

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SILENCERCO WEAPONS RESEARCH, LLC,

Petitioner,

v.

HUXWRX SAFETY CO. LLC,

Patent Owner.

Case IPR2024-01214

Patent 8,286,750

DECLARATION OF G. PAUL NEITZEL, PH.D.

PURSUANT TO 37 C.F.R. § 1.68

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I. INTRODUCTION

1. I am making this declaration (“Declaration”) at the request of Patent Owner HuxWrx Safety Co. LLC (“HuxWrx”) in the matter of the *Inter Partes* Review No. IPR2024-01214 of U.S. Patent No. 8,286,750 (“the ’750 Patent”) which was sought by Petitioner SilencerCo Weapons Research, LLC’s (“SilencerCo”).

2. I have been asked to consider and provide opinions on the following topics:

- general technical background regarding the ’750 Patent and issues raised in this IPR;
- whether or not the original claims 2, 3, 6, 9, 12-14, 18 and 20 of the ’750 Patent would be found to be anticipated and/or obvious over the grounds asserted in SilencerCo’s Petition by a person of ordinary skill in the art (“POSITA”); and
- whether the Proposed Substitute Claims in HuxWrx’s Motion to Amend (MTA) respond to grounds asserted in SilencerCo’s Petition and are supported by the original disclosure.

3. My opinions are based on my knowledge, education, experience, and a review of the material provided to me in this case.

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4. I understand that the PTAB has instituted an *Inter Partes* Review of claims 1-22 of the '750 Patent based on the arguments presented in the Petition (IPR2024-00214, Paper 2) ("Petition" or "Pet.") as supported by the Declaration of Mr. John Nixon (IPR2024-00214, Ex. 1013) ("the Nixon Declaration").

5. I understand that Petitioner sought review of all 22 claims of the '750 Patent on the Grounds set forth below. *See* Pet. at 1, 31.

Ground	Claims	35 U.S.C.	Reference(s)
1	1, 4, 5, 7-9, 15-17, 19, and 22	§102	Thurler
2	1, 4-11, 15-17, 19, 21, and 22	§103	Thurler
3	18	§103	Thurler + Bouton
4	1, 4–17, 19–22	§103	Thurler + Barlowatz
5	1, 9, 19, 20	§102	Barlowatz
6	1, 9, 19, 20	§103	Barlowatz
7	2	§103	Barlowatz + Reeves
8	1, 3–5, 8, 9, 18, 19	§103	Eichenseher + Barlowatz

6. I reserve the right to supplement or amend this Declaration based on any additional information that becomes known that affects my opinions.

7. I am being compensated for my work in this matter at an hourly rate of \$550 for consulting services. My compensation for this matter is neither determined by nor contingent on the outcome of this case.

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II. PROFESSIONAL BACKGROUND

8. I retired as Professor Emeritus of Mechanical Engineering in the George W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology in 2018, having served in that role for twenty-eight years. At the time of my retirement, I had been the Associate Chair for Graduate Studies for nine years, managing the largest mechanical-engineering graduate program in the country that had been consistently ranked (by US News & World Report) in the top five in the United States. Prior to Georgia Tech, I was an Assistant Professor, Associate Professor and Professor in the Department of Mechanical and Aerospace Engineering at Arizona State University for eleven years. Thus, I have spent thirty-nine years of my career in academia. My teaching at both institutions consisted of courses in both fluid dynamics and applied mathematics at both the undergraduate and graduate levels.

9. I received my undergraduate degree (Bachelor of Science) in mathematics/physics at Rollins College in Winter Park, Florida in 1969, and immediately accepted a position as a mathematician at the US Army Ballistic Research Laboratories (BRL—now called the Army Research Laboratory) at Aberdeen Proving Ground, Maryland where I worked until 1979. After a couple of years working in the Firing Tables Branch, I moved to the Free Flight Aerodynamics Branch, ultimately changing my job title to aerospace engineer.

While working at BRL, I pursued my M.S. degree in numerical science, which I received in 1974, and my Ph.D. degree in fluid dynamics, which I finished in 1979. Both of these degrees were conferred by The Johns Hopkins University in Baltimore, MD; I presently serve on the External Advisory Board of the mechanical-engineering department at Hopkins. My dissertation topic was concerned with the hydrodynamic stability of an unsteady swirling flow; this was a topic of relevance to liquid-filled projectiles of interest to the Army.

10. My various jobs at BRL encompassed a number of areas from building firing tables (already mentioned) to free-flight aerodynamic design and testing, in-flight stability of liquid-filled projectiles, and the modeling of armor penetration by shaped-charge jets. The research was both theoretical and experimental in nature. Because BRL had transferred me to a branch where there was not substantive research in fluid dynamics, I decided to leave government service in August of 1979, which is when my academic career began.

11. As an academic, I have conducted and published research in the field of fluid dynamics sponsored by a number of federal and commercial entities, including the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR), the Institute of Justice (IOJ), and corporate entities such as Advanced Tissue Sciences, a company focused on tissue

engineering. My initial research centered on aspects of my Ph.D. dissertation, such as the hydrodynamic stability of time-dependent swirling flows and turbulent, swirling flow through a sudden pipe expansion, and later moved on to the study of flows associated with materials processing, such as the instability of surface-tension-driven flow caused by temperature differences (known as thermocapillary convection), flow within rotating and spinner-flask bioreactors used for growing human cartilage, and later to droplet noncoalescence and levitation. In the latter area, I was granted one patent (US 7,670,560 B2) based on a technique I developed for levitating and transporting droplets without them contacting a surface; the intended application was to so-called “lab-on-a-chip” devices. At the time of my retirement and for a couple of years afterward, I was investigating droplet impact on surfaces, the aim of which was to position so-called “blood-spatter analysis” on a firmer scientific footing.

12. I am an elected Fellow of both the Division of Fluid Dynamics of the American Physical Society (the principal professional society for fluid dynamicists internationally) and the American Society of Mechanical Engineers and an Associate Fellow of the American Institute of Aeronautics and Astronautics (although I have allowed my membership in the last of these to lapse since my retirement). I was named in the first class of Presidential Young Investigators by the NSF and have received a research fellowship from the Alexander von

Humboldt Foundation in Germany. I have served in a variety of advisory capacities to various federal agencies and the fluid-dynamics community, including the standard reviewing of proposals and manuscripts, but also in more formal ways such as serving for six years as the chair of the Fluid Physics Discipline Working Group of NASA's microgravity program, serving on the US Space Station Utilization Advisory Subcommittee for four years, and testifying before a US House of Representatives subcommittee on NASA's behalf.

13. A more complete summary of my background, qualifications, professional experience, and affiliations is set forth in my *curriculum vitae*, which is attached as Appendix C, and a list of my patents and publications. I have also attached a complete list of the cases in which I have testified as an expert or have been deposed as Appendix D.

III. MATERIALS REVIEWED AND RELIED UPON

14. In the course of preparing this Declaration, I reviewed the following documents:

- Petition for Inter Partes Review of U.S. Patent No. 8,286,750 B1 ("Petition")
- Ex. 1001 US Patent 8,286,750 to Oliver
- Ex. 1004 750 Patent Prosecution History
- Ex. 1013 Nixon Declaration
- Ex. 1015 US 1,000,702 to Thurler

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- Ex. 1016 US 748,157 to Bouton
- Exs. 1017 and 1018 FR 493462 to Barlowatz (and its translation)
- Ex. 1019 US 582485 to Reeves
- Exs. 1020 and 1021 DE 305012C to Eichenseher (and its translation)
- Decision Granting Institution of *Inter Partes* Review for IPR2024-0214 (Paper 7) (“ID”)
- Deposition Transcript of John Nixon (4/22/2025)
- Any other documents mentioned in this declaration

IV. LEGAL STANDARDS

15. I am not an attorney. I have been advised of the following general principles of patent law to be considered in formulating my opinions as to whether the claims of the ’750 Patent would have been anticipated or obvious to a person of ordinary skill in the art (“POSITA”) at the time of the invention in view of the prior art identified in the Petition.

A. Anticipation

16. I understand that a prior art reference anticipates a claim if every limitation of the claimed invention is found in a single prior art reference, either expressly or inherently, arranged as in the claim. I understand that a claim element is inherent in a prior art reference if it is “necessarily present” in the disclosed apparatus, system or method, not merely probably or possibly present. I understand

that a patent claim cannot be anticipated by a prior art reference if the allegedly anticipatory disclosures in the reference are not enabled. I understand that merely naming or description of the subject matter is insufficient if it cannot be produced without undue experimentation.

B. Obviousness

17. I understand that a prior art reference can render a patent claim obvious to one of ordinary skill in the art if the differences between the subject matter set forth in the patent claim and the prior art are such that the subject matter of the claim would have been obvious at the time the claimed invention was made. In analyzing obviousness, I understand that it is important to consider the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any secondary considerations.

18. I understand that when the claimed subject matter involves combining preexisting elements to yield no more than one would expect from such an arrangement, the combination is obvious. I also understand that in assessing whether a claim is obvious, one must consider whether the claimed improvement is more than the predictable use of prior art elements according to their established functions. I understand that there need not be a precise teaching in the prior art directed to the specific subject matter of a claim because one can take account of

the inferences and creative steps that a person of ordinary skill in the art would employ. I further understand that a person of ordinary skill is a person of ordinary creativity, not an automaton. However, I understand that obviousness cannot be based on the hindsight combination of components selectively culled from the prior art. I also understand that a combination is not obvious if it requires extensive additional problem-solving steps that are not taught in the references and that are not simple matters for a person of ordinary skill in the art. That is, a combination is not obvious if it requires the development of an additional complex infrastructure.

19. I understand that, when there is a reason to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill in the art has good reason to pursue the known options within his or her technical grasp. I further understand that, if this leads to the anticipated success, it is likely the product, not of innovation, but of ordinary skill and common sense, which bears on whether the claim would have been obvious.

C. Claim Construction Standard

20. It is my understanding that in determining whether a patent claim is anticipated or obvious in view of the prior art, the PTAB must construe the claim using the federal court claim construction standard that is used to construe a claim in a civil action under 35 U.S.C. § 282(b). This is the same claim construction

standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc) (“*Phillips*”), and its progeny.

21. The *Phillips* standard requires the claims be given their ordinary and customary meaning to a person of ordinary skill in the art at the time of the invention, by considering the claims, specification, and prosecution history, as well as evidence extrinsic to the patent, when construing patent claims.

22. For the purposes of this Declaration, unless otherwise stated, I have construed each claim term in accordance with the *Phillips* standard.

D. Written Description

23. I understand that whether a patent claim satisfies the written description requirement under U.S. patent law depends on whether the description clearly allows persons of ordinary skill in the art to recognize that the inventor invented what is claimed. I further understand that an applicant may show possession of the claimed invention by describing it with all of its limitations using such descriptive means as words, structures, figures, diagrams, formulas, etc.

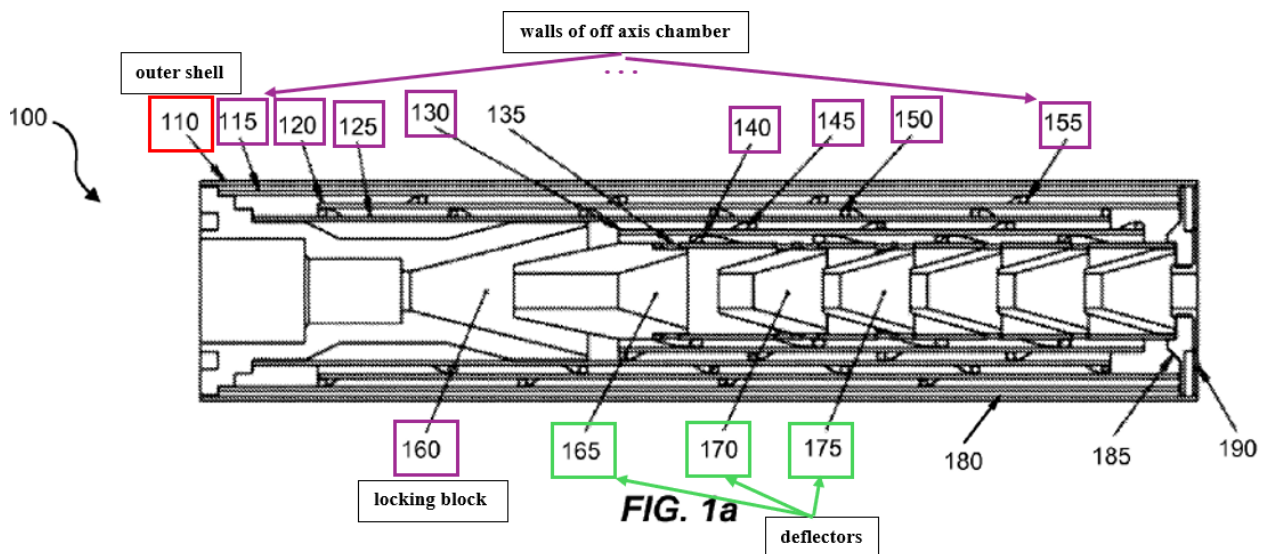
V. '750 PATENT

A. Overview of the '750 Patent

24. The '750 Patent relates to energy capture and control devices to address problems associated with high energy sources, in particular weapons. *See, e.g.*, Ex. 1001, 1:13-18; 4:3-4; 8:39; 8:43-50; 8:59-62; 9:23-25; 10:22-24.

25. As the '750 Patent explains: “High energy sources can produce undesirable levels of acoustic noise and/or particulate pollution.” Ex. 1001, 1:13-14. “In the field of firearm sound suppression, basic sound suppression technology has varied only modestly over the past hundred years.” Ex. 1001, 1:32-34. “Generally, sound suppression designs are based on internal baffles” that “direct gases into” various “flow patterns with optional expansion chambers” and may use sound-absorbing fluid. Ex. 1001, 1:38-48. But “challenges still remain in achieving a long service life suppressor with low maintenance requirements and high acoustic suppression performance.” Ex. 1001, 1:48-52.

26. The '750 Patent describes inventive energy capture and control devices “exemplified in terms of firearms, and more specifically in terms of silencer devices for sniper rifles.” Ex. 1001, 10:22-24. Figure 1a illustrates such a device in cross-section view from the side:



Ex. 1001, Fig. 1a (annotated); 1:56-58. This silencer/suppressor includes an outer shell (110) connected to a firearm through locking block (160) with a central chamber including deflectors (165, 170, 175) that allow the high energy material (e.g., a bullet) to pass through “while redirecting at least a portion of gases, sound/shock waves, and/or particulates into the off axis chamber.” Ex. 1001, 4:19-26; 5:32-49. The off axis chamber includes “multiple internal walls 115, 120, 125, 130, 140, 145, 150, and/or 155 defining a serpentine or winding fluid pathway.” Ex. 1001, 4:27-29.

27. The '750 Patent explains that these serpentine fluid pathways “provide an increased volume for fluid expansion and increased acoustic absorbent path length.” Ex. 1001, 4:29-31. The '750 Patent describes two types of serpentine pathways: axially serpentine and radially serpentine. Ex. 1001, 4:31-41. An “axially serpentine fluid pathway” “causes fluids received in the off axis chamber

to travel back and forth along a length of the off axis chamber.” Ex. 1001, 4:32-34.

A “radially serpentine fluid pathway” “causes the fluids received in the off axis chamber to flow back and forth around a radius of the off axis chamber” which can include such flow while traversing the length of the chamber or not. Ex. 1001, 4:34-41

28. I discuss the construction of “radially serpentine” further below in Section VII.A in light of Mr. Nixon’s comments on its ordinary and customary meaning.

29. Figure 1b illustrates a cross-sectional view of the device of 1a from its outlet end opposite the locking block. Ex. 1001, 1:59-60; 5:2-4. Figure 1b illustrates tubes nested within an octagonally-shaped outer shell, but the outer shell can have a circular cross-section or other shape. Ex. 1001, 5:2-4; 7:46-49. The ’750 patent provides that the outer shell can include an end cap at the outlet end that allows fluid to escape from the off axis chamber. Ex. 1001, 7:49-51. Figure 8a illustrates a tube cap with outlet slits 187 that correspond to the outermost tube of the off axis chamber:

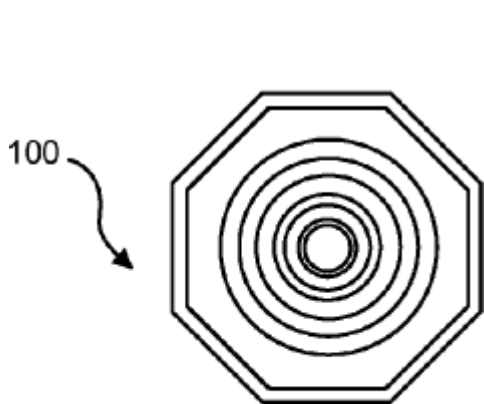


FIG. 1b

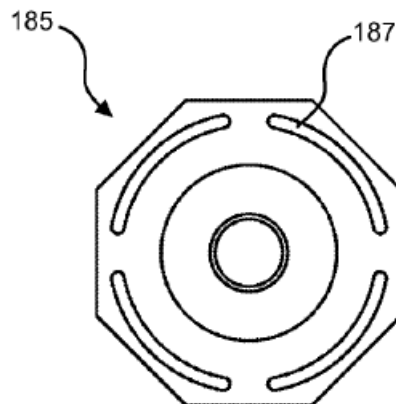


FIG. 8a

Ex. 1001, Figs. 1b, 8a.

30. The outlet slits correspond to the shape of the outermost tube “to enable gases from the tube to pass therethrough.” Ex. 1001, 7:55-57. The ’750 Patent explains that without “sufficient slits” “there is a potential for gases to be at least partially blocked from exiting the tube” and thus the need for a pathway as illustrated in Figures 8a and b. Ex. 1001, 7:57-63. The ’750 Patent likewise describes an end cap with apertures smaller than the slits of the tube cap to control the exit of fluids from the off-axis chamber. Ex. 1001, 7:64-8:2. The ’750 Patent notes that these apertures might be adjusted to change the amount of sound suppression and though “[c]ompletely blocking the discharge of such gases, waves, and the like, is another option,” that approach “can have increased detrimental effects on the high energy discharge device to which the energy capture device is

attached.” Ex. 1001, 8:2-12. Figures 9a and 9b show an example of such an end cap from the end view and in perspective:

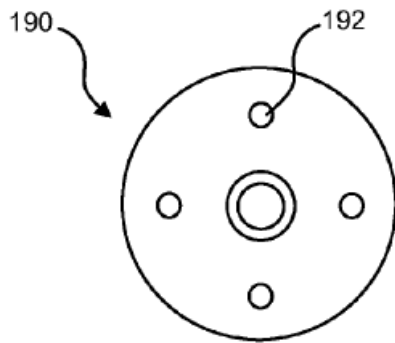


FIG. 9a

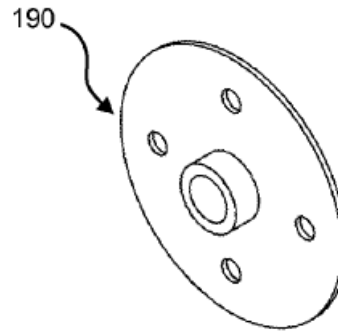


FIG. 9b

Ex. 1001, Figs. 9a, 9b.

31. The '750 Patent claims inter alia an energy capture and control device at various levels of specificity based on these disclosures.

B. Prosecution History

32. I have reviewed the prosecution history of the application that led to the '750 Patent including:

- 9/30/2011 Office Action (Ex. 1004, 114-26);
- Applicant's Amendment and Response (*id.*, 087-101);
- 2/8/2012 Office Action (*id.*, 067-079);
- Applicant's Amendment / Response (*id.*, 047-65).

33. The Patent Office issued a Notice of Allowance on 09/12/2012. *Id.*, 031-37. This document includes a mapping of the originally-filed claim numbers to their final claim numbers. *Id.* at 040.

34. The applicant consistently explained the nature of a “radially serpentine” pathway as allowing fluid to flow “clockwise to counter-clockwise” around an axis. *See, e.g., id.* 054, 061, 093, 095.

35. The applicant also noted specifically that the claims required “a fluid outlet” from the “off axis chamber” which “presents an outlet for fluids to escape the off axis chamber and the device *without* returning to the central chamber.” *Id.*, 054 (emphasis in original). As the applicant explained, “[t]his allows fluids to escape from the device without creating excessive back pressure in the host weapon.” *Id.*; *see also id.*, 093-94.

C. Claims Addressed

36. I understand that HuxWrx’s Response addresses the patentability of dependent claims 2, 3, 6, 9, 12-14, 18 and 20 over the petitioned grounds. Claims 2, 3, 6, 9, 12-14, 18 ultimately depend from independent claim 1, and claim 20 depends from independent claim 19. A full listing of the claims is provided in Appendix A.

37. I understand that HuxWrx’s Motion to Amend includes Proposed Substitute Claims as listed in Appendix B.

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VI. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

38. My assessment of the claim terms addressed herein assumes that they are being interpreted by a POSITA. In that regard, I have been asked to provide my opinion as to the educational level and professional experience of such a POSITA.

39. I understand that the Petitioner asserts that a person of ordinary skill in the art (“POSITA”) at the time of the invention for the ’750 patent “would have had a relevant technical degree in Mechanical Engineering, Fluid Engineering, or the like, and 2-3 years of experience researching, designing, manufacturing, or assessing ESDs [energy suppression devices], though less education may be sufficient with additional experience, and *vice versa*.” Pet. at 6.

40. For the purposes of this proceeding, I apply the same definition.

41. I note that I would have met or exceeded the qualifications of a POSITA. My opinions provided herein are from the perspective of such a person.

42. From the vantage point of such a POSITA, at the time of the effective filing date of the ’750 Patent, I do not believe that claims 2, 3, 6, 9, 12-14, 18 or 20 would have been anticipated or obvious over the art asserted in the Petition.

43. A detailed explanation of the reasoning that led to these opinions is provided below.

VII. CLAIM CONSTRUCTION

44. The Petition asserts that no “specific constructions are required at this time” but articulates its interpretation of the “ordinary and customary meanings (OCM)” of four terms with Mr. Nixon addressing the same as well as a fifth term. Pet. at 12-19; Ex. 1013, ¶¶101-35.

45. The Board discussed two of these interpretations in its Institution Decision. ID at 10-16.

46. I provide my opinions on the Petitioner’s interpretations of these terms from the perspective of a POSITA below.

A. “radially serpentine”

47. In the ID, the Board concluded that “‘radially serpentine’ as recited in the claims of the ’750 patent [] mean[s] a back and forth flow around a radius of the off axis chamber.” ID at 14.

48. This is consistent with the ’750 patent’s statements that “radially serpentine fluid pathway” “causes the fluids received in the off axis chamber to flow back and forth around a radius of the off axis chamber” and “a radially serpentine pathway [] causes the fluids to flow back and forth around a radius of the off axis chamber while also traversing a length of the off axis chamber.” Ex. 1001, 4:34-41. It is also consistent with the statements that were made during the prosecution of the ’750 patent. *See, e.g.*, Ex. 1004 at 054, 061, 093, 095.

49. Petitioner seeks to add limitations requiring that this “back and forth” flow must occur “while advancing outwardly along a radius of the off-axis chamber” and include at least two changes of direction. Neither of these additions is appropriately included in the meaning of “radially serpentine” in my opinion.

50. Petitioner and its expert did not provide any reason why “back and forth” movement would require at least two changes of direction. Pet. at 17; Ex. 1013, ¶130. I am not aware of any reason a POSITA would interpret it that way either. In my view, the Board correctly rejected this position in its preliminary decision. ID at 12-13. The literal meaning of the words describes a single change from one direction to another direction consistent with the ordinary meaning of “serpentine.” This interpretation is also consistent with the applicant’s repeated description during prosecution of this flow as being a change from clockwise to counter-clockwise. *See*, Ex. 1004, at 054, 061, 093, 095.

51. I find nothing in the ’750 Patent, its prosecution history, or otherwise that requires that a “radially serpentine” fluid pathway only directs flow outwardly along a radius of the off axis chamber. The Board’s initial decision found the same. ID at 13. The Board further noted that “[n]either Mr. Nixon nor Petitioner identifies any part of the ’750 patent or its prosecution history that imposes such a directional limitation, nor does our review reveal such support.” ID at 13. I agree

with the Board’s conclusion rejecting this addition to the meaning of “radially serpentine” is sound. ID at 13-14.

52. I nevertheless would clarify some of Petitioner’s characterizations of a “radially serpentine” pathway that were addressed in the preliminary decision.

53. As the Board noted, the ’750 patent’s specification states that a “radially serpentine fluid pathway” “causes the fluids received in the off axis chamber to flow back and forth around a radius of the off axis chamber.” Ex. 1001, 4:34-37. The specification also provides that “the fluid pathway *can be a radially serpentine pathway* which causes the fluids to flow back and forth around a radius of the off axis chamber *while also traversing a length of the off axis chamber.*” Ex. 1001, 4:37-41 (emphasis added). That is, a fluid pathway can remain “radially serpentine” while also moving in another direction, specifically including traversing the length of the chamber.

54. As the preliminary decision also notes, the ’750 patent describes one more “fluid pathway ‘which causes the fluids to spiral around the central chamber within the off axis chamber along a length of the off axis chamber,’ as a ‘helical fluid pathway.’” ID at 11 (*quoting* ’750 patent, 4:41-44). Accordingly, a pathway traversing the length of the chamber that spirals in one direction is “helical” whereas one that changes direction is “radially serpentine.”

55. Petitioner and its expert provide two examples from the patent that they admit are “radially serpentine” in Figures 1 and 2 from the expert’s declaration:

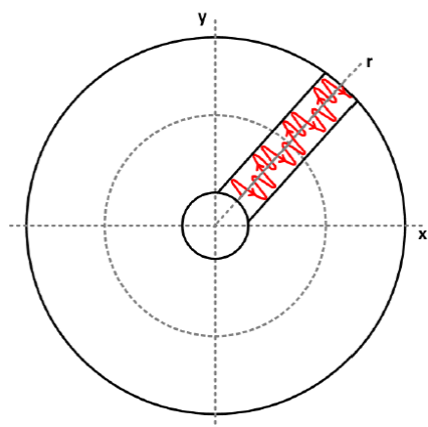


Figure 1

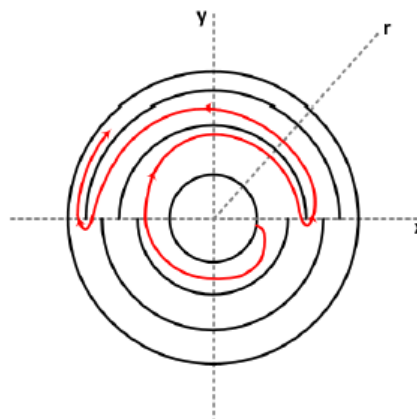


Figure 2

Ex. 1013, ¶¶127-28; Figs. 1 (omitting 2nd perspective) and 2; *see also* Pet. at 15 and 17.

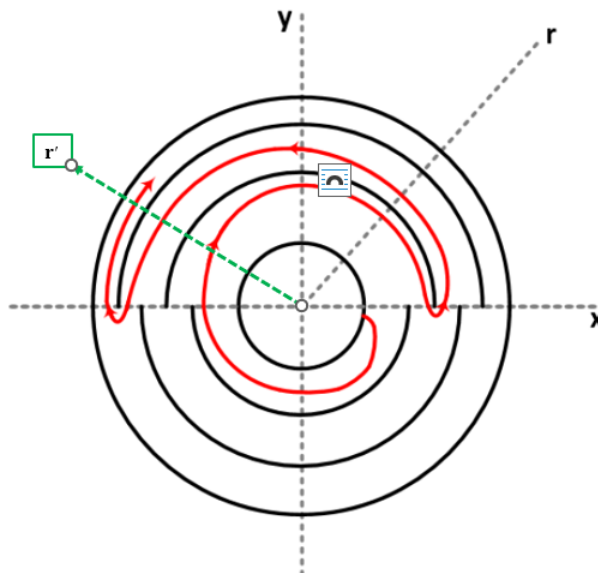
56. Figure 1 depicts what Petitioner’s expert characterizes as “in [his] opinion, a POSITA reading lines 34-37 in column 4 of the ’750 Patent would understand a ‘radially serpentine fluid pathway’ as a fluid pathway that winds back and forth around a radius that extends outwardly from a central point to an exterior of the ’750 Patent’s ESD and is normal to the axis extending through the length of the ’750 Patent’s ESD.” Ex. 1013, ¶ 127.

57. Figure 1, as drawn by Petitioner’s expert, reflects a pathway in red that moves across the radius r in one direction and then back in another direction. Setting aside the multiple changes of direction and its advancement outward, this

captures an example of flow “around a radius” albeit with narrow turns around the radius.

