

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

R.J. Reynolds Vapor Company
Petitioner

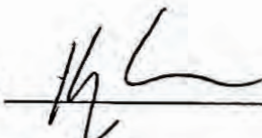
v.

Philip Morris Products S.A.
Patent Owner

Case No. – IPR2021-00585
U.S. Patent No. 10,555,556

DECLARATION OF KELLY R. KODAMA

I declare that all statements made herein on 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 Section 1001 of Title 18 of the United States Code.

By:  02/26/21

Kelly R. Kodama

RJR EX 1002

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I, Kelly Kodama, do hereby declare:

1. My name is Kelly Kodama. My opinions, as set forth herein, are based on my education and background in the fields discussed below.

2. I am making this declaration at the request of R.J. Reynolds Vapor Company (“Petitioner”) in the matter of the Inter Partes Review (“IPR”) of U.S. Patent No. 10,555,556 (“’556 Patent”). I have been asked to offer my opinions generally regarding the scope and content of the prior art, the level of skill of the person having ordinary skill in the art (“POSITA”), and whether the ’556 Patent is anticipated or would have been obvious to a POSITA at the time of the alleged invention, in view of the prior art.

3. I am being compensated for my work in this matter at my standard hourly rate of \$275 for such consulting services. My compensation in no way depends on the outcome of this proceeding.

4. In preparing this Declaration, I considered the following exhibit materials submitted with the IPR petition:

- EX1001 – U.S. Patent No. 10,555,556;
- EX1003 – File History of the ’556 Patent;
- EX1004 – U.S. Patent Publication No. 2013/0056012 (“Hearn”);
- EX1005 – U.S. Patent No. 7,920,777 (“Rabin”);
- EX1006 – U.S. Patent No. 8,314,591 (“Terry”);

- EX1007 – U.S. Patent No. 8,794,231 (“Thorens ’231”);
- EX1008 – Claim Construction Order, RAI Strategic Holdings, Inc. v. Altria Client Services, LLC, No. 1:20-cv-00393 (E.D. Va Nov. 24, 2020), ECF No. 360;
- EX1009 – Certified Document of PCT Publication No. WO 2011/107737 A1 (“Hearn PCT Counterpart”);
- EX1011 – Transcript of Motion Hearing Proceedings (Via Zoom Conference) Before The Honorable Theresa C. Buchanan, United States District Court Magistrate Judge, RAI Strategic Holdings, Inc., v. Altria Client Services, LLC, No. 1:20-cv-00393-LO-TCB (E.D. Va Dec. 4, 2020), ECF No. 444;
- EX1012 – General Order 2020-16 (E.D. Va May 26, 2020);
- EX1013 – General Order 2020-1 (E.D. Va Jan. 8, 2021);
- EX1014 – European Patent Publication No. 0288 874 B1 (“Lopatin”);
- EX1015 – U.S. Patent Publication No. 2005/0191481 (“He”);
- EX1016 – U.S. Patent No. 4,947,874 (“Brooks”);
- EX1017 – U.S. Patent No. 6,585,509 (“Young”);
- EX1018 – U.S. Patent Publication No. 2014/0150785 (“Malik”);
- EX1019 – U.S. Patent No. 7,888,275 (“Ward”);
- EX1020 – U.S. Patent No. 8,910,640 (“Sears”);

- EX1021 – Certified Translation of Chinese Patent No. CN 202456410 U (“Li”);
- EX1022 – Certified Document and Translation of Chinese Patent No. 201197360Y (“Zhiping”);
- EX1023 – European Patent No. 2,404,515 B1 (“Hon”);
- EX1024 – U.S. Patent No. 2,057,353 (“Whittemore”);
- EX1025 – Certified Document of PCT Publication No. WO 2009/132793 (“Thorens ’793”);
- EX1026 – Certified Translation of Chinese CN102861694A (“Junxiang”);
- EX1027 – U.S. Patent No. 8,156,944 (“Han”);
- EX1028 – U.S. Patent No. 9,943,108 (“Lord”);
- EX1029 – U.S. Patent No. 9,504,279 (“Chen”);
- EX1030 – Petitioner’s Supplemental Brief, Philip Morris Products, S.A., v. RAI Strategic Holdings, Inc., No. PGR2020-00071 (P.T.A.B. Dec. 11, 2020);
- EX1031 – PTAB’s PGR Institution Decision, Philip Morris Products, S.A., v. RAI Strategic Holdings, Inc., No. PGR2020-00071, Paper 11 (P.T.A.B. Jan. 13, 2021);

- EX1032 – Petitioner’s Request for Rehearing of Decision Denying Institution, Philip Morris Products, S.A., v. RAI Strategic Holdings, Inc., No. IPR2020-00921 (P.T.A.B. Dec. 15, 2020);

- EX1033 – Defendants-Counterclaim Plaintiffs’ Opening Claim Construction Brief, RAI Strategic Holdings, Inc., v. Altria Client Services LLC., No. 1:20-cv-00393-LO-TCB (E.D. Va Oct. 23, 2020), ECF No. 224; and

- EX1034 – Defendants-Counterclaim Plaintiffs’ Responsive Claim Construction Brief, RAI Strategic Holdings, Inc., v. Altria Client Services LLC., No. 1:20-cv-00393-LO-TCB (E.D. Va Nov. 6, 2020), ECF No. 310.

I. Background and Qualifications

5. I am the Chief Executive Officer and founder at Zoe Design Associates, an award-winning product development consultancy with offices in San Francisco and Taipei. Since 1991, we have worked on a wide range of consumer, medical, and communication products for multinational clientele that includes Acer, JTI, Motorola, Plantronics, Samsung, and Siemens. Much of my responsibility is to manage a diverse team of graphic designers and industrial, mechanical, software, and electrical engineers, as well as being intimately involved in all aspects of the design of our clients’ products.

6. I was also the Director of Product Design at Ploom from 2013 to 2014. My responsibilities at Ploom included building and managing a rapidly-

expanding product team, including industrial design, product design, QA, product management, product packaging, firmware development, and electrical engineering. At Ploom, I helped develop the Model 3 tobacco pod vaporizer, PAX 2 loose-leaf vaporizer, and JUUL e-cigarette products. I also worked closely with Ploom's R&D department to prototype and test new potential product concepts.

7. After I completed my employment at Ploom, JTI purchased the IP and product rights to Ploom's Model 2 & 3 vaporizer business. JTI contracted with my firm, Zoe Design Associates, to improve the performance and design of the Model 3 vaporizer. Subsequently, we worked closely with JTI on rebranding and redesigning the E-Lites and Logic product lines, including the CURV, Logic Pro, Logic Power, and Logic LQD. In addition, we were involved in redesigns of the Ploom TECH hybrid vaporizer.

8. I received a B.S. (1988) in Product Design Engineering from Stanford University. I have over 30 years of experience product design, development and consulting expertise covering a wide range of industries and products, including e-cigarettes. See, e.g., <http://zoepd.com/> (Exhibit B). Over that time, I have had a consistent focus on the design, mechanical engineering, and production of various devices, including e-cigarettes. See, e.g., <http://zoepd.com/projects/logic-e-cigarette-product-family/> (Exhibit C). In addition to doing engineering, design, and production work, my responsibilities have included assembling and managing

teams to develop new consumer, industrial and professional products. My CV is attached as Exhibit A.¹

9. In addition to my work at Zoe Design Associates and Ploom, I have held various engineering leadership positions at technology and product development companies. In 1992, I was an Applications Engineer for Parametric Technology Corporation, where I provided pre- and post-sales technical support for PTC customers. From 1990-1992, I was a senior mechanical engineer at Siemens Ultrasound, Inc., where I designed ultrasound equipment. From 1988 to 1990, I was a staff mechanical engineer at Watkins-Johnson, where I designed military communications electronics and semiconductor processing equipment. At both Siemens Ultrasound and Watkins-Johnson I was responsible for a range of mechanical design engineering tasks, including conceptual design, implementation, design for manufacturing (DFM), 2-D and 3-D computer aided design (CAD), and documentation. For a full list of my employment history, see my CV, attached as Exhibit A to this Declaration.

10. My experiences cover a broad technology base across a diverse set of industries, including in the areas of audio technology, industrial design, medical devices, consumer products, mechanical engineering, and electronic cigarettes (or

¹ Exhibits (other than those provided with this IPR petition) and Appendices referenced in this expert Declaration are attached hereto.

e-cigarettes). While working for Ploom, I managed the development of the Model 3 vaporizer and JUUL e-cigarettes, both of which had significant challenges with regards to aerosol performance, leakage prevention, heater reliability, and battery performance. During the development of JUUL, as an example, we explored various designs of the JUUL cartridge to improve aerosol performance and prevent leakage. For aerosol performance, my team tested different heater materials and designs, as well as various wick configurations and materials, in order to optimize vapor production and minimize battery usage. To prevent leakage, we tested various sponges, films, papers, and physical features in the injection-molded plastic housing components. These projects built off of and utilized prior aerosol generation research and development from product teardowns of competitive products available at that time.

11. I have also performed services in other patent disputes as an independent technical expert and consultant. I have consulted as an expert in matters involving the design of a variety of e-cigarette devices. *See Exhibit A* for a representative list of matters in which I have consulted over the last 4 years as well as all matters involving e-cigarettes.

12. I also have experience as an innovator and inventor. I am a named inventor on more than thirty-five U.S. patents, on new products and designs. I have also received numerous design awards for my work.

II. Legal Principles

13. It is my understanding that in determining whether a patent claim is anticipated or obvious in view of the prior art, the Patent Office must apply the *Phillips* standard to construe the claim by giving the claim its plain and ordinary meaning, consistent with the specification and prosecution history. For the purposes of this review, I have construed each claim term in accordance with its plain and ordinary meaning under the *Phillips* standard except where particular constructions are discussed.

A. Anticipation

14. I am advised that if each and every element or step of a claim is found in a prior art publication or a commercially available product on sale prior to the invention or more than a year before the earliest filing date to which the claims are entitled (*i.e.*, a “device” as used in this declaration) , then the claim is said to be “anticipated” by that prior art publication or device and is invalid or unpatentable under 35 U.S.C. § 102 because the claimed invention is not new or novel.

B. Obviousness

15. I understand that a claim may be invalid or unpatentable under 35 U.S.C. § 103(a) if the claimed subject matter as a whole would have been obvious to the hypothetical POSITA in view of a prior art publication or device or in view of a combination of publications and devices at the time the claimed invention was made. I further understand that a POSITA is assumed to have knowledge of all

relevant and analogous prior art in the field of endeavor covered by the '556 Patent.

16. I also understand that an analysis of whether a claimed invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the claimed invention, and the level of ordinary skill in the pertinent art involved. I also understand that a prior art publication or device should be viewed as a whole.

17. I understand that in considering whether an invention would have been obvious, I may assess whether there are reasons to combine known elements in the prior art in the manner claimed in view of the teachings of multiple prior art references and devices, the effects of demands known to the design community or present in the market place, and/or the background knowledge possessed by a POSITA. I also understand that other principles may be relied on in evaluating whether a claimed invention would have been obvious, and that these principles include:

- A combination of familiar elements according to known methods to yield predictable results;
- A simple substitution of one known element for another to obtain predictable results;

- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a POSITA can implement a predictable variation, the variation is likely obvious;
- If a technique has been used to improve one device, and a person of ordinary skill in the art would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;
- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references or devices to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing a teaching, suggestion, or motivation to combine;
- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- In determining whether the subject matter of a patent claim would have been obvious, neither the particular motivation nor the avowed purpose of the named inventor controls;
- One of the ways in which a patent's subject can be proved obvious is by noting that there existed at the time of invention a known problem

for which there was an obvious solution encompassed by the patent's claims;

- Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed;
- “Common sense” teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents or devices together like pieces of a puzzle;
- A POSITA is also a person of ordinary creativity, and is not an automaton;
- A patent claim can be proved obvious by showing that the claimed combination of elements was “obvious to try,” particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a person of ordinary skill in the art would have had good reason to pursue the known options within his or her technical grasp; and
- One should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

III. A POSITA

18. I understand that the factors that may be considered in determining the ordinary level of skill in the art include: (1) the level of education and experience of persons working in the field; (2) the types of problems encountered in the field; and (3) the sophistication of the technology. I understand that a POSITA is not a specific individual, but rather is a hypothetical individual having the qualities reflected by the factors above.

19. In my opinion, a POSITA with respect to the technology described in the '556 Patent would be a person with a Bachelor's degree in mechanical engineering, electrical engineering, industrial design or product design or product design engineering, chemistry, or physics, or a related field, and three to four years of industry experience; alternatively, a POSITA would have had a Master's degree in mechanical engineering, electrical engineering, industrial design or product design or product design engineering, chemistry, or physics, or a related field, and one to two years of industry experience, and a POSITA would have been familiar with electrically powered smoking articles and their components and underlying technologies or similar components and technologies. A higher level of education may substitute for a lesser amount of experience, and vice versa.

20. For purposes of this Declaration, unless otherwise noted, my statements and opinions below, such as those regarding my experience and the

understanding of a POSITA generally (and specifically related to the references I consulted herein), reflect the knowledge that existed as of and prior to February 10, 2014, with respect to the '556 Patent. As of the foregoing date, I would have qualified as one having at least ordinary skill in the art according to the above definition.

IV. The Scope and Content of The Prior Art

A. '556 Patent - Background

21. I understand that the filing date of the foreign application to which the '556 Patent claims priority (*i.e.*, EP 14154552, EP14154553, EP14154554) is February 10, 2014.

22. For the purposes of this Declaration, I have assumed that February 10, 2014 is the invention date for the '556 Patent.

23. All the challenged '556 patent claims require: “a liquid storage portion, comprising a housing” and “the housing having an opening.” I understand that Patent Owner’s position is that the claimed “opening” is not “limited to one through which liquid aerosol-forming substrate can flow” (EX1033, 9), and “the term ‘opening includes no modifier, much less any modifier that requires liquid to flow through it” (EX1034, 9).

24. All the challenged '556 patent claims further require: “a first capillary material ... provided in a vicinity of the opening of the housing.” I understand that

Patent Owner’s position is that the claim phrase “provided in a vicinity” means “the ‘first capillary material’ is near the ‘opening,’ relative to the ‘second capillary material,’” and that a POSITA “reading the claims in light of the specification would readily understand that ‘a vicinity’ denotes a particular location for the ‘first capillary material’—namely near the opening as compared to the second capillary material.” EX1033, 11-12. I further understand that Patent Owner’s position is that “the first capillary material ... being ‘in a vicinity of the opening’ denotes a specific location within the accused device—namely, close or near the opening ... as compared to the ‘second capillary material.’” EX1034, 9.

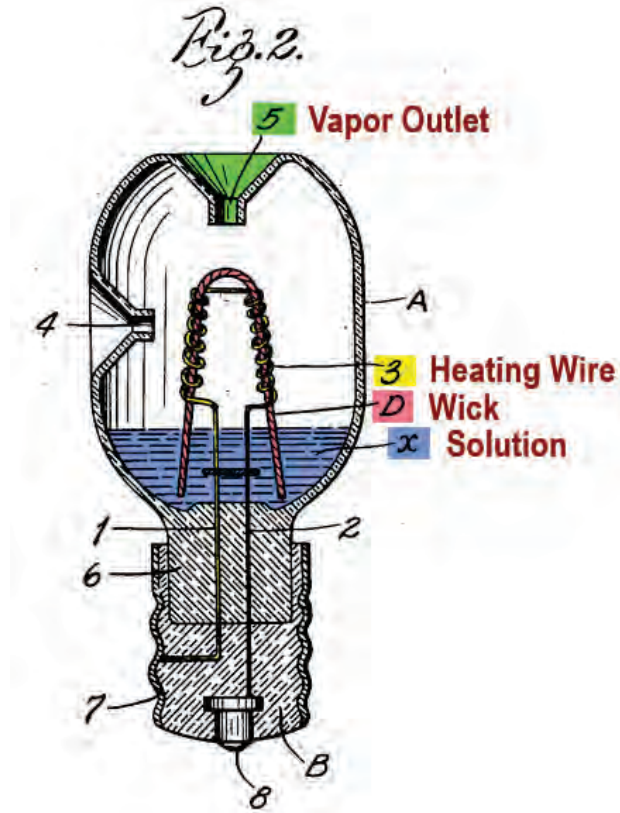
25. All the challenged ’556 patent claims additionally require: “a second capillary material ... spaced apart from the opening by the first capillary material.” I understand that Patent Owner’s position is that “[t]he claim language simply requires the ‘second capillary material’ to be ‘spaced apart’ or ‘separated’ from the ‘opening’ by the ‘first capillary material,’” and “[n]othing in the language of the claims specifies any ‘distance’ between the second capillary material and the opening, much less ‘a distance defined by the thickness of the first capillary material.’” EX1033, 13-15. I further understand that Patent Owner’s position is: “The claims require the ‘second capillary material’ to be ‘spaced apart from the opening by the first capillary material,’ i.e., the first capillary material must separate the second capillary material from the opening.” EX1034, 10.

B. Background and State of the Industry of E Cigarettes

1. Basic Concepts of E-Cigarettes

26. Electronic vaporizing devices generally serve as alternatives to combustible cigarettes for adult tobacco consumers. In addition to providing nicotine, e-cigarettes generally maintain at least some of the rituals of traditional smoking, such as inhaling an aerosol or vapor.

27. Vaporizer devices have been widely known and available in the United States for decades. They are based upon concepts dating back to the 1930s such as, for example, an aerosol forming liquid reservoir, an electric heating element, a wick for transporting the liquid from the liquid reservoir to the heating element by capillary action, an airflow passageway, and a power source including a battery. *See, e.g.*, U.S. Patent No. 2,057,353 (“Whittemore”) at 1:18-2:7, Figs. 1-3 (EX1024). As illustrated in the reproduced and annotated FIG. 2 below, Whittemore discloses storing a solution to be vaporized, transporting the stored solution via a wick to a battery-powered heating wire where the solution is vaporized, and flowing air over the heating wire to transport the vaporized solution through an aperture for inhalation by the user.



28. These concepts have been implemented into vapor products, including e-cigarettes, using various product designs disclosed in the literature over the past 90 years, and improvements in battery technology and microprocessors, and the miniaturization of these components have made their incorporation in e-cigarettes more practical.

29. Prior to the presumed invention date of the '556 Patent in February 2014, numerous e-cigarette designs were reported in the literature and dozens of e-cigarettes brands were commercially available in the United States. Many of these commercial products were manufactured in China. These commercial products, as well as the e-cigarette designs reported in the literature, while they differed in

some respects, all operated in a similar manner using well-known vaporizing principles and technology. For example, the devices were battery operated; the battery was used to power an electric heating element, usually made of wire; a nicotine solution of aerosol-forming substance was contained within the device and transported to the heating element by capillary action via one or more wicks; the heating element vaporized the nicotine solution or aerosol-forming substance; and then vapor mixed with air in an airflow to form an aerosol that was inhaled by the user.

30. As a POSITA would have readily appreciated well before the presumed invention date of the '556 Patent in February 2014, there were a variety of known design options for implementing these basic concepts of storing a solution or other aerosol forming material, positioning the aerosol-forming material in close proximity or transporting it by capillary action to a battery-powered heating element for vaporization, and then mixing the resulting vapor with airflow through the device to deliver an aerosol to a user, while preventing leakage of aerosol droplets from the e-cigarette. *See, e.g.*, WO 2009/132793 A1 (“Thorens ’793”) (EX1025). Thorens ’793 discloses an electronic cigarette that includes an electrical power supply (including a battery 103), a mouthpiece 201, a cartridge 205 (which contains liquid 205 and capillary wick 207), and a heating coil 209. Thorens ’793 at Figs. 2-3 (reproduced and annotated below).

Fig. 1

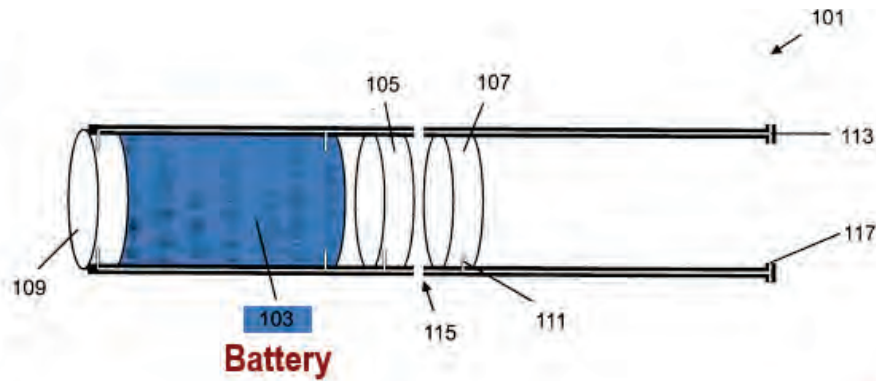
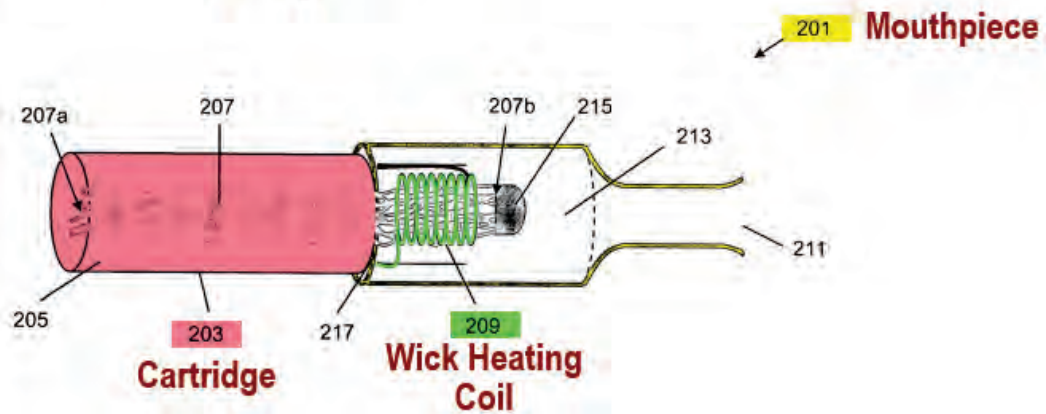


Fig. 2



31. Thorens '793 identifies various purported benefits to its electronic cigarette design, which help to demonstrate that the claimed concepts of the '556 Patent were well known in the art before the alleged invention date of the '556 Patent.

