached form(s) PTO/SB/08 in accordance with MPEP §609.

Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and /or to prove that this information may not be enabling for the teachings purportedly offered.

This statement is not intended to represent that a search has been made or that the information cited in the statement is, or is considered to be, prior art or material to patentability as defined in 37 CFR §1.56.

**FILING OF INFORMATION DISCLOSURE STATEMENT**

☐ **37 CFR §1.97(b)**

This statement is being submitted under 37 CFR §1.97(b) because the IDS is being filed:

- ☐ 1). Within 3 months of the application filing date, or
- ☐ 2). Within 3 months of entry of a national stage as set forth in § 1.491, or
- ☐ 3). Before the mail date of a first Office Action on the merits, or
  - ☐ 3a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below
- ☐ 4). With or after the filing of a request for continued examination (RCE) under § 1.114 but before the mailing date of a first Office Action (after RCE).
  - ☐ 4a). Certifications as specified in § 1.97(e) and § 1.704(d) are provided below



☒ **37 CFR § 1.97(c)**

This statement is being filed after the latest of:

- ☐ 1). Three months beyond the filing date of a national application, or
- ☐ 2). Three months beyond the date of entry of the national stage as set forth in § 1.491 in an international application, or
- ☒ 3). The mailing date of a first Office Action on the merits, but before the mailing date of the earlier of a final Office Action under § 1.113 or a Notice of Allowance under § 1.311, and then either:
  - ☒ A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or included with the payment of other papers filed together with this statement.
  - or
  - ☐ B). A certification as specified in § 1.97(e) is provided below; thus no fee is required.

☐ **37 CFR § 1.97(d)**

This statement is being filed after the mailing date of a Final Office action, a Notice of Allowance under §1.311, or an action that otherwise closes prosecution, but on or before payment of the issue fee, and then:

A). A fee of \$180 (\$90 for small entity) as set forth in § 1.17(p) is authorized below, enclosed, or payment is included with other papers filed together with this statement

--AND--

B). A certification as specified in § 1.97(e) is included below.

**CONTENT OF INFORMATION DISCLOSURE STATEMENT UNDER**  
**37 CFR § 1.98**

☒ **37 CFR §1.98 (a)(2)(ii), U.S. patents or patent application publication(s) cited**

- ☒ 1). Since not requested by the Office, U.S. patents and U.S. patent application publications are not included.
- ☐ 2). At the request of the Office, a copy of the following U.S. patent or patent application publication is attached:
- ☐ 3). Items identified by a double asterisk (\*\*) on the SB08A are \*commonly-owned U.S. patents and U.S. patent application publications.

☐ **37 CFR §1.98 (a)(2)(iii) and (d), \*Commonly-owned, unpublished U.S. applications cited**

- ☐ 1). A copy of each application specification including the claim(s), and any drawing, or that portion of the application that caused it to be listed, is attached.
- ☐ 2). A copy of each application specification is not submitted because the specification was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☐ 3). A copy of each application specification is not submitted because the application is stored in the IFW. Cite no(s):

*\*Applicant(s) assume the Examiner has access to the file histories of these items. However, if the Examiner would like to receive copies of Office Actions in any of the commonly-owned applications, publications and/or patents identified on the attached SB08, please inform the undersigned and copies will be provided.*

☒ **37 CFR §1.98 (a)(2)(iii) and (d), English language publication (other than U.S. patents, patent applications, or pending unpublished applications) cited**

- ☒ 1). A legible copy of each publication or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each publication or that portion which caused it to be listed is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

- ☒ 37 CFR §1.98 (a)(2)(i) and (d), Foreign patent(s) in English cited
- ☒ 1). A legible copy of each foreign patent or that portion which caused it to be listed is attached.
- ☐ 2). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:
- ☒ 37 CFR §1.98 (a)(2)(i), (a)(3)(i-ii) and 609.04(a)III, Foreign patent(s) or other foreign documents not in English cited. Either:
- ☒ 1). A legible copy of each foreign patent, each publication or that portion which caused it to be listed, is attached --AND--
- ☒ 2a). An English language abstract or an English language copy of a foreign search report or other action by a foreign patent office is provided herewith to fulfill the requirement for a concise explanation of the relevance, as it is presently understood by the individual designated in § 1.56(c) most knowledgeable about the content of the information, of each patent, publication, or other information listed that is not in the English language: Cite no(s): 416, 420, 433, 446, 450, and 452 --AND/OR--
- ☐ 2b). A copy of a written, English-language translation or portion thereof is readily available and attached: Cite no(s):
- OR--
- ☐ 3). A copy of each foreign patent is not submitted because the publication was previously submitted in the IDS of the following, earlier filed application relied on for an earlier effective filing date:

**STATEMENT UNDER 37 CFR § 1.97(e)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. Cite no(s):
- ☐ No item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of the information disclosure statement. Cite no(s):

**STATEMENT UNDER 37 CFR § 1.704(d)**

- ☐ Each item of information contained in the information disclosure statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

**FEE AUTHORIZATION**

- ☒ The Commissioner is hereby authorized to charge the above-referenced fees of \$90.00 and charge any additional fees or credit any overpayment associated with this communication to Deposit Account No. 50-4050.

Respectfully Submitted,

Dated: December 15, 2016

By: /Richard D. Shoop/  
Richard D. Shoop, Reg. No. 45,763

Shay Glenn LLP  
2755 Campus Drive, Suite 210  
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(650) 212-1700  
Customer No. 66854

I hereby certify that this correspondence is being filed via  
EFS-Web with the United States Patent and Trademark Office  
on April 3, 2017.

PATENT  
Attorney Docket No.: 52210-501C02US

MINTZ LEVIN COHN FERRIS GLOVSKY AND POPEO pc

By: /Teri Barnett /

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of:  
Adam Bowen et al.

Application No.: 14/925,968

Confirmation No.: 2707

Filed: October 28, 2015

Art Unit: 1747

For: NICOTINE SALT FORMULATIONS FOR  
AEROSOL DEVICES AND METHODS  
THEREOF

Examiner: Dionne W. MAYES

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**AMENDMENT IN RESPONSE TO THE NON-FINAL OFFICE ACTION**

In response to the Non-Final Office Action dated December 2, 2016, please amend  
the above-identified U.S. patent application as follows:

**Amendments to the Claims** begin on page **2** of this paper.

**Remarks** begin on page 6 of this paper.

| Electronic Patent Application Fee Transmittal |          |                                                                    |        |                      |
|-----------------------------------------------|----------|--------------------------------------------------------------------|--------|----------------------|
| Application Number:                           |          | 14925968                                                           |        |                      |
| Filing Date:                                  |          | 28-Oct-2015                                                        |        |                      |
| Title of Invention:                           |          | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |        |                      |
| First Named Inventor/Applicant Name:          |          | Adam BOWEN                                                         |        |                      |
| Filer:                                        |          | Fred C. Hernandez/Teri Barnett                                     |        |                      |
| Attorney Docket Number:                       |          | 13211-713.303                                                      |        |                      |
| Filed as Small Entity                         |          |                                                                    |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                                                    |        |                      |
| Description                                   | Fee Code | Quantity                                                           | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                                                    |        |                      |
| Pages:                                        |          |                                                                    |        |                      |
| Claims:                                       |          |                                                                    |        |                      |
| Miscellaneous-Filing:                         |          |                                                                    |        |                      |
| Petition:                                     |          |                                                                    |        |                      |
| Patent-Appeals-and-Interference:              |          |                                                                    |        |                      |
| Post-Allowance-and-Post-Issuance:             |          |                                                                    |        |                      |
| Extension-of-Time:                            |          |                                                                    |        |                      |

| Description                       | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|-----------------------------------|----------|----------|--------|----------------------|
| Extension - 1 month with \$0 paid | 2251     | 1        | 100    | 100                  |
| Miscellaneous:                    |          |          |        |                      |
| Total in USD (\$)                 |          |          |        | 100                  |

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 28819869                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Fred C. Hernandez/Teri Barnett                                     |
| <b>Filer Authorized By:</b>                 | Fred C. Hernandez                                                  |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 03-APR-2017                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 18:05:42                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

|                                          |                             |
|------------------------------------------|-----------------------------|
| Submitted with Payment                   | yes                         |
| Payment Type                             | DA                          |
| Payment was successfully received in RAM | \$ 100                      |
| RAM confirmation Number                  | 040417INTEFSW00005266500311 |
| Deposit Account                          | 500311                      |
| Authorized User                          | Teri Barnett                |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.19 (Document supply fees)

37 CFR 1.21 (Miscellaneous fees and charges)

|                              |                                                       |                              |                                           |                  |                  |
|------------------------------|-------------------------------------------------------|------------------------------|-------------------------------------------|------------------|------------------|
|                              |                                                       |                              |                                           |                  |                  |
| File Listing:                |                                                       |                              |                                           |                  |                  |
| Document Number              | Document Description                                  | File Name                    | File Size(Bytes)/ Message Digest          | Multi Part /.zip | Pages (if appl.) |
| 1                            |                                                       | 52210_501C02US_Amendment.pdf | 190358                                    | yes              | 10               |
|                              |                                                       |                              | babe53480cf31c735b3422504db974b2089e6b84  |                  |                  |
|                              | Multipart Description/PDF files in .zip description   |                              |                                           |                  |                  |
|                              | Document Description                                  |                              | Start                                     | End              |                  |
|                              | Applicant Arguments/Remarks Made in an Amendment      |                              | 6                                         | 10               |                  |
|                              | Claims                                                |                              | 2                                         | 5                |                  |
|                              | Amendment/Req. Reconsideration-After Non-Final Reject |                              | 1                                         | 1                |                  |
| Warnings:                    |                                                       |                              |                                           |                  |                  |
| Information:                 |                                                       |                              |                                           |                  |                  |
| 2                            | Fee Worksheet (SB06)                                  | fee-info.pdf                 | 30658                                     | no               | 2                |
|                              |                                                       |                              | f9cb468177bbbadc5dfbe4a6ec82b27e76bb885b4 |                  |                  |
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| Total Files Size (in bytes): |                                                       |                              | 221016                                    |                  |                  |

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**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**



## **REMARKS**

### **Claim Status**

Claims 1, 7, 13 and 23 are amended. Support for the amendments may be found throughout the application as filed, for example at paragraph [0070]. Therefore, no new matter has been added. With entry of this amendment, claims 1-3, 6-10, 12-18 and 20-23 will be pending and under examination.

### **Claim Rejections**

#### **35 U.S.C. § 112(a)**

The Office states that claims 7-20 and 22-23 are rejected under 35 U.S.C. § 112(a) first paragraph, as failing to comply with the written description requirement. Applicants note that claims 1-3, 7-10, 13-18 and 21-23 are pending and, therefore, have interpreted the rejection as applying to pending claims 7-10, 13-18 and 21-23.