58. Figure 2 depicts what Petitioner’s expert characterizes as “the radially serpentine fluid pathway illustrated in FIG. 14” “that serpentine back (*i.e.*, counterclockwise) and forth (*i.e.*, clockwise) while advancing radially outward through a series of annular spaces that are connected and progressively larger.” Ex. 1013, ¶128; Fig. 2. As shown, this pathway crosses over and back of the radius r just as in Figure 1 but with broader turns about the radius r .

59. One could also select a different radius r' where the pathway crosses closer or further from the center of the off axis chamber, or more frequently (as shown below):



(Modified version of Ex. 1013, Fig. 2 (adding radius r' in green))

60. For both Figure 1 and 2, Petitioner and its expert admit that these flow paths are “radially serpentine.” Ex. 1013, ¶¶127-28; Pet. at 15, 17. Figure 1 depicts an example of what is described at 4:34-37 of the specification, and Figure 2 represents the pathway illustrated in the patent’s Figure 14. Ex. 1013, ¶¶127-28.

61. In my opinion, when the applicant stated during prosecution that “[s]upport for radially serpentine flow can be found at page 7, lines 21-24 and FIG. 14” of the patent, there was no misrepresentation as Mr. Nixon alleges. Ex. 1004, 094; *see also id.* 054. The cited “page 7, lines 20-22” of the originally-filed application correspond to Col. 4:34-37. *Compare* Ex. 1004 at 252 *with* ’750 Patent, 4:34-37. Petitioner’s expert’s contention that the reference to the “axis” was somehow a misrepresentation is also misplaced. A radius extends from an origin of a polar, cylindrical, or spherical (although the latter is not relevant here) coordinate system, as shown in all of his figures, and in the case of a cylinder like those in Figure 14 of the patent, that origin is the common axis that extends along the length of the cylinders.

62. For these reasons, I disagree with the Board’s statements in the preliminary decision regarding the applicant’s statements during prosecution. ID at 14. The distinction suggested between “flow *circumferentially* about the central chamber” is not necessarily in opposition to it being “radially serpentine.” As noted above, what the Board appears to characterize as circumferential flow while

traversing the length of a chamber in the context of the '750 patent would be “helical” if there were no changes of direction, but “radially serpentine” when there is at least one change of direction.

B. “at least one of” [axially serpentine and radially serpentine]

63. I do not believe the phrase “at least one of” requires any construction for a POSITA and generally agree with the Board’s analysis in the preliminary decision. ID at 14-15. A POSITA would understand that this phrase requires that the claimed device must be “one or more of,” and is therefore either “axially serpentine” and/or “radially serpentine.” ID at 16.

C. “a common off axis chamber” / “a plurality of deflectors . . . configured to deflect the energy from the high energy material to the common off axis chamber

64. I understand that HuxWrx disagrees with Petitioner’s attempt to combine these phrases into one another and insert additional limitations (e.g., “separately and directly”). I do not believe Petitioner or Mr. Nixon’s arguments or any of my opinions provided herein turn on their proposed understanding of the ordinary meaning of these claim terms.

65. Further, I believe the language of the claims is clear and properly defines the scope of the inventions, and I have relied on this claim language in my analysis.

D. “fluid outlet”

66. Mr. Nixon opines briefly on the ordinary meaning of the term “fluid outlet,” but the Petition does not mention or rely on this opinion and generally ignores this limitation of the claims. *See* Ex. 1013, ¶¶115-16.

67. A proper understanding of this term and its scope in the context of the ’750 Patent is important. Petitioner’s expert asserts that “a fluid outlet” is simply “an orifice through which gas flows out of the common off axis chamber.” This is overly broad. The claim language, specification, and prosecution history make clear that the claimed “fluid outlet” is an outlet for fluids to escape the off axis chamber and the device without returning to the central chamber.

68. Claim 1 sets out the structure of the device as follows:

1. An energy capture and control device, comprising:
 - a) a central chamber oriented along a central axis within an outer shell . . .;
 - b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber *and* having a *fluid outlet*

Ex. 1001, Cl. 1 (emphasis added).

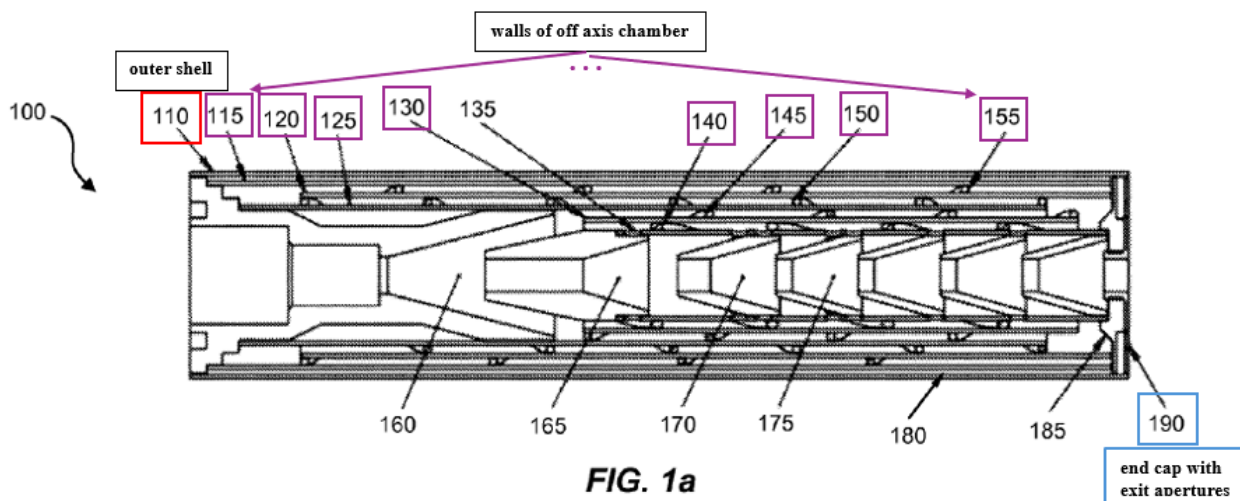
69. The claimed device is described as including two chambers within an outer shell: a central chamber and common off axis chamber. The common off axis chamber is required to be both “in fluid communication with the central chamber”

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and must have a “fluid outlet.” From the claim language alone, one of ordinary skill would understand the claimed “common off axis chamber” must, in addition to being in fluid communication with the central chamber, include an outlet for fluid to exit the chamber. In other words, the “fluid outlet” must allow fluids to leave the claimed device’s off axis chamber, via a mechanism other than that which creates the fluid communication between the common off axis chamber and the central chamber.

70. The specification likewise provides that the “off axis chamber can be oriented within the outer shell in fluid communication with the central chamber” and “can have a fluid outlet.” Ex. 1001, 4:13-16. As shown in Figures 1 and 9, the specification shows an outlet at the end of the common off axis chamber with an end cap 190 and exit apertures 192:



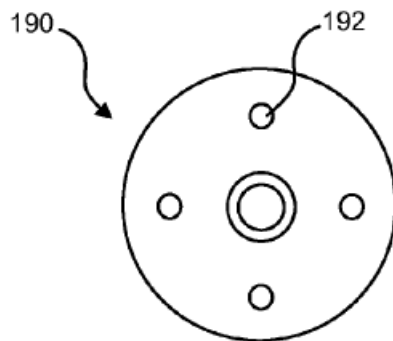


FIG. 9a

Ex. 1001, 7:64; Figs. 1 (annotated), 9. The fluid can escape from the common off axis chamber without returning to the central chamber. Indeed, there is no embodiment in the specification in which the fluids necessarily return from the off axis chamber to the central chamber before leaving the device.

71. In the prosecution history, the applicant further reinforced the meaning of the claimed “fluid outlet,” stating:

Furthermore, each of the independent claims requires that the off axis chamber includes “a fluid outlet.” This is a separate element from the fluid communication with the central chamber and presents an outlet for fluids to escape the off axis chamber and the device *without* returning to the central chamber. This allows fluids to escape from the device without creating excessive back pressure in the host weapon.

Ex. 1004, 054 (emphasis in original).

72. These remarks were provided in the Applicant’s 5/29/12 Response, and the Examiner subsequently allowed the claims. See Ex. 1004, 035. I believe one of ordinary skill would understand this as a clear and unmistakable statement about the scope of the term “fluid outlet” that should control its interpretation.

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73. The claims, specification, and prosecution history thus all compel the conclusion that one of ordinary skill in the art would understand the “fluid outlet” of claim 1 to require an outlet for fluids to escape the off axis chamber and the device without returning to the central chamber.

74. Petitioner’s expert makes an argument with respect to the limitations of issued claim 18. *See* Ex. 1013, ¶116. But this argument ignores that claim 18 includes further narrowing limitations, including that the fluid outlet is provided “at an outlet end” of the central chamber. Ex. 1001, cl. 18. It also fails to recognize that the correct understanding of “fluid outlet” does not preclude fluids from returning to the central chamber like claim 18 does.

75. The “fluid outlet” must simply allow fluids to escape the off axis chamber without returning to the central chamber.

VIII. TECHNOLOGY BACKGROUND

76. As discussed further below, the prior art references asserted against the ’750 Patent include patents directed to both silencers/suppressors for firearms and mufflers. In his declaration, Mr. Nixon refers to “energy suppression device(s)” generally as “ESD(s).” Ex. 1013, ¶54. As he explains, “ESDs used to suppress and/or attenuate energy created by internal combustion engines are frequently referred to as ‘mufflers’ whereas ESDs used to suppress and/or

attenuate energy created by firearms are frequently referred to as ‘silencers’ or ‘suppressors.’” Ex. 1013, ¶59.

77. Mr. Nixon further asserts that “[i]n general, the principles for suppressing energy created by internal combustion engines apply equally to the principles for suppressing energy created by firearms.” Ex. 1013, ¶62.

78. Although the fundamental principles behind noise reduction for firearm suppressors and IC engine mufflers are generally the same, there are at least some differences which may be relevant to the issues in this proceeding and discussed further in this declaration.

79. For example, the noise levels from a firearm on the one hand and an engine vary greatly. Some firearms can produce noise levels at a value of 175 decibels (dB) while most automotive engines operate in the 75-90 dB range (with some going as high as 120 dB, at or near the “threshold of pain” for human hearing. The decibel scale is logarithmic, not linear, so the differences between the two devices are significant.

80. Another fundamental difference between suppressors and mufflers is the fact that the former are generally designed to operate in a transient mode, with some time period existing between successive shots, while the latter operate in a continuous mode as long as the engine is running.

81. Thus, although the passage of a bullet through a suppressor may take but a fraction of a millisecond, the escape of the gases from the suppressor itself (depending on, among other things, its specific structural design) would require orders of magnitude longer.

82. A muffler operating in steady-state is expelling gases from its exit at the same rate the gases are entering (following an initial increase of internal pressure) while the vehicle is proceeding at a constant speed. Changes in, e.g., vehicle speed or gearing would likewise bring about changes in the flow rates through these devices, but the time scales for accommodation to, say, a higher speed (with concomitant higher flow rate) allow this to take place without a significant transient over-pressure increase within the muffler itself.

83. Furthermore, the purposes and uses of suppressors and mufflers diverge in ways that may have structural and design consequences for these devices. A muffler is designed, in addition to reducing the noise from combustion gases, to remove these typically noxious gases entirely from the vicinity of the engine and/or its operators. This purpose would compel a structure that directs all gases through the exit of the muffler in a suitable direction.

84. A firearm suppressor may have similar concerns in directing particulate discharge away from the shooter and the device to avoid damage, as recognized by HuxWrx, but subject to the need to maintain suitable back pressure

so as not to interfere with the firearm mechanism. Many firearms, typically referred to as semi-automatic or automatic, perform the reloading function from the recoil and appropriate operation of their normal firing mechanism. This adds an additional consideration for suppressors that any back pressure introduced by the suppressor's structure designed to reduce noise must also be calibrated for its particular application to avoid interfering with automatic reloading.

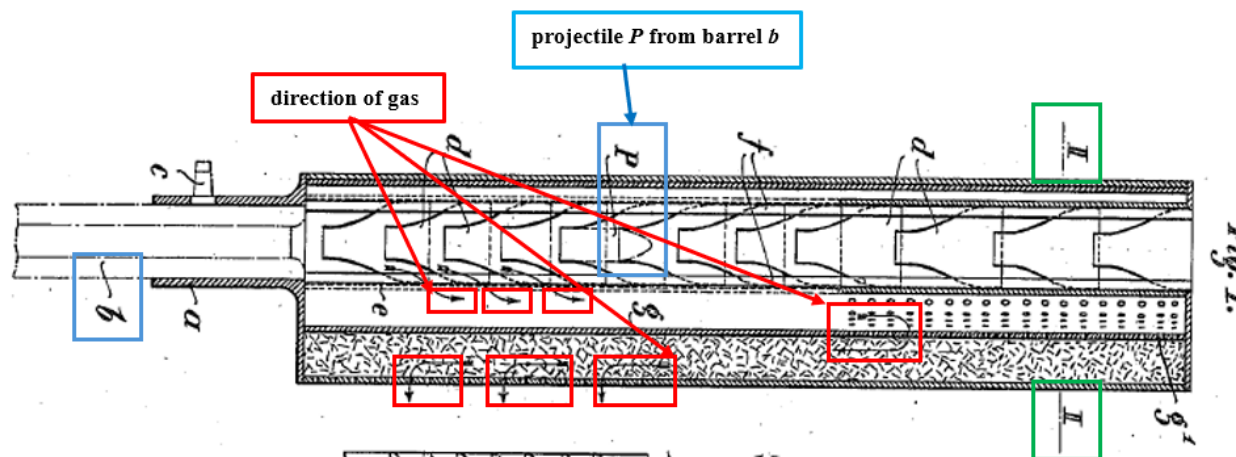
IX. PRIOR ART REFERENCES

A. Thurler (U.S. Patent No. 1,000,702)

85. Thurler discloses “devices for lessening the report of firearms.” Ex. 1015, 2:9-10. Figures 1-4 disclose different perspectives of such a device. Ex. 1015, 1:40-45. Figure 1 is a “horizontal longitudinal section” and Figure 2 is “a cross section along the line II—II” of Figure 1. Ex. 1015, 1:40-43.

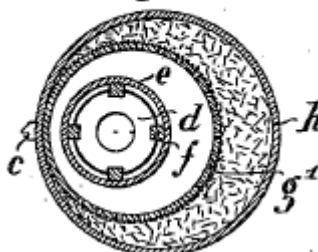
86. The device includes sleeve *a* that fits over the barrel *b*. Ex. 1015, 1:47-49. The interior of the device has a tube *e* with a series of non-concentric tubular sleeves *d*. Ex. 1015, 1:53-55. Tube *e* is made of a “fine net-work” for two-thirds its length with the remainder sheet metal. Ex. 1015, 1:55-58. Tube *g* surrounds tube *e* and is eccentric to the common axis. Ex. 1015, 1:69-73. Tube *g* is perforated for one-third its length at the front. Ex. 1015, 1:73-75. Finally, a third tube *h* surrounds tube *g*, is likewise eccentric as shown, and perforated for one-third of its length near the projectile exit, and the space between tubes *g* and *h* is filled with shavings

of metal. Ex. 1015, 1:75-82. Tubes *g* and *h* are eccentric to the tubes through which the projectile travels such that they hang down below its trajectory “so that the sight *c* projects over the device.” Ex. 1015, 1:79-82.



EX1015, FIG. 1 (annotated)

Fig. 2.



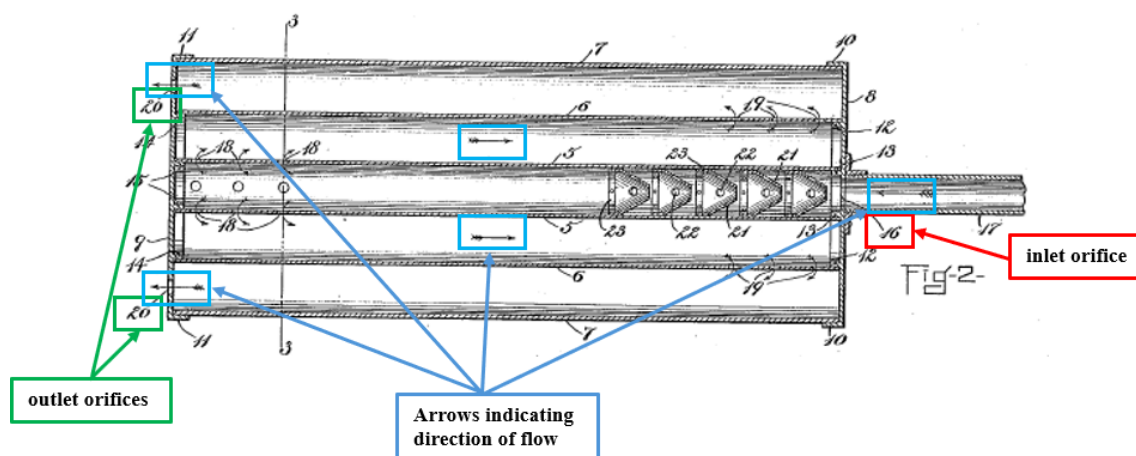
EX1015, FIG. 2

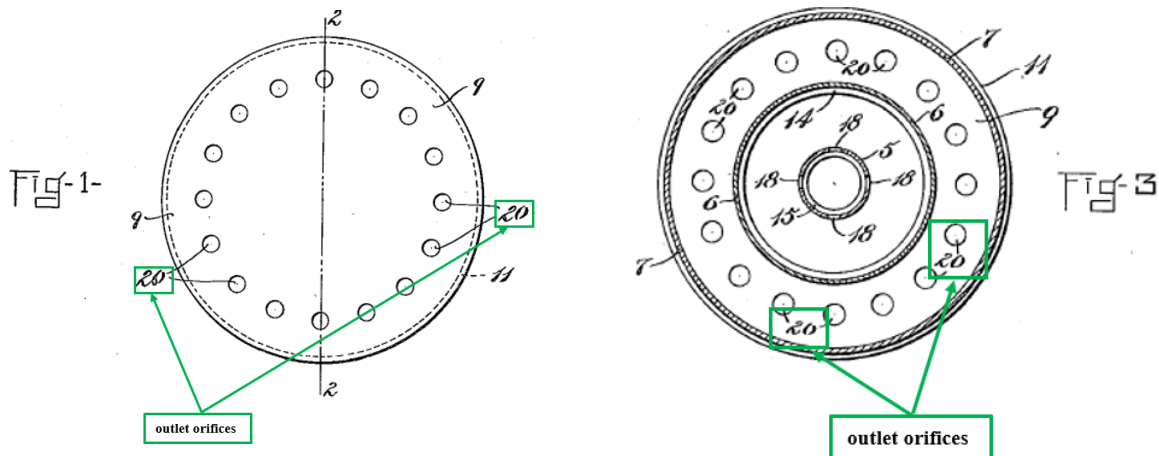
87. In Thurler, a projectile *P* fired from barrel *b* travels down a channel formed by the sleeves *d*. Ex. 1015, 1:84-87. The compressed gases pass through the openings of the tube *e* into the space between tubes *e* and *g*, then through the openings of tube *g* into the space between tubes *g* and *h*, “where the gas is prevented from expanding instantly owing to the filling of the metal shavings.” Ex. 1015, 1:88-99. The direction of the compressed gas is shown by the arrows in the figure above. Ex. 1015, 1:83-84.

88. Thurler notes that “[e]xperiments have shown that the recoil of a gun fitted with the above described device is only very slightly diminished, the automatic reloading by recoil could therefore be accomplished.” Ex. 1015, 2:4-8.

B. Bouton (U.S. Patent No. 748,157)

89. Bouton “relates to devices for muffling or deadening the sound of escaping vapors, such as exhaust-steam, gasolene vapors, and the like.” Ex. 1016, 1:8-11. Figure 1 shows an end elevation, Figure 2 is a longitudinal section taken on line 2 2 of Figure 1, and Figure 3 is a transverse section taken on line 3 3 of Figure 2. Ex. 1016, 1:38-44. The muffler includes an inlet 16 and outlet orifices 20. Ex. 1016, 1:61-71.



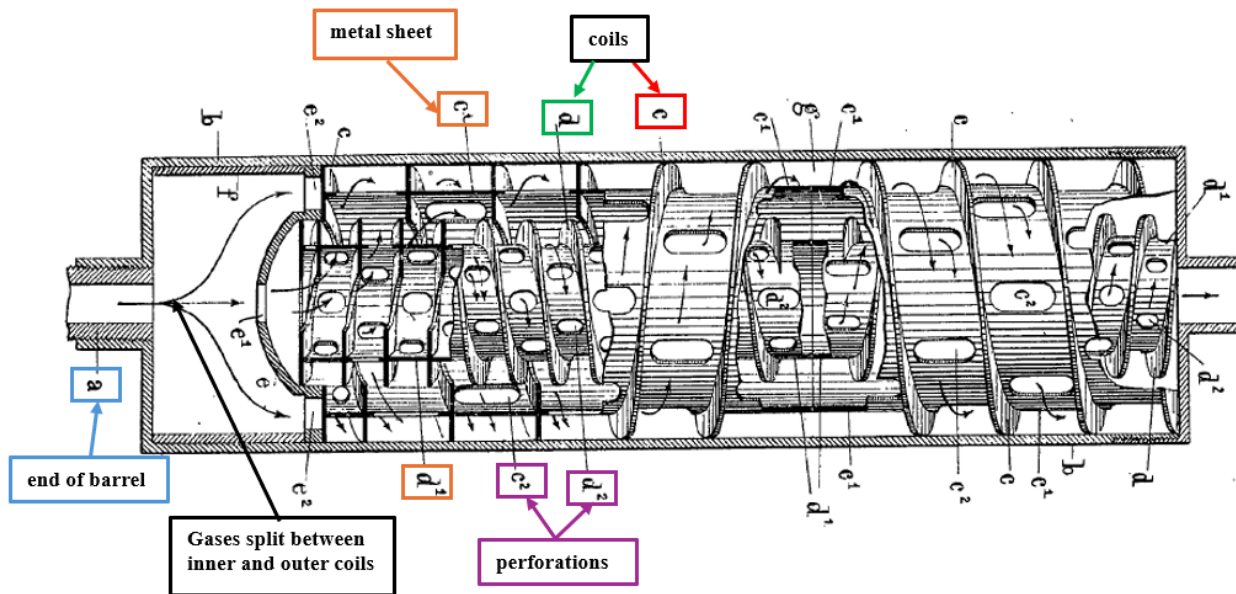


90. In operation, “[t]he exhaust gasoline vapor or steam” “enters the innermost tube 5 through . . . inlet-orifice 16” “travel[s] the entire length of the innermost tube 5, thence passing outwardly” and back and forth through the additional tubes “and outwardly through the orifices 20 20.” Ex. 1016, 1:82-99. Bouton explains that “the vapor finally passes out of the muffler through the orifices 20” such that “there is no perceptible sound caused thereby.” Ex. 1016, 2:2-5.

91. The annotated figures above indicate the direction of flow in Bouton’s muffler and demonstrate that the outlet orifices align between the end shown in Figure 1 and the section at 3 3 of Figure 2 which is shown in Figure 3 such that all the vapor that passes through the muffler is expelled as would be appropriate to a muffler “especially adapted to be used in connection with gasoline engines and motor vehicles.” Ex. 1016, 2:9-13.

C. Barlowatz (French Patent No. 493,462)

92. According to the translation provided by Petitioner, Barlowatz discloses a silencer “consisting of a sleeve” “enclosing two coils, nested one inside the other having turns oriented in different directions.” Ex. 1018 at 1. The silencer includes one external coil *c* and internal coil *d* whose turns are oriented in different directions:



93. In operation, a projectile passes from the end of a gun barrel *a* through the inner coil *d*. Ex. 1018 at 1. The blast gases are split into two parts at part *e* with some of the gases following the projectile through inner coil *d* while most of the gases are diverted to outer coil *c*. Ex. 1018 at 1. The gases flow through the two coils in different directions and “counteract each other.” Ex. 1018 at 2.

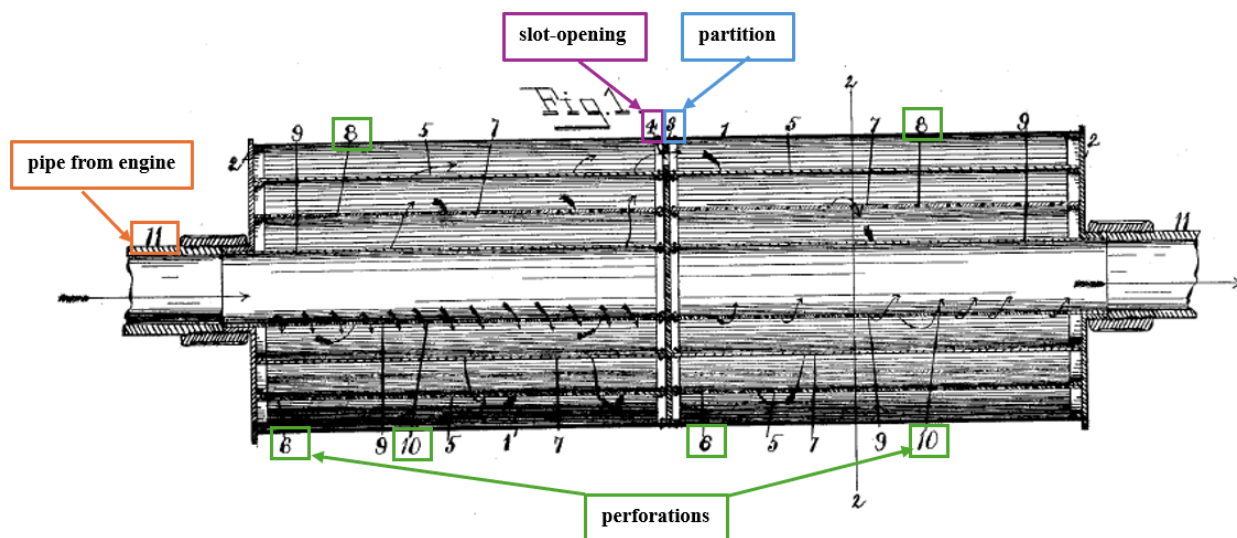
94. Barlowatz further discloses that the groups of two coils can be mounted one after the other with two groups shown in the figure having two outer

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coils *c* oriented in opposite directions and two inner coils *d* oriented in different directions such that the gases in each are forced to change direction. Ex. 1018 at 2. The directions of the gas flows are indicated by the arrows in the drawing indicating how they split, drive in different directions in the two coils to counteract one another before coming together to exit from the open end of the inner coil as shown. Ex. 1018 at 2.