32. For example, Thorens '793 discloses that:

[t]he capillary wick may have a fibrous or spongy structure. For example, the capillary wick may comprise a plurality of fibres or threads, generally aligned in the longitudinal direction of the smoking system, or sponge-like material formed into a rod shape along the longitudinal direction of the smoking system. The structure of the wick forms a plurality of small bores or tubes, through which the liquid can be transported

from the liquid storage portion to the heating element, by capillary action. The capillary wick may comprise any suitable material or combination of materials. Examples of suitable materials are ceramic- or graphite-based materials in the form of fibres or sintered powders. The capillary wick may have any suitable capillarity and porosity so as to be used with different liquid physical properties such as density, viscosity, surface tension and vapour pressure.

Id., 5:24-33.

2. Storage and Transfer of Aerosol-Forming Materials

33. The '556 Patent itself discloses that in some prior art aerosol-generating systems already known in the art, “liquid is conveyed from the tank by capillary action into the wick of a coil wick heater assembly where the liquid is vaporized”:

One type of aerosol-generating system is an electrically operated smoking system. Handheld electrically operated smoking systems consisting of a device portion comprising a battery and control electronics, and a cartridge portion comprising a supply of aerosol-forming substrate, and an electrically operated vapouriser, are known. A cartridge comprising both a supply of aerosol-forming substrate and a vapouriser is sometimes referred to as a “cartomiser”. The vapouriser typically comprises a coil of heater wire wound around an elongate wick soaked in liquid aerosol-forming substrate. Capillary material soaked in the aerosol-forming

substrate supplies the liquid to the [wick]. The cartridge portion typically comprises not only the supply of aerosol-forming substrate and an electrically operated vapouriser, but also a mouthpiece, which the user sucks on in use to draw aerosol into their mouth.

In some types of electrically operated aerosol-generating devices, a reservoir of aerosol-forming liquid is provided in a tank. In use in the aerosol-generating system, the liquid is conveyed from the tank by capillary action into the wick of a coil wick heater assembly where the liquid is vaporized. When a user draws at the mouthpiece an airstream flows over the heater assembly and the generated aerosol is inhaled by the user. '556 Patent, col. 1, lines 10-33.

34. Indeed, the prior art is replete with examples of common ways to store aerosol-forming materials, *e.g.*, liquids (sometimes also referred to as “e-liquids”), in e-cigarettes. For example, early aerosol forming designs involved the use of a liquid reservoir to store liquid, which can also contain nicotine or other liquid extracts. *See, e.g.*, Whittemore at 2:13-15, Figs. 1-3. Other designs involved carrying or impregnating the liquid on the heating element, using one or more storage containers for transferring liquid from a remotely located liquid reservoir to the heating element, and using porous or absorbent materials to hold and convey the liquid to the heating element. *See, e.g.*, Thorens '793 at 7:18-8:1, Fig. 2.

35. Using porous or absorbent materials (including materials having different porosities and densities) to store liquid, gel or other aerosol-forming material provides several advantages, including the ability to control liquid movement in the cartridge and liquid distribution relative to the heating element, was also well-known to a POSITA prior to the alleged invention date of the '556 Patent in February 2014. *See, e.g., Id.*, 8:33-9:1; U.S. Patent No. 8,794,231 (“Thorens ’231”) at [0025], [0048], Fig. 2 (EX1007); CN102861694A (“Junxiang”) at [0022], Fig. 1 (EX1026). A POSITA would also have known that the use of porous or absorbent materials to store the aerosol-forming material would occupy space and therefore reduce the volume of liquid storage in the reservoir. *See, e.g.,* U.S. Patent Publication No. 2013/0056012 (“Hearn”) at [0014] (EX1004). Therefore, a POSITA would balance the considerations of liquid storage capacity and control of liquid movement when deciding the volume of porous or absorbent material to use for storing aerosol-forming material.

36. In view of the ubiquitous disclosure—and use—of porous, fibrous, and flexible materials to store liquid in e-cigarette cartridges, a POSITA would have known to use these materials for that exact purpose to obtain predictable results.

3. Location of Liquid Storage Medium Relative to Heater Element

37. By the alleged invention date of the '556 Patent in February 2014, it was also known that it was possible to place the aerosolizing liquid in a variety of storage mediums located at various locations relative to the heating element.

38. For example, it was known to hold the bulk liquid in a reservoir or in a porous or fiber material saturated with liquid, and transport small volumes of liquid to the heating element via one or more wicks or capillary materials for efficient and quick vaporization. *See, e.g.*, EX1024, 1:50–2:8; EX1025, 3:14-32, 5:13-33, 7:31-8:8; U.S. Patent No. 8,156,944 (“Han”) at Figs. 8 and 16 (EX1028), and descriptions thereof; U.S. Patent No. 9,943,108 (“Lord”) at Col. 5:33-40 (EX1028). Moreover, a POSITA would have known that the location of the liquid storage medium(s) relative to each other and the heating element could vary and depend on, for example, design preference and features such as the composition, density, and porosity of the liquid storage medium(s) and the properties of the liquid itself.

39. Another known location for the liquid storage medium(s) is adjacent to or surrounding the heating element. *See, e.g.*, EX1028, Figs. 8 and 16; EX1004, Fig 2; U.S. Patent No. 9,504,279 (“Chen”) at Figs. 4 and 5 (EX1029).

40. Other designs taught by the art include the use of a porous liquid solution holding medium to facilitate the distribution and mixing of the air and

liquid mixture and the use of a wicking material to transport liquid from a liquid holding medium to the heating element. EX1027, Figs. 8 and 16, and descriptions thereof; EX1028, 5:33-40.

4. Use of Heating Elements to Vaporize Aerosol-Forming Materials and the Location and Orientation of Said Heating Element

41. By the presumed invention date for the '556 Patent in February 2014, heating elements were well-known in vapor products including e-cigarettes, and a POSITA would have understood that the placement and orientation of the heating element was a design option dictated by trade-offs amongst various factors including ease of manufacturing, energy efficiency and performance criteria including the amount and rate at which vapor is generated when a user draws upon the device.

42. There were several well-known techniques for creating vapor from a liquid in e-cigarettes and personal vaporizers, a heating wire or heating filament (*e.g.*, EX1028 Fig. 6 (item 822); CN 201197360Y (“Zhiping”) at 4, Figs. 2-3 (EX1022)), resistance heating element such as a carbon filament yarns and felts; porous metal wires or films, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; and porous substrates in intimate contact with resistance heating components (*e.g.*, U.S. Patent No. 4,947,874 (“Brooks”) (EX1016) at 7:25-8:3).

43. A POSITA would have known in February 2014 that heating elements could be selected based upon a variety of factors, including the desired mass, thickness, conductivity, resistivity, and thermal stability at the temperatures experienced during use. A POSITA would also consider the above factors to establish a desirable rate at which the heating element heats and cools as well as its overall energy efficiency. For example, a POSITA would have known that a heating element that heats up rapidly would provide almost immediate volatilization of the aerosol forming substance. *See id.*, 7:4-40.

5. Techniques for Transferring Liquid to Heating Element

44. Prior to the presumed February 2014 invention date of the '556 Patent, a POSITA would have known to place aerosol-forming materials such as liquids in close proximity to the heating element to maximize vaporization efficiency. *See, e.g.*, EX1024, Figs. 2 and 3; CN202456410U ("Li '410") at [0013], Figs. 7, 9 (EX1021). The prior art taught that liquid can be efficiently transferred from a bulk liquid storage medium to the heating element using one or more wicking materials. *See, e.g.*, EX1024, 1:50–2:8; EX1025, 3:14-32, 5:13-33, 7:31-8:8; EX1027, Figs. 8 and 16, and descriptions thereof; EX1028 5:33-40.

45. Prior to the alleged invention date of at least the '556 Patent, a POSITA would also have understood that characteristics including pore size, fiber size, porosity, and density for materials used as wicking or capillary materials

would impact the flow of liquid in an aerosol-forming device. *See, e.g.*, EX1004, [0021]-[0025]; U.S. Patent No. 7,920,777 (“Rabin”) at Col. 6:5-22 (EX1005); U.S. Patent No. 8,910,640 (“Sears”) at Col. 24:35-41, 50-65 (EX1020). A POSITA would also recognize that a material with a higher porosity and a larger pore size would be less dense, and therefore offer less resistance to liquid flow. Conversely, a material with a smaller pore size and lower porosity would be more dense, causing it to be more resistant to liquid flow. Therefore, a POSITA would recognize that the most efficient method of liquid transfer from the bulk storage medium to the heating element would have been to use a high-resistance material closer to the heating element and a lower-resistance material further away from the heating element (closer to the bulk storage medium). This is because for an e-cigarette application, a POSITA would not want *too much* liquid to flow towards the heater. Too much liquid near the heater could cause oversaturation of the heater (reducing heater performance and lowering vapor production) and leakage towards the heater end of the device. So, each link in the liquid-handling chain should have less flow efficiency than the last. *See* U.S. Patent No. 7,888,275 (“Ward”) at Col. 10:35-56, Fig. 21 (EX1019); EX1004, [0017]-[0019]; EX1028, 2:63-65.

46. As of February 2014, a POSITA would be aware of common wicking materials that could be used to transfer liquid towards the heater in an e-cigarette

device. Materials such as aluminum oxide ceramic (*e.g.*, EX1028, 12:18-20; U.S. Patent No. 8,314,591 (“Terry”) at 13:25-36 (EX1006), glass fiber (EX1021, [0003]; EP 2404515 (“Hon ’515”) at [0020] (EX1023)), cotton (EX1021, [0003]; EX1023, [0020]; felt (EX1023, [0020]; *see* EX1019), and steel wool (EX1006, 13:25-36), were well-known to a POSITA as suitable for delivering liquid directly or in close proximity to the heating element to be vaporized. A POSITA would have recognized that many of these materials are widely commercially available in a variety of pore sizes and densities and as such it would be routine for a POSITA to try various densities and pore sizes of these materials to optimize liquid flow towards the heater.

47. U.S. Patent No. 8,794,231 (Thorens ’231) disclosed that a capillary wick for an electrically heated smoking system could be made of “any suitable material or combination of materials” :

The capillary wick may have a fibrous or spongy structure. For example, the capillary wick may comprise a plurality of fibers or threads, generally aligned in the longitudinal direction of the smoking system, or sponge-like material formed into a rod shape along the longitudinal direction of the smoking system. The structure of the wick forms a plurality of small bores or tubes, through which the liquid can be transported from the liquid storage portion to the heating element, by

capillary action. The capillary wick may comprise any suitable material or combination of materials. Examples of suitable materials are ceramic- or graphite-based materials in the form of fibers or sintered powders. The capillary wick may have any suitable capillarity and porosity so as to be used with different liquid physical properties such as density, viscosity, surface tension and vapor pressure.

EX1007, 5:6-20.

48. Thorens '231 further disclosed that a capillary wick for an electrically heated smoking system “can be made from a variety of porous or capillary materials and preferably has a known, pre-defined capillarity,” and “[w]icks of different porosities can be used to accommodate different liquid physical properties such as density, viscosity, surface tension and vapor pressure.”

EX1007, 7:50-56. Thorens '231 teaches that “[t]he wick must be suitable so that the required amount of liquid can be delivered to the heating coil.” EX1007, 7:50-58.

49. It was also known in the art that the heating element itself can comprise a solution-holding medium by constructing the heating element from a porous or wicking material. *See, e.g.*, EX1016, 7:48-8:3; U.S. Patent Publication No. 2014/0150785 (“Malik”) at [0029] (EX1018); EX1021, [0031]). In this case, a POSITA would recognize that the same materials listed above are suitable to

deliver liquid directly or in close proximity to the heating element to be vaporized. Glass fiber and ceramic fiber materials would be especially obvious to use in a heater due to their heat-resistance.

50. As of the priority date of the '556 Patent in February 2014, a POSITA would have been aware of other common wicking materials that could be used to deliver liquid from a bulk storage reservoir either directly to the heater or to another capillary material in close proximity to the heater. Woven and non-woven fiber textiles (*See* EX1019; EX1021, 2:24-25; EX1023, [0020]), metal foams (EX1028, 5:1-3; EX1006, 13:25-36; EX1023, [0020]), and porous polymers (EX1006, 13:25-36) were known in the art as suitable to transport liquid towards a vaporization zone. A POSITA would further recognize that certain properties of this material, for example density and pore size, impact how much liquid is delivered from the bulk storage medium to the heater. *See* EX1004, [0021]-[0025]; EX1005, 6:5-22; EX1020, 24:35-41, 50-65.

51. A POSITA would further have recognized that certain properties of capillary materials, for example density and pore size, impact how much liquid is delivered from the bulk storage medium to the heater. *See* EX1004, [0021]-[0025]; EX1005, 6:5-22; EX1006, 24:35-41, 24:50-65. Especially as of the priority date of the '556 Patent, ranges of pore sizes and densities were known to be suitable for transportation and vaporization of liquids. For example a pore size

of between .01 and 50 μm was known to be “sufficiently small to provide an adequate supply of liquid to the vaporization zone to produce the desired vapor output and to provide the capillary forces necessary to maintain a discrete vaporization zone and at the same time, provide a porous environment for vaporization to occur in the vaporization zone. suitable for the porous zone on or adjacent to the heater, where vaporization takes place.” See U.S. Patent No. 6,585,509 (“Young ’509”) at Col. 6:28-39 (EX1017). A pore size between 5 and 150 μm was known to be suitable for a porous member that delivers liquid to another capillary member which is closer to the heater. *Id.*, 8:16-39. A porous fiber wick with a porosity of 51% to about 100% and/or a density of 0.2 to 1 g/ml was known in the art as suitable for fluid transmission and vaporization by 2014. EX1019, 2:11-18; 14:42-48, 15:47-59.

C. Prior Art References Embodying the Claimed Features

52. As described above, by the time of the alleged invention of the ’556 Patent in February 2014, the various features recited in the ’556 Patent claims were well-known in the prior art, including in the references further discussed below.

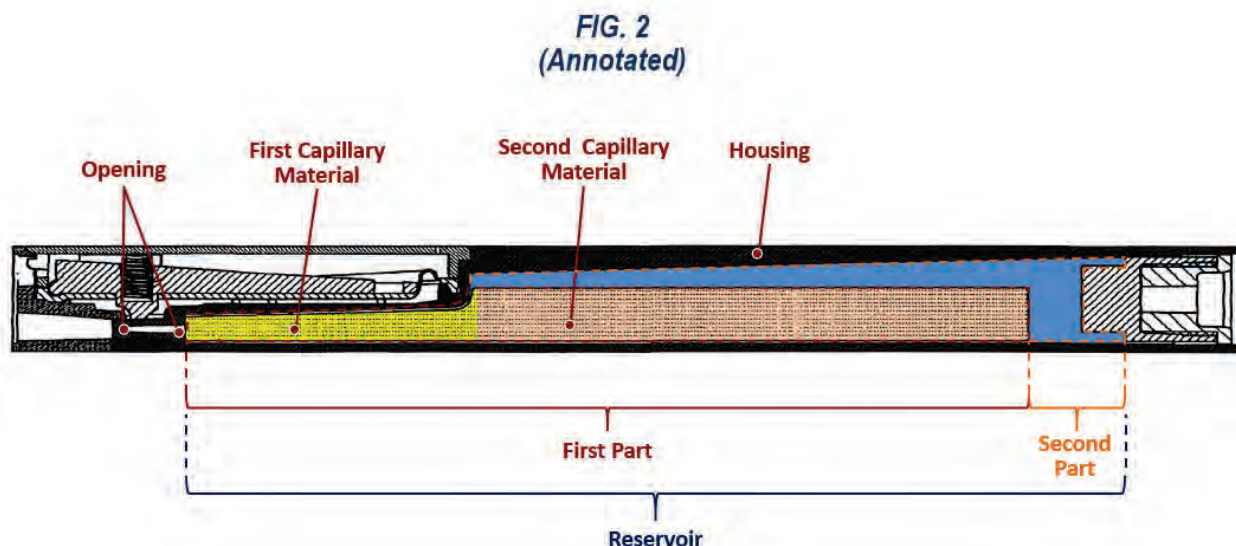
1. Prior Art References to the ’556 Patent

a. Hearn (US2013/0056012)

53. Hearn was filed on filed on November 12, 2012, published on March 7, 2013, and claims priority to GB1003552.5 filed on March 3, 2010.

54. Hearn was not of record during the prosecution of the '556 Patent, however its international PCT counterpart, WO 2011/107737A1, was cited but not substantively considered by the examiner during the prosecution of the '556 Patent.

55. Hearn is directed to a device that contains “a pressurised [sic] reservoir of inhalable composition and an outlet valve controlling the output of the inhalable composition.” EX1004, Abstract. As shown in FIG. 2 below, Hearn discloses an electronic cigarette with a housing (1) and a pressurized reservoir (5) containing an inhalable composition. EX1004, [0031]. The reservoir (5) can be a replaceable component (*i.e.*, a replaceable cartridge) and has an outlet orifice (11) from which the inhalable composition is dispensed. *Id.*, [0031, 0033]. Within the reservoir is a capillary plug (30), which extends for substantially the entire length of the reservoir with the exception of a gap where liquid can be received. *Id.*, [0038]. The plug may be comprised of “two or more materials each having different pore sizes.” *Id.*, [0017].



56. Hearn discloses that, “[i]n the region adjacent to the valve 7, the reservoir is significantly thinner. In this region, the rod 30 is compressed thereby reducing the pore size to provide increased capillary force in this region.” *Id.*, [0039].

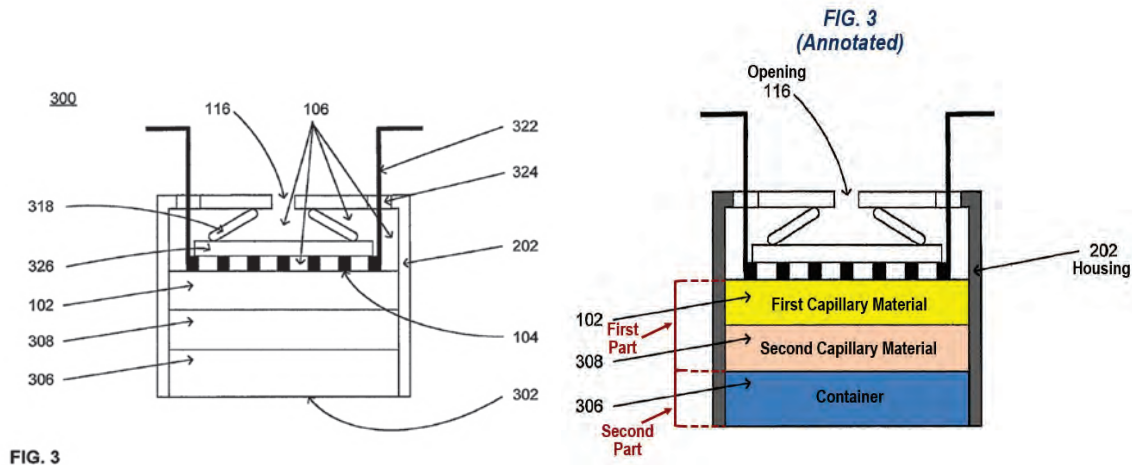
b. Rabin (US 7,920,777)

57. Rabin was filed on November 13, 2007, issued on April 5, 2011, and claims priority to U.S. Patent Application No. 10/691,067 filed May 16, 2005.

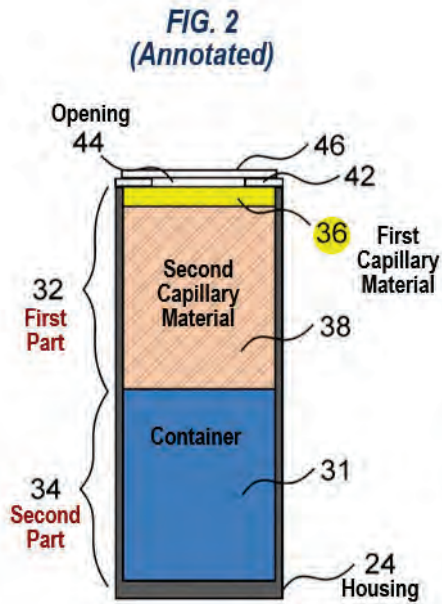
58. I understand that Rabin was not of record during the prosecution of the '556 Patent

59. Rabin is directed to “capillary force vaporizers” that “feature novel configurations that provide better mechanical reliability and improved response times to changes in input heat and power, in addition to offering other advantages over prior art devices.” EX1005, 2:20-25. Rabin discloses numerous vaporizer

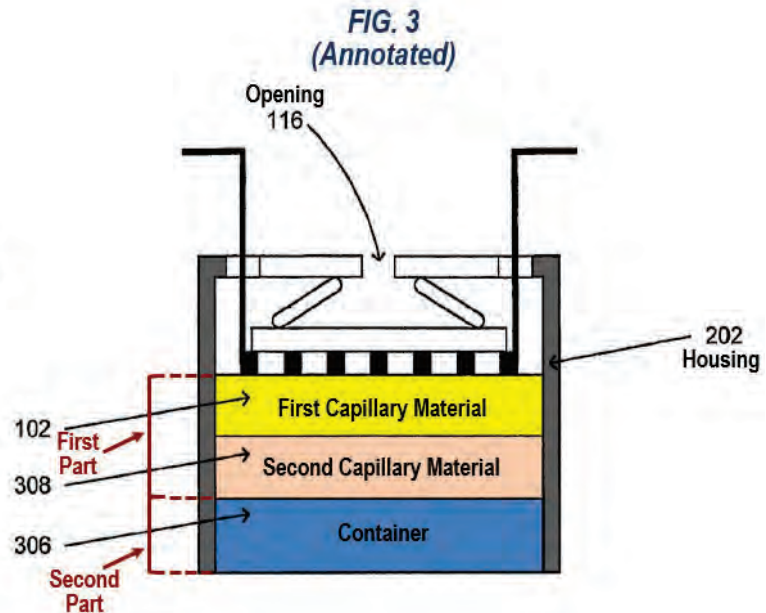
embodiments that utilize a stacked configuration of multiple capillary materials, with liquid flowing from a liquid reservoir or liquid supply component, passing through the multiple capillary materials, and being delivered to a heater component that produces vapor from the liquid.



60. In one exemplary embodiment, shown in FIG. 3 above, the capillary stack includes a liquid supply component 306, a thermal insulation component 308, and a porous member 102 disposed near the heater component 104; liquid travels by capillary action from the liquid supply component 306, through the insulation component 308, and through the porous member 102 to the heater 104. Rabin's basic teachings are very similar to the stacked arrangement of first and second capillary materials purported to be invented in the '556 Patent, as evidenced by the side-by-side annotations below.



