

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

R.J. Reynolds Vapor Company,

Petitioner

v.

Fontem Holdings 1 B.V.

Patent Owner

U.S. Patent No.: 9,370,205

Issue Date: June 21, 2016

Title: Electronic Cigarette

Inter Partes Review No.: IPR2017-01642

**DECLARATION OF DR. ROBERT H. STURGES
REGARDING U.S. PATENT NO. 9,370,205**

R.J. Reynolds Vapor

IPR2017-01642

R.J. Reynolds Vapor v. Fontem

Exhibit 1004-00001

Fontem Ex. 2055

R.J. Reynolds Vapor Company v. Fontem Holdings 1 B.V. IPR2018-00634

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I. INTRODUCTION

A. Engagement

1. I have been retained by the law firm of Brinks Gilson & Lione on behalf of R.J. Reynolds Vapor Company to provide this Declaration concerning the technical subject matter relevant to the *inter partes* review petition concerning U.S. Patent No. 9,370,205 (the “205 patent”; Exhibit 1001).¹ I have been asked to render an opinion regarding the validity of claims 1-22 (the “challenged claims”).

B. Background and Qualifications

2. I am currently a Professor in the Departments of Mechanical and Industrial Systems Engineering at Virginia Polytechnic Institute (“Virginia Tech”). From 1987 to 1997, I was first an Assistant Professor and then later an Associate Professor in the Mechanical Engineering Department at Carnegie Mellon University. I have a combined Bachelor of Science and Master of Science degree in mechanical engineering from M.I.T. and a Ph.D. in mechanical engineering from Carnegie Mellon University.

3. In my past work, I have extensively studied and designed various fluid power systems, including a robotic arm and robotic end effectors. In the latter, I

¹ I refer to exhibit numbers that correspond to those I understand will be submitted with the Petition for *Inter Partes* Review.

applied fluid “resistors” that rely on porous media to provide resistance to flow. I have also applied heat transfer fundamentals to design and build variations of commercial steam engines used in my undergraduate labs at Carnegie Mellon University and my graduate course in Sustainability at Virginia Tech. In addition, I have taught undergraduate courses focused on fundamental mechanics and the conservation of energy, including basic principles of fluid flow and heat transfer.

4. Based on my background, experience, education and professional activities, I consider myself an expert in the fields of mechanical design, mechatronics, and manufacturing, including systems that employ heat, mass and fluid transfer.

5. My Curriculum Vitae, including my publications and patents, is submitted herewith in Appendix A.

C. Compensation and Prior Testimony

6. I am being compensated at a rate of \$400 per hour for my study and time in this matter. I am also being reimbursed for reasonable and customary expenses associated with my work and time in this investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

7. The list attached at Appendix B identifies my past expert engagements.

D. Information Considered

8. My opinions are based on my years of education, research, and experience, as well as my investigation and study of relevant materials. In forming my opinions, I have considered, among other things, the 205 patent and its prosecution history, as well as the record of the two prior IPRs (IPR2016-01642 and IPR2017-00257) Nu Mark filed involving the 205 patent, in addition to the prior art and other materials referred to herein.

9. I may rely upon these materials and/or additional materials to rebut arguments raised by the patent owner.

10. I reserve the right to supplement this Declaration in response to additional evidence that may come to light.

II. LEGAL STANDARDS FOR PATENTABILITY

11. In expressing my opinions concerning the subject matter of the claims of the 205 patent, I am relying upon certain legal principles that counsel has explained to me.

12. It is my understanding that, to anticipate a claim under 35 U.S.C. § 102, a prior art reference must teach every limitation of the claim.

13. It is also my understanding that a claimed invention is unpatentable under 35 U.S.C. § 103 as being obvious if the differences between the invention and the prior art are such that the subject matter as a whole would have been

obvious at the time the invention was made to a person having ordinary skill in the art (“PHOSITA”) to which the subject matter pertains. I also understand that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter. I also understand that the prior art reference should be viewed as a whole.

14. I understand that in considering whether an invention is obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the market place, and/or the background knowledge possessed by a person having ordinary skill in the art. 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 the following:

- Combining prior art elements according to known methods to yield predictable results is likely obvious;
- Simple substitution of one known element for another to obtain predictable results is likely obvious;
- Use of a known technique to improve similar devices (methods, or products) in the same way, using the technique is

obvious unless its actual application is beyond the level of skill in the art;

- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results is likely obvious;
- “Obvious to try” - choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention 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 or avowed purpose of the named inventor controls;
- One of the ways in which a patent's subject matter can be proved obvious is by noting that there existed at the time of the 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 the 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 together like pieces of a puzzle;
- A person having ordinary skill in the art is also a person of ordinary creativity, and is not an automaton; and
- One should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

15. In determining obviousness, I understand that evidence of objective indicia of non-obviousness (also known as "secondary considerations") is also

considered and that this is to be done before any ultimate determination of obviousness is made. I have been advised that the following factors may be considered as secondary considerations: (1) a long-felt and unmet need in the art for the invention; (2) failure of others to achieve the results of the invention; (3) commercial success of the invention; (4) copying of the invention by others in the field; (5) whether the invention was contrary to accepted wisdom of the prior art; (6) expression of disbelief or skepticism by those skilled in the art upon learning of the invention; (7) unexpected results; (8) praise of the invention by those in the field; and/or (9) commercial acquiescence (licensing).

16. I also understand that, in order for secondary considerations to be relevant to the issue of obviousness, a patentee must establish a nexus between such secondary considerations and the claimed invention. Stated one way, the nexus requirement means that the secondary consideration is sufficiently derived from merits of the claimed invention, rather than other factors. I understand that if the patentee comes forward with a showing of one or more secondary considerations and the required nexus, then the burden of coming forward with evidence in rebuttal shifts to the party challenging the patent. Additionally, a party asserting invalidity may come forward with evidence of the absence of such secondary considerations or nexus. Further, it is my understanding that evidence

of secondary considerations does not always overcome a strong showing of obviousness.

III. OVERVIEW AND BACKGROUND OF THE 205 PATENT

A. Overview Of The 205 Patent

17. The 205 patent generally describes a vaporizing device such as an electronic cigarette. As shown in Figs. 2-4, the electronic cigarette includes a battery assembly, an atomizer assembly and a cigarette bottle assembly, respectively. Ex. 1001 at 1:61-64. The battery assembly includes an indicator 202, lithium ion battery 203, MOSFET electric circuit board 205, sensor 207, external thread electrode 209, a small hole 501, primary shell 211, and microcircuit 206 between MOSFET electric circuit board 205 and sensor 207. *Id.* at 2:4-12, 3:59-61; Fig. 2B. The atomizer assembly includes the internal thread electrode 302, atomizer 307 and the secondary shell 306. *Id.* at 2:32-34; Fig. 3. The cigarette bottle assembly includes the cigarette liquid bottle 401, fiber 402 and suction nozzle 403. *Id.* at 2:47-49; Fig. 4. The fiber 402 is “made of polypropylene fiber or nylon fiber to absorb cigarette liquid.” *Id.* at 3:39-40.

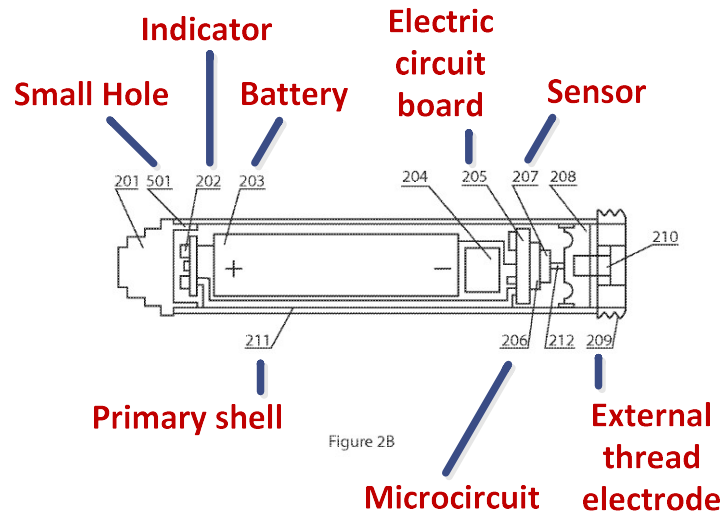


Figure 2B

Ex. 1001, Fig. 2B (Annotated)

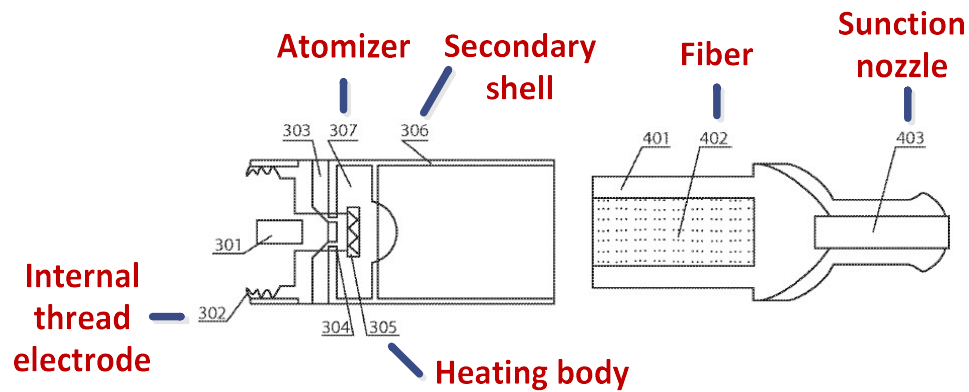


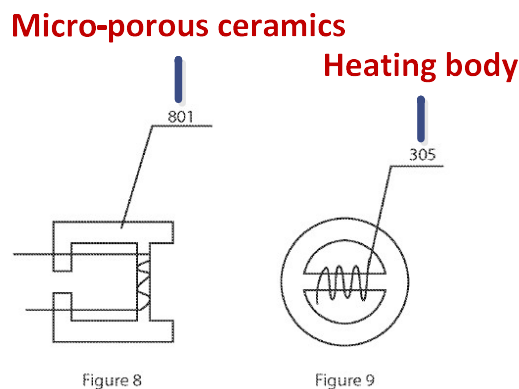
Figure 3

Figure 4

Ex. 1001, Figs. 3, 4 (Annotated)

18. The atomizer 307 includes heating body 305 and micro-porous ceramics 801. *Id.* at 3:5-8; Figs. 8-9. “Besides the micro-porous ceramics, the liquid supply material of the atomizer (307) may also be foamed ceramics, micro-porous glass, foamed metal, stainless steel fiber felt, terylene fiber, nylon fiber, nitrile fiber, aramid fiber or hard porous plastics. The heating body (305) is made

of the micro-porous ceramics on which nickel-chromium alloy wire, iron-chromium alloy wire, platinum wire, or other electro thermal materials are wound. Alternatively, it may be a porous component directly made of electrically conductive ceramics or PTC (Positive Temperature Coefficient) ceramics and associated with a sintered electrode.” *Id.* at 3:23-33.



19. Claims 1-22 are the subject of my opinion. Claims 1, 9 and 16 are independent claims, which are reproduced below:

1. A vaporizing device comprising:
 - a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit electrically connected to a circuit board within a tubular battery assembly housing;
 - a first electrode at an end of the battery assembly housing;
 - an atomizer assembly comprising an atomizer and a liquid supply in a tubular atomizer assembly housing;

with the atomizer including a heater wire coil wound around a porous body, with the heater wire coil and the porous body positioned perpendicular to a longitudinal axis of the tubular atomizer assembly housing; the heater wire coil and the porous body in an airflow path through the tubular atomizer assembly housing leading to a suction nozzle wherein air passes across the heater wire coil and the porous body; a second electrode at an end of the atomizer assembly housing; and the battery assembly and the atomizer assembly electrically connected by engagement of the first electrode with the second electrode, and with electricity conducted from the battery to the heater wire coil through the first and second electrodes.

9. A vaporizing device comprising:

a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit within a tubular battery assembly housing having a pressure balancing hole on a first side of the sensor, and a first cavity in the tubular battery assembly housing on a second side of the sensor opposite from the first side of the sensor;

an atomizer assembly comprising an atomizer and a second cavity in a tubular atomizer assembly housing, with the first cavity connecting into the

second cavity, the atomizer including a heater wire coil wound on a porous body, and the heater wire coil and the porous body perpendicular to a longitudinal axis of the tubular atomizer assembly housing, the heater wire coil and porous body in an airflow path through the tubular atomizer assembly housing wherein air flows across the wire coil and the porous body; and

the battery assembly and the atomizer assembly electrically connected via a first electrode at a first end of the battery assembly contacting a second electrode at a first end of the atomizer assembly with the battery assembly at any angular orientation relative to the atomizer assembly.

16. A vaporizing device comprising:

a battery assembly comprising battery, a sensor, and a micro-controller unit electrically connected to a circuit board within a battery assembly housing, and a first electrode at a first end of the battery assembly housing;

an atomizer assembly comprising an atomizer and liquid absorbed in fiber material in a tubular atomizer assembly housing, and a second electrode at a first end of the atomizer assembly, the atomizer including a porous body in physical contact with the fiber material, and the atomizer including a heater

wire wound in a coil on a part of the porous body which is perpendicular to a longitudinal axis of the tubular atomizer assembly housing;
an airflow path through a through hole of the atomizer located between spaced apart wire leads of the heater wire coil, and the heater wire coil and the porous body in the airflow path, wherein air flows across the wire and porous body; and
the battery assembly electrically connected to the atomizer assembly via the first electrode contacting the second electrode.

IV. PERSON HAVING ORDINARY SKILL IN THE ART

20. I understand that the 205 patent must be reviewed through the eyes of a person having ordinary skill in the art (*i.e.*, a “PHOSITA”). I understand that a PHOSITA is presumed to know the relevant prior art. I am advised that that factors that guide the determination of level of ordinary skill in the art may include: the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, the prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

21. It is my opinion that relevant and related art for the claims of the 205 patent includes, among other things, electromechanical devices with the ability to atomize liquids and deliver an aerosol to a user. Further, it is my opinion that a

PHOSITA for the 205 patent is a person with at least the equivalent of a Bachelor's degree in electrical engineering, mechanical engineering, or biomedical engineering or related fields, along with at least 5 years of experience designing electromechanical devices, including those involving circuits, fluid mechanics and heat transfer. I base my opinions on my review of the 205 patent, the relevant prior art, including art disclosing electronic cigarettes that atomized a nicotine solution to deliver an aerosol to a user to simulate smoking, and my background in designing and developing systems that apply heat transfer and fluid mechanics.

22. For purposes of my opinions as set forth in this Declaration, I have been asked to apply the perspective of a PHOSITA as of May 2006. As of this date, I would have qualified as one of skill in the art according to the above definition.

V. CLAIM CONSTRUCTION

23. It is my understanding that, in an *inter partes* review proceeding, the terms of the challenged claims should be given their broadest reasonable interpretation, as understood by a PHOSITA and consistent with the disclosure of the 205 patent. I understand that, where a patent applicant provides an explicit definition of a claim term in the specification, that definition may control the interpretation of that term in the claim. I also understand that if no explicit definition is given to a term in the patent specification, the claim terms must be

evaluated using the ordinary meaning of the words being used in those claims. I also understand that the words in the claims are to be evaluated using the perspective of a person of ordinary skill in the art. I have applied this standard to my understanding of the claims and the discussion of the prior art below.

24. In conducting my analysis, I have considered the terms used in claims 1-22 the 205 patent and what they mean. In my analysis, I have applied a meaning to the terms as they would have been understood by a PHOSITA.

25. In independent claims 1, 9 and 16, the term “micro-controller unit” is used. I note that the term “micro-controller unit” is not used in the specification, and appears only in the independent claims. Ex. 1001 at 4:44-6:45. Instead, the specification discloses a microcircuit 206. *Id.* at 4:25-35; Fig. 7.

26. In my opinion, the broadest reasonable construction of “micro-controller unit” is “a component of an electronic device that regulates a particular process or function.” This construction is consistent with my own experience in the field and with dictionary definitions of the term “microcontroller.” *See, e.g.*, Ex.1011, McGraw-Hill Dictionary of Scientific and Technical Terms (“McGraw-Hill”) at p.5 (defining “microcontroller” as “[a] microcomputer, microprocessor, or other equipment used for precise process control in data handling, communication, and manufacturing”).

27. It is also consistent with the 205 patent, which discloses that a “microcircuit (206)” is used to regulate the “atomizing capacity” of the claimed device when it is in operation (as a result of a sensor detecting user inhalation). *See* Ex.1001 at 4:25-35. I have construed “microcontroller unit” such that it includes within its scope a microcircuit as disclosed in the 205 patent.

28. I understand that the Board previously construed the term “liquid supply” in IPR2016-01283 and IPR2016-01438 to mean “the liquid itself (*i.e.*, ‘a stock, store, amount, etc., of’ liquid).” Ex. 1013 at pp. 5-10. Patent Owner has stated that “liquid supply” means “a store for liquid.” Ex. 1012, pp. 10-11. Under either interpretation, as set forth below, a “liquid supply” as used in the claims is disclosed in the prior art.

VI. DESCRIPTION OF THE PRIOR ART THAT FORMS THE BASIS FOR UNPATENTABILITY

A. State Of The Art By 2006

29. Electronic cigarettes (“e-cigarettes”) were well-known before 2006. In fact, they have been known since the 1980s, as demonstrated by, for example, Brooks. Ex. 1002. Moreover, the basics of the technology involved in e-cigarettes have been known since at least the 1930s. *See, e.g.*, Ex. 1003, Whittemore at 1:50-2:8 (disclosing an electronic vaporizing unit utilizing a porous wick/heating wire coil design).

30. By 2006, much was known about e-cigarettes and the variety of ways they could be designed. *See e.g.*, Ex. 1002, Brooks at Abstract (disclosing “[s]moking articles [that] employ an electrical resistance heating element and an electrical power source to provide a tobacco-flavored smoke or aerosol and other sensations of smoking”); Ex. 1031, Voges at 5:49-51 (disclosing a “nicotine dispenser comprising a cigarette-shaped hollow tubular body”).

31. As of 2006, a PHOSITA would have understood that an e-cigarette is generally designed to replicate the function and some of the experience of a conventional, combustible cigarette. An e-cigarette provides an aerosol that contains constituents such as nicotine and optionally flavors. A PHOSITA would have appreciated that e-cigarettes can come in different shapes and sizes, and that conventional drug delivery device technology, such as inhalers, vaporizers, nebulizers, etc., can be used to deliver nicotine and flavors. *See, e.g.*, Ex. 1002, Brooks at 3:15-29; Ex. 1031, Voges at 3:7-15 and 9:53-10:21.

32. E-cigarettes differ from combustible cigarettes in the way aerosols are formed. In combustible cigarettes, the aerosol is largely formed by the heat created by the combustion of tobacco. An e-cigarette generally is a device for electrically generating an aerosol from nicotine liquid solution for subsequent inhalation by the smoker. The aerosols typically contain nicotine and a carrier as well as flavoring or other desired ingredients. The e-cigarette therefore generally includes three

main parts: a means to store the liquid, a heating means for creating the aerosol and/or vapor from the liquid, and a power source, which is typically a battery. In addition, the e-cigarette also includes an inhalation means that enables the user to inhale the aerosols/vapor on demand.

33. By 2006, there were several known means to store liquid in vaporizers and e-cigarettes. Among the earliest known means was to store and/or transport the liquid in a porous/fibrous body positioned inside the device. *See, e.g.*, Ex. 1003, Whittemore at 1:50-2:18; Ex. 1023, Hon ‘043 at pp. 9-10 (disclosing a “solution storage porous body 28” comprising “polypropylene fiber, terylene fiber or nylon fiber,” among other materials.); Ex.1034, Hayward-Butt at 1:25-27 (disclosing a “chamber containing fibrous absorbent material for the volatile liquid analgesic”); Ex.1035, Gilbert at 3:23-34 (disclosing a cartridge for an electronic simulated cigarette that “may be composed of a porous, moisture-holding substance such as felt or plastic sponge”). Other prior art also discloses using fiber to store liquid in an electronic cigarette and similar applications. *See, e.g.s*, Ex. 1024 (USP 6,598,607), at 2:44-47; Ex. 1025 (USP 4,793,365), at 10:51-66; Ex. 1026 (USP 5,203,355), at 9:36-52; Ex. 1027 (USP 2,472,282), at 3:29-32; Ex. 1028 (USP 2,032,695), at 1:46-48.

34. Common techniques for converting liquid into aerosols included using heating and/or piezoelectric elements. These elements could be located in the

atomizer so as to contact the liquid directly or indirectly. It was also known that these elements could be used independently or combined together to convert liquid into aerosols. *See, e.g.*, Ex. 1023, Hon '043 at 10:28-11:2, 11:16-18; Ex. 1031, Voges at 3:62-4:33, 10:52-63; Ex. 1036, Takeuchi at Figs. 3-7. One common method of creating aerosols was to utilize heaters, with low thermal mass and sufficient capacity to deliver the needed heat, to rapidly vaporize the liquid. Such heaters were able to rapidly reach temperatures and vaporized the immediately surrounding liquid while power was applied, and then rapidly cooled to stop the vaporization process once the power was turned-off. *See, e.g.*, Ex. 1002, Brooks at 5:38-62.

35. A PHOSITA would have understood that heating elements came in different shapes, such as coiled heating wire coils, straight wire coils or rods, thin film wires, plates, etc. And, that selecting any particular shape over another would have been a matter of obvious design choice. *See, e.g.*, Ex. 1023, Hon '043 at Fig 6; Ex. 1003, Whittemore at Figs. 2-3; Ex. 1036, Takeuchi at Figs. 1-7, 10-11, and 15; Ex. 1002, Brooks at 1:19-32, 2:7-18, 2:36-3:14, 13:20-30.

36. Widespread knowledge about the materials and shapes of the heating elements advantageously allowed a skilled person to design and manufacture a low-cost and robust e-cigarette in the desired form factor. Furthermore, and as shown in the cited prior art references, a skilled person would have known that

widely known orientation, location, and structure of these elements allowed most efficient design of an e-cigarette based on several criteria, such as maximizing the contact of the heating or piezoelectric element with the liquid material, maximizing efficiency of an e-cigarette, minimizing air flow obstruction, etc. Therefore, it would have been obvious to a skilled person to replace, combine, orient, or locate them in any manner that suits a particular e-cigarette design, and a skilled person would have recognized and found it obvious that each of these could be selected, utilized, and applied with straightforward, predictable results.

37. Heater coils were particularly well-understood in the art of electronic vaporization devices, and were known to provide high power density and efficient and uniform heating. *See, e.g.*, Ex.1021, Howell at 11:20-22 (“The wire was wrapped in a fashion that produced close tight coils to insure good heat transfer to the tube.”); *see also* Ex.1002 at 1:64, 2:40-43, 3:4-6. It was similarly well-known to apply this feature of heater coils by wrapping it around a porous material to generate vapor or aerosol (whether for inhalation or other purposes) from liquid being transported due to capillary action within the porous material. *See* Ex.1003, Whittemore at 1:53-2:18; Ex.1019, Smith at 20:36-40; Ex.1020, Seuthe at 4:73-75.

38. It was also well-known that heating wires could be made from carbon fiber. Ex. 1048, Eur. Pat. Pub. 0501419, col. 2:19-36, 2:50-3:4; Ex. 1030, US Pat. 6,885,814, Abstract, 1:43-54, 4:11-16, 8:49-54. I have personal experience

working with carbon wires in the form of non-woven ribbon in aerospace industry applications prior to 2006.

39. It was also well known that the elements described above can be easily controlled by standard, low-cost electronic circuits. It was standard practice to use these elements with circuits coupled with simple electronic sensors, such as pressure actuated switches, etc. *See, e.g.*, Ex.1002 at 9:51-62, 13:1-6; Ex.1031 at 6:8-11; Ex.1036 at 6:23-6:25. It was well-known that, for example, sensors can detect conditions such as when negative pressure is generated within the device by the act of inhalation. When the person places the e-cigarette to his/her lips and inhales, it draws air into the device. The airflow creates a pressure drop through the e-cigarette that is detected by the pressure sensor and signals to the electronic circuit the need to power the piezoelectric or heating elements and generate aerosol. *See* Ex.1002 at 10:42-45. Pressure actuated switches require an equalization port to work properly. Specifically, pressure actuated switches have two chambers in the sensor separated by a diaphragm. One chamber has a suction port where negative pressure is created. The other chamber is connected to an equalization port that allows for ambient air to enter when negative pressure occurs on the other chamber. In other words, the pressure in the chamber is balanced. This balancing allows the diaphragm to move toward the chamber with the negative pressure. If there was no equalization port, the chamber would be sealed

and the diaphragm would be very difficult to move, if it could at all be moved. In other words, without an equalization port, the pressure switch would not work. To understand the importance of the balancing the pressure through the equalization port, one can consider the operation of a syringe. A user can pull back the plunger on a syringe and then push it back when the syringe tip is uncovered and open to ambient air. However, if the tip is sealed or closed off from ambient (for example the user covers the tip with a finger or a cap), the plunger cannot be pulled back from the syringe or pushed back into the syringe. This is the same result that would occur if a pressure switch did not have a equalization port to balance the pressure.

40. Indeed, the concept of balancing pressure in pressure switches in order for such differential sensors to accurately detect differences in air pressure induced by particular external events such as inhalation, a mechanism for equalizing pressure on both sides of the sensor is necessary to compensate for pressure build-up in the housing. *See, e.g.*, European Pat. No. 1584910 to Tohyama et al. (Ex.1032) at ¶¶3-4 (describing “known” pressure sensors in which a “diaphragm is deformed by the pressure difference between the pressure of fluid to be measured and the atmospheric pressure” but noting that “[s]ealing the main body case, however, brings about pressure change of the internal space of the main body case due to temperature change or diaphragm deformation, [with the result

that] pressure applied to the atmospheric pressure receiving surface of the diaphragm becomes unequal to the atmospheric pressure resulting in a problem of measurement accuracy deterioration”).

41. It was likewise well-known in the art that one simple solution to this pressure build-up problem, as explained above, was to include one or more small holes in the housing for the sensor in order to expose it to ambient air and thus equalize the standby pressure on both sides of the sensor. *See* Ex.1032 at ¶5 (“In order to solve the above problem, there is a method that the main body case is not arranged to have sealed structure, but a vent is provided to communicate the internal space of the main body case with the atmosphere.”); Ex.1033 (USP 6,311,561 to Bang et al., filed Feb. 1, 1999 and published Nov. 6, 2001) at 8:11-15 (“With further reference to FIG. 5B, a vent hole 145 is provided through the circuit board 115 to expose one side of the sensor 18 to ambient. The vent hole 145 is a gage pressure port which allows the sensor 18 to measure sensed pressure relative to ambient.”).

42. Further, it was well-known that logic within the control circuit can be applied to apply power to any e-cigarette components such as the aerosol generator at the desired time, duration, rate, and level. *See, e.g.*, Ex. 1002 at 13:62-14:34; Ex.1031 at 6:52-57; Ex.1036 at 6:55-59. A skilled person would have understood that control circuits, whether digital or analog, and including commonplace

components of electronic circuits, such as sensors, LEDs, microchips, microprocessors, Read Only Memory (ROM), Read and Write Memory (RAM), clocks, power supply and the like, or a combination of any of the above, are typically implemented on an electronic circuit board and thus necessarily, and inherently, include electronic circuit boards. *See, e.g.*, Ex.1037, Ghosh (a method of attaching a microchip to a circuit board patent); Ex.1038, Wood (an inhaler device patent); Ex.1039, Bremenour (a memory cartridge for a circuit board patent). In the alternative, these components are widely available and an ordinarily skilled person would have found it obvious to combine and use them in any way necessary.

43. The use of basic mechanical connecting means, including plugs or fitting pairs and screwthreads were well-known in the art in 2006, because such connectors are among the fundamental building blocks of mechanical engineering. *See generally* Ex.1040, Messler, *Joining of Materials and Structures* (2004) at p.3-4. It had been known since the dawn of the electrical age, moreover, that such mechanical connections—including screwthreads—could also be used to provide electrical conductivity. *See, e.g.*, Ex.1041, U.S. Pat. No. 438,310 to Edison at 1:66-72 (filed May 5, 1890) (“Referring to Fig. 6, it will be seen that if the base of the lamp be screwed into the socket the sleeve 1 would form electrical contact with the socket-sleeve 7, connected to one wire of the circuit, while the plug or terminal 6

would make end contact with the screw 8, connected to the other wire of the circuit.”).

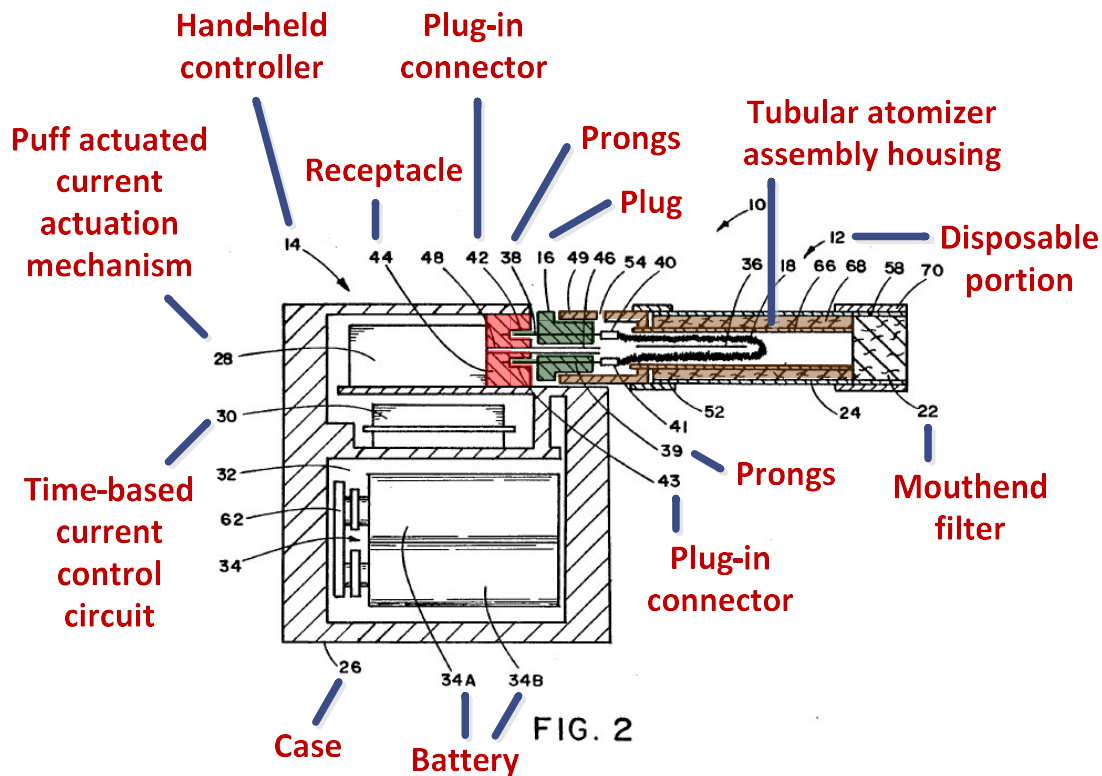
44. It was also well-known as of 2006 that these basic building blocks of mechanical and electrical engineering could be applied to detachably connect separate assemblies housing some of the components of e-cigarettes or electronic vaporizing devices described above and, in some cases, electrically linking the assemblies. *See, e.g.*, Ex.1002, Brooks at 9:41-46 (plug connector providing mechanical and electrical connection); Ex.1003, Whittemore at 1:39-45 (screwthreads providing mechanical and electrical connection); Ex.1031, Voges at 5:48-55 (screwthreads linking “body parts 2,3”); Ex.1042, Susa at 5:26-29 (plug connection optionally replaced by screwthreads).

45. It was also well-known in 2006 that e-cigarettes and electronic vapor devices could be powered using rechargeable batteries. *See, e.g.*, Ex.1036, Takeuchi at 6:15-17; Ex.1042, Susa at 8:43-45. It was further known that such batteries were preferable in order to reduce expenses and the interruption of operations caused by replacement. *See* Ex.1043, Connors at 1:21-23. It was further known that such batteries could be recharged using threaded connectors. *Id.* at 3:59-66.

B. Brooks (Ex. 1002)

46. Brooks discloses “cigarettes and other smoking articles such as cigars, pipes, and the like, which employ an electrical resistance heating element and an electrical power source to produce a tobacco-flavored smoke or aerosol.” Ex. 1002 at 1:6-10. As discussed in the “Background of the Invention,” many smoking articles and tobacco substitute smoking materials had been proposed in the past as alternatives to smoking products that burn tobacco, including alternatives that generate flavored vapor and/or visible aerosols. *Id.* at 1:19-34. These alternatives included smoking products, flavor generators and medicinal inhalers that utilized electrical energy to vaporize or heat a volatile material, or which otherwise attempted to provide the sensation of cigarette or pipe smoking without burning tobacco. *Id.* at 1:50-56. According to Brooks, “[p]referred smoking articles of the invention are capable of providing the user with the sensations of smoking (e.g., smoking, taste, feel, satisfaction, pleasure, and the like) by heating but not burning tobacco” *Id.* at 1:11-15; see also 3:63-4:2.

