EXHIBIT 1004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

IMIRACLE HK LIMITED,
PETITIONER,

v.

VPR BRANDS, LP,
PATENT OWNER.

Case IPR2023-01255

U.S. Patent No. 8,205,622

DECLARATION OF DR. ROBERT H. STURGES REGARDING U.S. PATENT NO. 8,205,622

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I, Robert H. Sturges, hereby declare as follows:

I. INTRODUCTION

1. I have been retained as a technical expert by counsel on behalf of iMiracle HK Limited ("Petitioner"). I understand that Petitioner is requesting that the Patent Trial and Appeal Board institute an *Inter Partes* review ("IPR") proceeding of U.S. Patent No. 8,205,622 ("the '622 Patent," EX1001).

2. I have been asked by Petitioner's counsel ("Counsel") to provide my independent analysis and consideration of whether certain references teach or suggest the features recited in claims 12-15 and 17-18 (the "Challenged Claims") of the '622 Patent. My opinions and the bases for my opinions are set forth below. My opinions are based on my education and experience.

3. In writing this Declaration, I have considered the following: my own knowledge and experience, including my teaching and work experience in the fields of mechanical/electrical system design and analysis; and my experience of working with others involved in those fields. In forming my opinions, I have considered the '622 Patent, its prosecution history, and the materials referred to herein. Further, I may consider additional documents and information in forming any necessary opinions – including documents that may not yet have been provided to me.

4. I am not, and never have been, an employee of Petitioner. I have no

financial interest in either party or in the outcome of this proceeding. I am being compensated for my work as an expert at a rate of $675 per hour, for all tasks involved. My compensation is not dependent on the outcome of these proceedings or on the content of my opinions. I will not receive any added compensation based on the outcome of any IPR or other proceedings involving the ’622 Patent.

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

II. QUALIFICATIONS

6. My qualifications for forming the opinions in this report are summarized here and explained in more detail in my curriculum vitae (“CV”), which is provided as Appendix A appended hereto.

7. As detailed in my CV, I have extensive experience in the research, design, development, and manufacture of electromechanical systems, with a career spanning over forty years in this field. I have extensively studied and designed various fluid power systems, including a robotic arm and robotic end effectors. 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 Polytechnic Institute (“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.

8. I earned my Combined Bachelor of Science and Master of Science in Mechanical Engineering from Massachusetts Institute of Technology in 1969. I obtained a Doctor of Philosophy in Mechanical Engineering from Carnegie Mellon University in 1986.

9. I had over fifteen-year's engineering work experience focusing on the design of various mechanical/electrical systems. I had taught undergraduate and graduate courses of Mechanical Engineering. From 1987 through 1997, I worked as an Assistant Professor and then an Associate Professor in the Mechanical Engineering Department at Carnegie Mellon University. From 1997 to 2017, I was a Professor in the Departments of Mechanical and Industrial Systems Engineering at Virginia Tech.

10. I have previously served as an expert in patent infringement cases involving electronic cigarettes. I also served as an expert in multiple IPR cases involving electronic cigarettes. A list of my past expert engagements is provided as Appendix B appended hereto.

11. Based on my experience and education, I believe that I am qualified to opine as to the knowledge and level of skill of one of ordinary skill in the art at the time of the alleged invention of the '622 patent ("POSITA"; refer to Section VII, below) and what such a person would have understood at that time, and the state of

the art during that time.

III. MATERIALS AND OTHER INFORMATION CONSIDERED

12. All of the opinions contained in this declaration are based on the documents I have reviewed and my professional judgment, as well as my education, experience, and professional knowledge. I am not an attorney and I am not offering any legal opinions in this declaration.

13. In forming the opinions expressed in this declaration, I relied upon my education, knowledge, and experience in the relevant field of the art, and have considered the viewpoint of a POSITA as of the alleged invention date of the ’622 patent. I have considered the materials referenced herein, including the ’622 Patent (EX1001), excerpts of the prosecution history (EX1003) of the ’622 Patent and the following materials:

- Certified English Language Translation of Chinese Patent Publication No. 201051862 (“Tao,” EX1006);
- Certified English Language Translation of Chinese Patent Publication No. 201029436 (“Yang,” EX1009);
- International Patent Application Publication No. WO 2008/139411 (“Wang411,” EX1012);
- U.S. Patent No. 8,375,957 (“Hon,” EX1013);
- Certified English Language Translation of Chinese Patent Publication

No. 201188868 (“Wang868,” EX1014);

- U.S. patent No. 6,594,369 (“Une,” EX1018); and
- Other materials which I understand are attached to the Petition.

14. I have considered these materials through the lens of a POSITA related to the ’622 Patent as of the alleged invention date, and I have done so during my review of these materials.

IV. SUMMARY OF MY OPINIONS

15. This Declaration explains the conclusions that I have formed based on my knowledge and experience and my review of the prior art references listed above. To summarize, I have concluded that:

- Claims 12 – 15 are anticipated by and/or obvious over Tao;
- Claims 12 – 15 are obvious over Yang and Tao;
- Claims 12 – 14 are anticipated by and/or obvious over Wang411;
- Claims 17 and 18 are obvious over Hon and Tao; and
- Claims 17 and 18 are obvious over Hon, Tao, and Wang868.

V. LEGAL STANDARDS FOR PATENTABILITY

16. In forming my analysis and conclusions expressed in this declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by Counsel.

A. Anticipation

17. I understand that a patent claim is invalid if it is anticipated by a single item of prior art. I understand that an anticipation analysis involves two steps. First, the patent claims are construed to ascertain their scope. Second, each construed asserted claim is compared to the prior art reference on an element-by-element basis. If the prior art reference discloses or contains each and every element of the claimed invention, either expressly or inherently, then it anticipates the claim.

18. I understand that anticipation by inherent disclosure is appropriate only when a prior art reference necessarily includes or discloses the unstated claim element. I further understand that there is no requirement that a POSITA would have recognized the inherent disclosure at the time of the invention.

19. For anticipation by a prior art publication or document, I understand that the reference's description must enable a POSITA to practice the claimed invention without undue experimentation. I further understand that the following factors may be considered to determine whether any experimentation would have been undue:

a) The quantity of experimentation necessary;

b) The amount of direction or guidance presented;

c) The presence or absence of working examples;

d) The nature of the claimed invention;

e) The state of the prior art;

f) The relative skill of those in the art;

g) the predictability or unpredictability of the art; and

h) The breadth of the claims.

B. Obviousness

20. I understand that a claimed invention is unpatentable 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 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 understand that a patent claim may be invalid because it was obvious in view of the prior art.

21. I further understand that a determination of whether a claim would have been obvious must consider several factors, including, among others:

a) The level of ordinary skill in the art at the time the invention was made;

b) The scope and content of the prior art; and

c) What differences, if any, existed between the claimed invention and the prior art.

22. I understand that the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to a person of ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider at least the following factors:

a) Whether the teachings of the prior art references disclose known concepts combined in familiar ways, which, when combined, would yield predictable results;

b) Whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;

c) Whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by a person of ordinary skill in the art;

d) Whether a person of ordinary skill in the art would have recognized a reason to combine known elements in the manner described in the claim;

e) Whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and

f) Whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

23. I understand that a person of ordinary skill in the art has ordinary creativity, and is not an automaton.

24. I understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered, and I have not done that in regards to my opinions expressed herein.

25. I understand that certain factors—often called "secondary considerations"—may support or rebut an assertion of obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the alleged invention, skepticism of those having ordinary skill in the art at the time of the alleged invention, unexpected results of the alleged invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I further understand that there must be a nexus— a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness. Further, it is my understanding that evidence of secondary considerations does not always

overcome a strong showing of obviousness.

VI. OVERVIEW OF THE ’622 PATENT

26. The ’622 Patent includes 18 claims, of which claims 1, 12, 13, 16, and 17 are independent. EX1001, 6:26–8:45. The claims are listed as follows:

Independent Claim 1	
1.Pre	An electronic cigarette comprising
1.1	a tubular electronic inhaler and
1.2	a tubular electronic atomizer that is detachably attached to the electronic inhaler,
1.3	wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer, and
1.4	wherein the tubular electronic atomizer includes a container and media within the container,
1.5	the media is soaked with a solution to be atomized, and
1.6	between the container and the media there is a side-space for airflow tubular electronic, and
1.7	wherein the tubular electronic inhaler includes an electric airflow sensor configured to turn on and off the electric power source by way of detecting an airflow, and
1.8	the airflow sensor is a diaphragm microphone.

Dependent Claims 2 - 11	
2.Pre	The electronic cigarette of claim 1, wherein the electronic inhaler includes a first electric connector disposed at a second end of the electronic inhaler, wherein the electronic atomizer includes a second

Dependent Claims 2 - 11	
	electric connector disposed at a first end of the electronic atomizer, and wherein the first electric connector is connected to the second electric connector so that the electronic inhaler and the electronic atomizer form the electronic cigarette.
3.	The electronic cigarette of claim 1, wherein the liquid container prevents or reduces liquid leak and reverse flow.
4.	The electronic cigarette of claim 3, wherein the electronic atomizer includes an electric heating wire which generates heat for atomization of the solution soaked in the media inside the liquid container, a heat equalizer onto which the electric heating wire is wired and is made of fibers that can withstand a temperature up to 2000 degrees centigrade.
5.	The electronic cigarette of claim 4, wherein the electronic atomizer includes a leak-proof member, wherein the leak-proof member and a second electric connector are closer to the first end of the electronic atomizer than the heat equalizer.
6.	The electronic cigarette of claim 5, where the first electric connector is a DC socket and the second electric connector is a DC plug, wherein the DC plug is embedded onto the leak-proof piece through a plug seat, which is connected to the electric heating wire, and wherein the first end of the electronic atomizer is connected to the second of the electronic inhaler by placing the DC plug to the DC socket.
7.	The electronic cigarette of claim 6, wherein the first electric connector is a cylinder terminal, and its outskirt is tightly embedded into the second end of the electric inhaler tube and its exposed portion has a screw thread, wherein the second electric connector is a cylinder terminal, which is tightly embedded into the first end of the electronic atomizer and has a screw thread inside the inhaler tube, and wherein the first electric connector and second electric connector are connected through the screw
8.	The electronic cigarette of claim 1, wherein the electronic atomizer includes, in sequence, a second electric connector, a leak-proof piece, a supporting piece, a heat equalizer coupled with an electric heating wire, the container filled with the media, and an atomizer cap with an air-puffing hole.
9.	The electronic cigarette of claim 1, wherein the electric power source is inside the electronic inhaler.

Dependent Claims 2 - 11	
10.	The electronic cigarette of claim 1, wherein the tubular electronic atomizer includes an exterior wall having an air-puffing hole formed therethrough, wherein the liquid container includes a container wall, there being a chamber disposed between the exterior wall and the container wall, and wherein the tubular electronic atomizer includes a tube extending from the air-puffing hole and into the chamber.
11.	The electronic cigarette of claim 1, wherein the media comprises cotton.

Independent Claim 12	
12.Pre	An electronic cigarette comprising
12.1	a tubular electronic inhaler and
12.2	a tubular electronic atomizer,
12.3	wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,
12.4	the electronic cigarette further comprising an integrated circuit board that has a Single Chip Micyoco that controls atomization of a liquid solution.

Independent Claim 13	
13.Pre	An electronic cigarette comprising
13.1	a tubular electronic inhaler and
13.2	a tubular electronic atomizer,

Independent Claim 13	
13.3	wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,
13.4	the electronic cigarette further comprising an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow and
13.5	sending a signal to a Single Chip Micyoco,
13.6	wherein the Single Chip Micyoco receives the signal from the electric airflow sensor, instructs the electric power source to send an electric current to the electronic atomizer, and a time period and a magnitude of the electric current.

Dependent Claims 14-15	
14.	The electronic cigarette of claim 13, wherein the electric airflow sensor is a diaphragm microphone.
15.	The electronic cigarette of claim 13, further comprising an LED indicator inside the electronic inhaler, wherein the LED indicator is connected to the Single Chip Micyoco and the electric power source, and wherein the on time of the LED indicator is controlled by the Single Chip Micyoco.

Independent Claim 16	
16.Pre	An electronic cigarette comprising
16.1	a tubular electronic inhaler and
16.2	a tubular electronic atomizer,
16.3	wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,

Independent Claim 16	
16.4	wherein the electronic inhaler includes, sequentially from a first end of the electronic inhaler to the second end, a cigarette cap, an LED indicator, the electric power source, an electric airflow sensor, a circuit board for a Single Chip Micyoco, and a first electric connector.

Independent Claim 17	
17.Pre	An electronic cigarette comprising:
17.1	a tubular electronic inhaler and
17.2	a tubular electronic atomizer that is detachably attached to the electronic inhaler,
17.3	wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,
17.4	wherein the tubular electronic atomizer includes a container and media within the container,
17.5	the media is soaked with a solution to be atomized,
17.6	wherein the tubular electronic atomizer includes an exterior wall having an air-puffing hole formed therethrough,
17.7	wherein the liquid container includes a container wall, there being a chamber disposed between the exterior wall and the container wall,
17.8	wherein the tubular electronic atomizer includes a tube extending from the air-puffing hole and into the chamber, and
17.9	wherein the tubular electronic inhaler includes an electric airflow sensor configured to turn on and off the electric power source by way of detecting an airflow,
17.10	and the airflow sensor is a diaphragm microphone.

Dependent Claim 18	
18.	The electronic cigarette of claim 17, wherein the tubular electronic atomizer includes, in sequence, an electric connector, a leak-proof piece, a supporting piece, a heat equalizer coupled with an electric heating wire, the container filled with the media, and the air-puffing hole.

A. Specification

27. The ’622 patent is directed to an electronic cigarette. EX1001, 2:23–25. The ’622 patent generally describes the electronic cigarette includes an electronic inhaler and an electronic atomizer 22. EX1001, 2:25–30.

