

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

SECOND 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 (“SilencerCo”).

2. I previously filed a Declaration in this IPR, signed on April 28, 2025, in which I provided my opinions on the following:

- 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. For this Declaration, I have been asked to consider and provide opinions on the following topics:

- Whether Proposed Substitute Claim 43 enlarges the scope of original independent claim 22;

- Whether the application for the '750 Patent provides written description support for a radially serpentine fluid pathway; and
- Whether the Proposed Substitute Claims would be found to be anticipated and/or obvious over the grounds asserted in SilencerCo's Opposition to Patent Owner's Motion to Amend.

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

5. 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 U.S. Pat. No. 1,000,702 to Thurler
- Ex. 1016 U.S. Pat. No. 748,157 to Bouton
- Exs. 1017 and 1018 FR 493462 to Barlowatz (and its translation)
- Ex. 1019 U.S. Pat. No. 582,485 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")

- Patent Owner's Response (Paper 17)
- Patent Owner's Motion to Amend Under 37 C.F.R. § 42.121 (Paper 18)
- Petitioner's Reply to Patent Owner's Response (Paper 20)
- Petitioner's Opposition to Patent Owner's Motion to Amend (Paper 21)
- Patent Trial and Appeal Board's Preliminary Guidance on Patent Owner's Motion to Amend (Paper 22)
- Ex. 1037 Second Declaration of John Nixon
- Ex. 1038 U.S. Pat. No. 3,667,570 to WerBell
- Ex. 1039 U.S. Pat. No. 1,017,003 to Kenney
- Deposition Transcript of John Nixon (4/22/2025)
- Any other documents mentioned in this declaration

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.

II. PROFESSIONAL BACKGROUND

8. My professional background and qualifications relevant to this IPR and Declaration are summarized in Section II of my first Declaration, and my CV is

attached thereto as Appendix C. I incorporate that discussion herein by reference. My CV is re-attached hereto as Appendix A.

III. LEGAL STANDARDS

9. I am not an attorney. I have been advised of the following general principles of patent law to be considered in formulating my opinions.

A. Anticipation

10. 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

11. 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.

12. 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.

13. 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

14. 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.

15. 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.

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

D. Written Description

17. 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 its limitations using such descriptive means as words, structures, figures, diagrams, formulas, etc.

E. Enlarged Claim Scope

18. I understand that a Motion to Amend filed in IPR cannot enlarge claim scope. I further understand that a claim is broader in scope than an original claim if it contains within its scope any conceivable apparatus or process which would not have infringed the original patent.

IV. Proposed Substitute Claim 43 Does Not Enlarge the Scope of the Claims.

19. I have been asked to analyze whether Proposed Substitute Claim 43 enlarges the scope of the claims. Specifically, I understand that, in its Preliminary Guidance, the Board stated that “in proposed substitute independent claim 43, which corresponds to original independent claim 22, Patent Owner proposes to delete ‘high energy device’ and replace it with ‘weapon,’” and that “[t]his proposed amendment improperly broadens the claim scope, as Patent Owner has not shown that all weapons are high energy devices.” Preliminary Guidance at 5. I have been asked to examine the Board’s Preliminary Guidance on this point and provide my opinion on the issue.

20. In my opinion, Proposed Substitute Claim 43 does not enlarge the scope of the claims because there is no conceivable apparatus or process which would

infringe Proposed Substitute Claim 43 but would not infringe original independent claim 22.

21. In my view, a person of ordinary skill in the art would understand, from both the claims and the specification history, that a “weapon” in the context of Proposed Substitute Claim 43 must be a high-energy weapon.

22. Proposed Substitute Claim 43 states as follows:

A method for energy capture and control from a 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 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 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.

23. Notably, Proposed Substitute Claim 43 recites a method that requires, among other things, “discharging a high energy material comprising a projectile and gases from the weapon.” If the weapon discharges “a high energy material,” it must be a high-energy weapon. No person of ordinary skill in the art would understand that a weapon that can discharge a “high energy material” would be anything other than a “high energy weapon.”

24. The specification reinforces this understanding. The entire specification describes an “energy capture and control device” that receives “a high energy material” and “dissipates energy transferred from the high energy material.” Ex. 1001 at Abstract; *see also id.* at 4:10-10:10. It describes the “energy capture and control device” specifically in the context of firearms. For example, the Background section describes the current state of the art of firearm suppression and the problems remaining to be solved. *Id.* at 1:13-52; *see also id.* at 3:65-4:9. And the description of the “energy capture and control device” repeatedly discusses its use with firearms. I have provided several examples below:

- 5:37-49: “In one aspect, the engagement surface can include a male component and a female component. For example, the engagement surface may comprise a coupling device which is threaded to enable threaded coupling of the shell **110** to the high energy discharge device. The threaded coupler can include a male component or a female component. In another more specific example, the threaded coupler can have helical threads rotating in an opposite direction as rifling in the high energy discharge device. Having the coupler threads rotate in an opposite direction as the rifling will result in torque on the energy control device **100** from the spin of the bullet which tightens the

threaded coupling of the energy control device to the high energy discharge device.”

- 5:55-57: “The ends of the energy control device can include an engagement or coupling mechanism to secure the modules to one another and/or to a firearm when desired.”
- 8:35-52: “As illustrated in FIGS. **10b-13**, the helical walls can have varying winding ratios (i.e. windings:diameter). This winding ratio can be varied to optimize performance of the device for particular applications based on a number of variables (e.g. caliber, back pressure, etc.). The helical walls can be optionally replaceable so as to provide an adjustable tuning or to be repaired. The winding ratio can also be changed in order to control and/or adjust the energy transfer velocity and subsequent back pressure returned to the high energy outlet. 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 the combinations of these issues. These drawbacks can be largely

eliminated or substantially reduced using the configurations described here.”

- 5:53-67: “Generally, a higher rate of twist provides a greater path length for fluids along the fluid pathway to the chamber outlet. Although other ratios can be suitable, in one aspect, the helical wall has a winding ration of about 3:1 to about 8:1. In one aspect, the device can include five multiple concentric tubes forming the annular spaces although other numbers of concentric tubes can be suitable. For example, pistol suppressors can sometimes utilize fewer chambers while high caliber rifles can utilize more chambers to achieve desirable sound suppression. Thus, each different diameter tube may have a different winding ratio if the number of windings is inconsistent within each tube. Alternately, each tube can be configured to have a substantially similar winding ratio by changing the number of windings in a specific tube according to a diameter of the tube.”
- 9:16-18: “Coupling mechanisms **535** and **540** can also optionally be used to secure the device to a muzzle adapter or other modular device.”
- 9:21-24: “In another optional aspect, a particulate modular attachment can be used to capture particulates from the high energy material as it

exits the chamber. This can be particularly useful in firearm applications where the high energy material is a bullet.”

- 9:45-49: “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.).”
- 10:22-25: “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 configurations.”

It is notable that the specification never describes use of an energy capture and control device with a weapon that is not a high-energy weapon.

25. Because a person of ordinary skill in the art would understand that a “weapon” in the context of Proposed Substitute Claim 43 must be a high-energy weapon, it is my opinion that Proposed Substitute Claim 43 is in fact narrower than original claim 22. Specifically, “weapon” is a narrower term than “high-energy device”—high-energy weapons are a subset of high-energy devices. Accordingly, every process that is covered by Proposed Substitute Claim 43 is also covered by original independent claim 22.

V. The Proposed Substitute Claims Do Not Introduce New Subject Matter.

26. I understand that a motion to amend may not introduce subject matter and that, when filing a motion to amend, a Patent Owner must identify the written description support for each proposed substitute claim.

27. In my first declaration, I provided my opinion on whether the Proposed Substitute Claims found written description support in U.S. Patent Application No. 13/025,989 (“the ’989 Application”) and identified where, in my view, each Proposed Substitute Claim was supported by the ’989 Application.

28. I understand that, in its Preliminary Guidance, the Board indicated that the MTA introduces new subject matter because Patent Owner has not “provided written description support for a radially serpentine fluid pathway.” The Board preliminarily construed “radially serpentine” as “a back and forth flow around a radius of the off axis chamber,” which, as I noted in my first declaration, is consistent with the specification of the ’750 Patent and the prosecution history.