47. Brooks discloses a smoking article 10 that includes a hand-held controller 14 and cigarette (e.g., a disposable portion) 12 (*see id.* at 4:7-12; 7:15-16) as shown in Fig. 2:



Id. at 7:15-16; Fig. 2. “The cigarette 12 includes electrical connection plug 16, resistance heating element 18 carrying an aerosol forming substance, a roll of tobacco 20, mouth end filter 22, and a resilient overwrap 24.” *Id.* at 7:17-20. The aerosol forming substance can be, for example, “a polyhydric alcohol, such as glycerin, propylene glycol, or a mixture thereof, water; a tobacco material such as tobacco aroma oil, a tobacco essence, a spray dried tobacco extract, a freeze dried tobacco extract, tobacco dust, or the like, in order to provide tobacco flavor; or a combination thereof. *Id.* at 8:8-14.

48. The smoking article also “includes one or more peripheral air inlet openings 54 which provide a flow of ambient air through the cigarette during draw.

Id. at 8:43-52. “Alternatively, the air inlet can be positioned through the extreme inlet end of the cigarette or elsewhere through the periphery of the cigarette, such that drawn ambient air passing through the cigarette to the mouth of the user passes the resistance element.” *Id.* at 8:53-57.

49. I note that Brooks discloses several heating element alternatives. *See, Id.* at 7:48-8:3 (“***Preferred resistance heating element*** include carbon filament yarns ... ***Other preferred heating elements*** include carbon felts and activated carbon felts ... ***Other suitable heating elements*** include porous metal wires or films; carbon yarns, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; porous substrates in intimate contact with resistance heating components; and the like.”).²

50. In the preferred embodiment, the heating element 18 “is impregnated with or otherwise carries the aerosol forming substance in order that the aerosol forming substance is in a heat exchange relationship with the electrical heating element.” *Id.* at 8:4-8. In a *different* embodiment, Brooks discloses that “other

² All emphasis added unless otherwise noted.

suitable heating elements” can be “porous *metal wire*³ or films; carbon yarns, cloths, *fibers*.” *Id.* at 7:65-8:2. Among the “other suitable heating elements” described is “a porous substrate in intimate contact with resistance heating components.” *Id.* at 8:1-2. A PHOSITA would have understood that this alternative “intimate contact” heating element necessarily includes a separate porous substrate that holds aerosol forming substance and separate resistance heating components (which may also hold aerosol forming substance) that are touching the substrate as compared to the preferred embodiment where only the heating element is impregnated with the aerosol forming substance. In fact, Brooks references Whittemore in the Background of The Invention Ex. 1002, Brooks at 1:57-61. Moreover, if separate porous substrate and resistance heating components in close physical contact (i.e. touching) did not comprise the alternative arrangement disclosed in Brooks, then use of the word “contact” in the specification would make no sense because the word “contact” means the “union

³ Brooks also discloses in the Background section that resistance heating coils were well-known for heating tobacco or aromatic substances in electrical smoking articles. *Id.* at 1:62-66 (“U.S. Pat. No. 2,104,266 to McCormick proposed an article having a pipe bowl or cigarette holder which included a *resistance coil* (i) wound on an insulating and heat resisting material,”), 2:36-43, 2:67-3:14.

or junction of two surfaces.” Ex. 1049 (*Contact*, Merriam-Webster's Collegiate Dictionary (11th ed. 2003)).

51. Moreover, a PHOSITA would further have understood that the “intimate contact” embodiment includes a separate porous substrate and separate resistance heating components based on the claims which distinguish between the preferred embodiment and the “intimate contact” embodiment. Specifically, I note that claims 53, 104, and 131 simply require that there be “an aerosol forming substance” without any requirement that it be carried by the electrical resistance heating element. Ex. 1002 at claims 53, 104 and 131.⁴ In contrast, the resistance heating elements recited in claims 1, 26 and 75 all require that there be an “aerosol forming substance carried by the [electrical resistance] heating element prior to use.” *Id.* at claims 1, 26 and 75. This difference in the claims make clear that the “intimate contact” embodiment includes a separate porous structure and resistance heating components, and is different from the preferred embodiment. I also note

⁴ Further, claims 57, 105 and 132 depend from claims 53, 104 and 131, respectively, and expressly add the limitation that the “aerosol forming substance is carried by the heating element prior to use.” Indeed, there is no other distinction between the independent and dependent claims. *Id.* at claims 53, 57, 104, 105, 131 and 132.

that this difference in the claims is consistent with the written description of the Brooks specification. Ex. 1002 at 6:45-52 (teaching that the aerosol forming substance can be located either “on the resistance heating element or elsewhere in the article.”).

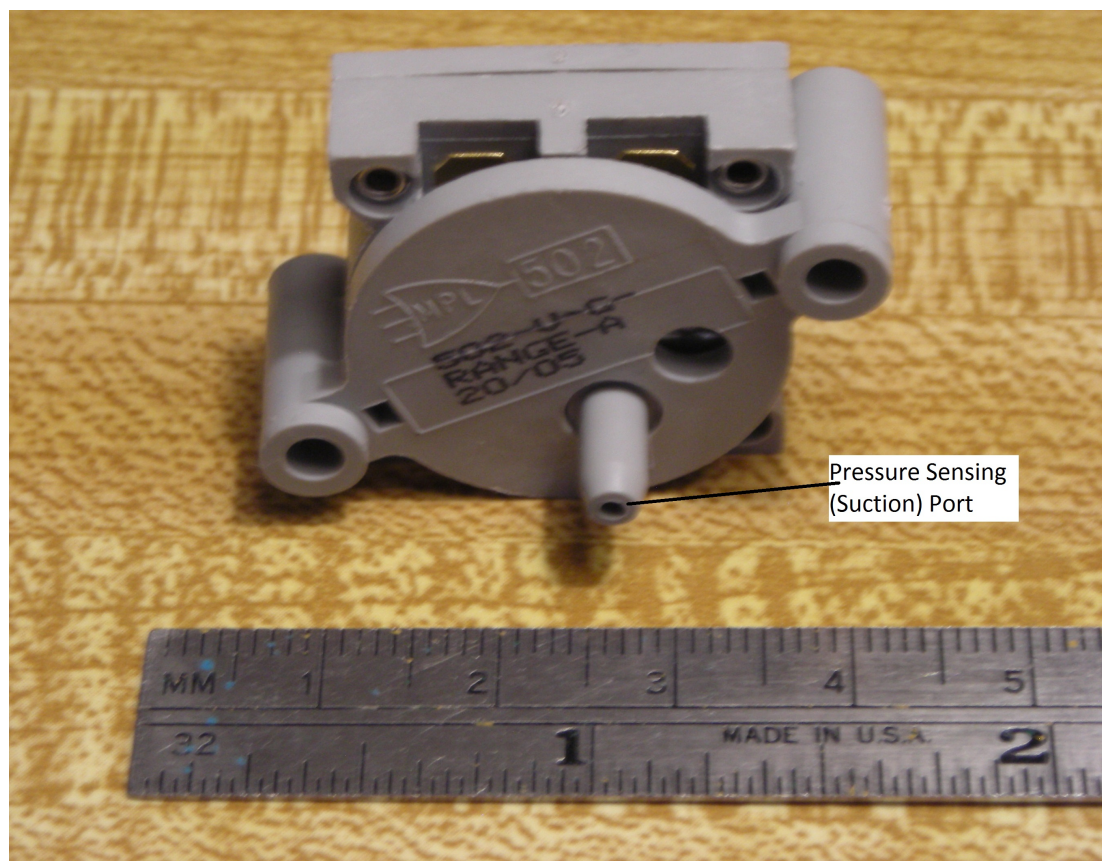
52. The hand-held controller 14 includes “a case 26, a puff actuated current actuation mechanism 28 having the form of a pressure sensitive switch, a time-based current control circuit 30, and a chamber 32 into which battery power supply 34 (shown as batteries 34A and 34B) is inserted.” Ex. 1002 at 7:20-25. The case 26 provides “a convenient and aesthetic holder for the user. The outer housing 26 can have a variety of shapes and can be manufactured from plastic, metal, or the like.” *Id.* at 9:37-41. In addition, the controller 14 has a receptacle 44 that “includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette. The other end of tube 48 is in airflow communication with pressure sensing switch 28, so that changes in air pressure which occur within the cigarette during draw can be sensed by the switch.” *Id.* at 9:41-50. The control circuit 30 is connected to the puff actuated, differential pressure sensitive switch 28 as well as to batteries 34A and 34B. *Id.* at 9:51-55.

53. A PHOSITA would have understood that that Brook’s pressure sensing switch 28 must have some sort of pressure balancing hole in order to

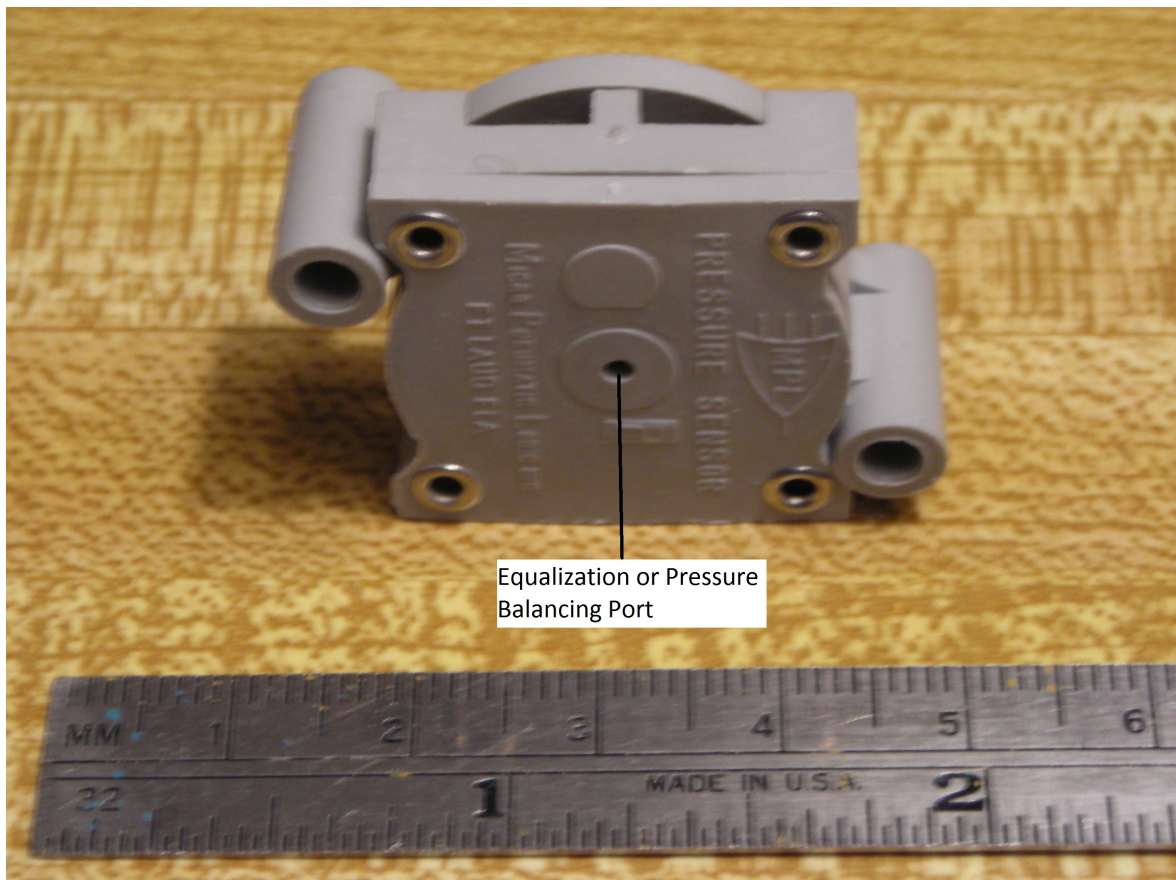
operate properly for the reasons I explained above. Specifically, without equalizing the pressure in the pressure switch 28, the device in Brooks would not work. Thus, a PHOSITA would understand that the pressure switch 28 in Brooks must have an equalization port to allow for ambient air to equalize the pressure in the chamber not connected to tube 48. A PHOSITA would also have understood that the controller case likewise would need to have some sort of opening to ambient air so that the ambient air could get to the pressure switch 28. Specifically, as shown in Figs. 1-2, the pressure switch 28 is located in case 26. Ex. 1002, 7:20-25, Figs. 1-2. Case 26 is shown in Figs. 1-2 without any opening to ambient. However, a PHOSITA would have understood that if there were no opening to ambient, the equalization chamber would be sealed and the system would not work. Thus, a PHOSITA would understand that there is an opening in the case 26 that allows for pressure balancing in the sensor. A PHOSITA would also understand that the location of the hole in the case would be located near the sensor's equalization port.

54. Brooks discloses the pressure differential switch Model No. MPL-502-V, Range A, by Micro Pneumatic Logic, Inc., Ft. Lauderdale, FL, as a preferred switch 28. Ex. 1002, 12:58-61, 17:46-48. I obtained and examined the Model No. MPL-502-V, Range A pressure sensor by MicroPneumatic Logic identified in Brooks and found that it had a pressure relief port and a pressure

sensing port as described above. Below and attached as Exhibits 1007 and 1008 are true and correct copies of photographs that I took of the MPL-502-V, Range A pressure sensor that I obtained and examined. Also attached as Exhibit 1051 is a true and correct copy of a receipt showing proof of my purchase of the pressure sensor. The original receipt and the actual device are available for inspection at the law offices of Brinks Gilson & Lione. Ex. 1054. I have annotated the photographs for ease of reference. The following front view of the the MPL-502-V. Range A pressure sensor illustrates the pressure sensing port or suction port for air flow.

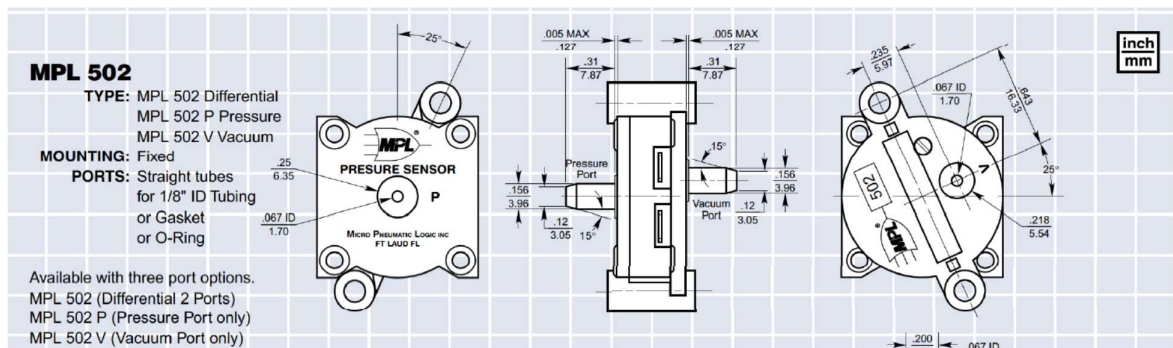
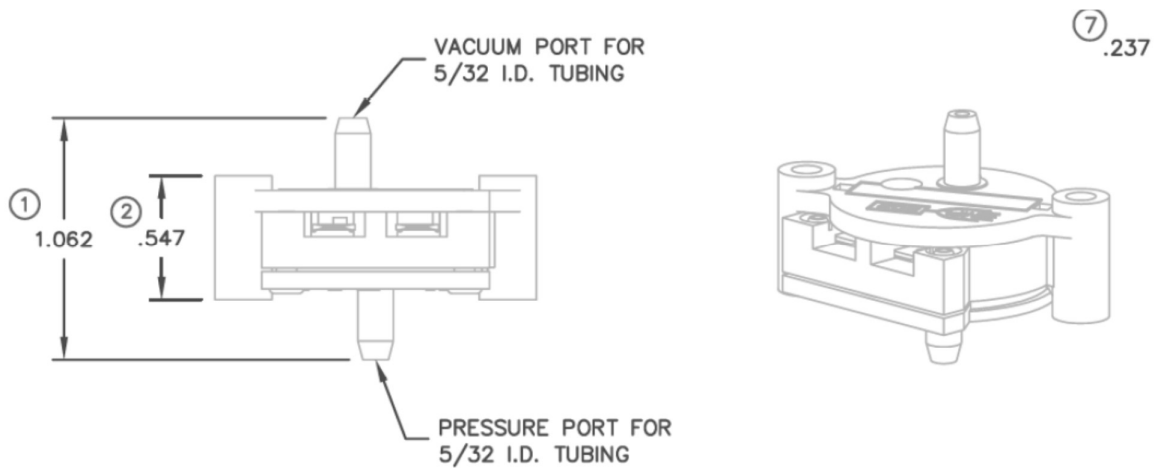


The following back view of the the MPL-502-V pressure sensor illustrates the pressure balancing or equalization port. The back view also shows the company's name and reference to Ft. Lauderdale, FL.



The positions of the pressure sensor port and the pressure balancing port on the MPL-502-V are consistent with technical drawings (shown below) of the Model No. MPL-502 pressure sensor, which drawings I understand were available on the website of Micro Pneumatic Logic, Inc., as of March 11, 2006. *See* Ex. 1009; Ex. 1010 at 8. A selection of these technical drawings were included in brochures, at

least one of which I understand was available on the Micro Pneumatic website as March 11, 2006. Ex. 1010 and 1053.



Since the MPL-502-V has its equalization port on the opposite side from the sensing port, one of ordinary skill would recognize that the logical place to locate the a pressure balancing hole in the case 26 would be on the left side of the case in Fig. 2 as shown below:

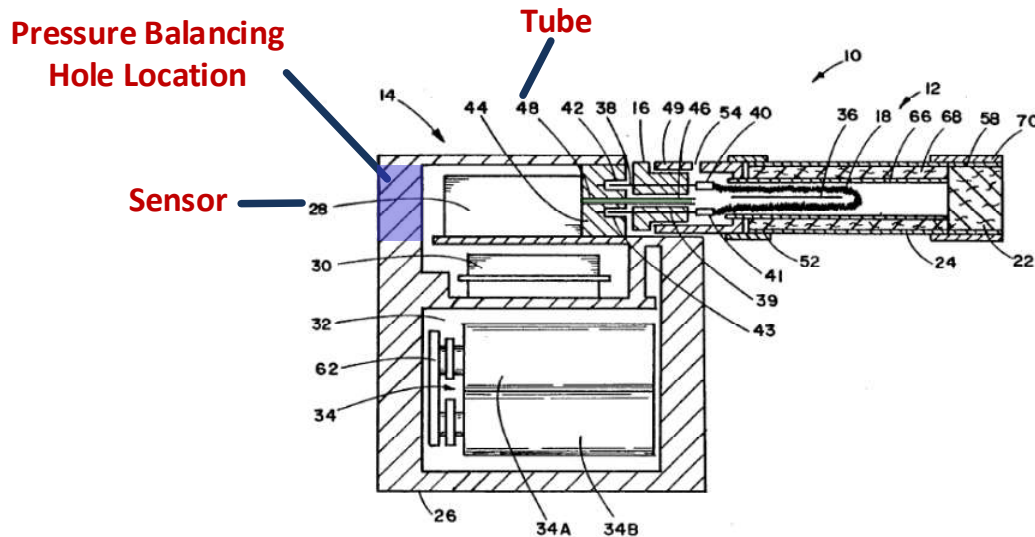


FIG. 2

55. In operation, “[w]hen the user puffs on the mouthend of the cigarette, ambient air enters the cigarette through air inlet 54. The pressure actuated switch 28 responds to a sensed change in air pressure within the cigarette during draw and permits current flow through the heating element 18. As a result, the heating element experiences an increase in temperature which in turn heats and volatilizes the aerosol forming substance. The volatilized aerosol forming substance mixes with the drawn air and forms an aerosol. The volatilized aerosol forming substance (in aerosol or vapor form) passes through the tobacco roll 20 where it elutes tobacco flavor from the tobacco, and exits the mouthend filter 22 into the mouth of the user.” *Id.* at 10:34-53.

56. The electrical current is controlled by a timing means. The timing means regulates current flow to the heating element. *Id.* at 13:62-14:2, see *also id.* at 13:20-30, 14:3-16:31, 16:32-35; claims Figs. 9-10, claims 161-202.

57. Notably, Brooks' "timer means" carries out control functions analogous to the functions that the 205 patent describes the micro-controller unit or "microcircuit" as carrying out. For example, the 205 patent describes the microcircuit as—depending on the signals received from the sensors— "restrict[ing] the atomizing capacity with the integral function of frequency to single operation time." Ex.1001 at 4:29-31. Along the same lines, the microcircuit "accomplishes the pulse width modulation and over discharging protection for the constant power output." *Id.* at 4:31-33. In other words, the 205 patent's microcircuit monitors and regulates the flow of electric current through the heating element to ensure the desired power output. Similarly, the Brooks timer means is capable of "generating a pulse train having a predetermined duty cycle" and "disabling current flow to the heating element in response to the pulse train from the timer means." Ex.1002 at 27:45-51 (claim 97), see *also id.* at 14:48-60. Brooks discloses that this regulation of current flow "acts to control the average current flow through the heating element, thus controlling the temperature range experienced by the heating element during the balance of a puff." *Id.* at 14:60-62. Accordingly, because the timing means regulates the process and function of the

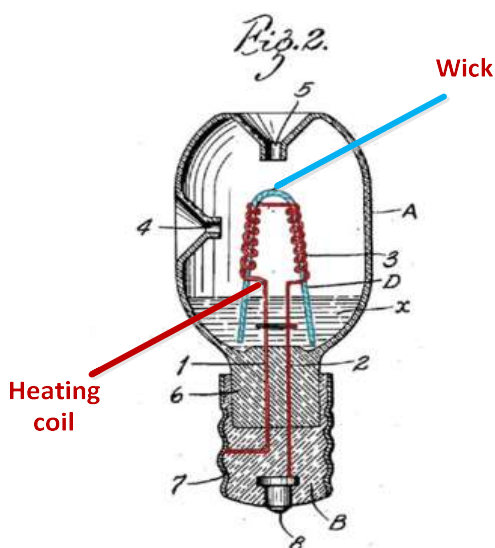
heating element, a person of ordinary skill in the art would recognize that the timing means constitutes a “micro-controller unit” under the broadest reasonable construction of that term. Figs. 1-6 of Brooks all show a physical example of a circuit board that is shown either on edge or obliquely.

58. This timing means (*i.e.*, micro-controller unit) is part of and affixed to the current control circuit, which a person of ordinary skill would understand to be laid out using the conventional method for doing so in small electronic devices—a circuit board (typically a small printed circuit board). This understanding is further confirmed by Brooks’ description, for example at 13:31-51, of the use of pin connectors, which are a well-known means for linking circuit components to and within a circuit board, and which persons of ordinary skill in the art would naturally assume and understand to be connected to a circuit board (there being no other purpose for such pins in the Brooks device). *See, e.g.*, Ex. 1017, U.S. Pat. No. 5,266,746 to Nishihara et al. (filed Nov. 29, 1990) at 1:20-25 (“In order to connect the semiconductor elements and devices mounted on the printed circuit board to an external circuit, there have been widely used connector pins of such a type that the printed circuit board is clamped by the pins at its peripheral portion from front and rear surfaces.”); *see also* Ex. 1018, U.S. Pat. No. 4,968,263 to Silbernagel et al. (filed Mar. 28, 1990) at 1:14-17 (“Multi-pin electrical connectors are widely used for connecting circuit traces on printed circuit boards with other

printed circuit boards or with a complementary connector.”). Thus, a person of ordinary skill in the art would recognize that the Brooks control circuit comprises a circuit board.

C. Whittemore (Ex. 1003)

59. Whittemore is prior art under 35 U.S.C. § 102(b). Whittemore discloses a vaporizing unit, which is illustrated in annotated Fig. 2 of Whittemore below.



60. A vaporizing vessel A is “adapted to hold a liquid medicament *x* and provided with an electrically-operated heating means comprising two electrical conductors 1 and 2 and a filament or heating element 3 combined in such a way that when said conductors are energized by an electric current, the filament 3 will become heated.” Ex. 1003 at 1:18-28. Whittemore also discloses a wick D around which the heating element 3 is wrapped. According to Whittemore, “a wick D

made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3.” *Id.* at 1:54-2:8. Whittemore also includes an air inlet orifice 4 and a vapor outlet 5. *Id.* at 1:31-33.

VII. CLAIMS 1-22 OF THE 205 PATENT ARE OBVIOUS

A. Motivation For Combining Brooks With Whittemore

61. It is my opinion that each of claims 1-22 of the 205 patent is obvious based on the combination of Brooks and Whittemore. As I discuss below, there would have been various reasons why the PHOSITA would have combined Brooks with Whittemore. First, Brooks discloses an embodiment where the heating element is in “intimate contact” with a porous substrate. One known way for achieving intimate contact between a heating element and a porous component is disclosed by Whittemore, which discloses a heating wire coiled around a porous wick. Thus, it would have been obvious to coil Brooks’ heating element around the porous substrate in “intimate contact” with the heating element. Alternatively, it would have been obvious to merely substitute Whittemore’s coiled heating wire/wick configuration for Brooks’ heating element, because the substitution of

Whittemore's coiled heating wire/wick configuration for Brooks' heating element is merely the substitution of one known element for another to achieve the predicted result of holding and atomizing liquid.

62. Brooks discloses that the heating element can be made of "metal wires." Ex. 1002 at 7:65-8:3. A PHOSITA would have recognized that the disclosed "metal wire" includes both straight and coiled wires, especially in view of Brooks' disclosure of the known use of heating elements that are coils. *Id.* at. 1:51-56, 1:62-2:6, 2:36-43, 2:67-3:14.

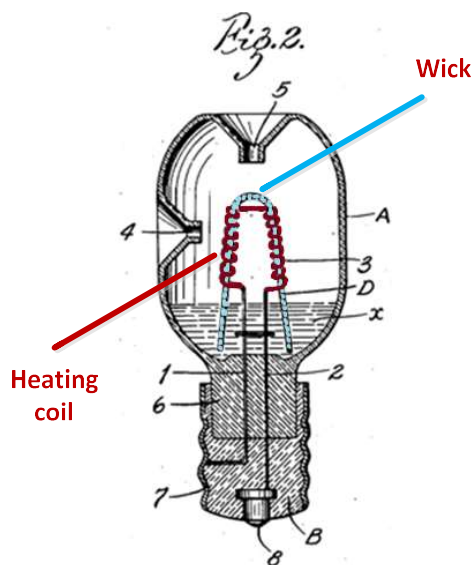
63. Brooks also discloses that another suitable heating element could be a porous substrate (*i.e.*, "porous body"), which is "in intimate contact with" a resistance heating component. *Id.* at 8:1-3. As discussed in ¶¶49-51 *supra*, a PHOSITA would have understood that in this "intimate contact" embodiment the porous substrate and resistance heating component are separate structures. Moreover, a PHOSITA would have understood that there were a finite number of identified, predictable ways to arrange the resistance heating component "in intimate contact with" the porous substrate. For example, the resistance heating component could be positioned either inside or outside of the porous substrate, with the outside component either totally or partially contacting the inside component. These arrangements are finite in number and predictable in orientation. For example, one way to arrange these two components is to wrap (that

is, partially envelope) the resistance heating component around the porous substrate: a heating wire wound around a wick. Winding a metal wire coil (resistance heating component) around a porous body would have been one of the best, and most well-known, shapes for such a heating wire, a technique that had been widely known in the art of electronic vaporizing devices for at least seven decades. *See, e.g.* Ex. 1003 (Whittemore) at 1:53-2:18, Fig. 2 (disclosing a filament 3 wound around a wick D for vaporizing); Ex.1019 (US2,461,664 to Smith) at 20:36-40 (disclosing a heating element “compris[ing] loops of a coil of electrical resistance wire and the said capillary feeder comprises a stretch of wick passing axially through said coil of wire”); Ex.1020 (US3,234,357 to Seuthe) at 4:73-75 (“The wire 71 is advantageously coiled around a wick or mandrel 63 which is easily wetted.”). Brooks even identifies the wire wrapped around a wick as one known way for vaporizing the liquid. Ex. 1002 at col. 1:57-61.

64. Thus, and in view of the teachings of Whittemore and the other prior art cited above, it would have been obvious to adapt Brooks to coil a heating element around a porous substrate.

65. To the extent that Patent Owner argues that Brooks does not disclose a distinct heating element in “intimate contact” with a separate porous substrate, it would nevertheless have been obvious to modify Brooks as taught by Whittemore. Whittemore, a reference cited and described by Brooks, removes any doubt that it

was known in the art to wind a heater coil around a porous component, such as Whittemore's wick D. *See e.g.*, Ex. 1003 at Fig. 2, 1:54-2:8 ("a wick D made of any suitable material and combined with the heating element of filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3.")



66. It would have been obvious to substitute Whittemore's coiled heating wire/wick configuration for Brooks' heating element, as this would merely amount to the substitution of one known element (Whittemore's coiled heating wire/wick configuration) for another (Brooks' heating element) to achieve the predictable result of holding and atomizing liquid. Indeed, the technique of winding a heating

coil around a liquid container to generate vapor had been known for almost a century before the claimed priority date of the 205 patent. *See, e.g.* Ex.1044, U.S. Pat. No. 1,084,304 to Vaughn (filed Jan. 27, 1913) at 3:39-43 (“As the current thus passes through the resistance heating coil 13, such coil will be heated and the medicinal compound a within the interior of the container 16 will be heated so that a vapor will be generated...”). Winding a heater coil around a porous material such as a wick to generate vapor is almost as old, as Whittemore itself demonstrates. *See* Ex.1003 at 1:53-2:18. Other decades-old references confirm that winding a heater coil around a porous substrate such as a wick has long been a conventional way of generating vapor. Ex.1019, U.S. 2,461,664 to Smith (filed Aug. 30, 1941) at 20:36-40 (claiming a “fume generating toy” in which the heating element “comprises loops of a coil of electrical resistance wire and the said capillary feeder comprises a stretch of wick passing axially through said coil of wire”); Ex.1020, U.S. 3,234,357 to Seuthe (filed October 29, 1962) at 4:73-75 (“The wire 71 is advantageously coiled around a wick or mandrel 63 which is easily wetted.”).

67. Thus, even if it were determined that Brooks does not disclose a distinct heating element that is separate from but in “intimate contact” with a porous substrate, the claims of the 205 patent are nevertheless obvious over the combination of Brooks and Whittemore. As noted above, it would have been obvious to substitute Whittemore’s coiled heating wire/wick configuration for

Brooks heating element. This would be the substitution of a known element (Whittemore's coiled heating wire/wick configuration) for Brooks' heating element to achieve the predictable result of holding and atomizing liquid. Indeed, given how well-established the practice of using a heater coil wound around a porous component was in the art, using Whittemore's coiled heating wire/wick configuration would be nothing more than the application of known techniques (winding a heater coil around a porous component) to a similar structure (Brooks' heating component in intimate contact with a porous substrate). The predicted result would be the transport of liquid aerosol forming substance via capillary action from the porous substrate to the resistance heating component where the liquid aerosol forming substance is held and vaporized; the same transporting and vaporizing function that the porous wick D/heating coil wire 3 configuration performs in Whittemore.

68. A PHOSITA would have also recognized the benefits of the heating coil wire/wick configuration disclosed in Whittemore. For example, and as confirmed by the prior art, tight wire coils promote effective heat transfer. Ex.1021 (U.S. Patent No. 5,743,251 to Howell et al.) at 11:20-22 ("The wire was wrapped in a fashion that produced close, tight coils to insure good heat transfer to the tube."); *see also* Ex.1020 at 4:75-5:2 ("In order to obtain a stronger heating effect, wire in the upper region is wound in a tighter coiled manner than the lower

portion.”). Accordingly, the PHOSITA would have expected Whittemore’s configuration to achieve good heating efficiency. Thus, Whittemore’s configuration is consistent with Brooks’ emphasis on the importance of rapid and efficient heating. Further, a PHOSITA would have known that the wick in Whittemore extends beyond the heating coils, so it can be filled with more fluid (or extend into a liquid reservoir) than the liquid impregnated heating element of Brooks. Accordingly, a PHOSITA would be motivated to combine the wick with more fluid from Whittemore with Brooks.

69. Moreover, modifying Brooks “withWhittemore’s heating coil wire/wick configuration would not have destroyed the operation of the smoking article of Brooks. To the contrary, and as noted above, the PHOSITA would have expected that the proposed modification would provide for efficient heating of the liquid solution.

70. Accordingly, a PHOSITA would have found it obvious to modify Brooks’ heating component by either coiling the heating wire around the porous substrate that is in “intmate contact” with the heating element as taught by Whittemore or, in the alternative, would have substituted Whittemore’s coiled heating wire/wick configuration for the heating element 18 of Brooks to achieve the predictable result of holding and atomizing liquid.