28. FIG. 2 shows a section view of the electronic atomizer 22 according to an embodiment. The ’622 Patent explains that the electronic atomizer 22 “includes an atomizer tube 263, and inside the atomizer tube 263, a second electric connector 267 with an internal screw thread … supporting piece 268, heat equalizer 269 twined with electric heating wire 265, liquid container 261.” *Id.*, 4:36-40. The ’622 states that “liquid-storing media 264 filled with liquids” is inserted inside the liquid container 261. *Id.*, 4:40-43.

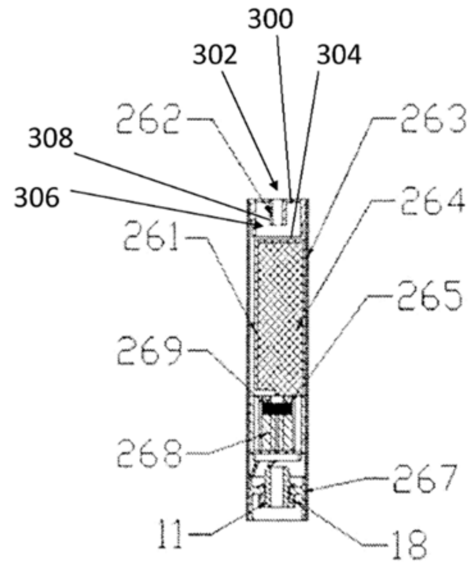


Figure 2

29. The ’622 explains that “[t]he two ends of the electric heating wire 265 are going through the small holes of the supporting piece 268 and connected to the second electric connector 267 to supply heat for atomization or vaporization of the liquid inside the liquid-storing media 264.” *Id.*, 4:58-62.

30. The ’622 explains that “the tubular electronic atomizer includes exterior wall 300 having air-puffing hole 302 formed therethrough.” *Id.*, 6:19-21. The ’622 explains that “[l]iquid container 261 includes a container wall 304” and “[c]hamber 306 is disposed between exterior wall 300 and container wall 304.” *Id.*, 6:21-22. The ’622 further states that “tube 308 extends from air-puffing hole 302 and into chamber 306.” *Id.*, 6:23-24.

31. FIG. 4 is section view of an electronic inhaler according to an embodiment. The ’622 explains that “[t]he electronic inhaler includes an inhaler tube 10, cigarette cap 13 with small holes for air inflow, LED indicator 12, electric power source 5, annular tube 16 with its cap 15, integrated circuit board with a CPU processor 14, electric airflow sensor 6, sensor supporter 61, and first electric connector 17.” *Id.,* 5:9-14. The ’622 indicates that the integrated circuit board 14 has a single chip micyoco 3. *Id.,* 7:35-37.

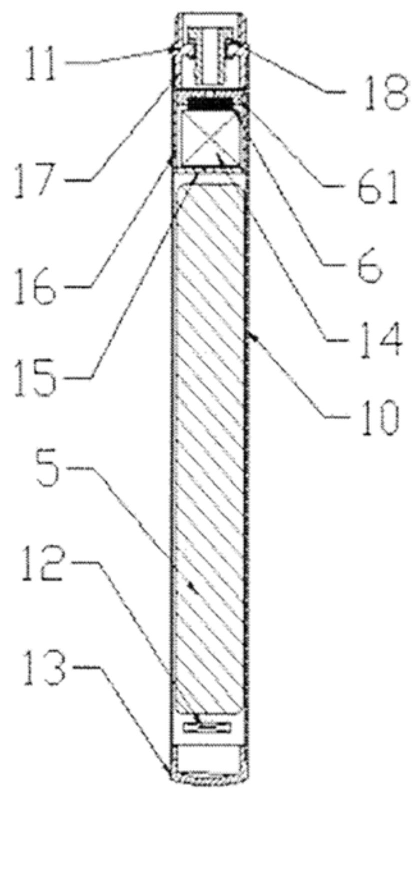


Figure 4

32. The ’622 explains that “[t]he electric power source 5 connects to the

circuit board 14, which connects to the first electric connector 17 and the electric airflow sensor 6." *Id.*, 5:16-18. The '622 explains that "the LED 12 is connected to both electric power source 5 and the circuit board 14." *Id.*, 5:18-19.

33. The '622 acknowledges that "[t]he electronic inhaler of the present invention represents the state-of-the-art electronic cigarette technology in both structural design and microelectronic devices." *Id.*, 3:21-24. Nonetheless, the '622 indicates alleges that "[o]ne of the new technologies that may be used with an electronic cigarette of the present invention is the use of an electric airflow sensor instead of a mechanical device in detecting an airflow generated by the user's puffing and creating a signal for the microprocessor to activate the electric circuit." *Id.*, 3:25-28. The '622 Patent indicates that the electric airflow sensor is "more sensitive" to the puffing of users "than the conventional mechanical system" and "[t]he life of the electric airflow sensor can last … many times longer than the mechanical device." *Id.*, 3:39-43.

34. The '622 states that the first electric connector 17 has "an outskirt screw thread" and "can be connected to the second electric connector [267] of the electric atomizer [22] to form an electronic cigarette." *Id.*, 5:21-24.

35. "When the user puffs on the electronic cigarette through the air-puffing hole [302] on the first end of the atomizer [22], the electronic sensor [6] detects an airflow and converts it to a signal, which then wakes up the single chip

micyoco [3] to record the signal." *Id.*, 2:51-54. The single chip micyoco 3 "may turn on the electric power source 5 to supply an electricity current with a predefined time length." *Id.*, 2:55-57. The '622 states that the electric current flows through the electric heat wire inside the atomizer tube and the electric heat wire heats up to "convert[] the liquid into a form of vapor mist, which is finally drawn into the month of the user." *Id.*, 2:60-61.

36. The '622 explains that "[t]he magnitude of the electric current supplied from the electric power source 5 depends on the magnitude of signal detected from the airflow proportional to the strength of user's puffing action." *Id.*, 4:26-29.

B. Summary of the Prosecution History

37. The Examiner initially found, among other things, the pending claims 1, 7, 8, 11, and 12 to be anticipated by European Patent No. 0845220 ("Susa," EX1019) and the pending claims 9, 10, 13, and 14 to be obvious over Susa. EX1003, 263-66. In addition, the Examiner indicated that claims 2 and 6 would be allowable if rewritten in independent form because, although Susa teaches using a circuit board to control the operation, Susa does not teach or suggest specifically using a Single Chip Micyoco to control the atomization in the electronic cigarette. EX1003, 266. The Examiner interpreted the "Single Chip Micyoco" to be a type of chip. *Id.*, 267.

38. In response, Applicant amended claim 1 to recites an electronic cigarette that includes "a tubular electronic inhaler and a tubular electronic atomizer that is detachably attached to the tubular electronic inhaler, wherein the tubular includes an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow." *Id.*, 238. Applicant argued that SUSA "does not include an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow." *Id.* Also, Applicant followed the Examiner's suggestion to rewrite claims 2 and 6 in independent form to get the claims allowed. *Id.*, 237.

39. Despite of the amendment and arguments, the Examiner rejected claims 1, 7, and 12 as being anticipated by U.S. Patent No. 5,060,671 ("Counts," EX1020). *Id.*, 218. The Examiner also rejected claims 8-11, 13, and 14 as being unpatentable over Counts in view of Susa. *Id.*, 219.

40. Applicant responded to the Examiner's rejections by amending claim 1 to recite "the tubular electronic atomizer includes a container and media within the container, the media is soaked with a solution to be atomized, and between the container and the media there is a side-space for airflow." *Id.*, 112. Applicant further added new claims 15-20. New claims 15-17 depend from claim 1. *Id.*, 114. New claim 18 is an independent claim and claims 19-20 depend from claim 18. *Id.*

41. Claim 18 recites, in part, "wherein the tubular electronic atomizer

includes an exterior wall having an air-puffing hole formed therethrough, wherein the liquid container includes a container wall, there being a chamber disposed between the exterior wall and the container wall, and wherein the tubular electronic atomizer includes a tube extending from the air-puffing hole and into the chamber." *Id.*, 114. Applicant alleged that "[t]hese features inhibit flow of liquid to the user's mouth" and "Susa and Counts, individually and combined, fail to teach these features." *Id.*

42. Despite of the amendments and allegations, the Examiner made further amendments on independent claims 1 and 18 before allowing the case. *Id.*, 84. In particular, the Examiner added further limitations "wherein the tubular electronic inhaler includes an electric airflow sensor configured to turn on and off the electric power source by way of detecting an airflow, and the airflow sensor is a diaphragm microphone" to independent claims 1 and 18. *Id.*, 85 and 89.

43. In the Notice of Allowance, the Examiner states that Counts and Susa are considered the closest prior art to the invention. *Id.*, 90. The Examiner indicated that, while prior art such as U.S. Patent Application Publication No. 2008/0092912 ("Robinson," EX1021) teaches electronic having the atomizing solution soaked into a media, neither Counts nor Susa teach or suggest using a diaphragm microphone as the airflow sensor. *Id.*

44. It is my understanding that the Examiner did not consider Tao, Yang,

Wang411, Hon, or Wang868 during the prosecution of the ’622 Patent.

VII. LEVEL OF ORDINARY SKILL IN THE ART

45. I understand that the ’622 Patent must be reviewed through the eyes of a person having ordinary skill in the art. I understand that is a hypothetical person who 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.

46. In determining the characteristics of a hypothetical person of ordinary skill in the art of the ’622 patent at the time of the claimed invention, I considered several things, including the type of problems encountered in this field, and the rapidity with which innovations were made. I also considered the sophistication of the technology involved, the educational background and experience of those actively working in the field, and the level of education that would be necessary to understand the ’622 patent. Finally, I placed myself back in the relevant period of time and considered the state of the art and the level of skill of the persons working in this field at that time.

47. It is my opinion that relevant and related art for the claims of the ’622

Patent include 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 POSITA for the ’622 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 five years of experience designing electromechanical devices, including those involving circuits, electroacoustics, fluid mechanics and heat transfer. A person could also have qualified as a person of ordinary skill in the art with some combination of (1) more formal education and less technical experience or (2) less formal education and more technical or professional experience in the fields listed above.

48. For this petition only, I have been asked to assume the invention date for the ’622 Patent is March 24, 2009. Although my qualifications and experience exceed those of the hypothetical person having an ordinary level of skill in the art, my analysis and conclusions herein are from the perspective of a person of ordinary skill in the art by March 24, 2009, unless otherwise noted.

VIII. CLAIM CONSTRUCTION

49. I understand that a claim must be construed under the *Phillips* standard. Under that standard, words of a claim are given their plain and ordinary meaning as understood by person of ordinary skill in the art at the time of

invention, in light of the specification and prosecution history, unless those sources show an intent to depart from such meaning, as well as pertinent evidence extrinsic to the patent.

50. For purposes of this declaration, I interpreted the claim terms in the below table as having the proposed claim construction stipulated by Patent Owner in the related Case No. 2-20-cv-02185 in the District Court for the District of Arizona. EX1005.

Claim Terms	**Claims**	**Proposed Claim Construction**
"electric airflow sensor"	13 and 17	An electric sensor to detect air movement generated by a user's inhaling or puffing act.
"time period and a magnitude of the electric current"	13	The duration of time and the strength of the current that is provided to the heating element.
"diaphragm microphone"	14	A device for converting pressure waves into electrical energy using a thin sheet of material that is capable of vibrating.

51. Otherwise, I applied the plain and ordinary meaning of each other term as would have been understood by a person of ordinary skill in art at the time of the alleged invention.

IX. THE PRIOR ART

A. Overview of Tao

52. Similar to the ’622 Patent, Tao is directed to a simulated cigarette simulating the effect of a cigarette. EX1006, 5.

53. Tao discusses a simulated cigarette disclosed by its prior art in 2005 with Chinese Patent Application No. 200420031182.0. *Id.*, 4. In this prior art, “the vaporization controller is composed of a sensor and an electronic circuit board, and the electronic circuit board includes an electronic switch circuit and a high-frequency generator. A mechanical sensor detects whether an airflow passes. If so, the high-frequency circuit is controlled to be started, and then starts the vaporizer. However, the whole vaporization controller is only used as a switch for use, and cannot control the smoking quantity of the vaporizer.” *Id.*, 6

54. Tao indicates that the problems existing in the prior art includes “[t]he electronic vaporization device has a complex structure and high manufacturing costs” and “[t]he generated vaporization amount is constant, which cannot be adjusted according to individual differences of users” resulting in a poor simulation effect. *Id.*, 4. The simulated cigarette disclosed in Tao “is intended to overcome the disadvantages of a complex structure, high manufacturing costs, and a poor simulation effect in the prior art.” *Id.*, 1

55. In contrast, the simulated cigarette disclosed in Tao “lays emphasis on a more reasonable electronic design instead of a mechanical design.” *Id.*, 6. Specifically, Tao teaches to use “the electret microphone and the electronic circuit

board" including the microprocessor and the ultrasonic circuit. *Id*. "The electret microphone may be used to sensitively receive a change in an inhalation amount of a person, and quantitatively analyze an amount of airflow through an A/D conversion circuit inside the microprocessor in the electronic circuit board, so as to determine an ultrasonic vaporization amount according to the amount of airflow." *Id*. That is, "the current of the ultrasonic circuit is adjusted according to the signal of the electret microphone, and the smoking quantity of the vaporizer is controlled by the ultrasonic circuit, which truly simulates the feeling of smoking of a person." *Id.*

56. In an embodiment, Tao discloses that the simulated cigarette includes a housing 4 "with a cigarette shape, a cigar shape, a tobacco pipe shape, or the like." *Id.*, 7. The housing 4 may "be divided into two or more sections according to carrying requirements." *Id.*

57. Tao explains that "[t]wo ends of the housing 4 are respectively provided with a simulated light-emitting end 1 and a mouthpiece 13, and an air inlet hole 2 is formed on an outer wall of the housing 4." *Id.*, 5.