‘556 PATENT



RABIN

61. In another embodiment, shown in FIG. 6 below, Rabin’s capillary force vaporizer 600 includes a liquid reservoir 602 and an upper assembly 610. EX1005, FIG. 6, 12:28-30. Rabin explains that the liquid reservoir in this embodiment may be removable or may connect “directly to housing 504.” EX1005, 12:37-40. In this embodiment, capillary force vaporizer 600 includes a wick component 608 for supplying liquid to the liquid supply component 306, with the liquid next passing to the thermal insulation component 308, and the liquid then passing to the porous member 102 located at the heater 104. EX1005, 12:25-54.

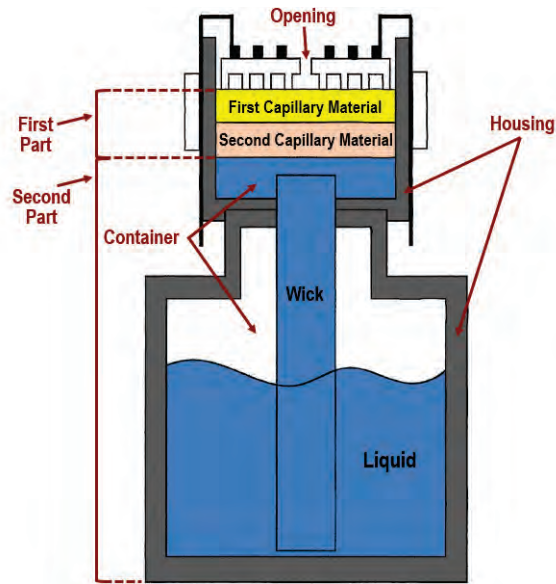
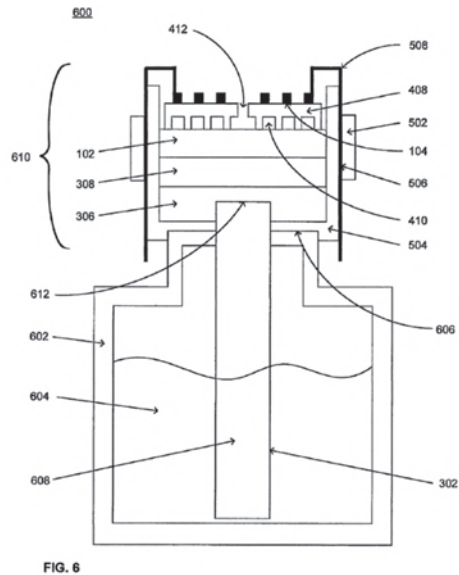


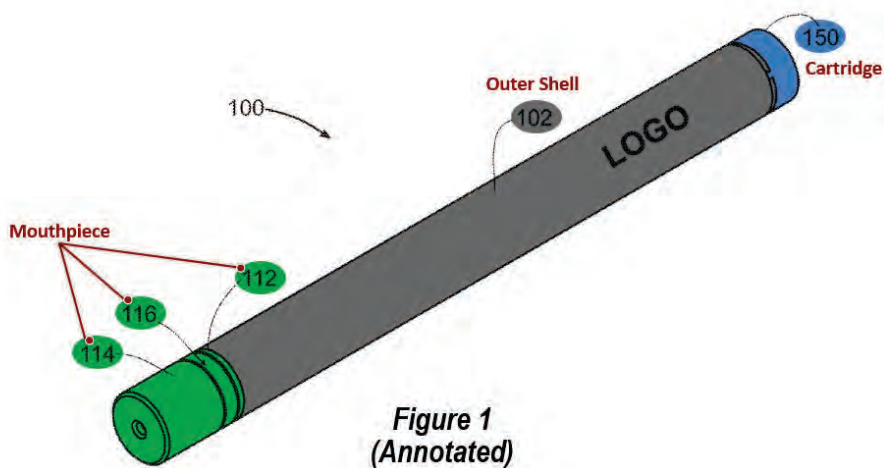
FIG. 6
(Annotated)

62. In Rabin, each of porous member 102, thermal insulation component 308, liquid supply component 306, and wick component 608 act as a capillary material, conveying liquid from one end of the capillary material to another.

63. In addition, Rabin points to and incorporates other prior art, including U.S. Pat. Nos. 6,634,864 and 6,585,509, and U.S. Ser. No. 10/691,067, issued as U.S. 7,431,570 (Rabin is a continuation-in-part of the 10/619,067 application). *Id.*, 18:22.

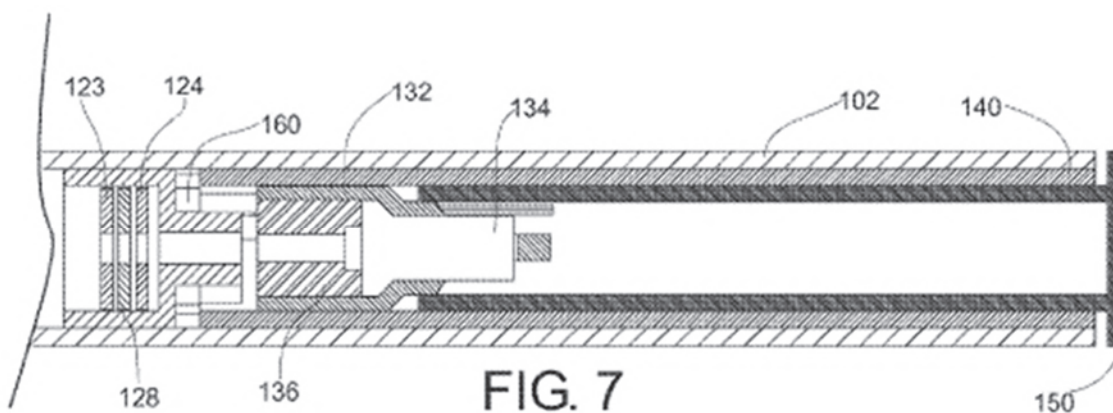
c. **Terry (US 8,314,591)**

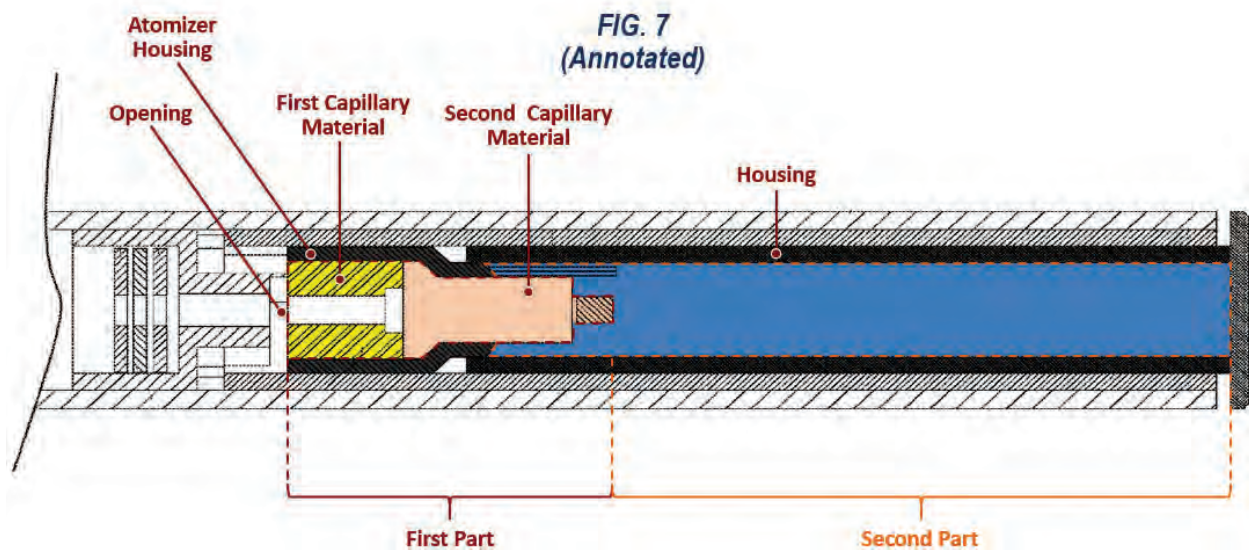
64. Terry was filed on May 15, 2010, issued on November 20, 2012. I understand that Terry was not of record during the prosecution of the '556 Patent. Terry discloses a personal vaporizing unit 110 including an outer main shell 102 and a cartridge 150 and atomizer housing 132. EX1006, 6:24-29.



65. Terry's vaporizer 100 comprises outer shell 102, with a mouthpiece structure 112, 114, 116 at one end and a cartridge 150 containing a liquid substance to be vaporized at another end, as illustrated in FIG. 1. EX1006, 5:16-27.

66. FIG. 7 of Terry below illustrates an embodiment showing the cartridge 150 and an atomizer housing 132 disposed within a light pipe sleeve 140. EX1006, 6:24-37.





67. Terry’s vaporizer includes two capillary materials—a proximal wick 134 (peach) and a distal wick 136 (yellow). The wicks are roughly situated in the atomizer housing 132 and extend into the cartridge 150. EX1006, 6:24-37. Both the atomizer housing 132 and cartridge 150 are situated inside light pipe sleeve 140. *Id.* Liquid flows from the interior of the cartridge 150 through the two wicks 134, 136 where it is vaporized in the atomizer 132. EX1006, 15:41:44.

d. Thorens ’231 (US 8,794,231)

68. Thorens ’231 was filed on April 29, 2009, issued on August 5, 2014, and also was published on November 5, 2009 as US 2009/0272379.

69. Thorens ’231 is directed to an electrically heated smoking system having a liquid storage portion, and discloses a shell and a replaceable mouthpiece which can be engaged to supply aerosol to a user on demand. EX1007, 6:54-58. In FIG. 2 below, a replaceable mouthpiece 201 “comprises a liquid storage portion

in the form of a cartridge 203” that contains liquid 205, a capillary wick 207, and a heating element 209. EX1007, 6:42-50.

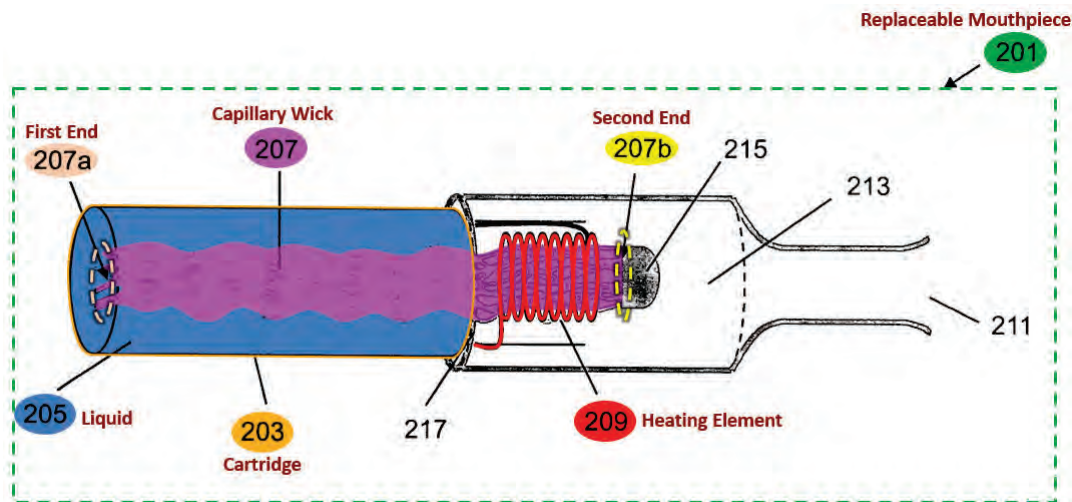


Figure 2
(Annotated)

70. A first end 207a of the capillary wick extends into the liquid storage portion for contact with liquid therein and a second end 207b of the capillary wick is surrounded by a heating element 209. EX1007, 6:42-53.

v. The '556 Patent

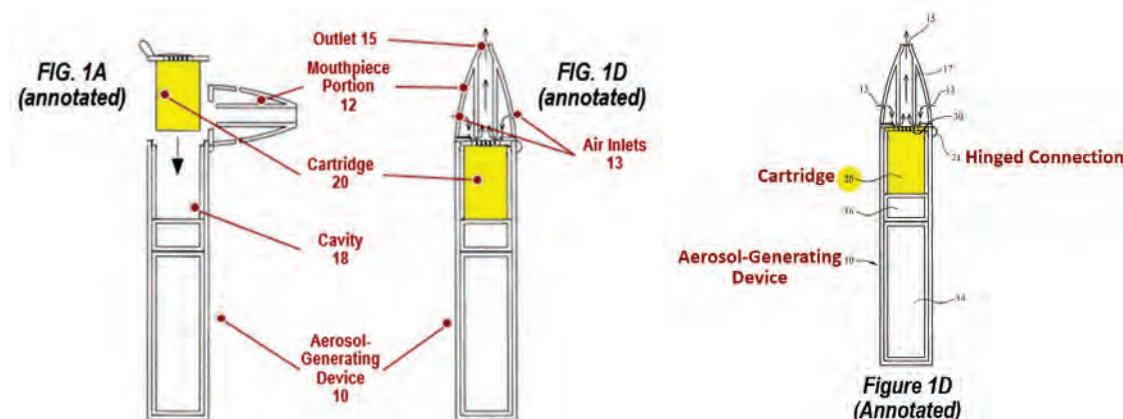
A. Overview of the '556 Patent

71. The '556 Patent is directed to a cartridge 20 (annotated in yellow below) for use in an aerosol-generating system. EX1001, Figs. 1A, 1D. The aerosol-generating system is formed of an aerosol-generating device 10 and the cartridge 20. EX1001, 10:44-46. The aerosol-generating device 10 includes a main body 11 and a mouth piece portion 12. EX1001, 10:57-59. “The mouthpiece portion 12 is connected to the main body by a hinged connection 21.” EX1001,

10:61-62. FIG. 1A illustrates the mouthpiece portion 12 in an open position.

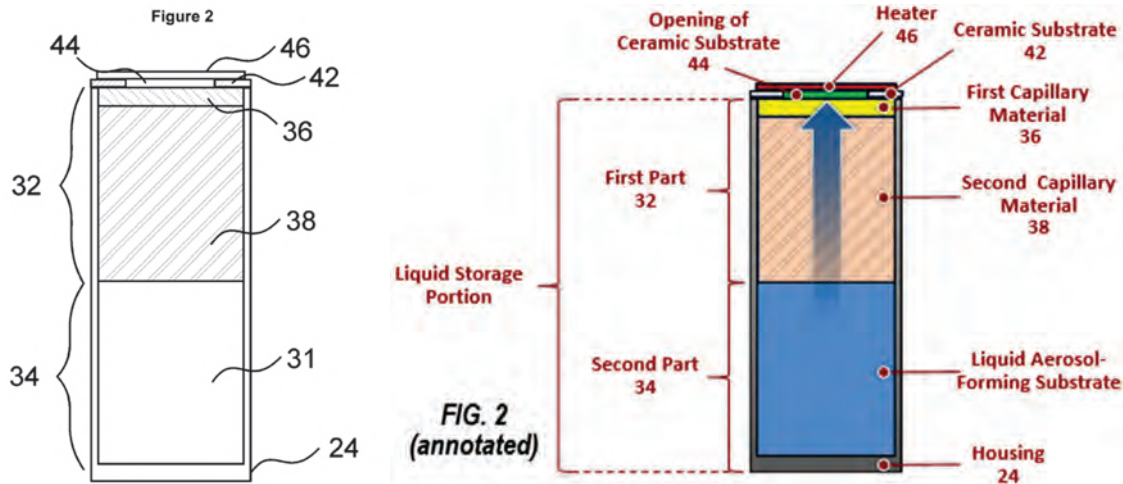
EX1001, Fig. 1A. The cartridge 20 “is configured to be received in a cavity 18” within the aerosol-generating device 10 in the direction indicated by arrow 1.

EX1001, 10:50, 10:53-55. FIG. 1D illustrates the mouthpiece 12 in a closed position with the cartridge inserted. EX1001, 11:23-28.



72. As recited in independent claims 1 and 25, the claimed “cartridge for use in an aerosol-generating system” includes a “liquid storage portion” that comprises, inter alia, a “housing having an opening,” “a first capillary material,” and “a second capillary material.” In this regard, the ’556 Patent discloses that a “capillary material” is “preferably a material that actively conveys liquid from one end of the material to another.” *Id.* 3:46-47. “The housing 24 has an open end to which a heater assembly is fixed” (*id.* 12:46-63), such that liquid aerosol-forming substrate flows from the liquid storage portion through the opening to the heater. “The capillary material is advantageously oriented in the housing to convey liquid to the heater assembly” through the opening at the open end of the housing. *Id.*,

3:46-49. The configuration of the housing, the opening, the first/second capillary materials, and the heater assembly is shown in FIG. 2 (at left) and as annotated (at right) below, with the arrow depicting the liquid flow to the “opening” in the housing and to the “heater assembly.”



73. The '556 Patent discloses, and independent claims 1 and 25 both require, that the “first capillary material” and “second capillary material” must be positioned in the housing of the cartridge in a particular orientation. *Id.*, 14:37-42. First, the “first capillary material” (36) must be “provided in a vicinity of the opening of the housing” (although the '556 patent specification fails to explain or provide any guidance as to what qualifies as “in a vicinity of the opening of the housing”). *Id.*, 14:38-40, 16:22-25. Second, the “second capillary material” 38 must be “spaced apart from the opening by the first capillary material [36]”; in other words, my understanding is that the “first capillary material” 36 must be

what separates and maintains the “second capillary material” 38 spaced apart from “the opening” in the housing (24). *Id.*, 14:40-42, 16:26-30.

B. Prosecution History

74. I have reviewed the priority EP applications, the PCT application along with the prosecution history leading up to the issuance of the ’556 Patent.

VI. Analysis Of Prior Art

75. I have analyzed the patentability of the claims in view of Hearn, Rabin, Terry, and Thorens ’231.

A. Claims 1, 3-9, 15, 18, 20-21, and 25-26: Hearn Alone, or Hearn in view of Rabin

76. Hearn discloses or suggests all of the elements of claims 1, 3-9, 15, 18, 20-21, and 25-26, including a capillary plug that “may be a single phase material formed with varying pore size, or may be two or more materials each having different pore sizes.” To the extent Patent Owner may argue, however, that any limitation is not explicitly disclosed or suggested by Hearn, in my opinion any such limitation is disclosed in Rabin or was well-known in the prior art and within the general knowledge of a POSITA.

1. Claim 1

a. Preamble: A cartridge for use in an aerosol-generating system, comprising:

77. Hearn discloses a simulated cigarette device 1 having a cartridge in the form of reservoir 5 containing a liquid inhalable composition and a capillary

plug 30, as illustrated in FIG. 2 below. Hearn's cartridge contains an inhalable composition inside a housing. EX1004, [0003]. The cartridge may be a replaceable component. *Id.*, [0031].

78. According to Hearn:

The present invention is particularly concerned with a simulated cigarette device comprising a housing; a pressurised reservoir of inhalable composition within the housing; an outlet for the inhalable composition from the reservoir and out of the housing; and an outlet valve controlling the flow of inhalable composition through the outlet.

Id., [0003].

79. While Hearn failed to label reservoir 5 in the figures, a POSITA would understand the interior of the reservoir 5 in Hearn to be where red arrow and blue shading are indicated in annotated FIG. 2 below.

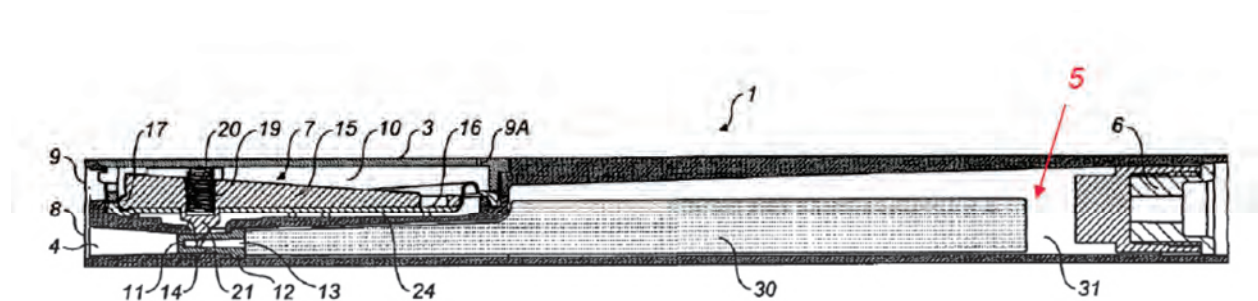
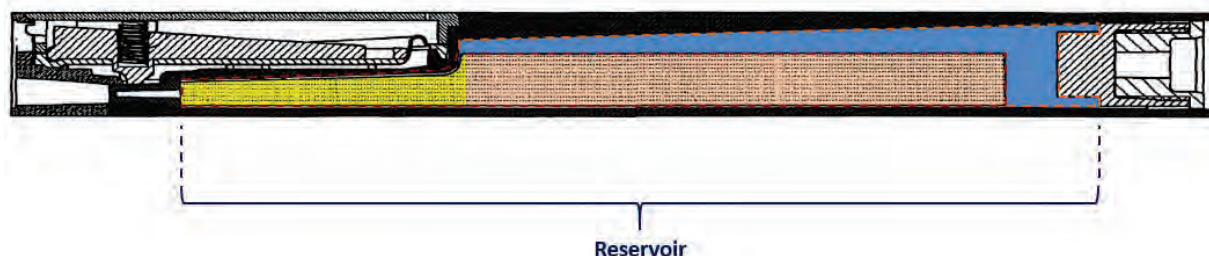


FIG. 2

FIG. 2
(Annotated)

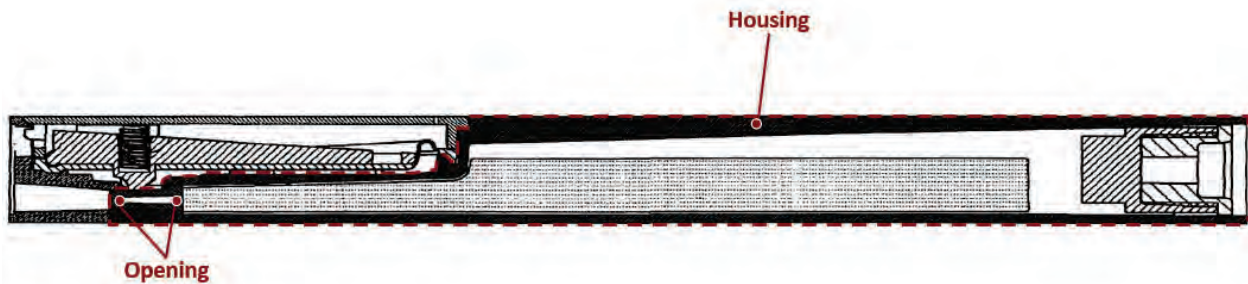


80. The simulated cigarette device of Hearn is described as a “pressurized reservoir of inhalable composition” that delivers a “flow of aerosol for the user,” and it is my opinion that a POSITA would recognize Hearn to be “an aerosol-generating system.” *Id.*, [0022].