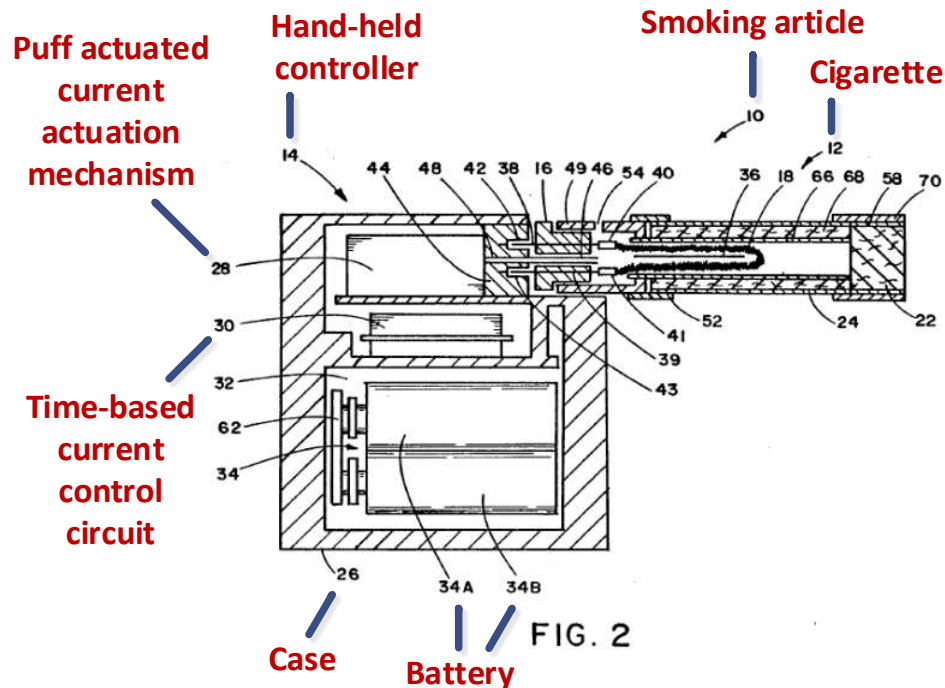
B. The Prior Art Discloses Every Element of Claims 1-22

71. It is my opinion that each of claims 1-22 is obvious in view of the combination of Brooks with Whittemore. The combination of Brooks and Whittemore discloses each and every limitation of claims 1-22 of the 205 patent.

72. Claim 1.Preamble recites “A vaporizing device comprising:” To the extent that the preamble is considered a claim limitation, Brooks discloses a vaporizing device. Brooks is directed to “[s]moking articles [that] employ an electrical resistance heating element and an electrical power source to provide a tobacco-flavored smoke or aerosol and other sensations of smoking.” Ex.1002 at Abstract; *see also* 6:45-53, 10:45-53.

73. Claim 1.1 recites “a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit electrically connected to a circuit board within a tubular battery assembly housing.” Brooks discloses a battery assembly comprising a battery, a sensor, and LED and a micro-controller unit electrically connected to a circuit board within a tubular battery assembly housing as shown at least in annotated Figure 2 below. Brooks discloses a device having two discrete components: (1) a reusable controller 14 that contains batteries and other electronic components and (2) a disposable portion 12 that includes the heating component and liquid. The controller 14 comprises “a case 26 or outer housing” that houses

batteries 34A and 34B and thus is “a battery assembly housing.” *Id.* at 7:15-25 and 9:37-41.



74. A PHOSITA would have understood that a “cigarette holder” is a tubular structure since its purpose is to hold a tubular cigarette while matching its general appearance and shape. Indeed, that a cigarette holder is tubular in shape is confirmed by the 205 patent, which states that “[a]s shown in FIG. 1, an electronic cigarette has an appearance similar to a cigarette inserted into the cigarette holder.” Ex. 1001 at 1:60-61, Figs. 1, 2; see also Ex. 1014 (parent application publication of the 205 patent) at ¶ [0026], Fig. 1 (“As shown in Fig. 1, the visual appearance of this invention is similar to a cigarette inserted into the cigarette holder, and includes a battery assembly, an atomizer assembly and a cigarette bottle

assembly.”) This statement—in light of the clear disclosure in Fig. 1 of a tubular device—shows that the 205 patent applicant understood a “cigarette holder” to be tubular. To the extent the Patent Owner disputes that the controller 14 in the form of a cigarette holder is tubular, tubular cigarette holder for smoking articles and similar devices were also known in the art, as evidenced by Ex. 1015 (Kleinhans) at 2:3-4 (“The new smoking device comprises a tubular cigarette holder generally of conventional design.”); Ex. 1016 (Bonanno) at 2:27-43 (“Referring to FIG. 1, the invention is illustrated as embodied in a cigarette holder ... Mounted concentrically within the outer sleeve 11 and spaced therefrom is a telescoping double-walled inner sleeve 14 comprising *a metal outer tubular portion 14a* formed with a spacing shoulder at its right hand end flange. Received within the outer portion 14a in a close sliding fit is *an inner tubular portion 14b* ...”). Accordingly, a PHOSITA would have understood that Brooks discloses a tubular battery assembly housing (case 26 of, for example, the disclosed “cigarette holder”-shaped embodiment of controller 14). I further note that Brooks discloses that the controller 14 may also be in the form of a pipe, which Brooks discloses as having a narrow tube with a tubular-shaped bowl at one end. Ex. 1001 at 4:46-49, Figs. 7 and 8.

75. Brooks discloses a sensor (“puff actuated current actuation mechanism 28”, also referred to as “puff actuated switch 28”) within the tubular

battery assembly housing (case 26). Ex. 1002 at 7:20-25, 12:58-13:6, Fig. 2.

Brooks describes “[a] typical puff actuated switch includes a means for sensing the difference in air pressure in a region within the previously described cigarette or disposable cartridge and an “on-off” switch responsive thereto.” *Id.* at 17:46-50.

The puff actuated switch 28 can sense the difference in air pressure or airflow. Ex. 1002 at 13:1-6, 10:42-45, 59-63, 12:47-57.

76. Brooks also discloses an LED (“light emitting diode 81”) electrically connected to the electrical circuitry. Ex. 1002 at 11:35-41 (“A light emitting diode 81 is positioned near the differential switch 28. The diode 81 is electrically connected to the electrical circuitry ... such that it emits light during draw. As such, the user has a visual means for identifying periods when current passes through the resistance heating element 18.”); Fig. 3. Brooks discloses that the embodiments illustrated in Figs. 2 and 3 are generally similar with respect to the light emitting diode 81, and thus the PHOSITA would have understood that the LED can be used in the Fig. 2 embodiment as well. *Id.* at 11:20-25 (“Referring to FIG. 3, the illustrated embodiment is generally similar to the embodiment of FIG. 2, except that the controller or power pack 14 includes a flexible, cord-like connector 72 [].”).

77. The 205 patent describes a microcircuit 206, which the PHOSITA would have understood to be encompassed by the claimed “micro-controller unit.”

⁵ Ex. 1001 at 4:25-35 (“Microcircuit (206) scans the sensor (207) in the power-saving mode of pulse, and according to the signal parameters of the sensor (207), restricts the atomizing capacity with the integral function of frequency to single operation time. Also, the microcircuit (206) accomplishes the pulse width modulation and over discharging protection for the constant power output [.]”) In order to encompass the embodiment disclosed in the 205 patent, the term “microcontroller unit” should be construed to encompass a microcircuit. To the extent the Patent Owner argues that Brooks’s control circuit is not a microcircuit or micro controller unit, it would be obvious to use that known technology as the control circuit.

78. Brooks further discloses a micro-controller unit (“time-based current control circuit 30,” as referred to as “time-based current regulating circuit”). Ex. 1002 at 7:20-25, 13:7-61; Fig. 2. The time-based current regulating circuit disclosed in Brooks performs functions similar to those of the microcircuit 206 in the 205 patent. The time-based current regulating circuit “generates a periodic digital wave having a preset on-off duty cycle, ... to control the temperature range

⁵ For purposes of this declaration, I am offering no opinion as to whether the 205 patent provides adequate written support or enablement for the claimed “micro-controller unit.”

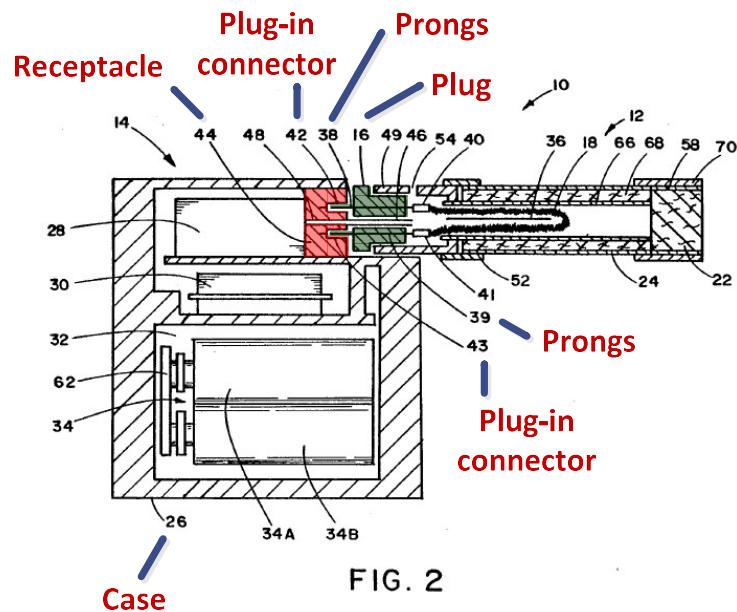
experienced by the resistance heating element” and “control[s] the passage of current through the resistance element during periods of current actuation.” *Id.* at 12:43-46; 13:62-14:2, 10:42-58; *see also* claims 97 (the time-based current regulating circuit “generat[es] a pulse train having a predetermined duty cycle,” and “enabl[es] and disable[es] current flow to the heating element in response to the pulse train from the timer means”), 104, 161-202. Accordingly, the “time-based current regulating circuit 30” in Brooks constitutes a “micro-controller unit” since it regulates the electricity flow through the device. Brooks’ “time-based current regulating circuit 30” regulates the electricity flow through the device.

79. Brooks discloses that the battery (“batteries 34A and 34B”), the sensor (“puff actuated current actuation mechanism 28”) and the LED (“light emitting diode 81”) are electrically connected to the micro-controller unit (the “time-based current regulating circuit 30”). Ex. 1002 at 9:51-56 (“Controller 14 also preferably includes a control circuit 30, which is connected to a puff actuated, differential pressure sensitive switch 28 by electrically conductive wires (not shown), as well as to batteries 34A and 34B via battery terminal 62. The control circuit 30 preferably is time based.”), 11:35-41 (“A light emitting diode 81 [] is electrically connected to the electrical circuitry”), Figs. 9, 10. A PHOSITA would have understood that electrical circuitry that comprises control circuit 30 is housed upon and electrically linked using one or more circuit boards. *See* Ex. 1002 at

Figs. 9, 10. A PHOSITA would have understood that the use of pin connectors – a well-known means for linking electrical circuit components to a circuit board – means that a circuit board is used in Brooks. Brooks describes electrical circuitry that is laid out using pin connectors (Ex.1002 at 13:31-51) – a well-known means for linking electrical circuit components to a circuit board that a PHOSITA would presume to be used in association with a circuit board – further establishes that Brooks discloses a circuit board. Indeed, the use of pins in connection with a circuit board was well-known to a PHOSITA. *See, e.g.*, Ex. 1017, Nishihara at 1:20-25 (“In order to connect the semiconductor elements and devices mounted on the printed circuit board to an external circuit, there have been widely used connector pins of such a type that the printed circuit board is clamped by the pins at its peripheral portion from front and rear surfaces.”); Ex.1018, Silbernagel at 1:14-17 (“Multi-pin electrical connectors are widely used for connecting circuit traces on printed circuit boards with other printed circuit boards or with a complementary connector.”).

80. Claim 1.2 recites “a first electrode at an end of the battery assembly housing.” Brooks discloses a first electrode (receptacle 44, including plug-in connectors 42 and 43) located at an end of the battery assembly housing (case 26). Brooks discloses that disposable portion 12 can be detachably connected to a battery assembly through a plug connection that facilitates the flow of electricity

and air. Ex.1002 at 10:34-40 (“the user inserts the plug 16 of the cigarette 12 into the receptacle 44 of the controller 14 ... Such action also provides for airflow communication between the switch 28 and the inner portion of the cigarette.”). Receptacle 44, which includes “plug-in connectors 42, 43 for engagement with prongs 38, 39 of plug 16” (prongs 38, 39 also referred to as “electrical connection pins 85, 86” in Fig. 4), is thus the receiver portion of the plug-in electrical connection portion. *Id.* at 9:41-43, 11:49-51. Accordingly, receptacle 44 (including plug-in connectors 42 and 43) and plug 16 (including prongs 38, 39) constitute a first electrode and a second electrode, respectively. As shown in annotated Fig. 2 below, receptacle 44 together with plug-in connectors 42 and 43 (*i.e.*, “first electrode”) is located at an end of case 26 (*i.e.*, “battery assembly housing”).



81. Claim 1.3 recites “an atomizer assembly comprising an atomizer and a liquid supply in a tubular atomizer assembly housing.” Brooks discloses an atomizer assembly (“disposable portion 12” of the smoking article 10, also referred to as “cartridge” or “cigarette 12.”) Ex. 1002 at 4:7-12, 7:15-16; Fig. 2. The cigarette 12 includes an atomizer assembly housing in the form of tube 68 and collar 49, which houses an atomizer formed by heating element 18 and insulative tube 66. Ex. 1002 at 8:43-36, 11:6-16; 17:28-35; Fig. 2 (annotated below).

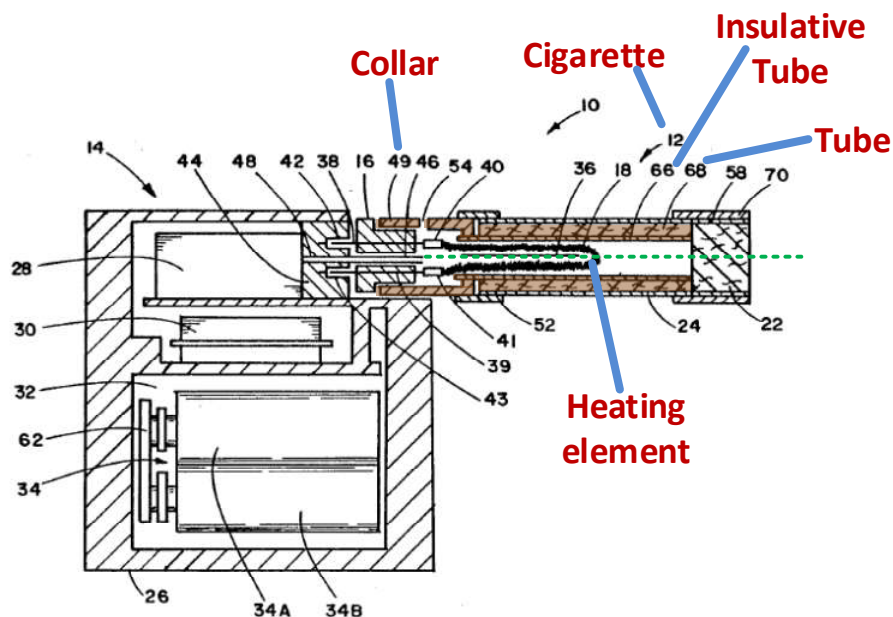


FIG. 2

Brooks also discloses a liquid supply in the atomizer assembly (disposable portion 12) in at least two embodiments. One embodiment stores liquid within a porous heating element, and thus the heating element is the liquid supply. Another embodiment includes a resistance heating component is “in intimate contact” with

a “porous substrate” (*i.e.* the heating element includes a heating resistance component that is distinct from the porous substrate that stores liquid). In this embodiment, both the heating element and the porous substrate are liquid supplies. Ex. 1002 at 7:65-8:3 (“Other suitable heating elements include porous metal wires or films, carbon yarns, clothes, fibers, discs or strips, graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; porous substrates in intimate contact with resistance heating components; and the like), 6:45-52 (the aerosol forming substance can be located “on the resistance heating element or elsewhere in the article.”). The “resistance heating element 18 [carries] an aerosol forming substance.” *Id.* at 7:17-20.

82. Alternatively, and as explained in detail above, it would have been obvious to substitute Whittemore’s coiled heating wire/wick configuration for Brooks’ heating element. Whittemore’s wick D is a liquid supply, and thus adapting Brooks’ heating element by substituting Whittemore’s coiled heating wire/wick configuration also meets the “liquid supply” limitation.

83. To the extent that this claim requires a “liquid supply” distinct from the porous component with a heater coil wound around it, it would have been obvious to a PHOSITA to add such a liquid supply to Brooks to improve the liquid storage capacity of the disposable portion 12 of the Brooks device. In view of Brooks’ own teaching that “holding...large quantities of liquid aerosol forming

substances” is “advantageous,” a PHOSITA would have been motivated to improve upon the liquid storage structures disclosed in Brooks by improving their overall capacity to store liquid. Ex. 1002 at 4:25-31, 10:66-11:5. The motivation may include the avoidance of waste that would result from reducing the frequency of cartridge replacement and disposal. There may be other ways to improve liquid storage capacity that would be obvious to implement in Brooks to a PHOSITA. For example, the porous substrate can be extended with a first section that is wound with heater coil and a second section that is impregnated with liquid but not in contact with the heater coil (*i.e.*, the porous material extends past the heating wire) as disclosed, for example, by Whittemore. The second section can act as a liquid reservoir for the first section. As the PHOSITA would have understood, liquid is vaporized by heat from the coil in the first section proximate the coil, a supply of replacement liquid impregnated within the second section of the porous substrate or wick would flow to the first section via capillary action. Moreover, the PHOSITA would have been familiar with the use of porous materials for holding liquid. Liquid storage methods have been in use in the art of vaporizing devices for decades as evidenced by at least Whittemore and other prior art references. Hayward-Butt teaches a device in which a first section of porous material (a wick) supplies liquid to a second section of porous material (a fibrous absorbent) for volatilization. *See, e.g.*, Ex. 1034 at 1:48-2:7 (“... the means for

feeding the liquid to the chamber for the absorbent may conveniently consist of a wick, one end of which is embedded in fibrous absorbent...[t]he absorbent may consist of other fibrous material or of a coil of the wick itself.”). For the reasons set forth above, modifying Brooks’ substrate (as described in the “intimate contact” embodiment of the heating element 18) or, in the alternative, adapting Brooks to have the heating wire coil/wick configuration of Whittemore would have been a simple modification that would predictably result in a liquid supply and increased liquid storage capacity in the disposable cartridge or cigarette 12 of Brooks, and therefore would have reduced the frequency of removal and replacement.

84. Claim 1.4 recites “with the atomizer including a heater wire coil wound around a porous body, with the heater wire coil and the porous body positioned perpendicular to a longitudinal axis of the tubular atomizer assembly housing.” Brooks in view of Whittemore discloses an atomizer including a heating coil wound around a porous component, with the heater wire coil and the porous body positioned perpendicular to a longitudinal axis of the tubular atomizer assembly housing. As discussed above in ¶¶62-64 *supra*, Brooks discloses the atomizer (“resistance heating element”) includes a heater wire coil (“resistance heating component”) wound around a porous body (“porous substrate”). To the extent that Patent Owner argues that the “intimate contact” heating element of

Brooks somehow does not constitute a heater wire coil wound around a porous body or a heater wire wound in a coil on a part of the porous body as recited in claims 1, 9 and 16, as discussed in ¶¶65-70 *supra*, it would have been obvious for a PHOSITA to modify Brooks' resistance heating component to coil around the porous substrate as taught by Whittemore. Brooks discloses that the heating element may be positioned perpendicular to the longitudinal axis of the air passageway. Ex. 1002, claims 11, 36, 54. Annotated Figures 2 and 4 below illustrate a longitudinal axis of airflow which is the longitudinal axis of the atomizer assembly (red arrows) in Brooks. Accordingly, a PHOSITA would have understood that the heating element including the heater wire coil and the porous body is positioned perpendicular to a longitudinal axis of the tubular atomizer assembly housing in Brooks.

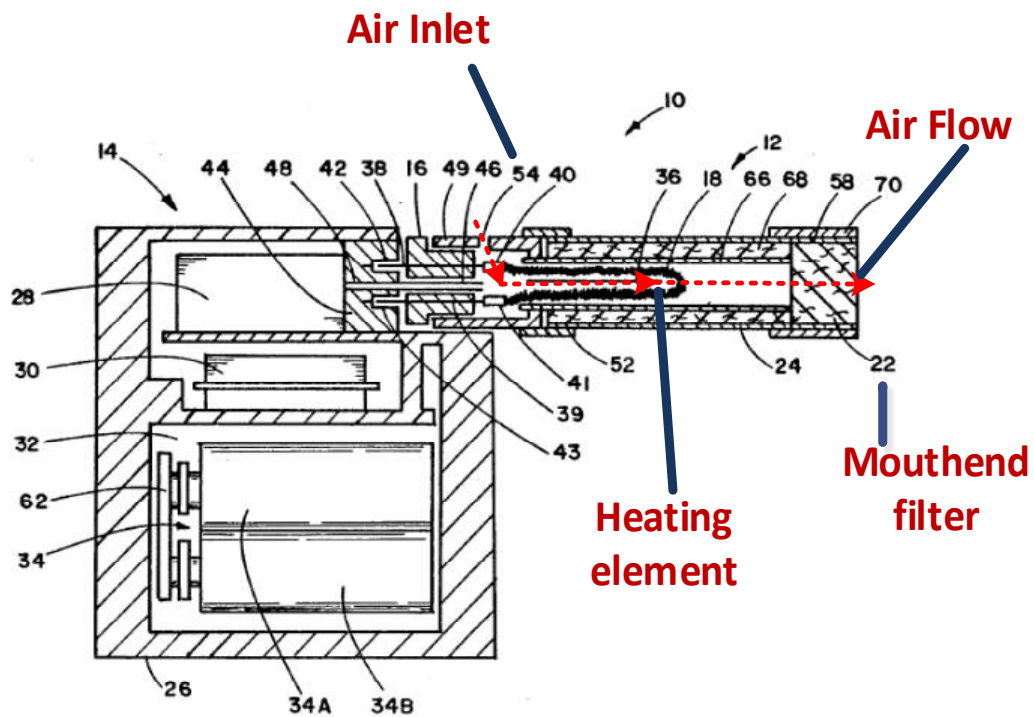


FIG. 2

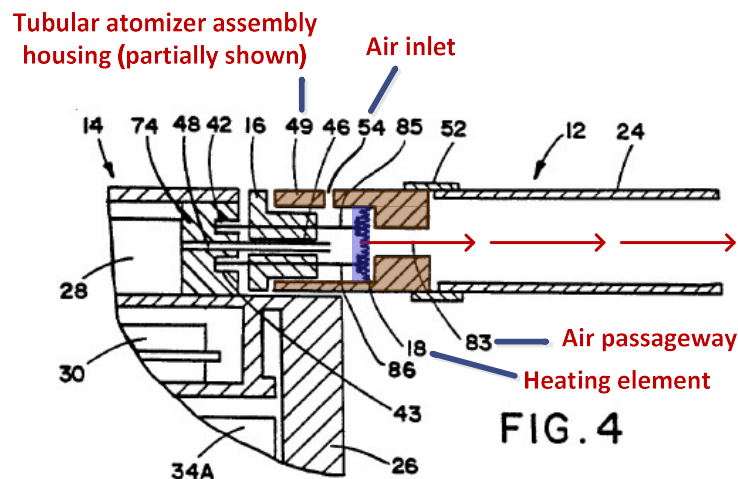


FIG. 4

85. Claim 1.5 recites “the heater wire coil and the porous body in an airflow path through the tubular atomizer assembly housing leading to a suction nozzle wherein air passes across the heater wire coil and the porous body.” Brooks

as modified by Whittemore discloses a heater wire coil and porous body (either the porous substrate of the “intimate contact” embodiment of heating element 18 or Whittemore’s heating wire coil/porous wick configuration) in an airflow path through the tubular atomizer assembly housing leading to a suction nozzle (mouthend of the cigarette), with air passing across the heater wire coil and porous body. Brooks discloses a mouthend of the cigarette, which when puffed by the user, causes air to be drawn through an air inlet (*i.e.*, the mouthend acting as a “suction nozzle”) and an air inlet 54 in the atomizer assembly (“disposable portion 12.”) Ex. 1002 at 10:40-53, 11:46-49; Figs. 2, 4-6 (Fig. 4 is a partial sectional view of the smoking article with the mouthend filter 22 (and other parts) omitted); claims 10, 55. Brooks discloses that “ambient air enters the cigarette through air inlet 54,” the drawn air passes through the heating element 18 and mixes with the aerosol forming substance to form aerosol, and the aerosol passes through an air passageway 83 and “exits the mouthend filter 22 into the mouth of the user.” *Id.* Every figure in Brooks discloses that the heating element is in the airflow path. Ex. 1002, Figs. 1-8. For example, as shown in annotated Figures 2 and 4, the red arrows illustrate an airflow path in the tubular atomizer assembly housing from the inlet (54), across the heating element, and out mouthend filter (22).

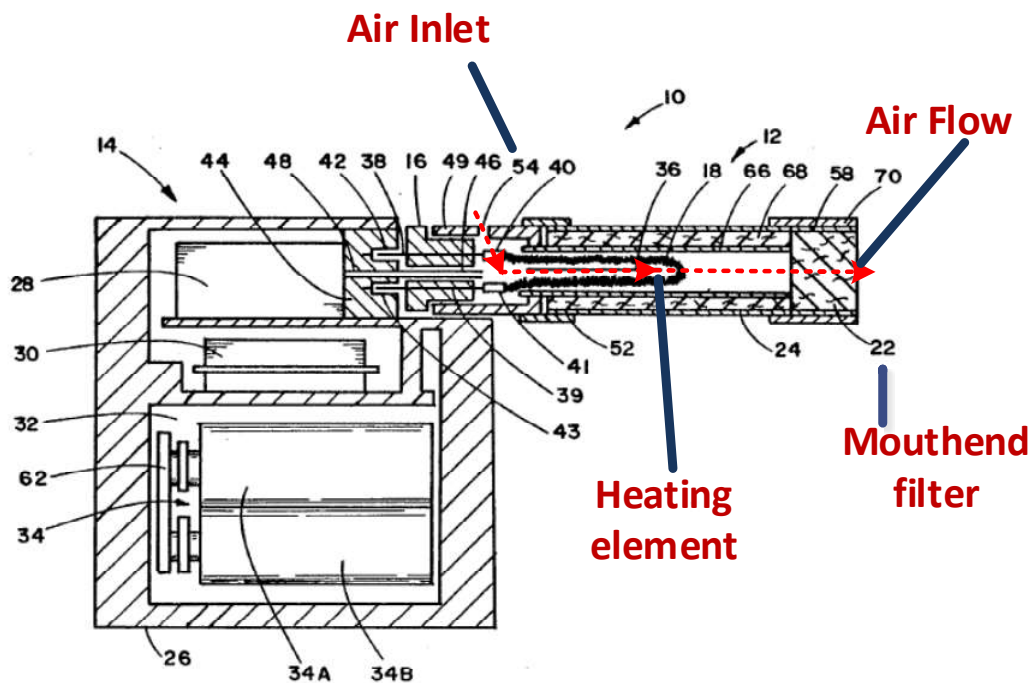


FIG. 2

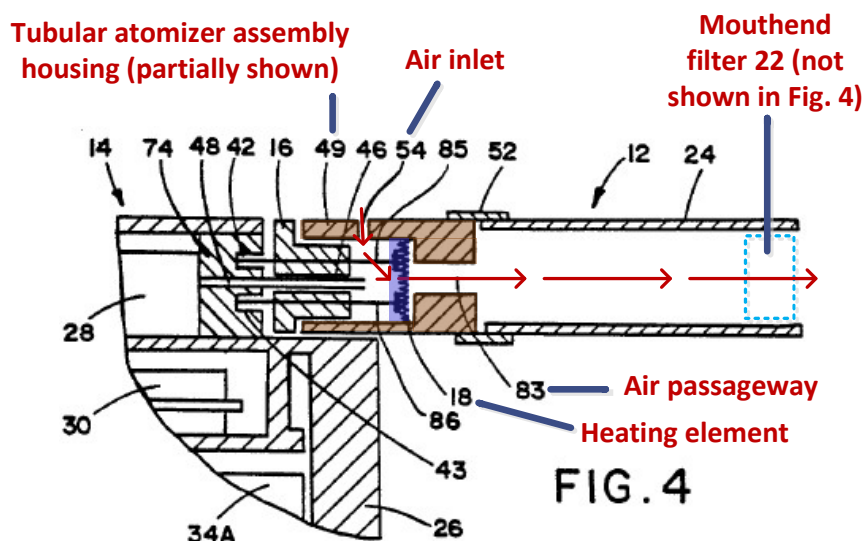


FIG. 4

86. Claim 1.6 recites “a second electrode at an end of the atomizer assembly housing.” Brooks discloses that plug 16 (which includes prongs 38, 39) conducts electricity between the battery assembly (controller 14) and the heating

element, and thus constitutes an electrode. Further, as shown in annotated Fig. 2 below, plug 16 including prongs 38, 39 (*i.e.*, “second electrode”) is located at an end of the atomizer assembly housing (tube 68 and tubular collar 49).

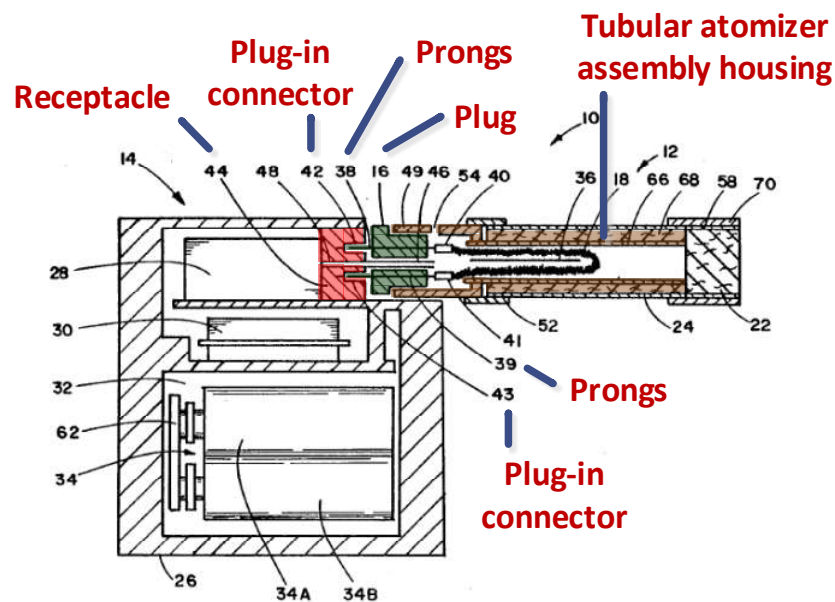
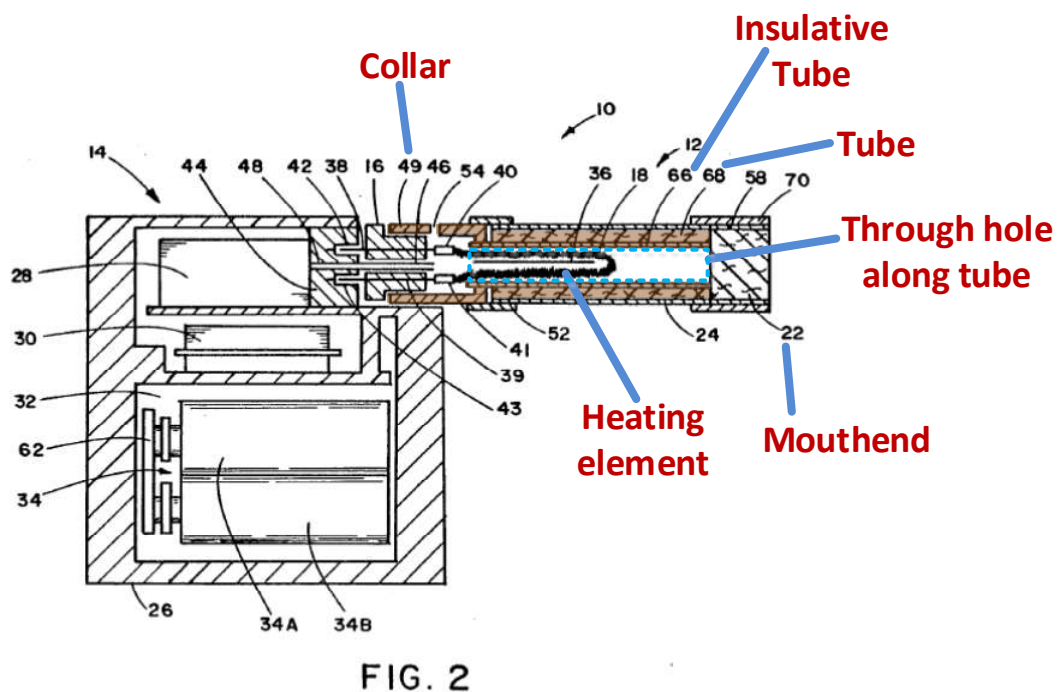


FIG. 2

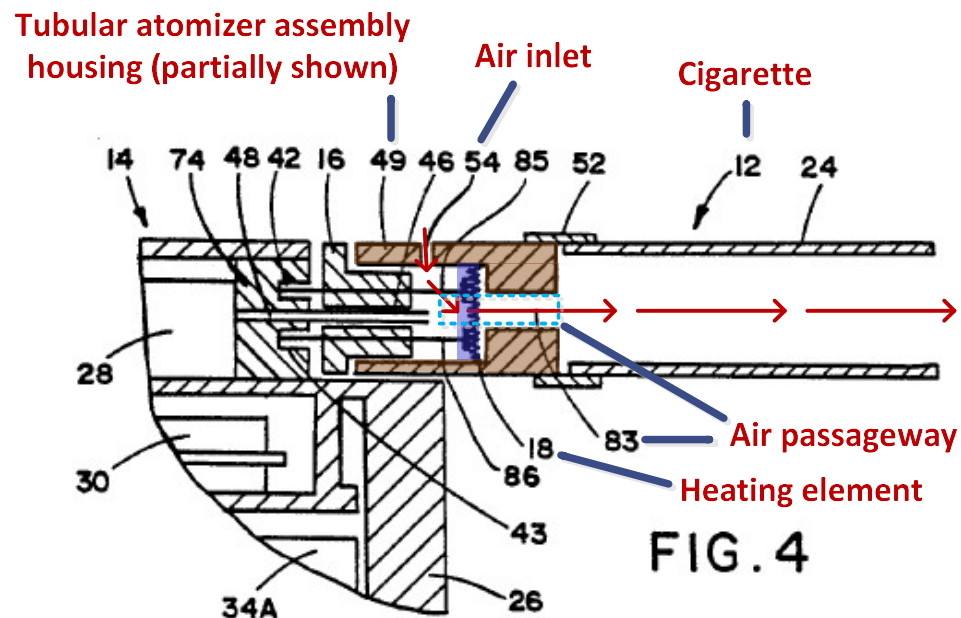
87. Claim 1.7 recites “the battery assembly and the atomizer assembly electrically connected by engagement of the first electrode with the second electrode, and with electricity conducted from the battery to the heater wire coil through the first and second electrodes.” As discussed in claim 1b and 1f *supra*, Brooks discloses the battery assembly (controller 14) and the atomizer assembly (disposable portion 12) electrically connected by engagement of the first electrode (receptacle 44 including plug-in connectors 42, 43) with the second electrode (plug

16 including prongs 38, 39), and with electricity conducted from the battery to the heater wire coil through the first and second electrodes. Ex. 1002 at 8:31-38, 10:34-38; Fig. 2.