The Office asserts that recitation of heart rate increases within the time periods recited in the previously pending claims are not supported by the evidence provided in Declaration of Adam Bowen. Applicants respectfully disagree.

In an effort to expedite prosecution, however, Applicants have amended the claims by removing the recitations at issue thereby rendering the rejection moot. Therefore, Applicants respectfully request withdrawal of the rejection.

#### **35 U.S.C. § 103**

Claims 1-3, 7-10, 13-18 and 21-23 are rejected under 35 U.S.C. § 103 as being unpatentable over Sebastian et al. (U.S. Patent Publication No. 2014/0000638) hereinafter “Sebastian”. Claims 6, 12 and 20 are rejected under 35 U.S.C. § 103 as being unpatentable over Sebastian in view of Gonda (U.S. Patent Publication No. 2014/0261474) hereinafter “Gonda”. Applicants respectfully disagree.

Nonetheless, in an effort to expedite prosecution, Applicants have amended the claims to specify that the recited aerosol includes protonated nicotine in an amount effective to increase the heart rate of a user.

None of the art cited by the Office teaches or suggests ***an aerosol containing a protonated nicotine*** as set forth in the pending claims as amended. For example, Sebastian merely teaches that certain organic acids may be included as a component of a composition ***prior to aerosolization*** for the purpose of ***altering flavor***. Sebastian lists several organic acids as flavoring agents, including levulinic acid, lactic acid and pyruvic acid, in addition to other flavoring agents such as vanillin, tea, coffee, fruit, cocoa, and many others. *See* Sebastian at paragraph [0059].

Nothing in Sebastian indicates that the suggested use of organic acids in a composition prior to aerosolization for the purpose of altering flavor would somehow result in protonated nicotine in the resulting aerosol, much less a sufficient amount of protonated nicotine to increase the heart rate of the user, as set forth in Applicants' amended claims.

Indeed, Sebastian teaches that lactic acid and other flavoring agents can be delivered to the heating element ***separately*** from other components, such as nicotine. *See* Sebastian at paragraph [0059]. In fact, the entire purpose of Sebastian is to provide ***separate delivery of two or more components*** of an aerosol precursor composition to one or more heaters so as ***to separately control the rate of delivery or heating*** of the separate components of the various portions of the aerosol precursor composition. *See e.g.* Sebastian at Abstract and Title. There is no disclosure in Sebastian indicating that separately supplying nicotine and lactic acid to one or more heaters so as to separately control their respective rate of delivery or heating would somehow result in protonated nicotine in the aerosol as set forth in Applicants' amended claims.

Moreover, Sebastian teaches that flavorants "can be provided ***on a substrate*** positioned within the aerosolization zone so as ***to be stored separate*** from the further components of the aerosol precursor composition." *See* Sebastian at paragraph [0059]. There is no disclosure in Sebastian indicating that the inclusion of lactic acid on a substrate within the aerosolization zone would somehow result in protonated nicotine in the aerosol, much less produce a sufficient amount of protonated nicotine to increase the heart rate of the user as set forth in Applicants' amended claims.

Nothing in Sebastian indicates that sufficient amounts of acid are combined with nicotine ***in a single nicotine formulation***, as presently claimed, in order to achieve formation of an aerosol containing protonated nicotine. Moreover, nothing in Sebastian indicates that sufficient amounts of acid are combined with nicotine ***with glycerol and propylene glycol in a single***

*nicotine formulation*, as presently claimed, in order to achieve formation of an aerosol containing protonated nicotine.

In fact, similar to the separate delivery of nicotine and organic acid flavorants, Sebastian further teaches that glycerol and propylene glycol can be delivered separately:

In one embodiment, *first reservoir layer 201 can include a polyol, such as glycerol, and a further component, such as nicotine, and second reservoir 202 can include a different polyol, such as propylene glycol.* The first reservoir layer 201 is in fluid connection with a first transport element 301 (a wick in this embodiment), and the second reservoir layer 202 is in fluid connection with a second transport element 302 (a wick in this embodiment). The first wick 301 and the second wick 302 separately transport the components of the aerosol precursor composition stored in the respective reservoir layers via capillary action to the aerosolization zone 400 of the cartridge 90. As illustrated, the first wick 301 and the second wick 302 essentially merge in the aerosolization zone 400 to form a single wick that this in direct contact with the resistive heating element 50 that is in the form of a metal wire coil in this embodiment.

See Sebastian at paragraph [0108]. There is no disclosure in Sebastian indicating that the separate delivery of glycerol and propylene glycol at different rates or to different heaters would somehow produce a composition that would allow protonated nicotine to form in the aerosol. And there is certainly no indication in Sebastian that a sufficient amount of protonated nicotine would be produced to increase the heart rate of the user as set forth in Applicants' amended claims.

Because Sebastian fails to teach or suggest protonated nicotine in the aerosol, much less any benefits of having protonated nicotine in the aerosol, a person having ordinary skill in the art would have *no reason* to modify the teachings of Sebastian to provide an aerosol having protonated nicotine. Even if the cited art did provide some reason to form an aerosol with protonated nicotine, nothing in the cited art indicates that a person having ordinary skill in the art would have *reasonably expected* to successfully increase the heart rate of the user.

As set forth in the previously submitted Declaration of Adam Bowen submitted, prior to Applicants' invention, "those of skill in the art believed that vaporized nicotine did not result in an effect on heart rate comparable to that seen with a traditional cigarette." See the Declaration of Adam Bowen previously submitted on December 12, 2016 at paragraph (7). It was Applicants' invention that protonated nicotine, for example in the form of nicotine lactate, resulted in a significant increase in heart rate. Prior to this discovery, a person having ordinary

skill in the art would have had ***no reason*** to form an aerosol with protonated nicotine and certainly ***no reasonable expectation*** of successfully doing so.

With regard to the rejection of claims 6, 12, 17, 18 and 20, Applicants respectfully submit that Griffith, Jr. and Gonda fail to cure the defects of Sebastian. Like Sebastian, nothing in Griffith, Jr. or Gonda teaches or suggests ***an aerosol containing a protonated nicotine*** as set forth in the pending claims as amended, much less a sufficient amount of protonated nicotine to increase the heart rate of the user as set forth in Applicants' amended claims.

For at least the reasons recited above, Applicants respectfully request withdrawal of the obviousness rejection.

**CONCLUSION**

In view of the foregoing amendments and remarks, reconsideration is respectfully requested. This application should now be in condition for allowance; a notice to this effect is respectfully requested. If the Examiner believes, after this amendment, that the application is not in condition for allowance, the Examiner is requested to call the Applicant's attorney at the telephone number listed below.

Except for the issue fees payable under 37 C.F.R. § 1.18, the Commissioner is authorized to charge any fees that may be due in connection with the filing of this paper, or to credit any overpayment thereof, to Deposit Account No. 50-0311 referencing the above-identified attorney docket number.

Respectfully submitted,

/Ken Jenkins /  
Kenneth E. Jenkins, Ph.D.  
Registration No. 51,846

MINTZ LEVIN COHN FERRIS GLOVSKY AND POPEO, P.C.

### AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings in the above-referenced patent application. The foregoing amendments are without prejudice and do not constitute an admission regarding the patentability of the amended subject matter and should not so be construed.

1. (Currently Amended) A method of delivering nicotine to a user comprising:  
deploying a low-temperature vaporizer comprising a nicotine formulation that  
comprises nicotine, lactate, and a biologically acceptable liquid carrier, wherein:
  - a. the nicotine ~~lactate~~ concentration is about 4% (w/w);
  - b. the biologically acceptable liquid carrier comprises glycerol and propylene glycol; and
  - c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol ~~of~~ comprising an amount of protonated nicotine effective to increase the heart rate of said user[[;]]  
~~wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes from the first puff.~~
2. (Previously presented) The method of claim 1, wherein a molar ratio of nicotine to lactic acid is between about 1:1 and 1:3.
3. (Original) The method of claim 1, wherein the nicotine formulation further comprises at least one flavorant.
4. (Cancelled)
5. (Cancelled)
6. (Original) The method of claim 1, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.

7. (Currently Amended) A method of delivering nicotine to a user comprising:  
deploying a low-temperature vaporizer comprising a nicotine formulation that comprises nicotine, lactate, and a biologically acceptable liquid carrier, wherein:
  - a. the nicotine ~~lactate~~ concentration is from about 4% (w/w) to about 6.5% (w/w);
  - b. the biologically acceptable liquid carrier comprises glycerol and propylene glycol propylene diol; and
  - c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to the heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol comprising an amount of protonated nicotine effective to increase the heart rate of said user[[;]]

~~wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes from the first puff.~~
8. (Previously presented) The method of claim 7, wherein a molar ratio of nicotine to lactic acid is between 1:1 and 1:3.
9. (Original) The method of claim 7, wherein the nicotine formulation further comprises at least one flavorant.
10. (Original) The method of claim 7, wherein the nicotine concentration is about 4.5%.
11. (Cancelled)
12. (Original) The method of claim 7, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.
13. (Currently Amended) A low-temperature vaporizer, comprising:  
a liquid reservoir;

a nicotine formulation within the liquid reservoir, the nicotine formulation comprising:

nicotine ~~lactate~~;  
**propylene glycol**; and  
glycerol;

wherein a concentration of the nicotine ~~lactate~~ in the nicotine formulation is about 4% (w/w) to about 6.5% (w/w);

a vaporizing component configured to produce an aerosol from the nicotine formulation by heating at least a portion of the nicotine formulation, **wherein the aerosol comprises an amount of protonated nicotine effective to increase the heart rate of a user of said low-temperature vaporizer,**

wherein the liquid reservoir is connected to the vaporizing component by a wick; and  
a mouthpiece configured to connect to the reservoir for inhalation of the aerosol[[:]]

~~wherein inhalation of the aerosol into the user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 5 minutes from the first puff.~~

14. (Original) The electronic cigarette of claim 13, further comprises a battery configured to provide power to the vaporizing component.

15. (Previously presented) The electronic cigarette of claim 13, wherein a molar ratio of nicotine to lactic acid is between 1:1 and 1:3.

16. (Original) The electronic cigarette of claim 13, wherein the nicotine formulation further comprises at least one flavorant.

17. (Original) The electronic cigarette of claim 13, wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation.

18. (Original) The electronic cigarette of claim 13, wherein the nicotine concentration is about 4.5%.