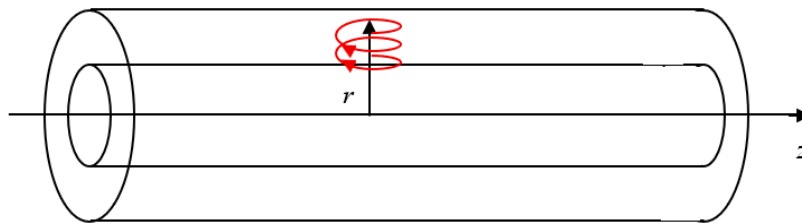
29. In its Preliminary Guidance, the Board indicated its belief that Patent Owner has not identified written description support for a radially serpentine flow path because in the MTA, Patent Owner “identifies a back and forth flow path around a longitudinal axis of the off axis chamber; that is, a circumferentially serpentine pathway.” Paper 22 at 6. The Board appears to be referring to Patent Owner’s discussion of Figure 14 of the ’750 Patent, which the Board described in its

Institution Decision as showing fluid that “flows *circumferentially* about the central chamber, not radially.” Paper 7 at 14.

30. I disagree with the Board’s preliminary conclusion. As an initial matter, I note that Petitioner and its expert, who appears to be a POSITA, have not contended that the term “radially serpentine” lacks written description support. This by itself indicates that the term “radially serpentine” has written description support. In addition, I note that the Proposed Substitute Claims do not introduce the term “radially serpentine.” “Radially serpentine” also appears in the original claims.

31. Second, I note that the construction of “radially serpentine” that the parties and I agree with—“a back and forth flow around a radius of the off axis chamber”—appears nearly verbatim in the specification. Specifically, the application for the ’750 Patent states: “In another aspect, 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.” Ex. 1004 at 7:20-22. In my first declaration, I identified this portion of the application when explaining why the term “radially serpentine” has written description support. Ex. 2001, ¶ 174. In my view, this portion of the specification alone conveys to a POSITA that applicant possessed the claimed invention—i.e., a device with a radially serpentine flow path.

32. Finally, the Board appears to have an incorrect understanding of “radially serpentine.” What the Board calls a “circumferentially serpentine pathway” as shown in Figure 14 is in fact a “radially serpentine” pathway. Based on the Institution Decision and Preliminary Guidance, it appears that the Board interprets “radially serpentine” to mean only a flow path that circles a radius drawn from the central chamber to a point in the outer shell and changes direction at least one. This concept is shown in the image below, although this example does not change directions and thus would not be radially serpentine.



In other words, the Board appears to interpret the word “around” as requiring rotation encircling a radius.

33. The Board’s understanding is inconsistent with the specification, which discloses *two* embodiments of “radially serpentine.” As the Board notes, the ’750 Patent first discloses that a “radially serpentine” pathway can be one “which causes the fluids to flow back and forth around a radius of the off axis chamber.” Ex. 1004 at 7:20-22. In the second embodiment, the ’750 patent states: “*In another aspect, 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*

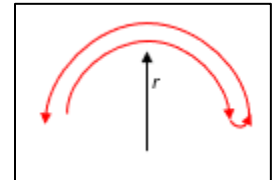
of the off axis chamber.” Ex. 1004 at 7:22-24 (emphasis added). If a “radially serpentine” pathway were one that required rotation encircling a radius as Petitioner asserts, then the fluid would never “travers[e] a length of the off axis chamber.”

34. These two embodiments can be harmonized by recognizing that Figure 14, which discloses a flow path that the Board refers to as a “circumferential” flow path, is in fact a “radially serpentine” flow path. Indeed, SilencerCo’s expert also understood that the flow path of Figure 14 is “radially serpentine.” Ex. 1013, ¶ 127; *see also* Paper 18 at 12-13. The prosecution history makes clear that Figure 14 discloses a “radially serpentine” flow path. When the applicant added the term “radially serpentine” to the independent claims, it made clear that “[s]upport for radially serpentine flow can be found at page 7, lines 21-24 *and FIG. 14.*” Ex. 1004 at 093. The applicant also explained that “axially serpentine flow is different from radially serpentine flow in which fluid would flow back and forth from clockwise to counter-clockwise *as described in page 7, lines 20-22 and shown in figure 14 (see units 500, 505 and 510.)*” *Id.* (emphasis added). This statement in the prosecution history makes clear what the applicant intended “radially serpentine” to mean and resolved any ambiguity (to the extent there was one in the first place).

35. Mr. Nixon argues that this view of “radially serpentine” “disregards the patent’s plain language by suggesting that ‘radially serpentine’ requires fluid to flow *across* rather than *around*, a radius” (Ex. 1037, ¶ 48), and the Board’s view appears

consistent with this argument. In other words, Mr. Nixon argues, and the Board appears to agree, that “around” requires rotation about the radius. But the plain meaning of “around” does not require rotation. For example, Merriam-Webster online provides several definitions of “around,” including “in, along, or through a circuit,” “here and there: from one place to another,” “in rotation or succession,” and “in or to an opposite direction or position.” Ex. 2004.

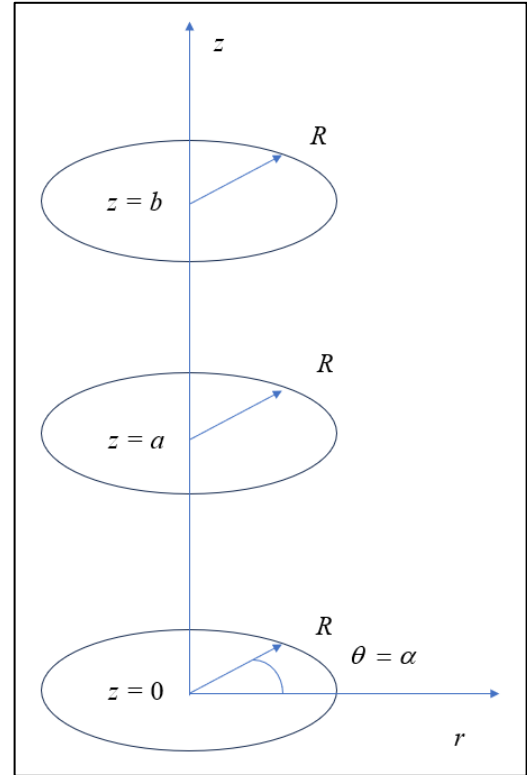
36. Even if “around” implies rotation, the view of Petitioner and the Board regarding what constitutes rotation is unduly narrow. A flow that moves back and forth over the top



of a radius does indeed rotate around the radius, as shown in the image to the right. This is exactly what is described in Figure 14.

37. Mr. Nixon also argues that my understanding of “radially serpentine” “would require reference to multiple radii at different locations.” Ex. 1037, ¶ 48. Mr. Nixon, however, ignores principles of cylindrical geometry. The devices of interest

are all cylindrical in nature, so a cylindrical coordinate system is best used to describe them. See, e.g., Ex. 1001, 4:63-64 (“tubes”); 9:1-11 (“incomplete cylinders”); Figs. 1a, 2, 14. In cylindrical coordinates, a point in three-dimensional space is described by three independent coordinates, indicated as a radius r , an axial position z , and an azimuthal angle θ , measured from a fixed reference line. When one specifies a *fixed radius*, this may be interpreted

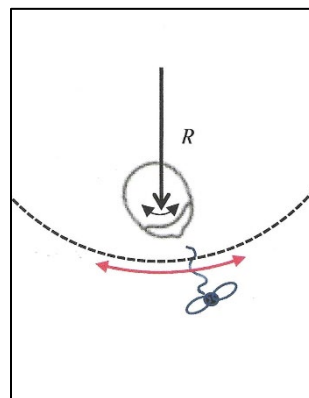


as a radius of a given length R at a specific azimuthal angle a , as indicated in the figure above. Thus, the three radial lines of length R indicated in the figure at $z = 0$, $z = a$ and $z = b$ constitute the *same radius*, not three different radii, as asserted by the Petitioner and Mr. Nixon. Motion *around* this radius R may therefore be interpreted as moving in either a clockwise (for increasing θ , if viewed from in the direction of increasing z), or counter-clockwise (for decreasing θ , when viewed along the z -axis). Indeed, this may *also* be interpreted, as the Board has noted, as motion around the symmetry axis, which may be identified as being located at $r = 0$. The fact that the radius is fixed also permits motion along the axis of symmetry without any additional specification necessary. In other words, a radius of a given length at a

constant angle in a cylindrical coordinate system is the same, regardless of where it begins on the axis that extends the length of the cylinder.