88. Claim 2 recites “[t]he device of claim 1 the atomizer further including a through hole aligned with the heater wire coil.” Annotated Figure 2 of Brooks shows a through hole aligned with the with the heater wire coil. Specifically, Figure 2 illustrates that the through hole is formed at the entry of the insulative tube 66 and extends aligned with the heating element 18 along insulative tube 66. The through hole along tube 66 is aligned with the heating element 18.



Annotated Figure 4 illustrates an alternative embodiment of the through hole (air passageway 83) that is aligned with the heating element (heater wire coil). The air passageway 83 is aligned through the heating element 18. Ex. 1002 at 11:42-49.



In annotated Figure 6, Brooks discloses a through hole that is formed within hollow tube 48 through which air passes with the pressure sensing switch 28. Ex. 1002 at 9:41-50. Tube 48 is present in all of the embodiments illustrated in Figs. 1-2 and 4-6, and is shown extending into the atomizer for sensing changes in air pressure. Figure 6 illustrates that the tube may extend through the heating element 18. The tube 48 forms a through hole in the atomizer that is aligned with the heating element 18.

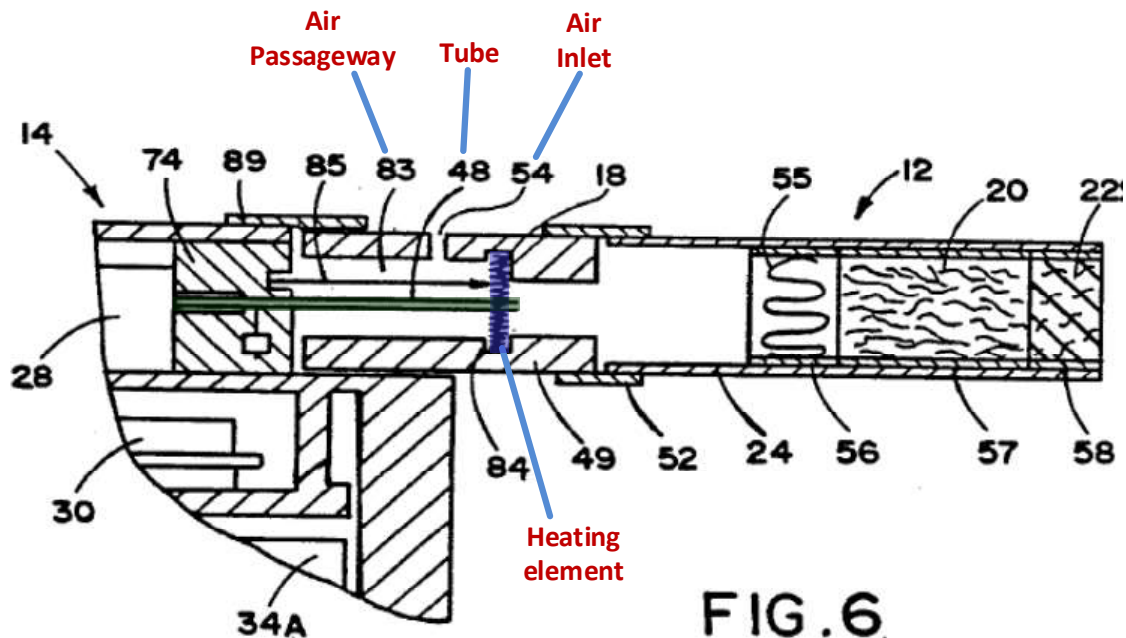
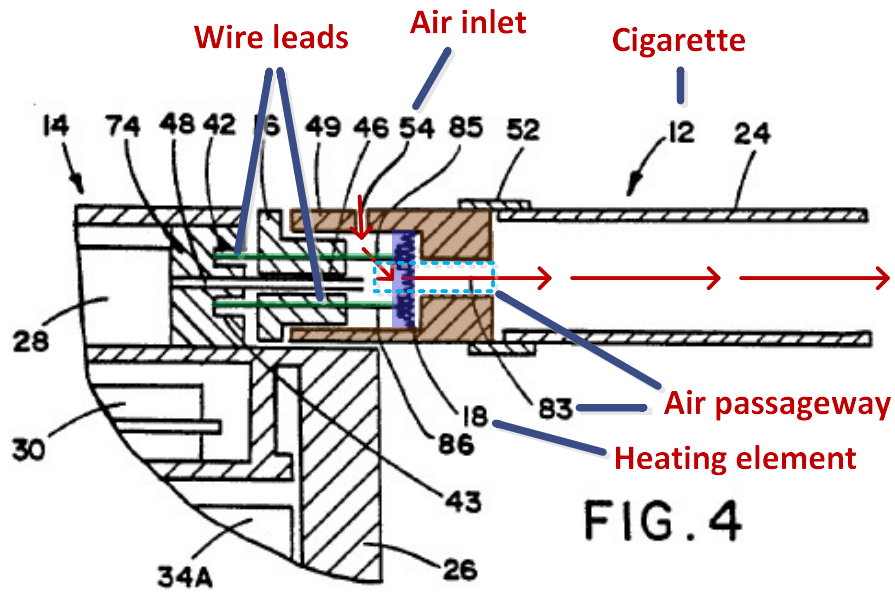


FIG. 6.

89. Claim 3 recites “[t]he device of claim 2 with the through hole centered between spaced apart wire leads of the heater wire coil.” As discussed with respect to claim 2, Brooks discloses a through hole aligned with the heating element. Figures 1-2 and 4-6 of Brooks illustrate a through hole formed by the aperture of tube 48. Tube 48 is centered between spaced apart metal wire leads of the heater element as shown in annotated Figure 4. The tube 48 is centered between the spaced apart wire leads.



The Figures of Brooks depict the tube 48 centered between the wire leads except in Figure 1A. The arrangement of the wire leads is a matter of design choice. A PHOSITA would recognize that the electrical pins 38, 39 of plug 16 (in Figure 2 below) can be arranged differently without changing the function of the heating element 18.

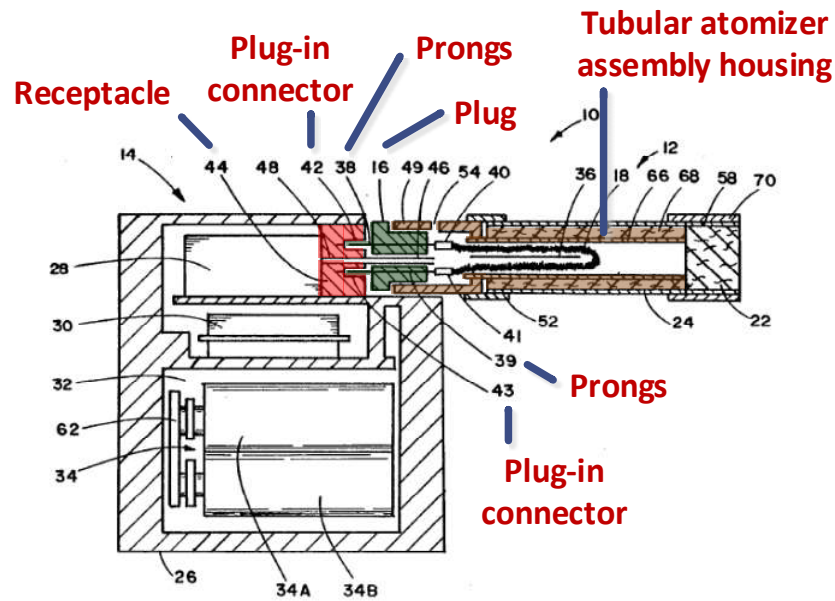


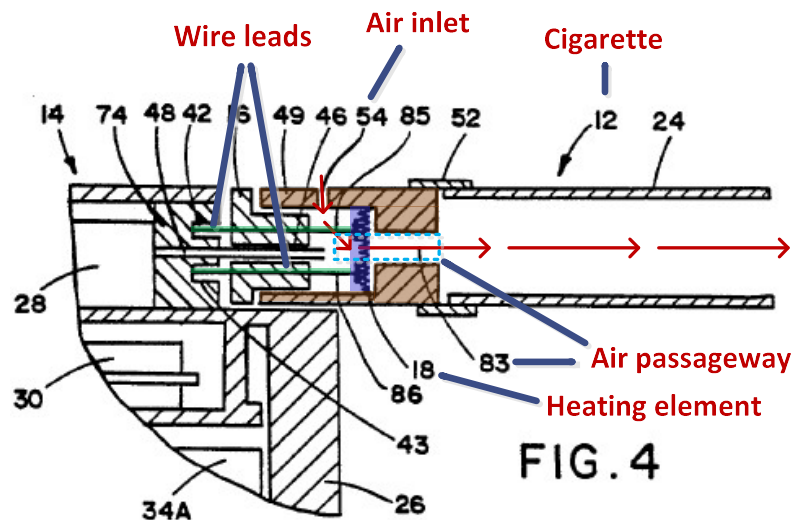
FIG. 2

The function of the plug 16 does not depend on its positioning relative to the tube 48. The wire leads electrically connect the heating element to the battery and can do so regardless of their spacing or arrangement relative to the through hole as long as they do not obstruct another aspect of the device. Further, the positioning of the tube 48 only needs to connect with the sensor 28 and can be positioned differently. The functioning of the sensor 28 and the tube 48 are not impacted based on whether the tube 48 is centered and there is no reason that tube 48 cannot be centered between the wire leads as shown in at least Figure 4. Brooks states that tube 48 can be used as one of the connecting pins. Ex. 1002 at 11:66-12:2. For reasons discussed above, tube 48 could be used for supporting both connecting

pins (*e.g.*, lead wires run along the length of the tube 48) and have a centered configuration that allows the tube 48 to support the lead wire(s) to prevent breakage. Annotated Figure 4 also illustrates that the air passageway which is a run through hole is centered between the spaced apart wire leads. As discussed with respect to claim 2, Figure 2 illustrates that the aperture of tube 66 can also be a through hole. Although tube 66 as shown in Fig. 2 of Brooks is not centered between the spaced apart wire leads for the resistance heater 18, slightly shifting the position of the heating element 18 (*i.e.*, to the right so that a section of the wire leads are located within tube 66 and the aperture of tube 66 is centered between spaced apart wire leads of the heating element) would have been merely a matter of design choice for the reasons discussed above with regard to the tube 48 and the wire leads. Specifically, the relative positioning of the wire leads and the through hole is not significant, and a PHOSITA would know that a shift in positioning of the wire leads relative to the aperture of tube 66 would have no effect on the design or operation.

90. Claim 4 recites “[t]he device of claim 3 with the airflow path further including an air inlet in a side wall of the tubular atomizer assembly housing at the second electrode.” Brooks discloses an airflow path (illustrated by the red arrows in annotated Fig. 4 above) further including an air inlet (air inlet 54) in a side wall (collar 49) of the tubular atomizer assembly housing (tube 68 and tubular collar 49)

at the second electrode (plug 16). Ex. 1002 at 8:50-52, 8:43-46, 8:54-55. 10:40-42. The positioning of the air inlet 54 with respect to plug 16 (the second electrode) that Brooks discloses is very similar to the 205 patent's depiction of the positioning of "air intake hole 502" on the atomizer assembly housing relative to the "internal screwthread electrode." See e.g., Ex. 1001 at 2:32-41, Figs. 3, 5a, 5b. Brooks states that the air inlet may be located "elsewhere through the periphery of the cigarette," which can be "at" the second electrode. Ex. 1002 at 8:54-55.



91. Claim 5 recites "[t]he device of claim 3 further including fiber containing cigarette liquid in contact with the porous body." As discussed in claim 1d *supra*, Brooks discloses that the heating element can be a "porous substrate[]" in intimate contact with [a] resistance heating component[]," which a PHOSITA would have understood could include a wick wrapped with a wire as in Whittemore. Ex. 1002 at 7:65-8:3. A PHOSITA also would have understood that

the resistance heating component could be made from fiber and will hold the liquid. Brooks discloses several different resistance heating component materials capable of holding liquid including “carbon yarns, cloths, fibers, discs or strips,” or carbon fiber. *Id.* at 7:65-8:3. Each of these are fibers that hold the liquid. *Id.* at 8:1-8, 4:22-29. Brooks discloses that the wire coil may include “carbon fiber yarn” where the carbon fiber is impregnated with glycerin (cigarette liquid). Ex. 1002 at 18:36-40 (“Kynol Catalog No CFY-0204-2 carbon fiber yarn having a length of about 32 nm had a resistance of 18 ohms was used to prepare a heat generating electrical resistance element. The yarn had 19 µl of glycerin applied thereto.”); *see also* Ex. 1002 at 4:18-25, 7:65-8:3, 12:18-23; claims 8, 9, 16, 33, 34, 41, 58, 59, 60, 79, 109-12, 139-142. Brooks thus discloses fiber (resistance heating component of the heating element, made of fiber or carbon fiber) containing cigarette liquid (liquid aerosol forming substance) in contact with the porous body (porous substrate of the heating element) or, in the alternative, adapting Brooks to have a heating wire coil/wick configuration as taught by Whittemore. A PHOSITA would have understood that the wick materials (thread, string, or strand) all identified in Whittemore were formed of fiber. Ex. 1003 at 2:8-10, claim 11. For example, the Dictionary defines the term “wick” as “a bundle of fibers or a loosely twisted, braided, or woven cord, tape, or tube usu. of soft spun cotton threads that by capillary attraction draws up to be burned a steady supply of the oil

in lamps or the melted tallow or wax in candles.” Ex.1049. Similarly, the Dictionary defines the term “thread” as “a filament, a group of filaments twisted together, or a filamentous length formed by spinning and twisting short textile fibers into a continuous strand.” *Id.* Similarly still, other prior art references disclose that a “wick used for drawing up the fuel is a string-like one obtained by twisting fibers.” Ex.1052, U.S. Pat. No. 6,217,315 to Mifune et al., col. 1:48-49. Thus, from the plain definitions of these terms and at least one other contextual prior art reference, a PHOSITA would have understood that Whittemore’s wick materials (thread, string, or strand) are formed of fibers. Modifying the Brooks smoking article to include a fiber in contact with the porous body of the heating element as a reservoir for liquid aerosol forming substance would have no adverse effect on the operation of the device. The heating element would function the same but with additional liquid provided to it from the fiber via capillary action. Indeed, this modification provides an improved Brooks device, that is, extended life for the disposable portion.

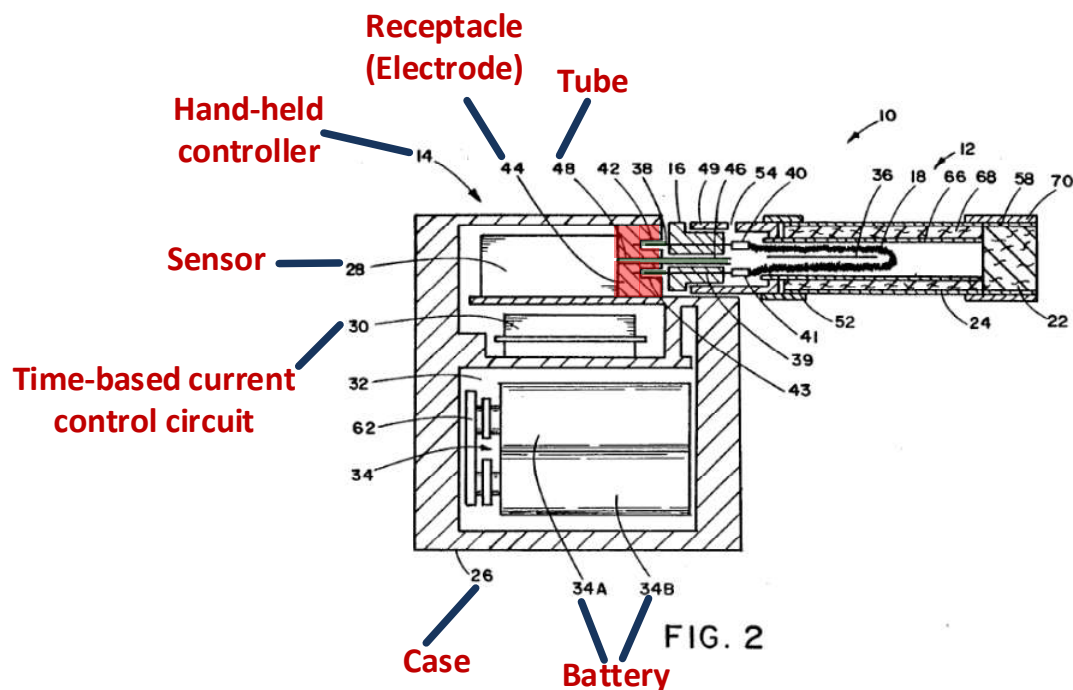
92. The combination of Whittemore with Brooks include a separate liquid supply which can extend the life of Brooks by increasing the amount of liquid available for the disposable cartridge. Brooks discloses that the heating element is impregnated with aerosol forming substance sufficient for 6-10 puffs. Thereafter, the “aerosol delivery drops below the level desired by the user,” and a new

disposable portion (cigarette) 12 needs to be inserted into the reusable controller in order to repeat the smoking process. Ex. 1002 at 6:32-36, 10:66-11:5. A PHOSITA would recognize the need to combine the liquid reservoir of Whittemore with the cigarette in Brooks to extend the life. The liquid supply may include extending a portion of the porous substrate of Brooks' intimate contact embodiment beyond the heating element 18 or adapting Brooks with the configuration disclosed by Whittemore, where the wick extending beyond the heating wire coil is a liquid supply. Brooks' porous substrate or Whittemore's wick that can extend beyond the coiled heating wire is a liquid supply that includes fiber containing cigarette liquid. The extending portions of the substrate or wick are thus a "fiber containing liquid in contact with the porous body" consisting of the portion of the porous substrate or wick, respectively, that is wrapped in coiled heating wire. Whittemore discloses a liquid reservoir D at the portion of the wick that extends beyond the heating coil. Another obvious design choice would be to include a replenishing cigarette liquid reservoir D as suggested by Whittemore, which is in contact with the porous body of the atomizer. The reservoir may be a replenishing cigarette liquid reservoir as suggested by Whittemore, which is in contact with the porous body of the atomizer for extending the life of the cartridge. It was well-known in the art to store replenishing cigarette liquid in fiber to prevent leakage and spillage. For example, Chinese Pat. No. 2719043Y ("Hon 043," Ex.

1022; English translation, Ex. 1023) discloses an atomizer with a porous body 36 in contact with a fiber containing cigarette liquid contained within liquid-supplying bottle 11. Ex. 1023 at p. 9, ll. 3-6, 11-13, 22-24; Fig. 1; p. 10, ll. 1-5 (“A solution storage porous body 28 is provided in the liquid-supplying bottle, and can be filled with polypropylene fiber, terylene fiber or nylon fiber [].” *Id.* at p. 10, ll. 1-5. The liquid stored in the fiber containing cigarette liquid of porous body 28 is transported to the porous body 36 via capillary action. *Id.* at p. 11, ll. 6-8. *See also* Ex. 1024 (US6,598,607), col. 2:44-47; Ex. 1025 (US4,793,365), col. 10:51-66; Ex. 1026 (US5,203,355), col. 9:36-52; Ex. 1027 (US2,472,282), col. 3:29-32; Ex. 1028 (US2,032,695), col. 1:46-48.

93. Claim 6 recites “[t]he device of claim 1 with the sensor in between a pressure balancing hole in the battery assembly housing and the first electrode.” Brooks discloses “a passageway 46” in the battery assembly housing (case 26), “through which tube 48 from pressure sensing switch 28 extends”. Ex. 1002 at 8:38-40, Fig. 2 (annotated below). The tube 48 allows airflow communication between the internal regional of the cigarette 12 and the pressure sensing switch 28 (“sensor”), thus constitutes a pressure balancing hole. *Id.* at 9:43-50, Fig. 2. The tube 48 acts to transmit the pressure downstream of the intake port 54 to the sensor 28. A pressure change at one end of tube 48 results in a flow of air to the sensor 28. In my opinion, the physical arrangement of the pressure balancing hole (tube

48) relative to the sensor and the first electrode has no bearing on the operation of the device. It is clear from Brooks that tube 48 is present to provide “airflow communication with the internal region of the cigarette” and the sensor 28. *Id.* at 9:43-50, Fig. 2. The physical location of the tube 48 relative to the sensor and the first electrode would not adversely affect the operation of the Brook’s device.



94. Brooks confirms that differential pressure sensors were well-known in the art before the claimed priority date of the 205 patent. Ex. 1002, 12:58-13:6 (Identifying numerous options including a “preferred puff actuated switch 28 is a pressure differential switch such as Model No. MPL-502-V, range A, from Micro Pneumatic Logic, Inc., Ft. Lauderdale, Fla.”), 17:46-48; Ex. 1007-1010, 1050-1051, and 1053-1054. Paragraphs 53-54 above further describe the pressure

differential switch. It was also well-known that in order for such differential sensors to accurately detect differences in air pressure induced by particular external events such as inhalation, a mechanism for equalizing pressure on both sides of the sensor is necessary to compensate for pressure build-up in the housing. It is well-known in the art that one simple solution to this pressure build-up problem was to include one or more small holes in the housing for the sensor in order to expose it to ambient air and thus equalize the standby pressure on both sides of the sensor. The pressure differential switch disclosed in Brooks provides a small hole that operates as equalization pressure balancing port. Ex. 1007-1010, 1050-1051, and 1053-1054. A PHOSITA would have known that that in order for the pressure sensor (*i.e.*, puff actuated switch 28) of Brooks to work properly it must have some mechanism for equalizing pressure on both sides of the sensor 28 to compensate for pressure build-up in the housing, which could easily be achieved with a pressure balancing hole in controller 14 which is shown in Brooks' preferred pressure differential switch Model No. MPL-502-V. Ex. 1007-1010, 1050-1051, and 1053-1054. An obvious and logical place to locate the pressure balancing hole would be on the side of the controller housing 14 where the pressure equalization port of the puff actuated switch 28 is located. In the MPL-502-V, the equalization port is on one side of the pressure switch and the sensing port is on the other. Thus, the pressure balancing hole in Brooks logically would

be placed on the side of the sensor opposite from the electrodes. However, the location of the pressure balancing hole relative to the first electrode does not change the operation of the pressure balancing hole. A PHOSITA would have understood that the location of the pressure balancing hole would be decided based on its proximity to the relief port on the sensor so that ambient air may enter the balancing hole and make its way to the relief port, and the other consideration would be design convenience as long as it serves its purposes. A modification to Brooks' battery casing would not have an adverse effect on the operation on the device because air would still be drawn across the heating element from inlet 54. Ex.1002 at 8:53-57 (. . . such that drawn ambient air passing through the cigarette to the mouth of the user passes the resistance element.) Adding an air inlet to the battery side of the device would have improved the operation of the device by exposing the sensor to ambient pressure and thus avoiding accuracy degradation resulting from gradual pressure build-up. This small, easily-made change (as taught by Tohyama, Ex. 1032 and Bang, Ex. 1033), addresses deficiencies well known to a PHOSITA when the sensor is located in a compartment without access to the atmosphere.

95. Claim 7 recites “[t]he device of claim 1 with the first electrode contacting the second electrode regardless of an angular orientation of the battery assembly relative to the atomizer assembly.” Brooks discloses an embodiment in

which the first electrode contacts the second electrode regardless of the angular orientation of the battery assembly. Specifically, Brooks discloses an embodiment in Figure 3, otherwise similar to that depicted in Fig. 2, in which “the controller or power pack 14 includes a flexible, cord-like connector 72 which terminates in a plug 74 having prongs 76, 77 for electrical connection into a receptacle 79 at one end of cigarette 12.” Ex.1002 at 11:20-25. Tube 48 “can be incorporated into the cord-like connector 72 and extend into the cigarette through the receptacle 79,” in order to facilitate detection of changes in pressure due to inhalation. *Id.* at 11:29-31.

angular orientation of the battery assembly (controller 14) relative to the atomizer assembly (disposable portion 12).

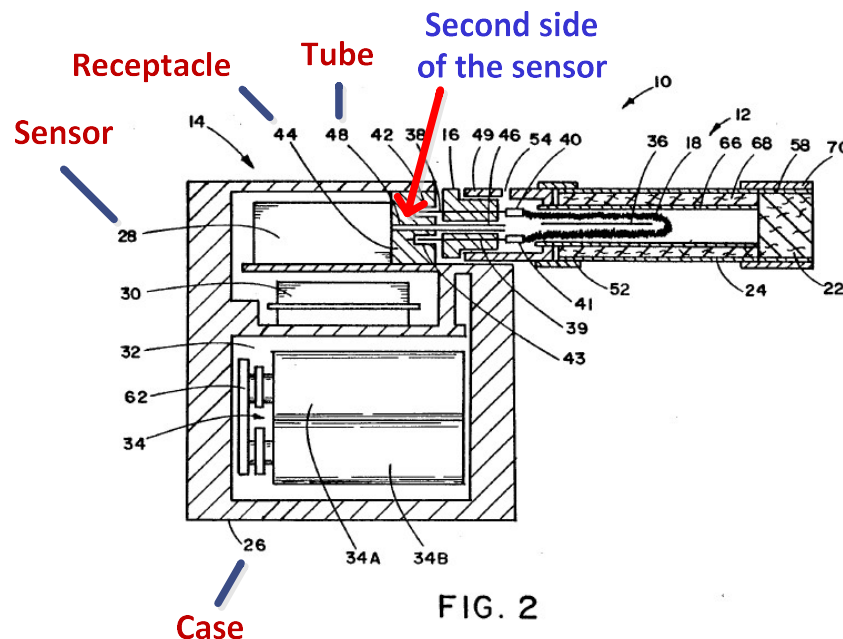
96. Claim 8 recites “[t]he device of claim 1 with the first electrode contacting the second electrode with the battery assembly at any angular orientation relative to the atomizer assembly.” Claim 8, as with claim 7, recites the first electrode contact the second electrode regardless of the angular relationship between two assemblies. As discussed above with respect to claim 7, the first electrode contacts the second electrode with the battery assembly at any angular orientation relative to the atomizer assembly.

97. Claim 9.Preamble recites “A vaporizing device comprising.” *See* claim 1.P above at *supra* ¶¶72.

98. Claim 9.1 recites “a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit within a tubular battery assembly housing.” *See* claim 1.1 above at *supra* ¶¶73-79.

99. Claim 9.2 recites “having a pressure balancing hole on a first side of the sensor, and a first cavity in the tubular battery assembly housing on a second side of the sensor opposite from the first side of the sensor.” *See* claim 6 above at *supra* ¶¶93-94. Brooks discloses a pressure balancing hole on a first side of the sensor, and discloses a first cavity in the tubular battery assembly housing (the portion of tube 48 within case 26) on a second side of the sensor (pressure sensing

switch 28) opposite from the first side of the sensor. Brooks discloses that receptacle 44 of controller 14 (the tubular battery assembly) “also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette.” Ex.1002 at 9:43-46. The hollow interior of tube 48 thus constitutes a “first cavity in the tubular battery assembly housing.” As shown in the annotated Fig. 2 below, Brooks further discloses that the “first cavity” (*i.e.*, the hollow interior of tube 48) is on a second side of the sensor (pressure sensing switch 28), in order to provide the airflow communication necessary for the sensor to detect inhalation-induced changes in air pressure in the disposable portion. Ex.1002 at 9:46-50 (“The other end of tube 48 is in airflow communication with pressure sensing switch 28, so that changes in air pressure which occur within the cigarette during draw can be sensed by the switch.”)



100. Claim 9.3 recites “an atomizer assembly comprising an atomizer and a second cavity in a tubular atomizer assembly housing, with the first cavity connecting into the second cavity.” *See* claim 1.3 above at *supra* ¶¶81-83. Brooks further discloses “a second cavity in a tubular atomizer assembly housing” with tube 48 of receptacle 44 that slides into and through passageway 46 of plug 16, which is located within the atomizer assembly housing when the controller and disposable portions of the device are connected. *See, e.g.,* Ex.1002 at 9:43-46 (“Receptacle 44 also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette.”); 8:38-40 (“Plug 16 also includes a passageway 46 through which tube 48 from pressure sensing switch 28 extends.”).

101. Claim 9.4 recites “the atomizer including a heater wire coil wound on a porous body, and the heater wire coil and the porous body perpendicular to a longitudinal axis of the tubular atomizer assembly housing.” *See* claim 1.4 above at *supra* ¶84.

102. Claim 9.5 recites “the heater wire coil and porous body in an airflow path through the tubular atomizer assembly housing wherein air flows across the wire coil and the porous body.” *See* claim 1.5 above at *supra* ¶85.

103. Claim 9.6 recites “the battery assembly and the atomizer assembly electrically connected via a first electrode at a first end of the battery assembly

contacting a second electrode at a first end of the atomizer assembly with the battery assembly at any angular orientation relative to the atomizer assembly.” *See* claims 1.1, 7, and 8 above at *supra* ¶¶73-79, and 95-96.

104. Claim 10 recites “[t]he vaporizing device of claim 9 with the airflow path passing through a through hole in the atomizer.” *See* claims 2 and 4 above at *supra* ¶¶88, 90. Specifically, Brooks discloses an airflow path (illustrated in red arrows) passing through a through hole in the atomizer (tube 66 in Fig. 2, and air passageway 83 or tube 48 in Figs. 4 and 6) in the atomizer. Ex. 1002 at 9:43-36 (“tube 48 [] is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette”), 5:68-6:4 (“This electrical communication means... preferably includes an air passageway used in conjunction with the preferred puff actuated current actuation means”), 11:25-31.