19. (Cancelled)



20. (Original) The electronic cigarette of claim 13, wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns.
21. (Previously presented) The method of claim 1, wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.
22. (Previously presented) The method of claim 7, wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin.
23. (Currently Amended) A method of delivering nicotine to a user comprising: deploying a low-temperature vaporizer comprising a nicotine formulation that comprises nicotine ~~lactate~~, and a biologically acceptable liquid carrier, wherein:
- a. the nicotine ~~lactate~~ concentration is about 4.5% (w/w);
  - b. the biologically acceptable liquid carrier comprises glycerol and propylene glycol; and
  - c. operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol ~~of nicotine lactate~~, wherein the inhalable aerosol comprises an amount of protonated nicotine effective to increase the heart rate of the user[[;]]
- ~~wherein inhalation of the aerosol into a user's lungs increases heart rate comparable to inhaling a traditional burned cigarette in that inhaling 10 puffs of the aerosol over a period of about 3 minutes results in an increase in heart rate that peaks within about 3.5 minutes from the first puff.~~

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

|                                                                                   |                                                   |                                  |                                       |
|-----------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------------------------------|
| <b>PATENT APPLICATION FEE DETERMINATION RECORD</b><br>Substitute for Form PTO-875 | Application or Docket Number<br><b>14/925,968</b> | Filing Date<br><b>10/28/2015</b> | <input type="checkbox"/> To be Mailed |
|-----------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------------------------------|

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

### APPLICATION AS FILED – PART I

| FOR                                                                        | NUMBER FILED | NUMBER EXTRA | RATE (\$)                                                                                                                                                                                                                     | FEE (\$) |
|----------------------------------------------------------------------------|--------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <input type="checkbox"/> BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))        | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| <input type="checkbox"/> SEARCH FEE<br>(37 CFR 1.16(k), (j), or (m))       | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| <input type="checkbox"/> EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))  | N/A          | N/A          | N/A                                                                                                                                                                                                                           |          |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                           | minus 20 =   | *            | X \$ =                                                                                                                                                                                                                        |          |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                     | minus 3 =    | *            | X \$ =                                                                                                                                                                                                                        |          |
| <input type="checkbox"/> APPLICATION SIZE FEE<br>(37 CFR 1.16(s))          |              |              | If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). |          |
| <input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j)) |              |              |                                                                                                                                                                                                                               |          |
| * If the difference in column 1 is less than zero, enter "0" in column 2.  |              |              | TOTAL                                                                                                                                                                                                                         |          |

### APPLICATION AS AMENDED – PART II

| AMENDMENT | (Column 1)                                                                               | (Column 2)                       | (Column 3) | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$)       | ADDITIONAL FEE (\$) |
|-----------|------------------------------------------------------------------------------------------|----------------------------------|------------|------------------------------------|---------------|-----------------|---------------------|
|           | <b>04/03/2017</b>                                                                        | CLAIMS REMAINING AFTER AMENDMENT |            |                                    |               |                 |                     |
|           | Total (37 CFR 1.16(i))                                                                   | * 18                             | Minus      | ** 20                              | = 0           | x \$40 =        | 0                   |
|           | Independent (37 CFR 1.16(h))                                                             | * 4                              | Minus      | ***4                               | = 0           | x \$210 =       | 0                   |
|           | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |               |                 |                     |
|           | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |               |                 |                     |
|           |                                                                                          |                                  |            |                                    |               | TOTAL ADD'L FEE | <b>0</b>            |

| AMENDMENT | (Column 1)                                                                               | (Column 2)                       | (Column 3) | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE (\$)       | ADDITIONAL FEE (\$) |
|-----------|------------------------------------------------------------------------------------------|----------------------------------|------------|------------------------------------|---------------|-----------------|---------------------|
|           |                                                                                          | CLAIMS REMAINING AFTER AMENDMENT |            |                                    |               |                 |                     |
|           | Total (37 CFR 1.16(i))                                                                   | *                                | Minus      | **                                 | =             | X \$ =          |                     |
|           | Independent (37 CFR 1.16(h))                                                             | *                                | Minus      | ***                                | =             | X \$ =          |                     |
|           | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |               |                 |                     |
|           | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |               |                 |                     |
|           |                                                                                          |                                  |            |                                    |               | TOTAL ADD'L FEE |                     |

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.  
 \*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".  
 \*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".  
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SLIE  
ALA HUNTER

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

## TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

|                                                                                                                                                                                        |                                                                    |                     |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------------|----------------|
| Application Number                                                                                                                                                                     | 14/925,968                                                         |                     |                |
| Filing Date                                                                                                                                                                            | October 28, 2015                                                   |                     |                |
| First Named Inventor                                                                                                                                                                   | Adam Bowen                                                         |                     |                |
| Title                                                                                                                                                                                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |                     |                |
| Art Unit                                                                                                                                                                               | 1747                                                               |                     |                |
| Examiner Name                                                                                                                                                                          | D. W. Mayes                                                        |                     |                |
| Attorney Docket Number                                                                                                                                                                 | 52210-501C02US                                                     |                     |                |
| <b>SIGNATURE of Applicant or Patent Practitioner</b>                                                                                                                                   |                                                                    |                     |                |
| Signature                                                                                                                                                                              | /Ken Jenkins/                                                      | Date (Optional)     | April 25, 2017 |
| Name                                                                                                                                                                                   | Kenneth E. Jenkins, Ph.D.                                          | Registration Number | 51,846         |
| Title (if Applicant is a juristic entity)                                                                                                                                              |                                                                    |                     |                |
| Applicant Name (if Applicant is a juristic entity)                                                                                                                                     |                                                                    |                     |                |
| <b>NOTE:</b> This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms. |                                                                    |                     |                |
| <input type="checkbox"/> *Total of <u>1</u> forms are submitted.                                                                                                                       |                                                                    |                     |                |

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## POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

| Application Number | Filing Date |
|--------------------|-------------|
|                    |             |

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

64046

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

|                         |       |     |  |
|-------------------------|-------|-----|--|
| Firm or Individual Name |       |     |  |
| Address                 |       |     |  |
| City                    | State | Zip |  |
| Country                 |       |     |  |
| Telephone               | Email |     |  |

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

PAX Labs, Inc.

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

### SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

|           |                                                                                     |                 |        |
|-----------|-------------------------------------------------------------------------------------|-----------------|--------|
| Signature |  | Date (Optional) | 4/5/17 |
| Name      | Ashley C. Gould                                                                     |                 |        |
| Title     | General Counsel, Chief Regulatory and Communications Officer                        |                 |        |

**NOTE:** Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of 1 forms are submitted.

## Electronic Acknowledgement Receipt

|                                             |                                                                    |
|---------------------------------------------|--------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 29025220                                                           |
| <b>Application Number:</b>                  | 14925968                                                           |
| <b>International Application Number:</b>    |                                                                    |
| <b>Confirmation Number:</b>                 | 2707                                                               |
| <b>Title of Invention:</b>                  | NICOTINE SALT FORMULATIONS FOR AEROSOL DEVICES AND METHODS THEREOF |
| <b>First Named Inventor/Applicant Name:</b> | Adam BOWEN                                                         |
| <b>Customer Number:</b>                     | 66854                                                              |
| <b>Filer:</b>                               | Kenneth Edwin Jenkins/Teri Barnett                                 |
| <b>Filer Authorized By:</b>                 | Kenneth Edwin Jenkins                                              |
| <b>Attorney Docket Number:</b>              | 13211-713.303                                                      |
| <b>Receipt Date:</b>                        | 25-APR-2017                                                        |
| <b>Filing Date:</b>                         | 28-OCT-2015                                                        |
| <b>Time Stamp:</b>                          | 17:00:03                                                           |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                        |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description | File Name              | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
|-----------------|----------------------|------------------------|------------------------------------------|------------------|------------------|
| 1               | Power of Attorney    | 52210_501C02US_POA.pdf | 80168                                    | no               | 2                |
|                 |                      |                        | 48740028d7916dac6c441d3da6bdc56395536bd5 |                  |                  |

### Warnings:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 80168 |
| <p><b>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> <b>If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> <b>If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> <b>If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</b></p> |       |



UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office  
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P.O. Box 1450  
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www.uspto.gov

| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 14/925,968         | 10/28/2015            | Adam BOWEN            | 13211-713.303          |

**CONFIRMATION NO. 2707**

**POWER OF ATTORNEY NOTICE**



\*CC000000090948909\*

66854  
SHAY GLENN LLP  
2755 CAMPUS DRIVE  
SUITE 210  
SAN MATEO, CA 94403

Date Mailed: 04/28/2017

**NOTICE REGARDING CHANGE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 04/25/2017.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/sleutchit/



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| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 14/925,968         | 10/28/2015            | Adam BOWEN            | 13211-713.303          |

64046  
Mintz Levin/San Diego Office  
One Financial Center  
Boston, MA 02111

**CONFIRMATION NO. 2707**  
**POA ACCEPTANCE LETTER**



Date Mailed: 04/28/2017

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 04/25/2017.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/sleutchit/





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Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NUMBER | PATENT NUMBER | GROUP ART UNIT | REQUEST ID |
|--------------------|---------------|----------------|------------|
| 14/925,968         |               | 1747           | 40380      |

## PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 148514 on 05/23/2017 via Private PAIR in view of the certification copied below that authorized the change.

- Correspondence Address

The address for Customer Number 148514 is:

148514

Mintz Levin/PAX

One Financial Center

Boston, MA 02111

### I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

|                             |                    |
|-----------------------------|--------------------|
| <b>Signature:</b>           | /Ken Jenkins/      |
| <b>Name:</b>                | Kenneth E. Jenkins |
| <b>Registration Number:</b> | 51846              |



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P. O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO.                                             | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.             | CONFIRMATION NO. |
|-------------------------------------------------------------|-------------|----------------------|---------------------------------|------------------|
| 14/925,968                                                  | 10/28/2015  | Adam BOWEN           | 52210-501C02US /713.303         | 2707             |
| 148514                                                      | 7590        | 06/02/2017           |                                 |                  |
| Mintz Levin/PAX<br>One Financial Center<br>Boston, MA 02111 |             |                      | EXAMINER<br>MAYES, DIONNE WALLS |                  |
|                                                             |             |                      | ART UNIT                        | PAPER NUMBER     |
|                                                             |             |                      | 1747                            |                  |
|                                                             |             |                      | NOTIFICATION DATE               | DELIVERY MODE    |
|                                                             |             |                      | 06/02/2017                      | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

IPDocketingBOS@mintz.com  
IPFilerombos@mintz.com

|                              |                                      |                                     |                                                   |
|------------------------------|--------------------------------------|-------------------------------------|---------------------------------------------------|
| <b>Office Action Summary</b> | <b>Application No.</b><br>14/925,968 | <b>Applicant(s)</b><br>BOWEN ET AL. |                                                   |
|                              | <b>Examiner</b><br>DIONNE W. MAYES   | <b>Art Unit</b><br>1747             | <b>AIA (First Inventor to File) Status</b><br>Yes |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 4/3/2017.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on \_\_\_\_; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims\*

- 5) ☒ Claim(s) 1-3,7-10,13-18 and 21-23 is/are pending in the application.  
5a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 6) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 7) ☒ Claim(s) 1-3,7-10,13-18 and 21-23 is/are rejected.
- 8) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 9) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

\* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

### Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

#### Certified copies:

- a) ☐ All    b) ☐ Some\*\*    c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\*\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |                                                                                                                                          |                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                                                                         | 3) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____. |
| 2) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)<br>Paper No(s)/Mail Date ____. | 4) <input type="checkbox"/> Other: ____.                                                |

## DETAILED ACTION

### *Notice of AIA Status*

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

### ***Claim Rejections - 35 USC § 112***

2. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1-3, 6-10, 12-18 and 20-23 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, because the specification, while being enabling for “a method of delivering nicotine to a user” and “a low temperature vaporizer” comprising nicotine lactate and a biologically acceptable liquid carrier (as previously recited), does not reasonably provide enablement for “a method of delivering nicotine to a user” and “a low temperature vaporizer” comprising “nicotine, lactate, and a biologically acceptable liquid carrier...to generate an inhalable aerosol comprising an amount of protonated nicotine” or “nicotine; propylene glycol; and glycerol...[to] produce an aerosol from the nicotine formulation...wherein the aerosol comprises an amount of

protonated nicotine" (which is presently claimed). The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention commensurate in scope with these claims.