58. Tao explains that "[a] battery compartment, an electret microphone cavity, and a vaporization cavity are arranged in the housing 4 in sequence from the simulated light-emitting end 1." *Id.*, 7. Tao states that the battery 6 and electronic circuit board 7 are arranged in the battery compartment, "the electret

microphone 8 is arranged in the electret microphone cavity," and a heating element 11, a vaporizer 10 and a reservoir 12 connected to the vaporizer are arranged in the vaporization cavity. *Id.*

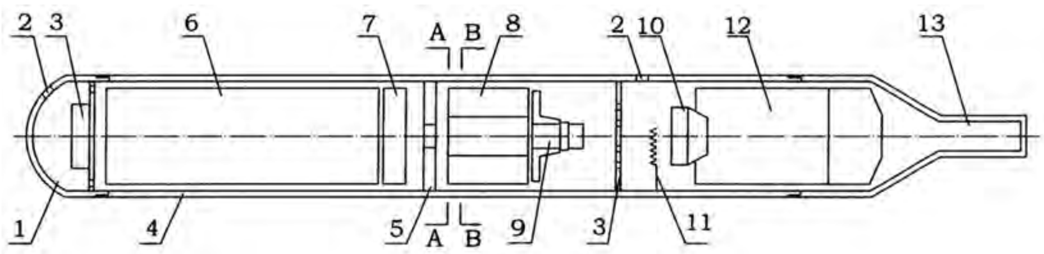


FIG. 1

59. Tao explains that "[t]he electronic circuit board 7 is composed of a microprocessor and an ultrasonic circuit." *Id.* "An output terminal of the electret microphone 8 is connected to the electronic circuit board 7" and "[a]n output terminal of the electronic circuit board 7 is connected to the vaporizer 10" and a heating element. *Id.*

60. Tao further explains that "[a] liquid guide is arranged in the reservoir 12, and the liquid guide is made of foamed nickel, stainless steel fiber felt, polymer foam, or foamed ceramics." *Id.*, 5-6.

61. "When a smoker smokes, the airflow entering from the air inlet 2 on the housing 4 at the end of the simulated light-emitting end 1 enters the electret microphone cavity …, so that the electret microphone 8 receives the airflow." *Id.*, 8. In response, "[t]he electret microphone 8 sends the signal to the microprocessor in the electronic circuit board 7, and the microprocessor transmits an instruction to

the ultrasonic circuit for transmission to the vaporizer 10." *Id.* "The vaporizer 10 starts after receiving the instruction and vaporizes an e-liquid in an e-liquid reservoir, and vaporized droplets are suspended to form aerosol." *Id.* Tao explains that "[w]hen air is inhaled from the air inlet hole 2 on the housing 4 at the end of the simulated light-emitting end 1, an airflow is also generated in the air inlet hole 2 on the housing 4 of the vaporization cavity." *Id.* As a result, "[t]he aerosol formed by the airflow with the e-liquid is sucked out by the mouthpiece 13." *Id.*

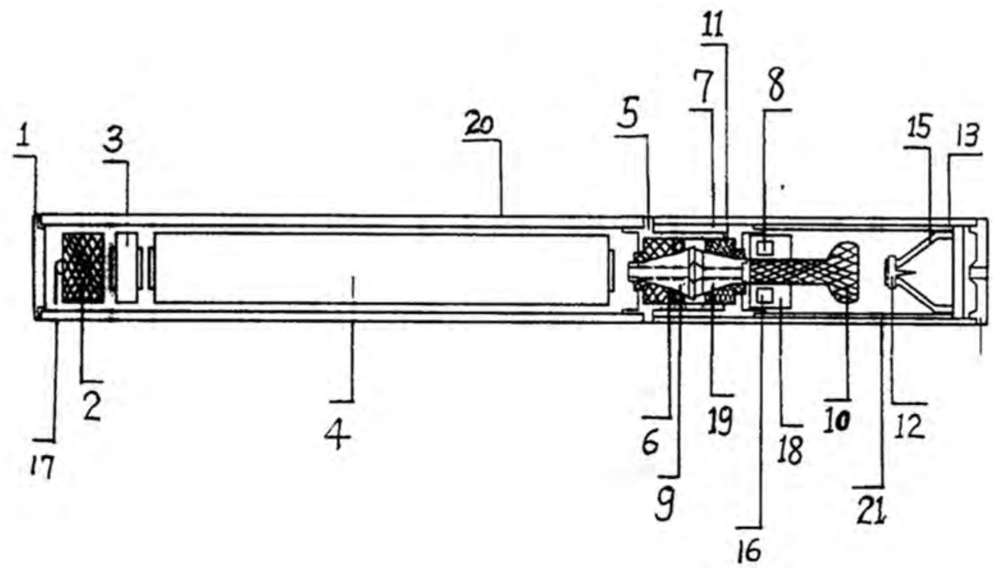
62. Tao explains that, at the time the microprocessor transmits instructions to supply the current to the vaporizer 10/heating element, "the illuminator 3 in the simulated light-emitting end 1, such as an LED, starts to emit light." *Id.*, 8 "As long as airflow exists on the electret microphone 8, the brightness of the LED is generated and changed" with the amount of the airflow. *Id.*

B. Overview of Yang

63. Yang, similar to Tao and the '622 Patent, is directed to an improved cigarette-simulating electronic device. EX1009, 3. In particular, Yang discloses "a simulated electromechanical electronic device which resembles a cigarette but is not a cigarette, which may be smoked like a cigarette." EX1009, 4.

64. Yang discloses the cigarette-simulating electronic device is "a stainless steel round tubular housing with a dimension ratio similar to a dimension

ratio of an actual cigarette." *Id.*, 3. The cigarette-simulating electronic device includes a longer cartridge-simulating tube 20 and a shorter mouthpiece-simulating tube 13, which are connected into a whole by an annular airflow guide bolt 5. *Id.*



65. Yang explains that "an integrated circuit board 2, a sensing device 3, a battery 4, and an annular airflow guide screw 5 are arranged inside the long stainless steel tube [20] in sequence from the air inlet end, thereby forming an independent control and energy output system." *Id.*, 5. Yang states "[a] light-emitting diode 17 is arranged on the integrated circuit board 2 and configured to simulate the light generated when the cigarette burns." *Id.*

66. Yang explains "[t]he annular airflow guide nut 7, the smoke generator 18, a gas-liquid mixing chamber 8, a funnel-shaped puncturing filler 15, a dust-proof damping cover 14, and a plastic sheath 21 are arranged inside a short stainless steel tube 13 in sequence to jointly form a mouthpiece system." *Id.*, 5.

67. "When airflow enters from the air inlet end, the vibration of the airflow causes the sensor 3 to work and send out a pulse signal, so that a controller in the integrated circuit 2 is started." *Id.*, 5. With the control of the controller, "[t]he power amplifier of the integrated circuit 2 keeps supplying power to a smoke generator 18 for a set period after receiving an instruction from the controller, so that [the heating coil 16 of] the smoke generator [18] operates to gasify the liquid tobacco to form smoke." *Id.*, 5 and 6.

C. The Combination of Yang and Tao was Predictable

68. Counsel has informed me that the teachings of a reference may only be used to establish unpatentability where the reference is analogous art to the'622 patent. Counsel has informed me that the reference and the '622 patent are analogous art where the reference and the '622 patent are directed to the same field of endeavor and to solving the same problem.

69. The field of endeavor of the '622 patent is an electronic cigarette. EX1001, 2:23–25. Yang and Tao are analogous art directed to the same field of endeavor as the '622 Patent. *See* EX1006, 5 ("The utility model provides a simulated cigarette."); EX1009, 3 ("The utility model relates to a cigarette-simulating electronic device realized by using electromechanical technologies, that is, a simulated electromechanical electronic device which resembles a cigarette but is not a cigarette, which may be smoked like a cigarette, and which may protect

against harm from tar in cigarettes.”).

70. The ’622 patent is directed to solving the problem of how to closely mimics the process of cigarette Smoking. *See, e.g.*, EX1001, 3:36–41 (“The new technology also makes the puffing of users on the cigarette much easier and Smoother. It is more sensitive in turning on and off the vaporizing process than the conventional mechanical system.”). Tao and Yang are directed to the same problem as the ’622 patent. *See* EX1006, 4 (“Users generally reflect that this kind of electronic cigarette is laborious to suck and smoke, and the simulation effect is poor”); EX1009, 3 (“The utility model is intended to provide an improved cigarette-simulating electronic device that simulates the cigarette smoking effect, has a similar form, a similar feeling process, and has the cigarette smoking effect and feeling.”).

71. When seeking to solve the problem of the ’622 patent, a POSITA would have predictably considered Yang and Tao because they extensively describe existing solutions to the same problem and are within the same field of endeavor as the ’622 patent.

72. A POSITA would have found it obvious to use the electret microphone 8 of Tao in place of the sensor 3 of Yang. First, the electret microphone 8 is used for the same purpose (*see* EX1006, 6]) as the sensor 3 (*see* EX1009, 5) – detecting airflow generated by a user’s inhaling or puffing act.

Second, a POSITA would have understood that Yang does not teach any structure, connection, or function that would preclude use of other types of airflow sensor. In particular, a POSITA would have understood the electret microphone can be readily connected to the integrated circuit 2 and "work and send out a pulse signal, so that a controller in the integrated circuit 2 is started." EX1009, 5.

73. The '622 patent explains that electric airflow sensors "makes the puffing of users on the cigarette much easier and smoother." EX1001, 3:34–38. Similarly, Tao teaches that, because of the use of the electret microphone, "the overall design requires a small amount of airflow, and the user does not need to exert very much strength in use and feels relaxed." EX1006, 6. When being faced with the problem of how to make puffing easier and smoother, the POSITA would have been motivated to use the electret microphone 8 in Tao in place of the sensor 3 in Yang.

74. In view of the function similarities between the electret microphone 8 and the sensor 3, the lack of Yang to describe any structure or connection which would prohibit use of another type of airflow sensor (such as the electret microphone 8), and the lack of Tao to describe the electret microphone 8 as requiring any particular structure or connection that is inapplicable to Yang, a POSITA would have had a reasonable expectation of success in making such a modification of Yang.

D. Overview of Wang411

75. Wang411 is directed to an alternative smoking device, which is in the same field of endeavor as the ’622 Patent. EX1012, ¶[0002]. Wang411 states that a common problem of previous smoking device is that they “use pressure sensors to detect a suck/ draw of the device by the consumer,” which cannot filter out the noises such as other airflow in the smoking device due to winds, vibrations or changes in atmospheric pressure and send false signal. *Id.*, ¶¶ [0005], [0031]. “This makes these devices waste significant amount of energy for heating air and agents even when the device is not actually suck/ draw on, i.e. while a release of agents is not asked for.” *Id.*, ¶[0005].

76. Fig. 1 B shows the first device 20 and the second device 30 of the smoking device 10. “The first device 20 comprises a first air inlet 25 for letting fresh air enter the device 20 and a first air outlet 26 for letting air exit the first device 20. The second device 30 comprises a second air inlet 35 meant to receive the airflow that comes out of from the first air outlet 26 and a second air outlet 36 for letting air exit the second device 30. This air that exits the second device 30 is meant to be sucked/ drawn in by the consumer of the smoking device 10.” *Id.*, ¶[0015].

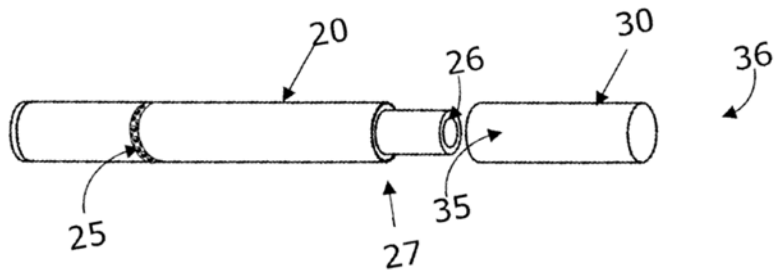


Fig. 1B

77. As shown in FIG. 1C and 1D, Wang411 explains that the first device 20 includes an accumulator 21 for storing and releasing electric energy, a sensing device 24, a heating device 22 such as a resistive coil, a charging interface 28, and control electronics 23. *Id.*, ¶[0018].

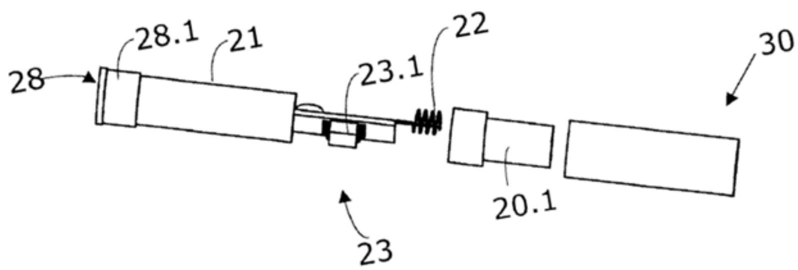


Fig. 1C

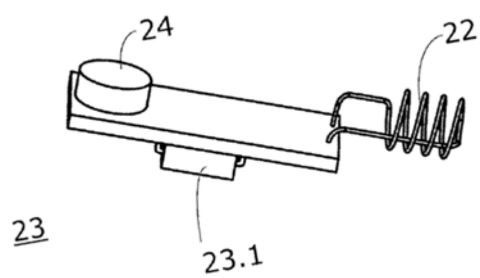


Fig. 1D

78. In a preferred embodiment, "the accumulator 21 is a specially designed lightweight and high capacity 200mAh, 3.7V rechargeable battery which is able to release enough energy to power the control electronics 23 and the energy

demanding heating device 22." *Id.*, ¶[0019].

79. Wang411 teaches that the "sensor device 24 has the main purpose to detect airflow through the first device 20 emitting a signal to the control electronics 23 which in turn will cause the accumulator 22 to release its entire electric energy to the heating device 22 in order to reach the temperature level that is hot enough to dissolve the agent 33" *Id.*, ¶¶[0027], [0022]. Wang411 explains that the agent 33 is placed in a "container section 31 of the second device 30." *Id.*, ¶[0047].

80. Wang411 teaches that the sensor device 24 is "electret microphones." *Id.*, ¶[0026]. "The most important part of these microphones is the electret, a stable dielectric material with a permanent static electric charge." *Id.* Wang411 further states that "[t]he main advantage of using an electret microphone is its low cost, reduced size and almost zero energy requirement." *Id.*, ¶[0026]; *see also* EX1024, 2:4-41.