D. Reeves (U.S. Patent 582,485)

95. Reeves discloses an “Exhaust-Muffler” designed “to provide means for expanding exhaust product gradually, and in so doing to break it up and cool it to such an extent that when it is finally exhausted into the atmosphere its pressure and temperature are practically normal.” Ex. 1019, 1:21-26. Reeves discloses “a central vertical section” of such a device in Fig. 1:

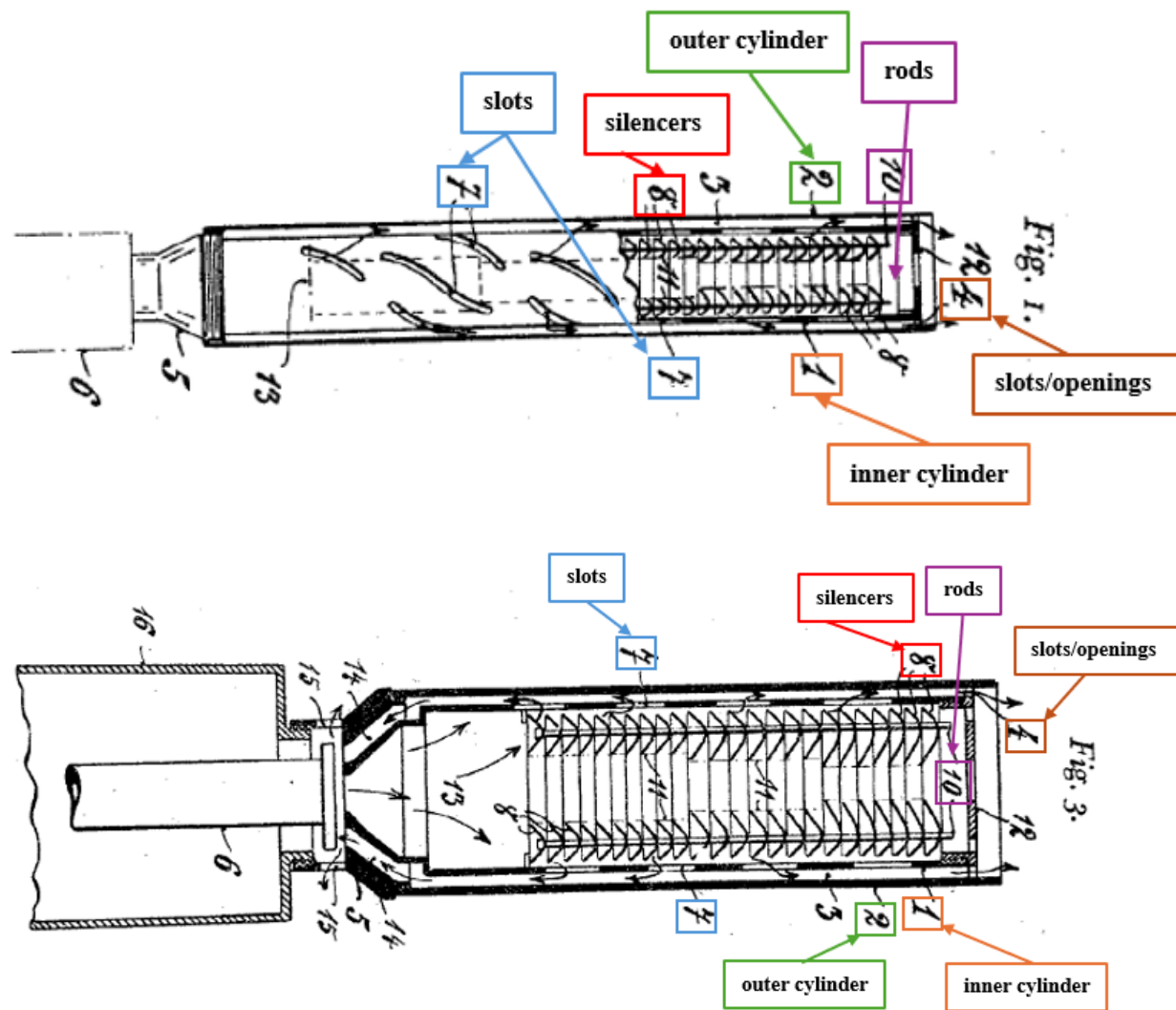


Ex. 1019, 1:32-33; Fig. 1 (annotated).

96. The device includes an outer shell 1, concentric shells 5, 7, and 9, partitioned at 3 with a slot-opening 4, and perforations labelled 6, 8, and 10. Ex. 1019, 1:35-70. Pipe 11 is connected to the exhaust of an engine and “gas or liquid entering the small chamber at one end must, before being expelled at the other end, pass through 180° in each annular chamber between the shells.” Ex. 1019, 1:55-59. In more detail, the gases from pipe 11 pass into the smaller chamber, then through perforations 10 to the chamber between shells 9 and 7, then through perforations 6 into the chamber between shells 5 and through opening 4 into the right-hand side. Ex. 1019, 1:59-70. The gases then reverse from the larger chambers to smaller through the same numerated perforations until it is “finally exhausted from the smaller chamber,” i.e. out at reference number 11 as indicated by the arrow. Ex. 1019, 1:70-74.

E. Eichenseher (German Patent No. 305,012)

97. According to the translation provided by Petitioner, Eichenseher discloses a silencer for rifles in Figures 1 and 2, and a silencer for a machine gun in Figure 3:



Ex. 1021, Figs. 1 and 3 (annotated).

98. Both silencers include inner cylinder 1 and outer cylinder 2, creating a cavity 3 between. Ex. 1021 at 1. The inner cylinder includes slots 7 that permit gas to escape into cavity 3. Ex. 1021 at 1. The inner cylinder 1 includes silencers 8 (also translated as “sound absorbers 8”), shown with notches 9 in Figure 4, that are loosely lined up on rods 10. Ex. 1021 at 1-2. In operation, Eichenseher asserts that

sound is intercepted by the sound absorbers 8 while gases can escape through 9, 7, 3, and 4. Ex. 1021 at 2.

X. OPINIONS REGARDING THE GROUNDS ASSERTED AGAINST CLAIMS 2, 3, 6, 9, 12-14, 18, AND 20

99. I have been asked to analyze the Petition's asserted grounds against Claims 2, 3, 6, 9, 12-14, 18, and 20. I address each ground in turn below to the extent it is applied to one or more of these claims.

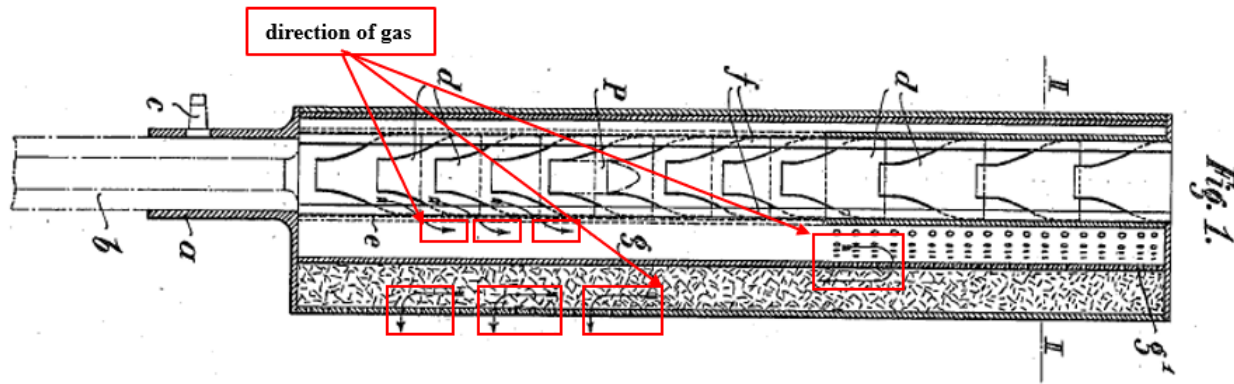
A. Ground 1: Thurler Does Not Anticipate Claim 9 Because It Does Not Disclose a "Radially Serpentine" Pathway.

100. Claim 9 requires that "the multiple internal walls are formed to produce a radially serpentine fluid pathway." Ex. 1001, cl.9.

101. The Petition and Mr. Nixon assert that Thurler's tubes create a radially serpentine pathway, but he has not identified anything in Thurler that discloses a radially serpentine fluid pathway. *See* Pet. at 35-36; Ex. 1013, ¶¶176-77.

102. In my opinion, Thurler only discloses an *axially* serpentine fluid pathway.

103. As explained above in Section VII.A, "radially serpentine" means a back and forth flow around a radius of the off axis chamber. Thurler does not disclose walls that produce a radially serpentine pathway. Figure 1 of Thurler illustrates the path that gases take with arrows, highlighted in red below:



EX1015, FIG. 1 (annotated); 1:83-84.

104. As the arrows show, fluid flows down the length of the chambers and back, which is an axially serpentine pathway. But there is no structure to cause a change of direction around a radius of the chamber.

105. Mr. Nixon, when asked at his deposition whether he would describe this pathway as “radially serpentine or axially serpentine or both,” he stated “[t]hat [it] would be axially serpentine.” Nixon Dep. at 35:20-36:1.

106. Because Thurler does not disclose a radially serpentine pathway, I understand that it cannot anticipate claim 9.

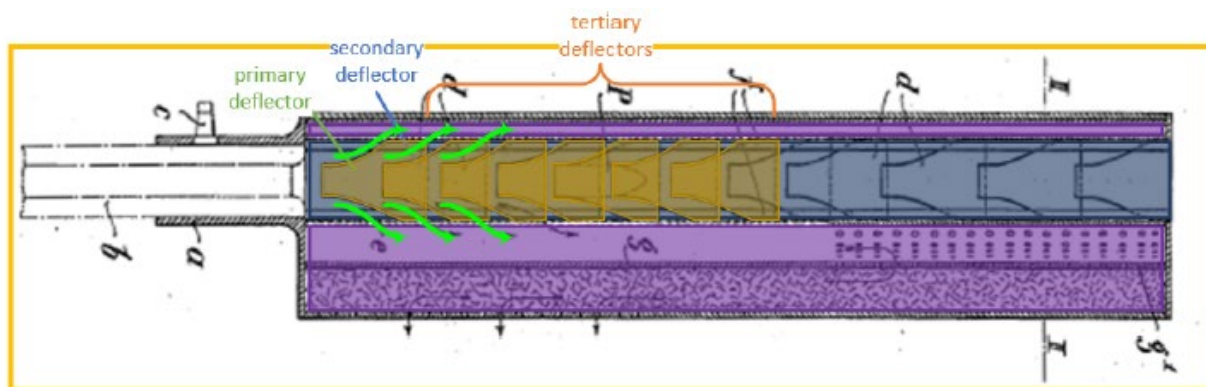
B. Ground 2: Thurler Does Not Render Claims 6 or 9 Obvious.

1. Claim 6

107. Claim 6 requires that “the fluid communication between the common off axis chamber and the central chamber occurs *only* at the primary deflector, the secondary deflector and a first tertiary deflector.” Ex. 1001, cl. 6 (emphasis added).

108. I note that Petitioner did not include this claim in its arguments under Ground 1 indicating that it is not disclosed by Thurler. *See* Pet. at 48; *see also id.* at 31 (excluding cl.6 from Ground 1 based on § 102). Petitioner instead asserts that it would be obvious to modify Thurler to meet this limitation. Pet. at 48.

109. In my opinion, Petitioner has failed to show that a person of ordinary skill in the art would modify Thurler in a way that would achieve the limitations of claim 6. Petitioner provides the annotated figure below and argues that, because Thurler discloses that tube *e* “is perforated for two thirds of its length,” it also “contemplates other lengths of perforations but opted to use a perforation configuration that extends two thirds of the length.” Pet. at 48 Thus, Petitioner concludes, “Thurler at least teaches or suggests shorter and longer perforation configurations for tube *e*, including a shorter perforation configuration that limits fluid communication between the central chamber and common off-axis chamber of Thurler to the first three sleeves.” *Id.* at 48-49.



EX1015, FIG. 1 (Petitioner-annotated)

Pet. at 48; Ex. 1013, ¶212.

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110. I note two problems with Petitioner's argument. First, Petitioner has not identified anything that suggests a shorter or longer perforation configuration. That Thurler discloses that tube *e* is perforated for two thirds of its length does not teach or suggest that any other configuration would be appropriate.

111. Second, Thurler does not disclose or suggest any particular connection between the sleeves *d*, which Petitioner points to as deflectors, and the length of perforations. Claim 6 requires that fluid communication occur only at the primary, secondary, and first tertiary deflectors. But Thurler does not suggest limiting the fluid communication between the central and off axis chambers at any of the purported deflectors. Instead, Thurler discloses that sleeves *d* extend the full length of tube *e*, with a "fine net-work" (described as "perforations" in its claim) spanning two-thirds of tube *e* where it is surrounded by tube *g*. Ex. 1015, 1:53-55, 1:69-74, 2:28-30; Fig. 1.

112. Accordingly, even if one were to accept Petitioner's contention that the length of perforations in tube *e* could be varied, it does not follow that a POSITA would limit the fluid communication to any particular subset of the sleeves *d*. The Petition fails to demonstrate that the limitations of claim 6 would be obvious.

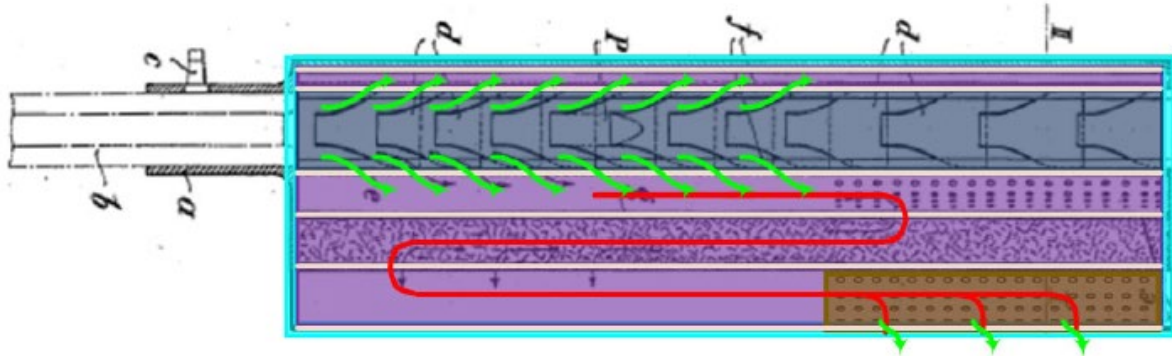
2. Claim 9

113. As set forth above in Section X.A, Thurler does not disclose any structure to “produce a radially serpentine fluid pathway” as required by Claim 9.

114. The Petitioner asserts, with no argument, that “[t]o the extent PO argues that Thurler fails to disclose any limitations of [Claim 9], Thurler renders obvious any such limitations.” Pet. at 46; *see also* Ex. 1013, ¶¶206-07.

115. I disagree with the Petitioner’s conclusory assertions that it would be obvious to modify Thurler to add a radially serpentine pathway. Thurler provides a solution for “lessening the report of fire-arms” and “destroying” “the gases of combustion” by adding more chambers of the same design as its Figure 1 to lengthen the fluid pathway. *See* Ex. 1015, 1:9-19; 1:27-30 (“The inner casing is further inclosed [sic] in *one or more* mantles which are alternately perforated at the front or at the rear end”) (emphasis added).

As discussed above, these chambers create an axially serpentine fluid pathway. *See* Pet. at 34; Ex. 1013, ¶174. Thurler’s disclosure teaches adding length to the axially serpentine pathway, not introducing an additional direction for fluid to flow (such as a radially serpentine pathway). Petitioner relies on precisely this aspect of Thurler elsewhere when it illustrates Thurler’s contemplated modifications with the below figure:



(Petitioner-modified ESD_1 of Thurler)

Pet. at 34; Ex. 1013, ¶174.

116. In my opinion, the Petitioner and Mr. Nixon have not articulated any reason why one of ordinary skill would seek to incorporate a radially serpentine pathway into Thurler's design.

C. Ground 3: Thurler in View of Bouton Does Not Render Claim 18 Obvious.

117. Claim 18 requires:

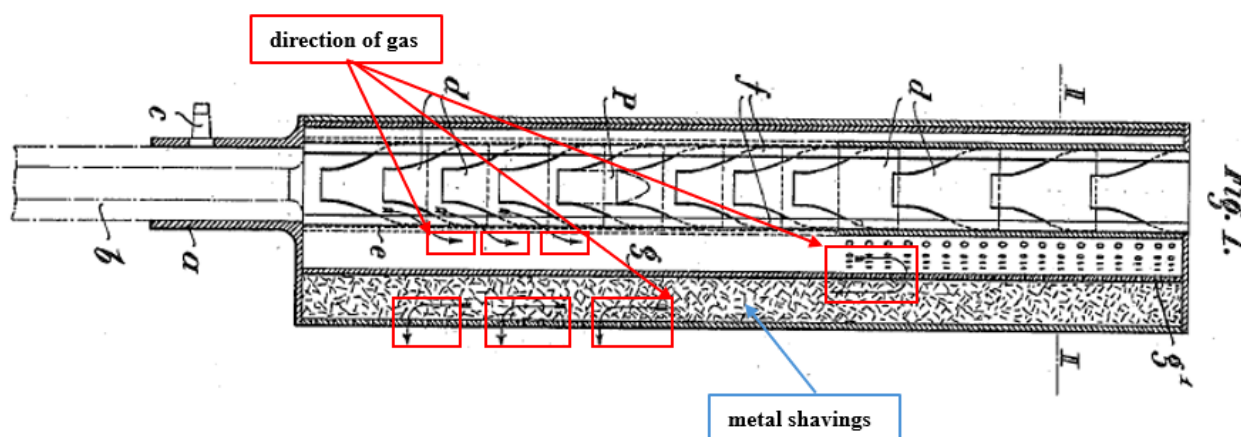
18. The device of claim 1, wherein the outer shell includes an end cap assembly at an outlet end of the central chamber and which allows fluid to escape from the common off axis chamber through the fluid outlet, the fluid outlet being only accessible to the fluid in the common off axis chamber.

Ex. 1001, cl.18.

118. Petitioner asserts that it would be obvious to modify Thurler's suppressor in view of the muffler of Bouton in order to achieve claim 18's requirements.

119. Petitioner has not articulated any sufficient reason why a POSITA would modify Thurler such that the claimed “fluid outlet” is located “at an outlet end of the central chamber and which allows fluid to escape from the common off axis chamber.” *See* Pet. at 54-55; *see also* Ex. 1013, ¶¶226-31.

120. Thurler’s design provides that the pathway of the gas is directed downward into metal shavings to prevent the gas from “expanding instantly”:



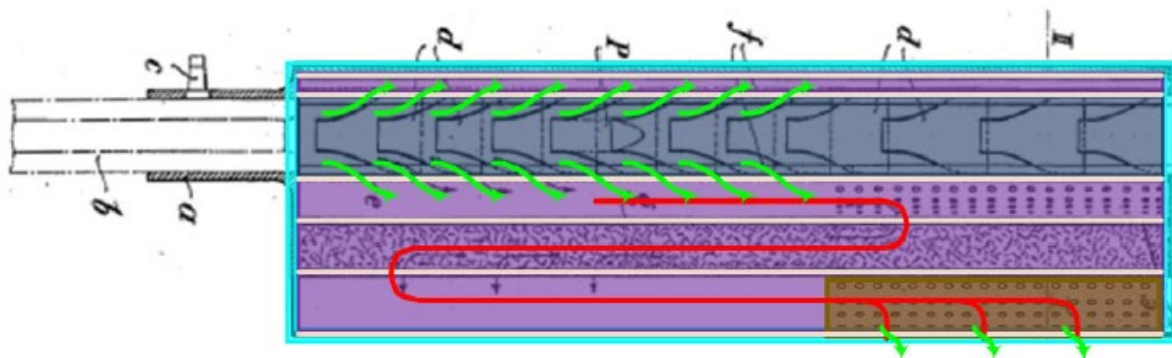
EX1015, FIG. 1 (annotated)

Ex. 1015, 1:77-78; 1:94-95. As shown in the annotated figure above, the gases exit the off-axis chamber at the bottom of the device and near the inlet, not at an outlet end of the central chamber

121. Thurler offers no reason to change this arrangement of its fluid outlet. Petitioner and its expert argue that a POSITA would add an additional tube from Bouton “to improve noise suppression by increasing a path length and expansion area for the deflected energy” and thus arrive at the ’750 Patent’s invention in claim 18. *See* Pet. at 55; *see also* Ex. 1013, ¶229. But this ignores the fact that Declaration of G. Paul Neitzel, Ph.D.

Thurler's solution for "lessening the report of fire-arms" and "destroying" "the gases of combustion" is to add more chambers of the same design which is eccentric and hangs below the path of the barrel and sight, to lengthen its pathway. See Ex. 1015, 1:9-19.

122. Petitioner illustrates Thurler's contemplated modifications with the below figure, which it provides in support of its arguments for an "axially serpentine" pathway:



(Petitioner-modified ESD_1 of Thurler)

Pet. at 34; Ex. 1013, ¶174. As Petitioner acknowledges, the modifications contemplated by Thurler maintain the downward direction of the fluid outlet.

123. Petitioner's assertion that one of ordinary skill would further add the outermost tube from Bouton's muffler finds no motivation in either reference. And doing so would potentially undermine the benefits of Thurler. Thurler itself notes that experimental results confirm its device does not interfere with automatic reloading or obstruct the sight *c* that projects over the device. Ex. 1015, 1:79-82;

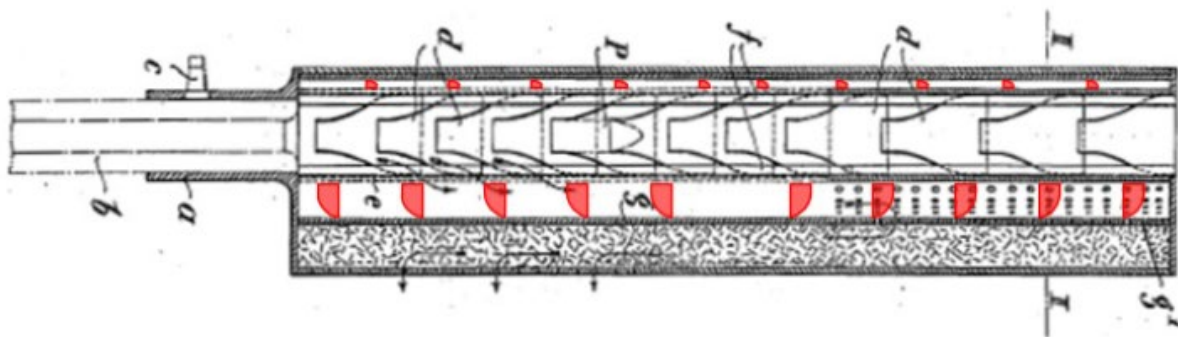
2:4-8. A fundamental design change such as moving the location and direction of the fluid outlet as Petitioner proposes could not be expected to maintain these conditions.

124. As Figure 2 of Bouton shows, adding the outermost tube from Bouton's muffler to Thurler would cause the device to obstruct Thurler's sight *c*, which Thurler explicitly avoids. *See* Ex. 1016, Fig. 2. In my opinion, Petitioner has failed to show that a POSITA would be motivated to combine and modify the different structures of Thurler and Bouton to achieve the invention of claim 18.

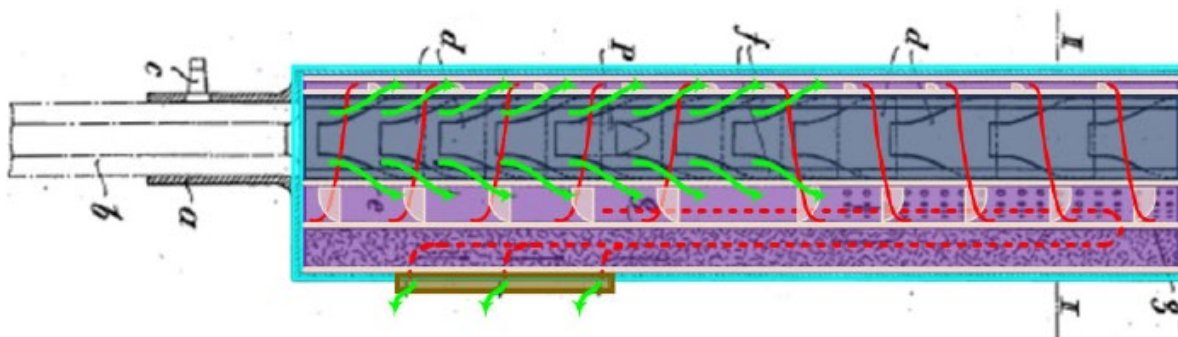
D. Ground 4: Thurler in View of Barlowatz Does Not Render Claim 6, 9, 12, 13, 14, or 20 Obvious.

125. Claims 6, 9, 12, 13, 14, and 20 are patentable over Ground 4 because of the fundamental incompatibility of the proposed combination of the structures from Thurler and Barlowatz.

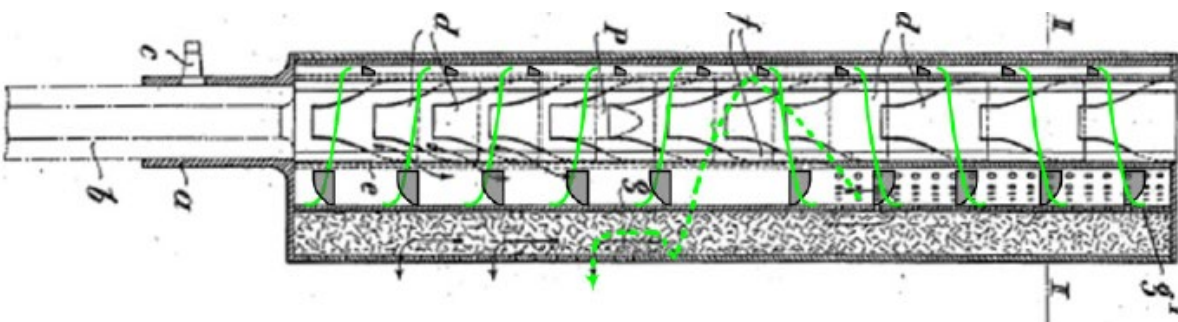
126. Petitioner and its expert propose "modify[ing] Thurler's ESD to include one or more helical coils (*e.g.*, Barlowatz's inner coil *d*) in one or more exterior tubes (*e.g.*, Thurler's tube *g*).” Pet. at 59. Petitioner and its expert provide drawings of the proposed combination as follows:



EX1013, Figure 7 (Thurler's modified ESD_3 with modifications in red)



Id., Figure 8 (mapping to Thurler's modified ESD_3)



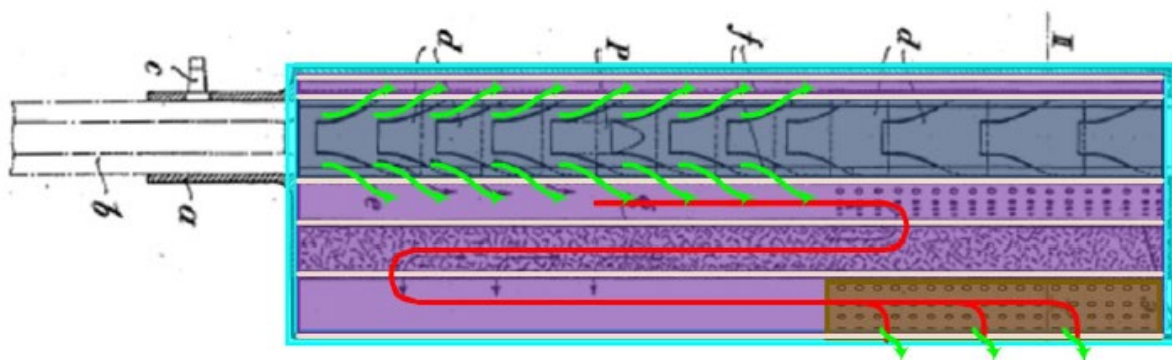
Id., Figure 9 (radially serpentine fluid flow in Thurler's modified ESD_3)

Pet. at 59-60; *see also* Ex. 1013, ¶¶240-42.

127. As shown, Petitioner proposes inserting one of Barlowatz's coils in tube *g* of Thurler. Petitioner argues that the motivation for combining these disparate structures from the two references would be "to improve noise

suppression by increasing a path length for the fluid flow and further slowing the speed of the fluid flow.” Pet at. 101-02.

128. I disagree that a POSITA would combine Thurler and Barlowatz this way for at least two reasons. First, Thurler teaches a different approach to lengthening the fluid pathway, as addressed above in Section X.B.2. As I explained there, Thurler teaches adding additional eccentric chambers as shown in Petitioner’s annotated figure below:



(Petitioner-modified ESD_1 of Thurler)

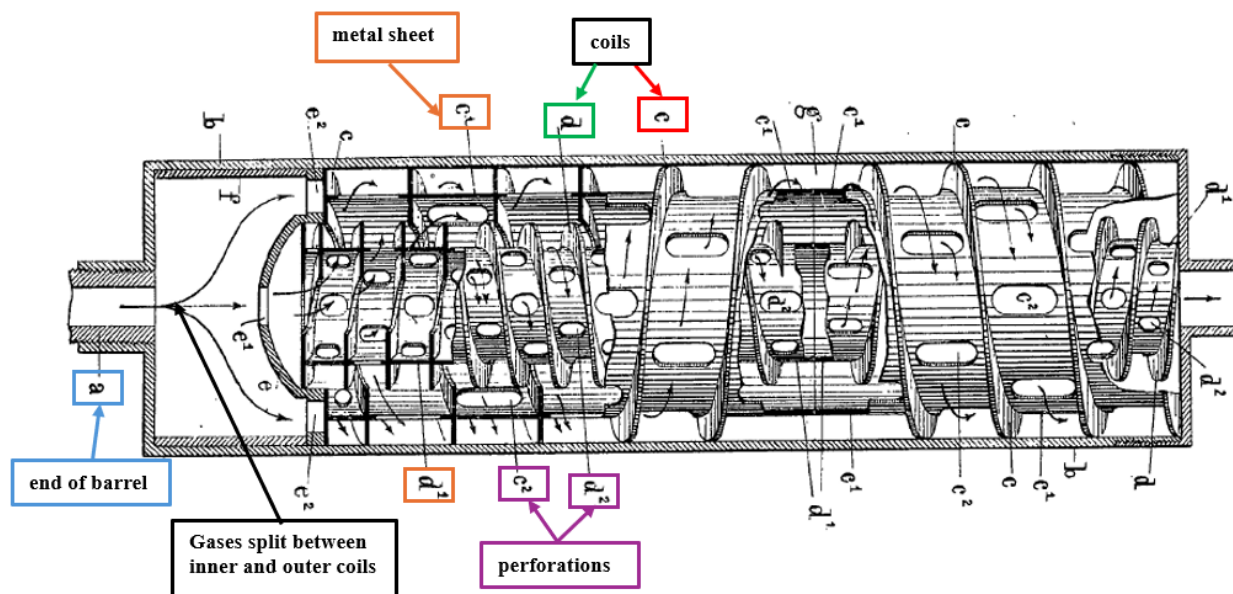
See Pet. at 34; Ex. 1013, ¶174.