- b. **1[a]: “a liquid storage portion, comprising a housing configured to hold a liquid aerosol-forming substrate, the housing having an opening,”**

81. Hearn discloses a “liquid storage portion.” EX1004, [0015], [0017], [0031]. In one embodiment, as shown in annotated FIG. 2 below, Hearn discloses a pressurized reservoir that forms a housing (dashed red lines) containing the inhalable composition.

FIG. 2
(Annotated)

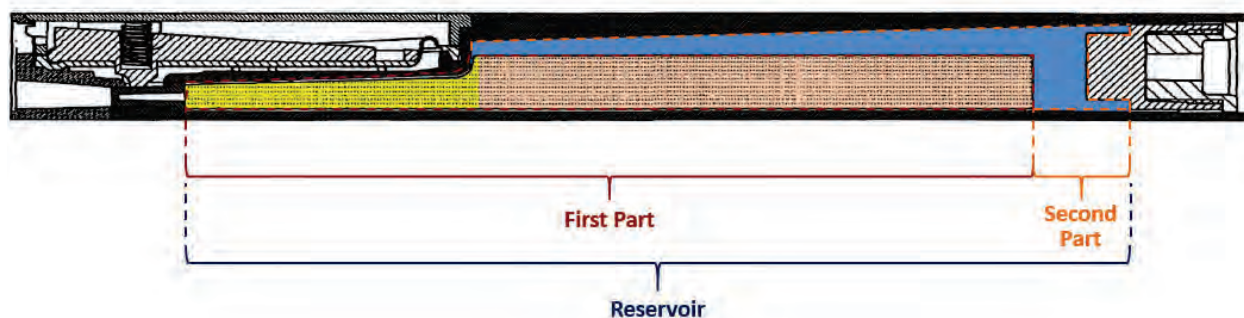


82. An outlet path 13 and outlet orifice 11 correspond to the opening of the housing. *Id.*, [0034].

- c. **1[b]: “wherein the liquid storage portion comprises at least two parts in fluid communication with each other,”**

83. Hearn shows a liquid storage portion having two parts in fluid communication. Within a first part of the reservoir is a capillary plug 30 that extends for substantially the entire length of the reservoir 5. *Id.*, [0038]. A second part of the reservoir 5 stores refill material by the capillary plug 30. *Id.* Hearn discloses two parts (first and second) because “it is preferable that the plug does not fill the entire reservoir. This is because the space occupied by the wicking material reduces the capacity of the reservoir.” *Id.*, [0014].

FIG. 2
(Annotated)



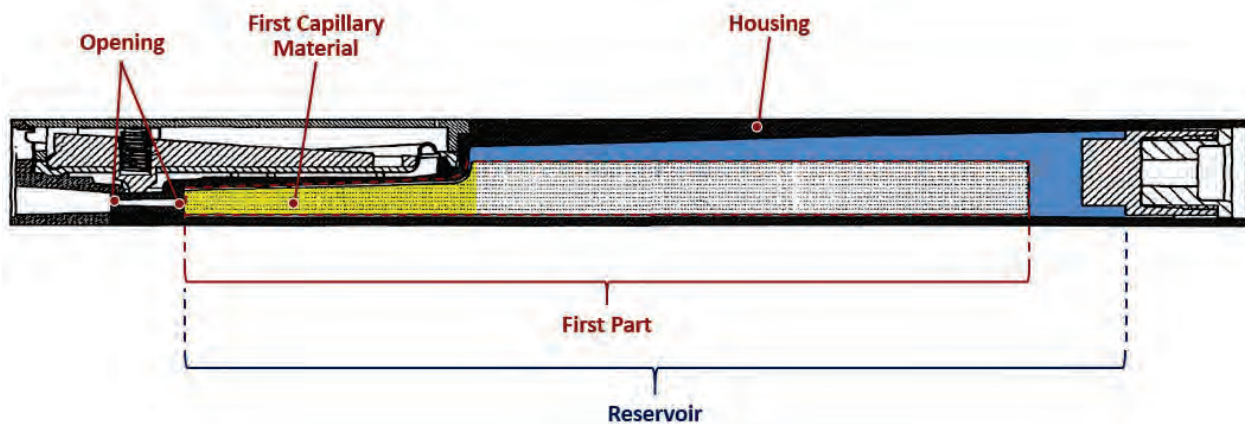
84. The first and second parts are in fluid communication with each other. The capillary plug acts “to wick the inhalable composition” from the second part to the first part and “towards the outlet valve.” *Id.*, [0011].

- d. **1[c]: “a first part of the liquid storage portion comprising a first capillary material, provided in a vicinity of the opening of the housing”**

85. As I previously described, Hearn includes a liquid storage portion having two parts in fluid communication. The first part of the reservoir includes a capillary plug 30 that extends for substantially the entire length of the reservoir. *Id.*, [0038].

86. The capillary plug 30 “may be made of a single phase material formed with varying pore size, or may be two or more materials, including each having different pore sizes,” and suitable materials may include polyolefin, polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA. *Id.*, [0016], [0024], [0025].

FIG. 2
(Annotated)



87. Hearn discloses the use of a first capillary material (shown in yellow above) adjacent to an opening of the housing (opening in FIG. 2 including the outlet path 13 which extends to the outlet orifice 11). “In the region adjacent to the valve 7, the reservoir is significantly thinner. In this region, the rod 30 is compressed thereby reducing the pore size to provide increased capillary force in this region.” *Id.*, [0039].

- e. **1[d]: “and, a second capillary material in fluid contact with the first capillary material and spaced apart from the opening by the first capillary material, and”**

88. As explained above, the first part of the liquid storage portion in Hearn contains a capillary plug:

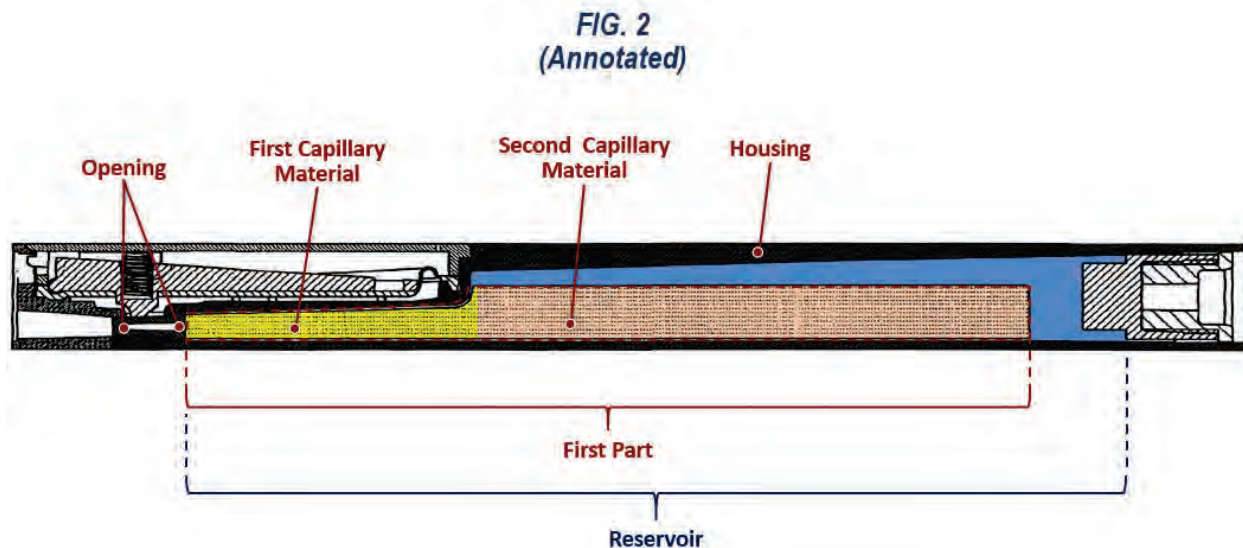
In order to enhance the capillary action, the plug preferably has a pore size which decreases towards the outlet valve. This may be achieved by using a graduated material which may be a single phase material formed with varying pore size, or may be two or more materials

each having different pore sizes, the relative proportions of which are varied along the length of the plug. However, preferably, this is achieved by compressing the plug in the vicinity of the outlet valve.

Id., [0017] (emphasis added).

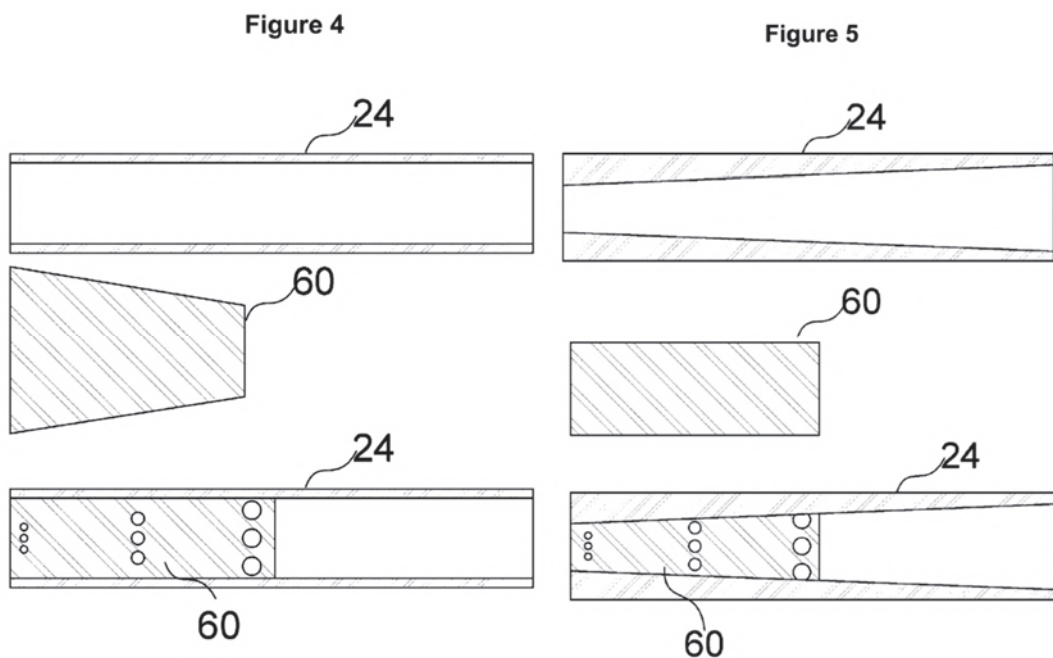
89. A POSITA would understand Hearn as disclosing first and second capillary materials either: (i) comprised of a single phase material with different regions formed with varying pore size, or (ii) comprised of two or more materials that each have different pore sizes.

90. In particular, Hearn discloses a method for varying the pore size in the capillary plug by compressing the capillary material, stating that, “preferably, this is achieved by compressing the plug in the vicinity of the outlet valve.” *Id.*, [0017]. This compressed portion of the capillary plug comprises a “first capillary material” (yellow), and the non-compressed portion of the capillary plug comprises a “second capillary material” (peach). Annotated FIG. 2 further demonstrates that Hearn’s second capillary material is in fluid contact with the first capillary material, and shows that the second capillary material is spaced apart from the opening 11, 13 by the first capillary material.



91. Therefore, I understand that Hearn discloses a first capillary material (compressed portion, in yellow) and a second capillary material (non-compressed portion, in peach) as disclosed and claimed in the '556 Patent.

92. Hearn's capillary plug configuration is similar to the embodiment shown in FIGs. 4 and 5 of the '556 Patent.



93. According to the '556 patent, just as Hearn discloses in some embodiments, the “first and the second capillary material are made from the same material and are integrally formed as [a] single continuous piece of capillary material” in FIGs. 4 and 5:

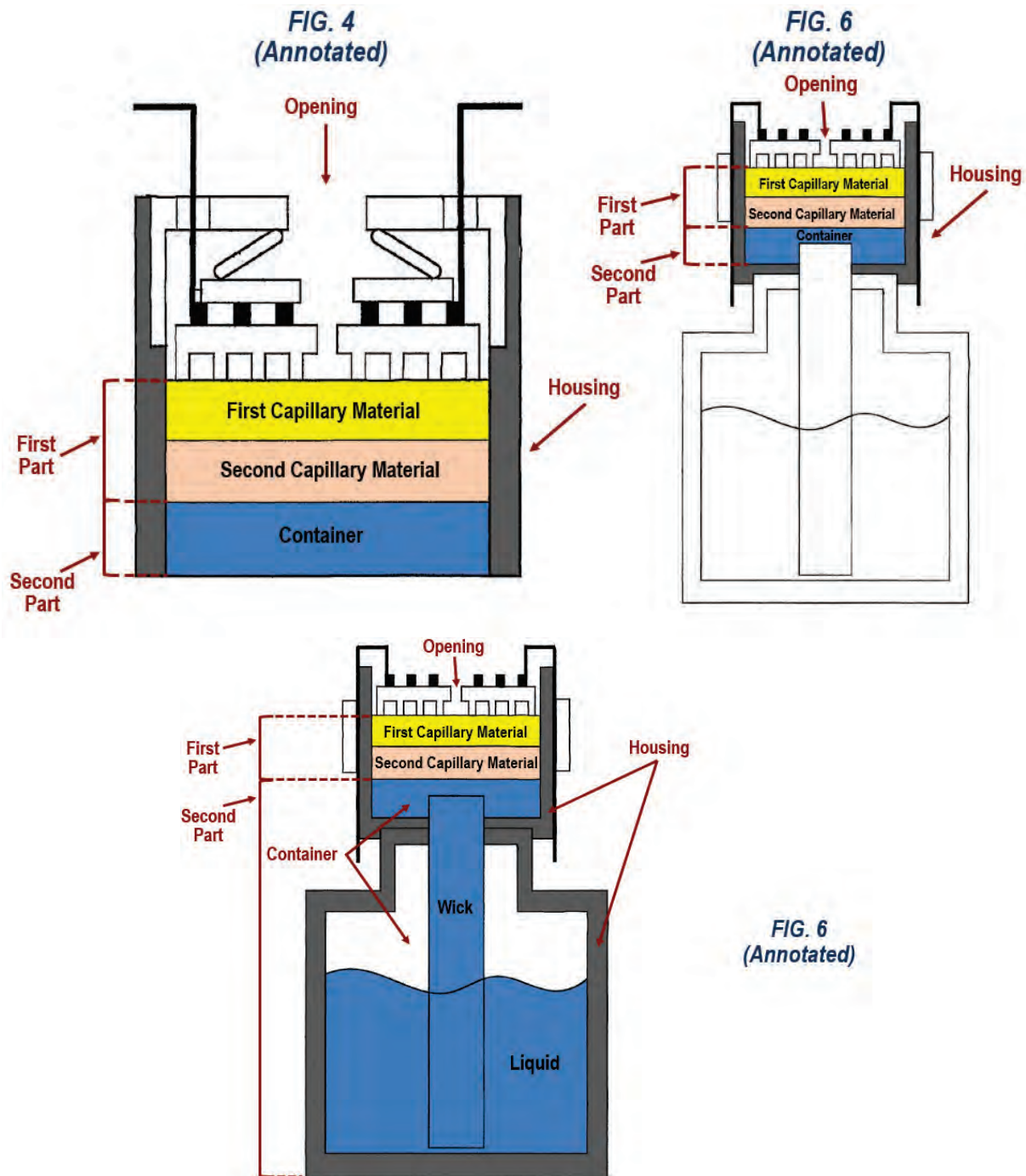
FIG. 4 shows an embodiment wherein the housing 24 has the shape of a regular cylinder with circular cross-section. The first and the second capillary material are made from the same material and are integrally formed as single continuous piece of capillary material 60 having the shape of a truncated cone. The diameter of the truncated apex of the cone corresponds to the inner diameter of the cylindrical housing. The diameter of the base of the cone is twice as large as the inner diameter of the cylindrical housing. The capillary material 60 is inserted apex first into the cylindrical housing 24 until the surface of the base of the cone lies flush with the front face of the cylindrical housing. Upon insertion the capillary material 40 is compressed, whereby due to the relative shape of the capillary material and the cylindrical housing, compression of the capillary material 60 is increased towards end face of the cylindrical housing. At the same time pore size or porosity of the capillary material is reduced such that the pore size or porosity of the capillary material in the vicinity of the end face of the housing is smaller than the pore size or porosity of the capillary material located in the center of the cylindrical housing. ***

FIG. 5 shows an alternative embodiment having a similar effect as the embodiment depicted in FIG. 4. In this case the inner surface of the housing is provided with a conical shape, such that the interior tapers towards one end of the housing 24. Here the inner diameter of housing 24 at the left hand side in FIG. 5 is half the inner diameter of housing 24 at the right hand side. Again the first and the second capillary material are made from the same material and are integrally formed as single continuous piece of capillary material 60. The piece of capillary material 60 has regular cylindrical form with a circular cross-section. The diameter cylindrical piece of capillary material 60 corresponds to the inner diameter of the housing 24 at the right hand side In FIG. 5. The capillary material 60 is inserted into the housing 24 until an end face of the capillary material 60 lies flush with the smaller diameter front face of the cylindrical housing, i.e with the end face at the left hand side of the housing 24. Again the capillary material 60 is compressed upon insertion, whereby due to the relative shape of the capillary material and the cylindrical housing, compression of the capillary material 60 is increased towards the left hand side end face of the cylindrical housing 24. At the same time pore size or porosity of the capillary is reduced such that the pore size or porosity of the capillary material 60 in the vicinity of the end face of the housing is smaller than the pore size or porosity of the capillary material 60 located in the center of the cylindrical housing.

EX1001, 12:64-13:49.

94. As such, it is my opinion that Hearn teaches a capillary plug that similarly includes both a “first capillary material” and a “second capillary material” that “are made from the same material and are integrally formed as single continuous piece of capillary material” as disclosed and claimed in the ’556 Patent.

95. Even it was argued that the ’556 Patent claims are somehow limited to a “first capillary material” that is distinct and separable from a “second capillary material,” Rabin discloses a stacked capillary configuration in which there are distinct first and second capillary materials. Rabin discloses a capillary force vaporizer 600 including an optional liquid reservoir 602, optional wick component 608 for supplying liquid to a liquid supply component 306, thermal insulation component 308, and a porous member 102 situated in a vicinity of the opening of a housing where a heater vaporizes the liquid. EX1005, 12:25-54.



96. Rabin's FIGs. 4 and 6 above show exemplary arrangements of the multiple distinct capillary materials in the device. In these embodiments, a first capillary material (porous member 102 in yellow) is in the vicinity of the opening

of the housing (116 or 412), and is stacked directly on top of a second capillary material (insulation component 308 in peach). Therefore, a second capillary material 308 is spaced apart from the opening (e.g., 116, 412) of the housing by a first capillary material 102.

97. Rabin, in my opinion, further discloses a second capillary material (insulation component 308) in fluid contact with the first capillary material (porous member 102), and Rabin discloses a container (liquid supply component 306 and liquid reservoir 602) that supplies liquid to the second capillary member (308).

98. As an alternative to using Hearn's compressed plug formed of a single phase material, for example, to enhance the capillary action of the plug, it is my opinion that it would have been obvious to a POSITA to have utilized a stacked arrangement of distinct capillary materials as taught by Rabin, with a first capillary material (102) disposed near the vaporizer opening, and a second capillary material (308) disposed near the liquid source. In this regard, Rabin specifically discloses that—like in Hearn—the first capillary material (102) may have a smaller pore size (“a mean pore size of about 1 micron (μm)”) than the larger pore size of the second capillary material (308) (“a mean pore size of about 20 μm ”). *Id.*, 15:26-30.

99. Therefore, it is my opinion that a POSITA starting with Hearn would have readily recognized that there may be other capillary configurations or more advantageous wicking technologies that could have been incorporated in an

electronic vaping device / electronic cigarette, and would have been motivated to consider prior art directed to other capillary configurations like the embodiments disclosed in Rabin.

100. The improvement described in Hearn is a simulated cigarette that can dispense aerosolized doses in any orientation in order to replicate the pharmacokinetic effects of a cigarette that persistent smokers desire. EX1004, [0002], [0004], [0007]. Hearn explains that the problem of orientation was alleviated by traditional metered dose inhalers which included a bend or neck, but that a simulated cigarette designed to resemble a real cigarette (narrow cylindrical construction) cannot accommodate such a bend or neck. *Id.*, [0005]. Hearn discloses a way to solve the orientation problem associated with simulated cigarette devices by providing a “capillary plug extending from the vicinity of the outlet valve into the reservoir, filling a substantial portion of the reservoir and being configured to wick the inhalable composition towards the outlet valve” with wicking action enhanced by compressing the capillary material into a smaller area towards the outlet valve, reducing its pore size. *Id.*, [0010], [0011]. Hearn further discusses that “the capillary plug can have a pore size and density level, which can be graduated across the device, to fit the optimum performance of the flow of aerosol for the user. With this in mind, not only can pore size be graduated upwards towards the distal end, pore size can be graduated across the device, so

that smaller pore sizes can form the core of the wicking area, and surround the outlet valve. In practical terms, this is achieved by layering smaller pore sized foam sheet onto larger sheets so that there is a graduation in pore size over the cross sectional area. This means than pore size can graduate across the device as well as along the device to increase performance.” *Id.*, [0022].