81. Wang411 states that the electret microphone can be specially constructed in order to "have a narrow frequency response that corresponds to the frequency of the vibration created by a cigarette consumer's suck/ draw." *Id.*, ¶[0030]. "Usually this frequency range is situated below 5Hz, a range low enough to eliminate the possibility of a false detection, since most environmental noises are above this frequency." *Id.*, ¶[0029].

82. Wang411 states "the control electronics 23 are preferably laid-out on

a circuit board," "the circuit board accommodates a processor 23.1," and "[the] processor 23.1 is preferably a Field Programmable Grid Array (FPGA) specially set up to achieve all the functions required to operate the smoking device 10." *Id.*, ¶[0022]. The functions include "[e]lectronically filtering signals received from the sensor device 24," "[c]ontrolling the temperature of the heating device 22," and "[m]onitoring the energy reserves of the accumulator 21," *Id.*, ¶[0022].

83. FIG. 4 shows the main structural blocks of the control electronics 23. Wang411 explains that when the smoking device 10 is sucked on/ drawn, "the sensor device 24 will pick up an analog signal which will then be converted into a digital signal by the 12 bit Analog/Digital converter 63." *Id.*, ¶[0062]. Wang411 explains that "the digital signal will then be analyzed by the CPU with aid of the Pulse Width Modem 62 and, if the signal matches a pattern that corresponds to an actual suck/ draw and not noise, the temperature control unit 61 will engage the heating device 22 in such a way as to achieve the preprogrammed temperature variation scheme." *Id.*, ¶[0062].

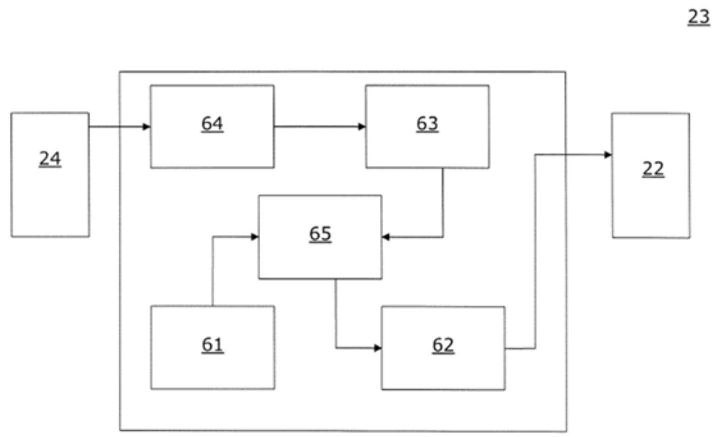


Fig. 4

E. Hon Overview

84. Hon is titled "Electronic Cigarette". Hon explains that the electronic cigarette includes "a battery assembly, an atomizer assembly and a cigarette bottle assembly." EX1013, 1:46-47. "The battery assembly connects with one end of the atomizer assembly [through the srewthread electrode], and the cigarette bottle assembly is inserted into the other end of the atomizer assembly, thus forming one cigarette type or cigar type body." *Id.*, 47:51, 2:66-67.

85. In an embodiment as shown in FIG. 2B, Hon teaches that the battery assembly includes the indicator 202, lithium ion battery 203, MOSFET electric circuit board 205, micro-controller unit (MCU) 206, sensor 207, primary screwthread electrode 209, and primary shell 211. *Id.*, 3:3-8, 4:65-57. Hon explains "the sensor (207) may be switch sensor made of elastic alloy slice, Hall element of linear output, semiconductor force-sensitive chip, semiconductor matrix

thermoelectric bridge chip, capacitance or inductance sensor." Id., 3:21-24. "The indicators (202) include two red LEDs." *Id.*, 3:24-25. "The lithium ion battery (203) may be either a rechargeable polymer lithium ion battery or a rechargeable lithium ion battery." *Id.*, 3:25-27.

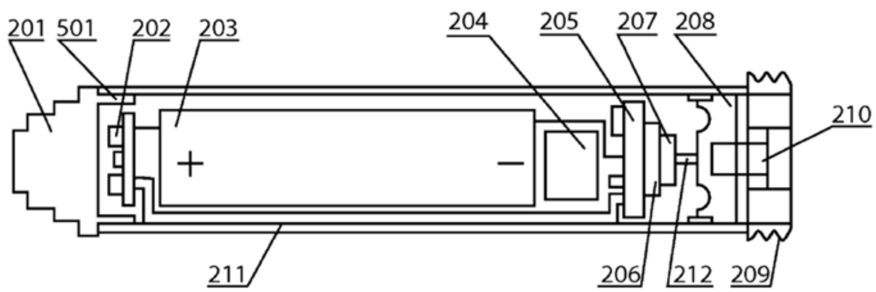


Figure 2B

86. In an embodiment as shown in FIG. 3, Hon teaches that the atomizer assembly includes "the internal thread electrode (302), air-liquid separator (303), atomizer (307) and the secondary shell (306)." *Id.*, 3:32-34. In an embodiment as shown in FIG. 4, Hon teaches that "the cigarette bottle assembly includes the cigarette liquid bottle (401), fiber (402) and suction nozzle (403)." *Id.*, 3:48-54. "The fiber (402) containing cigarette liquid is located on one end of the cigarette liquid bottle (401), and this end is inserted into the secondary shell (306) and lies against the atomizer (307)." *Id.*, 3:50-53.

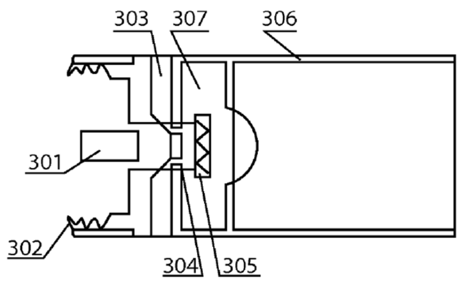


Figure 3

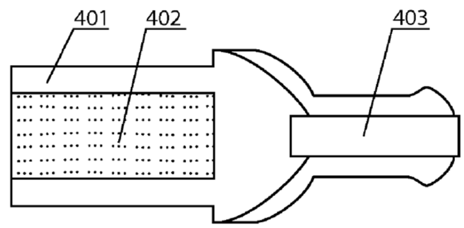


Figure 4

87. Hon states "[t]he primary and secondary shell (211,306) of this invention are made of stainless steel tube or copper alloy tube." *Id.*, 4:49-50. Hon teaches that "the battery assembly and atomizer assembly are connected through" the external thread electrode 209 located in one end of the battery assembly and an internal thread electrode 302 located in one end of the atomizer assembly. *Id.*, 3:63-66.

88. "When the user slightly sucks the suction nozzle (403), the formed negative pressure distorts the silica gel corrugated membrane (208) to "drive the switch spring (212) and sensor (207), thus invoking MCU (206) and MOSFET electric circuit board (205)." *Id.*, 5:7-15. At this moment, "the indicators (202) are lit gradually; the lithium ion battery (203) electrifies the heating body (305) inside the atomizer (307) through MOSFET electric circuit board (205) as well as the internal and external thread electrodes (302, 209), so that the heating body (305) inside the atomizer (307) produces heat." *Id.*, 5:15-20.

89. Then, Hon explains the atomization process by the atomizer 307. In particular, "[t]he fiber (402) inside the cigarette liquid bottle (401) contains cigarette liquid, which soaks the micro-porous ceramics (801) inside the atomizer through the fiber (402)." *Id.*, 5:20-23. "The airflow helps to form air-liquid mixture in the spray nozzle (304) of the atomizer (307)," and "[t]he air-liquid mixture sprays onto the heating body (305), gets vaporized, and is quickly absorbed into the airflow and condensed into aerosol." *Id.*, 5:24-29.

F. The Combination of Hon and Tao was Predictable

90. The field of endeavor of Hon is an electronic cigarette. EX1013, 1:5-6. Thus, Hon is analogous art directed to the same field of endeavor as the '622 Patent and Tao. *See* EX1001, 1:9 ("The present invention relates to an electronic cigarette"); EX1006, 5 ("The utility model provides a simulated cigarette").

91. Hon is directed to the problem of simulating the process of cigarette smoking. *See, e.g.,* EX1001, 3:36–41 ("For this invention, … the smokers can still enjoy the feel and excitement of smoking, and there is no fire hazard since there is no need for igniting."). The '622 patent and Tao are directed to the same problem as Hon. *See* EX1001, 3:36–41 ("the new technology also makes the puffing of users on the cigarette much easier and Smoother. It is more sensitive in turning on and off the vaporizing process than the conventional mechanical system."); EX1006, 4 ("Users generally reflect that this kind of electronic cigarette is

laborious to suck and smoke, and the simulation effect is poor”).

92. When seeking to solve the problem of the ’622 patent, a POSITA would have predictably considered Hon and Tao because they extensively describe existing solutions to the same problem and are within the same field of endeavor as the ’622 patent.

93. A POSITA would have found it obvious to use the electret microphone 8 of Tao in place of the silica gel corrugated membrane 208 plus the sensor 207 of Hon. the electret microphone 8 is used for the same purpose (*see* EX1006, 6) as the silica gel corrugated membrane 208 plus the sensor 207 (*see* EX1013, 5:7-15) – detecting airflow generated by a user’s inhaling or puffing act.

94. It is noted that the silica gel corrugated membrane 208 plus the sensor 207 serves as a mechanical airflow sensor. EX1013, 5:7-15 (“When the user slightly sucks the suction nozzle (403), the negative pressure forms on the silica gel corrugated membrane (208) through the air intake hole (503) and the primary and secondary negative pressure cavities (210, 301), and ***the silica gel corrugated membrane (208), under the action of suction pressure difference, distorts to drive the switch spring (212) and sensor (207***), thus invoking MCU (206) and MOSFET electric circuit board (205)”). A POSITA would have understood that Hon does not teach any structure, connection, or function that would preclude use of an electric airflow sensor in comparison with a mechanical airflow sensor. Moreover, Hon

explicitly teaches the use of a “capacitance … sensor” for this purpose. *Id.*, 3:21-24. A POSITA would have understood the electret microphone can be arranged “on MOSFET electric circuit board (205)” and “invoking MCU (206).” EX1013, 3:14-15, 5: 13-15.

95. The ’622 patent explains that electric airflow sensors “makes the puffing of users on the cigarette much easier and smoother.” EX1001, 3:34–38. Similarly, Tao teaches that, because of the use of the electret microphone, “the overall design requires a small amount of airflow, and the user does not need to exert very much strength in use and feels relaxed.” EX1006, 6. When being faced with the problem of how to make puffing easier and smoother, the POSITA would have been motivated to use the electret microphone 8 of Tao in place of the silica gel corrugated membrane 208 plus the sensor 207 of Hon. This is because airflow through a passage necessarily induces a change in pressure, and vice versa, according to Bernoulli’s Principle. *See, e.g.,* EX1022, 1 and 3.

96. In view of the function similarities between the electret microphone 8 and the silica gel corrugated membrane 208/the sensor 207, the lack of Hon to describe any structure, connection, or function which would prohibit use of another type of airflow sensor (such as the electret microphone 8), and the lack of Tao to describe the electret microphone 8 as requiring any particular structure or connection that is inapplicable to Hon, a POSITA would have had a reasonable

expectation of success in making such a modification of Hon.

G. Wang868 Overview

97. Similar to Hon and the '622 Patent, Wang868 is directed to an electronic cigarette. EX1014, 1. Wang868 explains that the electronic cigarette includes an end nozzle 1 and e-cigarette tube 6. EX1014, 5. Wang868 states "the cartridge box 3 is arranged in the end nozzle 1" and "the separator 3-1 partitions the cartridge box 3 into an inner cartridge cavity 3-2 and a mouthpiece cavity 3-3." *Id.* The mouthpiece cavity 3-3 includes condensed cartridge. *Id.*

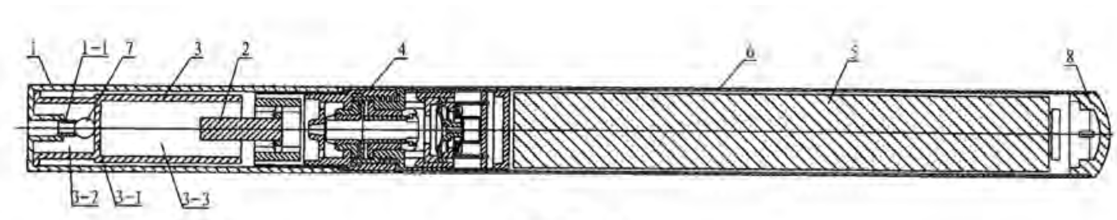


FIG. 1

X. ANALYSIS OF THE REFERENCES RELIED UPON BY PETITIONER

A. Claims 12 – 15 are Anticipated by and/or Obvious Over Tao

1. Claims 12 and 13

i. Claims 12 and 13 Preambles - "An electronic cigarette comprising"

98. As I have explained in Section IX.A, Tao discloses to a simulated cigarette. For example, Tao states "the simulated cigarette includes a housing 4 … and a mouthpiece 13" and "[a] battery 6, a vaporization controller, and a

vaporization assembly are fixedly arranged in the housing 4." EX1006, 5. Tao also illustrates the simulated cigarette in FIG. 1. Moreover, Tao teaches the simulated cigarette operates with the aid of the electricity in battery 6 and contains the e-liquid in the reservoir 12 that is vaporized by the vaporizer 10 of the vaporization assembly. *Id.*, 7. A POSITA would have understood the simulated cigarette in Tao to be an electronic cigarette.

ii. Claim Elements 12.1 and 13.1 - "a tubular electronic inhaler."

99. Tao discloses the simulated cigarette may be formed into various shapes such as a cigarette shape, a cigar shape, a tobacco pipe shape, or the like." EX1006, 7. FIG. 1 of the Tao shows that the housing 4 has a hollow length and defines an open space accommodating various components of the simulated cigarette. FIG. 2 and FIG. 3 of Tao are section views of the simulated cigarette, which shows that the housing 4 is a round tube. A POSITA would have understood the housing 4 of the simulated cigarette is tubular.