38. Thus, Mr. Nixon's argument that my understanding of "radially serpentine" requires reference to multiple radii is incorrect—any specific radius extends all along the z-axis (i.e., the entire length of the device).

39. An example is useful. Imagine a top view of a man seated behind a cylindrical window screen whose head is located a distance R from a symmetry axis, as illustrated in the sketch at right. Female mosquitos are attracted by plumes of carbon dioxide present in the exhaled breath of mammals.



As the man turns his head from side to side while exhaling, his breath is allowed to pass through the screen, which the mosquito attracted to but is too large to pass through. Following the CO_2 plume, the mosquito will traverse a clockwise to counter-clockwise path indicated by the red line, i.e., traveling *around* the fixed radius R . The mosquito's path exhibits what is meant by radially serpentine. If the man now stands from his seated position while keeping his head at the same radial location R , the mosquito will also track his expiration upward, i.e., along the axis of symmetry of the system (pointing out of the figure), as well as around R . This example thus illustrates both examples of radially serpentine as described in the '750 patent

40. In sum, in my opinion, one embodiment of a “radially serpentine” fluid path encompasses a back and forth flow path around a longitudinal axis of the off axis chamber, as shown in Figure 14. Thus, Figure 14 and the accompanying description provide written description support for a “radially serpentine” fluid path, and the MTA does not introduce new matter.

VI. Mr. Nixon Has Not Shown that the Proposed Substitute Claims Are Unpatentable.

41. I have been asked to provide my opinion on whether the Proposed Substitute Claims are patentable over the grounds asserted by SilencerCo in its Opposition to Petitioner’s Motion to Amend and Mr. Nixon’s second declaration.

42. I understand that SilencerCo and Mr. Nixon assert the following grounds of invalidity against the Proposed Substitute Claims:

- Ground 1: Proposed Substitute Claims 23, 26, 27-30, 32, 33, 37-39, 40, and 43 are rendered obvious by Thurler in view of Kenney and WerBell
- Ground 2: Proposed Amended Claims 34-36, 41, and 42 are rendered obvious by Thurler in view of Kenney, WerBell, and Barlowatz
- Ground 3: Proposed Amended Claim 24 is rendered obvious by Thurler in view of Kenney, WerBell, Barlowatz, and Reeves
- Ground 4: Proposed Amended Claims 25 and 31 are rendered obvious by Thurler in view of Kenney, WerBell, Barlowatz, and Eichenseher

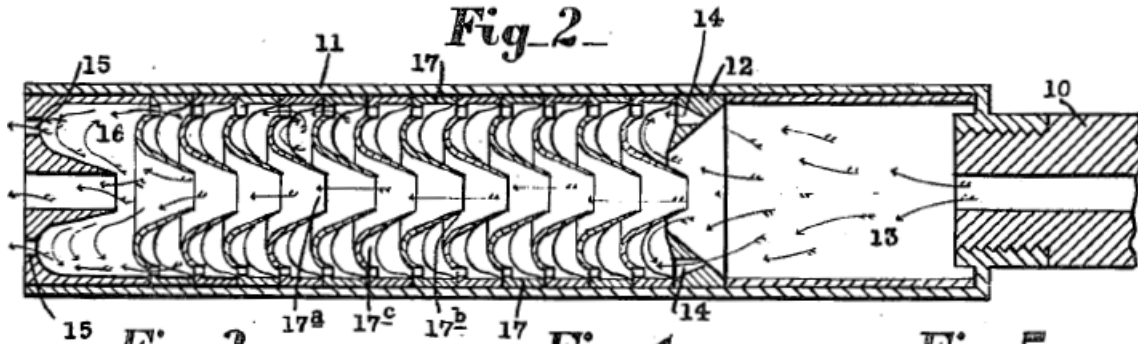
A. Summary of New Prior Art

43. In my first declaration, I provided a summary of Thurler. Ground 1 introduces two new prior art references, Kenney and WerBell, which I describe below.

1. Kenney (U.S. Patent No. 1,017,003)

44. Kenney describes a device that is intended to “provide simple yet effective means for modifying, and practically silencing, the report following discharge of a fire arm; having particularly in view the production of a symmetrical and reasonably cheap device that may be readily applied to the various types of arms now in common use, and which is specially adapted for use with automatic, and other rapid fire arms.” Ex. 1039, 1:9-18. According to Kenney, “one of the important features of [the] invention consists of means for so controlling and directing the exhaust and gases that a jacket of said gases, substantially concentric with the axial center of the path of the bullet, is provided around said path, thus preventing, or rather retarding, the rapid destruction of the vacuum in the atmosphere incident to discharge of the arm,” and that the invention provides “effective means for expanding the gases, as they pass from the muzzle proper of the arm, and for separating said gases into a plurality of sections, as well as for subsequently reuniting the said gases and for discharging them, or a considerable volume of them, in the form of a concentric jacket.” *Id.* at 1:19-36.

45. One embodiment of Kenney's device is shown in Figure 2, reproduced below.



46. “[N]umeral 10 indicates the barrel of the fire arm,” and “[s]ecured to the muzzle end of said barrel . . . is a forwardly extending, cylindrical, housing 11 in which fixedly secured a centrally perforated, substantial, ring 12 which is located a considerable distance from the muzzle of barrel 10 and thus provides a chamber 13 in which the gases may expand to a considerable extent, and become equalized as to pressure, before they pass on to the separating chambers.” *Id.* at 1:61-75.

47. The device has “a plurality of disks that are peculiarly cupped, and otherwise shaped, in order that they may first shear off and separate portions of the gases and direct the same radially from the bore, and then direct the said gases forwardly and discharge them into the free atmosphere through openings 15, in the muzzle end of the silencer.” *Id.* at 1:91-100. The disks “are formed as cups 17 whose central portion is perforated, as at 17^a, to allow the passage of a bullet; the circumferential wall defining said central opening being drawn up, or otherwise produced, to provide a rearwardly projecting annular knife edge 17^b by means of

which the gases that attempt to follow the course of the bullet, are mainly directed radially into the spaces between the confronting faces of the stack of shearing disks.” *Id.* at 1:109-2:7. The disks have “circumferential cut-away portions 17^d,” which are “provided to release the gases” from the annular spaces between disks and “direct said gases toward the muzzle end of the silencer in the form of a jacket, or cylindrical wall, of gas surrounding the path of the bullet.” *Id.* at 2:9-19.

48. Kenney discloses that its device causes the gases to be “gradually checked and expanded and are well spent and dissipated by the time they escape from the silencer.” *Id.* at 2:2:26-30. In addition, “the ring of gases thus released around the path of the bullet and around the gases following said bullet still have force enough to operate as a shield which checks and cushions the effort of the atmosphere as the latter seeks to close the vacuum resulting from the discharge of the arm.” *Id.* at 2:31-38.

49. Importantly, Kenney makes clear that “the gases are at no time blocked or trapped within the housing but are traveling constantly toward the discharge openings in the muzzle end of the silencer,” and that “[b]y thus providing for a constant forward movement and discharge of the gases, [the device is] able to produce a silencer that may be utilized safely with automatic, and other rapid fire arms.” *Id.* at 2:39-52.

2. WerBell (U.S. Patent No. 3,667,570)

50. WerBell discloses “[s]ilencers for use in conjunction with firearms and as mufflers for internal combustion engines and the like [that] are provided with entry, suppression and resonant chambers arranged coaxially within a tubular housing.” Ex. 1038 at Abstract. “A silencer constructed according to one embodiment of this invention may comprise a plurality of helical suppressor elements disposed about an axial passageway together with a plurality of radially disposed ports arranged to establish communication from the passageway to the suppressor elements so that out-of-phase vibrations are supplied from the axial passageway to the suppressor units in such manner as substantially to neutralize each other.” *Id.* at 1:12-19. Specifically, the “helical suppressor elements” are reversely wound so that “the opposed vibrations tend to neutralize each other.” *Id.* at 3:42-44.

B. The Proposed Substitute Claims Are Not Unpatentable Under Ground 1.

1. Independent Proposed Substitute Claims 23, 40, and 43

51. In my opinion, Mr. Nixon has failed to show that the independent Proposed Substitute Claims (and thus all Proposed Substitute Claims) are unpatentable for two reasons.

52. First, Mr. Nixon has not shown that a POSITA would combine Thurler, Kenney, and Werbell to achieve the limitation requiring “a central chamber oriented along a central axis within an outer shell oriented along the central axis,” which is present in all Proposed Substitute Claims.

