

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NESPRESSO USA, INC.,
Petitioner,

v.

K-FEE SYSTEM GMBH,
Patent Owner.

Case No. IPR2023-00502
U.S. Patent 10,994,923

**DECLARATION OF LAURENS HOWLE, PH.D., P.E. IN SUPPORT OF
PATENT OWNER'S RESPONSE**

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DECLARATION OF LAURENS HOWLE

I, Laurens “Lars” Howle, Ph.D., P.E., hereby declare under penalty of perjury that the following statements are made based on my personal knowledge and are true and correct.

I. Introduction and Qualifications

1. I have been retained by McDermott Will & Emery on behalf of K-Fee System GmbH (“K-fee”) to provide an analysis of U.S. Patent No. 10,994,923 (’923 Patent), the applications to which it claims priority, and certain issues raised in IPR2023-00502. I understand that the Parties are in litigation in which K-fee accuses Petitioner’s VertuoLine system of meeting the claim requirements.

2. I am being compensated at my standard hourly rate of \$600 per hour for my time. My compensation is not in any way contingent on my performance, the result of this proceeding, or any of the issues involved therein. I am also being reimbursed for expenses incurred as a result of activities performed as an expert.

3. From 1983 – 1989, I was Plant Manager and Vice President of Manufacturing at Kaye Products, Inc. At Kaye Products, I was responsible for all phases of manufacturing of the physical therapy equipment produced by that company. These responsibilities included, *inter-alia*, production scheduling and line balancing, procurement and inventory maintenance of raw materials, warehousing of completed product, design, installation, and maintenance of various automated

and semi-automated manufacturing processes. At Kaye Products, I had up to 30 direct reports.

4. Also at Kaye Products, I programmed custom bar codes for use in inventory control of more than 250 different raw materials and components. These bar codes were integrated with the custom line-of-business software system I wrote for controlling and tracking product manufacturing.

5. I hold B.S.E., M.S., and Ph.D. degrees from Duke University in the field of Mechanical Engineering. In 1993, I joined the faculty in the Department of Mechanical Engineering and Materials Science as an Assistant Professor. In 2000, I was promoted to Associate Professor with tenure. Later, in 2020, I was promoted to my current rank of Full Professor with tenure.

6. At Duke University, I have taught widely across the undergraduate and graduate curricula. At the undergraduate level, I have taught Mechanical Design, Analysis for Mechanical Design, Modeling and Control of Dynamical Systems, Fluid Mechanics, Heat and Mass Transfer, Wind Turbine Design and Analysis, Advanced Computer Aided Design, Manufacturing Engineering, and Advanced Manufacturing Engineering. At the graduate level, I have taught courses in Wind Turbine Design and Analysis, Introduction to Scientific Computing, Probabilistic Pharmacokinetics and Pharmacodynamics, Computational Fluid Dynamics and Heat

Transfer, Advanced Computational Fluid Dynamics, and Topics in Nonlinear Dynamics.

7. Additionally, I was previously a Professor of Radiology at the Duke University Medical Center and have previously also been a Professor of Marine Science and Conservation at the Duke University Marine Laboratory.

8. From 2008 to the present, I have been owner and Manager-Member of BelleQuant Engineering, PLLC, a North Carolina based and licensed professional engineering consulting firm (license number P-0774).

9. Through my research at Duke University, my experience in industry, and my consulting activities for numerous Governmental Agencies, and Non-Governmental Organizations, I have considerable experience with a wide array of measurement techniques and automated data acquisition methods. Such techniques include optical measurement of flow patterns using shadowgraphy and Schlieren methods, particle image velocimetry, active feedback control of fluid motions, displacement/angular measurement using potential change, optical gradients, and optical grating methods. I have considerable experience designing and using strain gauges, thermocouples, thermistors, photo emitter/detector circuitry, ultrasonic and inductive proximity sensors, Hall effect transducers, piezoelectric elements, pressure transducers, ultrasonic and impellor flow meters, accelerometers, and interferometers.

10. Through my research activities at Duke University, I gained considerable expertise with and contributed to the understanding of fluid flow in porous media by publishing peer-reviewed papers in the Scientific Literature; including the journal *Nature*. These contributions included developing models for anisotropic dispersive thermal conductivity in fluid-saturated packed beds. Additional contributions include developing shadowgraphic methods for fluid flow pattern visualization and measurement in fluid-saturated porous layers. Building on this body of work, I developed methods for control of fluid motion in bulk fluid and fluid-saturated porous layers through active feedback control of thermal boundary conditions.