129. There is nothing in Thurler that would suggest to a POSITA to seek to add the coils of Barlowatz to lengthen a fluid pathway in different directions.

130. Second, Barlowatz discloses a fundamentally different design for providing a fluid pathway in a silencer, relying on two coils oriented in different directions. *See supra* Section. IX.C. Barlowatz discloses a silencer “consisting of a sleeve” “enclosing two coils, nested one inside the other having turns oriented in different directions.” Ex. 1018 at 1.

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Ex. 1018 at 1, 4 (figure annotated).

131. Barlowatz provides that the blast gases are split into two parts at part *e* with some of the gases following the projectile through inner coil *d* while most of the gases are diverted to outer coil *c*. Ex. 1018 at 1. The point is for the gases to flow through the two coils in different directions and “counteract each other.” Ex. 1018 at 2. Inserting *one* of the coils of Barlowatz into Thurler would defeat the stated function of Barlowatz’s structure to allow the gases to split and counteract one another.

132. Petitioner elsewhere asserts that the “first two interior turns of Barlowawtz’s inner coil *d*” provide a “plurality of deflectors.” *See* Pet. at 67; Ex.

1013, ¶260. Petitioner does not even address how a POSITA should account for these alleged deflectors in conjunction with Thurler's sleeves *d*.

133. Inserting *both* of Barlowatz's coils into Thurler (which Petitioner has not shown or clearly advocated) likewise would defeat Thurler's operation. The gases flowing in different directions would counteract, if not prevent, the desired flow along the chambers to the perforations of Thurler to achieve Thurler's purpose of directing gases towards the metal shavings and out the bottom.

134. In light of these fundamental incompatibilities between the two references, I do not believe a POSITA would be motivated to combine and modify the different structures of Thurler and Barlowatz to achieve the claimed inventions.

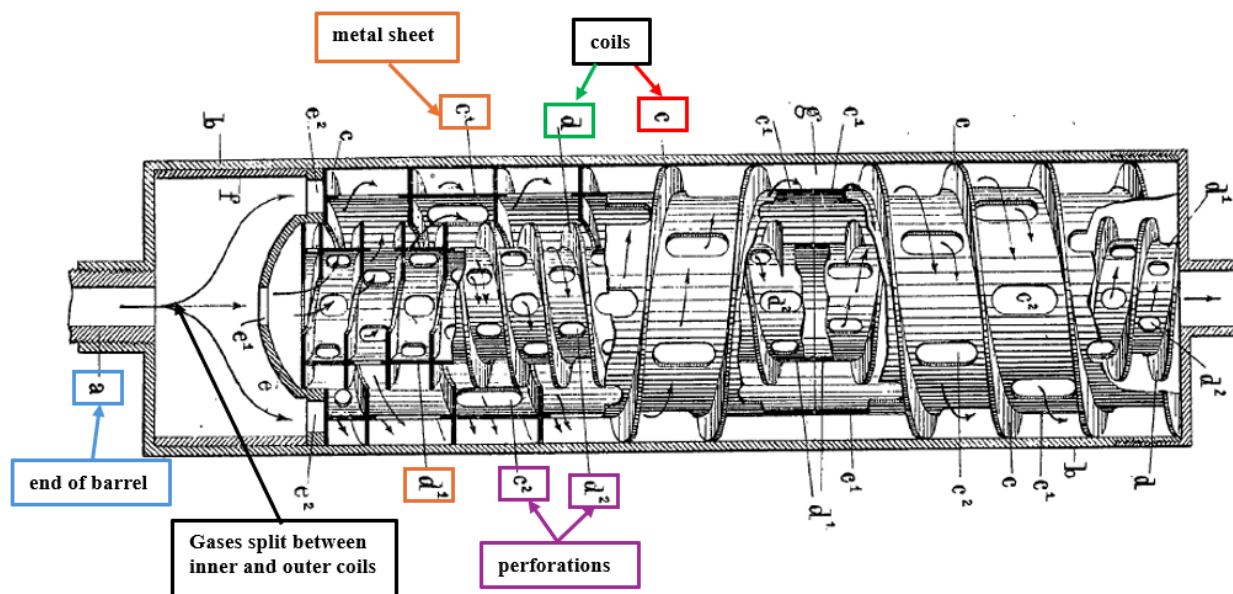
E. Ground 5: Barlowatz Does Not Anticipate Claim 9 or 20.

135. Claims 9 and 20 are patentable over Ground 5 because Barlowatz, fails to disclose at least two claim limitations.

136. Barlowatz does not disclose either of (1) "a fluid outlet" from the common off axis chamber; or (2) "a plurality of deflectors oriented in series along the central axis of the central chamber" as required by the independent claims from which claims 9 and 20 depend.

137. First, as set forth above in Section VII.D, the claimed "fluid outlet" of the common off axis chamber is an outlet for fluids to escape the off axis chamber and the device without returning to the central chamber. Barlowatz does not

disclose any such fluid outlet. As explained above in Section IX.C, Barlowatz discloses a silencer “consisting of a sleeve” “enclosing two coils, nested one inside the other having turns oriented in different directions.” Ex. 1018 at 1.



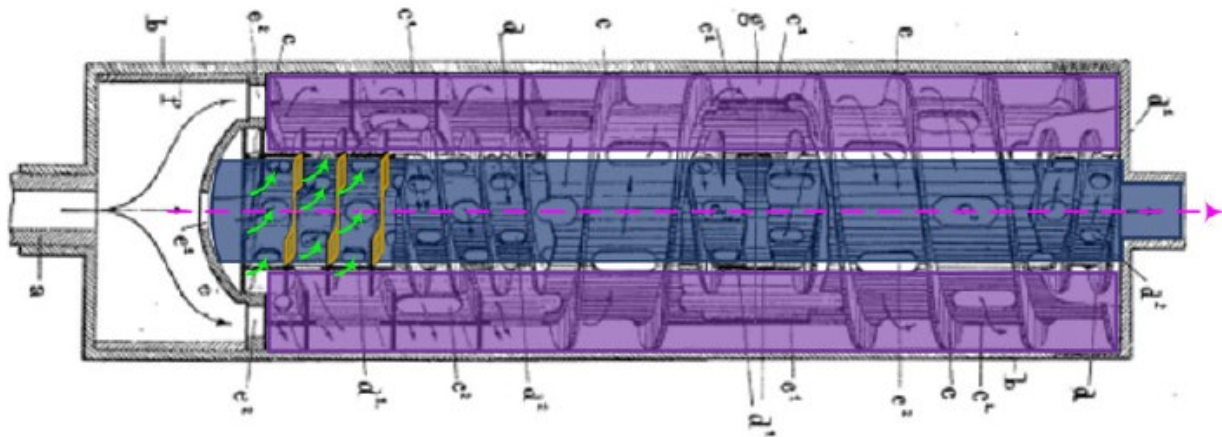
Ex. 1018 at 1, 4 (figure annotated).

138. The blast gases are split into two parts at part *e*, with some of the gases following the projectile through inner coil *d* while most of the gases are diverted to outer coil *c*. Ex. 1018 at 1. The goal of Barlowatz is for the gases to flow through the two coils in different directions and “counteract each other.” Ex. 1018 at 2. The arrows in Barlowatz’s figure indicate the flow of the gases, and as shown, the gases come together and exit from the central chamber, not the common off axis chamber.

139. Neither Petitioner nor Mr. Nixon addresses the lack of a fluid outlet from the common off axis chamber. *See* Pet. at 64-67; Ex. 1013, ¶¶255-59. And at Declaration of G. Paul Neitzel, Ph.D.

his deposition, Petitioner's expert confirmed that the gases come together back to the inner coil, which is the only part he would identify as a fluid outlet. Nixon Dep. at 53:10-24. Thus, Barlowatz fails to disclose a "fluid outlet" as claimed in the '750 Patent, and it cannot anticipate claims 9 and 20.

140. Second, Barlowatz fails to disclose "a plurality of deflectors oriented in series along the central axis of the central chamber." I understand that a "plurality" generally means "at least two" of something. To satisfy this limitation, Petitioner identifies "the first two interior turns of Barlowatz's inner coil *d*," as shown in the beige color in Petitioner's annotated figure from Barlowatz:



EX1018, FIG. 1 (Petitioner-annotated)

Pet. at 67; *see also* Ex. 1013, ¶260.

141. If the coil is a deflector in the context of the '750 patent, these "turns" fail to disclose a *plurality* of deflectors in that they are part of a single, continuous "helically wound metal strip." *See* Ex. 1018, 1. For this additional reason, Barlowatz cannot anticipate claims 9 and 20.

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F. Ground 6: Barlowatz Does Not Render Claim 9 or 20 Obvious.

142. Claims 9 and 20 are also patentable over Ground 6 because Barlowatz, fails to render obvious (1) “a fluid outlet” from the common off axis chamber, and (2) “a plurality of deflectors oriented in series along the central axis of the central chamber.”

143. As explained in connection with Ground 5, Barlowatz fails to disclose these limitations. *See* Section above. For Ground 6, Petitioner and Mr. Nixon offer nothing but the conclusory assertions that “a POSITA would have been motivated, and it would have been obvious to a POSITA, to modify Barlowatz’s ESD to include fewer or additional coils, perforations, or deflectors (e.g., by increasing or decreasing the winding of the coils), and the like.” Pet. at 70.

144. Furthermore, providing “a fluid outlet” from the common off axis chamber in Barlowatz would undermine its purpose. Requiring the fluids in the alleged off axis chamber to exit from the central chamber is an important aspect of Barlowatz’s design because, as discussed above, the gases in Barlowatz flow through the two coils in different directions and “counteract each other.” Ex. 1018 at 2.

145. If Barlowatz were modified such that the gases exited from the alleged off axis chamber, they would not reconnect in the central chamber and counteract one another, undermining the very purpose of Barlowatz’s design. Thus,

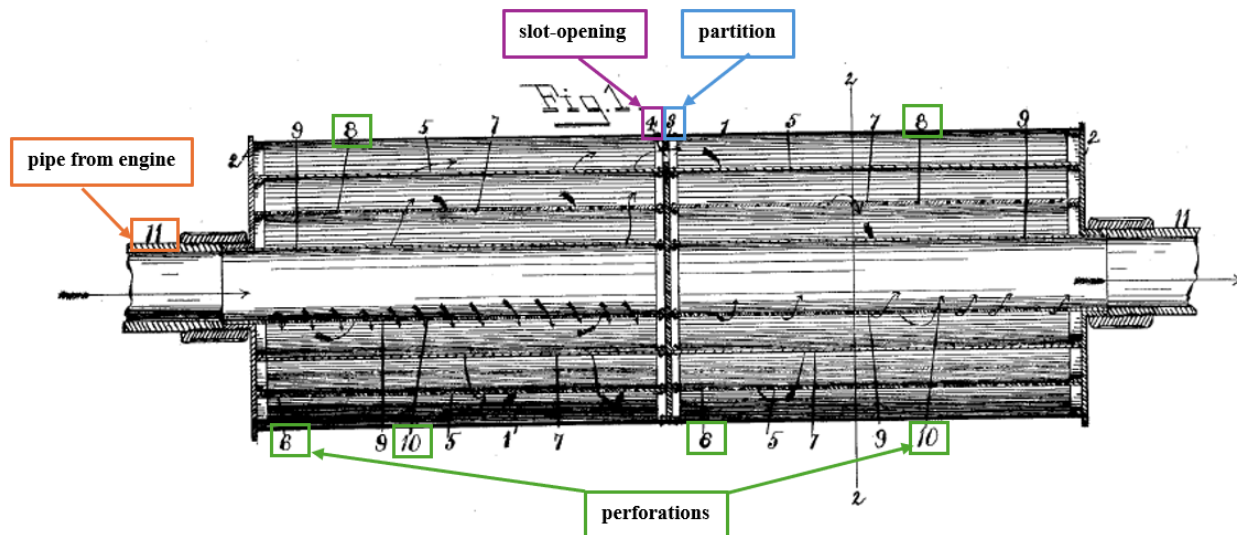
I do not believe a POSITA would be motivated to modify Barlowatz to implement a fluid outlet for fluids to escape the off axis chamber and the device without returning to the central chamber.

146. Nor would a person of ordinary skill in the art be motivated to modify Barlowatz such that it had a plurality of deflectors. Petitioner suggests that a POSITA might modify Barlowatz “by increasing or decreasing the winding of the coils,” but that would not change the fact that each coil is still one continuous helically wound metal strip, and thus still at best a single deflector. Petitioner has failed to show that Claims 9 and 20 are obvious over Barlowatz.

G. Ground 7: Barlowatz in view of Reeves Does Not Render Claim 2 Obvious.

147. Claim 2 is patentable over Ground 7 because Barlowatz in view of Reeves does not render Claim 2 obvious. As discussed above, Barlowatz fails to disclose the “fluid outlet” limitation of claim 1. *See* Sections X.E and F. The addition of Reeves does nothing to cure this deficiency.

148. When the muffler in Reeves provides a pathway for gases to move between different chambers, the gases ultimately return to Reeves’s central chamber before exiting at the right of pipe 11, as indicated by the arrows:



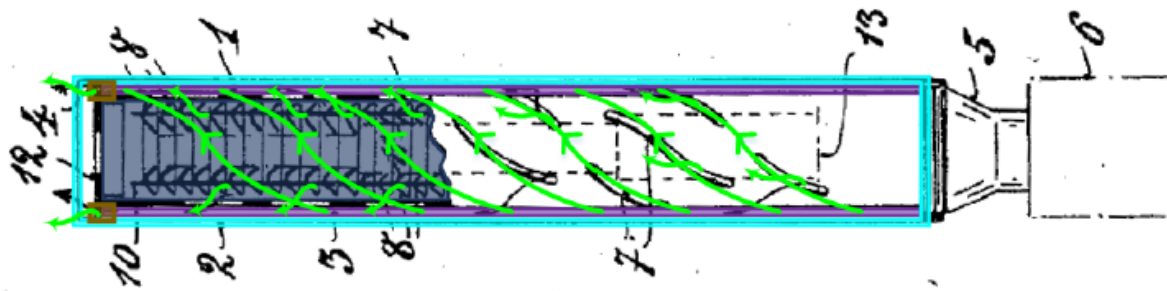
Ex. 1019, 1:32-33; Fig. 1 (annotated).

149. In this respect, Reeves is no different than Barlowatz. Mr. Nixon confirmed at his deposition that all of the fluid passing through the exhaust muffler of Reeves would exit out the pipe 11. Nixon Dep. at 77:12-78:2. Neither Petitioner nor its expert otherwise address the lack of the claimed “fluid outlet” in Reeves. See Pet. at 71; Ex. 1013, ¶¶272-74. Thus, Petitioner has failed to show that Claims 9 and 20 are obvious over Barlowatz in view of Reeves.

H. Ground 8: Eichenseher in View of Barlowatz Does Not Render Claims 3, 9, or 18 Obvious.

150. Claims 3, 9, and 18 are patentable over Ground 8. In Ground 8, Petitioner contends that a POSITA would combine Eichenseher with Barlowatz.

151. Petitioner recognizes that Eichenseher’s silencer alone lacks any “serpentine pathway,” as its gases flow helically without changing direction, as shown for example in Petitioner’s annotated Figure:

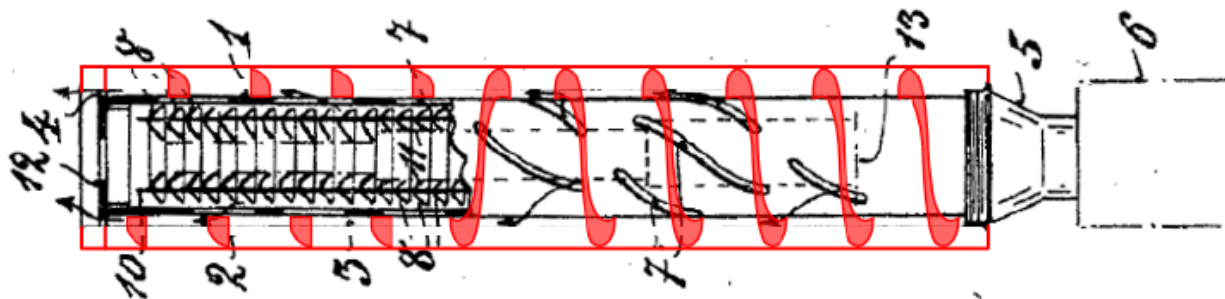


EX1021, FIG. 1 (Petitioner-annotated)

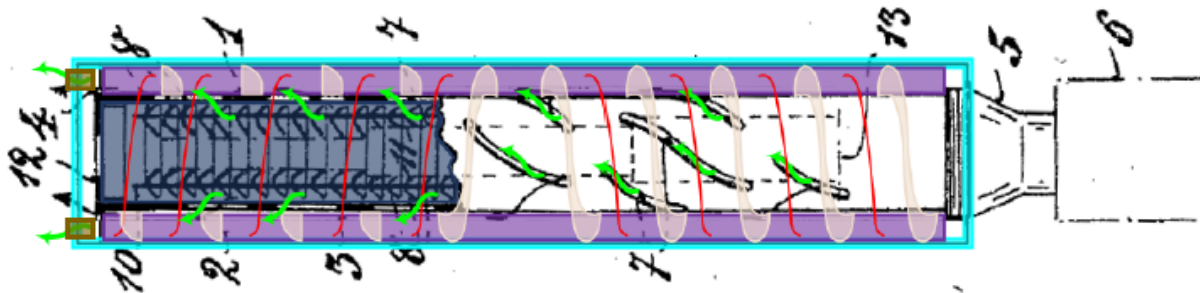
Pet. at 73; *see also* Ex. 1013, ¶277.

152. Accordingly, Petitioner proposes to add the coils of Barlowatz in order to provide a “radially serpentine pathway.” Specifically, Petitioner and Mr. Nixon propose “modify[ing] Eichenseher’s ESD to include an outer coil (e.g., Barlowatz’s outer coil c) in Eichenseher’s cavity 3 that forms a first helical channel extending around the inner cylinder 1 in a first direction 30 (e.g., clockwise) and a second helical channel extending around the inner cylinder 1 in an opposing direction (e.g., counterclockwise).” Pet. at 74-75.

153. Petitioner and Mr. Nixon provide drawings of its proposed combination as follows:



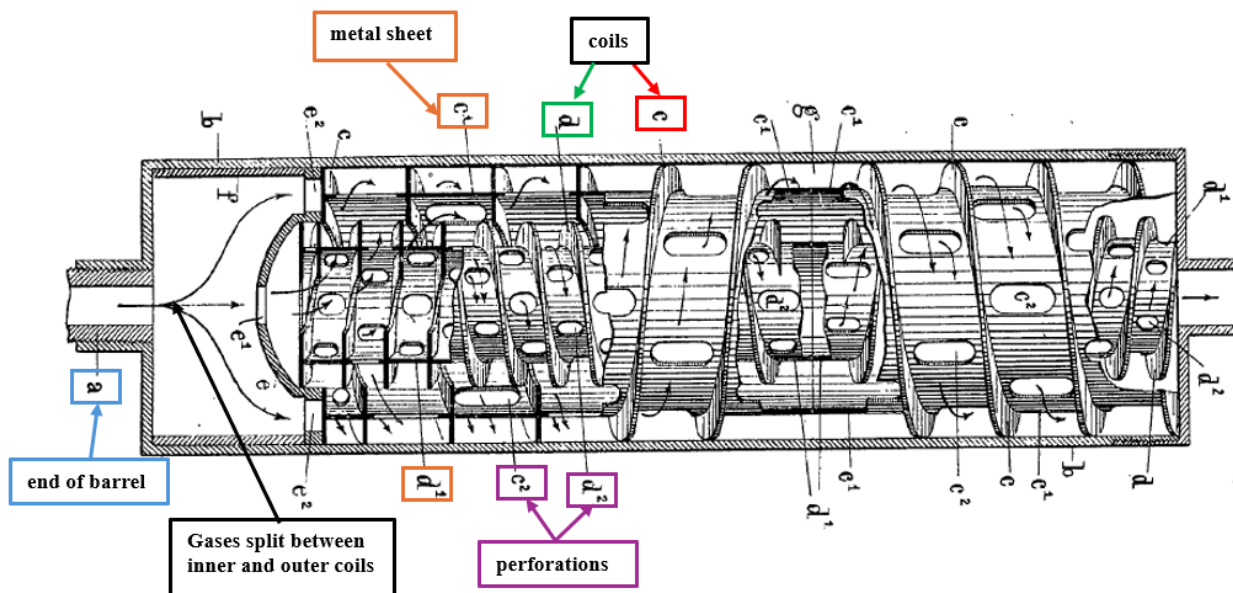
EX1013, 118, Figure 13 (Eichenseher’s modified ESD with modifications in red)



Id., 119, Figure 14 (mapping to Eichenseher's modified ESD)

Pet. at 75; *see also* Ex. 1013, ¶279.

154. These two different designs are incompatible, and the combination Petitioner proposes would work contrary to the purposes of each reference. As noted previously, Barlowatz's coils are designed to split the gases such that they flow through the two coils in different directions and "counteract each other." Ex. 1018 at 2. Barlowatz lacks a fluid outlet from its alleged off axis chamber created by the outer coil and instead directs those gases back to the inner coil so that the gases counteract one another, as indicated by the arrows:

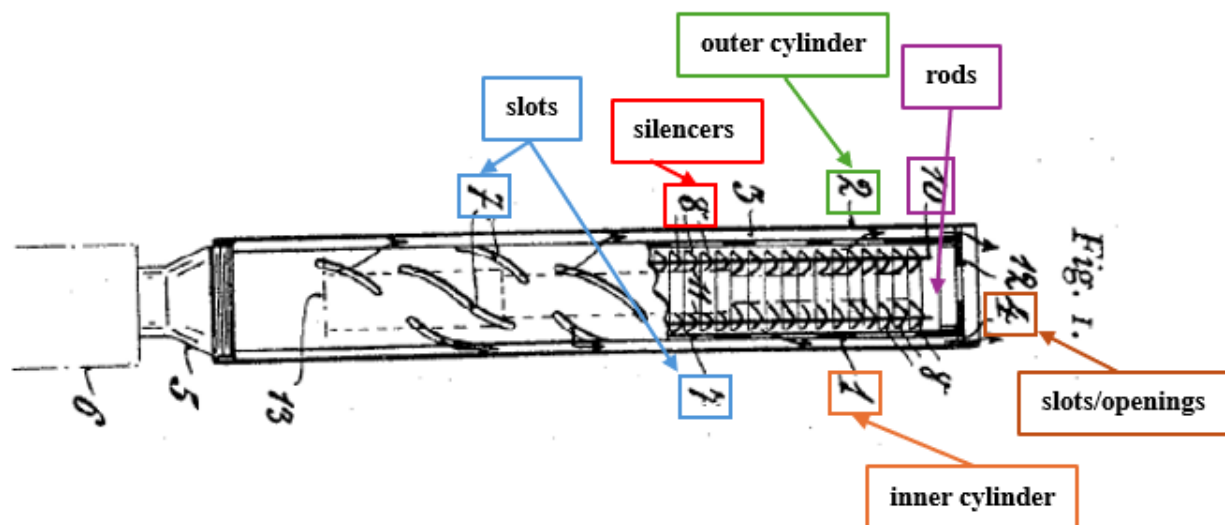


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Ex. 1018 at 1, 4 (figure annotated).

155. In contrast, Eichenseher directs gases in a helical pattern and then out of the cylinder at slots/openings 4 in the outer chamber (i.e., the alleged off axis chamber):



Ex. 1021 at 2; Fig. 1 (annotated).

156. Combining these two references as Petitioner proposes would undermine the design of each reference. Barlowatz sends gases out of the central chamber for a purpose—so that the gases from the alleged off axis chamber reconnect and counteract each other before exiting the device. Eichenseher works fundamentally differently—it relies on the sound absorbers 8 arranged along the rods in its inner cylinder to absorb sound and direct gases toward the outer chamber where they can escape at slots/opening 4. Specifically, Eichenseher provides that its purpose is “to ensure that the gases swirling with the projectile . . .

can quickly escape through slots 7 into cavity 3 and from there through openings 4 into the open air with as little resistance as possible.” Ex. 1021 at 1. Returning these gases to the path of the projectile and the remaining gases behind it would defeat this purpose.

157. Combining the references would either result in a device with Barlowatz’s coils in which gases exit out of the alleged off-axis chamber, defeating the purpose of Barlowatz, or a device with Barlowatz’s coils in which gases exit out the central chamber, defeating Eichenseher’s design to allow gases to escape with as little resistance as possible.

158. Additionally, there is no suggestion in either reference that a POSITA should seek to combine them in this way. Petitioner and Mr. Nixon’s conclusory assertion that a POSITA might do so “to improve noise suppression by increasing a path length for the deflected energy and further slowing the speed of the deflected energy” does not even attempt to grapple with these issues.

XI. OPINIONS REGARDING HUXWRX’S PROPOSED SUBSTITUTE CLAIMS.

159. I understand that HuxWrx is seeking to amend certain claims of the ’750 Patent. Specifically, I understand that HuxWrx is seeking to cancel claims 1, 4, 5, 7, 8, 10, 11, 15-17, 19, 21, and 22 and substitute Proposed Substitute Claims 23, 26, 27, 29, 30, 32, 33, 37-40, 42, and 43. I also understand that, if the Board finds claims 2, 3, 6, 9, 12-14, and 20 unpatentable, HuxWrx is seeking to substitute Declaration of G. Paul Neitzel, Ph.D.

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these claims with Proposed Substitute Claims 24, 25, 28, 31, 34-36, and 41.

HuxWrx's Proposed Substitute Claims are attached hereto as Appendix B.

160. I have been asked to review the Proposed Substitute Claims and provide my opinion on whether (a) the Proposed Substitute Claims are supported by the disclosure of the application for the '750 Patent, and (b) the Proposed Substitute Claims respond to a ground of unpatentability in the Petition.

A. The Proposed Substitute Claims Are Supported by the Disclosure of the Application for the '750 Patent

161. I have been informed that a motion to amend must identify the written description support in the originally filed disclosure of the subject patent for each proposed substitute claim. In other words, the motion to amend must identify the written description support for HuxWrx's Proposed Substitute claims in the original application for the '750 patent.

162. I have been informed that a specification adequately describes an invention when it reasonably conveys to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date.

163. I have reviewed HuxWrx's Proposed Substitute Claims and, in my opinion, they find written description support in U.S. Patent Application No. 13/025,989 (the "'989 Application"), which is the application that resulted in the '750 Patent. Specifically, each Proposed Substitute Claim is supported at least by the portions of the '989 Application identified in the table below.

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Limitation	'989 Application (EX 1004)
23[pre]	2:3-3:7, 6:26-16:18, claims 1-20, Abstract, Figs. 1a, 1b, 2, 3a, 3b, 4a, 4b, 5a, 5b, 6a, 6b, 7a, 7b, 8a, 8b, 9a, 9b, 10a, 10b, 11, 12, 13, 14, 15, 16
23[a]	7:4-7, 7:10-12, 10:7-9, 12:10-16, 15:9-13, 16:11-18, claims 1-20, Abstract, Figs. 1a, 1b, 2, 14
23[b]	7:6-9, 7:15-28, 8:7-9:3, 12:10-14:24, 15:14-22, claims 1-20, Abstract, Figs. 1a, 1b, 2, 8a, 8b, 9a, 9b, 10a, 10b, 11, 12, 13, 14, 16
23[c]	7:10-14, 10:6-17, 11:29-12:9, claims 1-16, Figs. 1a, 5a, 5b, 6a, 6b, 7a, 7b
24	14:11-24, Fig. 14
25	9:4-10:7, 11:19-12:4, claim 2, Figs. 3a-4b
26	10:9-11, 12:5-9, claim 3, Figs. 1a, 5a-7b
27	10:11-17, claim 4, Fig. 1a
28	Figs. 1a, 2
29	10:15-16, claim 5, Fig. 1a
30	10:16-17, claim 6, Fig. 1a
31	7:15-28, 14:11-24, claim 7, Fig. 14
32	8:9-26, claim 8, claim 19, Fig. 1a
33	8:23-26, 11:14-18, claim 9, Figs. 1a, 2,
34	8:27-9:3, 13:5-14:10, claim 10, Figs. 1a, 10a, 10b, 11, 12, 13
35	13:11-13, claim 11, Figs. 10a, 10b, 11, 12, 13
36	13:20-21, 14:2-3, claim 12, Figs. 1a, 10a, 10b, 11, 12, 13
37	10:18-11:4, claims 13-14, Fig. 1a
38	10:20-21, claim 14, Fig. 1a
39	10:23-28, claim 15
40	2:3-3:7, 6:26-16:13, Figs. 1a, 1b, 2,

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Limitation	'989 Application (EX 1004)
	14
41	8:7-9, 8:27-28, claim 18, Fig. 1a
42	2:3-3:7, 6:26-16:13, Figs. 1a, 1b, 2, 14

I briefly discuss each claim below.