53. With respect to this claim limitation, Mr. Nixon contends that a POSITA “would have been motivated to modify Thurler’s eccentric outer shell to be oriented along the central axis, i.e., in a concentric orientation” because “Kenney explains that a centered housing for a suppressor is desirable so that the exhaust forms ‘a jacket of gases, substantially concentric with the axial center of the path of the bullet’ to retard vacuum collapse after the shot,” and “thus teaches that concentricity is linked directly to predictable, symmetric gas expansion.” Ex. 1037, ¶ 107.¹ I note, however, that Mr. Nixon has not explained why the issue of vacuum collapse matters for a silencer, or, more importantly, why a POSITA would have been motivated to modify Thurler in view of Kenney to solve the unexplained vacuum collapse problem. Indeed, Mr. Nixon has not addressed at all whether the Thurler design suffers from vacuum collapse issues such that there would even be a reason to modify it to achieve “symmetric gas expansion.”

54. Mr. Nixon also has not explained *how* a POSITA would modify Thurler in view of Kenney. The device described in Thurler strips the gases off the central chamber quickly after they enter the device. Specifically, Thurler discloses that central tube *e* is perforated for the first two-thirds of its length beginning at the rear

¹ Mr. Nixon relies on WerBell because, in its view, it teaches that it is possible to use a concentric suppressor with a rifle. Ex. 1037, ¶ 110-11. It is of course *possible* to use a concentric suppressor with a rifle. But, as discussed above, Mr. Nixon has not shown that a POSITA *would be motivated to modify* Thurler to make it concentric in view of Kenney.

of the device (i.e., where the projectile and fluids enter the device), allowing the gases to escape into tube g. Ex. 1015 at 1:53-58, Fig. 1. The gases wind their way in an axially serpentine path and ultimately exit the side of the device at a location nearer to the operator. *See id.* at 1:83-99. While Mr. Nixon baldly asserts that a POSITA would make the device disclosed by Thurler to be concentric in view of Kenney, Mr. Nixon does not explain how a POSITA would do so given Kenney's disclosure. Kenney states that its device is concentric so that a "jacket of gases" is formed around the path of the bullet as it exits the device, preventing "rapid destruction of the vacuum." Ex. 1039 at 1:19-28. Kenney does this in part by allowing the gases to form a "jacket" or "cylindrical wall" around the path of the bullet as it proceeds through the device. *Id.* at 2:10-19. Indeed, Kenney makes clear that it provides for "constant forward movement and discharge of the gases. *Id.* at 2:47-52.

55. Mr. Nixon does not explain how Thurler and its axially serpentine pathway could be modified to form a "jacket" or "cylindrical wall" of gases around the pathway of the bullet in the device or as it exits the device. Indeed, sending the gases on a different pathway from the bullet would separate the gases from the path of the bullet within the device, and cause the gases to exit the device after the bullet, preventing a "jacket" from forming. Moreover, if the gases exit the side of the device as Thurler discloses, they could not form a jacket of gases around the bullet as it

exits the device. Mr. Nixon has not explained how Thurler could be modified in view of Kenney's design while maintaining Thurler's axially serpentine pathway.

56. Second, Mr. Nixon has not shown that a POSITA would have combined Thurler and Kenney² to achieve the limitation requiring that the "fluid outlet is located at an opposite end of the energy capture and control device as the inlet," which is present in all independent Proposed Substitute Claims. Mr. Nixon essentially argues that a POSITA would combine the end cap of Kenney, which he appears to equate with a fluid outlet, with the device of Thurler. *See* Ex. 1037, ¶¶ 113-18.

57. Mr. Nixon, however, fails to recognize that Kenney does not disclose a fluid outlet as claimed and thus does not explain how a POSITA would combine Thurler with Kenney to achieve a fluid outlet. Both Mr. Nixon and I agree that the claimed fluid outlet must be an outlet for fluids to escape the *off axis* chamber and the device without returning to the central chamber. Exhibit 1037, ¶¶ 35-36; Ex. 2001, ¶ 74. Paper 20 at 17-18. Kenney does not disclose an off axis chamber, and thus cannot disclose an outlet for fluids to escape the off axis chamber. Kenney discloses that its device contains "a plurality of disks that are peculiarly cupped, and otherwise shaped, in order that they may first shear off and separate portions of the gases, and direct the same radially from the bore, and then direct the said gases

² Mr. Nixon does not rely on WerBell vis-à-vis this limitation.

forwardly and discharge them into the free atmosphere.” Ex. 1039 at 1:91-100. While these disks redirect gases from the bore line of the device, they do not redirect the gases to a separate, off axis chamber. Instead, the disks direct the gases “into the spaces between the confronting faces of the stack of shearing disks,” and the disks have “circumferential cut-away portions” that allow the gases to flow toward the muzzle end. *Id.* at 2:8-19.

58. Moreover, Mr. Nixon’s purported reasons for combining Thurler with Kenney do not withstand scrutiny. Mr. Nixon contends that modifying Thurler in view of Kenney “would improve predictable symmetric gas expansion.” Ex. 1037, ¶ 115. But, as discussed above, the device of Kenney is symmetrical so that a jacket of gases is formed around the bullet path, preventing vacuum collapse, and Mr. Nixon has not explained why or how a POSITA would modify Thurler for this purpose.

59. Mr. Nixon also contends that a POSITA would modify Thurler in view of Kenney because doing so would “increase noise suppression by increasing path length[] and improve the expansion area for the deflected energy.” Ex. 1037, ¶ 117. But Mr. Nixon fails to recognize that Thurler and Kenney operate in fundamentally different ways such that a POSITA would not combine Thurler and Kenney to increase path length or improve the expansion area. As the Board recognized in its Preliminary Guidance, “the gas path in Thurler is circuitous whereas the gas path in

Kenney is essentially linear.” Paper 22 at 11. Thurler discloses that its goal is to destroy the energy in combustion gases “by guiding said gases through a certain number of chambers which are arranged at a certain distance apart the one before the other and which have passages for the projectile.” Ex. 1015 at 1:11-17. Kenney discloses that, in its silencer, “the gases are at no time blocked or trapped within the housing but are traveling constantly toward the discharge opening in the muzzle end of the silencer.” Ex. 1039 at 2:39-44. The gases “are equalized as to the force, obstructed, and gradually reduced as to velocity, as they pass forwardly through the silencer.” *Id.* at 2:44-47. Kenney notes that this “constant forward movement” is important so that the silencer “may be utilized safely with automatic, and other rapid firearms.” *Id.* at 2:49-52. In other words, the reason that Kenney has a fluid exit at the front of the device is to enable the constant forward movement of gases. The mechanisms of Thurler and Kenney are thus incompatible with one another, and Mr. Nixon does not explain why or how a POSITA would combine their two very different flow paths.

2. Dependent Proposed Substitute Claim 26

60. With respect to dependent Proposed Substitute Claim 26, Mr. Nixon incorporates by reference his opinions with respect to Claim 4 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply

to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 26.

3. Dependent Proposed Substitute Claim 27

61. With respect to dependent Proposed Substitute Claim 27, Mr. Nixon incorporates by reference his opinions with respect to Claim 5 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 27.

4. Dependent Proposed Substitute Claim 28

62. With respect to dependent Proposed Substitute Claim 28, Mr. Nixon incorporates by reference his opinions with respect to Claim 6 in Grounds 1 and 2 of his original declaration. I first note that Mr. Nixon did not discuss claim 6 in Ground 1 of his original declaration. In addition, I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 28.

63. In addition, Petitioner also adds that “Thurler teaches or suggests different perforation configurations for the 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,” and that, even if it does not, “it would have been obvious to a POSITA to modify Thurler’s ESD to achieve such a configuration.” Paper 21 at 14-15. I disagree.

64. I note that I addressed this argument in my first declaration. As I stated there, 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.

65. In addition, Thurler does not disclose or suggest any particular connection between the sleeves *d*, which Petitioner points to as deflectors, and the length of perforations. Proposed Substitute Claim 28 requires that the 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* by tube *g*. Ex. 1015, 1:53-55, 1:69-74, 2:28-30, Fig. 1.

66. 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*. Thus, Petitioner fails to demonstrate that the limitations of Proposed Substitute Claim 28 would be obvious.