101. It is my opinion that a POSITA starting with Hearn would have readily recognized that there may be other capillary configurations or more advantageous wicking technologies that could have been incorporated into a simulated cigarette device, and a POSITA would have been motivated, in my opinion, to consider prior art directed to other capillary configurations like the various capillary force vaporizer embodiments disclosed in Rabin. Rabin provides an alternative wicking arrangement in a capillary force vaporizer that includes multiple porous components with differing pore sizes that act to wick liquid via capillary action from a reservoir to an opening, and in Rabin’s teachings, there would have been no requirement for a portion of a “plug” to be squeezed into a smaller area to reduce its pore size. EX1005, 5:58-6:22. It is my opinion that a POSITA starting with Hearn and looking for enhanced capillary / wicking would have been motivated to utilize one or more of the multiple stacked capillary configurations disclosed by Rabin (*e.g.*, porous member 102, thermal component 308, liquid supply component 306, etc.). *Id.*

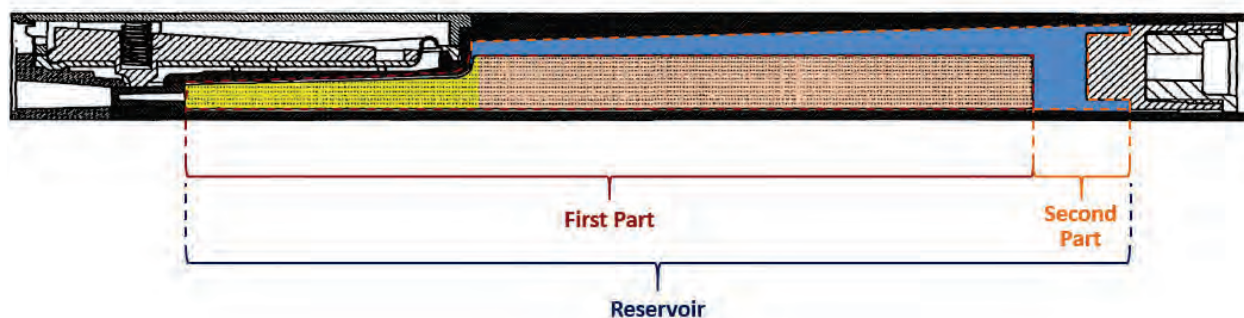
- f. **1[e]: a second part of the liquid storage portion comprising a container configured to hold the liquid aerosol-forming substrate and to supply the liquid to the second capillary material.**

102. As noted above and as illustrated in annotated FIG. 2 below, Hearn and/or Rabin discloses a liquid storage portion with two parts. The first part comprises the capillary plug and the second part is the remaining space within the reservoir where refill liquid is received. The function of the second part is to supply liquid to the second capillary material in the capillary plug. Hearn discloses:

Preferably, also, the plug does not occupy the full cross-section of the reservoir for a substantial proportion of the length of the reservoir to allow a liquid flow path within the reservoir alongside the porous plug. This ensures that some of the refill liquid can travel along this path before being absorbed laterally into the porous plug. This allows the wick to be saturated more readily than it would be if the plug filled the entire cross-section of the reservoir such that all of the refill liquid needed to flow along the porous plug.

Id., [0014], [0015]; *see also Id.*, [0038].

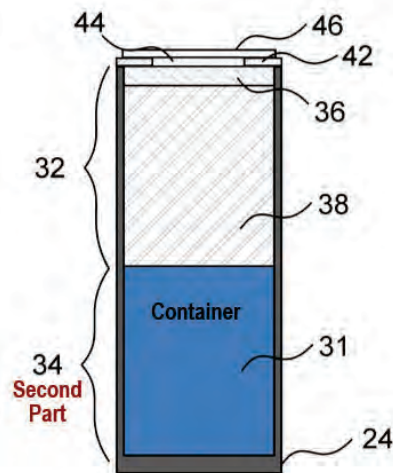
FIG. 2
(Annotated)



103. Therefore it is my opinion that Hearn discloses a second part of the liquid storage portion comprising a container (the space within the reservoir, including gap 31) configured to hold the liquid aerosol-forming substrate (inhalable composition, refill liquid) and to supply the liquid to the second capillary material (refill liquid is absorbed by the capillary plug 30).

104. Alternatively, Rabin discloses a “container” as claimed. The ’556 patent specification does not expressly illustrate a “container,” or any “container configured to hold the liquid aerosol-forming substrate and to supply the liquid to the second capillary material.” The specification does state that “[t]he second part 34 of the liquid storage portion is an empty tank”—like Hearn’s reservoir—“that can be filled or partly filled with liquid aerosol-generating substrate.” EX1001, 12:1-3. And FIG. 2 of the ’556 patent includes a numerical reference 31 in the second part 34 of the liquid storage portion, but there is no description of element 31 anywhere in the ’556 specification.

FIG. 2
(Annotated)



105. Rabin expressly discloses an embodiment using a distinct container:

“Optional liquid supply component 602 in FIG. 8 may comprise a container.”

EX1005, 14:11-12.

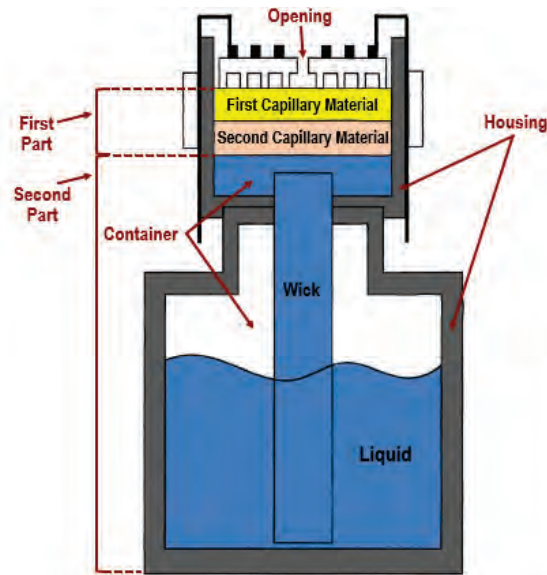
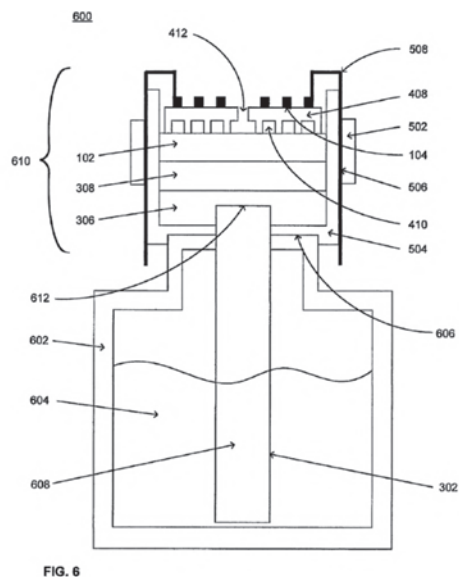


FIG. 6
(Annotated)

106. Rabin’s container (liquid reservoir 602) is configured to supply liquid (through wick 608 and optional liquid supply component 306) to the second capillary material (insulation component 308).

2. Dependent Claims – Porosity / Pore Size / Fiber Size

107. The dependent claims are directed to porosity / pore size / fiber size limitations for the “first capillary material” or “second capillary material” recited in independent claim 1. The recited ranges of pore sizes, fiber sizes, and densities for the capillary materials were disclosed and otherwise known in the prior art as a POSITA would have recognized in February 2014.

- a. **Claim 3: The cartridge according to claim 1, wherein an average pore size or porosity of the first capillary material is less than an average pore size or porosity of the second capillary material.**

108. As Hearn explains:

In order to enhance the capillary action, the plug preferably has a pore size which decreases towards the outlet valve. This may be achieved by using a graduated material which may be a single phase material formed with varying pore size, or may be two or more materials each having different pore sizes, the relative proportions of which are varied along the length of the plug. However, preferably, this is achieved by compressing the plug in the vicinity of the outlet valve.

Id., [0017] (emphasis added).

109. As described above in connection with claim 1[d], pore size in Hearn decreases from the non-compressed second capillary material, further from the outlet valve, to the compressed first capillary material, closer to the opening in the

housing. Pore size and porosity in Hearn is calibrated “to fit the optimum performance of the flow of aerosol for the user,” and pore size can be “graduated upwards towards the distal end.” *Id.*, [0022]. The first capillary material in Hearn is at the proximal end of the capillary plug, closest to the outlet valve, so the pore size of the compressed first capillary material is smaller than the pore size of the non-compressed second capillary material, further from the proximal end.

110. In an example, Rabin discloses a similar configuration in which a first capillary material (porous component 102) may have a smaller pore size (“a mean pore size of about 1 micron (μm)”) than the larger pore size of the second capillary material (insulator component 308) (“a mean pore size of about 20 μm ”). EX1005, 15:26-30. It is my opinion that a POSITA in February 2014 would have known to select “average pore sizes” or “mean pore sizes” consistent with Hearn’s teaching that pore size and porosity should be calibrated “to fit the optimum performance of the flow of aerosol for the user.” EX1004, [0022].

b. Dependent Claims 4 and 18 - Fiber Size Or Pore Size Of First Capillary Material

- a) **Claim 4: The cartridge according to claim 1, wherein the first capillary material has a fiber size or pore size of between 0.1 to 50 μm . & Claim 18: The cartridge according to claim 1, wherein the first capillary material has a fiber size or pore size of between 0.5 to 10 μm .**

111. Hearn discloses a range of potential pore sizes for the capillary plug, stating, “[w]hen detailing the precise characteristics, the pore radii are between 50 and 500 microns, preferably 100-300 and most preferably 100-150 microns.” EX1004, [0019]. Hearn’s disclosed range includes a pore size of 50 microns, meeting the claim 4 recitation of “pore size of between 0.1 to 50 μm .”

112. Moreover, as described above for claim 3, Hearn teaches that it would be routine and obvious for a POSITA to use a material or materials with differing pore sizes in order to “fit the optimum performance of the flow of aerosol” in the device. *Id.*, [0022].

113. A pore size or fiber size between 0.1 and 50 μm (and the subset range of 0.5 to 10 μm) would be especially obvious to a POSITA in light of Hearn’s preferred materials listed for the first and second capillary materials, some of which have a fiber size between 0.1 to 50 μm . For example, the first capillary material may be made from “polyolefin wick material,” as well as, “polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA.” *Id.*, [0024]-[0025]. A POSITA understands that several of these materials have a fiber size or pore size of between .1 and 50 μm .

114. Likewise, Rabin discloses a first capillary material (porous component 102) with “a mean pore size of about 1 micron (μm),” falling within claim 4 and,

additionally, falling within the claim 8 recitation of “pore size of between 0.5 to 10 μm .” EX1004, 15:28.

115. Given the wide range of materials disclosed above for the first and second capillary materials, including some that were widely available in February 2014 at smaller pore sizes, it is my opinion that it would have been obvious to a POSITA to use pore sizes in the range of between 0.1 to 50 μm (including the subset range of 0.5 to 10 μm) for the first capillary material. This pore size would be even more obvious to the POSITA given the disclosure described above for claim 3, wherein the first capillary material has a smaller pore size or porosity than the second capillary material.

116. Therefore, it is my opinion that Hearn and Rabin render obvious claims 4 and 18.

c. Dependent Claims 8 and 21 – Fiber Size Or Pore Size Of Second Capillary Material

a) **Claim 8: The cartridge according to claim 1, wherein the second capillary material has a fiber size or pore size of between 1 to 100 μm . &**

Claim 21: The cartridge according to claim 1, wherein the second capillary material has a fiber size or pore size of between 15 to 40 μm .

117. Hearn discloses a capillary plug with “pore radii [] between 50 and 500 microns, preferably 100-300 and most preferably 100-150 microns.” EX1004, [0019]. A pore size or fiber size between 1 and 100 μm (and the subset range of 15

to 40 μm) would have been obvious to a POSITA in light of Hearn's preferred materials listed for the first and second capillary materials, some of which have a fiber size between 1 to 100 μm . For example, the first capillary material may be made from "polyolefin wick material," as well as, "polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA." (*Id.*, [0024]-[0025].) A POSITA would have understood that several of these materials have a fiber size or pore size of between 1 and 100 μm and between 15 to 40 μm .

118. Rabin similarly discloses an example that utilized a second capillary material (insulator component 308) having "a mean pore size of about 20 μm " EX1005, 15:28-30.

119. In my opinion, it would have been obvious in February 2014 for a POSITA to choose the second capillary material in Hearn to have a fiber size or pore size of between 1 to 100 μm as recited in claim 8 and to have fiber size or pore size of between 15 to 40 μm as recited in claim 21.

d. **Dependent Claim 9 – Compressed To Reduce Effective Pore Size**

- a) **Claim 9: The cartridge according to claim 1, wherein the first capillary material or the second capillary material is compressed in the housing such that an effective pore size of the first capillary material or the second capillary material is reduced.**

120. The device in Hearn uses compression of the capillary plug, which includes the first and second capillary materials, to reduce the effective pore size of the first or second capillary materials. Hearn discloses:

In order to enhance the capillary action, the plug preferably has a pore size which decreases towards the outlet valve. This may be achieved by using a graduated material which may be a single phase material formed with varying pore size, or may be two or more materials each having different pore sizes, the relative proportions of which are varied along the length of the plug. However, preferably, this is achieved by compressing the plug in the vicinity of the outlet valve. This provides a simple means of achieving the variable pore size and also is readily achievable in a design where the opening/closing mechanism for the outlet valve lies alongside the portion of the reservoir at the end adjacent to the outlet valve as the reservoir is naturally thinner at this point.

EX1004, [0017] (emphasis added).

121. Hearn explains that: “In the region adjacent to the valve 7, the reservoir is significantly thinner. In this region, the rod 30 is compressed thereby reducing the pore size to provide increased capillary force in this region.” *Id.*, [0039]. As illustrated in FIG. 2 below, the “region adjacent to the valve 7” refers to and the “rod 30” refers to the capillary plug as a whole.

122. Rabin also discloses the desirable use of compression in its capillary system, explaining that “the need for peripheral sealing means has surprisingly been obviated through the use of compressive mechanical force.” EX1005, 4:40-43. For example, Rabin discloses that: “Compressive mechanical forces generated by friction between peripheral walls of housing component 202 and stacked components 102, optional 308 and optional 306 by optional spring component 318 effectively prevent leakage of vapor and liquid from inventive capillary force vaporizer 300, thereby allowing vapor pressure to increase at regions 106.” *Id.*, 6:29-34.

3. Dependent Claims – Density

123. Other dependent claims are directed to specific density limitations for the “first capillary material” or “second capillary material” recited in independent claim 1. In my opinion, these density limitations were disclosed or would have been obvious to a POSITA in February 2014 in view of Hearn and Rabin.

a. Dependent Claims 5 and 20 – Density Of First Capillary Material

a) **Claim 5: The cartridge according to claim 1, wherein the first capillary material has a density of below 2 g/ml. &**

Claim 20: The cartridge according to claim 1, wherein the first capillary material has a density of about 0.5 g/ml.

124. Because pore size is related to density (i.e. the higher the porosity in a material, the lower the density), it would be routine and obvious for a POSITA to use materials with differing densities in order to “fit the optimum performance of the flow of aerosol” in the device as taught by Hearn. EX1004, [0022].

125. In addition, Hearn states “Medium and High-Density capillary rods are 60 (kg/m³) and 120 (kg/m³), where the greater the density the higher the rise height of liquid through the capillary rod.” EX1004, [0022]. It is my opinion that a POSITA would readily recognize that such densities are converted respectively into 0.06 g/mL and 0.12 g/mL (both of which are below 2 g/mL).

126. Further as described above for claim 4 and 18, Hearn discloses several possible materials to be used for either the first or second capillary materials, including “polyolefin wick material,” as well as, “polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA.” *Id.*, [0024]-[0025]. A POSITA would have understood in February 2014 that several of these materials would have a density below 2 g/ml.

127. Furthermore, as described above in U.S. Patent No. 7,888,275 (“Ward”), a porous wick with a density of 0.2 to 1 g/ml was already known in the art as suitable for fluid transmission and vaporization by 2014. EX1019, 2:11-18, 14:42-48, 15:47-59. Therefore, it would have been obvious for the POSITA to

design the first capillary material in Hearn with a density below 2 g/ml as recited in claim 5 and with a density of about 0.5 g/ml,” as recited in claim 20.

b. Dependent Claims 6 and 7 – Density Of Second Capillary Material

- a) **Claim 6: The cartridge according to claim 5, wherein the second capillary material has a density of below 1 g/ml. & Claim 7: The cartridge according to claim 5, wherein the second capillary material has a density of between 0.1 and 0.3 g/ml.**

128. As described above, in my opinion, it would be routine and obvious for a POSITA to utilize materials with differing densities in order to “fit the optimum performance of the flow of aerosol” in the device. *Id.*, [0022]. Also, as described above, Hearn discloses several possible materials to be used for either the first or second capillary materials, including materials having a density below 1 g/ml. *Id.*, [0024]-[0025].

129. Furthermore, as described in Ward, a porous wick with a density of 0.2 to 1 g/ml was already known in the art as suitable for fluid transmission and vaporization by 2014. EX1019, 2:11-18, 14:42-48, 15:47-59. Therefore, it would have been obvious for the POSITA, in my opinion, to design the second capillary material in Hearn to have a density below 1 g/ml as recited in claim 6 and to have a density between 0.1 and 0.3 g/ml as recited in claim 7.

4. Dependent Claim 15 – System Comprising A Cartridge

a. Claim 15: An aerosol generating system comprising a cartridge according to claim 1.

130. Hearn discloses this limitation for the reasons discussed in claim 1.

131. As I described above, in my opinion, a POSITA starting with Hearn and looking for enhanced capillary / wicking would have been motivated to utilize one or more of the multiple stacked capillary configurations disclosed by Rabin.

5. Independent Claim 25

132. The combination of Hearn and Rabin discloses the subject matter recited in apparatus claim 1. That combination also renders obvious the corresponding method of manufacture claims 25 and 26. The side-by-side table below demonstrates that independent apparatus claim 1 and independent method of manufacture claim 25 include similar limitations.

Claim 1. A cartridge for use in an aerosol-generating system, comprising:	Claim 25. A method of manufacture of a cartridge for use in an aerosol-generating system, comprising:
1[a] a liquid storage portion, comprising a housing configured to hold a liquid aerosol-forming substrate, the housing having an opening,	25[a] providing a liquid storage portion comprising a housing with a first part and a second part, the housing having an opening;
1[b] wherein the liquid storage portion comprises at least two parts in fluid communication with each other,	
1[c] a first part of the liquid storage portion comprising a first capillary material, provided in a vicinity of the opening of the housing	25[b] placing a first capillary material in the first part of the housing of the liquid storage portion, such that first capillary material is provided in a vicinity of the opening of the housing; and

1[d] and a second capillary material in fluid contact with the first capillary material and spaced apart from the opening by the first capillary material, and	25[c] placing a second capillary material in the first part of the housing of the liquid storage portion, such that the second capillary material is in contact with the first capillary material and is spaced apart from the opening by the first capillary material,
1[e] a second part of the liquid storage portion comprising a container configured to hold the liquid aerosol-forming substrate and to supply the liquid to the second capillary material.	25[d] wherein the second part of the liquid storage portion is substantially empty and is configured to hold a liquid aerosol-forming substrate.

a. **Preamble: A method of manufacture of a cartridge for use in an aerosol generating system, comprising:**

133. As described above for claims 1[a]-1[e], Hearn discloses a cartridge for use in an aerosol-generating system. It is my opinion that using the disclosure in claims 1[a]-1[e] as framework for a method of manufacture of that cartridge would have been straightforward and within the capabilities of the POSITA.

b. **25[a]: providing a liquid storage portion comprising a housing with a first part and a second part, the housing having an opening;**

134. See claim 1[a] and 1[b]above.

c. **25[b]: placing a first capillary material in the first part of the housing of the liquid storage portion, such that first capillary material is provided in a vicinity of the opening of the housing; and**

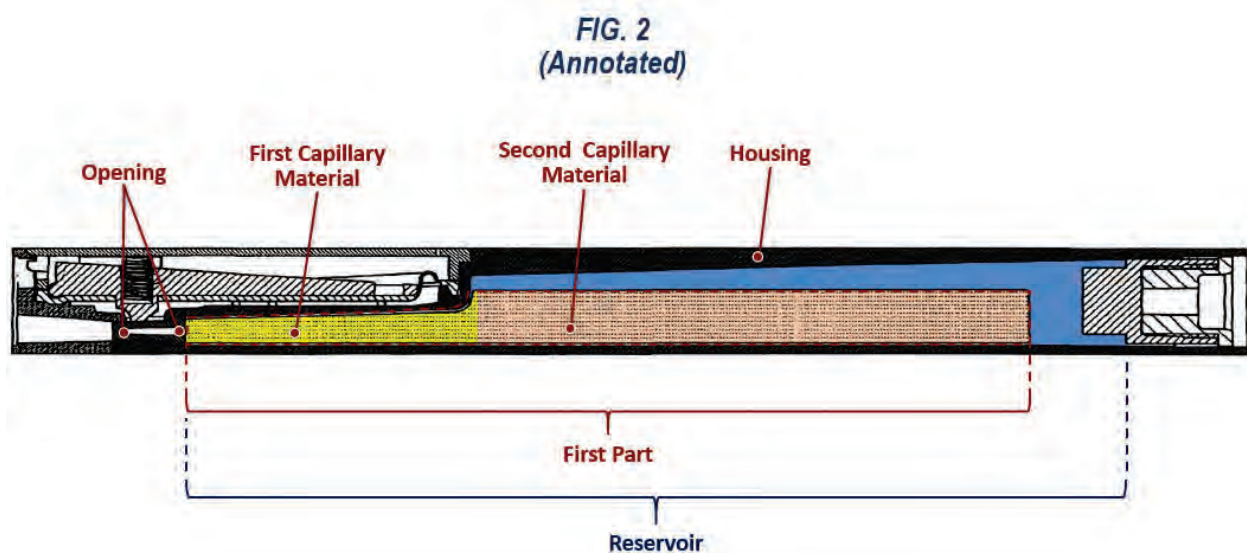
135. See claim 2[a] above.

d. **25[c]: placing a second capillary material in the first part of the housing of the liquid storage portion, such that the second capillary material is in contact with**

the first capillary material and is spaced apart from the opening by the first capillary material,

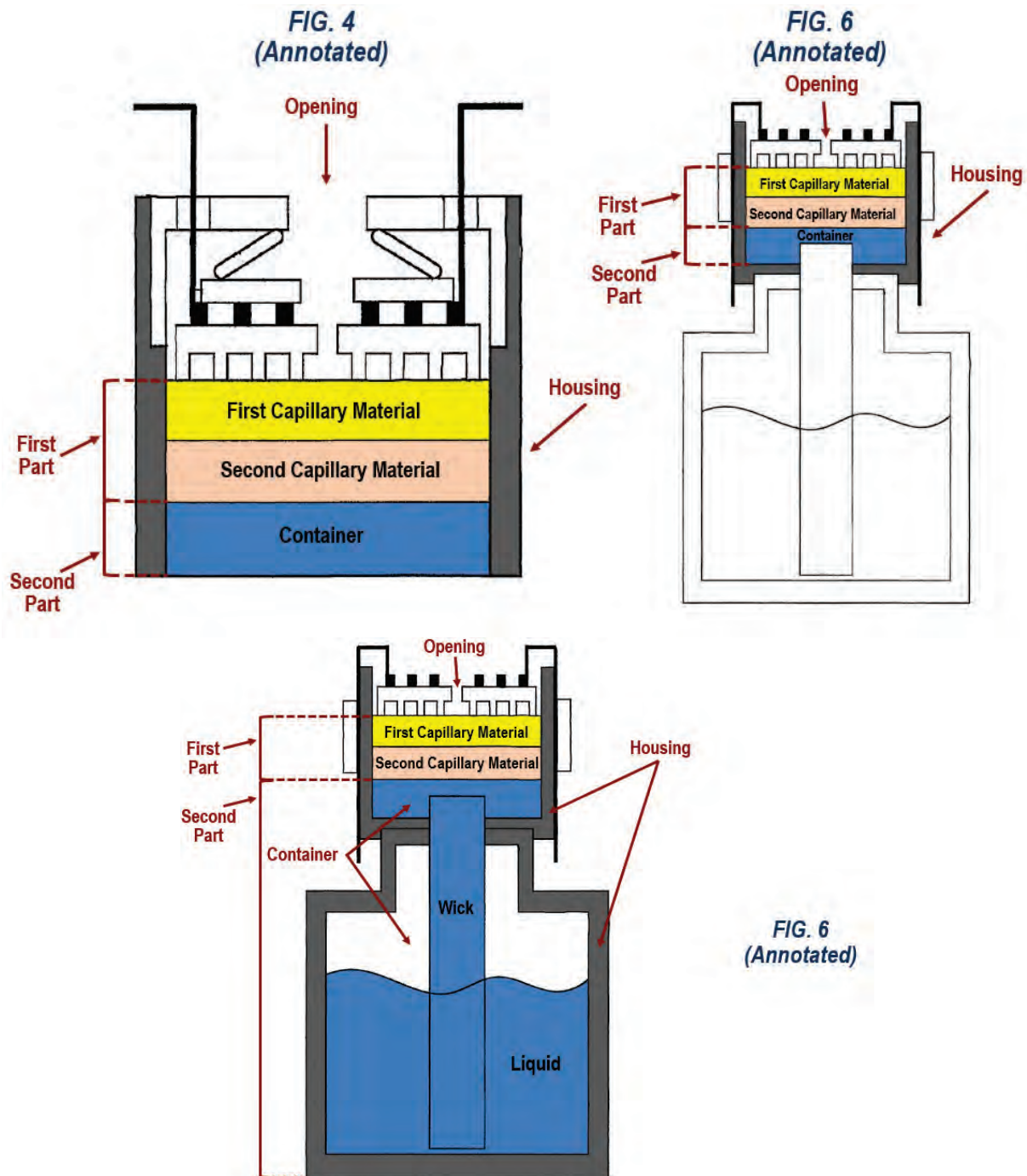
136. See claim 2[b] above.