1. Written Description Support for Limitation 23[pre]

164. Limitation 23[pre] states: “An energy capture and control device for use with a weapon, comprising.” In my opinion, the '989 Application describes this claim limitation.

165. The '989 Application as a whole describes an energy capture and control device, including in terms of a device for a weapon. Ex. 1004 at 2:3-3:7 (describing background of the art in terms of weapons and projectiles), 13:26-30 (“This configuration can resolve or mitigate adverse effects that traditional sound suppressors may have on their host weapon. For example, 75% loss of expected life span of the weapon due to excessive PSI, rate of fire increases, excessive fouling and carbon buildup, debris returning to the operators face via the chamber of the barrel, unreliability due to combinations of these issues.”), 16:11-13 (“Although the devices described are exemplified in terms of firearms, and more specifically in terms of silencer devices for sniper rifles used in counter-terrorism

efforts, other applications can also benefit from these configuration.”); see also *id.* at 6:26-16:13.

166. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim limitation.

2. Written Description Support for Limitation 23[a]

167. Limitation 23[a] states: “a) a central chamber oriented along a central axis within an outer shell oriented along the central axis, said central chamber having an inlet configured to receive a high energy material comprising a projectile and gases from a high energy outlet of the weapon.” In my opinion, the ’989 Application describes this claim limitation.

168. The ’989 Application discloses a central chamber that is oriented along a central axis within an outer shell. *Id.* at 7:4-7 (“An energy capture and control device can comprise a central chamber oriented along a central axis within an outer shell.”). For example, Figure 1a illustrates an energy capture and control device with a central chamber that is oriented along a central axis, as shown with the red arrow below.

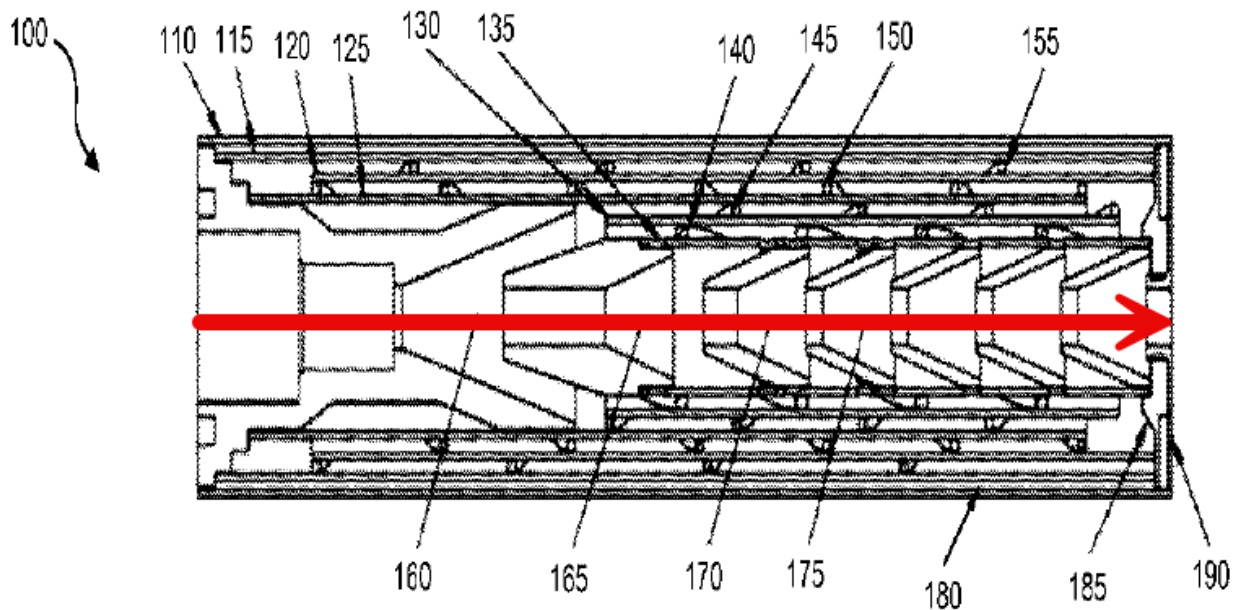


FIG. 1a

The central chamber is within an outer shell, shown as 110 in Fig. 1a. *Id.* at 7:4-6, 11-12. Fig. 1a shows that the outer shell can also be oriented along the same central axis as the central chamber. For example, the red arrow in the annotated version of 1a above illustrates the central axis of both the central chamber and the outer shell. The '989 Application also discloses that the central chamber has an inlet configured to receive a high energy material from a high energy outlet. *Id.* at 7:5-6. The high energy material can be a projectile and gases from a weapon. *Id.* at 7:12-14 ("The deflectors can be arranged to enable passage of a high energy material therethrough while redirecting at least a portion of the gases, sound/shock waves, and/or particulates into the off axis chamber."), 15:11-13 ("In one aspect, the central chamber includes a central chamber outlet along the central axis and the high energy

material is a bullet. The high energy outlet in this case can be a firearm muzzle (e.g. rifle, pistol, etc.).”), 15:13-15 (“For example, high velocity/high temperature gases, projectiles, heat or sound energy can be suppressed using these devices.”).

169. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim limitation.

3. Written Description Support for Limitation 23[b]

170. Limitation 23[b] states: “b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber and having a fluid outlet and multiple internal walls defining a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine and which dissipates energy transferred from the high energy material, wherein the fluid outlet is located at an opposite end of the energy capture and control device as the inlet.” In my opinion, the ’989 Application describes this claim limitation.

171. The ’989 Application discloses a common off axis chamber within the outer shell that is in fluid communication with the central chamber. *Id.* at 7:6-9 (“An off axis chamber can be oriented within the outer shell in fluid communication with the central chamber.”). For example, Fig. 1a, reproduced below, illustrates the off axis chamber as “a plurality of tubes 115, 120, 125, 130, 135 of differing diameters nested within one another.” *Id.* at 8:9-10.

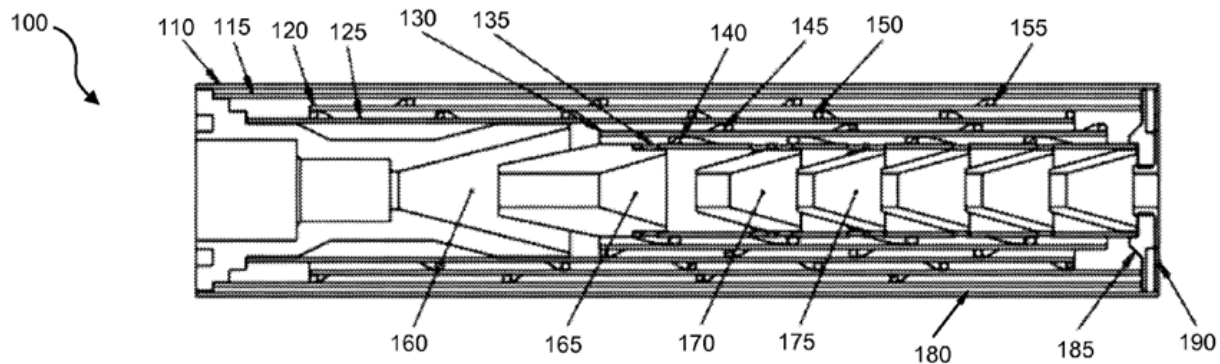
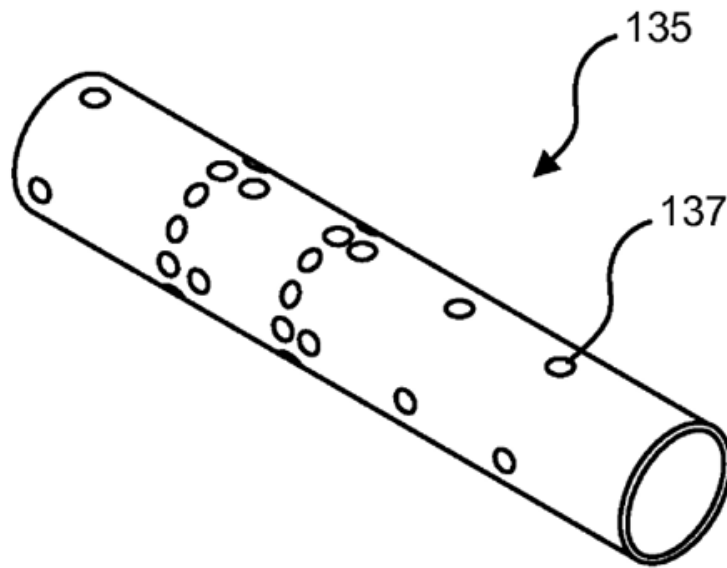


FIG. 1a

172. The central chamber can fluidly communicate with the off axis chamber in a number of ways. For example, as shown in Figure 1a, deflectors 165, 170, and 175 “can be arranged to enable passage of a high energy material therethrough while redirecting at least a portion of gases, sound/shock waves, and/or particulates into the off axis chamber.” *Id.* at 7:12-14. As another example, Figure 2, reproduced below, illustrates “an innermost tube having apertures to allow fluids to flow from the central chamber into the off axis chamber.” *Id.* 3:15-17, Fig. 2.



173. The '989 Application also discloses that the off axis chamber can have a fluid outlet, which allows gases in the off axis chamber to escape. *Id.* at 7:7-8 (“The off axis chamber can have a fluid outlet”). For example, the '989 Application discloses that “the outer shell can include an end cap assembly at an outlet end of the central chamber and which allows fluid to escape from the off axis chamber.” *Id.* at 12:14-15. Fig. 1a specifically shows a tube cap 185, which has outlet slits 187 (shown in Figures 8a and 8b) that “correspond to an outermost tube in the off axis chamber” and “provide a pathway for gases from the outermost tube through to an end cap.” *Id.* at 12:19-20, 22-23. Fig. 1a also shows an end cap 190, which has exit apertures 192 (shown in Figure 9) that are offset to prevent an unobstructed exit of fluids from the off-axis chamber. *Id.* at 12:24-25. The fluid outlet can be at an opposite end of the energy capture and control device as the

inlet. For example, the '989 Application discloses that an end cap assembly can be located “at an outlet end of the central chamber,” which is necessarily at the opposite side of the device as the inlet of the central chamber. This is shown in Figure 1a, where the fluid outlet (i.e., where the fluid comes out of the off-axis chamber) is at the opposite end of the energy capture and control device as the inlet.

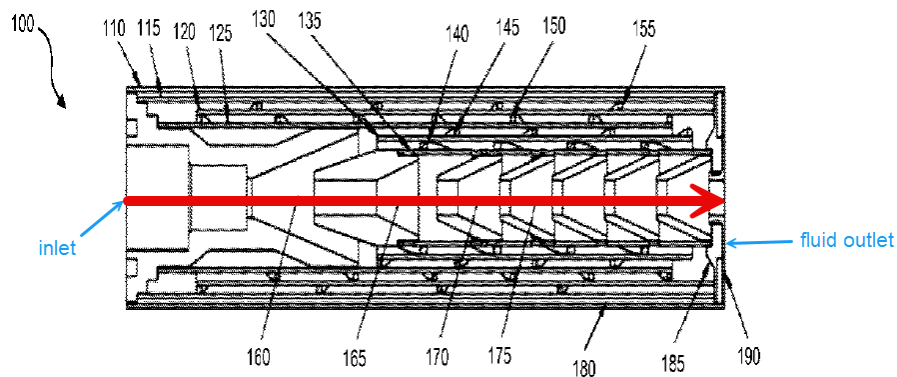


FIG. 1a

174. The '989 Application also discloses that the off axis chamber has multiple internal walls that define a serpentine pathway that is at least one of axially serpentine and radially serpentine. *Id.* at 7:7-9. These internal walls “provide an increased volume for fluid expansion and increased acoustic absorbent path length,” and thus dissipate energy from the high energy material. *Id.* at 7:15-18. “The fluid pathway can be an axially serpentine fluid pathway which causes fluids received in the off axis chamber to travel back and forth along a length of the off axis chamber.” *Id.* at 7:18-20. In addition, “the fluid pathway can be a radially serpentine fluid pathway which causes the fluids received in the off axis

chamber to flow back and forth around a radius of the off axis chamber.” *Id.* at 7:20-22. The ’989 Application describes a number of ways in which such pathways can be formed.

175. Figure 1a discloses an axially serpentine configuration. The walls are formed of tubes 115, 120, 125, 130, and 135, each with different diameters and nested within each other. *Id.* at 8:9-10. “In other words, the multiple internal walls can be formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube.” *Id.* at 8:11-13. “Each tube can have at least one inlet from a successively smaller tube . . . to allow fluid to flow from one tube to the next,” and the “concentric tubes can have ends offset from an adjacent tube,” resulting in an axially serpentine pathway. *Id.* at 8:7-9, 15-19, 22-23.

176. Figure 14, reproduced below, discloses a radially serpentine configuration.

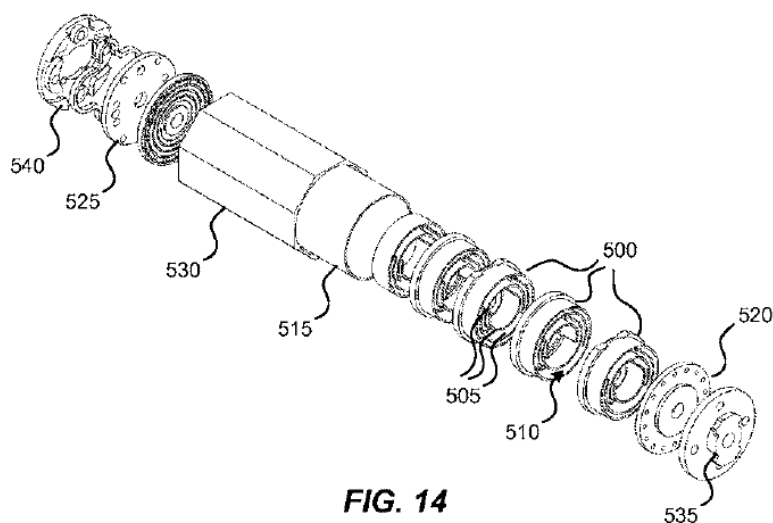


FIG. 14

The device shown in Figure 14 “includes multiple segments 500 which each have concentric offset cylinders 505.” *Id.* at 14:16-17. “Gases flow into a serpentine path 510 created by the offset and spaced cylinders.” *Id.* at 14:17-18. “The serpentine path in this case is a series of annular spaces which are connected and progressively larger.” *Id.* at 14:18-19. This configuration results in a radially serpentine pathway, as shown in the image reproduced from the declaration of Petitioner’s expert below.

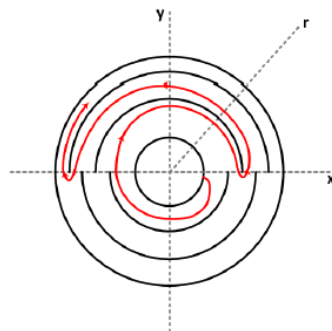


Figure 2

Ex. 1013, ¶ 128. As the red arrow indicates, the gases flow back and forth around radius r .

177. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim limitation.

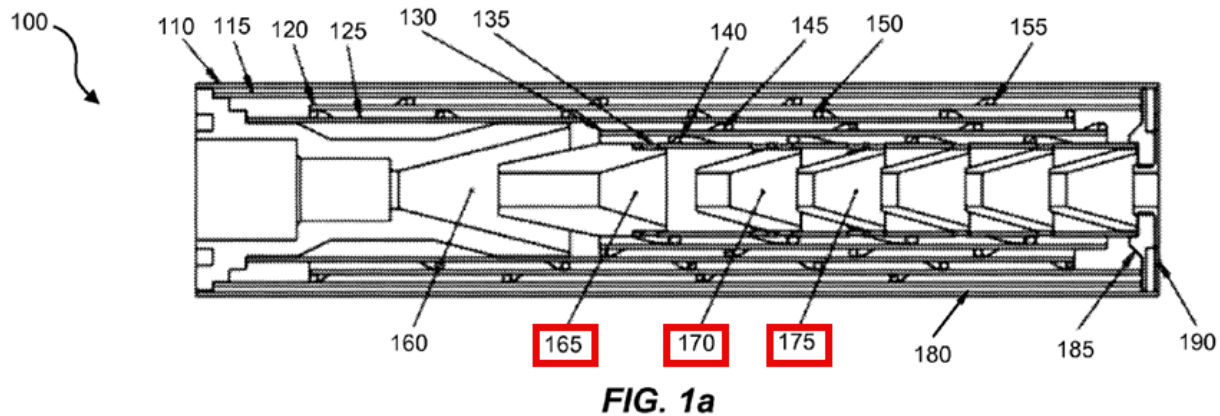
4. Written Description Support for Limitation 23[c]

178. Limitation 23[c] states: “c) a plurality of deflectors oriented in series along the central axis of the central chamber and configured to deflect the energy from the high energy material to the common off axis chamber.” In my opinion, the '989 Application describes this claim limitation.

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179. The '989 Application discloses that the “central chamber may further comprise a plurality of deflectors . . . oriented in series along the central axis.” *Id.* at 10:7-9. For example, in Figure 1a, deflectors 165, 170, and 175 are placed series along the central axis of the central chamber. *Id.*



180. The deflectors “enable passage of a high energy material therethrough while redirecting at least a portion of gases, sound/shock waves, and/or particulates into the off axis chamber,” which ultimately “dissipates energy transferred from the high energy material.” *Id.* at 7:7-9, 10-14.

181. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

5. Written Description Support for Claim 24

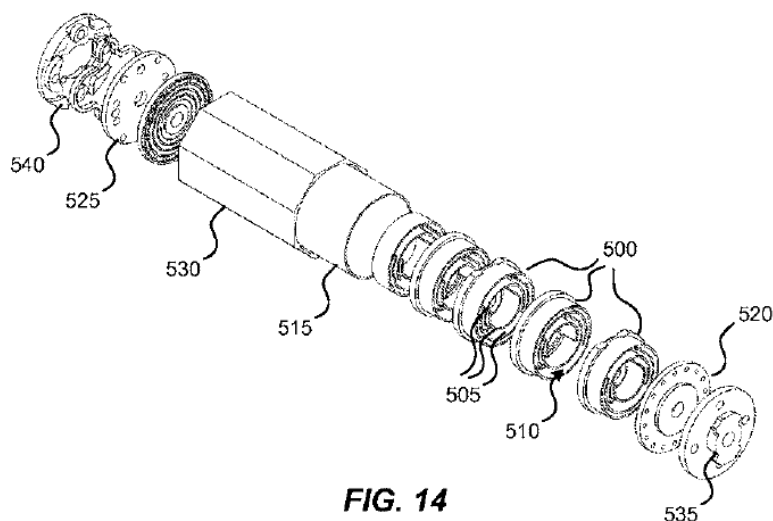
182. Claim 24 states: “The device of claim 23, wherein the common off axis chamber comprises a plurality of sub-chambers defined by the plurality of deflectors, each with the radially serpentine fluid pathway, and wherein the radially serpentine fluid pathways of each of the deflectors are axially non-linearly

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interconnected along an outermost portion of the plurality of sub-chambers.” In my opinion, the ’989 Application describes this claim.

183. The ’989 Application supports claim 24 in Figure 14 (reproduced below) and in the accompanying text. *See id.* at 14:11-24, Fig. 14.



184. In Figure 14, “the device includes multiple segments 500 which each have concentric offset cylinders 505,” and “[g]ases flow into a serpentine path 510 created by the offset and spaced cylinders.” *Id.* at 14:16-17. Each of these segments is a “sub-chamber” with a radially serpentine pathway. And, as shown in Figure 14, each segment interconnected along the outermost portion of each segment (i.e., are “axially non-linearly interconnected along an outermost portion of the plurality of sub-chambers”).

185. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

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6. Written Description Support for Claim 25

186. Claim 25 states: “The device of claim 23, wherein the central chamber further comprises a locking block oriented at the inlet, said locking block having an engagement surface configured to attach to the high energy outlet and a hollow interior along the central axis, said hollow interior having a reducing throat portion and a flared outlet.” In my opinion, the ’989 Application describes this claim.

187. Proposed Substitute Claim 25 is identical (except for the identification of the dependency) to claim 2 in the ’989 Application and is thus supported by the ’989 Application.

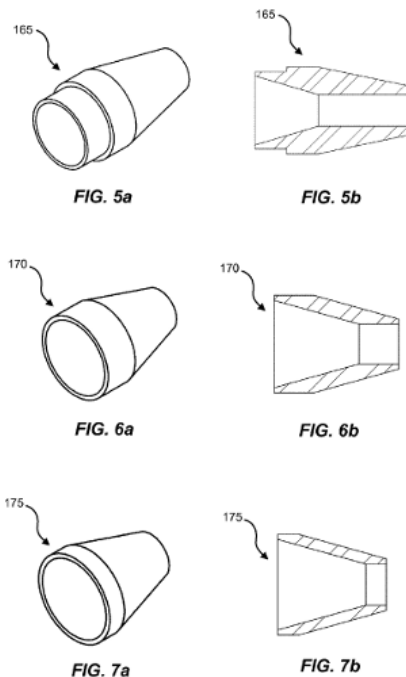
188. In addition, the claimed locking block feature is fully described in the ’989 Application. It discloses that “[t]he central chamber can further comprise a locking block 160 oriented at the inlet,” which “can have an engagement surface configured to attach to the high energy outlet and a hollow interior along the central axis, said hollow interior having a reducing throat portion and a flared outlet.” *Id.* at 9:4-7. And it discloses specific embodiments of such locking blocks. *See id.* at 9:4-10:5, 11:19-28, Figs. 3a-4b.

189. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

7. Written Description Support for Claim 26

190. Claim 26 states: “The device of claim 23, wherein the plurality of deflectors each comprise a frustoconical shape having a hollow interior along the central axis and a flared exit portion.” In my opinion, the ’989 Application describes this claim.

191. Proposed Substitute Claim 25 is substantively similar (except for the identification of the dependency) to claim 3 in the ’989 Application, and is thus supported by the ’989 Application. In addition, the ’989 Application states that “the plurality of deflectors can be frustoconical having a hollow interior along the central axis and each having a flared exit portion,” and discloses several embodiments. *Id.* at 10:9-11, 12:5-9, Figs. 1a, 5a-7b. For example, the figures reproduced below disclose several embodiments of frustoconical deflectors.



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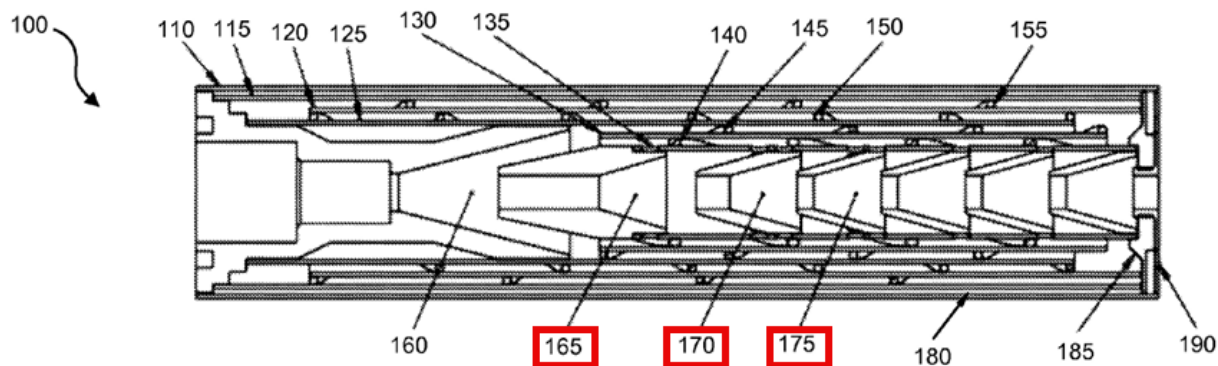
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192. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

8. Written Description Support for Claim 27

193. Claim 27 states: “The device of claim 26, wherein the plurality of deflectors include a primary deflector, a secondary deflector, and a first tertiary deflector.” In my opinion, the '989 Application describes this claim.

194. Proposed Substitute Claim 27 is identical (except for the identification of the dependency) to claim 4 in the '989 Application and is thus supported by the '989 Application. In addition, Fig. 1a shows an embodiment with “a plurality of deflectors which include a primary deflector 165, a secondary deflector 170, and at least one tertiary deflector 175.” *Id.* at 10:11-13; *see also id.* at 10:13-17.



195. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

9. Written Description Support for Claim 28

196. Claim 28 states: “The device of claim 27, wherein the fluid communication between the common off axis chamber and the central chamber occurs only at the primary deflector, the secondary deflector and a first tertiary deflector.” In my opinion, the '989 Application describes this claim.

197. Figures 1a and 2 support this claim. In these figures, access to the off axis chamber occurs only in front of the primary deflector 165, secondary deflector 170 (via the circumferential holes shown in Figure 2), and the first tertiary deflector (via the circumferential holes shown in Figure 2). The circumferential holes are shown in Figure 1a at the meeting of tube 135 and each of the deflectors 170 and 175, as shown in the figure below.

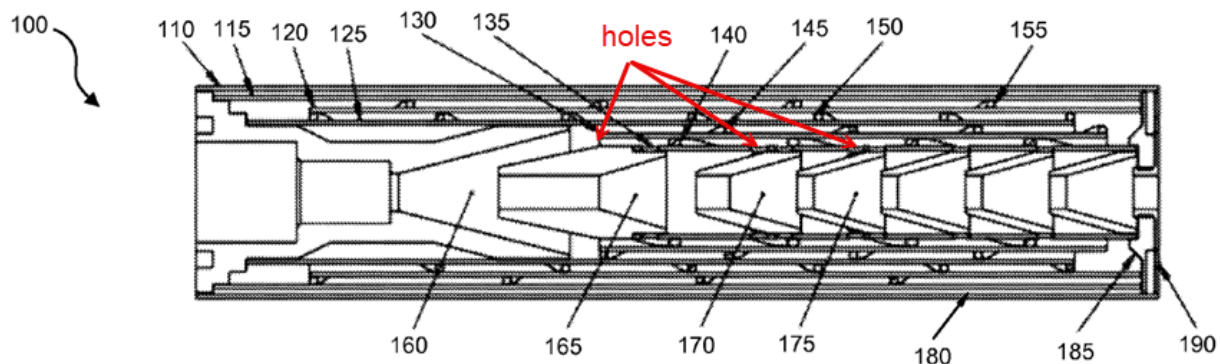


FIG. 1a

198. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

10. Written Description Support for Claim 29

199. Claim 29 states: “The device of claim 27, wherein at least one tertiary deflector is at least partially engaged within the flared exit portion of an adjacent deflector.” In my opinion, the ’989 Application describes this claim.

200. Proposed substitute claim 29 is identical (except for the identification of the dependency) to claim 5 in the ’989 Application and is thus supported by the ’989 Application. In addition, the ’989 Application states that “[t]he tertiary deflectors can be at least partially engaged within the flared exit portion of an adjacent deflector,” and Figure 1a shows an embodiment in which tertiary deflector 175 is partially engaged with the flared outlet portion of secondary deflector 170, as indicated in the red box below. *Id.* at 10:15-16, Fig. 1a.