5. Dependent Proposed Substitute Claim 29

67. With respect to dependent Proposed Substitute Claim 29, Mr. Nixon incorporates by reference his opinions with respect to Claim 7 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 29.

6. Dependent Proposed Substitute Claim 30

68. With respect to dependent Proposed Substitute Claim 30, Mr. Nixon incorporates by reference his opinions with respect to Claim 7 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references,

and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 30.

7. Dependent Proposed Substitute Claim 32

69. With respect to dependent Proposed Substitute Claim 32, Mr. Nixon incorporates by reference his opinions with respect to Claim 10 in Ground 2 of his original declaration. I note that Ground 2 in his original declaration is based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 32.

70. I note also that Proposed Substitute Claim 32 requires “multiple internal walls are formed by multiple concentric tubes.” Thurler discloses an eccentric device. And, as discussed above, a POSITA would not modify Thurler in view of Kenney or WerBell to make a device with concentric tubes.

71. I also note that Proposed Substitute Claim 32 requires that the “multiple concentric tubes . . . have alternating ends offset so as to produce the axially serpentine annular pathway.” Thurler does not disclose that its tubes have alternating ends off set. Instead, the tubes are perforated to allow passage from one tube to the next. Ex. 1015 at 1:55-77. Although Mr. Nixon claims that modifying Thurler’s perforations to achieve tubes having alternating ends off set would have been a

design choice, he does not explain why this is so or why a POSITA would be motivated to make such a change. While he states that a POSITA would be motivated to simplify the machining process, he does not explain why this change would make machining simpler.

8. Dependent Proposed Substitute Claim 33

72. With respect to dependent Proposed Substitute Claim 32, Mr. Nixon incorporates by reference his opinions with respect to Claim 11 in Ground 2 of his original declaration. I note that Ground 2 in his original declaration is based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 33.

73. I note that Proposed Substitute Claim 33 depends from Proposed Substitute Claim 32, so my analysis above applies to Proposed Substitute Claim 33.

9. Dependent Proposed Substitute Claim 37

74. With respect to dependent Proposed Substitute Claim 27, Mr. Nixon incorporates by reference his opinions with respect to Claim 15 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references,

and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 37.

10. Dependent Proposed Substitute Claim 38

75. With respect to dependent Proposed Substitute Claim 38, Mr. Nixon incorporates by reference his opinions with respect to Claim 16 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 38.

11. Dependent Proposed Substitute Claim 39

76. With respect to dependent Proposed Substitute Claim 39, Mr. Nixon incorporates by reference his opinions with respect to Claim 17 in Grounds 1 and 2 of his original declaration. I note that Grounds 1 and 2 in his original declaration are based on Thurler alone, and Mr. Nixon has not explained how those arguments apply to the combination at issue here, which involves Thurler and two other references, and why or how a POSITA would combine Thurler with Kenney and WerBell to achieve Proposed Substitute Claim 39.

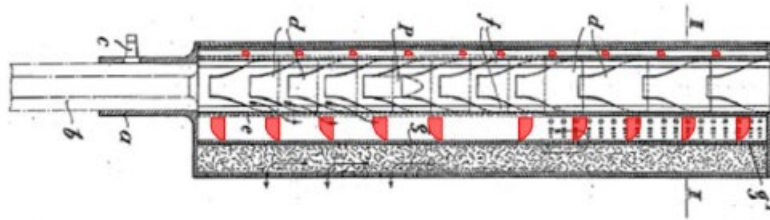
C. Dependent Proposed Substitute Claims 34-36, 41, and 42 Are Not Unpatentable Under Ground 2.

1. Dependent Proposed Substitute Claim 34

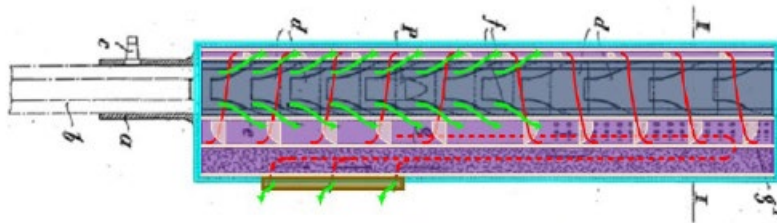
77. With respect to dependent Proposed Substitute Claim 34, Mr. Nixon incorporates by reference his opinions with respect to Claim 12 in Ground 4 of his original declaration. I note that Ground 4 in his original declaration is based on the combination of Thurler and Barlowatz, and Mr. Nixon has not explained how his arguments with respect to that limited combination apply to the combination at issue here, which involves Thurler, Barlowatz, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, and Barlowatz to achieve Proposed Substitute Claim 34.

78. In addition, Proposed Substitute Claim 34 adds the limitation “wherein the annular spaces further include a helical wall oriented within a least one of the annular spaces to direct fluids along a helical path within the at least one annular space.” Mr. Nixon argues that it would have been obvious to modify Thurler to include one or more helical coils.

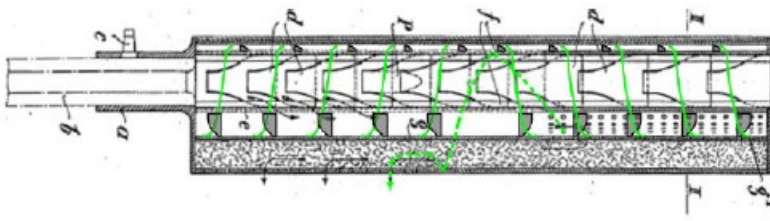
79. I note that I addressed a similar argument in my original declaration. As I noted there, Petitioner and Mr. Nixon proposed to modify Thurler’s device to include one or more helical coils in one or more exterior tubes, just as they do here. Petitioner and its expert provided the below figures.



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



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

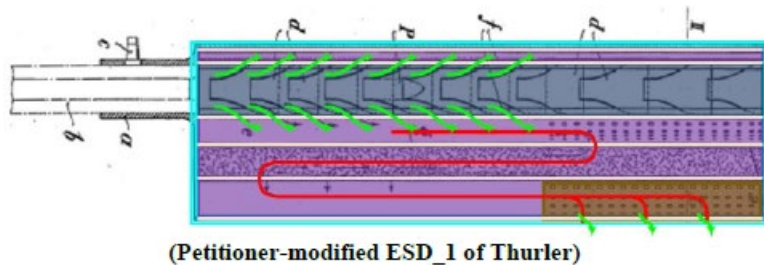


Id., Figure 9 (radially serpentine fluid flow in Thurler's modified ESD_3)

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

80. As shown therein, Petitioner and Mr. Nixon propose inserting one of Barlowatz's helical coils in tube *g* of Thurler. Petitioner and Mr. Nixon argue that a POSITA would be motivated to do so because such a device "would have improved noise suppression by increasing the path length for the deflected energy and further slowing the velocity of the deflected energy." Ex. 1037, ¶ 134. In his current declaration, Mr. Nixon adds additional details regarding why, in his view, a POSITA "would recognize that Barlowatz's helical coil configuration provides significant advantages that would naturally complement Thurler's existing suppressor design." Ex. 1037, ¶ 135.

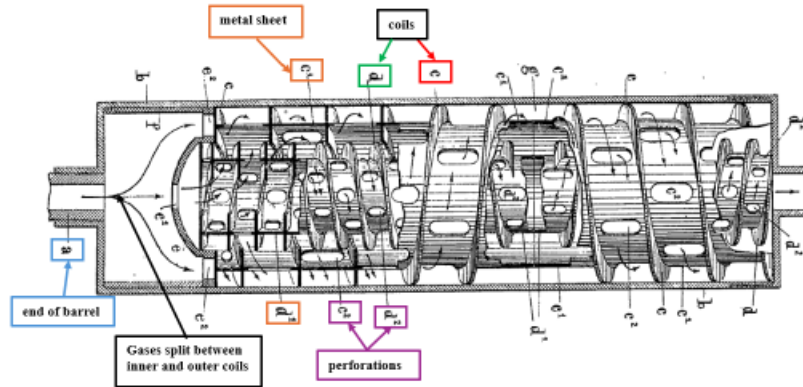
81. I disagree that a POSITA would combine Thurler and Barlowatz for at least two reasons. First, Thurler teaches a different approach to lengthening the fluid pathway. As I explained in Section X.B.2 of my previous declaration, Thurler teaches adding additional eccentric chambers as shown in Petitioner’s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



See Pet. at 34; Ex. 1013, ¶ 174.

82. 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.