On October 28, 2015, Applicant filed the instant application which included recitation in independent claim 1 which claimed, in part, "method of delivering nicotine to a user comprising: deploying an electronic cigarette comprising a nicotine formulation that comprises nicotine, an organic acid, and a biologically acceptable liquid carrier" and independent claim 13 which claimed, in part, "An electronic cigarette, comprising...a nicotine formulation comprising: nicotine lactate; propylene glycol; and glycerol". This recitation accurately reflects the disclosure of the instant specification. The newly amended recitation of the independent claims, filed on April 3, 2017, however, reflect embodiments wherein nicotine/lactic acid (or an organic acid) or nicotine lactate is not required - resulting in the claims being open to be "read upon" by a reference in which an aerosolizable formulation may include nicotine with any lactate or no lactate at all - which is not commensurate in scope with that which is enabled by the instant disclosure. For purposes of Examination, the Examiner will interpret independent claims 1, 7 and 23 as if they were recited, in part, as follows: "nicotine formulation that comprises **nicotine lactate** and a biologically acceptable liquid carrier", and independent claim 13 will be interpreted as if it were recited, in part, "nicotine formulation comprising **nicotine lactate**, propylene glycol and glycerol". Correction is requested.

4. Claims 1-3, 6-10, 12-18 and 20-23 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention.

As stated above, the now-presented claimed invention, reflected by the newly amended recitation of the independent claims (filed on April 3, 2017), reflect embodiments wherein nicotine is provided, in a liquid carrier, with (any) lactate or where nicotine is not provided with an organic acid. These embodiments do not appear to be disclosed in the instant specification at all and, as such, is certainly not disclosed in such a way as to reasonably convey to one skill in art that the inventor had possession of the claimed invention at the time the application was filed. Correction is requested.

5. The following is a quotation of 35 U.S.C. 112(b):  
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:  
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 1-3, 6-10, 12-18 and 20-23 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

In all of the independent claims, Applicant has amended the claims to recite that a portion of the nicotine formulation generates an inhalable aerosol comprising an amount of “protonated nicotine”; however, it is not clear how protonated nicotine would result from a nicotine formulation having no proton-donor source (i.e., organic acid). As stated above, for examination purposes, the Examiner will interpret the claims as requiring “nicotine lactate” which was provided in previously-filed claim sets.

Further, independent claim 7 includes the recitation, “the biologically acceptable liquid carrier comprises glycerol and propylene glycol propylene diol”; however, it is not clear what “propylene glycol propylene diol” is, as this particular “substance” is not disclosed in the instant specification. The Examiner presumes that this recitation is a typo, and for purposes of Examination will interpret this portion of the claim to recite: “the biologically acceptable liquid carrier comprises glycerol and propylene glycol” as is similarly recited in independent claims 1, 13 and 23.

### ***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

8. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

9. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

10. Claims 1-3, 7-10, 13-18 and 21-23 are rejected under 35 U.S.C. 103 as being unpatentable over Sebastian et al (US. Pat. App. Pub. 2014/0000638).

Regarding independent claims 1 and 23, Sebastian et al discloses an electronic smoking article (i.e., electronic cigarette) that provides for delivery of aerosolized components of an aerosol precursor composition to at least one heating element (See abstract. Note: According to Applicant's instant disclosure, the terms "electronic cigarette" and "low temperature vaporization device" are synonymous. See instant published application, para. [0119]) (corresponding to the claimed "deploying a low-temperature vaporizer").

The aerosol precursor composition may include a medicament, such as nicotine, which may comprise up to 10% of the weight of the aerosol precursor (see para. [0060]). When nicotine is chosen, organic acids can be combined with the nicotine in



order to favorably affect the flavor, sensation, or organoleptic properties. Organic acids such as lactic acid may be used, such that the total amount of acid present is equimolar to the total amount of nicotine present in the aerosol precursor (see para. [0059]). The aerosol precursor composition may also include a polyol. Specifically, in one embodiment, the composition may include a polyol in the form of glycerol (in an amount of about 70%), and propylene glycol (in an amount ranging from about 1% to about 10%)(see para. [0060]-[0061]). Since the nicotine and lactic acid can be provided in equimolar ratios, it is presumed that "nicotine lactate" is thereby formed, resulting in the claimed "nicotine formulation that comprises nicotine lactate, and a biologically acceptable liquid carrier...the biologically acceptable liquid carrier comprises glycerol and propylene glycol".

Further, Sebastian et al discloses that, as a non-limiting example, an aerosol precursor composition may include nicotine in an amount of about 0.1-5.0%. This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of nicotine to add to the precursor composition and, in doing so, selected the high end of this range, i.e. 3-5%, after determining that such nicotine concentration provided for superior flavor, sensation and organoleptic properties for the user (Note: "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (corresponding to the claimed "the nicotine concentration is about 4%/4.5% (w/w)").

At least one wick can be used to transport the aerosolized components of the aerosol precursor composition from a reservoir to an aerosolization zone (i.e., at or around a resistive heating element) within the electronic smoking article (para. [0009]) (corresponding to the claimed “operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate”).

Lastly, it follows to reason, that the upon inhalation of the aerosolized vapor resulting from heating the aerosol precursor nicotine composition in the modified Sebastian et al electronic smoking article, the user would experience heart rate increase as, absent any indication to the contrary, such effects would “flow naturally” from use of said apparatus which contains the nicotine formulation since Applicant has already indicated, in the instant specification, that “nicotine is a chemical stimulant and increases heart rate...when provided to an individual” (para. [0110] of published application) (corresponding to the claimed “an inhalable aerosol comprising an amount of protonated nicotine effective to increase the heart rate of said user”).

Regarding claim 2, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para. [0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 3, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).

Regarding independent claims 7 and 13, and claims 10 and 17-18, Sebastian et al discloses an electronic smoking article (i.e., electronic cigarette) that provides for delivery of aerosolized components of an aerosol precursor composition to at least one heating element (See abstract. Note: According to Applicant's instant disclosure, the terms "electronic cigarette" and "low temperature vaporization device" are synonymous. See instant published application, para. [0119]) (corresponding to the claimed "deploying a low-temperature vaporizer").

The aerosol precursor composition may include a medicament, such as nicotine, which may comprise up to 10% of the weight of the aerosol precursor (see para. [0060]). When nicotine is chosen, organic acids can be combined with the nicotine in order to favorably affect the flavor, sensation, or organoleptic properties. Organic acids such as lactic acid may be used, such that the total amount of acid present is equimolar to the total amount of nicotine present in the aerosol precursor (see para. [0059]). The aerosol precursor composition may also include a polyol. Specifically, in one embodiment, the composition may include a polyol in the form of glycerol (in an amount of about 70%), and propylene glycol (in an amount ranging from about 1% to about 10%)(see para. [0060]-[0061]). Since the nicotine and lactic acid can be provided in equimolar ratios, it is presumed that "nicotine lactate" is thereby formed, resulting in the claimed "nicotine formulation that comprises nicotine lactate, and a biologically acceptable liquid carrier...the biologically acceptable liquid carrier comprises glycerol and propylene glycol".

Further, Sebastian et al discloses that, as a non-limiting example, an aerosol precursor composition may include nicotine in an amount of about 0.1-5.0%. This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of nicotine to add to the precursor composition and, in doing so, selected the high end of this range, i.e. 3-5%, after determining that such nicotine concentration provided for superior flavor, sensation and organoleptic properties for the user (Note: “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (corresponding to the claimed “the nicotine lactate concentration is from about 4% (w/w) to about 6.5% (w/w)”); and the “wherein the nicotine concentration is about 4.5%” recitation of claims 10 and 18).

At least one wick can be used to transport the aerosolized components of the aerosol precursor composition from a reservoir to an aerosolization zone (i.e., at or around a resistive heating element) within the electronic smoking article (para. [0009]) (corresponding to the claimed “operation of the low-temperature vaporizer comprises wicking the nicotine formulation to a heating element and heating at least a portion of the nicotine formulation to generate an inhalable aerosol of nicotine lactate”; and the “wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation” recitation of claim 17).

Lastly, it follows to reason, that the upon inhalation of the aerosolized vapor resulting from heating the aerosol precursor nicotine composition in the modified

Sebastian et al electronic smoking article, the user would experience the claimed heart rate increase as, absent any indication to the contrary, such effects would “flow naturally” from use of said apparatus which contains the nicotine formulation since Applicant has already indicated, in the instant specification, that “nicotine is a chemical stimulant and increases heart rate...when provided to an individual” (para. [0110] of published application)(corresponding to the claimed “an inhalable aerosol comprising an amount of protonated nicotine effective to increase the heart rate of said user”).

Regarding claim 8, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para. [0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 9, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).

Regarding claim 14, the electronic smoking article of Sebastian et al may include a battery (40)(see Fig. 1, para. [0078]) (corresponding to the claimed “further comprises a battery configured to provide power to the vaporizing component”).

Regarding claim 15, as stated above, Sebastian et al discloses that its aerosol precursor can include nicotine and lactic acid provided in equimolar ratios (see para. [0059]) (corresponding to the claimed “wherein a molar ratio of nicotine to organic acid is between about 1:1 and 1:3”).

Regarding claim 16, Sebastian et al discloses that its aerosol precursor material can be combined with more than one flavorant (see para. [0031]) (corresponding to the claimed “wherein the nicotine formulation further comprises at least one flavorant”).