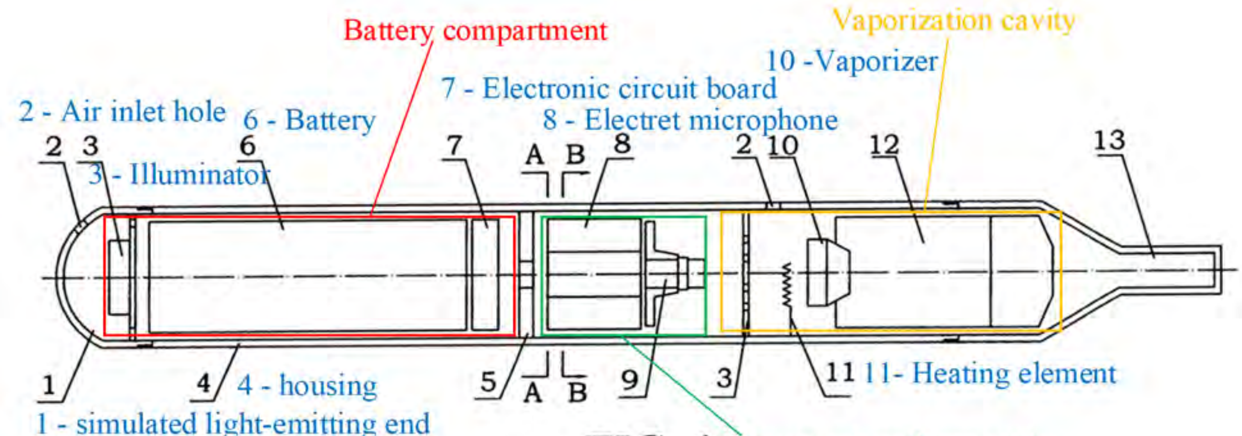


FIG. 1

100. As shown in annotated FIG. 1, the portion of housing 4 arranged with the simulated light-emitting end 1, the battery compartment, and the electret microphone cavity comprises the battery 6, the electronic circuit board 7, the electret microphone 8, and the air inlet hole 2 allowing airflow. *Id.*, 7 and 8. a POSITA would have understood the portion of housing 4 arranged with the simulated light-emitting end 1, the battery compartment, and the electret microphone cavity to be the "tubular electronic inhaler."

iii. Claim Elements 12.2 and 13.2 - "a tubular electronic atomizer,"

101. As shown in annotated FIG. 1, the portion of housing 4 arranged with the vaporization cavity comprises the vaporizer 10 and the heating element 11. Tao teaches "[a] heating element 11 is arranged in the vaporization cavity, and the heating element 11 is connected to the output terminal of the electronic circuit board 7." EX1006, 8. Tao teaches "[t]he vaporizer 10 starts after receiving the

instruction from [the microprocessor of the electronic circuit board 7] and vaporizes an e-liquid in an e-liquid reservoir [12], and vaporized droplets are suspended to form aerosol." *Id.,* 8. A POSITA would have understood the portion of housing 4 arranged with the vaporization cavity to be the "tubular electronic atomizer."

iv. Claim Element 12.3 and 13.3 - "wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,"

102. Tao teaches "[t]he electronic circuit board 7 is composed of a microprocessor and an ultrasonic circuit." EX1006, 5. When receiving the airflow, "[t]he electret microphone 8 sends the signal to the microprocessor in the electronic circuit board 7, and the microprocessor transmits an instruction to the ultrasonic circuit for transmission to the vaporizer 10." *Id.,* 8. The current of the ultrasonic circuit supplied by the battery 6 "is adjusted according to the signal of the electret microphone, and the smoking quantity of the vaporizer is controlled by the ultrasonic circuit, which truly simulates the feeling of smoking of a person." *Id.,* 6. A POSITA would have understood the battery 6 and the ultrasonic circuit to be the "electric power source."

v. Claim Element 12.4 - "the electronic cigarette further comprising an integrated circuit board that has a Single Chip Micyoco that controls atomization

of a liquid solution.”

103. Tao teaches “[t]he electronic circuit board 7” has “a microprocessor.” EX1006, 7. The “A/D conversion circuit inside the microprocessor” may “quantitatively analyze an amount of airflow … so as to determine an ultrasonic vaporization amount according to the amount of airflow.” *Id.*, 6. A POSITA would have understood the electronic circuit board 7 to be the “integrated circuit board” and the microprocessor to be the “Single Chip Micyoco.” *See Supra* ¶37.

vi. Claim Element 13.4 - “the electronic cigarette further comprising an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow and”

104. “Electric airflow sensor” is construed as “an electric sensor to detect air movement generated by a user’s inhaling or puffing act.” *See Supra* ¶50. As I explained in Section IX.A, Tao discusses a prior art reference in which a mechanical sensor is used to detects whether an airflow passes and indicates that the simulated cigarette in Tao is completely different from that in the prior art because “the entire device … lays emphasis on a more reasonable electronic design instead of a mechanical design. EX1006, 6. To this end, Tao teaches to use the electret microphone 8 to detect airflow, which “sensitively receive[s] a change in an inhalation amount of a person.” *Id.*, 6.

105. A POSITA would have understood that the electret microphone is an

electric airflow sensor in lieu of a mechanical airflow sensor. It is known to the POSITA at the time of the alleged invention that a microphone is "an acoustic-to-electric transducer or sensor that converts sound into an electrical signal." EX1017, 1. An electret microphone is "a type of condenser microphone," also known as "a capacitor microphone," in which "the diaphragm acts as one plate of a capacitor, and the vibrations [by sound waves] produce changes in the distance between the plates." *Id.*, 2. "An electret is a ferroelectric material that has been permanently electrically charged or polarized. The name comes from electrostatic and magnet; a static charge is embedded in an electret by alignment of the static charges in the material." *Id.*, 3-4. Drawing air through a passage creates sound waves of low frequency, known to a POSITA as infrasonic waves. These constitute pressure variations in the air, which we know from Bernoulli's Principle are caused by airflow changes. *See, e.g.*, EX1023, 3.

106. In addition, Tao teaches that "the current of the ultrasonic circuit is adjusted according to the signal of the electret microphone, and the smoking quantity of the vaporizer is controlled by the ultrasonic circuit, which truly simulates the feeling of smoking of a person." EX1006, 6. A POSITA would have understood the electret microphone 8 is used to turn on and off the electric power source by way of detecting an airflow.

vii. Claim Element 13.5 - "sending a signal to a Single

Chip Micyoco,"

107. Tao teaches "[w]hen a smoker smokes, the airflow entering from the air inlet 2 on the housing 4 … enters the electret microphone cavity …, so that the electret microphone 8 receives the airflow. The electret microphone 8 sends the signal to the microprocessor in the electronic circuit board 7." EX1006, 8.

viii. Claim Element 13.6 - "wherein the Single Chip Micyoco receives the signal from the electric airflow sensor, instructs the electric power source to send an electric current to the electronic atomizer, and a time period and a magnitude of the electric current."

108. Tao teaches "[t]he electret microphone 8 sends the signal to the microprocessor in the electronic circuit board 7, and the microprocessor transmits an instruction to the ultrasonic circuit for transmission to the vaporizer 10." EX1006, 6. "The vaporizer 10 starts after receiving the instruction and vaporizes an e-liquid in an e-liquid reservoir." *Id.* Tao further teaches "the current of the ultrasonic circuit [supplied to the vaporizer 10/ heating element 11] is adjusted according to the signal of the electret microphone [8], and the smoking quantity of the vaporizer is controlled by the ultrasonic circuit, which truly simulates the feeling of smoking of a person." *Id.*

109. "Time period and a magnitude of the electric current" is construed as "the duration of time and the strength of the current that is provided to the heating

element." *See Supra* ¶50. A POSITA would have understood the adjustment of the current supplied to the vaporizer 10/ heating element 11 indicates the strength of the current provided to the electric atomizer. Also, to control the atomization quantity, Tao inherently teaches a duration of time for supplying the current to the vaporizer 10/ heating element 11 for atomization.

2. Claim 14 - "The electronic cigarette of claim 13, wherein the electric airflow sensor is a diaphragm microphone."

110. "Diaphragm microphone" is construed to mean "a device for converting pressure waves into electrical energy using a thin sheet of material that is capable of vibrating." *See Supra* ¶50. As I explained above, an electret microphone is a capacitor microphone in which a diaphragm acts as one plate of a capacitor and the vibrations by sound waves produce changes in the distance between the plates, which converts the sound into an electrical signal. *See Supra* ¶105.

111. I also reviewed Une published on Jul. 15, 2003 which provides a detailed description on an electric microphone.

> "Electret capacitor microphones are often provided with a ***thin diaphragm having a thin metal film*** facing toward an opening in a metal casing and a fixed electrode opposed thereto, and utilize the principal of a change in capacity between the diaphragm and the fixed electrode dependently on the vibration of the diaphragm due to a sound wave. The diaphragm utilizes a thin metallized electret material on a surface thereof, and a capacitor is formed between the diaphragm and the fixed electrode. A change in capacity is converted into a

> current or voltage change through a solid state device, the sound wave being fetched as an electric signal." EX1018, 1:10-21.

Under the construction, a POSITA would have understood the electret microphone 8 in Tao to be a "diaphragm microphone."

3. Claim 15

i. Claim 15 Preamble - "The electronic cigarette of claim 13, further comprising"

112. *See* Section X.A.1.

ii. Claim Element 15.1 - "further comprising an LED indicator inside the electronic inhaler,"

113. Tao teaches "an illuminator 3 is arranged in the simulated light-emitting end 1." EX1006, 7. The illuminator 3 is, for example, "an LED." *Id.*, 8. A POSITA would have understood the illuminator 3 to be the LED indicator.

iii. Claim Element 15.2 - "wherein the LED indicator is connected to the Single Chip Micyoco and the electric power source,"

114. In Tao, when detecting the airflow, "[t]he electret microphone 8 sends the signal to the microprocessor in the electronic circuit board 7, and the microprocessor transmits an instruction to the ultrasonic circuit for transmission to the vaporizer 10." EX1006, 8. Meanwhile, "the illuminator 3 in the simulated light-emitting end 1, such as an LED, starts to emit light." *Id.*, 8. Tao also teaches

that "the simulated light-emitting end 1 [accommodating the illuminator 3] may be an independent part, and is connected to other parts through *threads*." *Id*.

115. As the light emission of the illuminator 3 is determined by the detection of the electret microphone 8, a POSITA would have understood the illuminator 3 is directly or indirectly connected to the electret microphone 8. In addition, the electret microphone 8 is connected to the microprocessor because the electret microphone 8 sends signals to the microprocessor. Accordingly, a POSITA would have understood the illuminator 3 is at least indirectly connected to the microprocessor.

116. Tao further teaches that "[a]s long as airflow exists on the electret microphone 8, the brightness of the LED is generated and changed accordingly." *Id*. That is, the brightness of the illuminator 3 is changed with the airflow received by the electret microphone 8. As it is the microprocessor, in particular the A/D conversion circuit inside the microprocessor, that determines the amount of the airflow that the electret microphone 8 receives, to change the brightness of the LED with the airflow received by the electret microphone 8, the illuminator 3 has to be directly or indirectly connected to the microprocessor.

117. Tao teaches that the illuminator 3 is a LED. EX1006, 8. To emit light, the LED has to be connected to an electric power source. Therefore, Tao inherently discloses that the illuminator 3 is connected to the battery 6.

iv. Claim Element 15.3 - "and wherein the on time of the LED indicator is controlled by the Single Chip Micyoco"

118. As I explained above, Tao teaches the brightness of the LED is generated and changed with the airflow received by the electret microphone 8. *See Supra* ¶116. It is the microprocessor that determines the amount of the airflow that the electret microphone 8 receives, controls the electric power source, *i.e.*, the ultrasonic circuit, and adjusts the output current of ultrasonic circuit. EX1006, 8. Therefore, Tao inherently discloses that the on time of the illuminator 3 is controlled by the microprocessor.

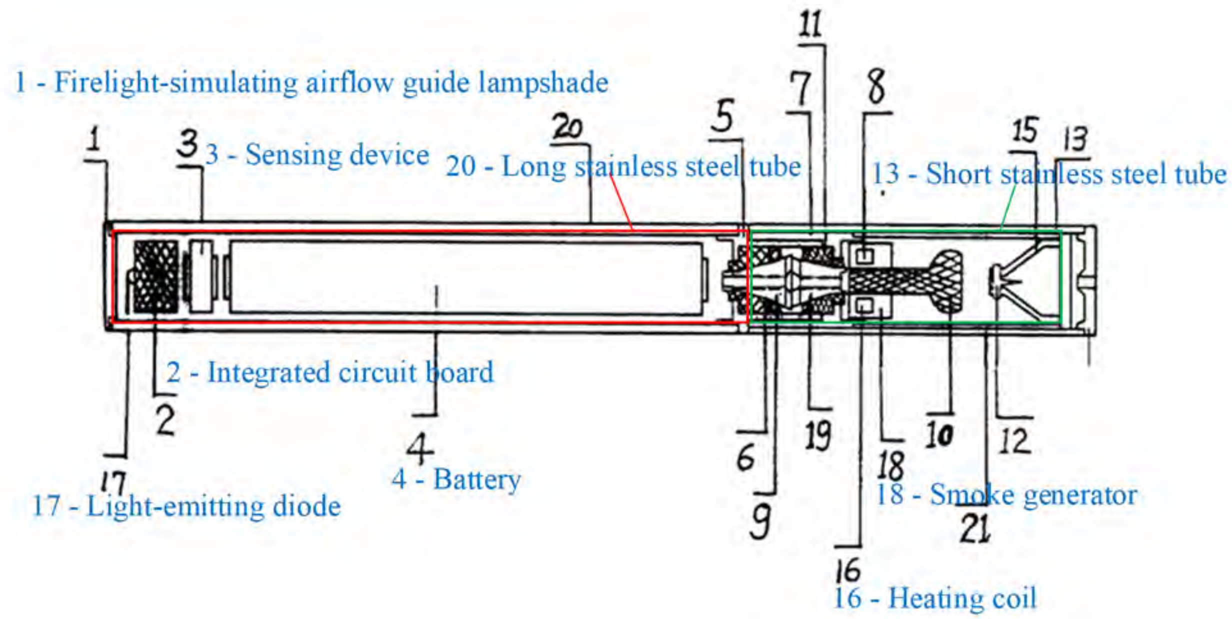
B. Claims 12-15 are Obvious Over Yang and Tao

1. Claims 12 and 13

i. Claims 12 and 13 Preambles - "An electronic cigarette comprising"

119. As I explained above in Section IX.B, Yang discloses a cigarette-simulating electronic device resembling a cigarette. EX1009, 3. The cigarette-simulating electronic device includes "the long stainless steel tube 20" and "the short stainless steel tube 13." *Id.*, 4-5. The long stainless steel tube 20 includes "an integrated circuit board 2, a sensing device 3, a battery 4." *Id.*, 5. The short stainless steel tube 13 includes "the smoke generator 18 [and] a gas-liquid mixing chamber 8." *Id.* The cigarette-simulating electronic device operates with the aid of

the electricity in battery 4 and vaporizes the liquid tobacco in the gas-liquid mixing chamber 8. *Id.*, 6. A POSITA would have understood the cigarette-simulating electronic device in Yang to be the "electronic cigarette."