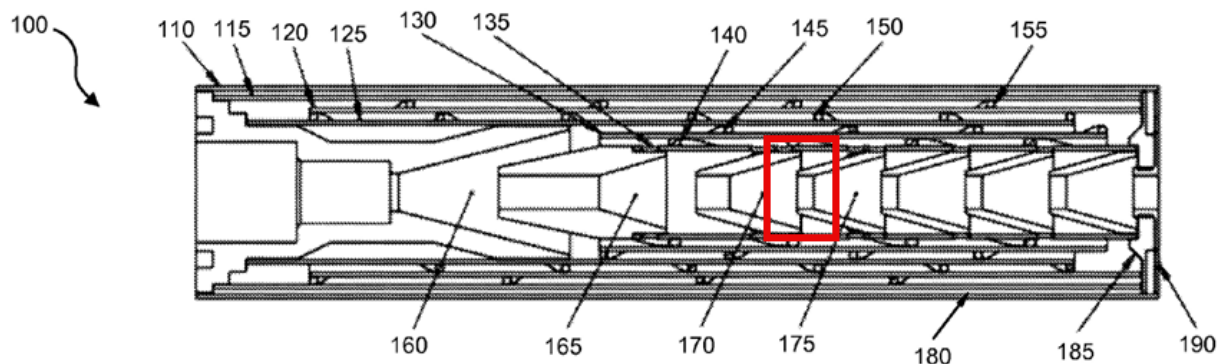


FIG. 1a

201. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

11. Written Description Support for Claim 30

202. Claim 30 states: “The device of claim 26, wherein the plurality of deflectors span substantially the entire central axis along the central chamber.” In my opinion, the ’989 Application describes this claim.

203. Proposed Substitute Claim 30 is identical (except for the identification of the dependency) to claim 6 in the ’989 Application and is thus supported by the ’989 Application. In addition, the ’989 Application states that “the plurality of deflectors can span substantially the entire central axis along the central chamber,” and Figure 1a shows an embodiment in which that is the case. *Id.* at 10:16-17, Fig. 1a.

204. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

12. Written Description Support for Claim 31

205. Claim 31 states: “The device of claim 23, wherein the multiple internal walls are formed to produce a radially serpentine fluid pathway.” In my opinion, the ’989 Application describes this claim.

206. Proposed Substitute Claim 31 is identical (except for the identification of the dependency) to claim 7 in the ’989 Application, and is thus supported by the ’989 Application. In addition, as explained above, the ’989 Application describes an embodiment in which the internal walls produce a radially serpentine fluid

pathway. Thus, for the same reasons, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

13. Written Description Support for Claim 32

207. Claim 32 states: “The device of claim 23, wherein the multiple internal walls are formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce the axially serpentine fluid annular pathway.” In my opinion, the '989 Application describes this claim.

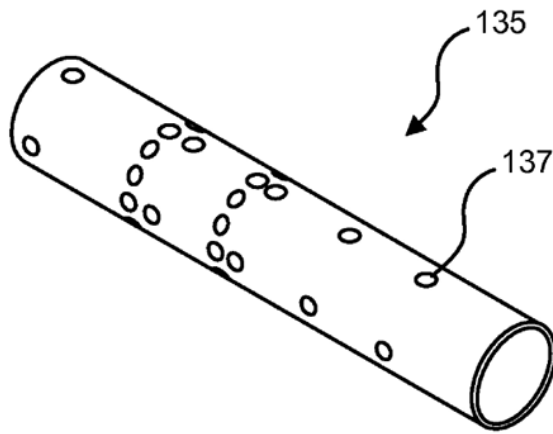
208. Proposed Substitute Claim 32 is identical (except for the identification of the dependency) to claim 8 in the '989 Application and is thus supported by the '989 Application. In addition, Figure 1a discloses an embodiment in which “the off axis chamber is comprised of a plurality of tubes 115, 120, 125, 130, 135 of differing diameters nested within one another.” *Id.* at 8:9-10. “In other words, the multiple internal walls can be formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube.” *Id.* at 8:11-13. “Each tube can have at least one inlet from a successively smaller tube (or from a deflector or other structure) to allow fluids to flow from one tube to the next),” and “the concentric tubes can have ends offset from an adjacent tube so as to produce a serpentine fluid annular pathway.” *Id.* at 8:15-26.

209. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

14. Written Description Support for Claim 33

210. Claim 33 states: “The device of claim 32, wherein the multiple concentric tubes include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.” In my opinion, the '989 Application describes this claim.

211. Proposed Substitute Claim 33 is identical (except for the identification of the dependency) to claim 9 in the '989 Application and is thus supported by the '989 Application. In addition, the '989 Application states that “[t]he multiple concentric tubes can include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.” *Id.* at 8:23-26. The '989 Application discloses one configuration of such orifices in Figure 2, reproduced below. *See id.* at 11:14-18, Fig. 2.



212. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

15. Written Description Support for Claim 34

213. Claim 34 reads: “The device of claim 33, wherein the annular spaces further include a helical wall oriented within at least one of the annular spaces to direct fluids along a helical path within the at least one annular space.” In my opinion, the '989 Application describes this claim.

214. Proposed Substitute Claim 34 is identical (except for the identification of the dependency) to claim 10 in the '989 Application and is thus supported by the '989 Application. In addition, the '989 Application states that “one optional aspect of the device is to include a helical wall oriented within at least one of the annular spaces to direct fluids along a helical path within the at least one annular space (e.g., the off axis chamber, or alternately a space within the off axis chamber

defined by one or more tubes).” *Id.* at 13:5-8. The ’989 Application discloses various types of such helical walls. *See id.* at 8:27-28, 13:8-14:10.

215. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

16. Written Description Support for Claim 35

216. Claim 35 states: “The device of claim 34, wherein the helical wall has a quadrilateral cross-section or a circular cross-section.” In my opinion, the ’989 Application describes this claim.

217. Proposed Substitute Claim 35 is identical (except for the identification of the dependency) to claim 11 in the ’989 Application and is thus supported by the ’989 Application. In addition, Figure 10a shows a circular cross-section of one such helical wall. *Id.* at 13:11-13, Fig. 10a.

218. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

17. Written Description Support for Claim 36

219. Claim 36 states: “The device of claim 34, wherein the helical wall has a winding ratio (windings:diameter) of about 3:1 to about 8:1.” In my opinion, the ’989 Application describes this claim.

220. Proposed Substitute Claim 35 is identical (except for the identification of the dependency) to claim 12 in the ’989 Application and is thus supported by the

'989 Application. In addition, the '989 Application states that “the helical walls can have varying winding ratios (i.e. windings:diameter),” noting that “a higher rate of twist provides a greater path length for fluids along the fluid pathway to the chamber outlet.” *Id.* at 13:20-21, 14:1-2. Specifically, “in one aspect, the helical wall has a winding ratio of about 3:1 to about 8:1.” *Id.* at 14:2-3.

221. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

18. Written Description Support for Claim 37

222. Claim 37 states: “The device of claim 23, wherein the common off axis chamber further includes an annular dampening chamber oriented about the central chamber and being filled with an energy absorbent material.” In my opinion, the '989 Application describes this claim.

223. Proposed Substitute Claim 37 is identical (except for the identification of the dependency) to claim 13 in the '989 Application and is thus supported by the '989 Application. In addition, the '989 Application discloses that “the common off axis chamber can further include an annular dampening chamber 180 oriented about the central chamber and being filled with an energy absorbent material,” and that this “dampening chamber can be oriented adjacent the outer shell 110 as illustrated in FIG. 1a.” *Id.* at 10:18-21.

224. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

19. Written Description Support for Claim 38

225. Claim 38 states: “The device of claim 37, wherein the dampening chamber is oriented adjacent the outer shell.” In my opinion, the '989 Application describes this claim.

226. Proposed Substitute Claim 38 is identical (except for the identification of the dependency) to claim 14 in the '989 Application and is thus supported by the '989 Application. In addition, the '989 Application discloses that “[t]he dampening chamber can be oriented adjacent the outer shell 110 as illustrated in FIG. 1a.” *Id.* at 10:21-21.

227. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

20. Written Description Support for Claim 39

228. Claim 39 states: “The device of claim 37, wherein the energy absorbent material is selected from the group consisting of powder tungsten filament, heavy metal powder, graphite, polymer, aluminum, stainless steel, carbon steels, iron, copper, tantalum, titanium, vanadium, chromium, zirconium, carbides of these, alloys of these, and combinations thereof.” In my opinion, the '989 Application describes this claim.

229. Proposed Substitute Claim 38 is identical (except for the identification of the dependency) to claim 15 in the '989 Application and is thus supported by the '989 Application. In addition, the '989 Application states that “[n]on-limiting examples of suitable material [for the energy absorbent material] can be a powder tungsten filament, metal powder, graphite, polymer, and the like,” and that “[i]n one aspect the material can be a powder tungsten filament or other heavy metal or metal powders (e.g. aluminum, stainless steel, carbon steels, iron, copper, tantalum, titanium, vanadium, chromium, zirconium, carbides of these, alloys of these, and the like.” *Id.* at 10:23-28.

230. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

21. Written Description Support for Claim 40

231. Claim 40 states: “An energy capture and control device for use with a weapon, comprising: a) a central chamber oriented along a central axis within an outer shell oriented along the central axis, said central chamber having an inlet configured to receive a high energy material comprising a projectile and gases from a high energy outlet of the weapon; b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber via a plurality of orifices and further includes including a fluid outlet, the common off axis chamber comprising a serpentine fluid pathway which is at least one of axially

serpentine and radially serpentine, wherein the fluid outlet is located at an opposite end of the energy capture and control device as the inlet; and c) a plurality of deflectors oriented in series along the central axis of the central chamber, wherein a position of multiple individual deflectors of the plurality of deflectors corresponds with the individual orifices of the plurality of orifices to the common off axis chamber.” In my opinion, the ’989 Application describes this claim.

232. The only limitations in Proposed Substitute Claim 40 that are not present in Proposed Substitute Claim 23 are the requirement that the common off axis chamber is in fluid communication with the central chamber “via a plurality of orifices,” and that “a position of multiple individual deflectors of the plurality of deflectors corresponds with the individual orifices of the plurality of the orifices to the common off axis chamber.” The ’989 Application discloses these limitations. It states that, in one embodiment, “[t]he multiple concentric tubes can include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.” *Id.* at 8:23-26. The ’989 Application illustrates this embodiment in Figure 1, in which “[a]n innermost tube 135 in the off axis chamber can include orifices which correspond to the plurality of deflectors.” *Id.* at 11:14-15. “In one aspect, the holes can be oriented adjacent a

contact point between a deflector and an inner wall of the innermost tube.” *Id.* at 17-18.

233. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the ’750 Patent possessed this claim.

22. Written Description Support for Claim 41

234. Claim 41 states: “The device of claim 40, wherein the common off axis chamber further comprises at least one helical wall defining the axially serpentine fluid pathway, the at least one helical wall being configured to produce an axially serpentine fluid pathway which helically spirals around the central chamber and which dissipates energy transferred from the high energy material.” In my opinion, the ’989 Application describes this claim.

235. Proposed Substitute Claim 41 is substantively similar (except for the identification of the dependency) to claim 18 in the ’989 Application and is thus supported by the ’989 Application. In addition, Figure 1a discloses an embodiment of this claim. “FIG. 1a illustrates an example configuration where the internal walls define an axially serpentine fluid pathway which helically spirals around the central chamber along a length of the off axis chamber.” *Id.* at 8:7-9. The walls are formed by a “plurality of tubes 115, 120, 125, 130, 135” and “a rod 140, 145, 150, 155 or other device helically winding within the tube to define a helical pathway within the tube.” *Id.* at 8:27-28.

236. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

23. Written Description Support for Claim 42

237. Claim 42 states: “The device of claim 40, further comprising multiple internal walls defining the axially serpentine fluid pathway, the multiple internal walls being formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce a serpentine fluid annular pathway.” In my opinion, the '989 Application describes this claim.

238. Proposed Substitute Claim 42 is substantively similar (except for the identification of the dependency) to claim 19 in the '989 Application and is thus supported by the '989 Application. In addition, this claim (except for the dependency) is identical to proposed substitute claim 32 and is supported by the '989 Application for the same reasons set forth above.

239. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

24. Written Description Support for Claim 43

240. Claim 43 states: “A method for energy capture and control from a high energy device weapon, comprising: a) discharging a high energy material comprising a projectile and gases from the weapon through an energy capture and

control device comprising a central chamber oriented along a central axis within an outer shell oriented along the central axis, said central chamber having an inlet configured to receive a the high energy material from a high energy outlet of the weapon, and a common off axis chamber oriented within the outer shell in fluid communication with the central chamber, the common off axis chamber comprising an axially serpentine fluid pathway and a fluid outlet, wherein the fluid outlet is located at an opposite end of the energy capture and control device as the inlet; and b) capturing energy within the common off axis chamber via a plurality of orifices from the central chamber using the axially serpentine fluid pathway, the energy being associated with discharge of the high energy material from the weapon.” In my opinion, the ’989 Application describes this claim.

241. Proposed Substitute Claim 43 is a method claim that uses an energy capture and control device. The claim limitations that relate to the energy capture and control device also appear in proposed substitute claims 23 and 40 and are thus supported by the ’989 Application for the reasons stated above. In addition, the ’989 Application specifically discloses “a method 400 for energy capture and control from a high energy device” in connection with Figure 17. *Id.* at 15:23-24, Fig. 17. The description of the method corresponds with the limitations of Proposed Substitute Claim 43. *See id.* at 15:23-16:2.

242. In light of this disclosure, a person of ordinary skill in the art would understand that the inventor of the '750 Patent possessed this claim.

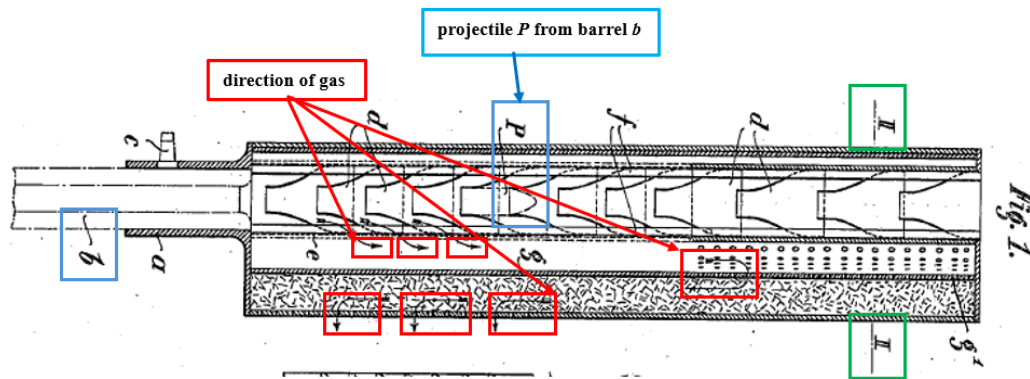
B. The Proposed Substitute Claims Respond to a Ground of Unpatentability in the Petition.

243. I have also been asked to provide my opinion on whether the Proposed Substitute Claims respond to any grounds of unpatentability asserted in the petition. In my opinion, the proposed substitute claims are responsive to at least Grounds 1, 2, 3, 4, and 7 in the Petition.

1. Grounds 1, 2, and 4

244. Grounds 1, 2, and 4 rely on Thurler. In my opinion Proposed Substitute Claims 23, 40, and 42 differ from Thurler in two important ways. Thus, in my opinion these Proposed Substitute Claims respond to a ground of unpatentability in the petition.

245. First, the device disclosed by Thurler is eccentric. As shown in annotated image from Thurler below, the device is made of tube *e*, tube *g*, and tube *h*. Although not labeled, Thurler makes clear that the bottom tube is tube *h*. Ex. 1015 at 2:75-82.

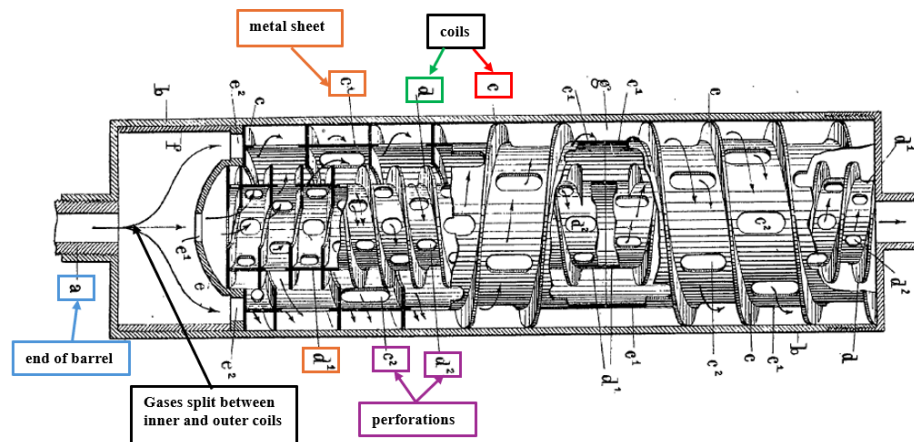


Tubes *g* and *h* are eccentric to the tubes through which the projectile travels “so that sight *c* projects over the device. Ex. 1015, 1:79-82.

246. Proposed Substitute Claims 23, 40, and 42, however, require that the central chamber and the outer shell both be oriented along the same central axis. Specifically, claims 23, 40, and 42 requires “a central chamber oriented along a central axis within an outer shell oriented along *the* central axis.” In other words, the claimed energy capture and control device cannot be eccentric. This limitation is not present in original claims 1, 19, and 22. In addition, I have seen no evidence that a person of ordinary skill in the art would modify Thurler (either alone or in combination with Barlowatz) to achieve this claim limitation, and in my opinion, a person of ordinary skill in the art would not do so. Indeed, removing Thurler’s eccentric design would prevent sight *c* from projecting over the device.

247. Second, the gases escape from the device in Thurler on the bottom of the device near where the gases and projectile enter the device. Proposed Substitute Claims 23, 40, and 42, however, require that the “fluid outlet is located at an

opposite end of the energy capture and control device as the inlet.” This limitation is also not present in original claims 1, 19, and 22. In addition, I have seen no evidence that a person of ordinary skill in the art would modify Thurler (either alone or in combination with Barlowatz) to achieve this claim limitation, and in my opinion a person of ordinary skill in the art would not do so. Modifying Thurler so that the fluid outlet is at the opposite end of the device as the inlet would require adding another tube below tube *h* and making the gases exit from the front of the tube, not the bottom. But Thurler itself provides no motivation for making such a drastic change to the device. And Barlowatz does not even have an outlet from the supposed off axis chamber. As shown in the annotated figure below, all fluids leave through the center of the device.



248. It is accordingly my opinion that Proposed Substitute Claims 23, 40, and 42 respond to at least Grounds 1, 2, and 4 in the Petition. Because all other Proposed Substitute Claims depend from Proposed Substitute Claims 23, 40, or 42,

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either directly or through another claim, all of these claims respond to Grounds 1, 2, and 4 as well.

2. Grounds 3 and 7

249. Finally, Proposed Substitute Claim 23 and 40 require an “energy capture and control device *for use with a weapon*,” and that the “high energy material compris[e] a projectile and a gases from a high energy outlet of the weapon.” Similarly, Proposed Substitute Claim 42 claims “[a] method for energy capture and control *from a weapon*,” and that the “high energy material compris[e] a projectile and gases from the weapon.” These limitations distinguish the Proposed Substitute Claims 23, 40, and 42, and all claims that depend therefrom, over U.S. Patent No. 748,157 to Bouton and U.S. Patent No. 582,485 to Reeves, both of which relate to mufflers. In Ground 3, Petitioner contends that Thurler in view of Bouton renders claim 18 obvious, and in Ground 7, Petitioner contends that Barlowatz in view of Reeves renders claim 2 obvious. These limitations are not present in original claim 1, and thus are also not present in original claims 2 or 18, which depend from claim 1. Thus, these amendments respond to at least Grounds 3 and 7 in the Petition.

XII. CONCLUSION

250. As set forth above, it is my opinion that none of the art referenced by the Petitioner in the Petition and discussed in the Nixon Declaration (Ex. 1013) renders claims 2, 3, 6, 9, 12-14, 18, and 20 of the '750 Patent unpatentable.

251. Additionally, it is my opinion that (a) the Proposed Substitute Claims are supported by the disclosure of the application for the '750 Patent, and (b) the Proposed Substitute Claims respond to grounds of unpatentability in the Petition.

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

Signed in Sandy Springs, GA, on April 28, 2025


G. Paul Neitzel, Ph.D

Appendix A

Claim Element	Claim Language
1.0 (Pre)	1. An energy capture and control device, comprising:
1.1	a) a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet;
1.2	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber and having a fluid outlet and multiple internal walls defining a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine and which dissipates energy transferred from the high energy material; and
1.3	c) a plurality of deflectors oriented in series along the central axis of the central chamber and configured to deflect the energy from the high energy material to the common off axis chamber.
2	The device of claim 1, wherein the common off axis chamber comprises a plurality of sub-chambers defined by the plurality of deflectors, each with the radially serpentine fluid pathway, and wherein the radially serpentine fluid pathways of each of the deflectors are axially non-linearly interconnected along an outermost portion of the plurality of sub-chambers.
3	The device of claim 1, wherein the central chamber further comprises a locking block oriented at the inlet, said locking block having an engagement surface configured to attach to the high energy outlet and a hollow interior along the central axis, said hollow interior having a reducing throat portion and a flared outlet.
4	The device of claim 1, wherein the plurality of deflectors each comprise a frustoconical shape having a hollow interior along the central axis and a flared exit portion.
5	The device of claim 4, wherein the plurality of deflectors include a primary deflector, a secondary deflector, and a first tertiary deflector.
6	The device of claim 5, wherein the fluid communication between the common off axis chamber and the central chamber occurs only at the primary deflector, the secondary deflector and a first tertiary deflector.

Claim Element	Claim Language
7	The device of claim 5, wherein at least one tertiary deflector is at least partially engaged within the flared exit portion of an adjacent deflector.
8	The device of claim 4, wherein the plurality of deflectors span substantially the entire central axis along the central chamber.
9	The device of claim 1, wherein the multiple internal walls are formed to produce a radially serpentine fluid pathway.
10	The device of claim 1, wherein the multiple internal walls are formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce the axially serpentine fluid annular pathway.
11	The device of claim 10, wherein the multiple concentric tubes include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.
12	The device of claim 11, wherein the annular spaces further include a helical wall oriented within at least one of the annular spaces to direct fluids along a helical path within the at least one annular space.
13	The device of claim 12, wherein the helical wall has a quadrilateral cross-section or a circular cross-section.
14	The device of claim 12, wherein the helical wall has a winding ratio (windings:diameter) of about 3:1 to about 8:1.
15	The device of claim 1, wherein the common off axis chamber further includes an annular dampening chamber oriented about the central chamber and being filled with an energy absorbent material.
16	The device of claim 15, wherein the dampening chamber is oriented adjacent the outer shell.
17	The device of claim 15, wherein the energy absorbent material is selected from the group consisting of powder tungsten filament, heavy metal powder, graphite, polymer, aluminum, stainless steel,

Claim Element	Claim Language
	carbon steels, iron, copper, tantalum, titanium, vanadium, chromium, zirconium, carbides of these, alloys of these, and combinations thereof.
18	The device of claim 1, wherein the outer shell includes an end cap assembly at an outlet end of the central chamber and which allows fluid to escape from the common off axis chamber through the fluid outlet, the fluid outlet being only accessible to the fluid in the common off axis chamber.
19 (Pre)	An energy capture and control device, comprising:
19.1	a) a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet;
19.2	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber via a plurality of orifices and further includes a fluid outlet, the common off axis chamber comprising a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine; and
19.3	c) a plurality of deflectors oriented in series along the central axis of the central chamber, wherein a position of multiple individual deflectors of the plurality of deflectors corresponds with the individual orifices of the plurality of orifices to the common off axis chamber.
20	The device of claim 19, wherein the common off axis chamber further comprises at least one helical wall defining the axially serpentine fluid pathway, the at least one helical wall being configured to produce an axially serpentine fluid pathway which helically spirals around the central chamber and which dissipates energy transferred from the high energy material.
21	The device of claim 19, further comprising multiple internal walls defining the axially serpentine fluid pathway, the multiple internal walls being formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce a serpentine fluid annular pathway.

Claim Element	Claim Language
22 (Pre)	A method for energy capture and control from a high energy device, comprising:
22.1	a) discharging a high energy material from the high energy device through an energy capture and control device comprising a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet, and a common off axis chamber oriented within the outer shell in fluid communication with the central chamber, the common off axis chamber comprising an axially serpentine fluid pathway and a fluid outlet; and
22.2	b) capturing energy within the common off axis chamber via a plurality of orifices from the central chamber using the axially serpentine fluid pathway, the energy being associated with discharge of the high energy material from the high energy discharge device.

Appendix B

Appendix B

Claim Element	Claim Language	Proposed Amendments ¹
1.0 (Pre)	1. An energy capture and control device, comprising:	~~423~~ . An energy capture and control device <u>for use with a weapon</u> , comprising:
1[a]	a) a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet;	a) a central chamber oriented along a central axis within an outer shell <u>oriented along the central axis</u> , said central chamber having an inlet configured to receive a high energy material <u>comprising a projectile and gases</u> from a high energy outlet <u>of the weapon</u> ;
1[b]	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber and having a fluid outlet and multiple internal walls defining a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine and which dissipates energy transferred from the high energy material; and	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber and having a fluid outlet and multiple internal walls defining a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine and which dissipates energy transferred from the high energy material, <u>wherein the fluid outlet is located at an opposite end of the energy capture and control device as the inlet</u> ; and
1[c]	c) a plurality of deflectors oriented in series along the central axis of the central chamber and configured to deflect the energy from the high energy material to the common off axis chamber.	c) a plurality of deflectors oriented in series along the central axis of the central chamber and configured to deflect the energy from the high energy material to the common off axis chamber.
2	The device of claim 1, wherein the common off axis chamber comprises a plurality of sub-chambers defined	~~224~~ . The device of claim ~~423~~ , wherein the common off axis chamber comprises a plurality of sub-chambers

¹ Material that is added to the original claim by the proposed amendment is underlined. Material that is deleted from the original claim by the proposed amendment is stricken through.

Claim Element	Claim Language	Proposed Amendments ¹
	by the plurality of deflectors, each with the radially serpentine fluid pathway, and wherein the radially serpentine fluid pathways of each of the deflectors are axially non-linearly interconnected along an outermost portion of the plurality of sub-chambers.	defined by the plurality of deflectors, each with the radially serpentine fluid pathway, and wherein the radially serpentine fluid pathways of each of the deflectors are axially non-linearly interconnected along an outermost portion of the plurality of sub-chambers.
3	The device of claim 1, wherein the central chamber further comprises a locking block oriented at the inlet, said locking block having an engagement surface configured to attach to the high energy outlet and a hollow interior along the central axis, said hollow interior having a reducing throat portion and a flared outlet.	~~3~~ <u>25</u> . The device of claim ~~1~~ <u>23</u> , wherein the central chamber further comprises a locking block oriented at the inlet, said locking block having an engagement surface configured to attach to the high energy outlet and a hollow interior along the central axis, said hollow interior having a reducing throat portion and a flared outlet.
4	The device of claim 1, wherein the plurality of deflectors each comprise a frustoconical shape having a hollow interior along the central axis and a flared exit portion.	~~4~~ <u>26</u> . The device of claim ~~1~~ <u>23</u> , wherein the plurality of deflectors each comprise a frustoconical shape having a hollow interior along the central axis and a flared exit portion.
5	The device of claim 4, wherein the plurality of deflectors include a primary deflector, a secondary deflector, and a first tertiary deflector.	~~5~~ <u>27</u> . The device of claim ~~4~~ <u>26</u> , wherein the plurality of deflectors include a primary deflector, a secondary deflector, and a first tertiary deflector.
6	The device of claim 5, wherein the fluid communication between the common off axis chamber and the central chamber occurs only at the primary deflector, the secondary deflector and a first tertiary deflector.	~~6~~ <u>28</u> . The device of claim ~~5~~ <u>27</u> , wherein the fluid communication between the common off axis chamber and the central chamber occurs only at the primary deflector, the secondary deflector and a first tertiary deflector.