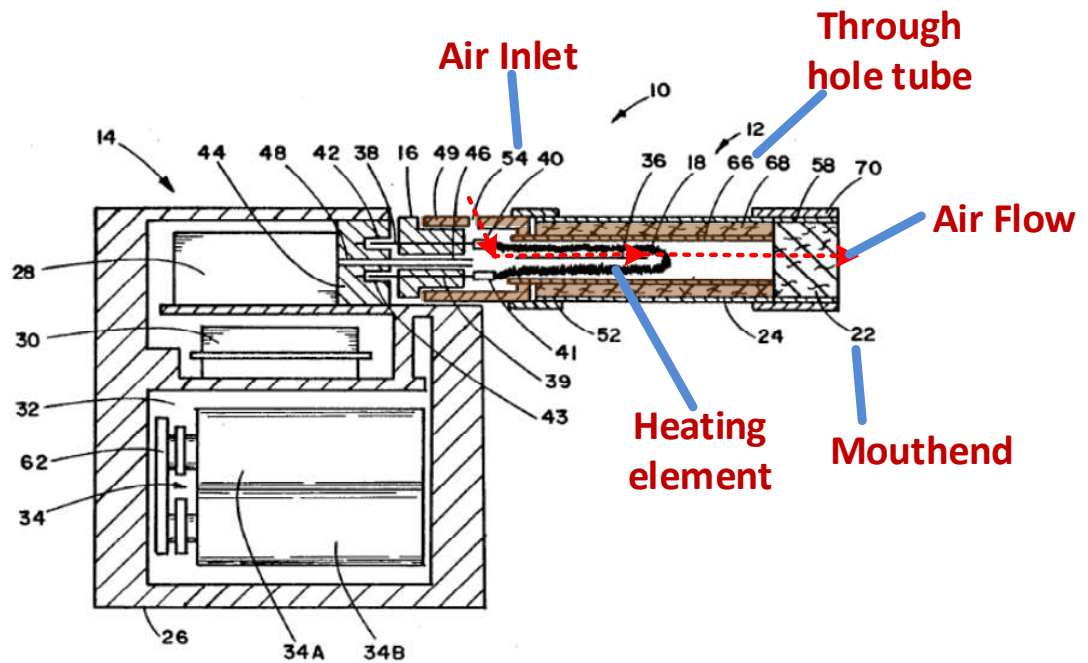


FIG. 2

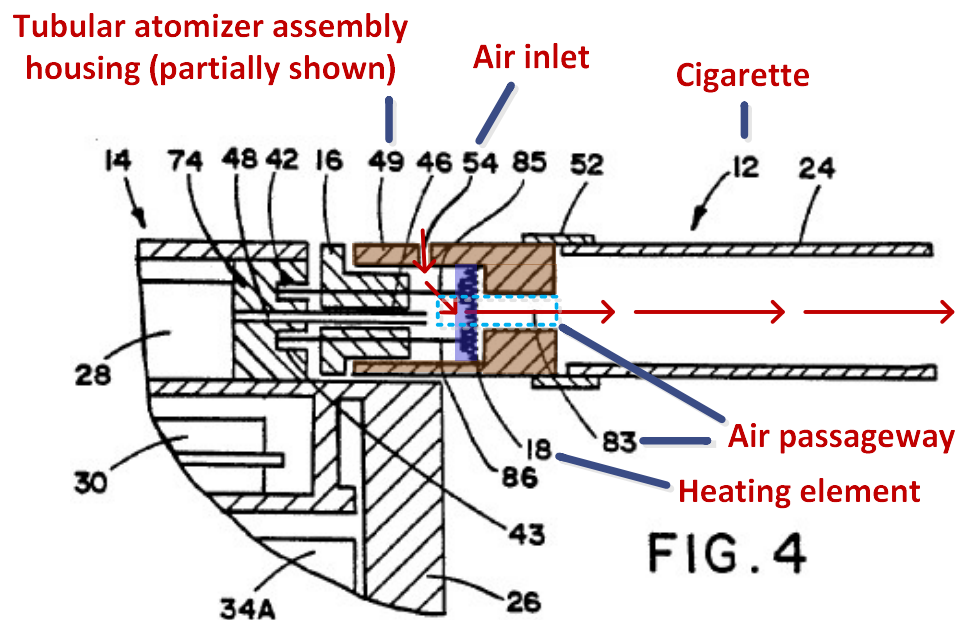
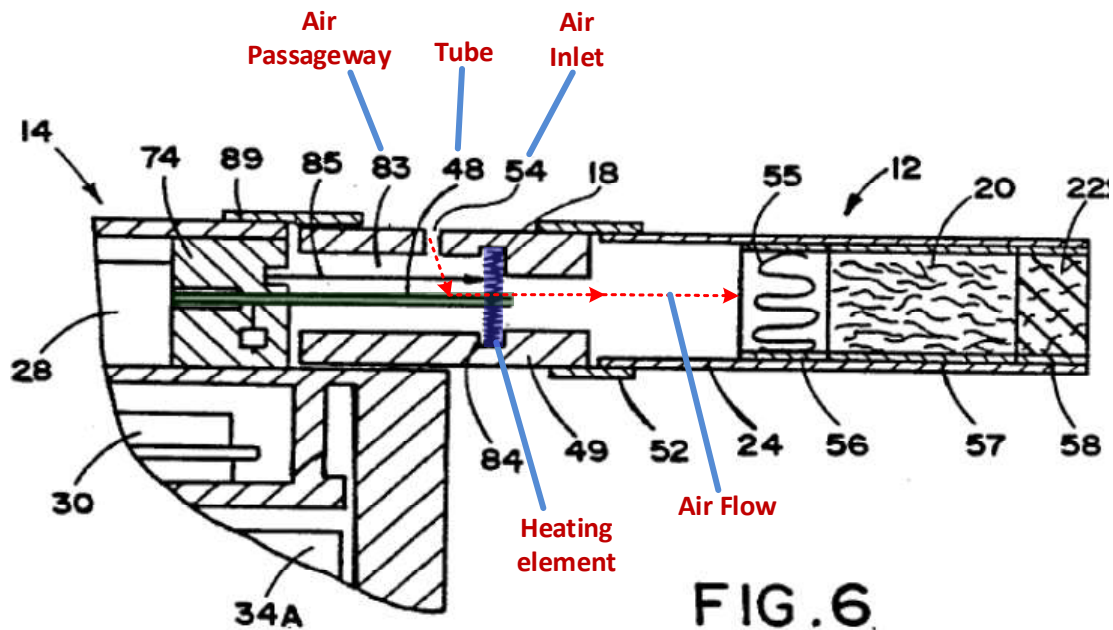


FIG. 4



105. Claim 11 recites “[t]he device of claim 10 wherein the heater wire coil is on a central section of the porous body.” See claim 1.4 above at *supra* ¶84. The combination of Whittemore with Brooks includes a heater wire coil wound on a porous body. A PHOSITA would have recognized that the heating wire coil can be located on the central section (and other sections) of the porous body. The PHOSITA would have put the wire coil at a central section of the porous body to center the vaporization portion of the heating element in the airflow passageway, which frees the external portions of the porous wick so that they can be used as liquid reservoirs or provide a bridge for transporting liquid from a liquid reservoir to the vaporization portion. Whittemore teaches a vaporization device having the heating wire on a central section of the porous material in the path of airflow through the device. Ex. 1003, Figs 2 and 3, 1:53-2:8, 2:26-34, claim 3.

106. Claim 12 recites “[t]he device of claim 11 with the through hole between spaced apart wire leads of the heater wire coil.” *See* claim 3 above at *supra* ¶¶89.

107. Claim 13 recites “[t]he device of claim 12 with the airflow path further including an air inlet in a side wall of the tubular atomizer assembly housing adjacent to the second electrode.” *See* claim 4 above at *supra* ¶90.

108. Claim 14 recites “[t]he device of claim 12 further including fiber containing a cigarette liquid in contact with the atomizer.” *See* claim 5 above at *supra* ¶¶91-92.

109. Claim 15 recites “[t]he device of claim 12 wherein the porous body provides capillary action.” *See* claim 1.4 above at *supra* ¶84. The combination of Brooks and Whittemore discloses a liquid-impregnated porous substrate or wick (the porous body) in contact with a resistance heating component. Whittemore expressly discloses that the wick moves the liquid through capillary action. *Ex. 1003 at 1:50-2:7*. A PHOSITA would have understood that the wick materials (thread, string, or strand) all identified in Whittemore would provide capillary action. *Id. at 2:8-10, claim 11*. For example, the Dictionary defines the term “wick” as “a bundle of fibers or a loosely twisted, braided, or woven cord, tape, or tube usu. of soft spun cotton threads that by capillary attraction draws up to be burned a steady supply of the oil in lamps or the melted tallow or wax in candles.”

Ex.1049. Similarly, the Dictionary defines the term “thread” as “a filament, a group of filaments twisted together, or a filamentous length formed by spinning and twisting short textile fibers into a continuous strand.” *Id.* Similarly still, other prior art references disclose that a “wick used for drawing up the fuel is a string-like one obtained by twisting fibers.” Ex.1052, U.S. Pat. No. 6,217,315 to Mifune et al., col. 1:48-49. Thus, from the plain definitions of these terms and at least one other contextual prior art reference, a PHOSITA would have understood that Whittemore’s wick materials (thread, string, or strand) provide capillary action.

110. A PHOSITA would have understood that this disclosure in Brooks of depletion of liquid impregnated within a porous fiber material through repeated heat-induced vaporization inherently discloses that the porous material “provides capillary action.” This is because, as liquid in the portions of the porous fiber material closest to the heat source is vaporized, liquid impregnated within portions of the fiber material further from the heat source would necessarily move through minute holes in the fiber to areas of lower liquid concentration; in other words, the liquid would move via capillary action. Brooks also discloses heating element materials that may be a fiber, which a PHOSITA would understand provides capillary action. Ex.1002 at 7:26-30. When the device has been actuated by inhalation, heat generated by the flow of electricity through the heating component volatilizes the impregnated liquid to form aerosol or vapor, and that this process

continues until the liquid is depleted to the point that the device user is dissatisfied with the production of aerosol/vapor, and replaces the disposable portion. *See*, e.g., Ex.1002 at 10:45-68.

111. Claim 16.Preamble recites “A vaporizing device comprising.” *See* claim 1.1 above at *supra* ¶¶73-79.

112. Claim 16.1 recites “a battery assembly comprising battery, a sensor, and a micro-controller unit electrically connected to a circuit board within a battery assembly housing, and a first electrode at a first end of the battery assembly housing.” *See* claim 1.1 above at *supra* ¶¶73-79.

113. Claim 16.2 recites “an atomizer assembly comprising an atomizer and liquid absorbed in fiber material in a tubular atomizer assembly housing, and a second electrode at a first end of the atomizer assembly.” *See* claims 1.3, 1.5, and 5 above at *supra* ¶¶81-83, 85, and 91-92.

114. Claim 16.3 recites “the atomizer including a porous body in physical contact with the fiber material.” *See* claims 1.3 and 5 above at *supra* ¶¶81-83 and 91-92.

115. Claim 16.4 recites “the atomizer including a heater wire wound in a coil on a part of the porous body which is perpendicular to a longitudinal axis of the tubular atomizer assembly housing.” *See* claim 1.3 above at *supra* ¶¶81-83.

116. Claim 16.5 recites “an airflow path through a through hole of the atomizer located between spaced apart wire leads of the heater wire coil, and the heater wire coil and the porous body in the airflow path, wherein air flows across the wire and porous body.” *See* claims 1.4, 2, and 3 above at *supra* ¶¶84 and 88-89.

117. Claim 16.6 recites “the battery assembly electrically connected to the atomizer assembly via the first electrode contacting the second electrode.” *See* claim 1.6 above at *supra* ¶86.

118. Claim 17 recites “[t]he device of claim 16 with the airflow path further including an air inlet in a side wall of tubular atomizer assembly housing adjacent to the first end of the tubular atomizer assembly housing.” *See* claim 4 above at *supra* ¶90.

119. Claim 18 recites “[t]he device of claim 16 with the sensor in between a pressure balancing hole in the tubular battery assembly housing and the first electrode.” *See* claim 6 above at *supra* ¶¶93-94.

120. Claim 19 recites “[t]he device of claim 16 with a central axis of the through hole bisecting the heater wire coil.” *See* claims 2 and 3 above at *supra* ¶¶88-89.

121. Claim 20 recites “[t]he device of claim 19 further including a first cavity in the battery assembly connecting into a second cavity in the atomizer assembly.” *See* claims 1.1, 9.1 and 9.2 above at *supra* ¶¶73-79 and 97-98.

122. Claim 21 recites “[t]he device of claim 16 with the first electrode contacting the second electrode with the battery assembly at any angular orientation relative to the atomizer assembly.” *See* claims 7 and 8 above at *supra* ¶¶95-96.

123. Claim 22 recites “[t]he device of claim 21 wherein the porous body provides capillary action” as shown in Ex. 1003 at p. 4:11 and p. 5:25-26. *See* claim 15 above at *supra* ¶¶108-109.

124. As illustrated in the claim chart below, the combination of Brooks and Whittemore discloses every limitation of claims 1-22.

Claims	Brooks And Whittemore
1. [preamble] A vaporizing device comprising:	<u>Brooks:</u> “Smoking articles employ an electrical resistance heating element and an electrical power source to provide a tobacco-flavored smoke or aerosol and other sensations of smoking.” Ex. 1002 at Abstract. “The present invention relates to cigarettes and other smoking articles such as cigars, pipes, and the like, which employ an electrical resistance heating element and an electrical power source to produce a tobacco-flavored smoke or aerosol.” <i>Id.</i> at 1:6-10. “As used herein, and only for the purposes of this

	application, "aerosol" is defined to include vapors, gases, particles, and the like, both visible and invisible, and especially those components perceived by the user to be "smoke-like," generated by action of heat from the resistance heating element upon aerosol forming substances and/or tobacco flavor substances located on the resistance element or elsewhere in the article.” <i>Id.</i> at 6:45-53. “As a result, the heating element experiences an increase in temperature which in turn heats and volatilizes the aerosol forming substance. The volatilized aerosol forming substance mixes with the drawn air and forms an aerosol. The volatilized aerosol forming substance (in aerosol or vapor form) passes through the tobacco roll 20 where it elutes tobacco flavor from the tobacco, and exits the mouthend filter 22 into the mouth of the user.” <i>Id.</i> at 10:45-53. To the extent that the preamble is considered a claim limitation, Brooks discloses a vaporizing device. Brooks is directed to “[s]moking articles [that] employ an electrical resistance heating element and an electrical power source to provide a tobacco-flavored smoke or aerosol and other sensations of smoking.” Ex.1002 at Abstract; see also 6:45-53, 10:45-53. ¶ 72, <i>supra</i>; see also Petition at VI.E.1.a.
[a] a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit electrically connected to a circuit board within a tubular battery assembly housing;	<u>Brooks:</u> “Referring to FIG. 1, smoking article 10 includes a cigarette 12 and a reusable, hand-held controller 14. The cigarette 12 includes electrical connection plug 16, resistance heating element 18 carrying an aerosol forming substance, a roll of tobacco 20, mouth end filter 22, and a resilient overwrap 24. The preferred controller 14 includes a case 26, a puff actuated current actuation mechanism 28 having the form of a pressure sensitive switch, a time-based current control circuit 30, and a chamber 32 into which battery power supply 34 (shown as batteries 34A

	and 34B) is inserted.” Ex. 1002 at 7:15-25. “The reusable controller 14 includes a case 26 or outer housing which provides a convenient and aesthetic holder for the user. The outer housing 26 can have a variety of shapes and can be manufactured from plastic, metal, or the like.” <i>Id.</i> at 9:37-41. “The reusable controller can be in the form of a pipe, a reusable cigarette holder, or a hand-held unit or other portable form into which the disposable portion can be inserted.” <i>Id.</i> at 4:46-49. “The preferred controller 14 includes a case 26, a puff actuated current actuation mechanism 28” within the tubular battery assembly housing (case 26). <i>Id.</i> at 7:20-25 “A preferred puff actuated switch 28 is a pressure differential switch ... Other suitable differential switches, analog pressure sensors, flow rate sensors, or the like, will be apparent to the skilled artisan.” <i>Id.</i> at 12:58-13:6. “The current regulating circuit preferably is time based. Normally, such a circuit includes a means for permitting uninterrupted current flow through the heating element for an initial time period during draw, and 10 a timer means for subsequently regulating current flow until draw is completed. Preferably, the subsequent regulation involves the rapid on-off switching of current flow (eg., on the order of about every 1 to 50 milliseconds) to maintain the heating element within the desired temperature range. Alternatively, the subsequent regulation involves the modulation of current flow through the heating element to maintain the heating element within a desired temperature range. One preferred time-based current regulating circuit preferably includes a transistor 110, a timer 112, a comparator 114, and a capacitor 116. Suitable transistors, timers, comparators and capacitors are commercially available and will be apparent to the skilled artisan. Exemplary timers are those available from NEC
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	Electronics as C-1555C and from General Electric Intersil, Inc. as ICM7555, as well as various other sizes and configurations of so-called "555 Timers". An exemplary comparator is available from National Semiconductor as LM311. In the preferred circuit of FIG. 9, the means for determining the length of the initial time period of uninterrupted current flow includes resistors 118, 120, 122 and 124; capacitor 116; and comparator 114. The comparator 114 is powered by connection to entrance pin 128 and to ground pins 130, 132. Resistors 122 and 120 constitute a voltage divider which provides a predetermined reference or threshold voltage at the voltage divider tap 134 (i.e., the common point between resistors 122 and 120). The voltage divider tap 134 is connected to the negative entrance pin 136 of comparator 114. Capacitor 116 is connected in parallel with resistor 124. The parallel combination of capacitor 116 and resistor 124 is connected in series with resistor 118 at one end and to the ground reference point of the power 45 source 34 at the other end. The other end of resistor 118 is connected to power source 34 via switch 28. The common node point between the resistor 118 and the parallel combination of capacitor 116 and resistor 124 is connected to the positive entrance pin 138 of comparator 114. Resistors 118 and 124 and the capacitance of capacitor 116 are chosen so that the charge rate of capacitor 116 approximates the heating and cooling rate of the resistance heating element 18. The ratio of the resistance of resistor 124 to the sum of the resistances of resistors 118 and 124 sets the maximum voltage to which capacitor 116 can charge. Preferably, the resistances of voltage divider resistors 120 and 122 provide a voltage which is slightly below the maximum capacitor voltage set by resistors 118 and 124." <i>Id.</i> at 13:7-61. "The timer means for regulating (or interrupting) current flow after the initial time period includes timer 112, diodes 140, 141, resistors 143, 145, and capacitor 147." <i>Id.</i> at 13:62-64.
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	The time-based current regulating circuit “preferably includes a transistor 110, a timer 112, a comparator 114, and a capacitor 116.” <i>Id.</i> at 13:20-22. “The pressure actuated switch 28 responds to a sensed change in air pressure within the cigarette during draw and permits current flow through the heating element 18.” <i>Id.</i> at 10:42-45 “When the user stops drawing on the cigarette, the pressure actuated switch 28 again responds to the sensed change in air pressure within the cigarette, and further current flow through the heating element ceases.” <i>Id.</i> at 10:59-63 “The circuit includes a puff actuated control switch 28, or some other suitable current actuation/deactuation mechanism, such as a manually actuated on-off switch, a temperature actuated on-off switch, or a lip pressure actuated switch. The preferred puff actuated switch 28 enables current to pass through the heating element 18 only during draw on the article. A typical puff actuated switch includes a means for sensing the difference in air pressure in a region within the previously described cigarette or disposable cartridge and an "on-off" switch responsive thereto.” <i>Id.</i> at 12:47-57. “The pressure sensitive switch was the switch portion of a Model No. MPL-502-V, range A, differential switch obtained from Micro Pneumatic Logic, Inc. A 20 mm long 18 gauge steel needle 48 was inserted into the appropriate opening in the switch.” <i>Id.</i> at 17:46-50. “The current regulating circuit preferably is time based. Normally, such a circuit includes a means for permitting uninterrupted current flow through the heating element for an initial time period during draw, and a timer means for subsequently regulating current flow until draw is completed. Preferably, the subsequent regulation involves the rapid on-off switching of current flow (eg., on the
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	order of about every 1 to 50 milliseconds) to maintain the heating element within the desired temperature range. Alternatively, the subsequent regulation involves the modulation of current flow through the heating element to maintain the heating element within a desired temperature range. One preferred time-based current regulating circuit preferably includes a transistor 110, a timer 112, a comparator 114, and a capacitor 116. Suitable transistors, timers, comparators and capacitors are commercially available and will be apparent to the skilled artisan. Exemplary timers are those available from NEC Electronics as C-1555C and from General Electric Intersil, Inc. as ICM7555, as well as various other sizes and configurations of so-called "555 Timers". An exemplary comparator is available from National Semiconductor as LM311." <i>Id.</i> at 13:6-61. "In particular, the circuit of FIG. 9 includes a power source 34, the electrical resistance heating element 18, a current actuation mechanism 28, and a preferred current regulating circuit or means for controlling the passage of current through the resistance element during periods of current actuation." <i>Id.</i> at 12:43-46 "The timer means for regulating (or interrupting) current flow after the initial time period includes timer 112, diodes 140, 141, resistors 143, 145, and capacitor 147. This timer means generates a periodic digital wave having a preset on-off duty cycle, which is used to rapidly switch the current "on" and "off" at transistor 110 after the passage of the initial time period, to control the temperature range experienced by the resistance heating element." <i>Id.</i> at 13:62-14:2. "Current regulating means which modulate current flow through the heating element can be employed in place of the previously described on-off time-based circuits." <i>Id.</i> at 16:32-35.
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	“This rapid switching acts to control the average current flow through the heating element, thus controlling the temperature range experienced by the heating element during the balance of a puff.” <i>Id.</i> at 14:60-63. “97. The smoking article of claim 76, wherein the means for regulating current flow comprises (i) timer means, activated by the puff control means, for generating a pulse train having a predetermined duty cycle, and (ii) timer responsive switching means for enabling and disabling current flow to the heating element in response to the pulse train from the timer means.” <i>Id.</i> at 27:45-51 (claim 97). “Controller 14 also preferably includes a control circuit 30, which is connected to a puff actuated, differential pressure sensitive switch 28 by electrically conductive wires (not shown), as well as to batteries 34A and 34B via battery terminal 62. The control circuit 30 preferably is time based. That is, the preferred current control circuit preferably is based on controlling the time period during draw during which current passes through the resistance element. This time based control, in turn, controls the temperature experienced by the resistance element and by the aerosol forming substances. Preferred pressure sensitive switches and control circuits, and their connection power source 34 and resistance element 18, are described in greater detail hereinafter with reference to FIGS. 9 and 10.” <i>Id.</i> at 9:51-65. “In the preferred circuit of FIG. 9, ... The comparator 114 is powered by connection to entrance pin 128 and to ground pins 130, 132 ... The voltage divider tap 134 is connected to the negative entrance pin 136 of comparator 114 ... The common node point between the resistor 118 and the parallel combination of capacitor 116 and resistor 124 is connected to the positive entrance pin 138 of comparator 114.” <i>Id.</i> at 13:31-51.
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	<i>Id.</i> at 14:3-16:51, claims 161-202. “The pressure actuated switch 28 responds to a sensed change in air pressure within the cigarette during draw and permits current flow through the heating element 18... During the puff, the preferred current control circuit (described in detail hereinafter) regulates the flow of current to control the temperature experienced by the heating element and the amount of aerosol forming substance which is volatilized.” <i>Id.</i> at 10:42-58. “When the user stops drawing on the cigarette, the pressure actuated switch 28 again responds to the sensed change in air pressure within the cigarette, and further current flow through the heating element ceases.” <i>Id.</i> at 10:59-63. “Referring to FIG. 3, the illustrated embodiment is generally similar to the embodiment of FIG. 2, except that the controller or power pack 14 includes a flexible, cord-like connector 72 which terminates in a plug 74 having prongs 76, 77 for electrical connection into a receptacle 79 at one end of cigarette 12.” <i>Id.</i> at 11:20-25. “A light emitting diode 81 is positioned near the differential switch 28. The diode 81 is electrically connected to the electrical circuitry (as described hereinafter) such that it emits light during draw. As such, the user has a visual means for identifying periods when current passes through the resistance heating element 18.” <i>Id.</i> at 11:35-41. “If desired, light emitting diode 81 and resistor 192 can be employed. The light emitting diode 81 is connected in series with resistor 192. The series combination of diode 81 and resistor 192 is connected in parallel with the resistance element 18. The light emitting diode thus illuminates during draw, and the user then can have a visual means for identifying periods when current passes through the resistance element for heat generation. Such
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light emitting diodes also can be employed in the preferred circuit illustrated in FIG. 9.” *Id.* at 15:63-16:4.

Id. at Fig. 2 (see annotated Fig. 2 as shown above).

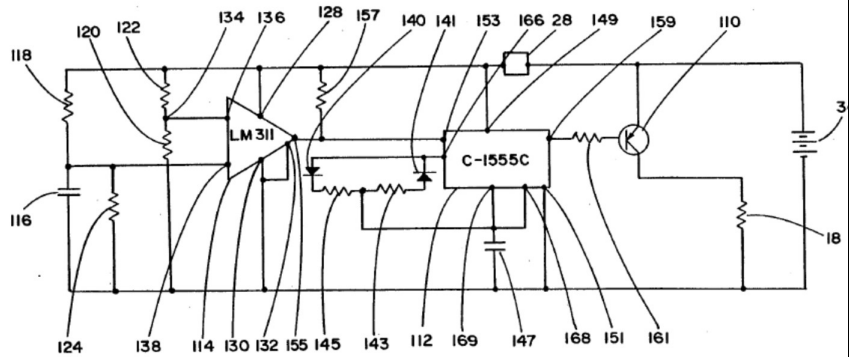


FIG. 9

Id. at Fig. 9

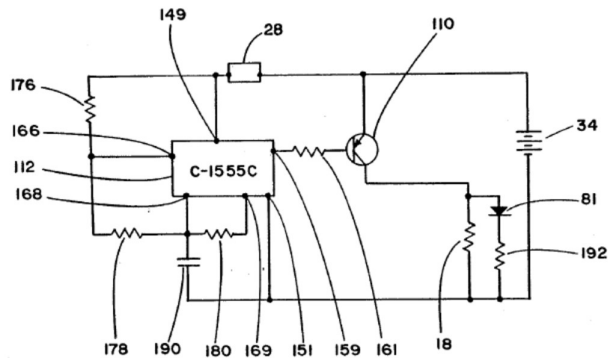


FIG. 10

Id. at Fig. 10

see also Petition at VI.E.1.b

[b] a first electrode at an end of the battery assembly housing;

Brooks:

“In use, the user inserts the plug 16 of the cigarette 12 into the receptacle 44 of the controller 14. Such action provides electrical connection of the resistance heating element 18 with the switch 28, the control circuit 30 and the batteries 34A and 34B. Such action also provides for airflow

	communication between the switch 28 and the inner portion of the cigarette.” Ex. 1002 at 10:34-40. “The electrical connection plug 16 preferably is manufactured from a resilient, electrically insulative material such as a thermoplastic material. The plug 16 includes two electrical connector pins or prongs 38, 39 connected to the ends of heating element 18 via connectors 40, 41. The pins 38, 39 engage with electrical terminals 42, 43 located in electrical connection receptacle 44 of the controller 14. Plug 16 also includes a passageway 46 through which tube 48 from pressure sensing switch 28 extends.” <i>Id.</i> at 8:31-40. “Controller 14 includes an insulative receptacle 44 which includes plug-in connectors 42, 43 for engagement with prongs 38, 39 of plug 16. Receptacle 44 also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette. The other end of tube 48 is in airflow communication with pressure sensing switch 28, so that changes in air pressure which occur within the cigarette during draw can be sensed by the switch.” <i>Id.</i> at 9:41-50. “Electrical connection pins 85, 86 from plug 74 contact the heating element and help hold it in place against collar 49.” <i>Id.</i> at 11:49-51. “Controller 14 includes an insulative receptacle 44 which includes plug-in connectors 42, 43 for engagement with prongs 38, 39 of plug 16.” <i>Id.</i> at 9:41-43. <i>Id.</i> at Fig. 2 (see annotated Fig. 2 as shown above).
[c] an atomizer assembly comprising an atomizer and a liquid supply in a tubular atomizer assembly housing;	<u>Brooks:</u> “The disposable article of claim 26, 35, 53 or 56, wherein the aerosol forming substance comprises a liquid...” Ex. 1002 at claim 71.

	“Referring to FIG. 1, smoking article 10 includes a cigarette 12 and a reusable, hand-held controller 14. The cigarette 12 includes electrical connection plug 16, resistance heating element 18 carrying an aerosol forming substance, a roll of tobacco 20, mouth end filter 22, and a resilient overwrap 24.” Ex. 1002 at 7:15-20. “In one aspect of the invention, the smoking article includes a cigarette or a disposable portion (eg., a cartridge) which utilizes an air permeable high surface area electrical resistance heating element that normally carries aerosol forming and/or tobacco flavor substances prior to use.” <i>Id.</i> at 4:7-12. “Other suitable heating elements include porous metal wires or films; carbon yarns, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; porous substrates in intimate contact with resistance heating components; and the like.” <i>Id.</i> at 7:65-8:3. “The pressure actuated switch 28 responds to a sensed change in air pressure within the cigarette during draw and permits current flow through the heating element 18. As a result, the heating element experiences an increase in temperature which in turn heats and volatilizes the aerosol forming substance. The volatilized aerosol forming substance mixes with the drawn air and forms an aerosol. The volatilized aerosol forming substance (in aerosol or vapor form) passes through the tobacco roll 20 where it elutes tobacco flavor from the tobacco, and exits the mouthend filter 22 into the mouth of the user.” <i>Id.</i> at 10:42-53. “Preferably, such porous heating elements are impregnated with liquid aerosol forming substances, such as glycerin, and with tobacco extracts. Such heating elements are particularly advantageous in that they are capable of holding and efficiently releasing relatively large quantities of liquid aerosol forming substances and tobacco flavor
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	materials. For example, such heating elements can carry enough aerosol forming substances to provide aerosol for 6 to 10 puffs, or more.” <i>Id.</i> at 4:22-31. “The resistance heating element 18 employed in cigarette 12 preferably is a fibrous material having a high surface area and an adsorbant, porous, wettable character, in order to carry a suitable amount of aerosol forming substance for effective aerosol formation. Suitable heating elements preferably have surface areas above about 50 m²g, more preferably above about 250 m²g, and most preferably above about 1,000 m²g.” <i>Id.</i> at 7:26-33. “Preferably, the heating element 18 is impregnated with or otherwise carries the aerosol forming substance in order that the aerosol forming substance is in a heat exchange relationship with the electrical heating element. The aerosol forming substance can be, for example, a polyhydric alcohol, such as glycerin, propylene glycol, or a mixture thereof; water; a tobacco material such as a tobacco aroma oil, a tobacco essence, a spray dried tobacco extract, a freeze dried tobacco extract, tobacco dust, or the like, in order to provide tobacco flavor; or a combination thereof. Other suitable aerosol forming substances are well known in the art. See, for example, U.S. Pat. Nos. 4,714,092 and 4,756,318. While the loading of the aerosol forming substance can vary from substance to substance and from heating element to heating element, the amount of liquid aerosol forming substance used typically will be greater than about 15 mg and preferably ranges from about 25 mg to about 50 mg.” <i>Id.</i> at 8:4-22. “This process continues, puff after puff, normally for at least about 6 puffs, until aerosol delivery drops below the level desired by the user. Then, the user can remove the cigarette 12 from the control pack 14, and dispose of the cigarette. The user then can select a new cigarette, insert the new cigarette into the reusable controller, and repeat the smoking process.” <i>Id.</i> at 10:66-11:5.
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	“The heating element was impregnated, dropwise, with 35 mg of a liquid aerosol forming substance comprising a mixture of 31 parts propylene glycol, 62 parts glycerin and 7 parts of a tobacco extract.” <i>Id.</i> at 17:6-9. “A portion of the length of the electrical connection plug 16 preferably is circumscribed by a collar 49 having the form of a thermoplastic tube, which preferably is friction fit around a portion of the length of the plug.” <i>Id.</i> at 8:43-46. “The embodiment illustrated in FIG. 2 is generally similar to the embodiment of FIG. 1, except that the heating element 18 is positioned within a heat resistant, insulative tube 66. The insulative tube 66 preferably is manufactured from a high temperature plastic such as a polyimide, a ceramic, a heat resistant cellulosic, an extruded tobacco material, an aluminum tube having a surface coating of aluminum oxide, or the like. Preferably, a plasticized cellulose acetate tube 68 circumscribes the insulative tube 66, and is itself circumscribed by paper overwrap 24. This embodiment also includes tipping overwrap 70 circumscribing the mouthend of the cigarette in order to attach filter element 22 to the remaining portion of the cigarette.” <i>Id.</i> at 11:6-19. <i>Id.</i> at Fig. 2 (see annotated Fig. 2 as shown above).
[d] with the atomizer including a heater wire coil wound around a porous body, with the heater wire coil and the porous body positioned perpendicular to a longitudinal axis of the tubular atomizer assembly housing;	<u>Brooks:</u> “Other suitable heating elements include porous metal wires or films; carbon yarns, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; porous substrates in intimate contact with resistance heating components; and the like.” Ex. 1002 at 7:65-8:3. “11. The cigarette of claim 10, wherein the heating element is positioned substantially perpendicularly to the longitudinal axis of the air passageway.” <i>Id.</i> at 23:11-13

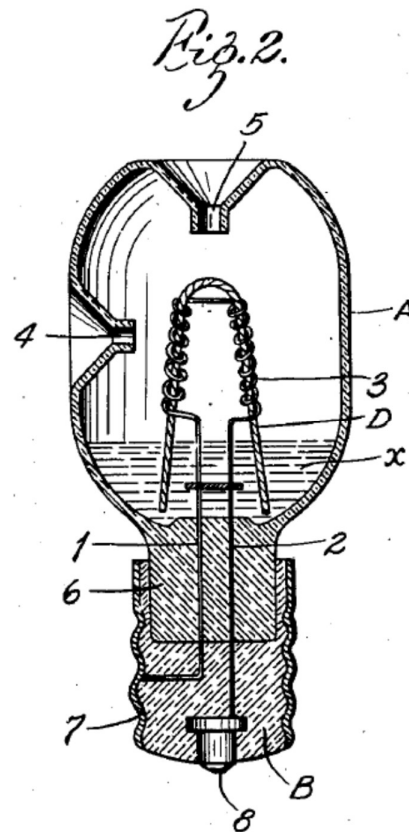
(claim 11).

“36. The disposable article of claim 35, wherein the heating element is positioned substantially perpendicularly to the longitudinal axis of the air passageway.” *Id.* at 24:22-24 (claim 36).

“54. The disposable article of claim 53, wherein the heating element is positioned substantially perpendicularly to the longitudinal axis of the air passageway.” *Id.* at 25:16-18 (claim 54).

Id. at Figs. 2, 4 (see annotated Figs. 2, 4 as shown above).

Whittemore:



Ex. 1003, Fig. 2

Ex. 1003 at Fig. 2.