11. In 2020, I was named as a Fellow of the Undersea and Hyperbaric Medical Society. In 2012, I was named as a Fellow of the American Society of Mechanical Engineers. In 2011, a New Product Award was granted at the MCEE expo in Montreal for a product that I designed. In 2009, I was a finalist for a design award from “INDEX: Design to Improve Life,” a Danish nonprofit organization.

12. I am the lead inventor on United States Patent No. 9,884,166, titled “Jetless Intravenous Catheters and Mechanical Assist Devices for Hand Injection of Contrast Media During Dynamic Computer Tomography and Methods of Using Same”.

13. I have served as an expert witness on more than 25 cases, have testified at trial on six occasions, and have been deposed eight times. Directly related to single-serve beverage brewing systems, I served as an expert and/or testified at trial in the cases 337-TA-929 “Certain beverage brewing capsules, components thereof, and products containing the same”, 337-TA-929 (Enforcement and Rescission Proceeding), C15-0522RSL “Eko Brands, LLC v. Adrian Rivera Maynez Enterprises, Inc., et al.”, 4:16-cv-2702 “Solofill, LLC v. Adrian Rivera, Adrian Rivera Maynez Enterprises, Inc.”, LA CV16-04676 JAK (SSx) Lead Case; LA CV16-04753 JAK (SSx); LA CV16-04706 JAK (SSx); LA CV16-047702 JAK (SSx), “Rivera v. Remington Designs, LLC; Rivera v. Eko Brands, LLC and Espresso Supply, Inc; Rivera v. Solofill, LLC; Rivera v. Creative Concepts”, and 4:20-cv-03732 “Eko Brands, LLC v. Solofill, LLC and Robert Vu”. I have accumulated more than 1,300 hours designing, analyzing, and evaluating single-serve beverage brewing systems.

14. My knowledge, experience, and training meet or exceed the level of a person of ordinary skill in the art (POSITA) for the technical subjects at issue in this litigation (including but not limited to mechanical engineering, fluid delivery devices, thermal and fluids engineering, and product design).

15. Additional information regarding my education and technical experience is included in my Curriculum Vitae, which is attached to this Report as Appendix A.

II. Materials Considered

16. All of the opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. In forming the opinions expressed in this Declaration, while drawing on my experience, I reviewed the following documents:

Exhibit	Description
Ex. 1001	U.S. Patent No. 10,994,923 (“’923 Patent”)
Ex. 1002	Prosecution History of U.S. Patent No. 10,994,923 (“’923 Patent File History”)
Ex. 1003	Declaration of Michael Jobin (“Jobin Decl.”)
Ex. 1004	U.S. Patent Pub. US2010/0239734A1 (“Yoakim”)
Ex. 1005	U.S. Patent Pub. US2013/0064937A1 (“Jarisch”)
Ex. 1006	U.S. Patent Pub. US2013/0064929A1 (“Jarisch 929”)
Ex. 1007	PCT Pub. WO2010/026053A1 (“Denisart”)
Ex. 1008	U.S. Patent Pub. US2012/0269933A1 (“Rapparini”)
Ex. 1009	U.S. Patent Pub. 2008/0105131 (“Castellani”)
Ex. 1010	PCT Pub. WO2005/079638A1 (“Panesar”)
Ex. 1011	U.S. Patent Pub. 2006/0233921 (“Mock”)

Exhibit	Description
Ex. 1012	National Coffee Association (“NCA”)
Ex. 1013	U.S. Patent Pub. 2002/0078831 (“Cai”)
Ex. 1014	U.S. Patent No. 726,793 (“Bezzera”)
Ex. 1015	U.S. Patent Pub. 2009/0007793 (“Glucksman”)
Ex. 1016	U.S. Patent No. 3,387,553 (“Tavera”)
Ex. 1017	U.S. Patent No. 3,631,793 (“Bednartz”)
Ex. 1018	U.S. Patent No. 4,136,202 (“Favre”)
Ex. 1019	U.S. Patent No. 6,142,063 (“Beaulieu”)
Ex. 1020	U.S. Patent No. 4,389,925 (“Piana”)
Ex. 1021	U.S. Patent No. 6,655,260 (“Lazaris”)
Ex. 1022	U.S. Patent Pub. 2006/0230941 (“Ryser”)
Ex. 1023	U.S. Patent Pub. 2009/0249961 (“Cheng”)
Ex. 1024	U.S. Patent Pub. 2004/0089158 (“Mahlich”)
Ex. 1025	PCT Pub. WO 2010/034663 (“Ozanne”)
Ex. 1026	ASM Handbook, Volume 14B: Metalworking: Sheet Forming, S.L. Semiatin, editor. (“ASM Handbook”)
Ex. 1027	https://www.italcoat.com/flexible-aluminium-markets/coffee/ (“Italcoat”)
Ex. 1028	EU Patent App. EP2145759A1 (“Geerts”)
Ex. 1029	Penix J.A. (1991) Thermoforming of Plastic Film and Sheet. In: Berins M.L. (eds) SPI Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. (“Penix”)