Annotated Figure of Yang

ii. Claim Elements 12.1 and 13.1 - "a tubular electronic inhaler."

120. Yang teaches "the cigarette-simulating electronic device has a stainless steel round tubular housing in shape, including a longer cartridge-simulating tube [20] and a shorter mouthpiece-simulating tube [13], which are connected into a whole by an annular airflow guide bolt." EX1009, 3. The long cartridge-simulating tube 20 has "an air inlet" at an end. Id., 5. "[A]n integrated circuit board 2, a sensing device 3, a battery 4 … are arranged inside the long stainless steel tube [20] in sequence from the air inlet end." *Id.* Therefore, a

POSITA would have understood the long stainless steel tube 20 to be the "tubular electronic inhaler."

iii. Claim Elements 12.2 and 13.2 - "a tubular electronic atomizer."

121. Yang teaches the short stainless steel tube 13 is a round tubular housing in shape. EX1009, 3. In addition, the short stainless steel tube 13 includes the smoke generator 18, which includes a heating coil 16 and the gas-liquid mixing chamber 8. EX1009, 5. "The heating coil 16 is placed in the center of the gas-liquid mixing chamber 8." *Id.*, 6. When the heating coil 16 operates, "the liquid tobacco has been transported into the gas-liquid mixing chamber 8 …, and the tobacco is gasified to form smoke." *Id.*, 6. A POSITA would understood the short stainless steel tube 13 to be the "tubular electronic atomizer."

iv. Claim Element 12.3 and 13.3 - "wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,"

122. Yang teaches that the long stainless steel tube 20 includes, among other things, an integrated circuit board 2, a sensing device 3, a battery 4, "thereby forming an independent control and energy output system." EX1009, 5. "A power amplifier of the integrated circuit 2 keeps supplying power to a smoke generator 18 [in the short stainless steel tube 13] for a set period after receiving an instruction

from the controller [of the integrated circuit board 2], so that the smoke generator operates to form smoke." *Id.*, 5. A POSITA would have understood the battery 4 plus the power amplifier of the integrated circuit 2 to be the "electric power source."

v. Claim Element 12.4 - "the electronic cigarette further comprising an integrated circuit board that has a Single Chip Micyoco that controls atomization of a liquid solution."

123. Yang teaches that the cigarette-simulating electronic device includes "an integrated circuit board 2" *Id.*, 5. The integrated circuit board 2 has "a controller," also referred to as "an electronic controller." *Id.*, 5. Yang indicates "[i]t is the main technical method of the smoke generator 18 that the electronic controller in the integrated circuit board 2 controls the electric energy to supply power to the heating coil as a heat source." *Id.*, 6. "When airflow enters from the air inlet end, the vibration of the airflow causes the sensor 3 to work and send out a pulse signal, so that a controller in the integrated circuit 2 is started." Then, Yang teaches the controller sends instruction to a power amplifier of the integrated circuit 2 such that the power amplifier "keeps supplying power to a smoke generator 18 for a set period." *Id.* A POSITA would have understood the electronic controller to be the "Single Chip Micyoco."

vi. Claim Element 13.4 - "the electronic cigarette

further comprising an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow and"

124. Yang teaches "[w]hen airflow enters from the air inlet end, the vibration of the airflow causes the sensor 3 to work and send out a pulse signal" to the controller in the integrated circuit 2. EX1009, 5. "A power amplifier of the integrated circuit 2 keeps supplying power to a smoke generator 18 for a set period after receiving an instruction from the controller." *Id.*, 5.

125. Tao teaches to use a specific electric airflow sensor, *i.e.*, the electret microphone 8, in an electronic cigarette. As I have explained in Section IX.C, a POSITA would have found it obvious to utilize the electret microphone 8 of Tao in place of the sensor 3 of Yang.

vii. Claim Element 13.5 - "sending a signal to a Single Chip Micyoco,"

126. Yang teaches "[w]hen airflow enters from the air inlet end, the vibration of the airflow causes the sensor 3 to work and send out a pulse signal, so that a controller in the integrated circuit 2 is started." EX1009, 8.

viii. Claim Element 13.6 - "wherein the Single Chip Micyoco receives the signal from the electric airflow sensor, instructs the electric power source to send an electric current to the electronic atomizer, and a time period and a magnitude of the electric current."

127. Yang teaches "[w]hen airflow enters from the air inlet end, the vibration of the airflow causes the sensor 3 to work and send out a pulse signal, so that a controller in the integrated circuit 2 is started." EX1009, 5. "A power amplifier of the integrated circuit 2 keeps supplying power to a smoke generator 18 for a set period after receiving an instruction from the controller, so that the smoke generator [18 including the heating coil 16] operates to form smoke." *Id.*, 5.

2. Claim 14 - "The electronic cigarette of claim 13, wherein the electric airflow sensor is a diaphragm microphone."

128. As I explained in Section X.A.2, a POSITA would have understood the electret microphone to be the diaphragm microphone. Also, as I have explained in Section IX.C, a POSITA would have been motivated to use the electret microphone as the sensor 3 in Yang.

3. Claim 15

i. Claim 15 Preamble - "The electronic cigarette of claim 13, further comprising"

129. *See* Section X.B.1.

ii. Claim Element 15.1 - "further comprising an LED indicator inside the electronic inhaler,"

130. As I explained above in Section X.B.1.ii, the long stainless steel tube 20 in Yang includes the integrated circuit board 2 and corresponds to the electric inhaler as claimed. Yang teaches that "a light-emitting diode [17] for simulating

burning and lighting of cigarettes is arranged on the integrated circuit board [2]" EX1009, 3 and 4. A POSITA would have understood the light-emitting diode 3 to be the LED indicator as claimed.

iii. Claim Element 15.2 - "wherein the LED indicator is connected to the Single Chip Micyoco and the electric power source,"

131. Yang teaches that the "controller [is] in the integrated circuit 2" and "[a] light-emitting diode 17 is arranged on the integrated circuit board 2." EX1009, 5. A POSITA would have understood the light-emitting diode 17 is directly or indirectly connected to the controller.

132. In addition, to emit light, the light-emitting diode 17 has to be directly or indirectly connected to an electric power source. Therefore, Yang inherently discloses that the light-emitting diode 17 is connected to the power source of the cigarette, *i.e.*, the power amplifier of the integrated circuit 2 plus the battery 4.

iv. Claim Element 15.3 - "and wherein the on time of the LED indicator is controlled by the Single Chip Micyoco"

133. Yang teaches "[d]uring operation, airflow enters from an [air inlet] of the tube [20], and energy is supplied to an electronic heater [16] after a [controller] is activated by a sensing device [3] …, and a light-emitting diode [17] at the other end is on to indicate an operating state." EX1009, 1. "When the negative pressure

around the airflow guide hole disappears, the sensing device [3] stops operating, the smoke generator [18] stops generating smoke, the light-emitting diode [] is off, and the electronic [controller] enters a sleep state after a few seconds." *Id.* "In this way, a whole simulation process is formed." *Id.* As it is the electronic controller controls the whole simulation process, the on time of the light-emitting diode 17 has to be controlled by the electronic controller.

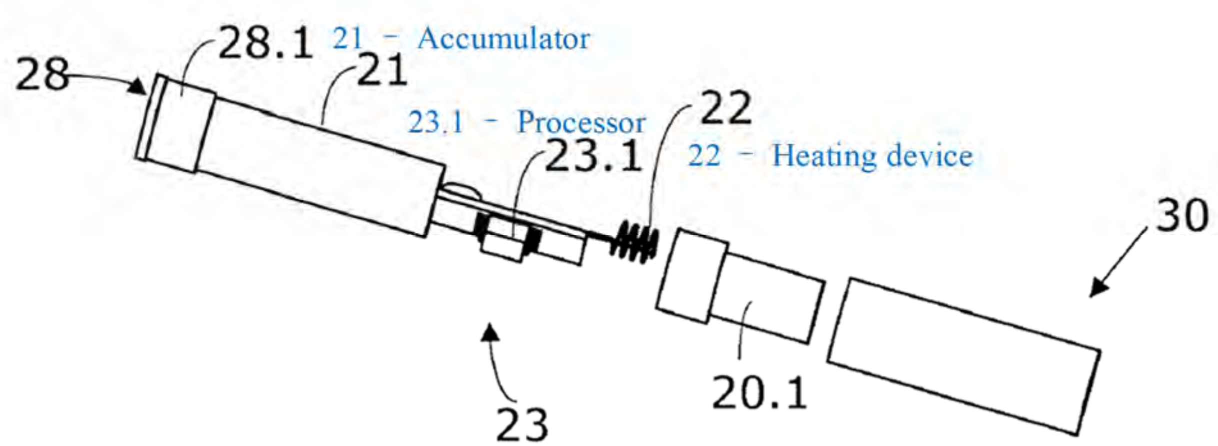
C. Claims 12 – 14 are Anticipated by and/or Obvious Over Wang411

1. Claims 12 and 13

i. Claims 12 and 13 Preambles - "An electronic cigarette comprising"

134. As I explained above in Section IX.D, Wang411 is directed to a smoking device including a first device and a second device. "The first device (20) comprises an accumulator [21] for storing electric energy and releasing it to a heating device (22) as a response to a sensor device (24) detecting a suck/ draw of the smoking device (10) by a consumer." EX1012, 1. The accumulator 21 may be a "rechargeable battery." *Id.*, ¶[0019]. "The second device (30) comprises an agent (33) …, releases said agent (33) by means of dispensing means (37) and streams out into the mouth of a consumer." *Id.* The heating device 22 is provided with energy to "sufficiently heat up the airflow to be able to dissolve the agent 33." Id., [0023]. The agent 33 may be "nicotine." Id., ¶[0012]. A POSITA would have

understood the smoking device in Wang411 to be the electronic cigarette as claimed because the smoking operates with the aid of the electricity in the accumulator 21 and vaporize the agent 33.



Annotated FIG. 1C of Wang411

ii. Claim Elements 12.1 and 13.1 - "a tubular electronic inhaler."

135. As shown in annotated FIG. 1C, the first device 20 is in tubular shape. "The first device 20 comprises a first air inlet 25 for letting fresh air enter the device 20" [0015] The internal parts of the first device 20 includes "an accumulator 21 for storing and releasing electric energy, a heating device 22 such as a resistive coil …, and control electronics 23." EX1012, ¶[0018]. A POSITA would have understood the portion of the first device 20 including the first air inlet 25, the accumulator 21 and the control electronics 23 to be the "tubular electronic inhaler."

iii. Claim Elements 12.2 and 13.2 - "a tubular electronic atomizer."

136. Wang411 teaches "[t]he heating device 22 is a resistive coil made of Cr20Ni80, capable of generating enough heat to be able to heat up the airflow that passes through to a temperature level that allows the release of the agent 33 residing in the second device 30." EX1012, ¶[0021]. A POSITA would understood the portion of the first device 20 including the heating device 22 to be the "tubular electronic atomizer."

iv. Claim Element 12.3 and 13.3 - "wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,"

137. Wang411 teaches "in response to the detection of the sucking/ drawing of air, releasing electric energy from said accumulator (21) for heating said heating device (22) and for heating air streaming through said smoking device (10)." EX1012, Claim 20. A POSITA would have understood the accumulator 21 to be the "electric power source."

v. Claim Element 12.4 - "the electronic cigarette further comprising an integrated circuit board that has a Single Chip Micyoco that controls atomization of a liquid solution."

138. Wang411 teaches "the components making up the control electronics

23 are preferably laid-out on a circuit board." EX1012, ¶[0021]. "Besides other electric and electronic components, the circuit board accommodates a processor 23.1." *Id*. "This processor 23.1 is preferably a Field Programmable Grid Array (FPGA) specially set up to achieve all the functions required to operate the smoking device 10." *Id.*, [0022]. Wang411 further teaches "[t]hese functions comprises: … [c]ontrolling the temperature of the heating device 22 according to a temperature variation scheme in order to ensure that the airflow is hot enough to dissolve the agent 33." s, [0022]. A POSITA would understood the processor 23.1 to be the "Single Chip Micyoco."

vi. Claim Element 13.4 - "the electronic cigarette further comprising an electric airflow sensor that is used to turn on and off the electric power source by way of detecting an airflow and"

139. Wang411 teaches "[t]his sensor device 24 has the main purpose to detect airflow through the first device 20 emitting a signal to [the processor 23.1 of] the control electronics 23 which in turn will cause the accumulator 22 to release its entire electric energy to the heating device 22 in order to reach the [desired] temperature level." EX1012, ¶[0027].