	“In the drawing A designates the vaporizing vessel of my improved unit, said vessel being preferably constructed in the form of a hollow glass container adapted to hold a liquid medicament x and provided with an electrically-operated heating means comprising two electrical conductors 1 and 2 and a filament or heating element 3 combined in such a way that when said conductors are energized by an electric current, the filament 3 will become heated.” <i>Id.</i> at 1:19-28. “In order that the unit will function properly, even though the heating element or filament 3 is spaced a considerable distance above or away from the medicament x, the unit is equipped with a wick D made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3.” <i>Id.</i> at 1:50-2:8. “A therapeutic vaporizing unit adapted to be plugged into a conventional socket terminal of an electric circuit, comprising . . . a porous wick entwined within the filament for lifting the medicament by capillary attraction whereby the liquid becomes vaporized upon the filament becoming heated. <i>Id.</i> at Claim 9.
[e] the heater wire coil and the porous body in an airflow path through the tubular atomizer assembly housing leading to a suction nozzle wherein air passes across the	<u>Brooks:</u> “When the user puffs on the mouthend of the cigarette, ambient air enters the cigarette through air inlet 54. The pressure actuated switch 28 responds to a sensed change in air pressure within the cigarette during draw and permits current flow through the heating element 18. As a result, the heating element experiences an increase in temperature which in turn heats and volatilizes the aerosol forming

heater wire coil and the porous body;	substance. The volatilized aerosol forming substance mixes with the drawn air and forms an aerosol. The volatilized aerosol forming substance (in aerosol or vapor form) passes through the tobacco roll 20 where it elutes tobacco flavor from the tobacco, and exits the mouthend filter 22 into the mouth of the user.” Ex. 1002 at 10:40-53. “The pad is permeable to airflow, and is disposed across an air passageway 83 in tubular collar 49 so that drawn air entering the cigarette 12 through opening 54 passes through the heating element 18.” <i>Id.</i> at 11:46-49. “Alternatively, the air inlet can be positioned through the extreme inlet end of the cigarette or elsewhere through the periphery of the cigarette, such that drawn ambient air passing through the cigarette to the mouth of the user passes the resistance element.” <i>Id.</i> at 8:53-57. “10. The cigarette of claim 1, wherein the cigarette includes an air passageway at least partially therethrough, and the heating element comprises an air permeable heating element positioned in the passageway.” <i>Id.</i> at 23:7-10 (claim 10). “55. The disposable article of claim 53, wherein the heating element substantially fills the cross sectional area of the air passageway.” <i>Id.</i> at 25:19-21 (claim 55). <i>Id.</i> at Figs. 2, 4 (see annotated Figs. 2, 4 as shown above). <u>Whittemore</u> “the unit is equipped with a wick D made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat
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from the filament 3. In the form of my invention shown in Figure 2, the wick D consists of a thread, string or strand of some suitable wick material doubled intermediate its ends so as to form a substantially inverted V-shaped device whose side portions are encased in . and surrounded by called or looped portions of the filament 3, the lower ends or free ends of the side pieces of the wick projecting downwardly into the medicament and terminating at or in close proximity to the closed bottom 6 of the vessel A.”
Ex.1003 at 1:53-2:18.

[f] a second electrode
at an end of the
atomizer assembly
housing

Brooks:

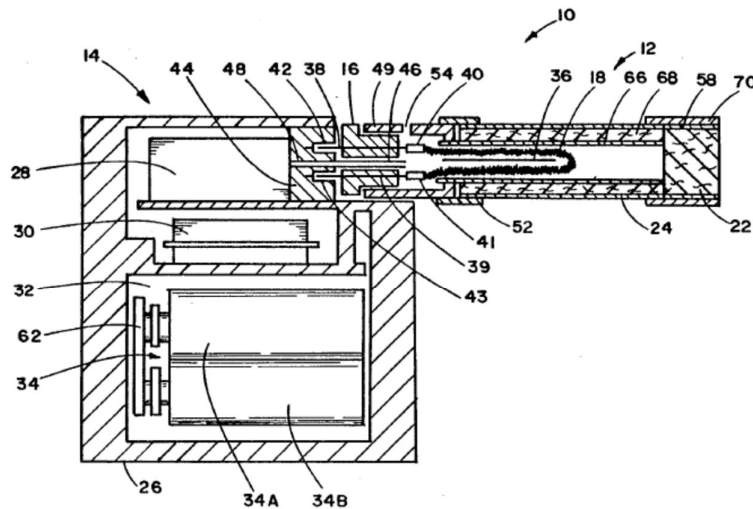


FIG. 2

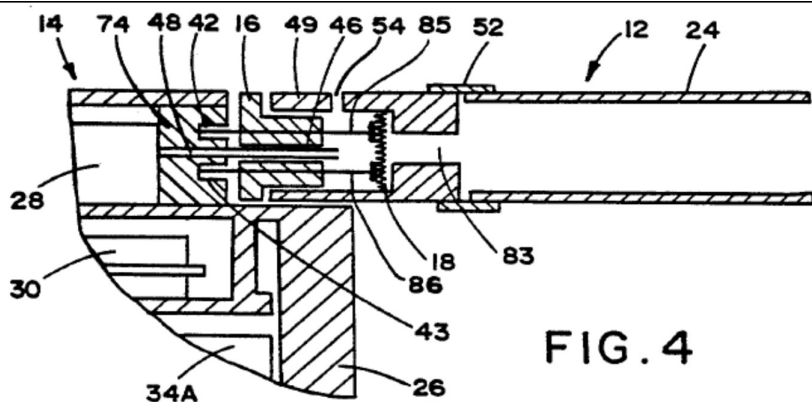
Ex. 1002 at Fig. 2.

[g] the battery assembly and the atomizer assembly electrically connected by engagement of the first electrode with the second electrode, and with electricity conducted from the battery to the heater

Brooks:

“In use, the user inserts the plug 16 of the cigarette 12 into the receptacle 44 of the controller 14. Such action provides electrical connection of the resistance heating element 18 with the switch 28, the control circuit 30 and the batteries 34A and 34B.” Ex. 1002 at 10:34-38.

“The electrical connection plug 16 preferably is manufactured from a resilient, electrically insulative



Ex. 1002, Fig. 4.

4. The device of claim 3 with the airflow path further including an air inlet in a side wall of the tubular atomizer assembly housing at the second electrode.

Brooks:

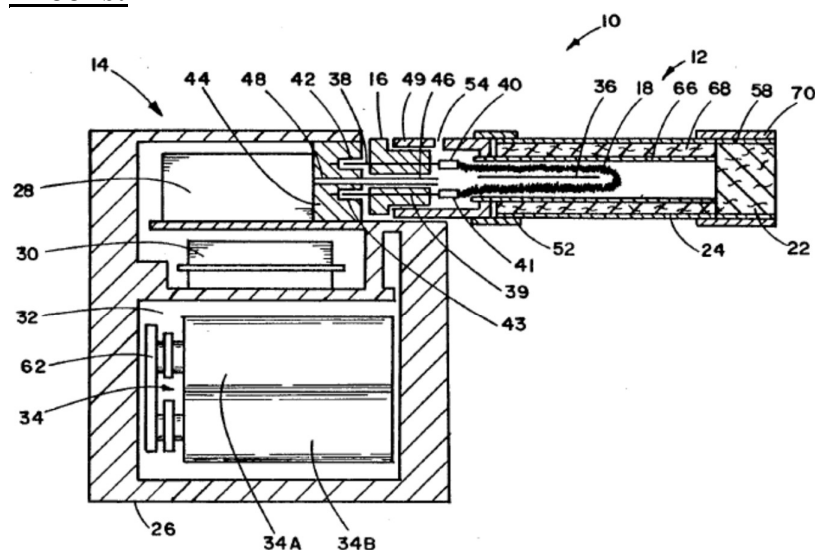


FIG. 2

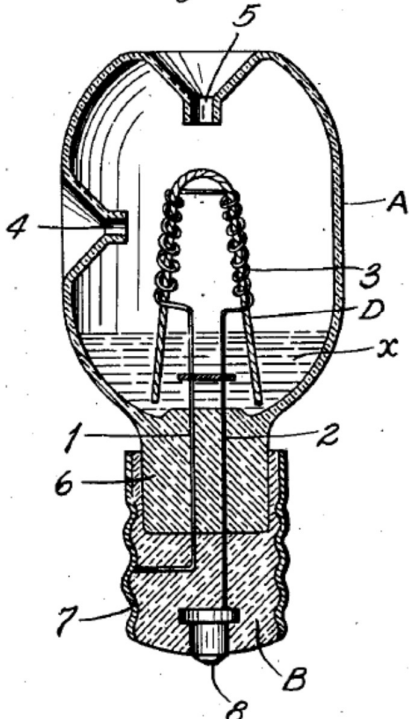
Id. at Fig. 2.

“ Preferably, the collar 49 includes one or more peripheral air inlet openings 54 which provide a flow of ambient air through the cigarette during draw.” *Id.* 1002 at 8:50-52.

“A portion of the length of the electrical connection plug 16 preferably is circumscribed by a collar 49 having the form of a thermoplastic tube, which preferably is friction fit around a portion of the length of the plug.” *Id.* at 8:43-

	46. “[T]he air inlet can be positioned through the extreme inlet end of the cigarette or elsewhere through the periphery of the cigarette.” <i>Id.</i> at 8:53-55 “When the user puffs on the mouthend of the cigarette, ambient air enters the cigarette through air inlet 54.” <i>Id.</i> at 10:40-42.
5. The device of claim 3 further including fiber containing cigarette liquid in contact with the porous body.	<u>Brooks</u> “Other suitable heating elements include porous metal wires or films; carbon yams, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities; porous substrates in intimate contact with resistance heating components; and the like.” Ex. 1002 at 7:65-8:3. “porous substrates in intimate contact with resistance heating components; and the like. Preferably, the heating element 18 is impregnated with or otherwise carries the aerosol forming substance in order that the aerosol forming substance is in a heat exchange relationship with the electrical heating element.” <i>Id.</i> at 8:1-8. “Preferably, such porous heating elements are impregnated with liquid aerosol forming substances, such as glycerin, and with tobacco extracts. Such heating elements are particularly advantageous in that they are capable of holding and efficiently releasing relatively large quantities of liquid aerosol forming substances and tobacco flavor materials.” <i>Id.</i> at 4:22-29 “Preferred smoking articles of the invention can deliver such aerosol, preferably in visible form, for a plurality of puffs, preferably at least about 6 puffs, more preferably at least about 10 puffs, under such conditions.” <i>Id.</i> at 6:32-36 “This process continues, puff after puff, normally for at

	least about 6 puffs, until aerosol delivery drops below the level desired by the user. Then, the user can remove the cigarette 12 from the control pack 14, and dispose of the cigarette. The user then can select a new cigarette, insert the new cigarette into the reusable controller, and repeat the smoking process.” <i>Id.</i> at 10:66-11:5 <u>Whittemore</u> “the unit is equipped with a wick D made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3. In the form of my invention shown in Figure 2, the wick D consists of a thread, string or stand of some suitable wick material doubled intermediate its ends so as to form a substantially inverted V-shaped device whose side portions are encased in . and surrounded by called or looped portions of the filament 3, the lower ends or free ends of the side pieces of the wick projecting downwardly into the medicament and terminating at or in close proximity to the closed bottom 6 of the vessel A.” Ex.1003 at 1:53-2:18.
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	<i>Fig. 2.</i>  Ex. 1003, Fig. 2
6. The device of claim 1 with the sensor in between a pressure balancing hole in the battery assembly housing and the first electrode.	<u>Brooks:</u> “Plug 16 also includes a passageway 46 through which tube 48 from pressure sensing switch 28 extends.” Ex. 1002 at 8:38-40. “Receptacle 44 also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette. The other end of tube 48 is in airflow communication with pressure sensing switch 28, so that changes in air pressure which occur within the cigarette during draw can be sensed by the switch.” <i>Id.</i> at 9:43-50.

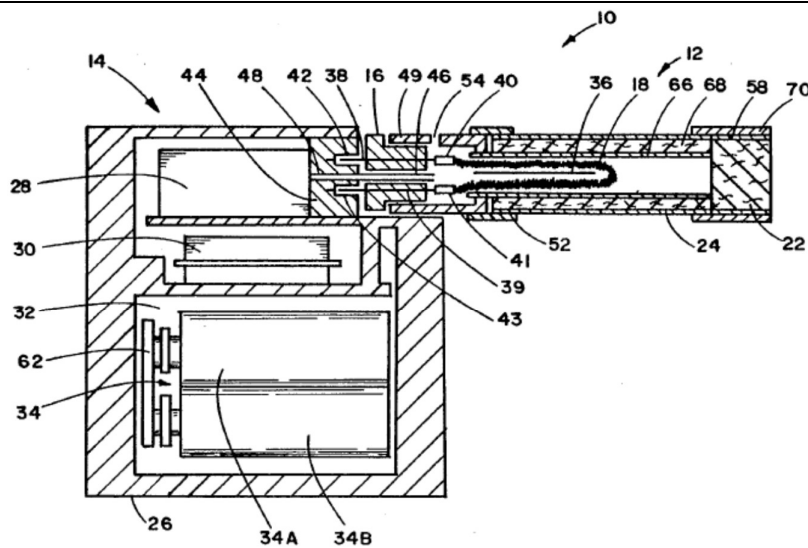


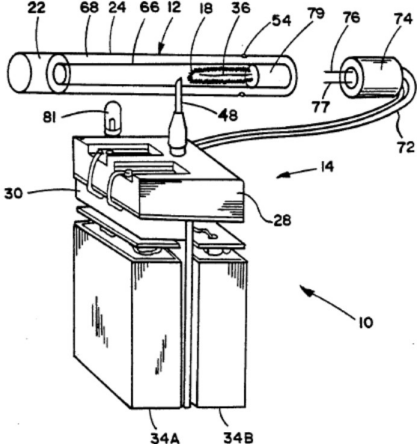
FIG. 2

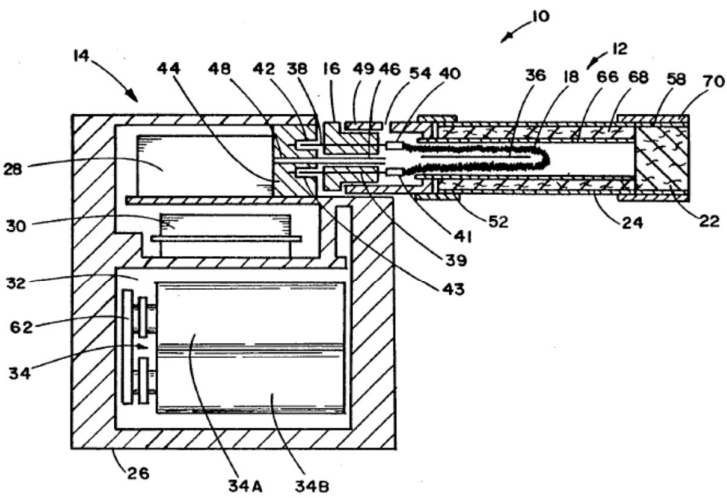
Id. at Fig. 2.

7. The device of claim 1 with the first electrode contacting the second electrode regardless of an angular orientation of the battery assembly relative to the atomizer assembly.

Brooks:

“Referring to FIG. 3, the illustrated embodiment is generally similar to the embodiment of FIG. 2, except that the controller or power pack 14 includes a flexible, cord-like connector 72 which terminates in a plug 74 having prongs 76, 77 for electrical connection into a receptacle 79 at one end of cigarette 12. A needle-like tube 48 extends from switch 28 and extends through resilient overwrap 24 in order that changes in air pressure within the cigarette during draw can be sensed by the switch. If desired, the tube 48 can be incorporated into the cord-like connector 72 and extend into the cigarette through the receptacle 79. With such a design, it is possible for the user to place the control pack in a shirt pocket or on a table, and hold the cigarette in a normal fashion, without holding the added weight of the control pack in his/her hands.” Ex. 1002 at 11:20-35.

	 FIG. 3 <i>Id.</i> at Fig. 3.
8. The device of claim 1 with the first electrode contacting the second electrode with the battery assembly at any angular orientation relative to the atomizer assembly.	<i>See claim 7 supra.</i>
9. [preamble] A vaporizing device comprising:	I have assumed for purposes of my analysis that the preamble is claim limitation. Brooks discloses a vaporizing device. <i>See claim 1 above.</i>
[a] a battery assembly comprising a battery, a sensor, an LED and a micro-controller unit within a tubular battery assembly housing	This limitation is disclosed. <i>See claim 1a above.</i>
[b] having a pressure balancing hole on a first side of the sensor, and a first	This limitation is disclosed. <i>See claim 6 above.</i>

cavity in the tubular battery assembly housing on a second side of the sensor opposite from the first side of the sensor;	
[c] an atomizer assembly comprising an atomizer and a second cavity in a tubular atomizer assembly housing, with the first cavity connecting into the second cavity,	This limitation is disclosed. <i>See</i> claim 1e above. <u>Brooks:</u> “Receptacle 44 also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette.” Ex.1002 at 9:43-46. “Plug 16 also includes a passageway 46 through which tube 48 from pressure sensing switch 28 extends.” <i>Id.</i> at 8:38-40.  FIG. 2 <i>Id.</i> at Fig. 2.
[d] the atomizer including a heater wire coil wound on a porous body, and the heater wire coil and	This limitation is disclosed. <i>See</i> claim 1d above.

the porous body perpendicular to a longitudinal axis of the tubular atomizer assembly housing,	
[e] the heater wire coil and porous body in an airflow path through the tubular atomizer assembly housing wherein air flows across the wire coil and the porous body; and	This limitation is disclosed. <i>See</i> claim 1e above.
[f] the battery assembly and the atomizer assembly electrically connected via a first electrode at a first end of the battery assembly contacting a second electrode at a first end of the atomizer assembly with the battery assembly at any angular orientation relative to the atomizer assembly.	This limitation is disclosed. <i>See</i> claims 1b, 1f, 1g, 7, and 8 above.
10. The vaporizing device of claim 9 with the airflow path passing through a through hole in the atomizer.	This limitation is disclosed. <i>See</i> claims 2 and 4 above. <u>Brooks:</u> “Receptacle 44 also includes tube 48 which is inserted into passageway 46 of plug 16 to be in airflow communication with the internal region of the cigarette. The other end of tube 48 is in airflow communication with

pressure sensing switch 28, so that changes in air pressure which occur within the cigarette during draw can be sensed by the switch.”

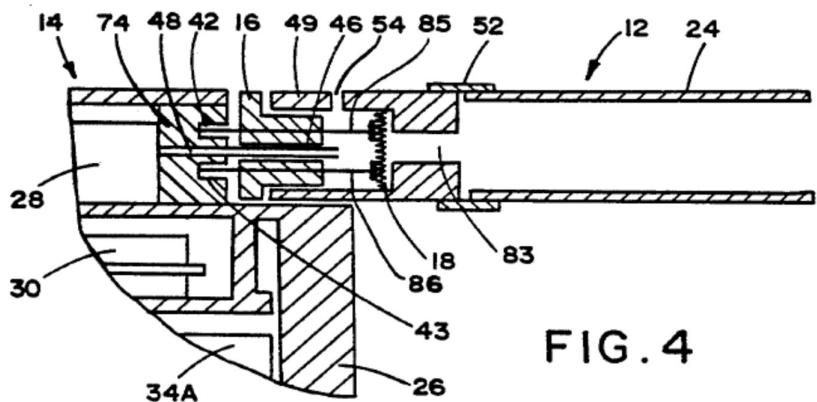
Ex. 1002, 9:43-50.

“This electrical connection means includes means for connecting the resistance element to the battery or other external power source, and preferably includes an air passageway used in conjunction with the preferred puff actuated current actuation means.”

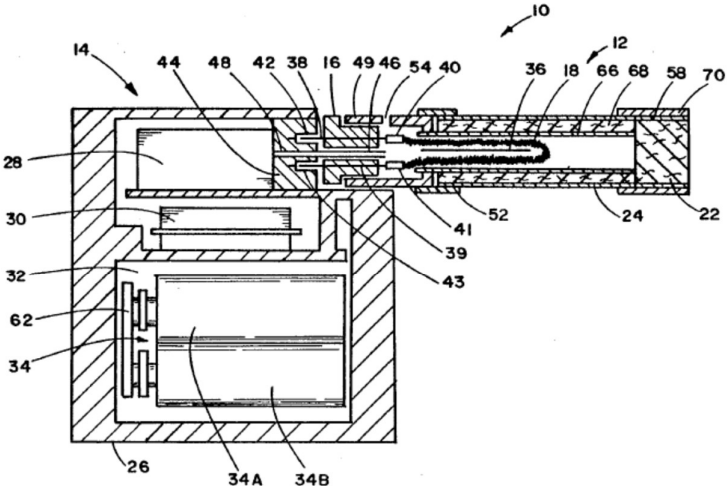
Id., 5:68-6:4.

“A needle-like tube 48 extends from switch 28 and extends through resilient overwrap 24 in order that changes in air pressure within the cigarette during draw can be sensed by the switch. If desired, the tube 48 can be incorporated into the cord-like connector 72 and extend into the cigarette through the receptacle 79.”

Id., 11:25-31.



Ex. 1002, Fig. 4.

	 FIG. 2 <i>Id.</i> at Fig. 2.
11. The device of claim 10 wherein the heater wire coil is on a central section of the porous body.	As discussed in claim 1.d <i>supra</i>. <u>Whittemore</u> “the unit is equipped with a wick D made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3.” Ex.1003, 1:53-2:8 “Figure 3 illustrates another form of my invention, in which the filament or heating element aa is constructed in the form of a single vertically-disposed coil attached to the electrical conductors 1 and 2, and arranged so as to surround a wick D' whose lower end terminates in close proximity to the inner face of the bottom 6 of the vaporizing vessel up through which the conductors 1 and 2 project.” <i>Id.</i> at 2:26-34 “A tiltable vaporizing unit of the kind described in claim 1, in which said vessel is provided with an air inlet and a

	vapor outlet.” <i>Id.</i> at claim 3
12. The device of claim 11 with the through hole between spaced apart wire leads of the heater wire coil.	This limitation is disclosed. <i>See</i> claim 3 above.
13. The device of claim 12 with the airflow path further including an air inlet in a side wall of the tubular atomizer assembly housing adjacent to the second electrode.	This limitation is disclosed. <i>See</i> claim 4 above.
14. The device of claim 12 further including fiber containing a cigarette liquid in contact with the atomizer.	This limitation is disclosed. <i>See</i> claim 5 above.
15. The device of claim 12 wherein the porous body provides capillary action.	This limitation is disclosed. <i>See</i> claim 1d above. <u>Brooks:</u> “The resistance heating element 18 employed in cigarette 12 preferably is a fibrous material having a high surface area and an adsorbant, porous, wettable character, in order to carry a suitable amount of aerosol forming substance for effective aerosol formation.” Ex. 1002 at 7:26-30. “Other suitable heating elements include porous metal wires or films; carbon yarns, cloths, fibers, discs or strips; graphite cylinders, fabrics or paints; microporous high temperature polymers having moderate resistivities;

	porous substrates in intimate contact with resistance heating components; and the like.” <i>Id.</i> at 7:65-8:3. “As a result, the heating element experiences an increase in temperature which in turn heats and volatilizes the aerosol forming substance. The volatilized aerosol forming substance mixes with the drawn air and forms an aerosol. The volatilized aerosol forming substance (in aerosol or vapor form) passes through the tobacco roll 20 where it elutes tobacco flavor from the tobacco, and exits the mouthend filter 22 into the mouth of the user ... When the user stops drawing on the cigarette, the pressure actuated switch 28 again responds to the sensed change in air pressure within the cigarette, and further current flow through the heating element ceases. As a result, the temperature of the heating element and the aerosol former quickly drop below the volatilization temperature of the aerosol former, and aerosol formation ceases. This process continues, puff after puff, normally for at least about 6 puffs, until aerosol delivery drops below the level desired by the user.” <i>Id.</i> at 10:45-68. <u>Whittemore:</u> “In order that the unit will function properly, even though the heating element or filament 3 is spaced a considerable distance above or away from the medicament x, the unit is equipped with a wick D made of any suitable material and combined with the heating element or filament 3 in such a way that a portion of said wick is always in contact or approximate contact with the heating element or filament 3, and a portion of said wick is always in contact with the medicament in the vaporizing vessel, whereby said medicament will be carried by capillary action to a point where it will be vaporized by the heat from the filament 3. In the form of my invention shown in Figure 2, the wick D consists of a thread, string or strand of some suitable wick material ...” Ex. 1003 at 1:50-2:10.
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	“11. As a new article of manufacture, a vaporizing unit for therapeutic use, comprising a plug terminal adapted to be plugged into a conventional socket terminal of an electrical circuit, a vessel for a medicament mounted upon said plug and having inlet and outlet openings to the atmosphere, filament wires extending from the plug through the bottom of the vessel and terminating therein, portions of the filament wires extending from the plug being located in that part of the vessel adapted to contain the medicament and other portions extending above the level thereof, and a wick carried by the filament wires for lifting the medicament by capillary attraction to those portions of the wires extending above the liquid level of the vessel.” <i>Id.</i> at Claim 11.
16. [preamble] A vaporizing device comprising:	I have assumed for purposes of my analysis that the preamble is claim limitation. Brooks discloses a vaporizing device. <i>See</i> claim 1P above.
[a] a battery assembly comprising battery, a sensor, and a micro-controller unit electrically connected to a circuit board within a battery assembly housing, and a first electrode at a first end of the battery assembly housing;	This limitation is disclosed. <i>See</i> claim 1a and 1b above.
[b] an atomizer assembly comprising an atomizer and liquid absorbed in fiber material in a tubular atomizer assembly housing,	This limitation is disclosed. <i>See</i> claims 1c, 1f, and 5 above.

and a second electrode at a first end of the atomizer assembly,	
[c] the atomizer including a porous body in physical contact with the fiber material, and	This limitation is disclosed. <i>See</i> claims 1d, and 5 above.
[d] the atomizer including a heater wire wound in a coil on a part of the porous body which is perpendicular to a longitudinal axis of the tubular atomizer assembly housing;	This limitation is disclosed. <i>See</i> claim 1d above.
[e] an airflow path through a through hole of the atomizer located between spaced apart wire leads of the heater wire coil, and the heater wire coil and the porous body in the airflow path, wherein air flows across the wire and porous body; and	This limitation is disclosed. <i>See</i> claims 1e, 2, and 3 above.
[f] the battery assembly electrically connected to the atomizer assembly via the first electrode	This limitation is disclosed. <i>See</i> claim 1g above.

contacting the second electrode.	
17. The device of claim 16 with the airflow path further including an air inlet in a side wall of tubular atomizer assembly housing adjacent to the first end of the tubular atomizer assembly housing.	This limitation is disclosed. <i>See</i> claim 4 above.
18. The device of claim 16 with the sensor in between a pressure balancing hole in the tubular battery assembly housing and the first electrode.	This limitation is disclosed. <i>See</i> claim 6 above.
19. The device of claim 16 with a central axis of the through hole bisecting the heater wire coil.	This limitation is disclosed. <i>See</i> claims 2, 3 above.
20. The device of claim 19 further including a first cavity in the battery assembly connecting into a second cavity in the atomizer assembly.	This limitation is disclosed. <i>See</i> claims 9a, and 9b above.

21. The device of claim 16 with the first electrode contacting the second electrode with the battery assembly at any angular orientation relative to the atomizer assembly.	This limitation is disclosed. <i>See</i> claims 7, 8 above.
22. The device of claim 21 wherein the porous body provides capillary action.	This limitation is disclosed. <i>See</i> claim 15 above.

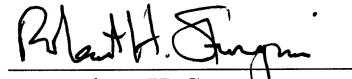
VIII. CONCLUSION

125. I am not aware of any secondary considerations that would affect my opinion.

126. For the reasons set forth above, it is my opinion that the subject matter recited in claims 1-22 of the 205 patent would have been obvious to a person having ordinary skill in the art at the time of the invention.

127. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Dated: June 26, 2017


Dr. Robert H. Sturges

**APPENDIX A TO THE
DECLARATION OF DR. ROBERT H. STURGES**

CURRICULUM VITAE

Robert H. Sturges, Jr.

GENERAL:

Education:

S.B.-S.M. Mechanical Engineering (combined degree), M. I. T., June, 1969

Ph.D. Mechanical Engineering, Carnegie Mellon University, December, 1986

Positions Held:

- 1969-1974 Staff Engineer, Charles Stark Draper Laboratories,
Cambridge, MA 01239
Mechanical/electrical system design and analysis for the Apollo project;
teleoperator controls research.
- 1974-1977 Lead Engineer, Westinghouse Electric, R&D Center (R&D), Churchill, PA 15238
Kinematic/mechanical/electrical system design and analysis for product and
process applications.
- 1977-1984 Senior Engineer, Westinghouse R&D
Robotics/teleoperator system design for nuclear fuels and reactor maintenance;
flexible manufacturing system development for sheet metal and wire harness
applications.
- 1984-1985 Residency year; research in dexterity.
- 1985-1986 Principal Engineer, Westinghouse Productivity and Quality Center (PQC),
Oakdale, PA 15230
Development of design for assembly methods; teaching design for producibility
and statistical process control.
- 1986-1987 Fellow Engineer, Westinghouse PQC
Teaching design for producibility and statistical process control methods, Value
Engineering facilitator.
- 1987-1992 Assistant Professor, Carnegie Mellon University, Department of Mechanical
Engineering
- 1992-1997 Associate Professor, Carnegie Mellon University, Department of Mechanical
Engineering
- 1997-2001 Associate Professor, Virginia Tech, Departments of Mechanical Engineering and
Industrial & Systems Engineering
- 2001- Professor, Virginia Tech, Departments of Mechanical Engineering and Industrial
& Systems Engineering, Director of Robotics and Automation Laboratory

TEACHING AND EDUCATION

A. Undergraduate Student Projects:

M. Burke, "Foot-Operated Mouse" 1988
J. Kalvan, "Balancing Machine" 1988
J. Kalvan, "Weaving Machine" 1989
R. Saulnier, "Quincunx" 1990
M. Pogozelski, "Probability Machine" 1990
P. Downey, "Review of Design for Assembly Methods," 1990
C. Wivell, "3-D Displays of Functions" 1991
A.-C. Kopp, "Generalized 3-D Displays" 1991
M. Darcy, "Modular Quincunx" 1991
C. Tesluk, "Hydrofoil Stabilizer for Sailboats" 1991
A. R. Abid, "Ball Mill Stabilizer," 1991 SURG awardee.
K. Pogany, "CAD/CAM System" 1992
S. Radney, "VuMan Shell" 1993
S. Crouse, "Prototype Flexible Wiring" 1993
J. Steven, "FMS Programming System" 1993
D. Fontaine, "Conceptual Design System" 1993
C. Tesluk, "Variable Attack Wind Turbine," 1993 SURG awardee.
J. R. Kasperik, "Adjustable Sheetmetal Gripper" 1993
M. T. Angus, "Bending Press Flexibility Modelling" 1993
M. Sigrist, "Design of a Table Top NC Mill" 1993
A. Rose, "Ultra-light Weight Steering System" 1994
W. Ouyang, "APT Translator for NC Mill" 1994
P. Klabnik, "Drives and Control for NC Mill" 1994
K. F. Moser, "Surgical Teleoperator Hand Control" 1994
T. Bruce, "An Adjustable Gripper for Sheet Metal Handling" 1994
R. Fenza, "Analysis and Simulation of a Robotic Gripper" 1995
S. Radney, "Convertible Child Seat" 1995
R. Sullivan, "Laser-Based DME for Medical Imaging" 1995
T. Okimoto, "Magnetic Structure for Haptic Interface" 1996
E. Augustin, "Fuel Injection for Formula Racing Engine" 1997
M. Abali, "Braking System Design for Formula Racecar" 1998
D. C. Reubush, "Optimization of Tires for Formula Racecar" 1999
J. Ballenger, "CAD Modeling of Formula Racecar" 2000
J. R. Batman, "Directional Drilling" 2003

B. MS Projects Completed:

P. Rao, "Engineered Compliances for Non-symmetric Insertion Tasks," Spring 1990
J.-T. Yang, "Orientation Feature Analysis for Assembly," Fall 1991
N. Pektas, "Stabilization of Nonlinear Computation Circuits" Fall 1992
Omid Rezania, "Assembly Process Synthesis," May 94.
Dongwon Lee "Design for Disassembly," May 94.
M. DeGuire "Operational Software for Control of Student CNC Milling Machine" Jan 1995

Chris Reider "Robotic Wire Termination," May 1996
H. Bauer, "Massively Parallel Micro Assembly" 1999

C. ME Theses Completed: (please note that at CMU, the terms ME and MS are reversed. Thus, the following works through 1996 are the equivalent of an MS Thesis at VT.)