83. Second, Barlowatz discloses a fundamentally different design for providing a fluid pathway in a silencer, relying on two coils oriented in different directions, as I discussed in Section IX.C of my first declaration. 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)

84. Barlowatz provides that the blast gases are split into two parts at *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 in Barlowatz into Thurler would defeat the stated function of Barlowatz’s structure to allow the gases to split and counteract one another.

85. Inserting *both* of Barlowatz’s coils into Thurler 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.

86. 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.

2. Dependent Proposed Substitute Claim 35

87. With respect to dependent Proposed Substitute Claim 35, Mr. Nixon incorporates by reference his opinions with respect to Claim 13 in Ground 4 of his original declaration. I note that Ground 4 in his original declaration is based on the combination of Thurler and Barlowatz, and Mr. Nixon has not explained how his arguments with respect to that limited combination apply to the combination at issue here, which involves Thurler, Barlowatz, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, and Barlowatz to achieve Proposed Substitute Claim 35.

88. I note that Proposed Substitute Claim 35 depends from Proposed Substitute Claim 34, so my analysis above applies to Proposed Substitute Claim 35.

3. Dependent Proposed Substitute Claim 36

89. With respect to dependent Proposed Substitute Claim 36, Mr. Nixon incorporates by reference his opinions with respect to Claim 14 in Ground 4 of his original declaration. I note that Ground 4 in his original declaration is based on the combination of Thurler and Barlowatz, and Mr. Nixon has not explained how his arguments with respect to that limited combination apply to the combination at issue

here, which involves Thurler, Barlowatz, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, and Barlowatz to achieve Proposed Substitute Claim 36.

90. I note that Proposed Substitute Claim 36 depends from Proposed Substitute Claim 34, so my analysis above applies to Proposed Substitute Claim 36.

4. Dependent Proposed Substitute Claim 41

91. With respect to dependent Proposed Substitute Claim 41, Mr. Nixon incorporates by reference his opinions with respect to Claim 20 in Grounds 4, 5, and 6 of his original declaration. I note that Ground 4 in his original declaration is based on the combination of Thurler and Barlowatz, and Grounds 5 and 6 are based on Barlowatz alone. Mr. Nixon has not explained how his arguments with respect to those grounds apply to the combination at issue here, which involves Thurler, Barlowatz, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, and Barlowatz to achieve Proposed Substitute Claim 41.

92. I note that Proposed Substitute Claim 40 adds the limitation “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.” For the same reasons I stated in connection with Proposed Substitute Claim 34, a POSITA would not combine Thurler with Kenney, WerBell, and Barlowatz to achieve this claim.

5. Dependent Proposed Substitute Claim 42

93. With respect to dependent Proposed Substitute Claim 42, Mr. Nixon incorporates by reference his opinions with respect to Claim 21 in Grounds 2 and 4 of his original declaration. I note that Ground 2 in his original declaration is based on Thurler alone, and Ground 4 is based on the combination of Thurler and Barlowatz. Mr. Nixon has not explained how his arguments with respect to those grounds apply to the combination at issue here, which involves Thurler, Barlowatz, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, and Barlowatz to achieve Proposed Substitute Claim 42.

94. I note also that Proposed Substitute Claim 42 requires “multiple internal walls are formed by multiple concentric tubes.” Thurler discloses an eccentric device. And, as discussed above, a POSITA would not modify Thurler in view of Kenney or WerBell to make a device with concentric tubes.

95. I also note that Proposed Substitute Claim 42 requires that the “multiple concentric tubes . . . have alternating ends offset so as to produce the axially serpentine annular pathway.” Thurler does not disclose that its tubes have alternating ends offset. Instead, the tubes are perforated to allow passage from one tube to the

next. Ex. 1015 at 1:55-77. Although Mr. Nixon claims (in his original declaration) that modifying Thurler's perforations to achieve tubes having alternating ends offset would have been a design choice, he does not explain why this is so or why a POSITA would be motivated to make such a change. While he states that a POSITA would be motivated to simplify the machining process, he does not explain why this change would make machining simpler.

D. Dependent Proposed Substitute Claims 24 Is Not Unpatentable Under Ground 3.

96. With respect to dependent Proposed Substitute Claim 24, Mr. Nixon incorporates by reference his opinions with respect to Claim 2 in Ground 7 of his original declaration. I note that Ground 7 in his original declaration is based on Barlowatz in view of Reeves. Mr. Nixon has not explained how his arguments with respect to that combination (which does not involve Thurler) apply to the combination at issue here, which involves Thurler, Barlowatz, Reeves, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, Barlowatz, and Reeves to achieve Proposed Substitute Claim 24.

97. Mr. Nixon contends that Reeves "discloses a series of compartments that each include encapsulated shells forming 'radially serpentine fluid pathways,' where the encapsulated shells are connected by an outermost opening 4," and that a POSITA "would be motivated to incorporate Reeves' compartmentalized design into the already-modified Thurler suppressor because it provides additional

opportunities for gas expansion and cooling through multiple discrete chambers. Ex. 1037, ¶¶ 145-46. Mr. Nixon ignores, however, that Proposed Substitute Claim 24 requires that the “plurality of sub-chambers” is “defined by the plurality of deflectors.” Reeves does not disclose deflectors, and thus cannot disclose sub-chambers that are defined by a plurality of deflectors. Moreover, Proposed Substitute Claim 24 requires that each sub-chamber has a radially serpentine fluid pathway. Each individual partition in Reeves, however, does not have a radially serpentine pathway—the fluids never change directions within each sub-chamber. Thus, a POSITA would not modify Thurler in view of Reeves to achieve the invention of Proposed Substitute Claim 24.

E. Dependent Proposed Substitute Claims 25 and 31 Are Not Unpatentable Under Ground 4.

1. Dependent Proposed Substitute Claim 25

98. With respect to dependent Proposed Substitute Claim 25, Mr. Nixon incorporates by reference his opinions with respect to Claim 3 in Ground 8 of his original declaration. I note that Ground 8 in his original declaration is based on Eichenseher in view of Barlowatz. Mr. Nixon has not explained how his arguments with respect to that combination, which does not involve Thurler, apply to the combination at issue here, which involves Thurler, Barlowatz, Eichenseher, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, Barlowatz, and Eichenseher to achieve Proposed Substitute Claim 25.

99. I note that Proposed Substitute Claim 25 adds the limitation “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.” Mr. Nixon contends that a POSITA would have been motivated to modify Thurler’s modified device with Eichenseher’s mounting mechanism. Ex. 1037, ¶¶ 150-51. But Mr. Nixon has not explained how the mounting mechanism of Eichenseher has a “hollow interior with a reducing throat portion and a flared outlet,” as required by the claim.

2. Dependent Proposed Substitute Claim 31

100. With respect to dependent Proposed Substitute Claim 31, Mr. Nixon incorporates by reference his opinions with respect to Claim 9 in Grounds 4, 5, 6, and 8 of his original declaration. I note that Ground 4 in his original declaration involves Thurler in view of Barlowatz, Grounds 5 and 6 involve Barlowatz alone, and Ground 8 involves Eichenseher in view of Barlowatz. Mr. Nixon has not explained how his arguments with respect to those combinations, apply to the combination at issue here, which involves Thurler, Barlowatz, Eichenseher, and two other references, and why or how a POSITA would combine Thurler with Kenney, WerBell, Barlowatz, and Eichenseher to achieve Proposed Substitute Claim 31.

101. I note in particular that, for the reasons stated above with respect to Proposed Substitute Claim 34, a POSITA would not combine Thurler with Barlowatz to achieve a device with a “radially serpentine” flow path. *See also* Ex. 2001, ¶¶ 47-51. In particular, a POSITA would not incorporate the coils of Barlowatz into Thurler. Thurler and Barlowatz teach different approaches to lengthening fluid pathways, and 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. Barlowatz discloses using two coils, and the point of Barlowatz 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. And inserting both of Barlowatz’s coils into Thurler 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.

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 September 2, 2025

A handwritten signature in blue ink that reads "G. Paul Neitzel, Ph.D." The signature is written in a cursive style.