140. Wang411 further teaches "the sensor device 24 is a specially adapted microphone. Most preferred are electret microphones, which eliminate the need for a power supply by using a permanently charged material. Eliminating the need for

a power supply is especially advantageous due to the extreme size, weight and thus energy reserve restrictions of the smoking device 10. The most important part of these microphones is the electret, a stable dielectric material with a permanent static electric charge. The main advantage of using an electret microphone is its low cost, reduced size and almost zero energy requirement." *Id.*, ¶[0026]. As I explained above in Section X.A.1.vi, a POSITA would have understood the electret microphone is an electric airflow sensor.

vii. Claim Element 13.5 - "sending a signal to a Single Chip Micyoco,"

141. Wang411 teaches "the control electronics 23 comprise a complex and powerful enough processor 23.1, an active, electronic signal filtering is implemented in said processor 23.1. In this case an unfiltered signal representing all vibrations around the sensor device 24 are transmitted to the processor 23.1, where this signal will be electronically filtered in order to detect the suck/ draw and only the suck/ draw on the smoking device 10, while all noise is to be ignored." EX1012, ¶[0030].

viii. Claim Element 13.6 - "wherein the Single Chip Micyoco receives the signal from the electric airflow sensor, instructs the electric power source to send an electric current to the electronic atomizer, and a time period and a magnitude of the electric current."

142. Wang411 teaches, in response to the signal emitted from the sensor device 24, the processor 23.1 of the control electronics 23 "cause[s] the accumulator 22 to release its entire electric energy to the heating device." EX1012, ¶[0027]. Wang411 teaches "usually this heating period is about 5 seconds." *Id.*, [0021]. Wang411 further teaches "the processor 23.1 of the control electronics 23 can be programmed to apply a specially customized temperature variation scheme … takes into account the ambient temperature since a variation of it has direct influence of the temperature of the air entering the smoking device 10, *i.e.* the lower the ambient temperature, the more energy must be provided to the heating device 22 to sufficiently heat up the airflow to be able to dissolve the agent 33." *Id.*, [0023].

2. Claim 14 - "The electronic cigarette of claim 13, wherein the electric airflow sensor is a diaphragm microphone."

143. Wang411 teaches the sensor device 24 is an electret microphone. EX1012, ¶[0026]. As I explained above in Section X.A.2, a POSITA would have understood the electret microphone to be the "diaphragm microphone."

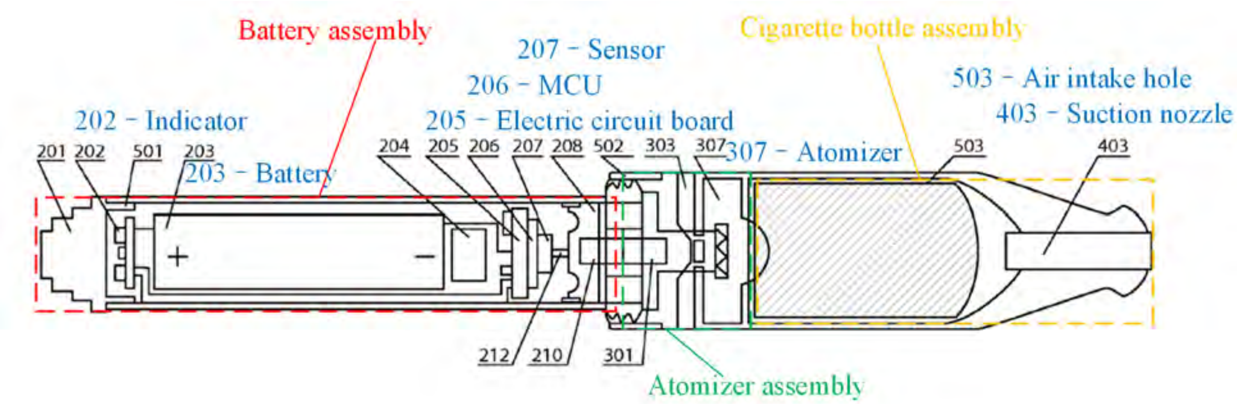
D. Claims 17 And 18 are Obvious Over Hon and Tao

1. Claim 17

i. Claim 17 Preamble - "An electronic cigarette comprising"

144. Hon discloses that "[t]he purpose of this invention is to provide an

electronic cigarette that substitutes for real cigarettes and helps smokers to quit smoking." EX1013, 1:42-43. Hon teaches the electronic cigarette includes "a battery assembly, an atomizer assembly and a cigarette bottle assembly" where "the battery assembly connects with one end of the atomizer assembly, and the cigarette bottle assembly is inserted into the other end of the atomizer assembly, thus forming one cigarette type or cigar type body." *Id.*, 1:46-51.



Annotated FIG. 5B of Hon

ii. Claim Element 17.1 - "a tubular electronic inhaler,"

145. Hon teaches that "the battery assembly includes the indicator (202), lithium ion battery (203), MOSFET electric circuit board (205), sensor (207), … and primary shell (211)." EX1013, 3:5-8. Hon teaches that the primary shell (211) is "made of stainless steel tube or copper alloy tube." 4:49-51. Hon further teaches that the battery assembly includes "MCU (206)" as shown in FIG. 2B. 4:65-67.

Hon further teaches "[i]n the battery assembly, there is a fine hole (501) on the indicator cap (201) for balancing the pressure difference on both sides of the silica gel corrugated membrane (208)." *Id.*, 4:42-45. A POSITA would have understood the battery assembly to be the "tubular electronic inhaler."

iii. Claim Element 17.2 - "a tubular electronic atomizer that is detachably attached to the electronic inhaler,"

146. Hon teaches the "atomizer assembly includes … atomizer (307) and a secondary shell (306)." EX1013, 3:32-24. The secondary shell (306) is "made of stainless steel tube or copper alloy tube." *Id.*, 4:49-51. "[T]he lithium ion battery (203) [in the battery assembly] electrifies the heating body (305) inside the atomizer (307)." *Id.*, 5:15-17. "[T]he cigarette bottle assembly includes the cigarette liquid bottle (401), fiber (402) and suction nozzle (403)." *Id.*, 3:48-50. The atomizer assembly is "inserted into the cigarette bottle assembly." *Id.*, 5:4-7. "The air-liquid mixture sprays onto the heating body (305), gets vaporized, and is quickly absorbed into the airflow and condensed into aerosol." *Id.*, 4:14-16. A POSITA would have understood the atomizer assembly and the cigarette bottle assembly in assembled state to be the "tubular electronic atomizer."

147. Hon further teaches that "[a]n external [screwthread] electrode (209) is located in one end of the battery assembly, and an internal [screwthread]

electrode (302) is located in one end of the atomizer assembly. The battery assembly and atomizer assembly are connected through the [external thread electrode (209) and the internal thread electrode (302)] into an emulation cigarette." *Id.*, 2:63-3:1, 6:1-3, and 6:12-15. As the battery assembly and the atomizer assembly are connected through the screw threads, the atomizer assembly is detachably attached to the battery assembly.

iv. Claim Element 17.3 - "wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,"

Hon teaches "the battery assembly includes … lithium ion battery (203)." EX1013, 3:4-5. "The lithium ion battery (203) may be either a rechargeable polymer lithium ion battery or a rechargeable lithium ion battery." 3:25-27. "[T]he lithium ion battery (203) electrifies the heating body (305) inside the atomizer (307) …, so that the heating body (305) inside the atomizer (307) produces heat." *Id.*, 5:16-20.

v. Claim Element 17.4 - "wherein the tubular electronic atomizer includes a container and media within the container,"

148. Hon teaches "the cigarette bottle assembly includes the cigarette liquid bottle (401) [and] fiber (402)." EX1013, 3:48-49. As shown in FIG. 4 of Hon, the fiber 402 is arranged within the cigarette liquid bottle 401. A POSITA would have

understood the cigarette liquid bottle 401 to be the "container" and the fiber 402 to be the "media."

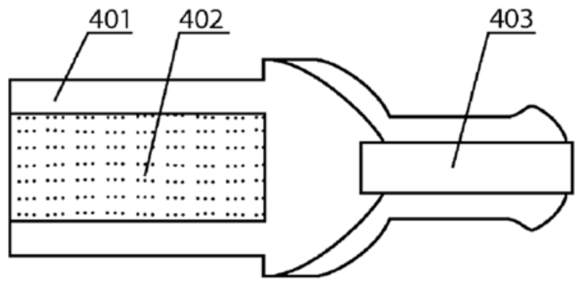


Figure 4

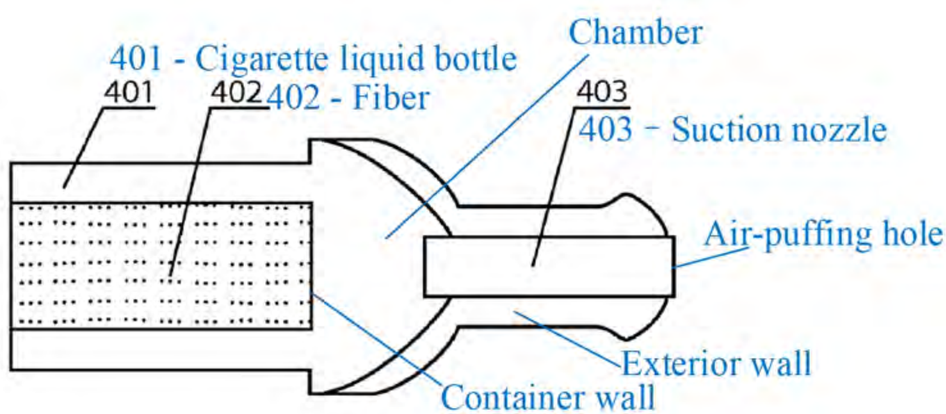
vi. Claim Element 17.5 - "the media is soaked with a solution to be atomized,"

149. Hon teaches "[t]he fiber (402) inside the cigarette liquid bottle (401) contains cigarette liquid, which soaks the micro-porous ceramics (801) inside the atomizer through the fiber (402)." EX1013, 5:20-23. "The cigarette liquid contains 0.1-3.5% nicotine, 0.05-5% tobacco flavor, 0.1-3% organic acid, 0.1-0.5% stabilizer, and propanediol for the remaining." *Id.*, 4:46-48.

vii. Claim element 17.6 - "wherein the tubular electronic atomizer includes an exterior wall having an air-puffing hole formed therethrough,"

150. Hon teaches "the cigarette bottle assembly includes … suction nozzle (403)." EX1013, 3:48-49. As shown in annotated FIG. 4 of Hon, the suction nozzle

403 is formed through the exterior wall of the cigarette bottle assembly. Hon teaches that the suction nozzle can be sucked by the user. EX1013, 5:8. Therefore, Hon inherently teaches that the suction nozzle 403 has an air-puffing hole at the end exposed from the exterior wall of cigarette bottle assembly, as shown in annotated FIG. 4 of Hon.



Annotated FIG. 4 of Hon

viii. Claim element 17.7 - "wherein the liquid container includes a container wall, there being a chamber disposed between the exterior wall and the container wall,"

151. As I explained above in Section X.D.1.v, the cigarette liquid bottle 401 corresponds to the liquid container as claimed. Annotated FIG. 4 of Hon shows the cigarette liquid bottle 401 includes a container wall with a chamber disposed between the exterior wall of the cigarette bottle assembly and the container wall of the cigarette liquid bottle 401. Additionally, the prosecution history demonstrates the Examiner appears to agree that this element is obvious to

a POSITA. *See Supra* ¶¶41-42.

ix. Claim Element 17.8 - "wherein the tubular electronic atomizer includes a tube extending from the air-puffing hole and into the chamber, and"

152. Hon teaches "the cigarette bottle assembly includes … suction nozzle (403)." EX1013, 3:48-49. As shown in annotated FIG. 4 of Hon, the suction nozzle 403 extends from the air-puffing hole and into the chamber. A POSITA would have understood the suction nozzle 403 to be the "tube."

x. Claim element 17.9 - "wherein the tubular electronic inhaler includes an electric airflow sensor configured to turn on and off the electric power source by way of detecting an airflow,"

153. Hon teaches "the battery assembly includes … sensor (207)." EX1013, 3:4-6. "When the user slightly sucks the suction nozzle (403), the negative pressure forms on the silica gel corrugated membrane (208) [which]…, under the action of suction pressure difference, distorts to drive … sensor (207), thus invoking MCU (206) and MOSFET electric circuit board (205). At this moment, the indicators (202) gradually die down; the lithium ion battery (203) electrifies the heating body (305) inside the atomizer (307) through MOSFET electric circuit board (205) …, so that the heating body (305) inside the atomizer (307) produces heat." *Id.*, 5:7-20. "When Suction stops, the … sensor (207) are reset; the atomizer (307) stops working; the indicators (202) gradually die down."

Id., 4:19-21

154. Tao teaches to use a specific electric airflow sensor, *i.e.*, the electret microphone 8, in an electronic cigarette. As I have explained in Section IX.F, a POSITA would have found it obvious to utilize the electret microphone 8 of Tao in place of the silica gel corrugated membrane 208 plus the sensor 207 of Hon.

xi. Claim element 17.10 - "and the airflow sensor is a diaphragm microphone."

155. As I explained above in Section VIII. A. 11, the POSITA is motivated to modify Hon to use the electret microphone to detect the airflow. As I explained above in Section X.A.2, a POSITA would have understood the electret microphone to be the "diaphragm microphone."

2. Claim 18 - "The electronic cigarette of claim 17, wherein the tubular electronic atomizer includes, in sequence, an electric connector, a leak-proof piece, a supporting piece, a heat equalizer coupled with an electric heating wire, the container filled with the media, and the air-puffing hole."

156. Hon teaches that "[a]n external thread electrode (209) is located in one end of the battery assembly, and an internal thread electrode (302) is located in one end of the atomizer assembly." EX1013, 2:63-66. The battery assembly and atomizer assembly are connected through the [external thread electrode (209) and the internal thread electrode (302)] into an emulation cigarette." *Id.*, 2:63-3:1, 6:1-3, and 6:12-15. Therefore, the internal thread electrode 302 of the atomizer

assembly serves as a connector connecting the atomizer assembly to the battery assembly.

157. Hon further teaches that both the internal thread electrode 302 and the external thread electrode 209 are "a gold-coated stainless steel or brass part with a hole drilled in the center." *Id.*, 3:27-29 and 3:42-44. Hon further teaches "the lithium ion battery (203) [in the battery assembly] electrifies the heating body (305) inside the atomizer (307) [of the atomizer assembly] through MOSFET electric circuit board (205) as well as the internal and external thread electrodes (302, 209)." *Id.*, 5:16-19. A POSITA would have understood the internal thread electrode 302 to be the "electric connector."