W. Wang, "Understanding Machineese," 1989
S. Laowatanna, "Physics of Endoscopes," 1990
E. Y. Hershkowitz, "Analog Matrix Inversion," 1991
K. O'Shaughnessy, "Functional Decomposition in Design," 1991
J. H.-W. Wong, "Design for Assembly of Large Components," 1991
M. I. Kilani, "Design for Assembly Reasoning System," 1991
C.-H. Wang, "2D and 3D Models of Bending Processes," 1992
R. G. Reed, "Performance-Intelligent Design Advisors" 1993
D. O. Hunt, "Application of Design for Assembly Theory to Assembly Workstation Design" 1993
C.-S. Chien "Optimization of Bending Processes" 1994
Gita Krishnaswamy "Control for Planetary Rover," 1994
André Butler "Design for Disassembly," 1995
Hong Dao "Reasoning with Functions in Design," 1995
(Winner of the "Bennet Prize" for best ME Project)
Anne-Claire Kopp "Design of Passive Assembly Devices," 1996

MS Theses Completed:

B. Wells, "Control of Multi-unit Tracked Vehicles" 6/99
J. Marehalli, "Optimization of Handling & Gripper Design" 9/99
A. Kanarat, "Modeling & Simulation of Multi-unit Tracked Vehicles" 9/99
V. Aishwarya, "A Software Based Hierarchical Real Time Control System for Rapid Development of Mobile Robot Prototypes", 4/00
S. Wiedmann, "Kinematic Analysis Of Threaded Fastener Assembly In 3 Dimensions", 2/00
Y. Wongwanich, "Fitt's Law Model for Large and Heavy Plates", 9/01
M. Abbott, "Compliance Model for a 6-Dof Robot", 4/02
S. Moutran, "Workspace Analysis for Fiber Placement", 5/02

D. Ph.D. Theses Completed:

S. Laowatanna, "Physics of Rapid Assembly" 6/94
K. Elkins, "Precision Sheet Metal Processes" 8/94
G. Roston, "Genetic Design Methodology for Configuration" 12/94
K. Sathirakul, "Geometric Modeling of Assembly" 9/97
V. Ayyadevara, "Algorithmic Planning of the Part Stacking Process" 12/99
A. Kanarat, "Control of Multi-unit Tracked Vehicles" 5/04
M. Lee, "Non-Autoclave Processing of Composites" 5/04
R. Anderson, "A New Approach to Materiel Movement Modeling" 4/06
J. Choi, "Workspace Modeling for Fiber Placement" 4/06

In Progress:

R. Jientrakul, "Vision-based Factory Automation"

R. Rich, "Optimization of a Truck-drone in Tandem Delivery Network"

E. Course Development:

Fall 1988: Developed 7 weeks of new material and introduced 10 "Take Home" Lab Problems for "Manufacturing Sciences" 24-208.

Spring 1990: Introduced "Design for Manufacture" 24-268

Fall 1991: Co-developed "Fundamentals of Mechanical Engineering" 24-101, with Prof. C. Amon
Featured in *Mechanical Engineering*, Aug, 92

Fall 1992: Started the "24-101 Live Steam Challenge" a distance competition for Freshman with student-designed pint-sized steam powered vehicles.

Fall 1997: Developed 6 weeks of new material and introduced 8 "Take Home" Lab Problems for "Manufacturing Processes" ISE-2204.

Summer 1998: Revised ISE-2204 for "Green Engineering Processes" emphasis, converted course material to web-based format.

Summer 2000: Introduced "Design and Manufacturing Integration" ME/I&SE 5984

Spring 2002: In ME 4524 and ECE 4704: Developed new course pack covering robotics theory and mathematical principles. Developed set of 6 new application lab projects using an industrial robot to build/assemble a working mobile robot.

Fall 2002: In ISE2204: Developed new approach to interactive learning in which all student work is presented orally in lieu of paper-based grading. Indeed, there are no grades at all during the semester, just "competent" or "quality" evaluations, and each student must complete each assignment before proceeding to the next one. The result was gratifying: all students who passed are competent in this subject, and many achieved a depth of understanding that indicates a quality learning experience.

Fall 2004

In ISE4264 Selected a new up-to-date textbook, authored ten new hands-on assignments, carried out major upgrade to the equipment in the DH197 lab for this purpose.

RESEARCH-BASED PUBLICATIONS

A. *Books*: Sturges, Robert H., Jr., 2015, Practical Field Robotics, John Wiley, 1st edition, ISBN 978-1-118-94114-0.

B. *Critically Reviewed Papers*:

Published & Accepted Journal Papers:

j1. Sturges, R.H. 1988. "Analog Matrix Inversion," *IEEE Journal of Robotics and Automation*, Vol 4, No. 2. pp 157-162.

j2. Sturges, R.H. 1988. "A Three Dimensional Assembly Task Quantification with Application to Machine Dexterity," *International Journal of Robotics Research*, Vol 7, No. 4. pp 34-78.

j3. Sturges, R.H., and Wright, P.K., 1989 "A Quantification of Dexterity," *Journal of Robotics and Computer Integrated Manufacturing*, Vol. 6, No. 1, pp 3-14.

j4. Sturges, R.H., 1989. "A Quantification of Manual Dexterity: the Design for Assembly Calculator," *Journal of Robotics and Computer Integrated Manufacturing*, Vol. 6 No. 3, pp 237-252.

j5. Sturges, R.H., 1989. "Toward a Rational Workholding Methodology" *Journal of Robotics and Computer Integrated Manufacturing*. Vol. 9, No. 3.

j6. Sturges, R.H., and Wang, W., 1990. "Application and Experimental Results of Geometric Models of Face Milling" *ASME Manufacturing Review*. Vol 3, No. 2, pp 115-122.

j7. Sturges, R.H., 1990. "A Quantification of Machine Dexterity Applied to an Assembly Task," *International Journal of Robotics Research*, Vol 9. No. 3, pp 49-62.

j8. Wong, J. H.-W., and Sturges, R.H., 1992. "Design for Assembly Factors for Large and Heavy Parts" *ASME Journal of Mechanical Design*, Vol. 116. No. 2, pp 508-510.

j9. Sturges, R.H., 1992. "Monitoring Milling Processes through AE and Tool/Part Geometry," *ASME Journal of Engineering for Industry*. Vol. 114, No. 1, pp 8-14.

j10. Sturges, R.H., and Kilani, M., 1992. "Towards an Integrated Design for Assembly Evaluation and Reasoning System" *Journal of Computer Aided Design*. Vol 24, No. 2, February, pp 67-79.

j11. Kilani, M. I., and Sturges, R.H., 1992. "Detection and Evaluation of Orientation Features for CAD Part Models" *Journal of Engineering Design*. Vol 2, No. 3, Jan 1992.

- j12. Sturges, R.H., and Laowattana, S., 1993. "A Flexible Tendon-Controlled Device for Endoscopy," *International Journal of Robotics Research*. Vol. 12 No. 2, pp 121-131, April 1993
- j13. Sturges, R.H., O'Shaughnessy, K., & Reed R. G., 1993. "A Systematic Approach to Conceptual Design Based on Function Logic" *Int'l Journ. of Concurrent Engineering: Research & Applications (CERA)*, Vol. 1, No. 2, June 1993, pp 93-106.
- j14. Sturges, R.H., 1994. "A Review of Teleoperator Safety," *Int'l Journ. of Robotics and Automation*, Vol. 9, No. 4, Nov, 1994, pp 175-187.
- j15. Reed, R.G., & Sturges, R.H., 1994. "A Model for Performance-Intelligent Design Advisors," *Int'l Journ. of Concurrent Engineering: Research & Applications (CERA)*, Vol. 2, No. 3, Sept. 1994.
- j16. Sturges, R.H., 1995. "Design of a Vernier Punch and Die Set for Single-Minute Bending Set-Ups," *Journal of Mechanical Design*. Vol 117, No. 3, pp 396-401.
- j17. Sturges, R.H., and Laowattana, S., 1995. "Virtual Wedging in Three Dimensions," *Journal of Mechanical Design*. Vol 118, No. 1, pp 99-105.
- j18. Sturges, R.H., & Laowattana, S., 1995. "Design of an Orthogonal Compliance for Polygonal Peg Insertion," *Journal of Mechanical Design*. Vol 118, No. 1, pp 106-114.
- j19. Sturges, R.H., Kilani, M., and O'Shaughnessy, K., 1995. "A Computational Model of Conceptual Design Based on Extended Function Logic" *AI EDAM*. Vol. 10, pp. 255-274.
- j20. Elkins, K. & Sturges, R.H., 1996. "In-Process Angle Measurement and Control for Sheet Metal Manufacture," *Journ. of Intelligent Manufacturing*. Vol. 7, No. 3, pp 177-187.
- j21. Roston, G. & Sturges, R.H., 1996. "Genetic Algorithm Synthesis of Four-bar Mechanisms," *AI EDAM*, Vol. 10, pp. 371-390.
- j22. Sturges, R.H. & Hunt, D.O., 1996. "Acquisition Time Reduction through New Design for Assembly Heuristics," *Journ. of Engineering Design*. Vol. 7 No. 2, Spring, 1996, pp 195-208.
- j23. Roston, G. & Sturges, R.H., 1996. "Using the Genetic Design Methodology for Structure Configuration," *Microcomputers in Civil Engineering*. Vol. 11 , No. 3, pp. 175-184.
- j24. Sturges, R.H., Laowattana, S., & Sathirakul, K, 1996. "Directly Visualizing Spatial Freedom from Solid Models," *International Journal of Robotics Research*. Vol 15, No. 5, pp. 505-521.
- j25. Wang, C-H., & Sturges, R.H., 1996. "Preliminary Process Planning with Concurrent Multiple Representations of Parts," *Journ. of Intelligent Manufacturing*. Vol 7, pp 133-144.
- j26. Sturges, R.H., & Sathirakul, K., 1998. "Jamming Conditions for Multiple Peg and Hole Assemblies," *Robotica*, Vol. 16 pp. 329-345.

- j27. Elkins, K. & Sturges, R.H., 1999 "Non-Iterative Control of Small Radius Bend Angle." *SME Journal of Manufacturing Processes*. Vol 1, No 1, pp. 18-30, May 1999.
- j28. Elkins, K. & Sturges, R.H., 1999 "Springback Analysis and Control in Small Radius Air Bending," *ASME Journal of Manufacturing Science and Engineering*. Vol. 121, No. 4, pp. 679-688.
- j29. Sturges, R.H., & Laowattana, S., "Constraint Network Analysis of Three Dimensional Insertion Tasks," *Journal of Intelligent Manufacturing*. Volume 13, No. 1, February 2002, pp 19 – 38
- j30. Elkins, K. & Sturges, R.H., "Design of a Sensor for On-Line Measurement of Loaded Bend Angle for Pressbrake Control," *Journal of Flexible Automation and Intelligent Manufacturing*. December 2000.
- j31. Ayyadevara, V. R., Bourne, D.A., Shimada, K., and Sturges, R.H., "Interference-free Polyhedral Configurations for Stacking" *IEEE Transactions on Robotics and Automation*, Vol.18, No.2, Apr 2002, pp 147-165
- j32. Babiceanu, R. F., F. Frank Chen, Robert H. Sturges, "A Framework for Control of Automated Material Handling Systems using the Holonic Manufacturing Approach,". accepted by the *International Journal of Production Research* (IJPR). Scheduled for publication: August 2004
- j33. Sturges, R.H., 1999 "Myth and Value in Conceptual Design" accepted by *Journal of Flexible Automation and Intelligent Manufacturing*.. Publication date uncertain due to merger of the Journal.
- j34. Sturges, R.H., & Sathirakul, K., "Multiple Peg Assembly Analysis through a Partitioning of the Jamming Space," accepted *Journal of Applied Mechanisms and Robotics*. April, 2000.
- j35. Sturges, R.H., & Sathirakul, K., "Solving Off-Axis Peg-In-Hole Insertion Problems With An RRR Compliant Mechanism" accepted *Journal of Applied Mechanisms and Robotics*. April, 2000.
- j36. Kanarat, A. and Sturges, R. H., "Motion planning for nonholonomic mobile robots under control uncertainty," *Computer-Aided Design and Applications*, Vol. 1 Nos. 1-4, 2004, CAD '04, pp tbd
- j37. Anderson, R. and Sturges, R. H., "The Use of Behavior in the Design of Complex Systems" *Computer-Aided Design and Applications*, Vol. 1 Nos. 1-4, 2004, CAD '04, pp tbd
- j38. R. F. Babiceanu, F. F. Chen and R. H. Sturges, "Real-Time Holonic Scheduling of Material Handling Operations in a Dynamic Manufacturing Environment," *Robotics and Computer Integrated Manufacturing*, 2004, (accepted 8/2004).

- j39. R. F. Babiceanu, F. F. Chen and R. H. Sturges, "A Framework for Control of Automated Material Handling Systems Using the Holonic Manufacturing Approach," *International Journal of Production Research*, Vol. 42, No. 17, 2004.
- j40. R. F. Babiceanu, F. F. Chen, and R. H. Sturges (2005) "The influence of material handling operations on the schedule makespan in manufacturing cell environments" *Transactions of NAMRI/SME*, Volume 33.
- j41. Wiedmann, S., & Sturges, R.H., "A Full Kinematic Model of Thread-Starting for Assembly Automation Analysis", *ASME Journal of Mechanical Design*.Vol. 128:No. 1 pp 116-127
- j42. Wiedmann, S., & Sturges, R.H., "Spatial Kinematic Analysis of Threaded Fastener Assembly", *ASME Journal of Mechanical Design*.Vol. 128:No. 1 pp 128-136
- j43. Musa, R, Sturges, R.H., & Chen F.F. (2006) "Process Capability Allocation in the Extended Enterprise Environment" *Transactions of the NAMRI/SME*, Volume 34, pp tbd.
- j44. Fong, N., & Sturges R.H., "A Control Design Strategy of a Reconfiguration Manufacturing System" accepted with revisions, *International Journal of Manufacturing Technology and Management (IJMTM)*.
- j45. Fong, N.H., Sturges, R.H & Shewchuk, J. "Dynamic Modeling of Multi-Stage Feedback Control Manufacturing Systems" *International Journal of Manufacturing Research (IJMR)* - special issue on "Innovation in Manufacturing", Vol.2, No.3, 2007.
- j46. Fong, N.H., & Sturges, R.H., "Complex Plane Design Strategy for a Responsive Lean Manufacturing System", *International Journal of Computer Applications in Technology (IJCAT)* Vol 34 No. 3, 2009.
- j47. Chaudhari, Gaurav S., Sturges, Robert H., Sandu, Corina, "Impact of combined feedback-feedforward control based ordering policies on supply chain stability and responsiveness", accepted by *Systems Research and Behavioral Science*, 2011, pp-tbd.
- j48. Daniel W. Steeneck , Timothy C. Krometis, Robert H. Sturges, "A Procedure for Using Ship Tow-tank Data to Simulate Ship Motion and Inclusion of Perturbations", *Computing Science and Technology International Journal (CSTIJ)*, Vol. 2, No. 4 (September, 2012) ISSN 2162-0660 (print) ISSN 2162-0667 (on-line).
- j49. David B. Bateman, Igor A. Zamlinsky, and Robert H. Sturges, "Controller and Platform Design for a Three Degree of Freedom Ship Motion Simulator", *Computing Science and Technology International Journal (CSTIJ)*, Vol. 2, No. 3 (September, 2012) ISSN 2162-0660 (print) ISSN 2162-0667 (on-line).
- j50. Sturges, R.H., " Real-World Automation Control through the USB Interface". *Int'l Journ. of Engineering Inventions*, ISSN: 2278-7461, Vol. 2, No. 6, pp 48-56, April 2013.

- j51. Anderson, R.J., & Sturges, R.H., "System Behaviors and Measures: Logical and State Complexity in Naval Weapons Elevators". *Complex Systems*, Vol 22, No. 3. pp 247-309
- j52. Anderson, R.J., & Sturges, R.H., "System Behaviors and Measures: Compressed State Complexity and Number of Unique States Used in a Naval Weapons Elevators". *Complex Systems*, Vol 23, No. 1. pp 27-54, 2014
- j53. Anderson, R.J., & Sturges, R.H., "Static Measures of Complexity in Naval Weapons Elevator System, Alternative Logic, and Mobile Carriage Systems". *Complex Systems*, Vol 23, No. 2. pp 149-176, 2014
- j54. Sturges, R.H., "Material Removal by Arc Ablation". *Int'l Journ. of Engineering Science and Invention*, ISSN: 2319-6734, Vol. 3, No. 6, pp 1-6, June 2014.
- j55. Sturges, R.H., "Simple and Inexpensive Hobbing for the General Shop". *Int'l Journ. of Engineering Inventions*, ISSN: 2278-7461, e-ISSN: 2278-7461, p-ISSN: 2319-6491, Volume 4, Issue 8 [January 2015] pp: 14-22.
- j56. Ferrandez, S.M., Harbison, T., Weber, T., Sturges, R.H., Rich, R.K., "Optimization of a Truck-drone in Tandem Delivery Network Using K-means and Genetic Algorithm", *Journal of Industrial Engineering and Management*, JIEM, 2016 – 9(2): 73-89 – Online ISSN: 2013-0953 – Print ISSN: 2013-8423

Journal Papers In Review:

- j57. Chaudhari, Gaurav S., Sturges, Robert H., Sandu, Corina, "On the Underlying Structure of System Dynamics Models", submitted for review for the Journal by *Systems Research and Behavioral Science*..
- j58. Lee, M, & Sturges, R.H., "Heat Transfer Modeling of Composite Fiber Tow in Fiber Placement", submitted for review for the Journal of Composites Part A.
- j59. Lee, M, & Sturges, R.H., "Consolidation Modeling of Composite Fiber Tow in Fiber Placement", submitted for review to the Journal of Composites Part A.
- j60. Kanarat, A. & Sturges, R. H., "Modeling and Simulation of a Multi-Unit Tracked Vehicle", submitted for review to the Journal of Robotic Systems.
- j61. Fong, N.H., Sturges, R.H. & Shewchuk, J. "DFSS of Production Control via Linear Control Methods" (UIIE-0293) submitted for review to IIE Transactions.

Peer- Reviewed Conference Papers:

- c1. Sturges, R.H., 1989. "Task/Effector System Models of Dexterity for Machine Assembly," *IEEE Conf. on Intelligent Control*, Albany, NY, Sept, 1989.

- c2. Sturges, R.H., and Kilani, M.I., 1990. "A Function Logic and Allocation Design Environment," *Proc. Industrial Process Control Conf. '90*, Detroit, MI, April, 1990.
- c3. Sturges, R.H., Bourne, D.A., and Wang, W., 1990. "Real Time Interpretation of Acoustic Emissions in Milling," *Proc. Industrial Process Control Conf. '90*, Detroit, MI, April, 1990.
- c4. Sturges, R.H., 1990. "A Rationale for Workholding Design," *Proc. Industrial Process Control Conf. '90*, Detroit, MI, April, 1990.
- c5. Sturges, R.H., 1990. "Toward a Rational Workholding Methodology," *IEEE Int'l Conf. on Robotics and Automation*, Cincinnati, OH, May, 1990.
- c6. Sturges, R.H., and Laowattana, S., 1991. "A Flexible Tendon-Controlled Device for Endoscopy," *IEEE Int'l Conf. on Robotics and Automation*, Sacramento, CA, April, 1991.
- c7. Wong, J. H.-W., and Sturges, R.H., 1992. "An Extension of Design for Assembly Methods for Large and Heavy Parts," *ASME Japan-USA Symposium on Flexible Automation*, San Francisco, July 1992.
- c8. Sturges, R.H., 1991. "Monitoring Milling Processes through AE and Tool/Part Geometry," *Proc. 4th World Meeting on Acoustic Emission*, Sept. 1991, Boston MA.
- c9. Sturges, R.H., and Laowattana, S., 1992. "Virtual Wedging in Three Dimension Peg Insertion Tasks," *Proc. ASME 4th Flexible Assembly Systems Conf.*, Sept 1992, Phoenix, AZ, pp tbd..
- c10. O'Shaughnessy, K., and Sturges, R.H., 1992. "A Systematic Approach to Conceptual Design," *ASME Fourth Int'l Conf. on Design Theory and Methodology*, Sept 1992, Phoenix, AZ, pp tbd.
- c11. Wong, J. H.-W., and Sturges, R.H., 1992. "Design for Assembly Factors for Large and Heavy Parts," *Proc. ASME 18th Design Automation Conf.*, Sept 1992, Phoenix, AZ, pp tbd.
- c12. Sturges, R.H., and Yang, J.-T., 1992. "Design for Assembly Evaluation of Orientation Difficulty Features," *Proc. ASME 18th Design Automation Conference*, Scottsdale, AZ, Sept. 13-16, pp tbd.
- c13. Sturges, R.H., 1992. "Towards Computer-Aided Value Engineering," *Proc. Soc. American Value Engineers Conference -- 1992*, Phoenix, AZ, June 1992, pp tbd.
- c14. Sturges, R.H., and Laowattana, S., 1992. "Virtual Wedging in Three Dimensional Peg Insertion Tasks," *IEEE Int'l Conf. on Intelligent Robots and Systems (IROS '92)*, Raleigh, NC, July, 1992, pp tbd.
- c15. Sturges, R.H., and Yang, J.-T., 1992. "Design for Assembly Evaluation of Orientation Difficulty Features," *Proc. ASME National Design Engineering Conference*, Chicago, IL, Feb 24-27, 92-DE-8.

- c16. Sturges, R.H., 1992. "Stability Models for Analog Matrix Inversion," *Proc IASTED Conf on Control & Robotics*, Vancouver, BC, Aug 4-7, 92
- c17. Sturges, R.H., 1992. "Accuracy Improvement for Analog Matrix Inversion," *Proc IASTED Conf. on Control & Robotics*, Vancouver, BC, Aug 4-7, 92
- c18. Sturges, R.H., 1992. "A Computational Model for Conceptual Design," *Proc. AI in Design '92*, June 1992, Pittsburgh, PA, pp-tbd
- c19. Sturges, R.H., 1992. "An Approach to Zero Set-Up Panel Bending," *Proc. ASME 18th Design Automation Conference*, Scottsdale, AZ, Sept. 13-16, pp tbd.
- c20. Wong, J. H.-W., and Sturges, R.H., 1992. "An Index of Difficulty for Manual Assembly of Large and Heavy Parts," *ASME PED Symp. on Concurrent Engineering*, 1992 Winter Annual Meeting.
- c21. Sturges, R.H., and Yang, J.-T., 1992. "Design for Assembly Evaluation of Orientation Difficulty Features," *ASME PED Symp. on Concurrent Engineering*, 1992 Winter Annual Meeting.
- c22. U. Flemming, S. Finger, J. Adams, C. Carlson, R. Coyne, S. Fenves, R. Ganeshan, J. Garrett, A. Gupta, Y. Reich, D. Siewiorek, R. Sturges, D. Thomas, R. Woodbury, 1992, "Form-Function Synthesis in Engineering Design," AAAI Fall Symposium Series, *Design from Physical Principles*, Cambridge, MA, October, 1992.
- c23. Wang, C-H., & Sturges, R.H., "Concurrent Product/Process Design with Multiple Representations of Parts," *'93 IEEE Robotics & Automation Conf.*, Atlanta GA, May 2-7, 1993.
- c24. Sturges, R.H., "The Function of Value Engineering," *9th International Conference on Engineering Design*, The Hague, The Netherlands, Aug 17-19, 1993.
- c25. Sturges, R.H., & Reed, R.G., "An Application of Extended Function Logic to the Design of a Wearable Computer," *9th International Conference on Engineering Design*, The Hague, The Netherlands, Aug 17-19, 1993.
- c26. Sturges, R.H., 1993. "The Function of Value Engineering," *ASME Design Automation Conference*, Albuquerque, NM, Sept 19-22, 1993.
- c27. Reed, R.G., & Sturges, R.H., "A Model for Performance-Intelligent Design Advisors," *ASME Design Automation Conference*, Albuquerque, NM, Sept 19-22, 1993.
- c28. Hunt, D.O. & Sturges, R.H., 1993. "Application of an Information-Based Design for Assembly Theory to Assembly Workstation Design," *ASME Design Automation Conference*, Albuquerque, NM, Sept 19-22, 1993.
- c29. Sturges, R.H., and Laowattana, S., 1993. "A Spatial Freedom Representation Derived from Solid Models," *ASME Design Automation Conference*, Albuquerque, NM, Sept 19-22, 1993.

- c30. Hunt, D.O. & Sturges, R.H., 1994. "Detection and Evaluation of Planes of Partial Symmetry in CAD Models," *ASME Design Automation Conference*, Minneapolis, NM, Sept. 1994.
- c31. Sturges, R.H. & Hunt, D.O., 1994. "Acquisition Time Reduction through New Design for Assembly Heuristics," *ASME Design Automation Conference*, Minneapolis, NM, Sept. 1994.
- c32. Sturges, R.H., and Laowattana, S., 1994. "Passive Assembly of Non-Axi-Symmetric Rigid Parts," *IEEE Int'l Conf. on Intelligent Robots and Systems (IROS '94)*, Germany, September 11-18, 1994.
- c33. Sturges, R.H., and Laowattana, S., "A Voice-Actuated Tendon-Controlled Device for Endoscopy," *Medical Robotics and Computer Assisted Surgery Conference*, September 22-24, Sept. 1994 Pittsburgh, PA.
- c34 Sturges, R.H., and Laowattana, S., 1994. "Polygonal Peg Insertion with Orthogonal Compliance," presented at *ASME Japan-USA Symposium on Flexible Automation*, Kobe, Japan, July 11-18, 1994. Also presented at the *5th ASME Conference on Flexible Assembly Systems*, Minneapolis, NM, Sept. 1994.
- c35. Sturges, R.H., and Laowattana, S., 1995. "Fine Motion Planning through Constraint Network Analysis," *1995 IEEE Int'l Sym. on Assembly and Task Planning*, Aug 10-11, Pittsburgh, PA, pp. 160-170.
- c36. Roston, G. and Sturges, R.H., 1995. "Genetic Design Methodology for Structure Configuration," *1995 ASME Design Automation Conference*, Sept. 12-17 Boston, MA.
- c37. Elkins, K. & Sturges, R.H., 1995. "Towards Flexible Sheet Metal Manufacture through In-Process Angle Measurement and Control," *ASME WAM, PED Symp. on Dimensional Measurement, Analysis and Control for Sheet Metal Forming and Assembly*. Dec. 1995.
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c70. Fong, N.H., and Sturges R. H., “Modeling and Design of a Responsive Manufacturing System Using Classical Control Theory and Six-Sigma Methodology” Proceedings 58th Annual Quality Congress, May 24-26, 2004, Toronto, Ontario, Canada. *Awarded “Best Student Paper”*

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- a11. O'Shaughnessy, K., and Sturges, R.H., 1993. "A Systematic Approach to Conceptual Design," *19th NSF Conf. on Manufacturing Systems*, North Carolina State University, Jan 1993, pub. by SME, NY, NY.
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- a34. Sainani, M. & Sturges, R.H., 1999. "Review of Robotic Manipulability Measures," *Proc. 1999 NSF Design & Manufacturing Grantees Conf.*, Los Angeles, CA, Jan 4-6, pub. by SME, Dearborn, MI.
- a35. Jayavardhan, M., & Sturges, R.H., 1999. "Sensor-Free Robotic Assembly" *Proc. 1999 NSF Design & Manufacturing Grantees Conf.*, Los Angeles, CA, Jan 4-6, pub. by SME, Dearborn, MI.
- a36-a49. Fourteen (14) Technical Reports delivered as part of our Phase One activities for ONR, Panama City, FL.

D. Sections or Chapters:

1. Sturges, R.H., 1992. "Reliability and Safety in Teleoperation," book chapter in *Safety, Reliability and Human Factors in Robotic Systems*, James H. Graham, editor, Van Nostrand-Reinhold, January 1992.

2. Sturges, R.H., and Laowattana, S., 1996. "A Voice-Actuated Tendon-Controlled Device for Endoscopy," book chapter in *Computer Integrated Surgery*, R.H. Taylor, ed. MIT Press, pp. 603-617.

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F. *Other Writings*:

Theses:

Sturges, R.H., 1969. "Design Modifications of the ME Braille," SB-SM Thesis, MIT.

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Sturges, R.H., "Moving Body and Mind: From Industry to University," *CIT*, Summer 1991.

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Selected Research Report Titles from Westinghouse Electric Corporation:

Please Note: The majority of the author's work between April 1974 and October 1987 is proprietary to the Westinghouse Electric Company and remain in their library. The selection below is representative of these works. Corporate departmental policy regarding listing of author's names on research reports varied. Those titles without named authors for which the candidate is the sole or senior author are denoted with an asterisk.

w1. *"Nuclear Fuel Pellet Inspection Gaging System," MRDD Report 76-8G8-HANFO-R1, 156pp., May 1977.

w2. *"Coupler Hand-Offs in Plug Weld Repair System," 7J41-PLUGR-05C, 13pp, June, 1977

- w3. **“Steam Generator Service Arm and Master Manipulator Design Report,”* 7J42-FOLLO, 36pp, July 1977
- w4. **“M/STI SAM Coupler Design Program,”* 7J42-PRDES, 50pp, Sept 1977.
- w5. **“Steam Generator M/STI SAM Coupler System,”* 7J42-CPLTO, 19pp, Sept 1977.
- w6. Sturges, R.H., 1978. *“The Structurally-Efficient Manipulator,”* Westinghouse R&D Center report 1J43-INHOS-R1.
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- d2. Sturges, R.H., 1972. *“Teleoperator Arm Design Progress,”* MAT-53, 11 pp, June 1972.
- d3. Sturges, R.H., 1972. *“On the Moving Base Problem,”* MAT-54, 3pp, July 1972.
- d4. Sturges, R.H., 1973. *“Singularities and Redundancies of the PaR-3000 Jacobian,”* MAT-80, 5 pp, January 1973.
- d5. Sturges, R.H., 1973. *“Six Degree of Freedom End-Effector Design,”* MAT-113, 4 pp, March, 1973.
- d6. Sturges, R.H., 1973. *“Work Volume of a Revolute Arm,”* MAT-133, 3pp, May, 1973.
- d7. Sturges, R.H., 1973. *“Optimization of Robot Link Parameters for Engine Assembly,”* MAT-145, 5 pp, June 1973.
- d8. Sturges, R.H., 1973. *“Wrist Force Sensor Elasticity Analysis,”* MAT-186, 4 pp, Dec, 1973.

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d12. Sturges, R.H., 1973. "Teleoperator Arm Design," C. S. Draper Laboratories Report E-2746.

d13. Nevins, J.L., et al., 1974. "Exploratory Research in Industrial Modular Assembly," R-800, 200pp, March, 1974.

d14. Nevins, J.L., et al., 1974. "A Scientific Approach to the Design of Computer Controlled Manipulators," R-837, 180pp, August, 1974.

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o1. Sturges, R.H., & Nehring, R., 2008. "Process Mapping the LCS-1 IETM," 14 pp., Jan 2008.

o2. Sturges, R.H., Nehring, R., & Steeneck, D., 2008. "Work Measurement for the LCS-1 IETM," 110 pp., April 2008.

o3. Sturges, R.H., & Nehring, R., 2009. "Part Mating Science for the LCS-1," 14 pp., May 2009.

o4. Sturges, R.H., Nehring, R., & Steeneck, D., 2009. "Simple Task Analysis for the LCS-1," 8 pp., June 2009.

o5. Sturges, R.H., Nehring, R., & Steeneck, D., 2009. "Pareto Analysis for the LCS-1," 15 pp., April 2009.

o6. Sturges, R.H., & Steeneck, D., 2009. "Simple Task Analysis for the LCS-1," 15 pp., April 2009.

o7. Sturges, R.H., & Butler, K., 2009. "Materials Handling Analysis for the LCS-1," 14 pp., June 2009.

o8. Sturges, R.H., & Mayer, B., 2009. "Materials Handling Workshop Results," 18 pp., September 2009.

o9. Sturges, R.H., & Mead, P., 2009. "Sea State Simulation Theory," 3 pp., November 2009.

o10. Sturges, R.H., & Steeneck, D., 2009. "Cost-Time Profiling for the LCS-1," 13 pp., September 2009.