G. Paul Neitzel, Ph.D.

APPENDIX A

September 2, 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

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)

“Measurements in Turbulent Swirling Flow Through an Abrupt Axisymmetric Expansion,” *AIAA Journal*, **26**, 669-681 (1988) (with P. A. Dellenback and D. E. Metzger)

“Energy Stability of Thermocapillary Convection in a Model of the Float-Zone, Crystal-Growth Process,” *Journal of Fluid Mechanics*, **217**, 639-660 (1990) (with Y. Shen, D. F. Jankowski and H. D. Mittelman)

“Thermocapillary Convection in a Model Float-Zone,” *AIAA Journal of Thermophysics and Heat Transfer*, **5**, 577-582 (1991) (with J. R. Hyer and D. F. Jankowski)

“Energy Stability of Thermocapillary Convection in a Model of the Float-Zone, Crystal-Growth Process. Part 2, Non-Axisymmetric Disturbances,” *The Physics of Fluids A*, **3**, 2841-2846 (1991) (with C. C. Law, D. F. Jankowski and H. D. Mittelman)

“A Large, Sparse and Indefinite Generalized Eigenvalue Problem from Fluid Mechanics,” *SIAM Journal of Scientific and Statistical Computing*, **13**, 411-424 (1992) (with H. D. Mittelman, C. C. Law and D. F. Jankowski)

“Linear Stability of Thermocapillary Convection in a Model of the Float-Zone, Crystal-Growth Process,” *The Physics of Fluids A*, **5**, 108-114 (1993) (with K.-T. Chang, D. F. Jankowski and H. D. Mittelman)

“Iterative Solution of the Eigenvalue Problem in Hopf Bifurcation for the Boussinesq Equations,” *SIAM Journal of Scientific and Statistical Computing*, **15**, 704-712 (1994) (with H. D. Mittelman, K.-T. Chang & D. F. Jankowski)

“Thermal Instability with Radiation by the Method of Energy,” *International Journal of Heat and Mass Transfer* **37**, 2909-2915 (1994) (with M. K. Smith and M. J. Bolander)

“Transient, Non-Axisymmetric Modes in the Instability of Unsteady Circular Couette Flow. Laboratory and Numerical Experiments,” *Physics of Fluids*, **7**, 324-334 (1995) (with C. S. Kirkconnell and L. J. Little)

“Numerical Evaluation of a Vortex-Breakdown Criterion,” *Physics of Fluids*, **8**, 3063-3071 (1996) (with J. P. Watson)

“Finite-Element Computations for Unsteady Fluid and Elastic Membrane Interaction Problems,” *International Journal for Numerical Methods in Fluids* **24**, 1091-1110 (1997) (with S.-J. Liang and C. K. Aidun)

“Instability of Thermocapillary Convection in Shallow Layers. Part 1. Characterization of Steady and Oscillatory Instabilities,” *Journal of Fluid Mechanics* **359**, 143-164 (1998) (with R. J. Riley)

“Instability of Thermocapillary Convection in Shallow Layers. Part 2. Suppression of Hydrothermal Waves,” *Journal of Fluid Mechanics*, **359**, 165-180 (1998) (with S. Benz, P. Hintz and R. J. Riley)

“Oscillatory Thermocapillary Convection in Liquid Bridges With Highly Deformed Free Surfaces. Experiments and Energy-Stability Analysis,” *Physics of Fluids* **13**, 107-120 (2001) (with L. B. S. Sumner, J.-P. Fontaine and P. Dell’Aversana)

“Experiments on Thermocapillary Instabilities,” *Annual Review of Fluid Mechanics* **33**, 93-127 (2001) (with M. F. Schatz)

“Noncoalescence and Non-Wetting Behavior of Liquids,” *Annual Review of Fluid Mechanics* **34**, 267-289 (2002) (with P. Dell’Aversana)

“Lubrication Analysis of Thermocapillary-Induced Non-Wetting,” *Physics of Fluids* **15**, 2923-2933 (2003) (with L. B. S. Sumner and A. M. Wood)

“Fluid Mechanics of a Spinner Flask Bioreactor,” *Biotechnology and Bioengineering* **85**, 34-46 (2004) (with P. Sucusky, D. Osorio and J. B. Brown)

“Behavior of Noncoalescing and Nonwetting Drops in Stable and Marginally Stable States,” *Experiments in Fluids* **36**, 299-309 (2004) (with P. Dell’Aversana)

“Regularized Phase-Tracker With Iso-Phase Scanning Strategy for Analysis of Dynamic Interferograms of Nonwetting Droplets Under Excitation,” *Applied Optics* **44**, 2695-2704 (2005) (with L. R. van den Doel, P. T. Nagy and L. J. van Vliet) (including journal cover)

“Multiscale Modeling in the Numerical Computation of Isothermal Nonwetting,” *Journal of Fluid Mechanics* **554**, 67-84 (2006) (with M. K. Smith)

“Flow Characterization of a Wavy-Wall Bioreactor for Cartilage Tissue Engineering,” *Biotechnology and Bioengineering*, **95**, 1009-1022 (2006) (with B. Bilgen, P. Sucusky and G. Barabino)

“Numerical Simulation of Thermocapillary Nonwetting,” *International Journal of Heat and Mass Transfer*, **49**, 4567-4576 (2006) (with J.-C. Chen and C.-W. Kuo)

“Numerical Simulation of Isothermal Nonwetting,” *International Journal for Numerical Methods in Fluids*, **53**, 257-275 (2007) (with C.-W. Kuo and J.-C. Chen)

“Control-Volume Momentum Flux: Getting the Sign Correct,” *International Journal of Mechanical Engineering Education*, **36**, 77-80 (2008) (with K. M. Schwing)

“Optical Levitation and Transport of Microdroplets: Proof of Concept,” *Physics of Fluids* **20**, 101703-1-4 (2008) (with P. T. Nagy)

“Simulating Deformable-particle Suspensions Using a Coupled Lattice-Boltzmann and Finite-element Method,” *Journal of Fluid Mechanics*, **618**, 13-39 (2009) (with R. M. MacMeccan, J. R. Clausen and C. K. Aidun)

“Failure of Thermocapillary-Driven Permanent Nonwetting Droplets,” *Physics of Fluids*, **21**, 112106-1-8 (2009) (with P. T. Nagy)

“Stephen H. Davis – 70, and Counting,” *Journal of Fluid Mechanics*, **647**, 3-12 (2010)

“Detection of Liquid-Metal Free-Surface Flow Using the DLP Technique,” *Experiments in Fluids*, **59**, 179-192 (2012) (with M. Hillenbrand and R. Stieglitz)

“Nanoliter Compound Droplet Generation with Composition Variation,” *Microfluidics and Nanofluidics* **20**, 133 (2016) (with J. Black)

“Stephen H. Davis, 7 September 1939 – 12 November, 2021,” *Journal of Fluid Mechanics* **956**, E2 (2023)

“Interfacial Dynamics Pioneer, Stephen H. Davis (1939 – 2021),” *Annual Review of Fluid Dynamics* **56**, 1 (2024) (with M. J. Miksis and P. W. Voorhees)

“A Mathematical Model for Fingering Observed in the Circular Hydraulic Jump,” in preparation (with A. Class and T. Schmidt)

“Droplet Impact on Inclined Planar Surfaces,” in preparation (with P. L. Carroll and M. K. Smith)

Other Publications

“Stability of Thermocapillary Convection During Float-Zone Crystal Growth,” in *Energy Stability and Convection*, G. P. Galdi and B. Straughan, eds., Pitman Research Notes in Mathematics Series, Longman, Essex, 346-363 (1988) (with D. F. Jankowski, Y. H. Shen and T. H. Squire)

“Application of Energy-Stability Theory to a Problem Related to Float-Zone Crystal Growth,” in *Progress in Low Gravity Fluid Dynamics and Transport Phenomena*, J. N. Koster and R. L. Sani, eds., AIAA Progress in Aeronautical and Astronautical Sciences Series, AIAA, Washington, 73-86 (1990) (with D. F. Jankowski)

“Stability of Thermocapillary Convection in Float-Zone Crystal Growth,” in *Numerical Methods for Free Boundary Problems*, P. Neittaanmäki, ed., International Series of Numerical Mathematics **99**, Birkhäuser, Basel, 58-69 (1991) (with H. D. Mittelman, C. C. Law and D. F. Jankowski)

“Linear Stability of Axisymmetric Thermocapillary Convection in Crystal Growth,” in *Bifurcation and Symmetry*, E. Allgower, K. Böhmer and M. Golubitsky, eds., International Series of Numerical Mathematics, **104**, Birkhäuser, Basel, 275-284. (1992) (with H. D. Mittelman, K.-T. Chang, and D. F. Jankowski)

Review of *The Energy Method, Stability and Nonlinear Convection* by Brian Straughan (Springer, 1992) in *Applied Mechanics Reviews* **46**, B25 (1993)

“When Liquids Stay Dry,” *Physics Today* **51**, 38-41 (1998) (with P. Dell’Aversana) (including cover)

“On Thinking and Other Ramblings,” *The Active Learner - A Foxfire Journal for Teachers* **3**, 24-25 (1998)

“Obituary for Stephen Howard Davis,” *Physics Today* **75**, 61 (2022) (with M. J. Miksis and W. W. Schultz)

*Edited
Proceedings*

Surface-Tension-Driven Flows, G. P. Neitzel and M. K. Smith, eds., AMD Vol. 170, 1993 Winter Annual Meeting Symposium, American Society of Mechanical Engineers (1993).