Regarding claim 17, as stated above, Griffith, Jr. et al discloses that the aerosol, from an inside cavity, is vaporized by a resistive heating element (50) that heats the nicotine-containing aerosol precursor material located on a substrate (53)(see para. [0137])(corresponding to the claimed “wherein the vaporizing component comprises a heating element in fluid communication with the nicotine formulation”).

Regarding claim 18, Griffith, Jr. et al discloses that a specific non-limiting example of the nicotine content in its aerosol precursor may be about 2-3% by weight (see para. [00888]). However, it would have been obvious to one having ordinary skill in the art to have adjusted this amount to be a bit higher - corresponding to the claimed amount - in order to satisfy the particular organoleptic preferences of the user (corresponding to the claimed “wherein the nicotine concentration is about 4.5%”).

Regarding claims 21-22, Sebastian et al discloses that the aerosol precursor composition can take a variety of conformations, and may comprises up to 95% by weight of a polyol. This total amount can be split in any combination between two or more different polyols, such as glycerol (i.e., vegetable glycerol) and propylene glycol. This would motivate one of ordinary skill to undergo routine experimentation to find the optimal amount of each polyol to add to the precursor composition and, in doing so, selected the claimed polyol combination (Note: “[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or

workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955))(corresponding to the claimed “wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin” recitation of claim 21; and the “wherein the nicotine formulation comprises 20% to 50% of propylene glycol and 80% to 50% of vegetable glycerin” recitation of claim 22”).

11. Claims 6, 12 and 20 are rejected under 35 U.S.C. 103 as being unpatentable over Sebastian et al (US. Pat. App. Pub. 2014/0000638) in view of Gonda (US. Pat. No. 2014/0261474).

Regarding claims 6, 12 and 20, based on the disclosure of Gonda, that by decreasing the particle size, the aerosolized particles of nicotine will deposit deeper in the lungs, which increases the rate of absorption of the nicotine and leads to an increase in peak nicotine plasma levels, it would have been obvious to one having ordinary skill in the art to have optimized the particle size of its aerosol to fall between 0.1 - 5 microns (Corresponding to the claimed “wherein the inhalable aerosol has a particle size from about 0.1 microns to about 5 microns”).

### ***Response to Arguments***

12. Applicant's arguments filed April 3, 2017 have been fully considered but they are not persuasive.

-Applicant argues that the prior art fails to teach or reasonably suggest the claimed “aerosol containing a protonated nicotine”. Specifically, Applicant submits, nothing in the Sebastian reference indicates that the suggested use of organic acids in a composition (prior to aerosolization) for the purpose of altering flavor would somehow

result in protonated nicotine in the resulting aerosol, much less a sufficient amount of protonated nicotine to increase the heart rate of the user. The Examiner, however, disagrees. First, it is true that Sebastian lists several acids (lactic acid, included) to be included in the nicotine composition for the purpose of altering flavor (“flavoring agents”)(see Sebastian para. [0060]); however, regarding the instant invention, it is to be noted that Applicant has also articulated that organic acids (including lactic acid) coupled with nicotine to produce nicotine lactate can be used to provide flavor (see instant published application para. [0131]). Second, because Sebastian teaches an equimolar ratio of nicotine to organic acid, as stated above, it is more than reasonable to presume that “nicotine lactate” is thereby formed, resulting in the claimed “nicotine formulation that comprises nicotine lactate” which, in turn, would produce an “inhalable aerosol comprising an amount of protonated nicotine”. Lastly, Applicant points out that Sebastian states that lactic acid can be delivered to the heating element separately from other components, such as nicotine and/or the liquid carrier, and separately supplying the components to one or more heaters. Applicant further seems to suggest that, in such an arrangement, the formation of protonated nicotine is doubtful or uncertain. The Examiner submits that while Sebastian may disclose the separate delivery of the various components of the nicotine formulation, the Examiner wishes to point out that this appears to be one of many different ways in which the formulation of Sebastian can be delivered to the heater. Note the use of the words “can be” (see para. [0059]) of Sebastian. As disclosed above, the Examiner has also provided evidence in Sebastian that it envisions a formulation that includes a homogeneous mixture of nicotine, lactic



acid (hence, forming nicotine lactate) in a liquid carrier. Further, Sebastian even clearly articulates the same in para, [0058] where it states that "components [of the aerosol precursor composition] can be separately or simultaneously delivered to the resistive heating element for aerosolization in an air stream to be inhaled by a user".

### ***Conclusion***

13. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DIONNE W. MAYES whose telephone number is (571)272-5836. The examiner can normally be reached on Tuesdays and Thursdays, 8:00A - 4:30P.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael H. Wilson can be reached on (571) 270-3882. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DIONNE W MAYES/  
Examiner, Art Unit 1747

/MICHAEL H WILSON/  
Supervisory Patent Examiner, Art Unit 1747



## EAST Search History

## EAST Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                                         | DBs                                                      | Default Operator | Plurals | Time Stamp       |
|-------|------|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|------------------|---------|------------------|
| S1    | 3    | ((("20060195518") or ("20120256567") or ("20080241255")).PN.                                                         | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:41 |
| S2    | 3    | ((("20060195518") or ("20120255567") or ("20080241255")).PN.                                                         | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:41 |
| S3    | 2    | ((("20120255567") or ("20080241255")).PN.                                                                            | US-PGPUB; USPAT                                          | OR               | OFF     | 2015/01/20 11:42 |
| S4    | 0    | ("2006").pn. and (hon).in.                                                                                           | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 11:42 |
| S5    | 42   | (hon).in. and cigarette                                                                                              | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 11:44 |
| S6    | 25   | ("131"/\$ or "128"/\$).ccls. and electronic cigarette and nicotine and plasma                                        | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:06 |
| S7    | 6    | ("131"/\$ or "128"/\$).ccls. and (fuisz).in. and nicotine and plasma                                                 | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:06 |
| S8    | 91   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and plasma                                                 | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:15 |
| S9    | 25   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and plasma and ((max or maxim\$3) near25 time)             | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:16 |
| S10   | 23   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 near15 nicotine and (plasma near25 (peak or max or maxim\$3) near25 time)  | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:25 |
| S11   | 9    | ("131"/\$ or "128"/\$).ccls. and inhal\$5 same (nicotine same (plasma near25 (peak or max or maxim\$3) near25 time)) | US-PGPUB; USPAT; USOCR                                   | ADJ              | ON      | 2015/01/20 15:25 |
| S12   | 9    | ("131"/\$ or "128"/\$).ccls. and inhal\$5 same (nicotine same (plasma near25 (peak or max or maxim\$3) near25 time)) | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ              | ON      | 2015/01/20 15:26 |
| S13   | 32   | ("131"/\$ or "128"/\$).ccls. and inhal\$5 and (nicotine same (plasma near25 (peak or max or maxim\$3) same time))    | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ              | ON      | 2015/01/20 15:28 |
| S14   | 2    | ("131"/\$ or "128"/\$).ccls. and nicotine benzoate                                                                   | US-PGPUB; USPAT; USOCR; FPRS;                            | ADJ              | ON      | 2015/01/20 15:51 |

|     |     |                                                                                      |                                                                            |     |     |                     |
|-----|-----|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----|-----|---------------------|
|     |     |                                                                                      | EPO; JPO;<br>DERWENT;<br>IBM_TDB                                           |     |     |                     |
| S15 | 2   | (vaporiz\$3 or electronic cigarette) and nicotine benzoate                           | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:52 |
| S16 | 346 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine)                               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:53 |
| S17 | 230 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) same (acid )                  | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:54 |
| S18 | 210 | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) near35 (acid )                | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>15:55 |
| S19 | 17  | ("131"/\$ or "128"/\$).ccls. and (salt near5 nicotine) near35 (carboxylic or citric) | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>16:08 |
| S20 | 1   | ("2356185").PN.                                                                      | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>16:32 |
| S21 | 1   | ("2356185").PN.                                                                      | USOCR                                                                      | OR  | OFF | 2015/01/20<br>16:33 |
| S22 | 4   | nicotine benzoate                                                                    | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>16:38 |
| S23 | 1   | ("20010029959").PN.                                                                  | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>16:43 |
| S24 | 0   | electronic cigarette and inhal\$4 near25 every near15 (seconds or secs)              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/01/20<br>16:47 |
| S25 | 1   | nicotine and inhal\$4 near25 every near15 (seconds or secs)                          | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/01/20<br>16:48 |
| S26 | 1   | nicotine and inhal\$4 near25 every near15 (seconds or secs)                          | US-PGPUB;<br>USPAT;<br>USOCR;                                              | ADJ | ON  | 2015/01/20<br>16:59 |

|     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                            |     |     |                     |
|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----|-----|---------------------|
|     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                                  |     |     |                     |
| S27 | 53   | inhal\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:33 |
| S28 | 222  | puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:37 |
| S29 | 207  | ("131"/\$ or "128"/\$ or cigarette) and puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                    | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:40 |
| S30 | 179  | ("131"/\$ or "128"/\$) and puff\$4 near25 every near15 (seconds or secs)                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2015/01/20<br>17:40 |
| S31 | 28   | ((("20070163610") or ("20090293895") or ("20130186416") or ("7832410") or ("8,156,944") or ("8,511,318") or ("20140345631") or ("20140345635") or ("20040191322") or ("20060018840") or ("20060196518") or ("20080241255") or ("20090004249") or ("20100242976") or ("20110268809") or ("20120255567") or ("4,830,028") or ("4,836,224") or ("6,102,036") or ("6,234,169") or ("6,799,576") or ("6,874,507") or ("7,767,698") or ("8,079,371") or ("8,322,350") or ("8,375,957") or ("8,381,739") or ("8,741,348"))).PN. | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/01/20<br>20:10 |
| S32 | 1    | (14/512311).APP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/03/23<br>22:03 |
| S33 | 1    | (14/512311).APP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2015/05/14<br>15:25 |
| S34 | 1605 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent)                                                                                                                                                                                                                                                                                                                                                                                                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:07 |
| S35 | 237  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic                                                                                                                                                                                                                                                                                                                                                                                                  | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:08 |
| S36 | 221  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4)                                                                                                                                                                                                                                                                                                                                                               | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2015/05/14<br>16:08 |

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| S37 | 191 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood)                                                                                       | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:08 |
| S38 | 163 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:09 |
| S39 | 108 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size)              | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:10 |
| S40 | 87  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5 or mouth or oral\$4) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4  | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:11 |
| S41 | 77  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4                      | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 16:12 |
| S42 | 4   | ("2004076289").PN.                                                                                                                                                                                                                                                     | FPRS; EPO; JPO         | OR  | OFF | 2015/05/14 18:13 |
| S43 | 15  | ANDERSSON near3 SVEN-BORJE                                                                                                                                                                                                                                             | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:15 |
| S44 | 13  | ANDERSSON near3 SVEN-BORJE and nicotine                                                                                                                                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:15 |
| S45 | 71  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and ph and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4 and lung             | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:26 |
| S46 | 21  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and (ph near5 "7") and ((drop\$4 or vapor\$4 or aerosol\$4 or particle) near25 size) and heat\$4 and lung | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:27 |
| S47 | 26  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                   | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:28 |
| S48 | 38  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and benzoic and (inhal\$5) and                                                                                                                 | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/14 18:31 |