137. As annotated FIG. 2 shows, Hearn's second capillary material (peach) is "in contact with" (as well as being "in fluid contact with" per claim 1) the first capillary material (yellow).



138. There is no barrier between Hearn's first and second capillary materials, therefore they are "in contact with" each other. Hearn's second capillary material (peach) also is spaced apart from the opening 11, 13 by the first capillary material (yellow).

139. Rabin likewise discloses a second capillary material (peach) is "in contact with" (as well as being "in fluid contact with" per claim 1) the first capillary material (yellow).



140. There is no barrier between Rabin’s first and second capillary materials, therefore they are “in contact with” each other. Rabin’s second capillary

material (peach) also is spaced apart from the opening by the first capillary material (yellow).

- e. **25[d]: wherein the second part of the liquid storage portion is substantially empty and is configured to hold a liquid aerosol forming substrate.**

141. See claim 1[e] above.

142. In my opinion, a POSITA would understand that during the “method of manufacturing” the cartridge, Hearn’s reservoir would be “substantially empty” during assembly before the capillary plug and liquid is added. Hearn teaches that the reservoir may be “refillable” through the filling valve 6, suggesting to a POSITA, in my opinion, that the simulated cigarette could be manufactured and initially sold without including the liquid inhalable composition, with the liquid to be selected by the end-user and added to the reservoir at the time of use. EX1004, [0031].

143. Rabin likewise discloses an embodiment with a “liquid reservoir 602” configured to hold a liquid aerosol forming substrate.

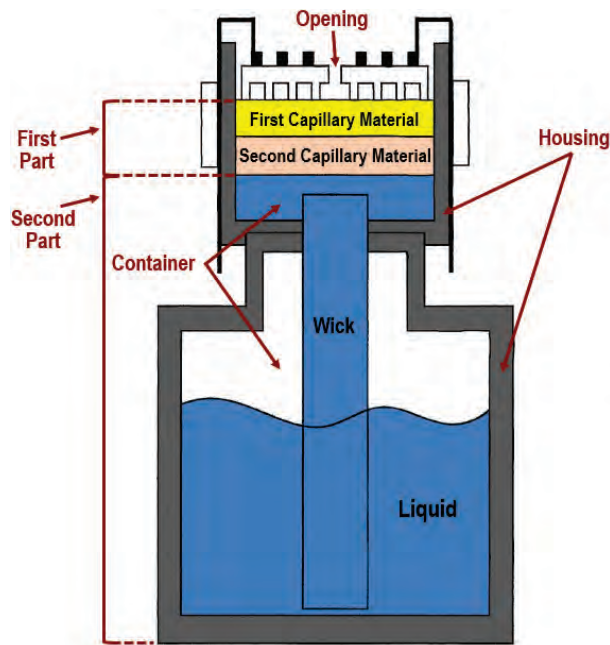


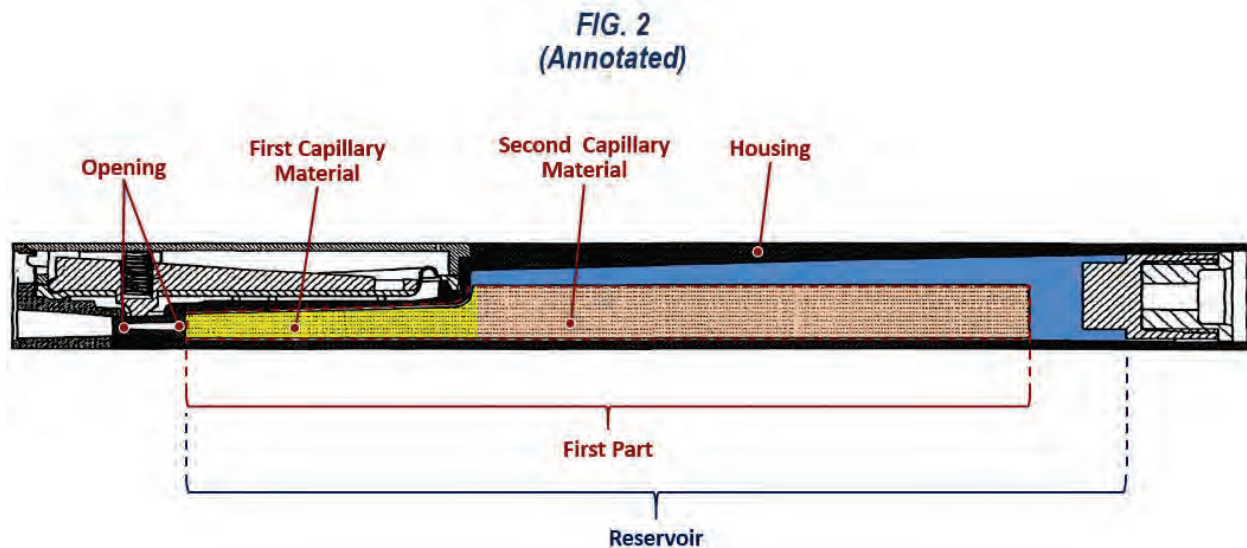
FIG. 6
(Annotated)

144. Rabin’s reservoir “can be provided as a removable, replaceable or disposable refill cartridge, separate from upper subassembly 610.” EX1005, 12:64-67. Here again, I believe a POSITA would understand that at least during the “method of manufacturing” the device, Rabin’s reservoir would be “substantially empty” during assembly before the liquid and optional wick would be added.

6. Dependent Claim 26 – Compressed To Reduce Porosity / Pore Size

- a. **Claim 26: The method according to claim 25, wherein a portion of the first capillary material or the second capillary material is compressed during or before insertion into the housing such that a porosity or pore size of the portion of the first capillary material or the second capillary material is reduced.**

145. Hearn discloses this limitation for the reasons discussed in claim 9. More particularly, Hearn discloses that “a portion of the first capillary material or the second capillary material is compressed during ... insertion into the housing such that a porosity or pore size of the portion of the first capillary material or the second capillary material is reduced.”



146. Hearn uses compression to reduce the effective pore size of the first or second capillary materials. Hearn discloses:

In order to enhance the capillary action, the plug preferably has a pore size which decreases towards the outlet valve. ***
[P]referably, this is achieved by compressing the plug in the vicinity of the outlet valve. This provides a simple means of achieving the variable pore size and also is readily achievable in a design where the opening/closing mechanism for the outlet valve lies alongside the portion of the reservoir at the end

adjacent to the outlet valve as the reservoir is naturally thinner at this point.

Id., [0017].

147. Thus, Hearn “preferably” compresses a portion of the first or second capillary material during insertion into the housing as “a simple means of achieving the variable pore size.”

148. Rabin also discloses the advantageous use of compression of a capillary material in a vaporizer to “effectively prevent leakage of vapor and liquid.” EX1005, 6:29-34.

149. Rabin discloses that “[a] process for manufacture of a capillary force vaporizer device for the vaporization of liquid and the pressurization of vapor according to one embodiment of the present invention” may include the step of “providing ... a mechanical force conductor and at least one orifice for the release of the vapor, wherein the mechanical force conductor provides compressive force among the porous member, heater component and vapor containment component.”

Id., 12:5-21. Rabin teaches, for example, that: “Compressive mechanical forces generated by friction between peripheral walls of housing component 202 and stacked components [porous member] 102, optional [insulator] 308 and optional [liquid supply component] 306 by optional spring component 318 effectively prevent leakage of vapor and liquid from inventive capillary force vaporizer 300.”

Id., 6:29-33. Rabin thus discloses a method in which “a portion of the first

capillary material or the second capillary material is compressed” during or before insertion into the housing (via friction or spring force or otherwise), such that a porosity or pore size of the first or second capillary material would be reduced.

150. As described above, a POSITA starting with Hearn and looking for enhanced capillary / wicking would have been motivated to utilize one or more of the multiple stacked capillary configurations disclosed by Rabin (including an arrangement in which one of the first and second capillary materials is compressed).

151. Therefore, it is my opinion that either Hearn in combination with a knowledge of a POSITA and Hearn in view of Rabin renders obvious claim 26.

B. Claims 1, 4-8, 15, 18, 21, and 25: Terry In View Of Thorens '231

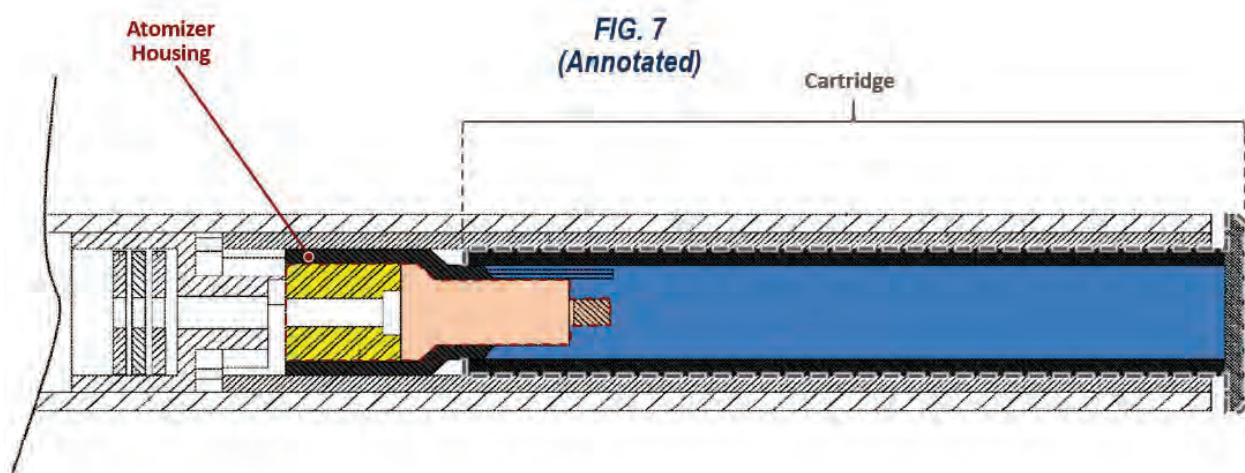
152. Terry discloses or suggests all of the elements of claims 1, 4-8, 15, 18, 21, and 25, including a cartridge with a liquid storage portion comprised of a hollow tank and two capillary wicks disposed within a housing. But to the extent that Patent Owner may argue, however, that Terry’s liquid tank and capillary wicks are not disposed within a single housing structure, then Thorens ’231 discloses a single housing enclosing a liquid tank, a wick, and a heater, and it would have been obvious for POSITA to have combined Terry and Thorens ’231 as explained below. Additionally, a POSITA would be motivated to combine the teachings of

Terry and Thorens '231 as they disclose an electronic cigarette that uses capillary elements to prevent leakage of fluid to be aerosolized.

1. Independent Claim 1

a. Preamble: A cartridge for use in an aerosol-generating system, comprising:

153. Terry discloses a cartridge 150 that is “inserted into the distal end of personal vaporizer unit 100” and is coupled to an atomizer housing 132, as illustrated in FIG. 7 below. EX1006, 5:22-23.



154. Terry's is described as being used for “administer[ing] flavors, medicines, drugs, or substances that are vaporized and then inhaled,” and a POSITA, in my opinion, would understand Terry to be “an aerosol-generating system.” The '556 Patent explains, in this regard, that vaporization of liquid takes place in “electrically operated aerosol-generating devices” like the personal vaporizer disclosed in Terry: “In use in the aerosol-generating system, the liquid is

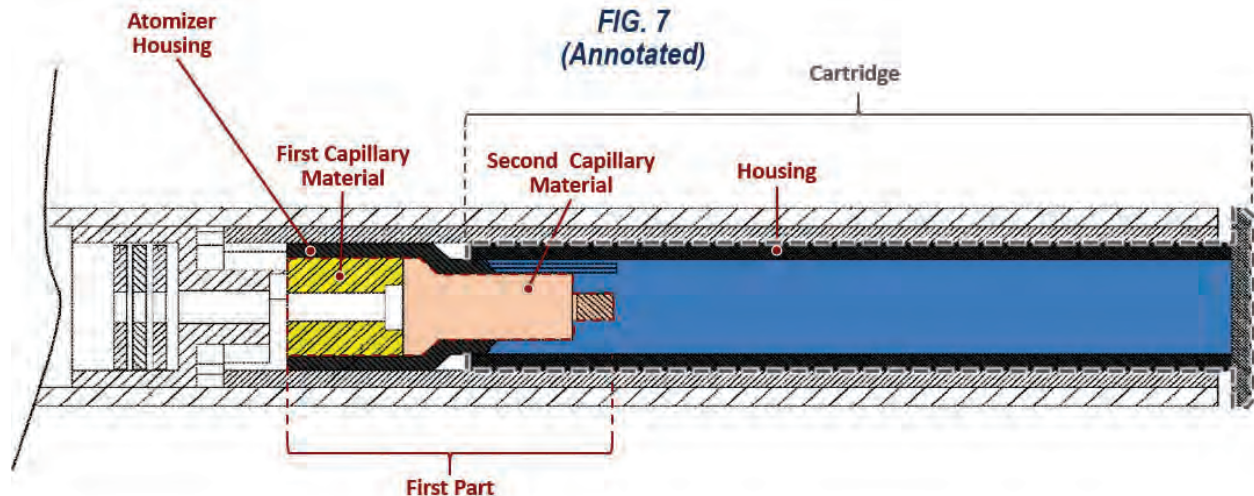
conveyed from the tank by capillary action into the wick of a coil wick heater assembly where the liquid is vaporized.” EX1001, 5:22-23, 1:28-30.

155. It is my opinion that Terry discloses a cartridge (150, 132) for use in an aerosol-generating system (personal vaporizer unit 100).

- b. **1[a]: “a liquid storage portion, comprising a housing configured to hold a liquid aerosol-forming substrate, the housing having an opening,”**

156. As illustrated by annotated FIG. 7 below, the liquid storage portion of Terry includes a combination of cartridge 150 combined with atomizer housing 132 encapsulating a distal wick 134 and a proximal wick 136 inside light pipe sleeve 140. EX1006, 6:24-37.

157. The “hollow portion of the cartridge 150 holds the substance to be vaporized in direct contact with distal wick 134 or 234.” EX1006, 14:16-20. This allows distal wick 134 or 234 to become saturated with the substance to be vaporized.” *Id.*, 14:16-27. As also illustrated in FIG. 7, Terry discloses an opening at the open end of the atomizer 132 where proximal wick 136 terminates and where aerosol generated by the atomizer is released. *Id.*, 6:24-37.

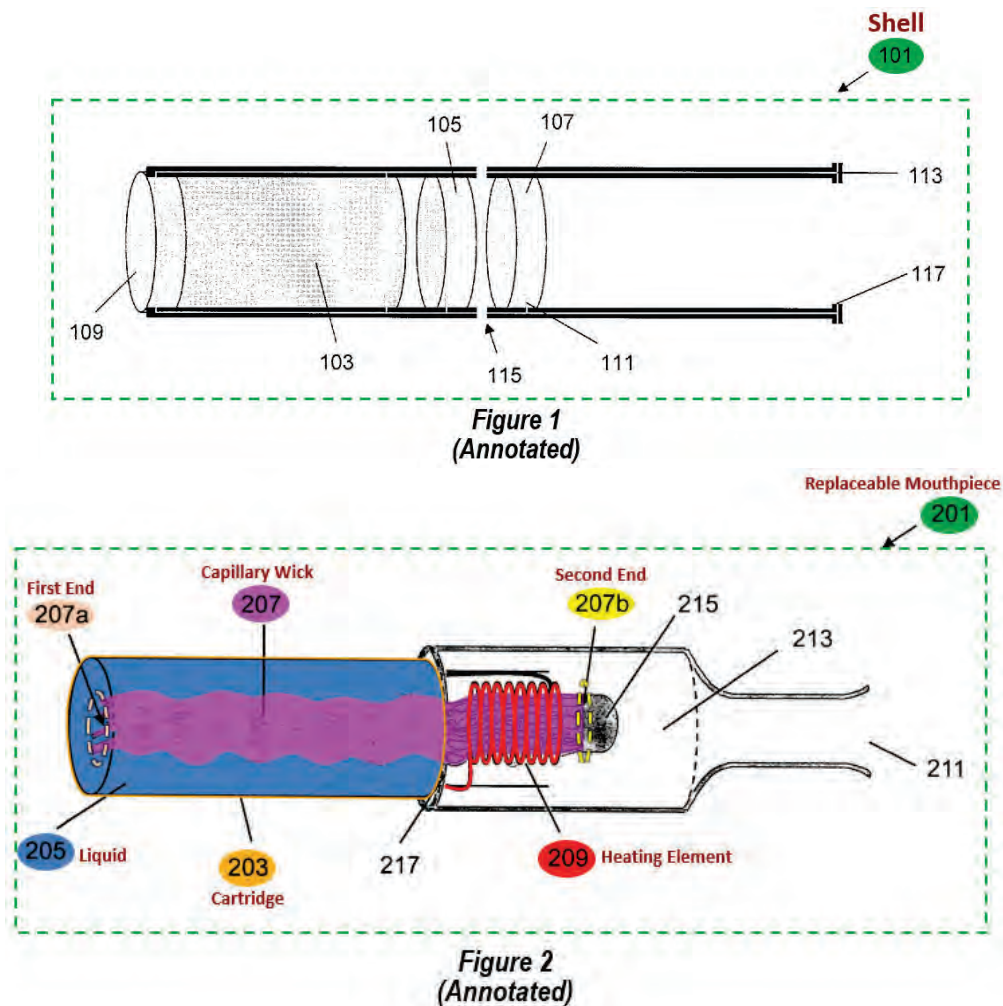


158. It is my opinion that Terry discloses a liquid storage portion (cartridge 150 combined with atomizer housing 132) comprising a housing (walls of cartridge 150 in combination with walls of atomizer housing 132) configured to hold a liquid aerosol-forming substrate (cartridge 150 and wicks 134, 136 hold a substance to be vaporized), the housing having an opening (annotated space at the proximal end of the atomizer housing 132).

159. In Terry, the cartridge 150 and atomizer housing 132 are shown as separate structures that mate together, with just the cartridge 150 designed to be removable from the device. Thorens '231, however, disclosed an electrically heated smoking system with a removable cartridge that included both the liquid tank and the heating element/atomizer. EX1007, 6:42-53. Specifically, Thorens '231 teaches that the removable "mouth piece 201"—which includes "cartridge 203 containing liquid 205, a capillary wick 207, [and] a heating element in the

form of a heating coil 209” —is “designed to engage with the shell 101 of FIG. 1.”

Id., 6:42-53.



160. Rather than using separate housings to contain the liquid tank and the atomizer as in Terry, Thorens '231 specifically teaches that the liquid container and the atomizer can be combined into a single removable cartridge 201. *Id.*, 2:10-34.