Interfaces for the Twenty-First Century, New Research Directions in Fluid Mechanics and Materials Science, M. K. Smith, M. J. Miksis, G. B. McFadden, G. P. Neitzel and D. R. Canright, eds., Imperial College Press (2002)

*Research
Reports*

A Computer Program to Calculate the Physical Properties of a System of Coaxial Bodies of Revolution, “Ballistic Research Laboratories Memorandum Report No. 2213, August 1972.

“Gun/Ammunition Commonality Study,” Ballistic Research Laboratories Interim Memorandum Report No. 234, June 1974 (with A. Thrailkill, et al.).

“Gun/Ammunition Commonality Study - Continued,” Ballistic Research Laboratories Interim Memorandum Report No. 293, September 1974 (with A. Thrailkill, et al.).

“Aerodynamic Characteristics of 30mm HS831-L Ammunition Used in the British 30mm Rarden Gun,” Ballistic Research Laboratories Memorandum Report No. 2466, March 1975.

“BRL 30 mm AP Projectile,” Ballistic Research Laboratories Memorandum Report No. 2671, August 1976 (with A. Ricchiazzi and M. Piddington).

“Turbulent Swirling Flow Downstream of an Abrupt Pipe Expansion - Modeling and Experimental Measurements,” Interim Progress Report for ONR Contract N0014-81-K-0428, College of Engineering and Applied Science Report No. CF-R82036, July 1983 (with D. E. Metzger).

“An Alternate Convergence Criterion for Internal Elliptic Flow Computations,” ASU CEAS Report No. 84029, May 1984 (with B. K. Sultanian).

“Modeling of Heat and Fluid Flow in Czochralski Crystal-Growth Melts: A Preliminary Literature Survey,” ASU CEAS Report No. 85001, January 1985 (with G. L. Nelson).

“Modeling and Measurement of Turbulent Swirling Flows through Abrupt Expansion,” ASU CEAS Report ERC-R-86104, March, 1987 (with D. E. Metzger).

*Conference
Proceedings
and
Presentations*

“Impact Models for Penetration and Hole Growth,” presented as a poster session paper at the Fourth International Symposium on Ballistics, sponsored by the American Defense Preparedness Association, Monterey, CA, October 17-19, 1978 (with W. P. Walters and J. N. Majerus)

“Stability of Decelerating Swirl-Flow in an Infinite Circular Cylinder by the Method of Energy,” presented at the Thirty-First Meeting of the Division of Fluid Dynamics of the American Physical Society, Los Angeles, CA, November 19-21, 1978 (with S. H. Davis).

“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).

“An Analytical Model for Predicting Performance of Finite-Length Hypervelocity Jets,” presented at the Sixteenth Annual Meeting of the Society of

Engineering Science, Inc., Evanston, IL, September 5-7, 1979 (with W. P. Walters and J. N. Majerus).

“Centrifugal Instabilities During Spin-Down in Finite Circular Cylinders - Numerical Experiments,” presented at the Thirty-Second Meeting of the Division of Fluid Dynamics of the American Physical Society, South Bend, IN, November 18-20, 1979 (with S. H. Davis).

“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.

“Stability of Impulsively Initiated Couette Flow,” presented at the Second Taylor Vortex Flow Working Party Meeting, Medford, MA, June 2-3, 1981.

“Stability of Circular Couette Flow with Time-Dependent Boundary Conditions,” presented at the Thirty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, Monterey, CA, November 22-24, 1981.

“Strong Stability of Impulsively-Initiated Couette Flow for Both Axisymmetric and Non-Axisymmetric Disturbances,” presented at the Ninth U.S. National Congress of Applied Mechanics, Ithaca, NY, June 21-25, 1982. Also presented at the American Society of Mechanical Engineers Winter Annual Meeting, Phoenix, AZ, November 14-18, 1982 (with J.-C. Chen).

“Numerical Experiments on Circular Couette Flow with an Impulsively Started Inner Cylinder,” presented at the Third Taylor Vortex Flow Working Party Meeting, Nancy, France, April 5-7, 1983.

“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).

“The Onset of Instability in Time-Dependent, Circular Couette Flow,” presented at the Thirty-Sixth Meeting of the Division of Fluid Dynamics of the American Physical Society, Houston, TX, November 20-22, 1983 (with E. R. Cooper and D. F. Jankowski).

“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).

“Thermocapillary Convection in a Model Float-Zone,” presented at the Thirty-Eighth Meeting of the Division of Fluid Dynamics of the American Physical Society, Tucson, AZ, November 24-26, 1985 (with T. H. Squire, Y. H. Shen and D. F. Jankowski).

“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).

“Stability of Thermocapillary Convection During Float-Zone Crystal-Growth,” invited presentation at the Congress on Energy Stability and Convection, Capri, Italy, May 21-28, 1986. (with D. F. Jankowski, Y. H. Shen and T. H. Squire).

“A Study of Sudden Expansion Pipe Flow Using an Algebraic Stress Model of Turbulence,” AIAA/ASME 4th Fluid Mechanics, Plasma Dynamics and Lasers Conference, Atlanta, GA, May 12-14, 1986 (AIAA Paper 86-1062 (with B. K. Sultanian and D. E. Metzger).

“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).

“Numerical Computations of Streakline Behavior for Vortex Breakdown,” presented at the Third Arizona Fluid Mechanics Meeting, Tucson, AZ, February 20-21, 1987.

“Numerical Experiments on the Onset of Instability in Unsteady Circular Couette Flow,” presented at the Fifth Taylor-Vortex Flow Working Party, Tempe, AZ, March 25-27, 1987 (with D. F. Jankowski and J.-C. Chen).

“Experiments on the Onset of Instability in Impulsively-Initiated Circular Couette Flow,” presented at the Fifth Taylor-Vortex Flow Working Party, Tempe, AZ, March 25-27, 1987 (with K. R. Kohuth).

“Nonlinear Stability of Time-Dependent Circular Couette Flow,” presented at the International Conference on Fluid Mechanics, Beijing, China, July 1-4, 1987. Proceedings, 231-237 (with J.-C. Chen).

“Heat Transfer to Turbulent Swirling Flow Through a Sudden Axisymmetric Expansion,” presented at the Twenty-Fourth National Heat Transfer Conference, Pittsburgh, PA, August 9-12, 1987. ASME Paper 87-HT-8 (with P. A. Dellenback and D. E. Metzger).

“Energy Stability of Thermocapillary Motion in a Model Half-Zone,” presented at the Fortieth Meeting of the Division of Fluid Dynamics of the American Physical Society, Eugene, OR, November 22-24, 1987 (with D. F. Jankowski and T. H. Squire).

“Streakline Motion During Steady and Unsteady Axisymmetric Vortex Breakdown,” presented at the Fortieth Meeting of the Division of Fluid Dynamics of the American Physical Society, Eugene, OR, November 22-24, 1987.

“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).

“Energy Stability of Thermocapillary Convection in a Model Half-Zone. New Results,” 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 D. F. Jankowski and Y. Shen).

“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).

“Stability of Thermocapillary Convection in Float-Zone Crystal Growth,” presented at the Conference on Numerical Methods for Free Boundary Problems, Jyväskylä, Finland, July 23-27, 1990 (with H. D. Mittelman, C. C. Law and D. F. Jankowski).

“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).

“Numerical Simulation of Vortex Breakdown in an Enclosed Circular Cylinder,” presented at the Forty-Fourth Meeting of the Division of Fluid Dynamics of the American Physical Society, Scottsdale, AZ, November 24-26, 1991 (with J. P. Watson and D. Carrizosa).

“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 JASMAC-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