Exhibit	Description
Ex. 1030	U.S. Patent No. 3,437,253 (“Davis”)
Ex. 1031	U.S. Patent No. 5,261,558 (“Claydon”)
Ex. 1032	U.S. Patent No. 5,243,164 (“Erickson”)
Ex. 1033	U.S. Patent No. 6,645,537 (“Sweeney”)
Ex. 1034	EU Patent App. EP1849718A1 (“Rubino”)
Ex. 1035	PCT Pub. WO2010/041179A2 (“Mariller”)
Ex. 1036	EU Patent App. EP0455337B1 (“Bentley”)
Ex. 1037	U.S. Patent Pub. 2002/0048621A1 (“Boyd”)
Ex. 1038	U.S. Patent Pub. 2007/0203587A1 (“Erlandsson”)
Ex. 1039	U.S. Patent Pub. 2005/0150391A1 (“Schifferle”)
Ex. 1040	PCT Pub. WO2005/044067A1 (“Ruchonnet”)
Ex. 1041	PCT Pub. WO2010/099806A1 (“Rossi”)
Ex. 1042	US Patent Pub. 2009/0205747 (“Lillard”)
Ex. 1043	U.S. Patent Pub. 2010/0078480A1 (“Aker”)
Ex. 1044	U.S. Patent Pub. 2013/0099597 (“Perentes”)
Ex. 1045	Official English translation of German application No. 102011010534.4 (“February 2011 Application”)
Ex. 1046	Official English translation German application No. 102010031988.0 (“July 2010 Application”)
Ex. 1047	Official English translation German application No. 102010044251.8 (“September 2010 Application”)

Exhibit	Description
Ex. 1048	K-Fee System GmbH v. Nespresso USA, Inc. et al., Case No. 2:22-cv-00525 (“Complaint”)
Ex. 1049	K-Fee System GmbH v. Nespresso USA, Inc. et al., Case No. 2:22-cv-00525 – Supplemental Disclosure of Infringement Contentions (July 11, 2022) (“Infringement Contentions”)
Ex. 1050	Excerpt from Prosecution History of U.S. Appl. No. 13/744,623 (“’623 Appl.”)
Ex. 1051	https://nestle-nespresso.com/our_products/product (“Nespresso Vertuo System”)
Ex. 1052	K-Fee System GmbH v. Nespresso USA, Inc. et al., Case No. 2:21-cv-3402; Dkt. 111. (“Claim Construction Order”)
Ex. 1053	Intentionally Omitted
Ex. 1054	K-Fee System GmbH v. Nespresso USA, Inc. et al., Case No. 2:21-cv-3402; Dkt. 211. (“Summary Judgment Order”)
Ex. 1055	Food Packaging and Shelf Life: A Practical Guide (2009), Chapter 11 – “Packaging and the Shelf Life of Coffee” (“Food Packaging”)
Ex. 1056	Illy, Andrea, and Rinantonio Viani, eds. Espresso coffee: the science of quality. Academic Press, 2005. (“Espresso Coffee”)
Ex. 1057	Excerpt from Appl. No. 16/538,752: Nov. 8, 2019 Office Action Rejection (“752 Appl. First Rejection”)
Ex. 1058	Excerpt from Appl. No. 16/538,752: Jan. 23, 2020 Response to Office Action (“752 Appl. First Response”)
Ex. 1059	Excerpt from Appl. No. 16/538,752: Apr. 28, 2020 Office Action Rejection (“752 Appl. Second Rejection”)
Ex. 1060	Excerpt from Appl. No. 16/538,752: Jul. 27, 2020 Response to Office Action (“752 Appl. Second Response”)
Ex. 1061	Excerpt from Appl. No. 16/538,752: Nov. 3, 2020 Notice of Allowance (“752 Appl. Notice of Allowance”)