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|     |     | (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                                                                                                                                                                                                                    |                        |     |     |                  |
| S49 | 1   | ("20060196518").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/05/14 19:32 |
| S50 | 34  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and (salicylic or sorbic or lauric or levulinic or citric or benzoic or pyruvic) and (inhal\$5) and ((plasma or blood or peek or peak) near10 concentration) and (ph near5 "7") and heat\$4 and lung | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 08:30 |
| S51 | 1   | ("8831739").PN.                                                                                                                                                                                                                                                                                                              | US-PGPUB; USPAT        | OR  | OFF | 2015/05/15 08:43 |
| S52 | 1   | ("8381739").PN.                                                                                                                                                                                                                                                                                                              | US-PGPUB; USPAT        | OR  | OFF | 2015/05/15 08:43 |
| S53 | 14  | (igor near3 gonda) and nicotine and ng/ml                                                                                                                                                                                                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:42 |
| S54 | 13  | (igor near3 gonda) and nicotine near50 concentration near50 ng/ml                                                                                                                                                                                                                                                            | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:42 |
| S55 | 0   | (igor near3 gonda) and nicotine near50 concentration near50 ng/ml near50 salt                                                                                                                                                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:43 |
| S56 | 64  | (igor near3 gonda) and ((blood or plasma or nicotine) near50 concentration)                                                                                                                                                                                                                                                  | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:46 |
| S57 | 13  | (igor near3 gonda) and ((blood or plasma or nicotine) near50 concentration) same nicotine                                                                                                                                                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/05/15 10:46 |
| S58 | 1   | ("20030136404").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/05/17 15:16 |
| S59 | 1   | (14/512311).APP.                                                                                                                                                                                                                                                                                                             | US-PGPUB; USPAT        | OR  | OFF | 2015/07/14 09:12 |
| S60 | 1   | ("20140261474").PN.                                                                                                                                                                                                                                                                                                          | US-PGPUB; USPAT        | OR  | OFF | 2015/07/14 10:27 |
| S61 | 1   | (14/512311).APP.                                                                                                                                                                                                                                                                                                             | US-PGPUB; USPAT        | OR  | OFF | 2015/09/17 14:40 |
| S62 | 934 | (A24F47/008).cpc.                                                                                                                                                                                                                                                                                                            | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:46 |
| S63 | 78  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and acid and (inhal\$5) and (plasma or blood) and (ph near5 "7") and heat\$4 and lung                                                                                                                | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:46 |
| S64 | 367 | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and acid and (inhal\$5) and (plasma or blood) and heat\$4 and lung                                                                                                                                   | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:47 |
| S65 | 283 | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and nicotine near25 (formulation or solution or liquid or solvent) and (levulinic or pyruvic or salicylic or sorbic or lauric or benzoic) and (inhal\$5 or mouth or oral\$4) and                                                                                                    | US-PGPUB; USPAT; USOCR | ADJ | ON  | 2015/09/17 14:48 |



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|     |      | (plasma or blood)                                                                                                                                        |                                                          |     |     |                  |
| S69 | 2    | ((("20060196518") or ("20140261474")).PN.                                                                                                                | US-PGPUB; USPAT                                          | OR  | OFF | 2015/12/10 16:09 |
| S70 | 1    | ("9215895").PN.                                                                                                                                          | US-PGPUB; USPAT                                          | OR  | OFF | 2016/03/30 20:38 |
| S71 | 0    | (14/925958).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:41 |
| S72 | 1    | (14/925968).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:41 |
| S73 | 2    | (12/236439).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/24 10:56 |
| S74 | 120  | (A24F47/008).cpc. and temperature near25 ("100" or "200" or "300")                                                                                       | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:53 |
| S75 | 34   | (A24F47/008).cpc. and temperature near25 ("100" or "200" or "300") near25 degrees                                                                        | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:56 |
| S76 | 35   | (A24F47/008 or A24F47/00 or A24F47/002).cpc. and temperature near25 ("100" or "200" or "300") near25 degrees                                             | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 12:57 |
| S77 | 0    | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees              | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:27 |
| S78 | 1787 | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature                                                           | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:28 |
| S79 | 118  | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees              | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:28 |
| S80 | 29   | ((128/\$ or 131/\$).ccls. or (A24F47/008 or A24F47/00 or A24F47/002).cpc.) and low temperature and ("100" or "200" or "300") near25 degrees and nicotine | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 13:29 |
| S81 | 2    | (12/336439).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 13:38 |
| S82 | 1    | ("5,544,646").PN.                                                                                                                                        | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 19:16 |
| S83 | 10   | (rose).in. and pyruvic and nicotine                                                                                                                      | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/25 19:18 |
| S84 | 1    | (12/481908).APP.                                                                                                                                         | US-PGPUB; USPAT                                          | OR  | OFF | 2016/04/25 21:20 |
| S85 | 389  | nicotine near50 (lactic or lactate)                                                                                                                      | US-PGPUB; USPAT; USOCR                                   | ADJ | ON  | 2016/04/27 09:16 |
| S86 | 440  | nicotine near50 (lactic or lactate)                                                                                                                      | US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB | ADJ | ON  | 2016/04/27 09:16 |
| S87 | 65   | ((a24f47/00)".cpc" or (131/\$.ccls.) or (128/\$.ccls.) and nicotine near50 (lactic                                                                       | US-PGPUB; USPAT;                                         | ADJ | ON  | 2016/04/27 09:20 |

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|      |      | or lactate)                                                                                                 | USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                        |     |     |                     |
| S88  | 70   | ((a24f47/00).cpc. or (131/\$.ccls.) or (128/\$.ccls.) and nicotine near50 (lactic or lactate)               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>09:20 |
| S89  | 73   | ((a24f47/00 or a24f47/008).cpc. or (131/\$.ccls.) or (128/\$.ccls.) and nicotine near50 (lactic or lactate) | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>09:20 |
| S90  | 1    | ("9,215,895").PN.                                                                                           | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/04/27<br>11:18 |
| S91  | 6717 | (a24f47/00 or a24f47/008).cpc.                                                                              | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/04/27<br>18:29 |
| S92  | 754  | glycerol near50 ((veggie or vegetable) near2 glycerol)                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:10 |
| S93  | 719  | glycerol near5 ((veggie or vegetable) near2 glycerol)                                                       | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:10 |
| S94  | 48   | glycerol near5 (veggie glycerol or vegetable glycerol)                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:14 |
| S95  | 3    | glycerin near5 (veggie glycerol or vegetable glycerol)                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:15 |
| S96  | 3    | glycerin near25 (veggie glycerol or vegetable glycerol)                                                     | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:15 |
| S97  | 3    | (a24f47/00 or a24f47/008).cpc. and (veggie glycerol or vegetable glycerol)                                  | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/05/05<br>09:17 |
| S99  | 1    | ("20130255702").PN.                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/06/09<br>12:43 |
| S100 | 1    | (14/925968).APP.                                                                                            | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/06/09<br>12:44 |
| S101 | 7    | ((han near3 li) or (lik near3 hon)).in. and wick\$4                                                         | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/06/09<br>12:50 |
| S102 | 16   | a24f47/\$2.cpc. and wick\$3                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/06/09<br>12:53 |
| S103 | 1    | ("20150128967").PN.                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/07/12<br>08:38 |

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| S104 | 1   | (14/213108).APP.                                                                                                       | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/07/12<br>11:29 |
| S105 | 2   | ((("4,793,365") or ("5,101,839"))).PN.                                                                                 | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/07/12<br>12:51 |
| S106 | 686 | (131/\$.cds. or a24f47/\$.cpc.) and lactic                                                                             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:04 |
| S107 | 252 | (131/\$.cds. or a24f47/\$.cpc.) and lactic<br>and nicotine                                                             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:04 |
| S108 | 219 | (131/\$.cds. or a24f47/\$.cpc.) and lactic<br>and nicotine and (glycer\$\$ or glycol)                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:05 |
| S109 | 218 | (131/\$.cds. or a24f47/\$.cpc.) and lactic<br>and nicotine and (glycer\$4 or glycol)                                   | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:05 |
| S110 | 76  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol)                                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:06 |
| S111 | 72  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol) and temperature                                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:42 |
| S112 | 73  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 or glycol) and heat\$4                                      | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:44 |
| S113 | 57  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and heat\$4                                     | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S114 | 57  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and heat\$4 and<br>temperature                  | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S115 | 52  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and (heat\$4<br>near50 temperature)             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:45 |
| S116 | 38  | (a24f47/\$.cpc.) and lactic and nicotine<br>and (glycer\$4 and glycol) and (heat\$4<br>near50 temperature) and wick\$4 | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/07/12<br>15:46 |
| S117 | 1   | ("20060196518").PN.                                                                                                    | US-PGPUB;<br>USPAT           | OR  | OFF | 2016/10/23<br>19:49 |
| S118 | 195 | ((han or hon) near3 (lik or li)).in. and<br>temperature                                                                | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:52 |
| S119 | 48  | ((han or hon) near3 (lik or li)).in. and<br>temperature near5 (low)                                                    | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:53 |
| S120 | 0   | ((han or hon) near3 (lik or li)).in. and low-<br>temperature and cigarette                                             | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:54 |
| S121 | 12  | ((han or hon) near3 (lik or li)).in. and low<br>near10 temperature and cigarette                                       | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>19:54 |
| S122 | 19  | ((han or hon) near3 (lik or li)).in. and<br>citric and glycerol                                                        | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>20:32 |
| S123 | 6   | (adam near3 bowen).in. and "C.sub.max"                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR | ADJ | ON  | 2016/10/23<br>20:55 |