Claim Element	Claim Language	Proposed Amendments ¹
7	The device of claim 5, wherein at least one tertiary deflector is at least partially engaged within the flared exit portion of an adjacent deflector.	~~7~~ <u>29</u> . The device of claim ~~5~~ <u>27</u> , wherein at least one tertiary deflector is at least partially engaged within the flared exit portion of an adjacent deflector.
8	The device of claim 4, wherein the plurality of deflectors span substantially the entire central axis along the central chamber.	~~8~~ <u>30</u> . The device of claim ~~4~~ <u>26</u> , wherein the plurality of deflectors span substantially the entire central axis along the central chamber.
9	The device of claim 1, wherein the multiple internal walls are formed to produce a radially serpentine fluid pathway.	~~9~~ <u>31</u> . The device of claim ~~1~~ <u>23</u> , wherein the multiple internal walls are formed to produce a radially serpentine fluid pathway.
10	The device of claim 1, wherein the multiple internal walls are formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce the axially serpentine fluid annular pathway.	~~10~~ <u>32</u> . The device of claim ~~1~~ <u>23</u> , wherein the multiple internal walls are formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce the axially serpentine fluid annular pathway.
11	The device of claim 10, wherein the multiple concentric tubes include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.	~~11~~ <u>33</u> . The device of claim ~~10~~ <u>32</u> , wherein the multiple concentric tubes include an innermost tube which includes orifices oriented to allow fluid to pass from the central chamber into a first annular space adjacent the innermost tube and through the annular spaces of progressively larger diameter.
12	The device of claim 11, wherein the annular spaces further include a helical wall oriented within at least	~~12~~ <u>34</u> . The device of claim ~~11~~ <u>33</u> , wherein the annular spaces further include a helical wall oriented within at

Claim Element	Claim Language	Proposed Amendments ¹
	one of the annular spaces to direct fluids along a helical path within the at least one annular space.	least one of the annular spaces to direct fluids along a helical path within the at least one annular space.
13	The device of claim 12, wherein the helical wall has a quadrilateral cross-section or a circular cross-section.	~~13~~ <u>35</u> . The device of claim ~~12~~ <u>34</u> , wherein the helical wall has a quadrilateral cross-section or a circular cross-section.
14	The device of claim 12, wherein the helical wall has a winding ratio (windings:diameter) of about 3:1 to about 8:1.	~~14~~ <u>36</u> . The device of claim ~~12~~ <u>34</u> , wherein the helical wall has a winding ratio (windings:diameter) of about 3:1 to about 8:1.
15	The device of claim 1, wherein the common off axis chamber further includes an annular dampening chamber oriented about the central chamber and being filled with an energy absorbent material.	~~15~~ <u>37</u> . The device of claim ~~1~~ <u>23</u> , wherein the common off axis chamber further includes an annular dampening chamber oriented about the central chamber and being filled with an energy absorbent material.
16	The device of claim 15, wherein the dampening chamber is oriented adjacent the outer shell.	~~16~~ <u>38</u> . The device of claim ~~15~~ <u>37</u> , wherein the dampening chamber is oriented adjacent the outer shell.
17	The device of claim 15, wherein the energy absorbent material is selected from the group consisting of powder tungsten filament, heavy metal powder, graphite, polymer, aluminum, stainless steel, carbon steels, iron, copper, tantalum, titanium, vanadium, chromium, zirconium, carbides of these, alloys of these, and combinations thereof.	~~17~~ <u>39</u> . The device of claim ~~15~~ <u>37</u> , wherein the energy absorbent material is selected from the group consisting of powder tungsten filament, heavy metal powder, graphite, polymer, aluminum, stainless steel, carbon steels, iron, copper, tantalum, titanium, vanadium, chromium, zirconium, carbides of these, alloys of these, and combinations thereof.
19[pre]	19. An energy capture and control device, comprising:	~~19~~ <u>40</u> . An energy capture and control device <u>for use with a weapon</u> , comprising:

Claim Element	Claim Language	Proposed Amendments ¹
19[a]	a) a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet;	a) a central chamber oriented along a central axis within an outer shell <u>oriented along the central axis</u> , said central chamber having an inlet configured to receive a high energy material <u>comprising a projectile and gases</u> from a high energy outlet <u>of the weapon</u> ;
19[b]	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber via a plurality of orifices and further includes a fluid outlet, the common off axis chamber comprising a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine; and	b) a common off axis chamber oriented within the outer shell in fluid communication with the central chamber via a plurality of orifices and further ~~includes~~ <u>including</u> a fluid outlet, the common off axis chamber comprising a serpentine fluid pathway which is at least one of axially serpentine and radially serpentine, <u>wherein the fluid outlet is located at an opposite end of the energy capture and control device as the inlet</u> ; and
19[c]	c) a plurality of deflectors oriented in series along the central axis of the central chamber, wherein a position of multiple individual deflectors of the plurality of deflectors corresponds with the individual orifices of the plurality of orifices to the common off axis chamber.	c) a plurality of deflectors oriented in series along the central axis of the central chamber, wherein a position of multiple individual deflectors of the plurality of deflectors corresponds with the individual orifices of the plurality of orifices to the common off axis chamber
20	The device of claim 19, wherein the common off axis chamber further comprises at least one helical wall defining the axially serpentine fluid pathway, the at least one helical wall being configured to produce an axially serpentine fluid pathway which helically spirals	~~2041~~ . The device of claim ~~1940~~ , wherein the common off axis chamber further comprises at least one helical wall defining the axially serpentine fluid pathway, the at least one helical wall being configured to produce an axially serpentine fluid pathway which helically spirals

Claim Element	Claim Language	Proposed Amendments ¹
	around the central chamber and which dissipates energy transferred from the high energy material.	around the central chamber and which dissipates energy transferred from the high energy material.
21	The device of claim 19, further comprising multiple internal walls defining the axially serpentine fluid pathway, the multiple internal walls being formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce a serpentine fluid annular pathway.	2142. The device of claim 1940, further comprising multiple internal walls defining the axially serpentine fluid pathway, the multiple internal walls being formed by multiple concentric tubes having progressively larger diameters so as to form annular spaces between each adjacent tube, and having alternating ends offset so as to produce a serpentine fluid annular pathway.
22[pre]	A method for energy capture and control from a high energy device, comprising:	2243. A method for energy capture and control from a ~~high energy device~~ <u>weapon</u> , comprising:
22[a]	a) discharging a high energy material from the high energy device through an energy capture and control device comprising a central chamber oriented along a central axis within an outer shell, said central chamber having an inlet configured to receive a high energy material from a high energy outlet, and a common off axis chamber oriented within the outer shell in fluid communication with the central chamber, the common off axis chamber comprising an axially serpentine fluid pathway and a fluid outlet; and	a) discharging a high energy material <u>comprising a projectile and gases</u> from the ~~high energy device~~ <u>weapon</u> through an energy capture and control device comprising a central chamber oriented along a central axis within an outer shell <u>oriented along the central axis</u> , said central chamber having an inlet configured to receive ~~a the~~ <u>the</u> high energy material from a high energy outlet <u>of the weapon</u> , and a common off axis chamber oriented within the outer shell in fluid communication with the central chamber, the common off axis chamber comprising an axially serpentine fluid pathway and a fluid outlet, <u>wherein the fluid outlet is located at an</u>

Claim Element	Claim Language	Proposed Amendments ¹
		<u>opposite end of the energy capture and control device as the inlet; and</u>
22[b]	b) capturing energy within the common off axis chamber via a plurality of orifices from the central chamber using the axially serpentine fluid pathway, the energy being associated with discharge of the high energy material from the high energy discharge device.	b) capturing energy within the common off axis chamber via a plurality of orifices from the central chamber using the axially serpentine fluid pathway, the energy being associated with discharge of the high energy material from the ~~high energy discharge device~~ <u>weapon.</u>

Appendix C

April 27, 2025

CURRICULUM VITAE - G. PAUL NEITZEL

Education

Ph.D., fluid mechanics, The Johns Hopkins University, 1979.
Thesis advisor - Professor Stephen H. Davis

M.S., numerical science, The Johns Hopkins University, 1974.

B.S., mathematics/physics, Rollins College, 1969.

*Academic
Experience*

The Johns Hopkins University
Department of Mechanical Engineering

Doctor of the University, 2018-

Georgia Institute of Technology
The George W. Woodruff School of Mechanical Engineering

Professor Emeritus, 2018-

Associate Chair for Graduate Studies, 2009-18

Professor, 1990-2018

Chair, Fluid Mechanics Research Area, 1991-97

Arizona State University
Department of Mechanical and Aerospace Engineering

Professor, 1989-90

Associate Professor, 1983-89

Assistant Professor, 1979-83

Universität Karlsruhe, Institut für Strömungslehre
und Strömungsmaschinen

Alexander von Humboldt Research Fellow, 1985-86

Imperial College of Science & Technology, Department of Mathematics

Visiting Professor, 1986

Université d'Aix-Marseille 2, Institut de Mécanique des Fluides

CNRS Professeur Invité, 1995

SilencerCo Weapons Research, LLC v. HuxWrx Safety Co. LLC

HuxWrx Safety Co. LLC Ex. 2001 - 116

U.S. Patent No. 8,286,750

IPR2024-01214

Institut für Kern- und Energietechnik, Forschungszentrum Karlsruhe

Guest Scientist, 2006

*Government
Experience*

U.S. Army Ballistic Research Laboratory

Terminal Ballistics Division, Shaped Charge Branch
Aerospace Engineer, 1978-79

Launch and Flight Division, Fluid Dynamics Research Group
Aerospace Engineer, 1977-78

Exterior Ballistics Laboratory, Free-Flight Aerodynamics Branch
Aerospace Engineer, 1972-77

Exterior Ballistics Laboratory, Firing Tables Branch
Mathematician, 1969-72

*Professional
Activities*

The American Physical Society (Fellow)
American Society of Mechanical Engineers (Fellow)
American Institute of Aeronautics and Astronautics (Associate Fellow)
American Society for Engineering Education
Sigma Xi, The Scientific Research Society
Pi Tau Sigma (honorary member)

referee, *Journal of Fluid Mechanics*
referee, *The Physics of Fluids*
referee, *The Physical Review*
referee, *Proceedings of the Royal Society of London*
referee, *AIAA Journal*
referee, *SIAM Journal on Applied Mathematics*
referee, *Journal of Computational Physics*
referee, *Journal of Fluids Engineering*
referee, *Journal of Biomechanical Engineering*
referee, *Physical Review Letters*
referee, *Applied Physics Letters*
referee, *International Journal of Multiphase Flow*
referee, *Journal of Applied Mechanics*
referee, *Biorheology*
referee, *Journal of Aircraft*
referee, *Journal of Crystal Growth*
referee, *Fluid Dynamics Research*
referee, *Chemical Engineering Science*
referee, *Computers & Fluids*

referee, *American Journal of Physics*
referee, *Numerical Heat Transfer*
referee, *Journal of Tribology*
referee, *Metallurgical and Materials Transactions*
referee, *European Journal of Mechanics B/Fluids*
referee, *Theoretical & Computational Fluid Dynamics*
referee, *International Journal of Thermal Sciences*
referee, *Journal of Membrane Science*
and several others

reviewer, National Science Foundation
reviewer, National Research Council, Army Research Office
reviewer, National Aeronautics and Space Administration
reviewer, US Department of Energy
and several others

Member, Space Station Utilization Advisory Subcommittee, NASA Advisory Council, 1995 - 1999

Chair, Discipline Working Group on Fluid Physics, NASA Office of Biological and Physical Research, 1997 – 2002 (Member, 1991 - 2004)

Member, Physical Sciences Advisory Subcommittee, NASA Office of Biological and Physical Research, 1997 - 2004

Member, ASME/Applied Mechanics Division Technical Committee on Mechanics of Materials Processing and Manufacturing

Organizing Committee, SIAM Fall Meeting, Arizona State University, Oct. 28-30, 1985.

Organizing Committee, Fifth Taylor-Vortex Flow Working Party, Arizona State University, March 25-27, 1987.

Member, Selection Committee, Otto Laporte Award, American Physical Society, 1989-91.

Organizing Committee, Forty-Fourth Meeting of the Division of Fluid Dynamics, American Physical Society, Arizona State University, November, 1991.

International Scientific Committee, Chapman Conference on Double-Diffusive Convection, Scottsdale, November, 1993.

Co-Organizer, Symposium on Surface-Tension-Driven Flows, ASME Winter Annual Meeting, New Orleans, November, 1993.

Chair, Organizing Committee, Forty-Seventh Meeting of the Division of Fluid Dynamics, American Physical Society, Georgia Institute of Technology, November, 1994.

Organizing Committee, Ninth International Conference on Numerical Methods in Laminar and Turbulent Flow, Georgia Institute of Technology, July, 1995.

Scientific Committee, Joint Xth European and VIth Russian Symposium on Physical Sciences in Microgravity, St. Petersburg, Russia, June, 1997.

Organizing Committee, Interfaces for the Twenty-First Century, Monterey, August, 1999.

Member, Task Group on Institutional Arrangements for Space Station Research, Space Studies Board, National Research Council, 1999.

Member, Study Team, International Space Station Operations and Utilization Architecture Study, commissioned by NASA, 2000.

Member, On-Orbit Evaluation Board (International Space Station), NASA Johnson Space Flight Center, 2000 – present

Organizing Committee, Conference on Selected Topics in Interfacial Phenomena in Physico-Chemical and Bio Processes (IMA Conference 2001, Giessen, Germany)

External Advisory Board, Space Medicine and Life Sciences Research Center, Morehouse School of Medicine, 2000 – 2006

Vice Chair, Gordon Conference on Gravitational Effects in Physico-Chemical Systems, New London, CT, July, 2003

Co-Chair Minisymposium on Microgravity Flow Phenomena, International Congress on Theoretical and Applied Mechanics, Warsaw, Poland, August, 2004

Chair, Gordon Conference on Engineering Sciences for Space Exploration, Les Diablerets, Switzerland, August, 2005

Member, Acrivos Dissertation Award Committee, American Physical Society, 2005 – 2006 (Chair, 2006)

Member, Marangoni Advisory Group, Japan Aerospace Exploration Agency (JAXA), 2006 – 2008

Lecturer, von Kàrmàn Institute short course on Thermohydraulic Instabilities, November, 2006.

Congressional Testimony, NASA's Space Shuttle and International Space Station Programs: Status and Issues, Subcommittee on Space and Aeronautics, Committee on Science and Technology, U.S. House of Representatives. July 24, 2007

Lecturer, Pan American Advanced Studies Institute on Interfacial Fluid Dynamics: From Theory to Application, Mar del Plata, Argentina, August, 2007

Member, Organizing Committee, Seventy-First Meeting of the Division of Fluid Dynamics, American Physical Society, Atlanta, GA, November, 2018.

Awards and Honors

Fellow, American Physical Society (1994)

Fellow, American Society of Mechanical Engineers (2001)

Associate Fellow, American Institute of Aeronautics and Astronautics (1990)

Jack M. Zeigler Outstanding Educator Award, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology (2011)

NSF Presidential Young Investigator Award (1984-89)

Alexander von Humboldt Research Fellowship (1985-86)

listed in *Who's Who in America*, 58th ed. 2004, and in other biographical indices.

Sponsored Research

Hydrodynamic Stability of Unsteady Flows, Arizona State University Faculty Grant-in-Aid, January 1980 - May 1981, \$3,000

Hydrodynamic Stability of Decelerating Swirl-Flows, National Science Foundation, May 1980 - October 1982, \$40,000

Hydrodynamic Stability of Decelerating Swirl-Flows, National Center for Atmospheric Research, August 1980 - May 1981, 20,000 Computer Resource Units

Turbulent Swirling Flow Downstream of an Abrupt Pipe Expansion - Modeling and Experiments, Office of Naval Research, June 1981 - May 1984, \$337,730 (co-P.I., D. E. Metzger)

Nonlinear Stability of Time-Dependent Couette Flow, National Science Foundation, October 1982 - October 1984, \$126,187 (co-P.I., D. F. Jankowski)

Presidential Young Investigator Award, National Science Foundation, June 1984 - June 1989, variable award - \$100,000/year maximum

Energy Stability of Thermocapillary Convection in Models of the Float-Zone Process, National Aeronautics and Space Administration, June 1984 - December 1987, \$295,262 (co-P.I., D. F. Jankowski)

Convective Effects in Czochralski Crystal Growth, Monsanto Electronic Materials Company, August 1984 - August 1985, \$29,982 (first year industrial funding in support of NSF PYI award)

Numerical Experiments on Vortex Breakdown, Lockheed-Georgia, August, 1985 - August, 1986, \$10,819

Fifth Taylor-Vortex Flow Working Party, National Science Foundation, August, 1986 - August, 1987, \$16,000 (co-P.I., D. F. Jankowski)

Stability and Instability of Thermocapillary Convection in Models of the Float-Zone Process, National Aeronautics and Space Administration, June 1989 - September 1992, \$480,000 (co-PI, D.F. Jankowski).

Computational Studies of Vortex Breakdown, U.S. Air Force Office of Scientific Research, November, 1990 - October, 1991, \$41,670.

Control of Oscillatory Thermocapillary Convection in Microgravity, National Aeronautics and Space Administration, October, 1992 - October, 1995, \$390,000 (co-P.I., D. F. Jankowski).

Thermocapillary Convection in Half-Zones with Highly Deformed Interfaces, North Atlantic Treaty Organization Collaborative Research Grant, August, 1993 - August, 1995, \$5,467.

Microgravity Tissue Engineering, National Aeronautics and Space Administration, January, 1995 - December, 1998, \$3,746,719 (P.I., L. E. Freed, MIT–Georgia Tech joint project).

Time-Dependent Stability and Non-Coalescence Effects in Microgravity, National Aeronautics and Space Administration, February, 1996 - February, 2000, \$480,000.

Fluid Dynamic Studies of Tissue Engineered Cartilage, Advanced Tissue Sciences, Inc., August, 1998 – July, 1999, \$73,070 (co-P.I. with Professor Marc K. Smith)

Interfaces for the Twenty-First Century, National Science Foundation and National Aeronautics and Space Administration, August, 1999, \$40,000 (\$20,000 each agency) (co-PI with Professor Marc Smith *et al.*).

Non-Coalescence in Microgravity: Science and Technology, National Aeronautics and Space Administration, June, 2000 - May, 2004, \$315,000.

Enhancing *In Vitro* Cartilage Synthesis for Human Therapy, Advanced Tissue Sciences, Inc., September, 2001 – August, 2003, \$218,100 (co-P.I. with Professor Marc K. Smith) (company bankrupt after first year of support—grant terminated early)

Novel Applications of Permanent Nonwetting, National Aeronautics and Space Administration, May, 2005 – April, 2009, \$491,291; re-funded at a reduced level through June, 2013.

Development of Novel Models for the Growth of Tissue Engineered Cartilage, National Science Foundation, June 2006 – May, 2009, \$270,000 (co-P.I. with Prof. G. Barabino, Northeastern Univ.)

Optical/Thermal Droplet Levitation and Transport for Lab-On-A Chip, National Science Foundation, October, 2008 – September, 2013, \$270,000.

The Fluid Dynamics of Droplet Impact on Inclined Surfaces with Application to Forensic Blood-Spatter Analysis, National Institute of Justice, October, 2013 – September, 2015, \$299,680 (co-P.I. with Professor Marc K. Smith).

The Fluid Dynamics of Forensic Bloodstain Analysis: Droplet Impact on Inclined Surfaces, National Institute of Justice, January, 2018 – December 2021, \$683,619 (co-P.I. with Professor Marc K. Smith).

*Refereed
Publications*

“Energy Stability Theory of Decelerating Swirl-Flows,” *The Physics of Fluids*, **23**, 432-437 (1980) (with S. H. Davis)

“Centrifugal Instabilities During Spin-Down to Rest in Finite Cylinders. Numerical Experiments,” *Journal of Fluid Mechanics*, **102**, 329-352 (1981) (with S. H. Davis)

“Onset of Convection in Impulsively Heated or Cooled Fluid Layers,” *The Physics of Fluids*, **25**, 210-211 (1982)

“Marginal Stability of Impulsively Initiated Couette Flow and Spin-Decay,” *The Physics of Fluids*, **25**, 226-232 (1982)

“Stability of Circular Couette Flow with Variable Inner Cylinder Speed,” *Journal of Fluid Mechanics*, **123**, 43-57 (1982)

“Strong Stability of Impulsively Initiated Couette Flow for Both Axisymmetric and Nonaxisymmetric Disturbances,” *Journal of Applied Mechanics*, **49**, 691-696 (1982) (with J.-C. Chen)

“Numerical Computation of Time-Dependent Taylor-Vortex Flows in Finite Length Geometries,” *Journal of Fluid Mechanics*, **141**, 51-66 (1984)

“Experiments on Impulsive Spin-Down to Rest,” *The Physics of Fluids*, **28**, 449-454 (1985) (with D. M. Mathis)

“The Influence of Starting Condition on the Linear Stability of Unsteady Circular Couette Flow,” *The Physics of Fluids*, **28**, 749-751 (1985) (with J.-C. Chen and D. F. Jankowski)

“Experiments on the Onset of Instability in Unsteady Circular Couette Flow,” *Journal of Fluid Mechanics*, **161**, 97-113 (1985) (with E. R. Cooper, D. F. Jankowski and T. H. Squire)

“Experiments with Deceleration from a Taylor-Vortex Flow,” *The Physics of Fluids*, **29**, 2742-2743 (1986) (with T. H. Squire and D. F. Jankowski)

“Numerical Experiments on the Stability of Unsteady Circular Couette Flow with Random Forcing,” *The Physics of Fluids*, **30**, 1250-1258 (1987) (with J.-C. Chen and D. F. Jankowski)

“Heat Transfer to Turbulent Swirling Flow Through a Sudden Axisymmetric Expansion,” *Journal of Heat Transfer* **109**, 613-620 (1987) (with P. A. Dellenback and D. E. Metzger)

“Comment on ‘The Flowfield in a Suddenly Enlarged Combustion Chamber,’” *AIAA Journal*, **25**, 893-895 (1987) (with B. K. Sultanian and D. E. Metzger)

“Experiments on the Instability of Impulsively-Initiated Circular Couette Flow,” *Experiments in Fluids*, **6**, 199-208 (1988) (with K. R. Kohuth)

“Streak-Line Motion During Steady and Unsteady Axisymmetric Vortex Breakdown,” *The Physics of Fluids*, **31**, 958-960 (1988)

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“Penetration of Monolithic and Layered Targets,” presented at the Fourth Symposium on Vulnerability and Survivability, sponsored by the American Defense Preparedness Association, Panama City, FL, March 14-15, 1979 (with W. P. Walters and J. N. Majerus).

“Instabilities of a Spinning-Down Flow,” presented at an Army Research Office Workshop on Hydrodynamic Stability, Troy, NY, July 31 - August 2, 1979 (with S. H. Davis).

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“Stability of Time-Dependent Circular Couette Flow,” presented at the Thirty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Ithaca, NY, November 23-25, 1980.

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“Energy Stability Considerations for Unsteady Couette Flow,” presented at the 60th Anniversary Taylor Vortex Flow Workshop, Eugene, OR, June 13-15, 1983.

“Onset of Taylor-Görtler Vortices During Spin-Down to Rest,” presented at the Thirty-Sixth Meeting of the Division of Fluid Dynamics of the American Physical Society, Houston, TX, November 20-22, 1983 (with D. M. Mathis and D. F. Jankowski).

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“Influence of Initial Conditions on the Linear Stability of Unsteady Couette Flow,” presented at the Thirty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Providence, RI, November 18-20, 1984 (with J.-C. Chen and D. F. Jankowski).

“The Influence of LDV Measurements on the Onset of Instability in Unsteady Circular Couette Flow,” presented at the Thirty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Providence, RI, November 18-20, 1984 (with D. F. Jankowski and T. H. Squire).

“Convective Effects in Float-Zone and Czochralski Melts,” invited presentation at a Department of Energy sponsored conference on Crystal Growth for High-Efficiency Solar Cells, San Diego, CA, December 3-4, 1984.

“Numerical Computations of Unstable, Time-Dependent Circular Couette Flow,” presented at the First Arizona Fluid Mechanics Meeting, Tucson, AZ, March 1, 1985 (with J.-C. Chen).

“Turbulent Flow Prediction in a Sudden Axisymmetric Expansion,” Proceedings of the Int’l Symposium on Refined Flow Modeling and Turbulence Measurements, Iowa City, IA, September 16-18, 1985 (with B. K. Sultanian and D. E. Metzger).

“The Nonlinear Stability of Slowly-Varying, Unsteady Circular Couette Flow,” presented at the Thirty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tucson, AZ, November 24-26, 1985. Also presented at the Second Arizona Fluid Mechanics Meeting, Tempe, AZ, April 4-5, 1986 (with J.-C. Chen and D. F. Jankowski).

“Experiments with Deceleration from a Taylor-Vortex Flow,” presented at the Thirty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tucson, AZ, November 24-26, 1985. Also presented at the Second Arizona Fluid Mechanics Meeting, Tempe, AZ, April 4-5, 1986 (with D. F. Jankowski and T. H. Squire).

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“Transient Instabilities in Impulsively-Initiated Couette Flow,” presented at the Thirty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tucson, AZ, November 24-26, 1985. Also presented at the

Second Arizona Fluid Mechanics Meeting, Tempe, AZ, April 4-5, 1986 (with K. R. Kohuth and D. F. Jankowski).

“Computer Simulation of Steady Thermocapillary Convection in a Model Float-Zone,” presented at the Second Arizona Fluid Mechanics Meeting, Tempe, AZ, April 4-5, 1986 (with Y. H. Shen and D. F. Jankowski).

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“Numerical Experiments on Unsteady Circular Couette Flow,” presented at the Thirty-Ninth Meeting of the Division of Fluid Dynamics of the American Physical Society, Columbus, OH, November 23-25, 1986 (with J.-C. Chen and D. F. Jankowski).

“A Penalty-Method Formulation of Energy Stability Theory,” presented at the Thirty-Ninth Meeting of the Division of Fluid Dynamics of the American Physical Society, Columbus, OH, November 23-25, 1986. Also presented at the Third Arizona Fluid Mechanics Meeting, Tucson, AZ, February 20-21, 1987 (with D. F. Jankowski and T. H. Squire).

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“Energy Stability of Thermocapillary Convection in a Model Half-Zone. Finite-Difference Results,” presented at the Forty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, Buffalo, NY, November 20-22, 1988.

“The Appearance of Transient, Non-Axisymmetric Modes in the Instability of Unsteady Taylor-Couette Flow,” presented at the Forty-Second Meeting of the Division of Fluid Dynamics of the American Physical Society, Palo Alto, CA, November 19-21, 1989 (with W. R. Myers).

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“Thermocapillary Convection in a Model Float-Zone,” presented at the Twenty-Eighth AIAA Aerospace Sciences Meeting, Reno, NV, January 8-11, 1990 (with J. R. Hyer and D. F. Jankowski).

“Energy Stability Limits for the Heated Cylinder Problem with Axisymmetric and Non-Axisymmetric Disturbances,” presented at the Sixth Arizona Fluid Mechanics Meeting, Tempe, AZ, February 23-24, 1990 (with C. C. Law and D. F. Jankowski).

“A Large, Sparse and Indefinite Generalized Eigenvalue Problem from Fluid Mechanics,” presented at the Copper Mountain Conference on Iterative Methods, Copper Mountain, CO, April 1-5, 1990 (with H. D. Mittelman, C. C. Law and D. F. Jankowski).

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“Non-Axisymmetric Energy Stability for a Model Half-Zone,” presented at the Forty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Ithaca, NY, November 18-20, 1990. Also presented at the Seventh Arizona Fluid Mechanics Meeting, Tucson, AZ, March 1-2, 1991 (with C. C. Law, D. F. Jankowski and H. D. Mittelman).

“Stability and Instability of Thermocapillary Convection in Models of Float-Zone Crystal Growth,” presented at the IKI/AIAA Microgravity Sciences Symposium, Moscow, USSR, May 10-21, 1991 (with C. C. Law, D. F. Jankowski and H.D. Mittelman).

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“Linear Stability of Thermocapillary Convection in a Model Half-Zone,” presented at the Forty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, Scottsdale, AZ, November 24-26, 1991 (with K.-T. Chang, D. F. Jankowski and H. D. Mittelman).

“Numerical Simulation of Transient, Non-Axisymmetric Instability of Taylor-Couette Flow,” presented at the Forty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, Scottsdale, AZ, November 24-26, 1991 (with L. Little).

“Linear Stability Theory of Thermocapillary Convection in a Model of Float-Zone Crystal Growth,” presented at the Thirtieth AIAA Aerospace Sciences Meeting, Reno, NV, January 6-9, 1992 (with K.-T. Chang, D. F. Jankowski and H. D. Mittelman).

“Thermocapillary Convection Instability in Microgravity Crystal Growth,” invited presentation at the VIIIth European Symposium on Materials and Fluid Sciences in Microgravity,” Brussels, Belgium, April 12-16, 1992 (with D. F. Jankowski, H. D. Mittelman, Y. Shen, C. C. Law and K.-T. Chang).

“Numerical Evaluation of a Vortex-Breakdown Criterion,” presented at the Forty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tallahassee, FL, November 22-24, 1992 (with J. Watson)

“Thermal Instability with Radiation by the Method of Energy,” presented at the Forty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tallahassee, FL, November 22-24, 1992 (with M. J. Bolander and M. K. Smith)

“Experiments on Transient, Non-Axisymmetric Instability of Unsteady Circular Couette Flow,” presented at the Forty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tallahassee, FL, November 22-24, 1992 (with C. S. Kirkconnell)

“Linear Stability of Combined Thermocapillary-Buoyancy Convection in a Horizontal Slot,” presented at the Forty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tallahassee, FL, November 22-24, 1992 (with R. J. Riley)

“Steady, Multicellular Flow of Combined Thermocapillary-Buoyancy Convection in a Shallow Horizontal Slot,” presented at the Forty-Sixth Meeting of the Division of Fluid Dynamics of the American Physical Society, Albuquerque, NM, November 21-23, 1993 (with R. J. Riley)

“Experiments on Multicellular Thermocapillary-Buoyancy Convection,” presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, New Orleans, LA, November 28 - December 3, 1993. In *Surface-Tension-Driven Flows*, G. P. Neitzel and M. K. Smith, eds., AMD-Vol. 170, American Society of Mechanical Engineers, New York (1993), 75-88. (with R. J. Riley).