158. Hon teaches that "the atomizer assembly includes … air-liquid separator (303)." *Id.*, 3:32-33. "The air-liquid separator (303) is made of stainless steel or plastic with a hole drilled." *Id.*, 3:41-42. As shown in FIG. 3 of Hon, "[t]he air-liquid separator (303) and the atomizer (307) are connected with the internal thread electrode (302) successively." *Id.*, 3:38-40. During operation of the electronic cigarette, "[t]he air … passes through the run-through hole on the air-liquid separator (303), and helps to form air-liquid mixture in the spray nozzle (304) of the atomizer (307)." *Id.*, 5:23-26. A POSITA would have understood the air-liquid separator 303 in Hon to be the "leak-proof piece."

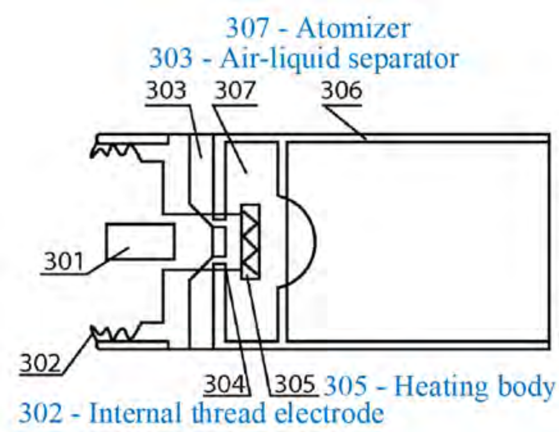
159. In Hon, FIGs. 8-10 show exemplary atomizers 307. *Id.*, 3:45-47. In

particular, the diagram of the structure of the capillary impregnation atomizer and FIG. 9 is the left view of FIG. 8. *Id.*, 2:43-45. FIG. 10 is the diagram of the structure of the spray atomizer and FIG. 11 is the left view of FIG. 10. *Id.*, 2:46-48. The atomizer 307 includes "the micro-porous ceramics (801)" and "the heating body (305)" producing heat. *Id.*, 5:22-23 and 5:16-20. As shown in FIGs. 8-10, the micro-porous ceramics 801 supports the heating body 305. A POSITA would have undersood the micro-porous ceramics 801 in Hon to be the "supporting piece."

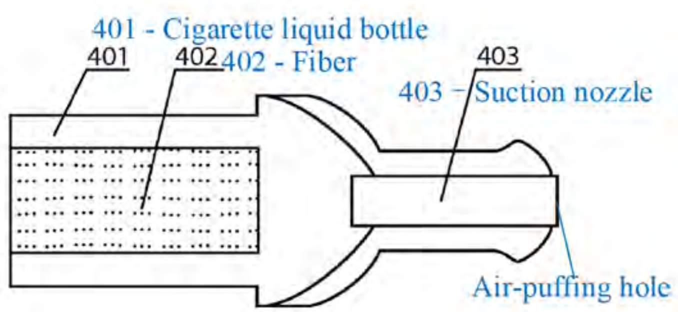
160. Hon teaches "[t]he heating body (305) [of the atomizer 307] is made of the microporous ceramics on which nickel-chromium alloy wire, iron-chromium alloy wire, platinum wire, or other electrothermal materials are wound." 4:29-35. Hon further teaches "the lithium ion battery (203) electrifies the heating body (305) … so that the heating body (305) inside the atomizer (307) produces heats." *Id.*, 5:16-20. A POSITA would have understood the microporous ceramics of the heating body 305 to be the "heat equalizer" and the electrical wire wound on the microporous ceramics of the heating body 305 to be the "electric heating wire."

161. Additionally, as I explained above in Section X.D.1.v, the cigarette liquid bottle 401 corresponds to the container as claimed and the fiber 402 corresponds to the media as claimed. As I explained above in Section X.D.1.vii, the suction nozzle 403 has an air-puffing hole at the end exposed from the exterior wall of cigarette bottle assembly.

162. As shown in annotated FIG. 3 and FIG. 4 reproduced as below including the atomizer assembly and the cigarette bottle assembly in disassembled manner, the tubular electronic atomizer includes, in sequence (from left to right), an electric connector (the internal thread electrode 302), a leak-proof piece (the air-liquid separator 303), a supporting piece (the micro-porous ceramics 801 in the atomizer 307), a heat equalizer (the microporous ceramics of the heating body 305) coupled with an electric heating wire (electrical wire wound on the microporous ceramics of the heating body 305), the container (the cigarette liquid bottle 401) filled with the media ("the fiber 402"), and the air-puffing hole (an end of the suction nozzle 403).



Annotated FIG. 3 of Hon



Annotated FIG. 4 of Hon

E. Claims 17 And 18 are Obvious Over Hon, Tao And Wang868

1. Claim 17

i. Claim 17 Preamble - "An electronic cigarette comprising"

163. *See* Section X.D.1.i.

ii. Claim Element 17.1 - "a tubular electronic inhaler."

164. *See* Section X.D.1.ii.

iii. Claim Element 17.2 - "a tubular electronic atomizer that is detachably attached to the electronic inhaler."

165. *See* Section X.D.1.iii.

iv. Claim Element 17.3 - "wherein the electronic inhaler includes an electric power source that provides an electric current to the electronic atomizer,"

166. *See* Section X.D.1.iv.

v. Claim Element 17.4 - "wherein the tubular electronic atomizer includes a container and media withinthe container,"

167. *See* Section X.D.1.v.

vi. Claim Element 17.5 - "the media is soaked with a solution to be atomized,"

168. *See* Section X.D.1.vi.

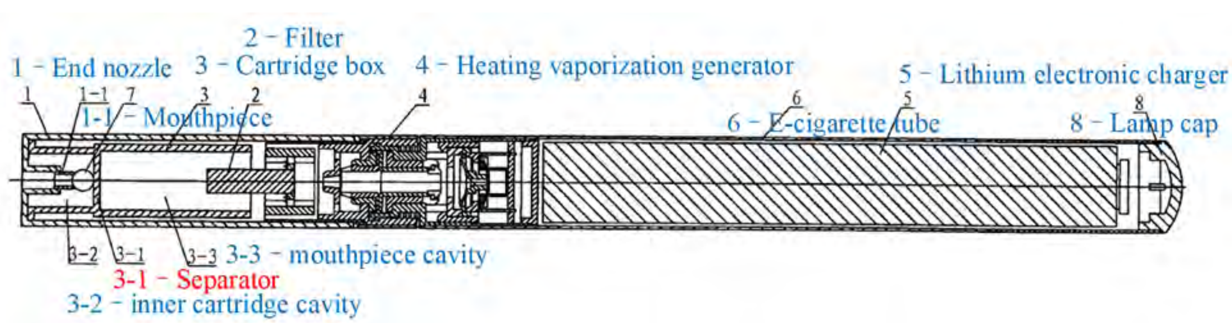
vii. Claim element 17.6 - "wherein the tubular electronic atomizer includes an exterior wall having an air-puffing hole formed therethrough,"

169. *See* Section X.D.1.vii.

viii. Claim element 17.7 - "wherein the liquid container

includes a container wall, there being a chamber disposed between the exterior wall and the container wall,"

170. As I explained above in Section IX.G, Wang868 discloses an electronic cigarette ("e-cigarette"). Wang868 teaches that the electronic cigarette includes "an end nozzle 1, a filter 2, a cartridge box 3, a heating vaporization generator 4" EX1014, 4. As shown in annotated FIG. 1 of Wang868, "a separator 3-1 is arranged in the cartridge box 3" and "[t]he separator 3-1 partitions the cartridge box 3 into an inner cartridge cavity 3-2 and a mouthpiece cavity 3-3." *Id.* Wang868 further teaches "[a] left end of the filter 2 is arranged at a right end of [mouthpiece cavity 3-3], and a right end of the filter 2 is connected to a left end of the heating vaporization generator 4." *Id.* Therefore, the mouthpiece cavity 3-3 serves as a liquid container as claimed. Accordingly, the separator 3-1 serves as the container wall as claimed and the inner cartridge cavity 3-2 serves as the chamber as claimed.



171. In order to separate the fiber 402 from the chamber in the cigarette

liquid bottle 401 so as to prevent the liquid in the fiber 402 from being drawn into the chamber and then getting into the user's mouth through the suction nozzle 403, the POSITA would have been motivated to modify the cigarette liquid bottle 401 to arrange a separator serving as the container wall between the fiber 402 and the chamber, as taught by Wang868.

172. This is a minor modification. Also, Hon does not describe any structure, connection, or function which would prohibit use of the separator. Therefore, a POSITA would have had a reasonable expectation of success in making such a modification of Hon.

ix. Claim Element 17.8 - "wherein the tubular electronic atomizer includes a tube extending from the air-puffing hole and into the chamber, and"

173. *See* Section X.D.1.ix.

x. Claim element 17.9 - "wherein the tubular electronic inhaler includes an electric airflow sensor configured to turn on and off the electric power source by way of detecting an airflow,"

174. *See* Section X.D.1.x.

xi. Claim element 17.10 - "and the airflow sensor is a diaphragm microphone."

175. *See* Section X.D.1.xi.

2. Claim 18 - "The electronic cigarette of claim 17, "wherein

> **the tubular electronic atomizer includes, in sequence, an electric connector, a leak-proof piece, a supporting piece, a heat equalizer coupled with an electric heating wire, the container filled with the media, and the air-puffing hole."**

379. *See* Section X.D.2.

XI. CONCLUSION

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Dated: July 6, 2023

By: Robert H. Sturges

Robert H. Sturges

Appendix A

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
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 industrial 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
2001-2017	Professor, Virginia Tech, Departments of Mechanical Engineering and Industrial & Systems Engineering, Director of Robotics and Automation Laboratory
2017---	Professor Emeritus, Virginia Tech, Department of Industrial & Systems Engineering, Adjunct Professor, Department of Mechanical Engineering

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, “Analaysis 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 Machinese," 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
G. Chaudhari, "Optimization of Factory Processes"

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

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*..**28**(4):340-352 (13 pages) 01 Jul 2011

Journal Papers In Review:

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.

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Research Reports from C. S. Draper Laboratories:

d10. Woodin, A.E., et al. 1972. “Annual Progress Report for the Development of Multi-Moded Remote Manipulator Systems No. 1,” C-3901, 146pp, January, 1972.

d11. Woodin, A.E., et al. 1973.“Annual Progress Report for the Development of Multi-Moded Remote Manipulator Systems No. 2,” C-3790, 174pp, January, 1973.

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.

Other Reports:

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.

o11. Sturges, R.H., & Showalter, M., 2009. "Sea-State Simulator Design and Control," 66 pp., September 2009.

G. *Discussions:*

“Research Opportunities in Flexible Assembly,” Panelist, ASME Design Technical Conferences, 14 Sept, 1992, Scottsdale, AZ

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 Axisymm-etric 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 .... control of bending operations	6,292,716	09-18-01
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-Airdox Company, one day session, Blacksburg, Virginia, June, 1999

9. "Value Analysis Workshop: 8-16 UniHauler," for Long-Airdox 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.

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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

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

Litigation Support Experience 2019-2023

Expert Engagement:

Case Name:	Nevro Corp. v. **Boston Scientific Corp., et al.,** United States District Court for the Northern District of California, Case No. 3:16-cv-06830
Filing Date:	November 28, 2016
Activity:	Reports, Deposition, Trial testimony

Expert Engagement:

Case Name:	**Days Corp** v Lippert Components, Inc., United States District Court for the Northern District of Indiana, Case No. 3:17-CV-00208-PPS-MGG. United States Patent and Trademark Office, Patent Trial and Appeal Board, Case No. IPR2018-00777
Filing Date:	March 14, 2018
Activity:	Reports, Deposition

Expert Engagement:

Case Name:	**Fisher-Rosemount Systems** v ABB, Inc., United States District Court for the Southern District of Texas, Case No. 4:18-CV-00178-KPE.
Filing Date:	August 21, 2018 (Prot. Order)
Activity:	Reports

Expert Engagement:

Case Name:	**Shipman** v Victaulic, Inc., Matter for arbitration.
Filing Date:	November 27, 2018 (Agreement)
Activity:	Reports, Affidavit

Expert Engagement:

Case Name:	FosterMiller v **FLIR**., United States Patent and Trademark Office, Patent Trial and Appeal Board, Case Nos. IPR2019-01548, IPR2019-01549.
Filing Date:	September 10, 2019
Activity:	Reports, Depositions

Expert Engagement:

Case Name:	**Nite Ize** v Premier Accessory Group, United States District Court for the District of New Jersey, Civil Action No. 19-cv-11822.
Filing Date:	April 30, 2019
Activity:	Reports

Expert Engagement:

Case Name:	ABM International, Inc. v. **Juki America, Inc**. And Juki Corporation, Inc. Civil Action No. 2:20-cv-687, United States District Court for the Central District of New Jersey.
Filing Date:	Engagement: April 9, 2020
Activity:	Reports, Deposition

Expert Engagement:

Case Name:	Intuitive Surgical v **Auris Healthcare**, Civ Action No. 18-1359-MN (D. Del.).
Filing Date:	Engagement: January 23, 2020
Activity:	Reports, Deposition

Expert Engagement:

Case Name:	Wastow v **Truckmovers**., United States District Court for the Western District of Missouri, Western Division, Civil Action No. 4:19-Cv-00249-NKL
Filing Date:	March 29, 2019
Activity:	Reports

Expert Engagement:

Case Name:	Hillman Group v **KeyMe, Inc**., United States District Court for the Eastern District of Texas Marshall Division, Civil Action No. 2:19-Cv-00209
Filing Date:	June 3, 2019
Activity:	Reports, Deposition

Expert Engagement:

Case Name:	K. Mizra LLC v. **Toshiba Tec Corporation** et al., Case No. 6:21-cv-01293-PGB-EJK (M.D. Fla.)
Filing Date:	August 16, 2022
Activity:	Reports, Deposition