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| S124 | 1   | (14/925968).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/10/23<br>20:55 |
| S125 | 23  | (adam near3 bowen).in. and nicotine                                                                                      | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>20:58 |
| S126 | 6   | (adam near3 bowen).in. and (plasma or blood) near15 (peak or max or maxim\$3)                                            | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>20:59 |
| S127 | 102 | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3)                                                    | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:00 |
| S128 | 82  | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3) and acid and nicotine                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:01 |
| S129 | 61  | a24f47/\$.cpc. and (plasma or blood) near15 (peak or max or maxim\$3) and ((organic or citric) near30 acid) and nicotine | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/10/23<br>21:02 |
| S130 | 1   | (14/925968).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/09<br>13:58 |
| S131 | 2   | (14/512311).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/10<br>09:32 |
| S132 | 1   | (14/271071).APP.                                                                                                         | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/10<br>09:33 |
| S133 | 22  | 131/\$.ccls. and nicotine and levulinate                                                                                 | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>20:23 |
| S134 | 153 | 131/\$.ccls. and nicotine and levul\$5                                                                                   | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>21:59 |
| S135 | 140 | 131/\$.ccls. and nicotine and (levul\$5 near50 acid)                                                                     | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>21:59 |
| S136 | 47  | 131/\$.ccls. and (nicotin\$3 near50 (levul\$5 near50 acid))                                                              | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/14<br>22:00 |
| S137 | 70  | 131/\$.ccls. and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                                   | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:30 |
| S138 | 70  | (131/\$.ccls. or a24f47/\$.cpc) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:30 |
| S139 | 0   | (a24f47/\$.cpc) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                                                | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:31 |
| S140 | 94  | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                               | US-PGPUB;<br>USPAT;<br>USOCR                                               | ADJ | ON  | 2016/11/27<br>12:31 |
| S141 | 103 | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or lactate))                               | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/11/27<br>12:31 |
| S142 | 49  | (131/\$.ccls. or a24f47/\$.cpc.) and (nicotin\$3 near50 ((lactic near50 acid) or                                         | US-PGPUB;<br>USPAT;                                                        | ADJ | ON  | 2016/11/27<br>14:14 |

|      |    |                                                                                                                    |                                                                            |     |     |                     |
|------|----|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----|-----|---------------------|
|      |    | lactate)) and wick\$4                                                                                              | USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB                        |     |     |                     |
| S143 | 1  | (14/925968).APP.                                                                                                   | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/27<br>14:31 |
| S144 | 1  | ("9,215,895").PN.                                                                                                  | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2016/11/27<br>21:05 |
| S145 | 30 | (131/\$.ccls. or a24f47/\$.cpc.) and<br>(nicotin\$3 near50 ((lactic near50 acid) or<br>lactate)) and particle size | US-PGPUB;<br>USPAT;<br>USOCR;<br>FPRS;<br>EPO; JPO;<br>DERWENT;<br>IBM_TDB | ADJ | ON  | 2016/11/27<br>23:17 |
| S146 | 1  | (14/925961).APP.                                                                                                   | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2017/05/22<br>13:03 |
| S147 | 0  | (2016/0037825).CCLS.                                                                                               | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2017/05/22<br>21:50 |
| S148 | 1  | ("20160037825").PN.                                                                                                | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2017/05/22<br>21:51 |
| S149 | 1  | (14/960122).APP.                                                                                                   | US-PGPUB;<br>USPAT                                                         | OR  | OFF | 2017/05/22<br>21:52 |

**EAST Search History (Interference)**

| Ref # | Hits | Search Query                                                                                                                                                                                                                                               | DBs      | Default Operator | Plurals | Time Stamp          |
|-------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------|---------|---------------------|
| S66   | 723  | (A24F47/008).cpc.                                                                                                                                                                                                                                          | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:46 |
| S67   | 246  | ("128"/\$ or "131"/\$ or "424"/\$ or "514"/\$).ccls.<br>and nicotine near25 (formulation or solution or<br>liquid or solvent) and acid and (inhal\$5) and<br>(plasma or blood) and heat\$4 and lung                                                        | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:47 |
| S68   | 196  | ("128"/\$ or "131"/\$ or "424"/\$).ccls. and<br>nicotine near25 (formulation or solution or<br>liquid or solvent) and (levulinic or pyruvic or<br>salicylic or sorbic or lauric or benzoic) and<br>(inhal\$5 or mouth or oral\$4) and (plasma or<br>blood) | US-PGPUB | ADJ              | ON      | 2015/09/17<br>14:49 |

**5/23/2017 9:09:13 AM****C:\Users\dmayes\Documents\EAST\Workspaces\14925968.wsp**

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| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

**U. S. PATENT DOCUMENTS**

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|                    | 670                   | US- 3,443,827                                               | 5/13/1969                      | Acker et al.                                       |                                                                                 |
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|                    | 150                   | US- 7,015,796                                               | 3/21/2006                      | Snyder                                             |                                                                                 |
|                    | 675                   | US- 7,801,573                                               | 9/21/2010                      | Yazdi et al.                                       |                                                                                 |
|                    | 173                   | US- 8,820,330                                               | 9/2/2014                       | Bellinger et al.                                   |                                                                                 |
|                    | 174                   | US- 8,851,081                                               | 10/7/2014                      | Fernando et al.                                    |                                                                                 |
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|                    | 696                   | US- 2007/0277816                                            | 12/6/2007                      | Morrison et al.                                    |                                                                                 |
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|                    | 263                   | US- 2010/0200008                                            | 8/12/2010                      | Taieb                                              |                                                                                 |
|                    | 676                   | US- 2011/0240047                                            | 10/6/2011                      | Adamic                                             |                                                                                 |
|                    | 297                   | US- 2012/0285475                                            | 11/15/2012                     | Liu                                                |                                                                                 |
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|--------------------|-----------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|----------------|
|                    | 387                   | EP2856893A1                                                                                                  | 4/8/2015                       | Fontem Holdings                                    |                                                                                 |                |
|                    | 388                   | EP2908675A1(asWO2014/060268)                                                                                 | 8/26/2015                      | Nicoventures Holdings Ltd                          |                                                                                 |                |
|                    | 389                   | EP2915443A1                                                                                                  | 9/9/2015                       | Fontem Holdings                                    |                                                                                 |                |
|                    | 757                   | EP3062646A1 (WO2015/66136)                                                                                   | 9/7/2016                       | Rai Strategic Holdings Inc                         |                                                                                 |                |
|                    | 758                   | EP3065581A2 (WO2015/68044)                                                                                   | 9/14/2016                      | SIS Resources Ltd                                  |                                                                                 |                |
|                    | 759                   | EP3068244A1 (WO2015/73975)                                                                                   | 9/21/2016                      | VMR Products LLC                                   |                                                                                 |                |

Examiner  
Signature

/DIONNE W. MAYES/

Date  
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| Attorney Docket Number | 13211-713.303       |

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|                        | 316                   | US- 2014/0053856                         | 2/27/2014                      | Liu                                                |                                                                                 |
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|                        | 322                   | US- 2014/0123990                         | 5/8/2014                       | Timmermans                                         |                                                                                 |
|                        | 323                   | US- 2014/0150810                         | 6/5/2014                       | Hon                                                |                                                                                 |
|                        | 324                   | US- 2014/0174459                         | 6/26/2014                      | Burstyn                                            |                                                                                 |
|                        | 327                   | US- 2014/0196735                         | 7/17/2014                      | Liu                                                |                                                                                 |
|                        | 328                   | US- 2014/0216450                         | 8/7/2014                       | Liu                                                |                                                                                 |
|                        | 329                   | US- 2014/0230835                         | 8/21/2014                      | Saliman                                            |                                                                                 |
|                        | 331                   | US- 2014/0270727                         | 9/18/2014                      | Ampolini et al.                                    |                                                                                 |
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|                        | 336                   | US- 2014/0355969                         | 12/4/2014                      | Stern                                              |                                                                                 |
|                        | 340                   | US- 2015/0020825                         | 1/22/2015                      | Galloway et al.                                    |                                                                                 |

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|                          |                       | Country Code <sup>3</sup> *Number <sup>4</sup> *Kind Code <sup>5</sup> (if known) |                                |                                                 |                                                                           |                |
|                          | 416                   | WO2004/080216A1(EngAbs)                                                           | 9/23/2004                      | Hon, Lik                                        |                                                                           |                |
|                          | 420                   | WO2008/077271A1(EngAbs)                                                           | 7/3/2008                       | Maas, Bernard                                   |                                                                           |                |
|                          | 427                   | WO2012/120487A2                                                                   | 9/13/2012                      | Chong Corp                                      |                                                                           |                |
|                          | 430                   | WO2013/089551A1                                                                   | 6/20/2013                      | Foo, Kit Seng                                   |                                                                           |                |
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| Examiner Signature | /DIONNE W. MAYES/ | Date Considered | 05/24/2017 |
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|                        | 341                   | US- 2015/0020831                         | 1/22/2015                      | Weigensberg et al.                                 |                                                                                 |
|                        | 343                   | US- 2015/0027472                         | 1/29/2015                      | Amir                                               |                                                                                 |
|                        | 344                   | US- 2015/0034103                         | 2/5/2015                       | Hon                                                |                                                                                 |
|                        | 724                   | US- 2015/0034104                         | 2/5/2015                       | Zhou                                               |                                                                                 |
|                        | 345                   | US- 2015/0040929                         | 2/12/2015                      | Hon                                                |                                                                                 |
|                        | 346                   | US- 2015/0101625                         | 4/16/2015                      | Newton et al.                                      |                                                                                 |
|                        | 347                   | US- 2015/0122252                         | 5/7/2015                       | Frija                                              |                                                                                 |
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|                        | 698                   | US- 2015/0164147                         | 6/18/2015                      | Verleur et al.                                     |                                                                                 |
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|                        | 359                   | US- 2015/0196059                         | 7/16/2015                      | Liu                                                |                                                                                 |
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|                          | 439                   | WO2014/150704A2                                                                   | 9/25/2014                      | Altria Client Svs Inc.                          |                                                                           |                |
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|                          | 444                   | WO2015/028815A1                                                                   | 3/5/2015                       | British American Tobacco                        |                                                                           |                |
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|                          | 447                   | WO2015/063126A1                                                                   | 5/7/2015                       | Choukroun, B.                                   |                                                                           |                |
|                          | 450                   | WO2015/089711A1(EngAbs)                                                           | 6/25/2015                      | Kimree Hi-Tech Inc.                             |                                                                           |                |

|                    |                   |                 |            |
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| Examiner Signature | /DIONNE W. MAYES/ | Date Considered | 05/24/2017 |
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Sheet 4

of 6

**Complete if Known**

|                        |                     |
|------------------------|---------------------|
| Application Number     | 14/925,968          |
| Filing Date            | October 28, 2015    |
| First Named Inventor   | Adam Bowen          |
| Art Unit               | 1747                |
| Examiner Name          | Mayes, Dionne Walls |
| Attorney Docket Number | 13211-713.303       |