“Control of Oscillatory Thermocapillary Convection in Microgravity,” presented at the Second Microgravity Fluid Physics Conference, Cleveland, OH, June 21-23, 1994

“Hydrothermal-Wave and Steady, Multicellular Instability of a Thermocapillary-Buoyancy Driven Flow,” presented at the Forty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Atlanta, GA, November 20-22, 1994 (with R. J. Riley)

“The Stability of Thermocapillary Convection in Liquid Bridges with Highly Deformed Interfaces,” presented at the Forty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Atlanta, GA, November 20-22, 1994 (with L. B. S. Sumner, P. Dell’Aversana and J.-P. Fontaine)

“Control of Hydrothermal Wave Instabilities in a Thermocapillary-Driven Flow,” presented at the Forty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Irvine, CA, November 19-21, 1995 (with R. J. Riley)

“Energy-Stability of Thermocapillary Convection in Liquid Bridges with Highly Deformed Interfaces,” presented at the Forty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Irvine, CA, November 19-21, 1995 (with L. B. S. Sumner)

“Control of Oscillatory Thermocapillary Convection,” presented at the Second European Symposium on Fluids in Space, Naples, Italy, April 22-26, 1996 (with R. J. Riley)

“Non-Coalescence Effects in Microgravity,” presented at the Third Microgravity Fluid Physics Conference, Cleveland, OH, June 13-15, 1996

“Improved Active Control of Hydrothermal Wave Instabilities,” presented at the Forty-Ninth Meeting of the Division of Fluid Dynamics of the American Physical Society, Syracuse, NY, November 24-26, 1996 (with S. Benz and P. Hintz)

“Non-Coalescence of Liquid Drops and Suppression of Surface Wetting,” *invited* talk presented at the March Meeting of the American Physical Society, Kansas City, MO, March 17-20, 1997

“Features of Non-Wetting and Non-Coalescing Drops,” *invited* talk presented at the Joint Xth European and Vith Russian Symposium on Physical Sciences in Microgravity (proceedings, pp. 164-171), St. Petersburg, Russia, June 15-21, 1997 (with D. Castagnolo, P. Dell’Aversana and V. Tontodonato)

“Suppression of Oscillatory Thermocapillary Convection in Thin Liquid Layers,” *invited* paper (AIAA-97-2119) presented at the 28th AIAA Fluid Dynamics Conference/4th AIAA Shear Flow Control Conference, Snowmass Village, CO, June 29 - July 2, 1997 (with S. Benz, P. Hintz & R. J. Riley)

“Thermocapillary Convection in Microgravity,” *invited* talk presented at JASMACH-13 Meeting of the Japan Society of Microgravity Application, Fukuoka, Japan, October 30-31, 1997

“Non-Coalescence and Wetting Suppression via Thermocapillarity,” presented at the Fiftieth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Francisco, CA, November 23-25, 1997 (with P. Dell’Aversana, D. Castagnolo & V. Tontodonato)

“Visualization and Measurement of Flow in a Model Rotating-Wall Bioreactor,” presented at the Fiftieth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Francisco, CA, November 23-25, 1997 (with J. B. Brown)

“The Flow in a Model Rotating-Wall Bioreactor,” presented at the Fiftieth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Francisco, CA, November 23-25, 1997 (with M. K. Smith)

“Cell Function and Tissue Growth in Bioreactors: Fluid Mechanical and Chemical Environments,” *invited* talk presented at the First Pan-Pacific Basin

Workshop and Fourth Japan/China Workshop on Microgravity Sciences, Tokyo, Japan, July 8-11, 1998 (with R. M. Nerem *et al.*) Also presented at the 32nd COSPAR Scientific Assembly, Nagoya, Japan, July 12-19, 1998

“Non-Coalescence Effects in Microgravity,” presented at the Fourth Microgravity Fluid Physics Conference, Cleveland, OH, August 12-14, 1998 (with P. Dell’Aversana and D. Castagnolo)

“Effect of Fluid-Mechanical and Chemical Environments on Cell Function and Tissue Growth: Experimental and Modeling Studies,” presented at the American Society of Mechanical Engineers 1998 International Mechanical Engineering Congress and Exposition, Anaheim, CA, November 16-20, 1998 (with R. M. Nerem *et al.*)

“Load and Pressure Effects in Non-Coalescing Systems,” presented at the Fifty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, Philadelphia, PA, November 22-24, 1998 (with P. Dell’Aversana)

“Energy Stability of Thermocapillary Convection in Deformed Half-Zones,” presented at the Fifty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, Philadelphia, PA, November 22-24, 1998 (with L. B. S. Sumner)

“The Interface of Fluid Mechanics and Cell Biology: From Blood Flow to Bioreactors,” invited one-day presentation in the 1998-99 Fluids Lecture Series, National Center for Microgravity Research on Fluids and Combustion, Cleveland, OH, March 4, 1999 (with R. M. Nerem)

“The Fluid Mechanics of Bioreactors,” *invited* talk presented at the ASME 1999 Summer Bioengineering Conference, Big Sky, MT, June 16-20, 1999 (with M. K. Smith, J. B. Brown & A. C. Weber)

“Experiments on the Instability of Thermocapillary Convection—A Brief Review,” *keynote* lecture presented at the Engineering Foundation Conference on Microgravity Fluid Physics and Heat Transfer, Oahu, Hawaii, September 19-24, 1999

“Behavior of Self-Lubricated Liquids Under Normal and Reduced-Pressure Conditions,” presented at the Fifty-Second Meeting of the Division of Fluid Dynamics of the American Physical Society, New Orleans, LA, November 21-23, 1999 (with P. Dell’Aversana)

“PIV Measurements of Bioreactor Flow Fields,” presented at the Fifty-Second Meeting of the Division of Fluid Dynamics of the American Physical Society, New Orleans, LA, November 21-23, 1999 (with J. B. Brown)

“Non-Coalescence in Microgravity—Science and Technology,” presented at the Fifth Microgravity Fluid Physics Conference, Cleveland, OH, August 9-11, 2000 (with P. Dell’Aversana)

“Principles, Limits and Microgravity Applications of Self-Lubricated Liquids,” presented at the First International Symposium on Microgravity Research and Applications in Physical Sciences and Biotechnology (sponsored by the European Space Agency), Sorrento, Italy, September 10-15, 2000 (with P. Dell’Aversana, V. Tontodonato and M. R. Vetrano)

“Characteristic Frequencies, Mode Shapes and Damping Rates of Pinned Droplets,” presented at the Fifty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Washington, DC, November, 19-21, 2000 (with P. Nagy and K. Wines)

“Fluid Mechanics of Spinner-Flask Bioreactors,” presented at the Fifty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Washington, DC, November, 19-21, 2000 (with P. Sucusky)

“Drops Sliding Upon a Solid Surface Without Wetting,” presented at the Fifty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Washington, DC, November, 19-21, 2000 (with P. Dell’Aversana and M. R. Vetrano)

“The Use of Liquid Droplets as Bearings—Technological Challenges,” presented at the first Conference of the International Marangoni Association on Interfacial Fluid Dynamics and Processes in Physico-Chemical Systems, Giessen, Germany, September 12-16, 2001 (with P. Dell’Aversana and M. R. Vetrano)

“Experiments and Simulations of a Spinner-Flask Bioreactor,” presented at the Fifty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Diego, CA, November, 18-20, 2001 (with P. Sucusky and D. Osorio)

“Rupture Modes of Wetting-Suppression Lubricating Films,” presented at the Fifty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Diego, CA, November, 18-20, 2001 (with P. Dell’Aversana and M. R. Vetrano)

“Fluid Dynamics of the Spinner-Flask Bioreactor,” presented at the Third Smith & Nephew International Symposium, Atlanta, GA, October 13-16, 2002 (with P. Sucusky and D. Osorio)

“Fluid Dynamics of Bioreactors for Tissue-Engineered Cartilage,” presented at the Second Joint Meeting of the IEEE Engineering in Medicine and Biology

Society and the Biomedical Engineering Society, Houston, TX, October 22-26, 2002 (with M. K. Smith, P. Sucusky, D. Moreau and J. Pennecot)

“Numerical Simulation of Thermocapillary Wetting Suppression,” presented at the Fifty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Dallas, TX, November 24-26, 2002 (with J.-C. Chen and C.-W. Kuo)

“Lubrication Analysis of the Influence of Thermocapillary Nonwetting on Interface Shape, presented at the Fifty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Dallas, TX, November 24-26, 2002 (with L. B. S. Sumner)

“Elasto-Hydrodynamic Lubrication of Ball Bearings and Drops,” presented at the Fifty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Dallas, TX, November 24-26, 2002 (with P. Dell’Aversana and M. Lappa)

“Determination of Frictional Forces Associated with Isothermal Non-wetting,” presented at the Fifty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, Dallas, TX, November 24-26, 2002 (with M.-I. Carnasciali)

“Microsegregation in As-cast Aluminum Alloys,” presented at the Fifty-Sixth Meeting of the Division of Fluid Dynamics of the American Physical Society, Meadowlands, NJ, November 23-25, 2003 (with T. Zoeller and T. H. Sanders)

“Flow Characterization in a Spinner-Flask Bioreactor,” presented at the Sixth International Conference and Exposition of the Tissue Engineering Society International, Orlando, FL, December 10-13, 2003 (with P. Sucusky and D. Osorio)

“Cartilage Tissue Engineering in a Wavy-Walled Bioreactor,” Regenerate 2004: Tissue Engineering the Human Body, Seattle, WA, June 10-12 2004 (with E. M. Bueno, B. Bilgen, P. Sucusky and G. A. Barabino)

“Recent Results on Permanent Noncoalescence and Nonwetting,” presented at the 21st International Congress of Theoretical and Applied Mechanics, Warsaw, Poland, August 15-21, 2004 (with P. H. Nagy, M.-I. Carnasciali and P. Dell’Aversana)

“Flow Characterization in a Wavy-Walled Bioreactor for Cartilage Tissue Engineering”. Presented at the American Institute of Chemical Engineers (AIChE) Annual Meeting, Austin, TX, November 7-12, 2004 with B. Bilgen, P. Sucusky and G. A. Barabino)

“Characterization of Dynamic, Permanent Wetting,” presented at the Fifty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Seattle, WA, November 19-21, 2004 (with P. Nagy, L. van den Doel and L. van Vliet)

“The Fluid Mechanics of a Wavy-Wall Bioreactor,” presented at the Fifty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Seattle, WA, November 19-21, 2004 (with P. Sucusky, B. Bilgen, A. Aleem and G. Barabino)

“Nonwetting of an Isothermal Liquid Drop above a Moving Solid Surface,” presented at the Fifty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, Seattle, WA, November 19-21, 2004 (with M. K. Smith)

“The Use of Particle Image Velocimetry to Validate Computational Fluid Dynamics Modeling of a Wavy-Walled Bioreactor for Cartilage Tissue Engineering,” presented at the ASME-BED 2005 Summer Bioengineering Conference, Vail, CO, June 22-26, 2005 (with B. Bilgen, P. Sucusky and G. A. Barabino)

“Bioreactor Fluid Dynamics,” *invited* presentation at the 4th AIAA Theoretical Fluid Dynamics Meeting, Toronto, Canada, June 6-9, 2005

“CFD-Based Model of Cartilage Growth in a Spinner-Flask Bioreactor,” presented at the Eighth Tissue Engineering Society International Annual Meeting, Shanghai, China, October 22-25, 2005 (with P. Sucusky, B. Obradovic, and G. Vunjak-Novakovic)

“Simulation of a Deformable Particle Using Lattice-Boltzmann Method,” presented at the Fifty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Chicago, IL, November 20-22, 2005 (with S. Rezak, R. MacMeccan, E. Ding, J. Clausen, J. Wu and C. Aidun)

“Multiscale Modeling in the Numerical Computation of Isothermal Nonwetting,” presented at the Fifty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Chicago, IL, November 20-22, 2005 (with M. K. Smith)

“Frictional Forces Associated With Isothermal Nonwetting,” presented at the Fifty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Chicago, IL, November 20-22, 2005 (with M.-I. Carnasciali)

“Failure Loading on a Thermocapillary Nonwetting Droplet,” presented at the Fifty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Chicago, IL, November 20-22, 2005 (with P. T. Nagy)

“Multiparticle Simulations of Deformable Red Blood Cells using Lattice-Boltzmann Method,” presented at the Fifty-Ninth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tampa, FL, November 19-21, 2006 (with R. MacMeccan, J. Clausen, S. Rezak and C. Aidun)

“Float-Zone Instabilities and Control,” *invited* presentation at the Pan American Advanced Studies Institute on Interfacial Fluid Dynamics: From Theory to Application, Mar del Plata, Argentina, August 6 – 17, 2007.

“Non-coalescence, Non-Wetting and Applications,” *invited* presentation at the Pan American Advanced Studies Institute on Interfacial Fluid Dynamics: From Theory to Application, Mar del Plata, Argentina, August 6 – 17, 2007.

“Direct Numerical Simulations of Whole Blood,” presented at the Sixtieth Meeting of the Division of Fluid Dynamics of the American Physical Society, Salt Lake City, UT, November 18-20, 2007 (with R. MacMeccan, J. Clausen, and C. Aidun)

“Rotational Symmetric Hydraulic Jump in Liquid Metal Flow,” presented at the OpenFOAM International Conference 2007, Old Windsor, UK, November 26-27, 2007 (with T. M. Schmidt, and A. G. Class)

“Numerical Simulation of a Liquid-Metal Circular Hydraulic Jump Using a Level-Set Method,” presented at the Sixty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, San Antonio, TX, November 23-25, 2008 (with T. M. Schmidt and A. G. Class)

“Detection of a Liquid-Metal Surface Using the DLP Technique,” presented at the Sixty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, San Antonio, TX, November 23-25, 2008 (with M. Hillenbrand, R. Stieglitz and A. G. Class)

“Generation of Single, Monodisperse Compound Droplets,” presented at the Sixty-Second Meeting of the Division of Fluid Dynamics of the American Physical Society, Minneapolis, MN, November 22-24, 2009 (with J. Black, P. Bhawe and O. Touré)

“Droplet Impact on Inclined, Planar Surfaces,” presented at the Sixty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Long Beach, CA, November 21-23, 2010 (with P. L. Carroll)

“Generation of Single, Monodisperse Compound Droplets,” presented at the Sixty-Third Meeting of the Division of Fluid Dynamics of the American Physical Society, Long Beach, CA, November 21-23, 2010 (with J. Black)

“Formation of Nanoliter-Scale Compound Droplets of Controlled Volume Ratio,” presented at the 24th European Conference of the Institute of Liquid Atomization and Spray Systems, Estoril, Portugal, September 5-7, 2011 (With J. Black)

“Thermocapillary Levitation of Nanoliter-Volume Single- and Compound-Phase Droplets,” presented at the 6th Conference of the International Marangoni Association, Haifa, Israel, June 18-21, 2012

“Thermocapillary Levitation of Nanoliter-Volume Droplets and Extension to Two-Phase Systems,” presented at the Sixty-Fifth Meeting of the Division of Fluid Dynamics of the American Physical Society, San Diego, CA, November 18-20, 2012 (With J. Black)

“University-Industry Cooperation in Research and Education in the Twenty-First Century,” Invited plenary presentation at the 2014 Global Industry-University Cooperation Forum, Seoul, Korea, October 15, 2014

“Droplet Impact Patterns on Inclined Surfaces with Variable Properties,” presented at the Sixty-Seventh Meeting of the Division of Fluid Dynamics of the American Physical Society, San Francisco, CA, November 23-25, 2014 (With M. Lockard & M. K. Smith)

“Droplet Impact on Inclined Surfaces for Forensic Bloodstain Analysis,” presented at the Sixty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Boston, MA, November 22-24, 2015 (With M. Lockard & M. K. Smith)

“Compound Droplet Levitation for Lab-on-a-Chip,” presented at the Sixty-Ninth Meeting of the Division of Fluid Dynamics of the American Physical Society, Portland, OR, November 20-22, 2016 (With J. Black)

*Invited
Seminars*

Northwestern University, Apr. 7, 1980; Oct. 28, 1982, May 23, 1988, October 28, 2009
Columbia University, April 9, 1980
University of Colorado, September 23, 1980; October 5, 1987
NASA Marshall Space Flight Center, December 5, 1980
The Johns Hopkins University, July 24, 1981; July 27, 1984, June 4, 1987, October 28, 2004
University of California, Los Angeles, January 28, 1982; November 17, 2009
University of Arizona, May 19, 1982
Kernforschungszentrum, Karlsruhe, April 8, 1983; November 15, 1985
University of California, Berkeley, April 21, 1983; November 2, 2012
Stanford University, April 22, 1983, March 6, 1992
Monsanto Electronic Materials Co., April 24, 1984

University of Southern California, October 3, 1984
Universität Karlsruhe, January 19, 1986; March 16, 1986
Universität des Saarlandes, February 16, 1986
DFVLR, Göttingen, March 5, 1986
Universität Giessen, March 11, 1986; July 11, 1994, September 15, 1997
Glasgow University, May 6, 1986
University of Cambridge, May 16, 1986
Imperial College, June 6, 1986; March 29, 1999
National Central University (Taiwan), June 25, 1987; March 20, 2006
Southwestern Jiaotong University (Emei, PRC) July 8-10, 1987
Rockwell International Science Center, September 21, 1987
Cornell University, April 8, 1988, October 6, 1998
Battelle-Columbus Laboratories, April 12, 1988
University of Western Ontario, November 16, 1990
Brown University, March 19, 1991
Yale University, March 20, 1991
Tuskegee University, October 16, 1991
University of Alabama in Huntsville, October 29, 1991, October 16, 1997
MARS Center, Naples (Italy), October 9, 1992, June 16, 1995
University of Florida, January 25, 1993, January 30, 1998
Massachusetts Institute of Technology, March 7, 1994, January 24, 2003,
September 30, 2009
Clarkson University, March 21, 1994
Université d'Aix-Marseille II, July 8, 1994, September 6 & 7, 1995
University of Kentucky, October 7, 1994
University of Virginia, April 13, 1995, May 3, 2007
The Pennsylvania State University, February 2, 1996
Emory University, September 13, 1996
Moscow State University (Russia), November 21, 1996
University of North Carolina at Charlotte, October 14, 1997
Université Libre de Bruxelles, September 15, 1998
Arizona State University, February 5, 1999
University of Illinois at Urbana/Champaign, April 5, 1999
Vanderbilt University, February 25, 2000
Morehouse University School of Medicine, June 8, 2000
University of California at Davis, January 10, 2001
Rutgers University, January 30, 2002
Università degli Studi di Napoli Federico II (Italy), June 11, 2002
The Ohio State University, April 1, 2005
Japan Space Agency, March 22, 2006
Osaka University, March 23, 2006
Forschungszentrum Karlsruhe, July 14, 2006, October 31, 2008
Georgia Tech Lorraine, August 31, 2006
KTH Royal Institute of Technology (Sweden), September, 21, 2006
ETH Zürich, October 18, 2006
Technische Universität Wien, December 11, 2006

City College New York, April 28, 2009
 University of Texas, Austin, September 9, 2009
 Morehouse College, September 24, 2009
 University of Maryland, December 1, 2009
 University of Notre Dame, April 23, 2010
 University of Michigan, September 30, 2010
 University of Pennsylvania, October 13, 2010
 University of California, San Diego, November 1, 2010
 Tufts University, September 19, 2011
 Koç University, September 26, 2011
 Sabanci University, September 28, 2011
 Boğazici University, September 29, 2011
 Middle East Technical University, October 4, 2011
 University of Southern California, November 3, 2011
 University of Pittsburgh, March 22, 2012
 Korea Advanced Institute of Science and Technology, October 19, 2012
 Tsinghua University, March 22, 2016
 Shanghai Jiaotong University, March 24, 2016
 Hanyang University, April 20, 2016
 Seoul National University, March 19, 2018

*Courses
Taught*

at Georgia Institute of Technology:

ME 6601 Introduction to Fluid Mechanics
 ME 6602 Viscous Flow
 ME 7340 Hydrodynamic Stability
 ME 7027 Perturbation Methods in Mechanics
 ME 7757 Teaching Practicum
 ME 3340 Fluid Mechanics
 ME 3322 Thermodynamics
 ME 3347 Fluid Flow and Convection
 ME 2016 Computing Techniques

at Arizona State University:

MAE 571 Fluid Mechanics
 MAE 572 Inviscid Fluid Flow
 MAE 573 Viscous Fluid Flow
 MAE 505 Perturbation Methods in Mechanics
 MAE 591 Hydrodynamic Stability
 ASE 582 Linear Algebra in Engineering
 MAE 471 Computational Fluid Mechanics
 MAE 371 Fluid Mechanics
 MAE 372 Fluid Mechanics
 ECE 386 Partial Differential Equations for Engineers

ECE 312 Engineering Mechanics II - Dynamics

*Student
Supervision**Ph.D. Students:*

B.K. Sultanian (December 1984)
J.-C. Chen (September, 1986)
Y. Shen (February, 1989)
R. J. Riley (December, 1995)
L. B. S. Sumner (July, 1998)
P. Sucosky (May, 2005)
T. Durbin (May, 2005 – co-advisor, Prof. T. Sanders)
P. Nagy (December, 2006)
R. N. MacMeccan (December, 2007 – co-advisor, Prof. C. Aidun)
M.-I. Carnasciali (May, 2008)
J. P. Watson (re-started August, 2002; left program in 2006)
J. Black (December, 2015)
J. Fisher (began September, 2010; switched advisors in 2013)
G. Chambers (began January, 2018; left program in 2022)

M.S. Students:

J.-C. Chen (April 1982)
D. M. Mathis (April 1984)
K. R. Kohuth (December 1986)
J. R. Hyer (December, 1989)
W. R. Myers (May, 1990)
K.-T. Chang (October, 1991)
L. Little (November, 1991)
K. S. Kirkconnell (March, 1992)
M. J. Bolander (August, 1992)
J. P. Watson (August, 1992)
J. C. Nalevanko (May, 1997)
J. B. Brown (March, 1998)
A. C. Weber (May, 2000)
M. J. Casiano (August, 2000)
A. M. Wood (November, 2000)
K. Wines (M.S. project, December, 2000)
P. Serrat (May, 2001)
D. Osorio (August, 2001)
O. Langeard (August, 2002)
D. Moreau (September, 2002)
G. Jouan (June, 2003)
P. Bhave (May, 2008)

M. Hölle (August, 2009)
M. Lockard (August, 2015)

Undergraduate projects - advisor for several senior projects and group design projects

Appendix D

Appearances/Depositions/Reports by G. Paul Neitzel

Case	Type	Employer	Expert Report Date	Deposition Date	Trial Testimony Date
State of GA v. B. Slakman	Homicide	Fulton Co. DA through Darryl Cohen, Esq., attorney for family of deceased	October, 1993	N/A	April 20, 1994
Charles and Diane Dixon v. Hormel Foods Corporation	Personal Injury	Smith, Gambrell & Russell, attorneys for Hormel Foods Corp.	November, 1995	N/A	October 31, 1996
Porex Technologies Corp. & Porex Scientific, Inc. v. Labcon, North America	Patent Infringement	Lane, Aitken & McCann, attorneys for Porex	April, 1997	N/A	N/A - case settled
CFMT, Inc. et al. v. Steag MicroTech, Inc. et al.	Patent Infringement	Brooks, Haidt, Haffner & Delahunty and Connolly, Bove, Lodge & Hutz, attorneys for Steag Microtech, Inc.	September, 1996	December 17, 1996	December 10, 1997
Pfizer case (not filed)	Hinted patent infringement	Connolly, Bove, Lodge & Hutz, attorneys for Pfizer	March, 2000	N/A	Inactive
Iracheta v. General Motors	Product liability	Hartline, Dacus, Dreyer & Kern, attorneys for GM	none	September 7, 2000	N/A, did not testify at trial
State of GA v. B. Slakman (Retrial)	Homicide	Fulton Co., GA District Attorney	N/A	N/A	November 13, 2001
Arcure/Murphy v. General	Product liability	Lavine, Coleman, O'Neil, Ricci, Finarelli	October 3, 2002	N/A	N/A - case settled

Case	Type	Employer	Expert Report Date	Deposition Date	Trial Testimony Date
Motors		& Gray, attorneys for GM			
Lance Jones v. General Motors	Product liability	Hartline, Dacus, Barger, Dreyer & Kern, attorneys for GM	N/A	N/A	N/A
Mainord v. General Motors	Product liability	Hartline, Dacus, Barger, Dreyer & Kern, attorneys for GM	N/A	February 23, 2004	N/A, did not testify at trial
American Biophysics Corp v. Blue Rhino Corp.	Patent Infringement	Pillsbury Winthrop Shaw Pittman, attorneys for ABC	February 3, 2004 February 17, 2004 March 1, 2004 May 17, 2004	March 15-16, 2004 May 24, 2004	May 26-28, 2004
Humberto Chavez v. R & L Builders, LLC <i>et al.</i>	Personal Injury	Lewin & Schneider, attorneys for R & L Builders	October 29, 2004 March 8, 2005	N/A	N/A - case settled
Bayer Healthcare v. Abbott Laboratories	Patent Infringement	Munger, Tolles & Olson, attorneys for Abbott	July 14, 2004 January 24, 2005	September 10, 2004 January 27, 2005	N/A – case settled
Reinauer Transportation Companies v. Atlantic Marine, Inc.	Arbitration	Timothy McHugh, Esq., attorney for Reinauer Transportation Companies	August 27, 2004 October 25, 2004	September 24, 2004	October 27, 2004 November 3, 2004
Zaczyk v. Daewoo Motors, Ltd., General Motors, GMDAT <i>et al.</i>	Product Liability	DLA Piper Rudnick Gray Cary, attorneys for Daewoo Motor Co.	January, 2006 March, 2006	N/A	N/A – case settled
Weiss v. U-Haul of Texas	Product Liability	Dorsey & Whitney, LLP, attorneys for U-Haul of Texas	January, 2007	June 23, 2008	N/A – case settled

Case	Type	Employer	Expert Report Date	Deposition Date	Trial Testimony Date
Woodstream Corp. v. Kaz, Inc.	Patent Infringement	Jacobson Holman LLC, attorneys for Woodstream	N/A – case settled		
Zendejas v. ConocoPhillips <i>et al.</i>	Personal Injury	Hartline, Dacus, Barger, Dreyer & Kern, LLP, attorneys for ConocoPhillips	N/A – case settled		
Hutto v. Lester & Southland Logging	Personal Injury	Power, Cooper & Jaugstetter, attorneys for Debra Sue Hutto	August, 2009 (draft only)		N/A – case settled
Euro-Pro v. Euroflex	Patent Infringement	Venable LLP, attorneys for Euro-Pro	N/A – case settled		
Zendejas v. Shell	Personal Injury	Haynes and Boone, LLP, attorneys for Shell	N/A	October 12, 2009	November 13, 2009
Plantation Pipeline v. AEGIS	Pipeline Leak Insurance Mediation	Fellows Labriola, attorneys for Plantation Pipeline	March 31, 2011	June 1, 2011	February 29, 2012 (Mediation)
Kinder Morgan v. AEGIS	Pipeline Leak Insurance Action	Martin, Disiere, Jefferson & Wisdom, attorneys for Kinder Morgan	May 27, 2012	August 7, 2012	N/A – case settled
AFA Polytek v. Guala	Patent Infringement	Thomas Horstemeyer, attorneys for Guala	N/A – case settled		
Parse v. Brunswick Cellulose and Gerald Baker	Personal Injury	Hall Booth & Smith, attorneys for Brunswick Cellulose and Gerald Baker	N/A	January 5, 2017	N/A – case settled
Ignite USA v. Pacific Market Intl & Aladdin	Patent Infringement	Meunier, Carlin & Curfman, attorneys for Ignite	July 10, 2019	July 31, 2019	N/A – case settled
Confidential	Aircraft incident	RTI Group LLC, consultants	2021-22	N/A	N/A – acting as non-testifying experts

Case	Type	Employer	Expert Report Date	Deposition Date	Trial Testimony Date
HuxWrx v. SilencerCo	Patent Infringement	Nelson Bumgardner Conroy, attorneys for HuxWrx	April 29, 2025	N/A current	N/A current