Exhibit	Description
Ex. 1062	Excerpt from Appl. No. 16/860,441: Jul. 13, 2020 Office Action Rejection (“441 Appl. First Rejection”)
Ex. 1063	Excerpt from Appl. No. 16/860,441: Oct. 13, 2020 Response to Office Action (“441 Appl. Response”)
Ex. 1064	Excerpt from Appl. No. 16/860,441: Nov. 12, 2020 Notice of Allowance (“441 Appl. Notice of Allowance”)
Ex. 2001	441 Appl. Notice of Allowance
Ex. 2002	Applicant-Initiated Interview Summary for Appl. No. 16/538,752
Ex. 2003	K-fee System GmbH v. Nespresso USA, Inc., Case No. 2:21-cv-3402 GW(AGRx), Dkt. No. 126-1 (Apr. 1, 2022)
Ex. 2004	K-fee System GmbH v. Nespresso USA, Inc., Case No. 2:21-cv-3402 GW(AGRx), Dkt. No. 211 (June 17, 2022)
Ex. 2005	K-fee System GmbH v. Nespresso USA, Inc., Case No. 2:21-cv-3402 GW(AGRx), Dkt. No. 71 (January 19, 2022)
Ex. 2006	Excerpts from file history of Appl. No. 16/538,752
Ex. 2007	Examiner-Initiated Interview Summary for Appl. No. 17/324,182
Ex. 2008	Examiner-Initiated Interview Summary for Appl. No. 17/108,175
Ex. 2009	File History of U.S. Patent No. 10,800,600
Ex. 2010	Excerpts from file history of Appl. No. 16/860,441
Ex. 2011	Applicant-Initiated Interview Summary for Appl. No. 17/963,392

Exhibit	Description
Ex. 2012	Notice of Allowance for Appl. No. 17/330,572
Ex. 2013	Excerpts from Appl. No. 17/670,629
Ex. 2014	NOT USED
Ex. 2015	NOT USED
Ex. 2016	NOT USED
Ex. 2017	Declaration of Laurens “Lars” Howle in Support of Patent Owner’s Response (“Howle Decl.”)
Ex. 2018	NOT USED
Ex. 2019	Transcript of deposition of Michael Jobin taken November 28, 2023
Ex. 2020	NOT USED
Ex. 2021	NOT USED
Ex. 2022	NOT USED
Ex. 2023	NOT USED
Ex. 2024	NOT USED
Ex. 2025	NOT USED
Ex. 2026	Brian D. Wood, et. al., <i>Modeling Turbulent Flows in Porous Media</i> , Annu. Rev. Fluid Mech. (2020)

17. I also referenced other publications in order to confirm my understanding of the state of the art.

18. My opinions are additionally guided by my appreciation of how a POSITA would have understood the claims of the '923 Patent and its earlier-filed applications at the time of the invention, which I have been asked to assume is February 7, 2011.

III. Understanding of Governing Law

19. I am not an attorney and do not have formal legal training. Consequently, I offer no opinion on the law itself. The following understanding of law has been provided to me by counsel. I have applied this understanding in my analysis.

20. I have been informed and understand that a person having ordinary skill in the art (“POSITA”) is a hypothetical person who is presumed to be aware of all pertinent prior art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

21. I have been informed and understand that a patent is entitled to the filing date of its earlier-filed applications so long as the earlier-filed applications provide written description support by disclosing the claimed invention to a POSITA, with all of the POSITA’s knowledge and creativity.

A. Priority

22. I have been informed and understand that a patent is entitled to the filing date of its earlier-filed applications so long as the earlier-filed applications provide

written description support by disclosing the claimed invention to a POSITA, with all of the POSITA's knowledge and creativity. I further understand that support for the claimed embodiments as a whole may be shown through description of a combination of elements that are linked to create the claimed embodiments in an earlier-filed application.

B. Anticipation

23. I have been informed that a patent claim is invalid as anticipated under 35 U.S.C. § 102 if each and every element of a claim, as properly construed, is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or includes the claimed elements, it anticipates.

24. I have been informed that a patent claim is invalid as anticipated under 35 U.S.C. § 102 if each and every element of a claim, as properly construed, is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or includes the claimed elements, it anticipates.

25. I have been informed that a claim is invalid under 35 U.S.C. § 102(a) if the claimed invention was known or used by others in the U.S., or was patented or published anywhere, before the Applicant's invention.