| U. S. PATENT DOCUMENTS |                       |                                          |                                |                                                    |                                                                                 |
|------------------------|-----------------------|------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|
| Examiner Initials*     | Cite No. <sup>1</sup> | Document Number                          | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages or Relevant<br>Figures Appear |
|                        |                       | Number-Kind Code <sup>2</sup> (if known) |                                |                                                    |                                                                                 |
|                        | 361                   | US- 2015/0208731                         | 7/30/2015                      | Malamud et al.                                     |                                                                                 |
|                        | 700                   | US- 2015/0216237                         | 8/6/2015                       | Wensley et al.                                     |                                                                                 |
|                        | 362                   | US- 2015/0223521                         | 8/13/2015                      | Menting et al.                                     |                                                                                 |
|                        | 363                   | US- 2015/0224268                         | 8/13/2015                      | Henry et al.                                       |                                                                                 |
|                        | 364                   | US- 2015/0237917                         | 8/27/2015                      | Lord                                               |                                                                                 |
|                        | 365                   | US- 2015/0237918                         | 8/27/2015                      | Liu                                                |                                                                                 |
|                        | 366                   | US- 2015/0245654                         | 9/3/2015                       | Memari et al.                                      |                                                                                 |
|                        | 367                   | US- 2015/0245660                         | 9/3/2015                       | Lord                                               |                                                                                 |
|                        | 368                   | US- 2015/0257445                         | 9/17/2015                      | Henry Jr. et al.                                   |                                                                                 |
|                        | 369                   | US- 2015/0258289                         | 9/17/2015                      | Henry Jr. et al.                                   |                                                                                 |
|                        | 370                   | US- 2015/0282527                         | 10/8/2015                      | Henry Jr.                                          |                                                                                 |
|                        | 701                   | US- 2015/0305409                         | 10/29/2015                     | Verleur et al.                                     |                                                                                 |
|                        | 702                   | US- 2016/0021933                         | 1/28/2016                      | Thorens et al.                                     |                                                                                 |
|                        | 750                   | US- 2016/0242466                         | 8/25/2016                      | Lord et al.                                        |                                                                                 |
|                        | 751                   | US- 2016/0249680                         | 9/1/2016                       | Liu                                                |                                                                                 |
|                        | 753                   | US- 2016/0295924                         | 10/13/2016                     | Liu                                                |                                                                                 |
|                        | 754                   | US- 2016/0302483                         | 10/20/2016                     | Liu                                                |                                                                                 |
|                        | 717                   | US- 2016/0309784                         | 10/27/2016                     | Silvestrini et al.                                 |                                                                                 |
|                        | 726                   | US- 2016/0324215                         | 11/10/2016                     | Mironov et al.                                     |                                                                                 |

| FOREIGN PATENT DOCUMENTS |                       |                                                                                   |                                |                                                    |                                                                                 |                |
|--------------------------|-----------------------|-----------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------|----------------|
| Examiner Initials*       | Cite No. <sup>1</sup> | Foreign Patent Document                                                           | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines,<br>Where Relevant Passages<br>Or Relevant Figures Appear | T <sup>6</sup> |
|                          |                       | Country Code <sup>3</sup> -Number <sup>4</sup> -Kind Code <sup>5</sup> (if known) |                                |                                                    |                                                                                 |                |
|                          | 452                   | WO2015/109616A1(EngAbs)                                                           | 7/30/2015                      | Kimree Hi-Tech Inc.                                |                                                                                 |                |
|                          |                       |                                                                                   |                                |                                                    |                                                                                 |                |
|                          |                       |                                                                                   |                                |                                                    |                                                                                 |                |
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Examiner  
Signature

/DIONNE W. MAYES/

Date  
Considered

05/24/2017

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. <sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> See Kinds Codes of USPTO Patent Documents at [www.uspto.gov](http://www.uspto.gov) or MPEP 901.04. <sup>3</sup> Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>5</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup> Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.W.M/

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|-------|---|----|---|
| Sheet | 5 | of | 6 |
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## 3634

PTO/SB/08b (07-09)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

**Complete if Known**

|       |   |    |   |                        |                     |
|-------|---|----|---|------------------------|---------------------|
| Sheet | 6 | of | 6 | Application Number     | 14/925,968          |
|       |   |    |   | Filing Date            | October 28, 2015    |
|       |   |    |   | First Named Inventor   | Adam Bowen          |
|       |   |    |   | Art Unit               | 1747                |
|       |   |    |   | Examiner Name          | Mayes, Dionne Walls |
|       |   |    |   | Attorney Docket Number | 13211-713.303       |

**NON PATENT LITERATURE DOCUMENTS**

| Examiner Initials* | Cite No. <sup>1</sup> | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.                                   | T <sup>2</sup> |
|--------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                    | 481                   | BRADLEY et al.; Electronic cigarette aerosol particle size distribution measurements; Inhal. Toxicol.; 24(14); pp. 976-984; Dec. 2012                                                                                                                                                             |                |
|                    | 482                   | BULLEN et al.; Effect of an electronic nicotine delivery device (e cigarette) on desire to smoke and withdrawal, user preferences and nicotine delivery: randomised cross-over trial; Tobacco Control; 19(2); pp. 98-103; Apr. 2010                                                               |                |
|                    | 678                   | CAPPONNETTO et al.; Successful smoking cessation with cigarettes in smokers with a documented history of recurring relapses: a case series; Journal of Medical Case Reports; 5(1); 6 pages; (year of pub. sufficiently earlier than effective US filing date and any foreign priority date); 2011 |                |
|                    | 677                   | HURT et al.; Treating tobacco dependence in a medical setting; CA: A Cancer Journal for Clinicians; 59(5); pp. 314-326; Sept. 2009                                                                                                                                                                |                |
|                    |                       |                                                                                                                                                                                                                                                                                                   |                |
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|                    |                   |                 |            |
|--------------------|-------------------|-----------------|------------|
| Examiner Signature | /DIONNE W. MAYES/ | Date Considered | 05/24/2017 |
|--------------------|-------------------|-----------------|------------|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO:

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /D.W.M/

|                                                                                                              |                                                |                                                                    |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------|
| <b>Search Notes</b><br><br> | <b>Application/Control No.</b><br><br>14925968 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>BOWEN ET AL. |
|                                                                                                              | <b>Examiner</b><br><br>DIONNE W MAYES          | <b>Art Unit</b><br><br>1747                                        |

| CPC- SEARCHED         |           |          |
|-----------------------|-----------|----------|
| Symbol                | Date      | Examiner |
| a24f47/00; a24f47/008 | 4/27/2016 | DWM      |

| CPC COMBINATION SETS - SEARCHED |      |          |
|---------------------------------|------|----------|
| Symbol                          | Date | Examiner |
|                                 |      |          |

| US CLASSIFICATION SEARCHED |          |      |          |
|----------------------------|----------|------|----------|
| Class                      | Subclass | Date | Examiner |
|                            |          |      |          |

| SEARCH NOTES                                         |            |          |
|------------------------------------------------------|------------|----------|
| Search Notes                                         | Date       | Examiner |
| EAST Search conducted (see attached search strategy) | 12/10/2015 | DWM      |
| Inventor search conducted                            | 12/10/2015 | DWM      |
| EAST Search conducted (see attached search strategy) | 4/27/2016  | DWM      |
| Inventor search updated                              | 4/27/2016  | DWM      |
| EAST Search conducted (see attached search strategy) | 11/28/2016 | DWM      |
| EAST Search conducted (see attached search strategy) | 5/23/2017  | DWM      |

| INTERFERENCE SEARCH     |                         |      |          |
|-------------------------|-------------------------|------|----------|
| US Class/<br>CPC Symbol | US Subclass / CPC Group | Date | Examiner |
|                         |                         |      |          |

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www.uspto.gov

| APPLICATION NUMBER | PATENT NUMBER | GROUP ART UNIT | REQUEST ID |
|--------------------|---------------|----------------|------------|
| 14/925,968         |               | 1747           | 45212      |

## PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 148514 on 08/14/2017 via Private PAIR in view of the certification copied below that authorized the change.

- Correspondence Address

The address for Customer Number 148514 is:

148514

Mintz/JUUL/PAX

One Financial Center

Boston, MA 02111

### I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

|                             |                 |
|-----------------------------|-----------------|
| <b>Signature:</b>           | /npm/           |
| <b>Name:</b>                | Nicholas Mouton |
| <b>Registration Number:</b> | 75306           |



# UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

| APPLICATION NO.                                            | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.             | CONFIRMATION NO. |
|------------------------------------------------------------|-------------|----------------------|---------------------------------|------------------|
| 14/925,968                                                 | 10/28/2015  | Adam BOWEN           | 52210-501C02US/713.303          | 2707             |
| 148514                                                     | 7590        | 01/10/2018           |                                 |                  |
| Mintz/JUUL/PAX<br>One Financial Center<br>Boston, MA 02111 |             |                      | EXAMINER<br>MAYES, DIONNE WALLS |                  |
|                                                            |             |                      | ART UNIT                        | PAPER NUMBER     |
|                                                            |             |                      | 1747                            |                  |
|                                                            |             |                      | NOTIFICATION DATE               | DELIVERY MODE    |
|                                                            |             |                      | 01/10/2018                      | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

IPDocketingBOS@mintz.com  
IPFilerombos@mintz.com

|                              |                        |                     |
|------------------------------|------------------------|---------------------|
| <b>Notice of Abandonment</b> | <b>Application No.</b> | <b>Applicant(s)</b> |
|                              | 14/925,968             | BOWEN ET AL.        |
|                              | <b>Examiner</b>        | <b>Art Unit</b>     |
|                              | DIONNE W. MAYES        | 1747                |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on 02 June 2017.
  - (a) ☐ A reply was received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the period for reply (including a total extension of time of \_\_\_\_\_ month(s)) which expired on \_\_\_\_\_.
  - (b) ☐ A proposed reply was received on \_\_\_\_\_, but it does not constitute a proper reply under 37 CFR 1.113 to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) if this is utility or plant application, a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. Note that RCEs are not permitted in design applications.)
  - (c) ☐ A reply was received on \_\_\_\_\_ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
  - (d) ☒ No reply has been received.
2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
  - (a) ☐ The issue fee and publication fee, if applicable, was received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
  - (b) ☐ The submitted fee of \$\_\_\_\_\_ is insufficient. A balance of \$\_\_\_\_\_ is due.  
The issue fee required by 37 CFR 1.18 is \$\_\_\_\_\_. The publication fee, if required by 37 CFR 1.18(d), is \$\_\_\_\_\_.
  - (c) ☐ The issue fee and publication fee, if applicable, has not been received.
3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
  - (a) ☐ Proposed corrected drawings were received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the period for reply.
  - (b) ☐ No corrected drawings have been received.
4. ☐ The letter of express abandonment which is signed by the attorney or agent of record or other party authorized under 37 CFR 1.33(b). See 37 CFR 1.138(b).
5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34) upon the filing of a continuing application.
6. ☐ The decision by the Patent Trial and Appeal Board rendered on \_\_\_\_\_ and because the period for seeking court review of the decision has expired and there are no allowed claims.
7. ☐ The reason(s) below:

/MICHAEL H WILSON/  
Supervisory Patent Examiner, Art Unit 1747

/DIONNE W MAYES/  
Examiner, Art Unit 1747

Petitions to revive under 37 CFR 1.137, or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.