161. A POSITA would have found it obvious to modify Terry so as to include the atomizer 132 and wicks 134, 136 all within a removable cartridge as

disclosed by Thorens '231. Thorens '231 provides explicit motivation for such a modification in the following passage

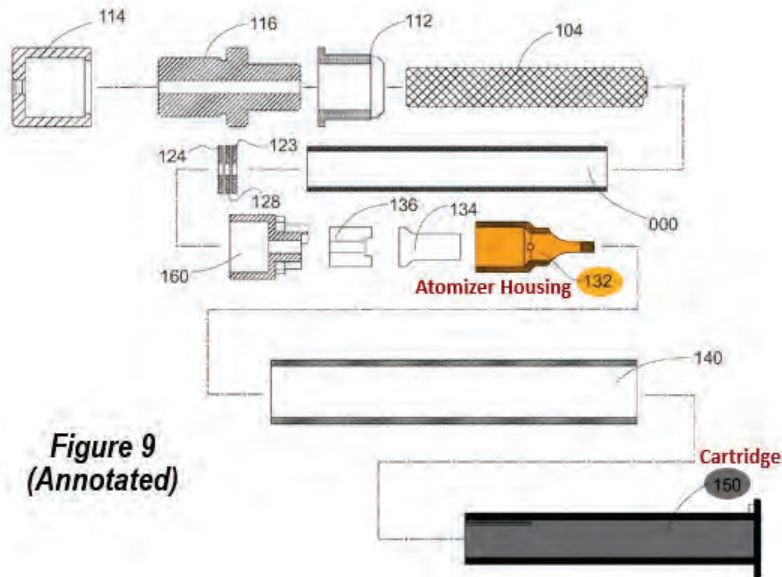
The electrically heated smoking system according to the invention provides a number of advantages.

Firstly, because the replaceable mouthpiece contains the at least one heating element, the liquid storage portion and the wick, all elements which are potentially in contact with the liquid are changed when the mouthpiece is replaced. There will be no cross-contamination in the shell between different mouthpieces, for example ones using different liquids. In addition, the liquid in the liquid storage portion is protected from oxygen (because oxygen cannot generally enter the liquid storage portion via the capillary wick) and, in some embodiments light, so that the risk of degradation of the liquid is significantly reduced. Therefore, a high level of hygiene can be maintained. Secondly, the mouthpiece structure means that there is a low risk of leakage from the liquid storage portion, which is not the case for many of the electrically heated smoking systems of the prior art. This prevents waste of the liquid, but also makes it difficult for an unauthorized user to access the liquid by dismantling the mouthpiece. Also, if the mouthpiece is replaced at suitable intervals, there is little chance of the heating element becoming clogged with liquid. Finally, using a capillary wick extending between the liquid and

the heating element allows the structure of the mouthpiece to be relatively simple. There is preferably only one capillary mechanism in the system.

EX1007, 2:10-34.

162. It is my opinion that in view of Thorens '231, a POSITA would understand that a removable cartridge that included both the liquid tank and the atomizer is desirable because “all elements which are potentially in contact with the liquid are changed” when the cartridge is replaced, and “there is little chance of the heating element becoming clogged with liquid.” In view of these teachings, it is my opinion that a POSITA would have found it obvious to modify Terry to combine the cartridge 150 and the atomizer housing 132 containing the wicks 134, 136 into a single structure or housing that would be removable from the device. As shown in Terry’s exploded view in FIG. 9, this advantageous modification could have been made relatively easily by simply combining cartridge 150 and atomizer housing into a single structure.

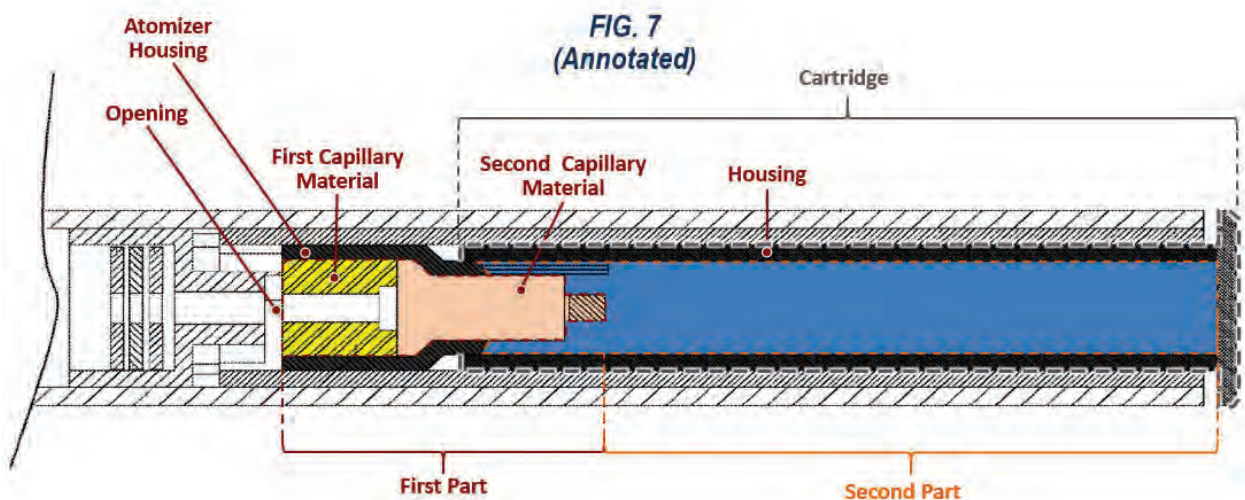


163. It is my opinion that a POSITA would have been motivated to combine the disclosures of Terry and Thorens '231 for a variety of additional reasons. For example, both Terry and Thorens '231 are directed to technologies directed to aerosolizing a liquid delivered through a capillary element to be inhaled to simulate smoking a traditional cigarette. As noted in the '556 Patent, one of the major issues being addressed is to provide a cartridge that reduces the likelihood of leakage during use of aerosol-generating devices such as an electronic cigarette (EX1001, 37-47). In my opinion, the POSITA seeking to address such problems and starting from Terry would have considered Thorens '231. Thorens '231, in particular, is directed to a replacement mouthpiece having “a low risk of leakage from the liquid storage portion, which is not the case for many of the electrically heated smoking systems of the prior art.” EX1005, 2:22-26.

164. Given the close nature of Terry and Thorens '231 in relation to the problem being solved (*i.e.*, providing an electronic cigarette that uses capillary elements to prevent leakage of fluid to be aerosolized), a POSITA, in my opinion, would be motivated to combine the teachings of Terry and Thorens '231.

c. **1[b]: “wherein the liquid storage portion comprises at least two parts in fluid communication with each other,”**

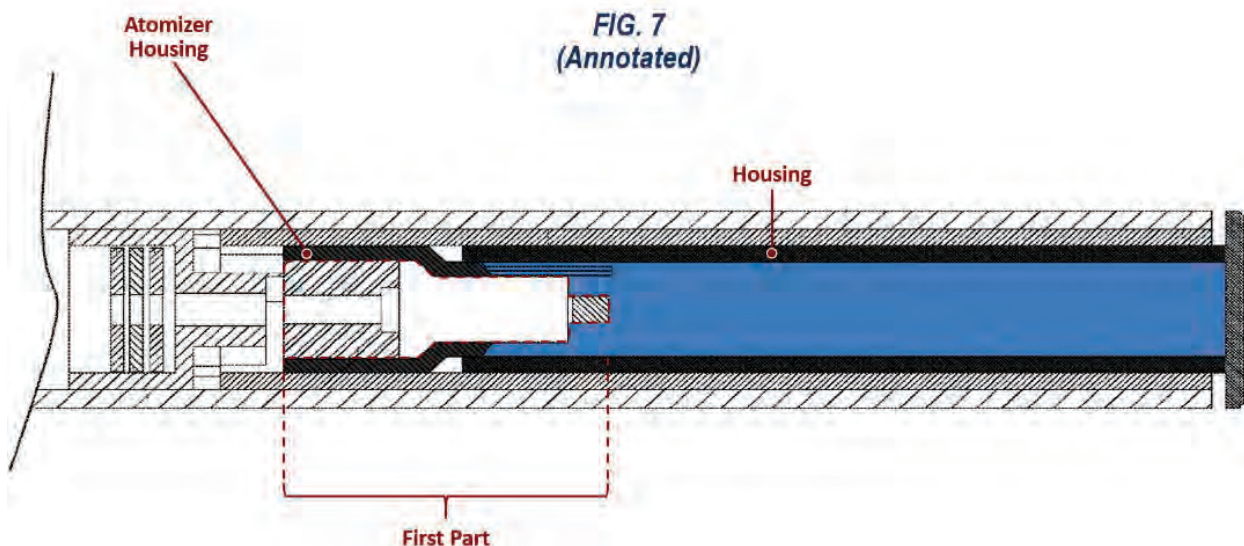
165. As I described above with regard to claim 1[a], the liquid storage portion of Terry includes cartridge 150 combined with atomizer housing 132 encapsulating a distal wick 134 and a proximal wick 136. EX1006, 6:24-37. The first part of the liquid storage portion includes the space defined by the atomizer housing 132 that encloses the proximal wick 136 and at least a portion of the distal wick 134. *Id.*, 6:35-37. The second part of the liquid storage portion includes the hollow portion of the cartridge 150. *Id.*, 14:16-27.



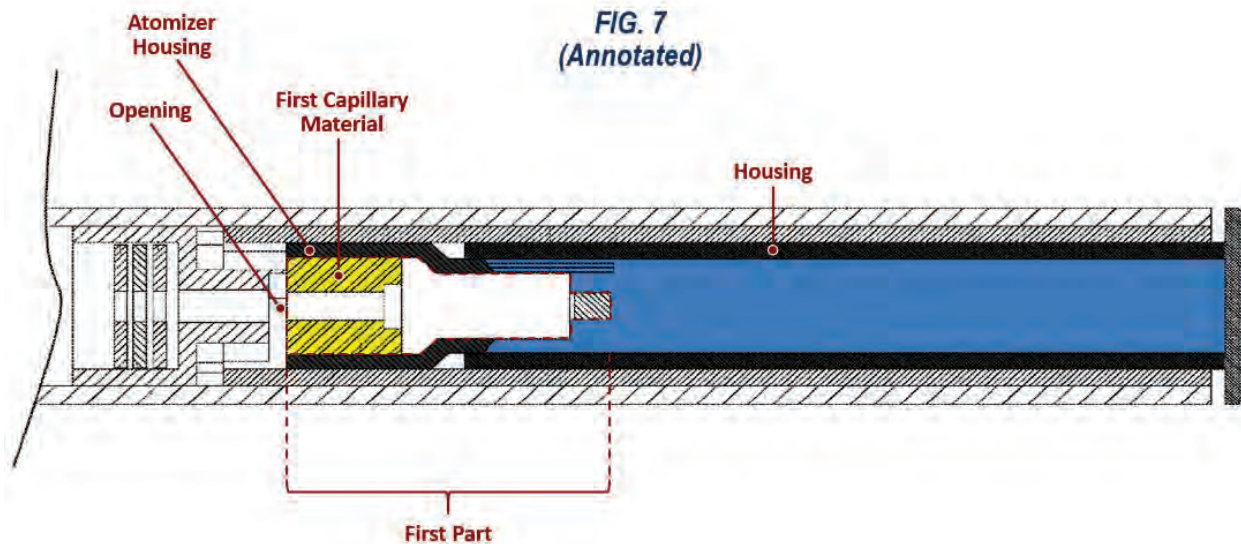
166. The first part and second part are in fluid communication with each other as the “hollow portion of the cartridge (150) holds the substance to be vaporized in direct contact with distal wick 134 or 234. This allows distal wick 134 or 234 to become saturated with the substance to be vaporized.” EX1006, 14:16-27.

- d. **1[c]: “a first part of the liquid storage portion comprising a first capillary material, provided in a vicinity of the opening of the housing”**

167. Terry discloses a first part (annotated first part from FIG. 7) of the liquid storage portion (the cartridge 150 combined with the two wicks 134, 136 in the atomizer housing 132).



168. Terry also discloses a first capillary material, proximal wick 136. *Id.*, 6:28.



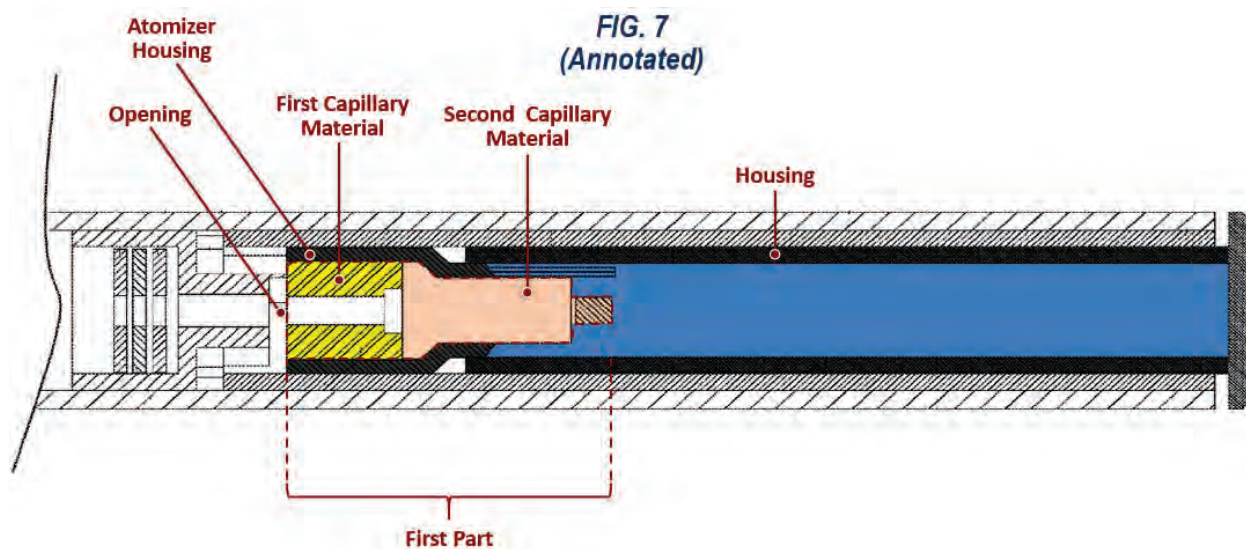
169. The proximal wick 136 is made up of “a porous ceramic.” It is my understanding that the ’556 Patent similarly discloses that the first capillary material is a “porous ceramic disc.” EX1001, 4:41-44. Terry further discloses a number of other porous materials such as porous metals including steel, aluminum, platinum, titanium, ceramic coated porous metal, porous polymer, porous coated polymer, porous silica, and/or porous Pyrex. EX1006, 13:25-34.

170. It is therefore my opinion that Terry discloses a first capillary material (proximal wick 136), provided in a vicinity of the opening of the housing (at the terminus of the atomizer housing 132 at a proximal end).

- e. **1[d]: “, and a second capillary material in fluid contact with the first capillary material and spaced apart from the opening by the first capillary material, and”**

171. As I previously described above, the first part of the liquid storage portion contains a first capillary material (proximal wick 136), and that first part

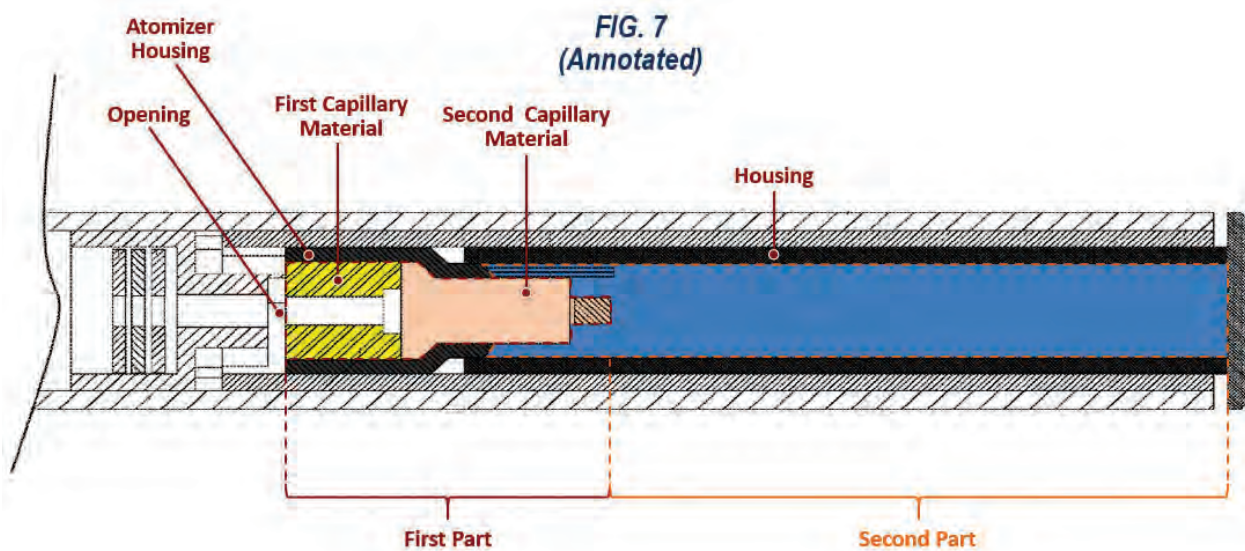
also includes a second capillary material (distal wick 134). FIG. 7 below illustrates the layout of these components. Liquid flows from the hollow interior of the cartridge through the second capillary material (in peach), then through the first capillary material (in yellow), to the heater in the atomizer. Aerosol is generated in the atomizer and exits through an opening in the housing at the proximal end where the atomizer terminates.



172. The configuration is such that the first capillary material (proximal wick 136) is situated at the opening of the housing, and the opposite end of the first capillary material is “in fluid contact” with the proximal end of the second capillary material (distal wick 134). *Id.*, 10:40-59. (“The proximal end of the distal wick 134 is typically in contact with proximal wick 136.”). The second capillary material is therefore spaced apart from the opening of the housing by the thickness of the first capillary material.

- f. **1[e]: a second part of the liquid storage portion comprising a container configured to hold the liquid aerosol-forming substrate and to supply the liquid to the second capillary material.**

173. The hollow part of the cartridge 150 is a second part of a liquid storage portion and it supplies the liquid aerosol-forming substrate to the second capillary material (distal wick 134, peach in annotated FIG. 7).



174. Terry discloses:

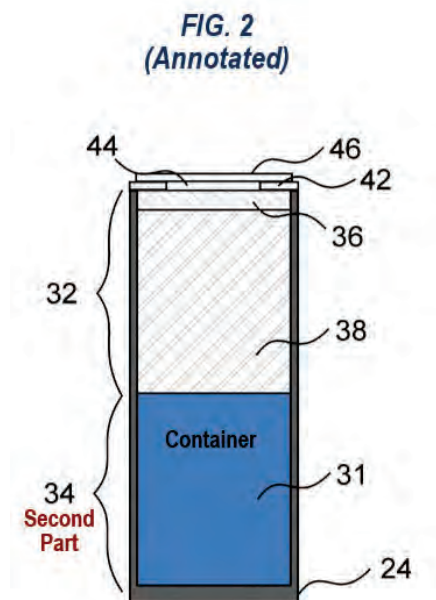
The hollow portion of cartridge 150 is configured as a reservoir to hold the substance to be vaporized by personal vaporizer unit 100. The hollow portion of cartridge 150 holds the substance to be vaporized in direct contact with distal wick 134 or 234.

EX1006, 14:16-21.

175. Therefore, it is my opinion that Terry discloses a second part of the liquid storage portion (annotated second part from FIG. 7) comprising a container

(including hollow part of cartridge 150) configured to hold the liquid aerosol-forming substrate and to supply the liquid to the second capillary material (distal wick 134, 234).

176. Based upon my review, the '556 patent specification does not expressly illustrate a “container” as recited in claim 1. The specification states that “[t]he second part 34 of the liquid storage portion is an empty tank that can be filled or partly filled with liquid aerosol-generating substrate” , EX1001, 12:1-3; and while FIG. 2 shows a numerical reference 31 in the second part 34, there is no description of element 31 in the '556 specification.



177. To the extent the '556 patent discloses any kind of “container,” Terry likewise discloses such a “container.” The '556 patent refers to “an empty tank that can be filled or partly filled with liquid aerosol-generating substrate,” just as Terry

discloses a “hollow portion of cartridge 150 [that] is configured as a reservoir to hold the substance to be vaporized.”

2. Dependent Claims – Porosity / Pore Size / Fiber Size

a. Dependent Claims 4 and 18 – Fiber Size / Pore Size Of First Capillary Material

a) **Claim 4: The cartridge according to claim 1, wherein the first capillary material has a fiber size or pore size of between 0.1 to 50 μm . &**

Claim 18: The cartridge according to claim 1, wherein the first capillary material has a fiber size or pore size of between 0.5 to 10 μm .

178. Terry discloses that a wide variety of materials that may be used for the first capillary material (proximal wick 136, 236) and the second capillary material (distal wick 134, 234), teaching that any material “that can absorb a substance to be vaporized” would be suitable:

In an embodiment, distal wicks 134, 234, and proximal wicks 136, 236, may be made of, or comprise, for example a porous ceramic. Distal wicks 134, 234, and proximal wicks 136, 236, may be made of, or comprise aluminum oxide, silicon carbide, magnesia partial stabilized zirconia, yttria tetragonal zirconia polycrystal, porous metal (e.g., steel, aluminum, platinum, titanium, and the like), ceramic coated porous metal, woven metal, spun metal, metal wool (e.g., steel wool), porous polymer, porous coated polymer, porous silica (i.e., glass), and/or porous Pyrex. Distal wicks 134, 234, and

proximal wicks 136, 236, may be made of or comprise other materials that can absorb a substance to be vaporized.

EX.1006, 13:25-36

179. Terry does not disclose specific pore sizes, fiber sizes, or densities for the lengthy list of suitable capillary materials, however. But it is my opinion that a POSITA would have known that some of these materials, including porous polymers and porous metals, would have had a fiber size or pore size between (i) 0.1 and 50 μm or (ii) 0.5 to 10 μm , and would have selected a suitable pore size for the first capillary material.

180. This position is supported by He, which disclosed “the use of porous materials, for example, polymeric wicking materials, for transporting liquids from a reservoir in a vapor-dispensing device...” EX1015, [0008]. He further discloses that “... the pore size is suitably selected to be on the order of from about 2 to about 250 microns, and more preferably in the range of from about 2 to about 70 microns. In certain applications, smaller pore size ranges may advantageously be selected, for example, such that the pore size is on the order of between about 3 to about 30 microns, and more preferably on the order of about 4 to about 5 microns to about 28 to about 30 microns.” *Id.*, [0044]; *see also id.* [0019], [0034], [0035], [0037], [0046], [0051], [0053], Tables 2 and 4.