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G. Discussions:

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H. Patents Awarded:

Title	Number	Date
1. Remote Access Manipulator	4,168,782	09-25-79
2. Photoelectric Docking Device	4,295,740	10-20-81
3. Electromech. Display Apparatus	4,316,189	02-16-82
4. Pellet Inspection Apparatus	4,349,112	09-14-82
5. Surface Flaw Detection	4,377,238	03-22-83
6. Apparatus and method for classifying fuel pellets for nuclear reactor	4,448,680	04-15-84
7. Fuel Transfer Manipulator	4,485,067	11-27-84
8. Vernier Press Brake Die Set	4,489,587	12-25-84
9. Apparatus for Mapping...an Element within a Field of Elements	4,503,506	03-05-85
10. Manipulator ... for Decontaminating Nuclear Steam Generators	4,521,844	06-04-85
11. Wire Routing & Terminating Device	4,862,927	09-04-89
12. Apparatus for Assembly of Axisymmetric and Non-Axisymmetric Rigid Parts	5,396,714	03-14-95
13. Flexible Steerable Device for Exploratory Procedures	5,759,151	09-03-97
14. Method and apparatuses for control of bending operations	5,761,940	06-09-98
15. Method and apparatuses for	6,292,716	09-18-01

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16. Automated continuous haulage system 7,076,346 07-11-06

GRANTS AND CONTRACTS

A. Awarded to Date

1. Analog Matrix Inversion, CMU Faculty Grant, \$4,800, 1988-1990, Principal Investigator.
2. Design for Assembly Evaluation, Engineering Design Research Center. NSF Support: \$243,000 from 1988 through 1994. Principal Investigator
3. Development of Smart Endoscopes, Center for Entrepreneurial Development, \$15,000 in-kind; Pittsburgh Roboscope Co., PA, \$17,000 in-kind; Advanced Technology Center of Western PA, \$48,000; and, AT&T Foundation, \$30,000, 1988-1989. Principal Investigator
4. Representation of Aircraft Design Data for Supportability, Operability, and Producibility Evaluations, Boeing Helicopter Company, \$58,000, June 1989 - December 1989. Principal Investigator
5. The Teaching Factory, DARPA, General Motors, \$35,000, 1988-1989. Co-Principal Investigator with Duane Adams (Computer Science), et al.
6. "1990 George Talman Ladd Award," Carnegie Mellon University, \$3,000, 1990.
7. Design for Manufacture of the CMT, U.S. Post Office, Mellon Institute, \$35,000, 1989-1990. Role: Principal Investigator
8. Intelligent Manufacturing Workcell, DARPA, CMU-RI. This co-PI granted \$35,000. Co-Principal Investigator with David Bourne (Robotics)
9. Toward Achieving Dexterity in Flexible Assembly Systems, NSF Research Initiation, \$60,000, September 1989 - August 1990. Principal Investigator
10. Function Logic Models of Design, AT&T Grant to EDRC, \$12,500, 1990-1991. Principal Investigator
11. Research in Rapid Assembly and Part Design, NSF PYI, \$312,500, August 1990 - July 1995. Principal Investigator
12. Design for Manufacture of the CMT, U.S. Post Office, Mellon Institute, \$21,000, 1990. Principal Investigator
13. Mail Flow Analysis, U.S. Post Office, Mellon Institute, \$10,000, 1990. Principal Investigator

14. An Intelligent Bending Workstation, U.S. Amada Corp, \$55,000/year, July 1991 through June 1995. Co-Principal Investigator with D. Bourne (Robotics) and P. Khosla (ECE)
15. Devices for Advanced Laparoscopic Surgery, Mercy Hospital Foundation, \$15,000, September 1991. (Awarded, but withdrawn due to change of personnel at Mercy Hospital.) Principal Investigator
16. Development of Smart Endoscopes, CMU Faculty Development, \$2,000, August 1992. Principal Investigator
17. Value Chain Implications for Green Design, NSF Management of Technological Innovation Program, \$200,000, October 1994 - September 1997. Co-Principal Investigator with S. Kekre and K. Srinivasan (GSIA)
18. Planning Assembly of Sheet Metal Products, U.S. Amada Corp., \$75,000/year, January 1995 through May 1997. Co-Principal Investigator with D. Bourne (Robotics)
19. Grant for research in Design for Manufacture, Westinghouse Electric Corp, \$21,000, December 1994. Principal Investigator
20. Total Passive Automatic Assembly, NSF DMII, May 1995 - April 1998, \$260,000. Principal Investigator
21. Contact State Space: Automatic Generation, Reasoning and Search, NSF CISE/IRI: Robotics and Machine Intelligence, Sept. 1997-Aug 1999, Grant No. GPG/NSF 95-27, \$225,000. Co-PI (\$78,000) with Dr. Jing Xiao, PI, of UNC-Charlotte.
22. Mobile Bridge Carrier Guidance, Long-Airdox Corp. and Virginia CIT, Aug 1998-July 1999. \$200,000. Principal Investigator
23. Green Engineering Curriculum Development, VT, Aug 1998-May 1999. \$5,000. Principal Investigator
24. Environmentally Conscious Manufacturing, VT ReachOUT, Oct 1998-June 1999. \$7,500. Principal Investigator
25. Continuous Miner and Battery Haulage Design, Long-Airdox Corp. and Virginia CIT, Aug 1999-July 2000. \$200,000. Principal Investigator
26. Continuous Haulage and Battery Haulage Analysis & Manufacturing, Long-Airdox Corp. and Virginia CIT, Aug 2000-July 2001. \$80,000. Principal Investigator
27. Non-Autoclave Composite Materials and Structures, NASA, through UNO/NCAM program, June 2001-March 2002. \$389,000. Co-PI (\$122,530)
28. Pre-Fabricated Steel Building Analysis, Future Steel Ltd., Ont. Canada, \$27,900. Principal Investigator

29. Center for High Performance Manufacturing, Virginia CTRF, July 2001-2004. \$4.35 million, one of 12 co-PI's (\$77,161)
30. Advanced Weapons Elevator, Newport News Shipbuilding, March 2002-December 2002. \$370,000. Co-PI with Virginia Consortium for Material Handling and logistics, (\$50,000)
31. Non-Autoclave Composite Materials and Structures, NASA, through UNO/NCAM program, June 2002-March 2003. \$200,000. Co-PI (\$65,000)
32. Continuous Haulage and Battery Haulage Analysis & Manufacturing, DBT America, Jan 2002-May 2003. \$12,500. Principal Investigator
33. Nat'l Center for Advanced Manufacturing/NASA, "Non-Autoclave Processing And Manufacture Of Large Reusable Aerospace Structures", co-PI with Al Loos, et al. (VT ESM), This co-PI responsible for \$65,300 in Year 3 (July 03-March 04) due to cut-back in the program from original levels.
34. Center for High Performance Manufacturing, Virginia CTRF, July 2001-2004. \$4.35 million, one of 12 co-PI's (\$77,161)
35. CHPM Company Project: Bristol Compressor, PI, \$49,875. (Aug 03-Feb 04)
36. CHPM Company Project: DBT Hillsville, PI, Aug 25 '03, \$25,025. (Aug 03-Dec 03)
37. CHPM Company Project: Federal-Mogul, co-PI 25%, \$27,975 + \$12,102 cost sharing. (July 03-Dec 03)
38. DBT America, Pulaski Division, "Control of REACH System Vehicles," 2 projects initiated. 15 Aug 03, PI, \$24,180; and 1 Jan 04, PI, \$30,677. (Aug 03-Jun 04)
39. International Technologies of Pittsburgh, two gifts of \$10,000 each, in December, 2003, and in April '04 "to support Professor Robert H. Sturges's research and laboratory work in Engineering Design and Manufacturing Processes."
40. CHPM Center Project: PI, \$48,736 "Process Mapping and Cost-Time Profiling in Support of Lean Manufacturing". (July 04-July 05)
41. Titan Corp. PI, \$110,000 "Designing and Defending Against Swarming Behavior", (Aug 04-May 05)
42. NSF, "Embodiment Awareness" Sub Fund \$45,000; supporting Francis Quek, PI
43. CHPM Project "Strain Model" \$8,000, PI, for Metalsa Corp.

44. Nat'l Center for Advanced Manufacturing/NASA, "Non-Autoclave Processing And Manufacture Of Large Reusable Aerospace Structures", co-PI with Romesh Batra, et al. (VT ESM), responsible for \$22,000 in Year 5 (July 05-March 06).

45. Concoa, Inc., "New Product Design & Development", PI, \$48,812 from Concoa, \$26,765 State match, total = \$75,487.

46. ONR, "Meeting Mandated Manning Requirements Through Effort Leveling", PI, \$1,577,418; co-PI's Thurmon Lockhart and Roger Anderson; responsible for \$981,318. (Jan 08-May 09)

47. ONR, "Meeting Mandated Manning Requirements Through Effort Leveling: Phase 2", PI, \$745,404; co-PI Thurmon Lockhart; responsible for \$372,702. (Jan 10-May 11)

48. TEMCI, "New Product and Process Development for SVI", PI, \$80,000; responsible for \$80,000. (June 2011, May 2012)

49. TEMCI, "Second Product and Process Development for SVI", PI, \$80,000; responsible for \$80,000. (June 2012, May 2013)

Total as PI: \$4,556,069; Total in Research Projects \$8,216,822 (Nov 1987 - present)

B. Proposals Pending total requested in FY 2011 = \$880,000.

PROFESSIONAL ACTIVITIES

A. Short Courses:

1. "Design for Quality in Manufacturing," for the Carnegie Bosch Institute, Advanced Program for Technical Managers, 8 class contact hours: August 1991.

2. "Manufacturing Concerns in Design," for the Carnegie Bosch Institute, Advanced Program for Technical Managers, 12 class contact hours: August 1992.

3. "Design for Manufacture," for the Carnegie Bosch Institute, Advanced Program for Technical Managers, 12 class contact hours: August 1993.

4. "TQM and Design for Manufacture," for the Korean/GSIA Management Institute, Program for Technical Managers, 9 class contact hours: August 1995.

5. "Excellence in Manufacturing," for the Executive Education Network (EXEN) with CMU Graduate School of Industrial Administration, 3 class hours by direct satellite, with 2-way audio interaction. February 1996.

6. "Management of Technological Information," for the Executive Education Network (EXEN) with CMU Graduate School of Industrial Administration, 3 class hours by direct satellite, with 2-way audio interaction. March 1996.

7. "Excellence in Manufacturing," for the Executive Education Network (EXEN) with CMU Graduate School of Industrial Administration, 3 class hours by direct satellite, with 2-way audio interaction. April 1997.

8. "Design For Assembly Workshop: Theory and Practice," for Long-Airbox Company, one day session, Blacksburg, Virginia, June, 1999

9. "Value Analysis Workshop: 8-16 UniHauler," for Long-Airbox Company, eight weekly 4-hour sessions, Blacksburg, Virginia, Aug.-Sept., 2000

10. "Design for Manufacture and Assembly," for ABB, Ltd. one day sessions presented at Pine Tops, NC; Brno, Czech Rep.; Ratingen, Germany; Nashik, India; Cairo, Egypt; Sao Paulo, Brasil. 2004 - 2005

Seminars:

1. "Design for Assembly Methods," CMU Robotics Institute Colloquium, August, 1985.

2. "Robotic Dexterity," Ben Franklin Institute, May, 1986.

3. "Human and Machine Dexterity," CMU Mechanical Engineering Department Graduate Seminar, October, 1986.

4. "Design for Producibility." METAC Symposium, January, 1989.

5. "Dexterity for Automated Assembly," Ohio State University Mechanical Engineering Graduate Seminar Series, invited speaker, Nov 1989.

6. "Workholding and Design for Manufacture," CMU Robotics Institute, April, 1990.

7. "Design For Assembly: Theory and Practice," Ohio State University Mechanical Engineering Graduate Seminar Series, invited speaker, May 1990.

8. "Design for Manufacture," Lord Corporation, Erie, PA, November, 1990.

9. "A Flexible Tendon-Controlled Device for Endoscopy," CMU Robotics Institute, March, 1991.

10. "Functional Process Planning for DfM," CMU Robotics Institute, October, 1991.

11. "Information Content in Design for Manufacture," CMU Engineering Design Research Center Seminar Series, November, 1991.

12. "Design for SMED in Sheet Metal Fabrication," CMU Engineering Design Research Center Seminar Series, March 5, 1992.

13. "Design for Manufacture," CMU Post College Professional Education Program for Technical Managers, March 20, 1992.
14. "Single-Minute Bending Set-Ups with a Vernier Punch and Die Set," CMU Robotics Institute, March 31, 1992.
15. "Design for Manufacture: Is There Any Other Way?" CMU College of Fine Arts Seminar Series, April 20, 1992.
16. "Applications of Symmetry to Sheet Metal Part Design and Manufacture," CMU Robotics Institute, June 23, 1992.
17. "Getting the Design Process Started," CMU Engineering Design Research Center Seminar Series, June 24, 1992.
18. "Flexible Assembly Systems," for the EC Researchers, EC/US Collaboration on Advanced Manufacturing, at EDRC, October 27, 1992.
19. "An Advisor for Designing a Process and a Process for Designing an Advisor," CMU Engineering Design Research Center Seminar Series, DfM Lab, 9 Feb 1993.
20. "Passive Assembly," CMU Mechanical Engineering Department Graduate Seminar, November, 1993.
21. "Design For Assembly: Product and Process," Ohio State University Mechanical Engineering Graduate Seminar Series, invited speaker, April 1994.
22. "Automating the Planning of Sheet Metal Products," CMU Robotics Institute, May 23, 1994.
23. "Assembly Strategy 2000," EARN Program Speaker, 25 May, 1994. Also presented at the Production Engineering Research Labs of Hitachi, Ltd., Himeji, Japan, 18 July 1994.
24. "Design for Manufacture: Myths and Realities," CMU Mechanical Engineering Department Graduate Seminar, April, 1995.
25. "Passive Assembly," University of Pittsburgh Mechanical Engineering Department Graduate Seminar, October, 1995.
26. "Getting it All Together: Modern Manual and Machine Assembly Measurement," SPQA, Virginia Forum for Excellence, Workshop 6, April 29, 1998, Richmond, VA.
27. "Modern Optimization Methods in Design," invited seminars at KMIT, Thonburi, and KMUT, Ladkrabang, Bangkok, Thailand, 2006.
28. "Collaborative Automotive Design" for International Co-op program with IESTM, Monterrey Mexico, Fall 2007.

29. "Robotic Safety Considerations" for ASSE, Roanoke, VA, 5 March 2010.

30. "The Next Killer App" for ISE Department, VT, 21 October 2011.

Videotape Productions:

"Design for Manufacture," 10:00, June 1986.
"Design for Assembly Calculator," 16:15, July 1986.
"Voice-controlled Flexible Endoscope," 2:35, June 1989.
"Smart Endoscope Development at CMU," 4:25, Feb 1991.
"Model Mail Culler Demonstration," 3:32, April, 1991.
"24-101 Introduction," 11:00, August, 1991.
"24-101 Lecture Series," approx 6 hours, April 1992.
"Spatial Remote Center Compliance," 4:10, September 1992.
"24-101 Live Steam Challenge," Part I, 4:02, October 1992.
"24-101 Live Steam Challenge '92," Part II, 3:50, December 1992.
"Passive Assembly," 10:30, November, 1993.
"Flexible Gripper for Sheetmetal Handling," 2:50, December, 1994.
"Rational VHS Cassette Design," 5:00, April 1995.
"Passive Assembly of Multiple Pegs and Screws," 4:00, July, 1996.
"This is ISE Manufacturing," 35:20, August, 2000
"Shop Hobbing," 18:10, September 2008
"Sea-State Simulator Platform" 4:00, October 2010
"TruTrac Model Operation" 18:00, February 2012

B. Government Committees:

1. "NSF Workshop on Computer Assisted Surgery," 28 Feb - 2 Mar 1993, Wash. DC, Plenary Session Speaker.
2. NSF DDM Proposal Review Panel, April 27-28, 1993, Wash. DC.
3. NSF DMII Proposal Review Panel, April 25-26, 1995, Wash. DC.
4. NSF IIS Proposal Review Panel, September 1998, remote.

C. Memberships:

Sigma Xi, Member.
ASME, Member
IIE, Member
Westinghouse Engineer's Society, President 1978.

D. Editorial Roles:

Reviewed Papers for:

Advances in Engineering Software
AI EDAM
ASME Design Theory & Methodology Conferences
ASME Japan-USA Conf. on Flexible Automation
ASME Journal of Engineering for Industry

ASME Journal of Engineering Materials and Technology
ASME Journal of Mechanical Design
ASME Manufacturing Review
Computing Systems in Engineering
FAIM Transactions
IEEE Control Systems Society
IEEE Expert
IEEE International Robotics and Automation Conferences
IEEE Trans. on Control Systems Technology
International Journal of Robotics Research
Journal of Computer Aided Design
Mechatronics
International Journal of Solids and Structures
Journal of Engineering Design

E. Professional Awards:

Professional Engineer, Commonwealth of Pennsylvania, certificate number PE-041434-E, Jan 1991.

“1990 George Talman Ladd Award,” recognizing excellence in research for a young faculty member, Carnegie Mellon University.

“1990 Presidential Young Investigator,” National Science Foundation.

“B.G. Lamme Fellowship,” Westinghouse Electric Corp., 1984.

“Silver Signature Award,” Westinghouse Electric Corp., 1983, for the development of the Wire Harness Flexible Manufacturing System.

“Engineering Achievement Award,” Westinghouse Productivity and Quality Center, Oakdale, PA, 1982, for the development of the Mobile Interactive Terminal.

“Dean’s Teaching Excellence Award,” Virginia Tech, April 2005.

F. Service/Committees:

CMU:

Manufacturing Strategy Task Force (1988-91)
Xerox CMU Challenge TQM Program (June 1992)
Interdisciplinary Design MS Program Planning Committee (1992)
Faculty Development Committee (1992-93)
MSMEM Degree Program Development (1992-93)
Multidisciplinary MS Design Program Development (1992)
ESL Oral Examinations Workshop (1994)

Carnegie Institute of Technology, Mechanical Engineering:
Departmental Undergraduate Committee (1988-89)

Departmental Seminar Program Coordinator (1988-89)
 Departmental Graduate Committee, Graduate Applications Coordinator (1989-90), Design Curriculum Subcommittee
 Coordinator (1990, 1991), Qualifying Exam Coord (93)
 Departmental Faculty Search Committee (1989-90, etc.)
 Departmental Freshman Course Committee (1990-91, 94-95)
 Departmental Undergraduate Committee (1993-95)

VPI&SU, Industrial & Systems Engineering:

Awards Committee (1997-2004)
 Undergraduate Honor Board Panelist (2000-2008)
 Graduate Honor Board Panelist (2007-2008)
 AdHoc P&T Committee (2004-2005)

VPI&SU, Mechanical Engineering:

Formula SAE Team Advisor (1998-2000)
 Graduate Program Committee (1999-2001)

VPI&SU, College/University:

Engineering Faculty Organization, member (1998-present)
 Engineering Faculty Organization, Chair (2001-present)
 College of Engineering Commencement Committee, General Marshall
 College of Engineering Green Engineering Program Steering Committee
 College of Engineering Undergraduate Curriculum Committee
 Commission on Undergraduate Curriculum
 Commission on Undergraduate Studies And Policies
 Intellectual Property Committee

IEEE: Session Chair "Integration and CAD/CAM," *Third Int'l Conf. on Computer Integrated Manufacturing*, RPI, Troy, NY, May 1992.

ASME:

1. Session Chair, "Machining and Manufacturing Processes," *ASME 18th Design Automation Conference*, Scottsdale, AZ, Sept. 15, 1992
2. Panelist, "Research Opportunities in Flexible Assembly," *ASME 18th Design Automation Conference*, Scottsdale, AZ, Sept. 14, 1992
3. Session Chair, "Concurrent Engineering," *ASME 19th Design Automation Conference*, Albuquerque, NM, Sept. 20, 1993
4. Program Committee, *Japan-USA Symposium on Flexible Automation*, Boston, MA, July, 1996.
5. ASME Student Design Contest Committee, 1997-2000.
6. Program Committee, and Session Chair, *3rd ASME-DFM Conference*, Atlanta, GA, Sept. 13-16, 1998.
7. Conference Chair, *4th ASME-DFM Conference*, Las Vegas, NV, Sept. 12-14, 1999.
8. Program Committee, and Session Chair, *5th ASME-DFM Conference*, Baltimore, MD, Sept. 11-13, 2000.
9. ASME DFM Committee, Vice Chair, 1999-2001
10. Program Committee, *Japan-USA Symposium on Flexible Automation*, Denver CO., July, 2004.

11. Session Chair CAD' 04 International CAD Conferences and Exhibitions, May 24-28, 2004. Pattaya, Thailand
 12. Session Chair CAD' 06 International CAD Conferences and Exhibitions, Jun 19-23, 2006. Phuket, Thailand
- SME: Student Section Advisor, 2007-2009, 2009,-2011

Other:

“NSF Workshop on Computer Assisted Surgery,” 28 Feb - 2 Mar 1993, Wash., DC.
Plenary Session Speaker.

“First Int’l Symposium on Medical Robotics and Computer Assisted Surgery,”
Pittsburgh, PA, 22-24 Sept 1994, Program Committee.

Mentor in "The LiNC Project": a joint research effort on behalf of the National Science Foundation Networking Infrastructure for Education program between Virginia Tech and Montgomery County Public Schools, Spring 1999.

Mentor for International Co-op program with IESTM, Monterrey Mexico, Fall 2007, Spring 2008.

Mentor for student team in the Roanoke Valley Governor's School, project on "Hyper-miling" any late-model car with an OB2 connector and an iPod. Fall 2010.

Panelist for AAAS proposals, 2105.

**APPENDIX B TO THE
DECLARATION OF DR. ROBERT H. STURGES**

Litigation Support Experience

Expert Engagement:

Type of Matter: Patent
Law Firm: Reed Smith
Case Name: Vamco v. Sankyo
Services Provided: Hired by Vamco, expert report, depositions, testimony
Disposition: Judgment in favor of Vamco
Date: February 1991

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: TDC Electronics v. Toll Partners, Inc.
Services Provided: Hired by Toll Partners, expert report, depositions, testimony
Disposition: Judgment (3x) in favor of Toll Partners
Date: August 1992

Expert Engagement:

Type of Matter: Trade Secret
Law Firm: Buchanan Ingersoll
Case Name: Hauser v. RACO
Services Provided: Hired by Hauser, expert report, depositions, testimony
Disposition: Judgment in favor of Hauser
Date: October 1992

Expert Engagement:

Type of Matter: Patent
Law Firm: Reed Smith
Case Name: McClain v. KNI
Services Provided: Hired by KNI, expert report, depositions, demonstratives, testimony
Disposition: Judgment in favor of KNI
Date: June 1994

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: Stnd Car Truck v. A. Stucki Co.
Services Provided: Hired by A. Stucki Co, expert report, depositions, demonstratives, testimony
Disposition: Judgment in favor of Stucki
Date: Aug 1995

Expert Engagement:

Type of Matter: Patent
Law Firm: Cleary Gottlieb
Case Name: Ricoh Co v. ICMI/Nashua
Services Provided: Hired by Ricoh, expert report, depositions, testimony
Disposition: Judgment in favor of Ricoh
Date: May 1996

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: Ductmate v. Mez
Services Provided: Hired by Ductmate, expert report, depositions, testimony
Disposition: Judgment in favor of Ductmate
Date: May 1996

Expert Engagement:

Type of Matter: Patent
Law Firm: N/A
Case Name: II-VI Corp. v. Raiskin
Services Provided: Hired by II-IV Corp, expert report, depositions, testimony
Disposition: Judgment in favor of II-VI
Date: Jan 1996

Expert Engagement:

Type of Matter: Patent
Law Firm: Merchant & Gould
Case Name: Century v. Chevron
Services Provided: Hired by Chevron, expert report, depositions, testimony
Disposition: Judgment in favor of Chevron
Date: March 1996

Expert Engagement:

Type of Matter: Accident
Law Firm: Buchanan Ingersoll
Case Name: Kennedy v. Shadyside Hospital
Services Provided: Hired by Shadyside Hospital, expert report, depositions
Disposition: Settled in favor of Shadyside Hospital
Date: Sept 1996

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: AGR
Services Provided: Hired by Buchanan Ingersoll, written opinion
Disposition: ---
Date: Sept 2001

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: Electrogrip v. MEC
Services Provided: Hired by MEC, expert report, deposition
Disposition: Settled
Date: Aug 1998

Expert Engagement:

Type of Matter: Patent
Law Firm: Kane Dalsimer
Case Name: Daktronics v. Trans-lux
Services Provided: Hired by Trans-lux, expert report, depositions
Disposition: Settled
Date: October 1999

Expert Engagement:

Type of Matter: Patent
Law Firm: Kane Dalsimer
Case Name: Kirsh v. Brother, Int'l
Services Provided: Hired by Brother Int'l, expert report, depositions, testimony
Disposition: Settled
Date: June 1999

Expert Engagement:

Type of Matter: Trade Secret
Law Firm: N/A, FTI Consulting
Case Name: Memtec v. Puroflow
Services Provided: Hired by Memtech, expert report, depositions, testimony
Disposition: Judgment in favor of Puroflow
Date: February 1999

Expert Engagement:

Type of Matter: Patent
Law Firm: Myers Bigel
Case Name: Tee-Lok v. MiTek
Services Provided: Hired by Tee-Lok, expert report, depositions, testimony
Disposition: Judgment in favor of MiTek
Date: August 1999

Expert Engagement:

Type of Matter: Patent
Law Firm: Lewis Rice
Case Name: Engle v. Systemation
Services Provided: Hired by Engle, expert report, depositions, testimony
Disposition: Judgment in favor of Engle
Date: 2000

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: GETS v. Wabtech
Services Provided: Hired by Wabtech, expert report, depositions, testimony
Disposition: Judgment in favor of Wabtech
Date: May 2003

Expert Engagement:

Type of Matter: Patent
Law Firm: Lewis Rice
Case Name: TruFitness v. Precor
Services Provided: Hired by TruFitness, expert report, depositions, testimony
Disposition: Judgment in favor of TrueFitness
Date: Jan 2001

Expert Engagement:

Type of Matter: Patent
Law Firm: Lewis Rice
Case Name: SRAM v. AD-II
Services Provided: Hired by SRAM, expert report, depositions, testimony
Disposition: Judgment in favor of SRAM
Date: Jan 2002

Expert Engagement:

Type of Matter: Patent
Law Firm: Pillsbury Winthrop
Case Name: Kirsch v. TABS
Services Provided: Hired by TABS, expert report, depositions, testimony
Disposition: Judgment in favor of TABS
Date: Feb 2006

Expert Engagement:

Type of Matter: Patent
Law Firm: Stradling Yocca
Case Name: Intuitive v. Computer Motion
Services Provided: Hired by Computer Motion, expert report, depositions, testimony
Disposition: Settled: buyout of Computer Motion by Intuitive
Date: May 2003

Expert Engagement:

Type of Matter: Patent
Law Firm: Moss & Rocovich
Case Name: Musser v. Group7
Services Provided: Hired by Musser, expert report, depositions, testimony
Disposition: Judgment in favor of Musser
Date: March 2004

Expert Engagement:

Type of Matter: Patent
Law Firm: Reed Smith
Case Name: Medrad v. Liebel-Flarsheim
Services Provided: Hired by Medrad, expert report, depositions, testimony
Disposition: Judgment in favor of Medrad (historic)
Date: March 2005

Expert Engagement:

Type of Matter: Patent
Law Firm: Buchanan Ingersoll
Case Name: Newell v. Intercrown
Services Provided: Hired by Intercrown, expert report, deposition
Disposition: Settled
Date: Aug 2010

Expert Engagement:

Type of Matter: Contract/Technical
Law Firm: N/A
Case Name: Morrill Motors v. Lamb Technicon
Services Provided: Hired by Lamb Technicon, expert report, depositions, testimony
Disposition: Settled in favor of Lamb Technicon
Date: March 2005

Expert Engagement:

Type of Matter: Patent
Law Firm: Oblon Spivak
Case Name: Ricoh v Katun
Services Provided: Hired by Ricoh, expert reports, depositions
Disposition: Settled
Date: June 2007?

Expert Engagement:

Type of Matter: Patent
Law Firm: Oblon Spivak
Case Name: NPI v. Gamber-Johnson
Services Provided: Hired by Gamber-Johnson, expert report, deposition
Disposition: Settled
Date: June 2006

Expert Engagement:

Type of Matter: Patent
Law Firm: Myers Bigel
Case Name: Avitech v. Embrex
Services Provided: Hired by Embrex, expert report, depositions, testimony
Disposition: Settled in favor of Embrex
Date: ?

Expert Engagement:

Type of Matter: Patent
Law Firm: Vorys Sater Seymour & Pease
Case Name: Kendall Holdings v. Eden Cryogenics, LLC
Services Provided: Hired by Kendall, expert report, court testimony
Date: 2008-11

Expert Engagement:

Type of Matter: Patent
Law Firm: Banner & Witcoff
Case Name: Sure Bros. v. N/A
Services Provided: Hired by Sure Bros., expert report
Disposition: Settled

Robert H. Sturges, Jr., Ph.D., PE

Date: Feb 2008

Expert Engagement:

Type of Matter: Patent
Law Firm: Polsinelli
Case Name: Dentsply v. Forestadent
Services Provided: Hired by Dentsply, expert report, depositions, testimony
Disposition: Judgment in favor of Forestadent
Date: Feb 2010

Expert Engagement:

Type of Matter: Trade Secret
Law Firm: Vorys Sater
Case Name: Kendall Holdings v. Eden Cryogenics
Services Provided: Hired by Kendall, expert report, depositions, testimony
Disposition: Jury in favor of Kendall
Date: Oct 2013

Expert Engagement:

Type of Matter: Patent
Law Firm: Thompson Hine
Case Name: Hyko v. Hillman
Services Provided: Hired by Hyko, expert report, depositions, testimony
Disposition: Judgment in favor of Hyko
Date: June 2012

Expert Engagement:

Type of Matter: Patent, ITC
Law Firm: Fitzpatrick Cella
Case Name: Canon KK v. Multiple Defendants
Services Provided: Hired by Canon KK, expert report, depositions, testimony
Disposition: Judgment in favor of Canon KK
Date: August 2012

Expert Engagement:

Type of Matter: Patent
Law Firm: McDermott Will & Emory
Case Name: Lincoln Electric v. National Standard
Services Provided: Hired by National Standard, expert report, depositions, testimony
Disposition: Settled in favor of National Standard
Date: July 2012

Expert Engagement:

Type of Matter: Patent
Law Firm: Hayes Boone
Case Name: Imaginal v. Legget & Platt

Robert H. Sturges, Jr., Ph.D., PE

Services Provided: Hired by Legget & Platt, expert report, depositions, testimony
Disposition: Settled in favor of Legget & Platt
Date: Aug 2012

Expert Engagement:

Type of Matter: Patent
Law Firm: Orrick
Case Name: Imaginal v. Legget & Platt
Services Provided: Hired by Legget & Platt, expert report, depositions, testimony
Disposition: Settled in favor of Legget & Platt
Date: Oct 2014

Expert Engagement:

Type of Matter: Patent, IPR
Law Firm: Fitzpatrick Cella
Case Name: Canon KK v. General Plastic
Services Provided: Hired by Canon KK, expert report, deposition
Disposition: Jury held for Canon
Date: 20 June 2017

Expert Engagement:

Type of Matter: Patent
Law Firm: Boies Schiller
Case Name: ROY-G-BIV v. ABB
Services Provided: Hired by ROY-G-BIV, expert report, depositions
Disposition: Settled, ROY-G-BIV patents held valid in landmark AIA case
Date: Sept 2014

Expert Engagement:

Type of Matter: Patent
Law Firm: Beck Thomas
Case Name: Ductmate Ind. v. Famous Distr.
Services Provided: Hired by Ductmate, expert report, declarations
Disposition: Settled in favor of Ductmate
Date: Nov 2014

Expert Engagement:

Type of Matter: Patent
Law Firm: McCarter English
Case Name: OncQue v KAZ
Services Provided: Hired by OncQue, expert report
Disposition: Settled
Date: November 2015

Expert Engagement:

Type of Matter: Patent
Law Firm: Dickstein Shapiro/ Blank Rome
Case Name: Murata v. Daifuku
Services Provided: Hired by Daifuku, expert report, depositions, IPR
Disposition: Settled
Date: Sept 2016

Expert Engagement:

Type of Matter: Patent
Law Firm: Munck Wilson Mandala
Case Name: Nintendo v iLife
Services Provided: Hired by iLife, expert report, depositions
Disposition: ongoing
Date: --

Expert Engagement:

Type of Matter: Patent
Law Firm: Greenberg Traurig
Case Name: Megdal v La-Z-Boy
Services Provided: Hired by La-Z-Boy, expert report, court testimony
Disposition: Favorable to La-Z-Boy
Date: 6 March 2016

Expert Engagement:

Type of Matter: Patent
Law Firm: Brinks Gilson
Case Name: Fontem v RJReynolds Vapor
Services Provided: Hired by RJReynolds, IPR expert reports
Disposition: ongoing
Date: --

Expert Engagement:

Type of Matter: Patent
Law Firm: Mintz Levin
Case Name: Medigus v Endochoice
Services Provided: Hired by Medigus, expert consulting
Disposition: Defendants defaulted
Date: 2 Nov 2016

Expert Engagement:

Type of Matter: Patent
Law Firm: Alston & Bird
Case Name: Hyosung v Diebold
Services Provided: Hired by Diebold, expert report, court testimony

Disposition: Hearing Completed
Date: 4 Nov. 2016

Expert Engagement:

Type of Matter: Patent
Law Firm: Lewis-Rice
Case Name: Fox Factory v SRAM; SRAM v Fox Factory
Services Provided: Hired by SRAM, expert report
Disposition: On going
Date: Nov. 2016

Additional Litigation Consulting Experience

- Emery Tree Services, Inc., Pittsburgh, PA: Intellectual property, device analysis
- Baxter Healthcare, Chicago, IL: Manufacturing Process Analysis
- AGR International, Inc., Pittsburgh, PA: Intellectual property, device analysis
- U.S. Filter, Inc., Orlando, FL: Intellectual property, device analysis
- Enviro Tek, Inc., Waterford, VA: Process design and analysis
- Bear Archery, Inc., Orlando, FL: Manufacturing/Tolerance analysis
- Westinghouse AirBrake Company, Pittsburgh, PA: Intellectual property, device analysis
- Marvin Windows, Inc.: Intellectual property, device analysis
- Musser Lumber, Inc., device analysis.
- Excel Products, Inc.: Intellectual property, device analysis
- Simmons Co.: Intellectual property, device analysis

Additional Consulting Experience

- Rockwell International Corp., Raleigh, NC: Engine valve line welding robot design and controls
- W G Products, 7875 Saltsburg Rd., Pittsburgh, PA: Magnetic field/structure analysis for high current circuit breakers
- Westinghouse Electric Corp., Pittsburgh, PA: Robotic handling system design for Savannah River Laboratory,
- Hall Industries, Inc., Pittsburgh, PA: Electromechanical system design, manufacturing process controls
- Lord Corp, Aerospace Products Division, Erie, PA: Design for manufacture
- American Carbon & Metals Corp., Pittsburgh, PA: Design, device analysis
- Sensus Technologies, Inc., Uniontown, PA: Automatic assembly system analysis