181. And a POSITA would likewise have understood the porosity properties of porous alumina, as demonstrated by Rabin: “Example 1. The porous member and insulator component were fabricated from highly porous alumina using known techniques. The vaporizer material had a mean pore size of about 1 micron (μm) and the total porosity was about 80%. The insulator component had a mean pore size of about 20 μm and the total porosity was about 80%.” EX1005, 15:23-29; see also id. 3:24-28 (“Suitable materials for the porous member [102] have a mean pore size preferably between 0.5 μm and 100 μm , more preferably between 1 μm and 50 μm , and most preferably between 2 μm and 30 μm .”). Rabin further teaches that porous member 102 may have a mean pore size preferably between 0.5 μm and 100 μm , more preferably between 1 μm and 50 μm , and most preferably between 2 μm and 30 μm .” EX1005, 3:25-28.

182. In my opinion, it would have been an obvious choice for the POSITA to select a pore size for the first capillary material in Terry to have a pore size within the range of 0.1 to 50 μm as recited in claim 4, and to have a pore size within the range of 0.5 to 10 μm as recited in claim 18.

b. Dependent Claims 8 and 21 – Fiber Size / Pore Size Of Second Capillary Material

a) **Claim 8: The cartridge according to claim 1, wherein the second capillary material has a fiber size or pore size of between 1 to 100 μm . &**

Claim 21: The cartridge according to claim 1,

wherein the second capillary material has a fiber size or pore size of between 15 to 40 μm .

183. As noted above in connection with claims 4 and 18, Terry discloses a wide variety of preferred materials for the first and second capillary materials (proximal wick 136, distal wick 134); a POSITA would have known that these disclosed materials had pore sizes within the recited ranges of claims 8 and 21.

184. It is my opinion that a POSITA would have known that some of these materials including a porous polymer wick have a fiber size or pore size between (i) 1 and 100 μm or (ii) 15 to 40 μm , and would have selected a suitable pore size for the second capillary material if made of porous polymer. As He confirms, a POSITA would have understood that pore size for a porous polymer capillary material “is suitably selected to be on the order of from about 2 to about 250 microns,” as well as other narrower ranges that are within the ranges recited in claims 8 and 21. EX1015, [0044], [0019], [0034], [0035], [0037], [0046], [0051], [0053], Tables 2 and 4.

185. And it is my opinion that a POSITA would likewise have understood Terry’s disclosure of porous aluminum as falling within the range of pore sizes recited in claims 8 and 21, as demonstrated by Rabin’s teaching of a second capillary material such as an “insulator component fabricated from highly porous alumina” having “a mean pore size of about 20 μm .” EX1005, 15:22-30.

186. Therefore, it is my opinion that it would have been an obvious design choice for the POSITA to select a pore size for the second capillary material within the range of 1 to 100 μm as recited in claim 8, and to have a pore size within the range of 15 to 40 μm as recited in claim 21.

3. Dependent Claims – Density

a. Dependent Claims 5 and 20 – Density Of First Capillary Material

a) **Claim 5: The cartridge according to claim 1, wherein the first capillary material has a density of below 2 g/ml. &**

Claim 20: The cartridge according to claim 1, wherein the first capillary material has a density of about 0.5 g/ml.

187. As I noted above, Terry discloses a wide variety of preferred materials for both the first and second capillary materials including porous polymer wicks and other capillary materials. EX1006, 13:25-36. It is my opinion that a POSITA would have known that some of the materials disclosed in Terry—including porous polymers—would have had a density below 2 g/ml and a density of about 0.5 g/ml, and a POSITA would have selected a suitable density for the first capillary material.

188. That a POSITA would have known and understood the densities of porous polymers in the field is further demonstrated by Hearn. Hearn teaches the use of “porous polymers” for a capillary plug/capillary wick in a simulated

cigarette, including a “polyolefin wick material” and “other preferred materials” such as “polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA.” EX1004, [0024, 0025]. Hearn further discloses known densities for a porous polymer capillary plug: “Medium and High-Density capillary rods are 60 (kg/m³) and 120 (kg/m³), where the greater the density the higher the rise height of liquid through the capillary rod.” EX1004, [0020]. It is my opinion that a POSITA would readily recognize that such densities are converted respectively into 0.06 g/mL and 0.12 g/mL (both of which fall below 2 g/mL as recited in claim 5). Additionally, it is my opinion that the POSITA would have recognized that a density of about 0.5 g/ml could be chosen based on the particular polymer material being used for Terry’s first capillary material (proximal wick 136) and the particular liquid being utilized in Terry’s vaporizer.

189. Furthermore, as described in U.S. Patent No. 7,888,275 (“Ward”), a porous polymer wick with a density of 0.2 to 1 g/ml (a range that covers the limitations of both claims 5 and 20) was already known in the art as suitable for fluid transmission and vaporization by February 2014. EX1019, 2:11-18, 14:42-48, 15:47-59.

190. It would have been an obvious design choice for a POSITA to select Terry’s first capillary material (proximal wick 136) with a density below 2 g/ml as in claim 5, and with a density of about 0.5 g/ml as recited in claim 20.

b. Dependent Claims 6 and 7 – Density of Second Capillary Material

a) Claim 6: The cartridge according to claim 5, wherein the second capillary material has a density of below 1 g/ml. &

Claim 7: The cartridge according to claim 5, wherein the second capillary material has a density of between 0.1 and 0.3 g/ml.

191. Terry discloses a wide variety of preferred materials for both the first and second capillary materials, including porous polymers. EX1006, 13:25-36.

192. It is my opinion that a POSITA would have known that some of the materials disclosed in Terry, including porous polymers, would have had densities below 1 g/ml and between 0.1 and 0.5 g/ml, and would have selected a suitable density for Terry's second capillary material (distal wick 134).

193. Hearn, as discussed above, confirms that those skilled in the art understood in February 2014 that porous polymers ("polyolefin"; "polyurethane, Capu-Cell, a polyether/polyester hybrid, neoprene, Basotect and PVA") were known to be available in densities below 1 g/ml and between 0.1 and 0.5 g/ml. Ward also described a porous polymer capillary material with a density of 0.2 to 1 g/ml (a range that covers the limitations of both claims 6 and 7) for fluid transmission and vaporization. EX1019, 2:11-18, 14:42-48, 15:47-59. It would have been obvious for a POSITA to select Terry's second capillary material (distal

wick 134) with a density of below 1 g/ml as recited in claim 6, and a density between 0.1 and 0.5 g/ml as recited in claim 7.

4. Dependent Claim 15 – System Comprising A Cartridge

- a. **Claim 15: An aerosol-generating system comprising a cartridge according to claim 1.**

194. Terry discloses this limitation for the reasons discussed in claim 1.

5. Independent Claim 25

195. As noted above, the combination of Terry and Thorens '231 discloses the subject matter recited in independent apparatus claim 1. As such, the combination of Terry and Thorens '231 also renders obvious the corresponding independent method of manufacture claim 25 based on the same reasoning provided above.

- a. **Preamble: “A method of manufacture of a cartridge for use in an aerosol generating system, comprising:”**

196. As described above for claims 1[a]-1[e], Terry discloses a cartridge for use in an aerosol-generating system. As such, using the disclosure in claims 1[a]-1[e] as framework for a method of manufacture of that cartridge would have been straightforward and within the capabilities of a POSITA.

- b. **25[a]: “providing a liquid storage portion comprising a housing with a first part and a second part, the housing having an opening;”**

197. See claim 1[a] and 1[b] above.

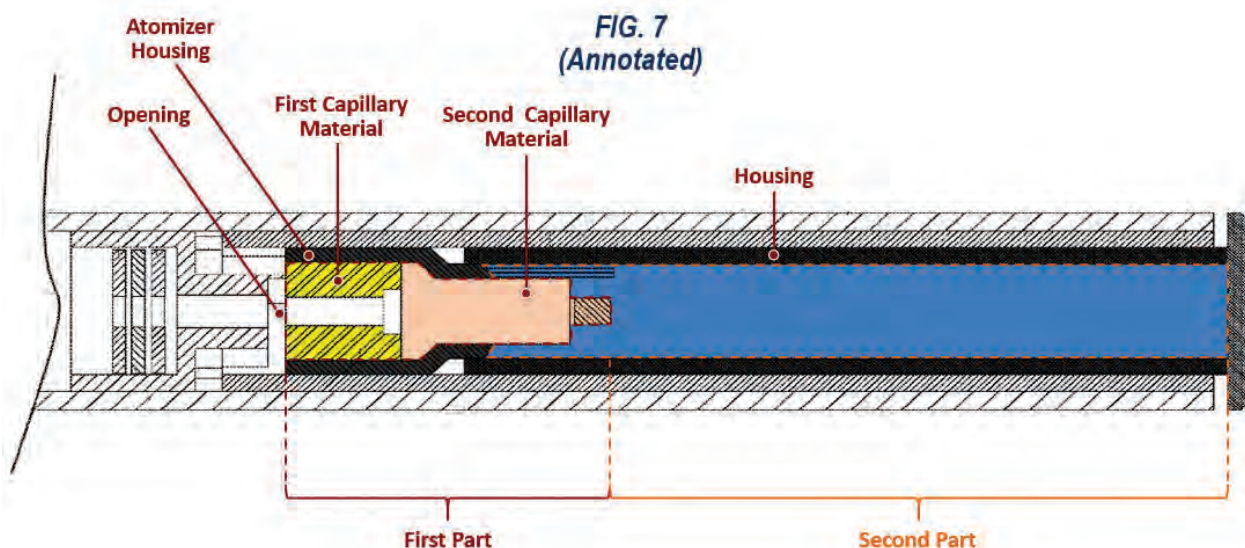
- c. 25[b]: “placing a first capillary material in the first part of the housing of the liquid storage portion, such that first capillary material is provided in a vicinity of the opening of the housing; and”

198. See claim 1[c] above.

- d. 25[c]: “placing a second capillary material in the first part of the housing of the liquid storage portion, such that the second capillary material is in contact with the first capillary material and is spaced apart from the opening by the first capillary material,”

199. See claim 1[d] above.

200. Terry’s second capillary material (peach) is “in contact with” (as well as being “in fluid contact with” per claim 1) the first capillary material (yellow).



201. Terry’s first and second capillary materials are “in contact with” each other, and Terry’s second capillary material (peach) is spaced apart from the opening by the first capillary material (yellow).

- e. **25[d]: “wherein the second part of the liquid storage portion is substantially empty and is configured to hold a liquid aerosol forming substrate.”**

202. See claim 1[e] above.

203. Terry discloses that “[t]he hollow portion of cartridge 150 is configured as a reservoir to hold the substance to be vaporized by personal vaporizer unit 100.” EX1006, 14:16-18. Additionally, a POSITA would understand that during a “method of manufacturing” Terry’s cartridge, the hollow reservoir would be “substantially empty” during assembly before the liquid is added at some later processing step.

204. Indeed, it is my opinion that a POSITA would have understood that during one potential method of manufacturing Terry’s vaporizer and cartridge, the hollow space within the cartridge would be “substantially empty” and “configured to hold a liquid aerosol-forming substrate” before the liquid was added during a subsequent manufacturing step.

205. Thorens, moreover, discloses a cartridge for an electrically heated smoking system in which “the liquid storage portion may be refillable.” EX1007, 4:34-35. A POSITA would thus have known that the cartridge taught by Thorens could be manufactured and initially sold “substantially empty” without including the liquid, with the liquid to be selected by the end-user and added to the e-cigarette at the time of use.

C. Claims 3, 9, and 26: Terry In View of Thorens '231 and Rabin

206. Terry discloses that a wide variety of materials that may be used for the first capillary material (proximal wick 136, 236) and the second capillary material (distal wick 134, 234), teaching that any material “that can absorb a substance to be vaporized” would be suitable:

In an embodiment, distal wicks 134, 234, and proximal wicks 136, 236, may be made of, or comprise, for example a porous ceramic. Distal wicks 134, 234, and proximal wicks 136, 236, may be made of, or comprise aluminum oxide, silicon carbide, magnesia partial stabilized zirconia, yttria tetragonal zirconia polycrystal, porous metal (e.g., steel, aluminum, platinum, titanium, and the like), ceramic coated porous metal, woven metal, spun metal, metal wool (e.g., steel wool), porous polymer, porous coated polymer, porous silica (i.e., glass), and/or porous Pyrex. Distal wicks 134, 234, and proximal wicks 136, 236, may be made of or comprise other materials that can absorb a substance to be vaporized.

EX1006, 13:25-36.

207. In view of Terry’s teachings, and further to the above, a POSITA would have been motivated to further combine Rabin with Terry and Thorens. A POSITA would have combined Terry and Thorens given that they are both explicitly directed to electronic cigarette devices in which a liquid is delivered to a

heater via capillary materials and is aerosolized and delivered to a user, which is the focus of the '556 patent. Rabin discloses a stacked capillary structure very similar to that of the '556 Patent (and Rabin is cited in other patent applications of the assignee of the '556 patent). Given these similarities and the technical objectives of each of these three references (namely to provide improved delivery of an aerosolized liquid using capillary materials), a POSITA would clearly have been motivated to combine these three references to achieve an improved aerosol-generating device like an electronic cigarette.

1. Dependent Claim 3 – Porosity / Pore Size of First Capillary Material Less Than Second Capillary Material

- a. **Claim 3: The cartridge according to claim 1 wherein an average pore size or porosity of the first capillary material is less than an average pore size or porosity of the second capillary material.**

208. Rabin discloses as background that “[a] number of uses for these prior art [vaporizer] devices included situations in which both high flow rate was required and the generated vapor needed to overcome some external system pressure. This combination required the devices to employ a thin, small pore size vaporizer component in combination with a thicker, larger pore size insulator component.” EX1005, 3:5-11. Based on Rabin’s teachings, it is my opinion that a POSITA would understand that “an average pore size or porosity” of two different capillary materials need to differ in order to facilitate a desired flow rate. Rabin

even discloses a specific example in which the first capillary material (porous component 102) has a smaller pore size (“a mean pore size of about 1 micron (μm)”) than the larger pore size of the second capillary material (insulator component 308) (“a mean pore size of about 20 μm ”). EX1005, 15:26-30.

209. Given that the pore size and density of a material impacts its ability to transport liquid, it would have been an obvious design choice for a POSITA, in my opinion, to make the average pore size or porosity of the first capillary material less than that of the second capillary material. (*see also* Hearn: “In order to enhance the capillary action, the plug preferably has a pore size which decreases towards the outlet valve...achieved by using...two or more materials each having different pore sizes.” EX1004, [0017]. This is because in designing a vaporizer device, it is my opinion that a POSITA would know to prevent too much liquid from flowing toward the heater, as too much liquid could cause oversaturation of the heater, reducing its performance and lowering vapor production. A system with a lower-pore-size capillary material closer to the heater and a higher-pore-size capillary material further from the heater would be an obvious way to control the flow of liquid to prevent this oversaturation. The second capillary material (high pore size/porosity) would have less liquid flow resistance, allowing plenty of liquid to flow from the liquid storage tank towards the first capillary material. The first capillary material, acting as the gateway between the second capillary material and

the heater, would have a lower pore size and/or porosity and accordingly would have a higher flow resistance. This prevents excess liquid from flowing towards the heater.

210. A POSITA seeking to improve the delivery of an aerosolized liquid using capillary materials (including an arrangement in which the pore size of the first capillary material is less than the pore size of a second capillary material) would have been motivated to combine Terry with Thorens '231 and Rabin.

2. Dependent Claim 9 – Compressed To Reduce Effective Pore Size

211. Rabin discloses:

Compressive mechanical forces generated by friction between peripheral walls of housing component 202 and stacked components 102, optional 308 and optional 306 by optional spring component 318 effectively prevent leakage of vapor and liquid from inventive capillary force vaporizer 300...

EX1005, 6:29-34.

212. Based on the teachings of Rabin, it is my opinion that a POSITA would understand that applying compressive mechanical force to the first and/or second capillary material would advantageously prevent leakage of vapor and liquid from a vaporizer (*Id.*), and that compression would collapse the weaker, open pore areas, reducing their size. As described above, POSITA seeking to

improve the delivery of an aerosolized liquid using capillary materials (including an arrangement in which the first capillary material or the second capillary material is compressed as recited in claim 9) would have been motivated to combine Terry with Thorens '231 and Rabin.

3. Dependent Claim 26 – Compressed To Reduce Porosity / Pore Size

213. Rabin also discloses the advantageous use of compression of a capillary material in a vaporizer to “effectively prevent leakage of vapor and liquid.” EX1005, 6:29-34. A POSITA would have recognized that compression would collapse the weaker, open pore areas, reducing their size.

214. Rabin further discloses that “[a] process for manufacture of a capillary force vaporizer device for the vaporization of liquid and the pressurization of vapor according to one embodiment of the present invention” may include the step of “providing ... a mechanical force conductor and at least one orifice for the release of the vapor, wherein the mechanical force conductor provides compressive force among the porous member, heater component and vapor containment component.” *Id.*, 12:5-21. Rabin teaches, for example, that: “Compressive mechanical forces generated by friction between peripheral walls of housing component 202 and stacked components [porous member] 102, optional [insulator] 308 and optional [liquid supply component] 306 by optional spring component 318 effectively prevent leakage of vapor and liquid from inventive capillary force vaporizer 300.”

Id., 6:29-33. Rabin thus discloses a method in which “a portion of the first capillary material or the second capillary material is compressed” during or before insertion into the housing (via friction or spring force or otherwise), such that a porosity or pore size of the first or second capillary material would be reduced.

215. It is my opinion that a POSITA seeking to improve the delivery of an aerosolized liquid using capillary materials (including an arrangement in which the first capillary material or the second capillary material is compressed during or before insertion into the housing as recited in claim 26) would have been motivated to combine Terry with Thorens and Rabin.

Exhibit A

Kelly R. Kodama

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Walnut Creek, CA USA
email: kelly@zoepd.com
website: <http://www.zoepd.com>



Executive Profile:

Strategic, creative manager of design and engineering teams partnering with clients creating innovative consumer, medical, industrial, and communications products. Responsible for building and nurturing talented design teams responsible for bringing to market over 150 new products. Holds patents on a wide-range of designs and technologies.

Key Accomplishments:

- Primary design, branding, and UX consultant for client Cutera for over 20 years, which has grown from a 12 person startup to a US\$750M market cap company.
- Primary design and branding consultant for client Digilock for over 10 years, which in that time has become the global leader in electronic locks and locker security solutions due in large part to their innovative, unique designs.
- As Director of Product Design at Ploom, managed and expanded engineering and design team from 5 to 16 employees to develop breakthrough products critical to the future of the company. One of which, JUUL, has rapidly taken over 32% of the e-cigarette market after only 2 years.

Key Competencies:

- Proven track record of launching innovative, successful products
- Strong consumer and customer focus
- Deep expertise in design and innovation thinking techniques and processes
- Intimately involved in all aspects of the product branding experience
- Extensive international experience working with clients and vendors in China, Hong Kong, Taiwan, USA, and Western Europe

Work Experience:

Zoe Design Associates, San Francisco, CA
CEO and Founder

10/1991 – present

Manage a diverse internal team of industrial designers and mechanical engineers in San Francisco and Taipei, as well as a team of consultant industrial designers, graphic designers, and mechanical, software, and electrical engineers. Multinational clientele including Acer, JTI, Motorola, Plantronics, Samsung, and Siemens. Extensive experience working with Asian manufacturers to coordinate production and engineering resources.

Ploom, San Francisco, CA
Director of Product Design

09/2013 - 08/2014

1 year contract to manage, mentor, and rapidly expand product design team, including industrial design, product design, QA, project management, packaging, firmware development, and electrical engineering. Developed the Model 3 tobacco pod vaporizer, PAX 2 loose-leaf vaporizer, and JUUL e-cigarette products. Worked closely with R&D to prototype and test new potential product concepts.

Parametric Technology Corporation, Mountain View, CA 05/1992 - 12/1992
Applications Engineer
Provided pre- and post-sales technical support for PTC customers

Siemens Ultrasound Inc., San Ramon, CA 05/1990 - 05/1992
Senior Mechanical Engineer
Designed diagnostic ultrasound equipment.

Watkins-Johnson, San Jose, CA 06/1988 - 05/1990
Staff Mechanical Engineer
Designed military communications electronics and semiconductor processing equipment.

Education:
Stanford University, Stanford, CA 1984 – 1988
B.S. Product Design Engineering

Industry Qualifications:
Certified Engineering Provider, Mechanical Level II, Pro/Engineer
Co-founder of the Silicon Valley Pro/Engineer User's Group

Design Awards:
2012 iF Product Design Award
2011 Gold Excellence in Design Award
2011 Silver Excellence in Design Award
2011 Good Design Award
2001 Good Design Award

Utility Patents:
US 7,019,964 PORTABLE ELECTRONIC DEVICE
US 7,555,134 ANTENNA FOR MINIATURE WIRELESS DEVICES...
US 20120242587 CHARACTER RECOGNITION SYSTEM

Design Patents:
D394,316 D475,694 D504,407 D504,408 D504,419 D505,935 D506,455 D507,654 D516,533
D517,059 D519,500 D524,795 D530,766 D557,678 D557,694 D672,585 D714,788 D720,200
D720,201 D720,202 D730,712 D731,287 D734,125 D734,650 D737,083 D737,084 D752,945
D752,947 D758,114 D762,102 D762,103 D764,892 D777,696 D804,279

Other Relevant Experience:
JTI
Soon after my contract was over at Ploom, JTI purchased the IP and product rights to Ploom's Model 2 & 3 vaporizer business. JTI contracted with my firm, Zoe Design Associates, to improve the performance and design of the Model 3. Subsequently, we worked closely with JTI on rebranding and redesigning the E-Lites and Logic product lines, including the CURV, Logic Pro, Logic Power, and Logic LQD. In addition, we were involved in redesigns of the Ploom TECH hybrid vaporizer.

Exhibit B



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FILTER / All / Audio / Industrial / Branding / Medical / Production / Consumer /
Mechanical Engineering / Industrial Design





























Zoe Design Associates ©

Exhibit C



LOGIC E-CIGARETTE PRODUCT FAMILY

Melding multiple technologies into a single brand.

Zoe was approached by JTI (Japan Tobacco International) after their acquisition of several electronic cigarette producers. The goal was to meld the multiple innovations of each company into a new and unified brand. Zoe provided branding, Industrial Design, Mechanical Engineering, and production support, to ultimately create a family of products under the Logic brand.

◀ **PREV**

Project (<http://zoepd.com/projects/sandisk-ultra-flair-usb-storage/>) Project
(<http://zoepd.com/projects/zoe-poppop-phone-stand/>)

NEXT ▶

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