26. I further have been informed that a claim is invalid under 35 U.S.C. § 102(b) if the invention was patented or published anywhere, or was in public use, on sale, or offered for sale in this country, more than one year prior to the filing date of the patent application (critical date).

27. And a claim is invalid, as I have been informed, under 35 U.S.C. § 102(e), if an invention described by that claim was described in a U.S. patent granted on an application for a patent by another that was filed in the U.S. before the date of invention for such a claim.

C. Obviousness

28. I have been informed that a patent claim is invalid as “obvious” under 35 U.S.C. § 103 in light of one or more prior art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention (“POSITA”), taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness, which include “long felt need” for the claimed invention, commercial success attributable to the claimed invention, unexpected results of the claimed invention, skepticism of others, failure by others to achieve the claimed invention, and “copying” of the claimed invention by others.

29. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify the single prior art reference, or combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved. The reason that would have prompted a POSITA to modify the single prior art reference, or combine two or more references may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

D. Claim Construction

30. I understand that claim construction is a matter that will be decided by the Board presiding over this IPR. I understand that the relevant inquiry in claim construction is the question of how a person of ordinary skill in the art would have understood the claim terms at the time of the earliest priority date, in light of the

patent specification, the prosecution history, and any other relevant intrinsic and extrinsic evidence.

31. I understand that claim construction is a matter that will be decided by the Board presiding over this IPR. I understand that the relevant inquiry in claim construction is the question of how a person of ordinary skill in the art would have understood the claim terms at the time of the earliest priority date, in light of the patent specification, the prosecution history, and any other relevant intrinsic and extrinsic evidence.

32. For the purposes of this Declaration, I understand that Petitioner has not proposed formally construing any term of the '923 Patent, and therefore, the claim terms should be given their plain and ordinary meaning as would be understood by a person of ordinary skill in the art.

IV. The Level of Ordinary Skill in the Art and Perspective Applied in this Declaration

33. I have reviewed the qualifications that Petitioner contends that a POSITA would have. I note that the Board, in its Decision Granting Institution of Inter Partes Review of the '923 Patent, adopted Patent Owner's definition of the level of ordinary skill, which requires a POSITA to have a bachelor's degree in engineering plus five years of experience in design of mechanical beverage systems, or similar products, as well as experience with sensors for recognizing an identifier. IPR2023-00502, Paper 9 at 8. Additional education might substitute for some of the

experience, and substantial experience might substitute for some of the educational background. I adopt this definition for the purposes of this Declaration.

34. I would have qualified as a person of at least ordinary skill in the art as of September 2, 2010, and I have a sufficient level of knowledge, experience, and education to provide an expert opinion in the field of the challenged claims of the '923 Patent.

V. Overview of the '923 Patent and Prosecution

35. The '923 Patent is titled "Portion Capsule Having an Identifier" and published on May 4, 2021, from an application filed June 12, 2019. Ex. 1001 at (22), (45), (54). The claims of the '923 Patent are generally directed to a portion capsule for producing a beverage. Ex. 1001 at Abstract. The portion capsule includes a base element with a cavity in which a beverage raw material is provided and closed by a membrane fastened to the base element. *Id.* An object of the '923 Patent is to "provide a portion capsule which only is suitable for a specific coffee machine" to avoid the security issues and potential damage that might result from the use of capsules designed by other manufacturers that are not suited for use in a particular beverage machine. *Id.* at 1:11-24. The '923 Patent has two independent claims (Claims 1 and 9) and 14 dependent claims (Claims 2-8 and 10-16).

36. The family claims priority to PCT No. PCT/EP2011/003677 ("the PCT application"), which was filed on July 22, 2011. The PCT application, in turn, claims

priority to three German patent applications: DE 10 2010 031 988.0 filed on July 22, 2010 (Ex. 1046 or “the first German application”); DE 10 2010 044 251.8 filed on September 2, 2010 (Ex. 1047 or “the second German application”); and DE 10 2011 010 534.4 filed on February 7, 2011 (Ex. 1045 or “the third German application”) (collectively, “the German applications”).

37. During prosecution of the ’923 Patent, Examiner Smith considered each of the three references Petitioner relies upon here. In complying with its duty of candor to the USPTO throughout the course of examination, Patent Owner submitted all of the information concerning validity that Petitioner asserted against patents related to the ’923 Patent. *See* Ex. 1002, Part 1 at 51, 86; Part 3 at 46, 301, Part 4 at 329, Part 6 at 36 (showing references from previous related examinations in the patent family, including foreign prosecution and observation documents, opposition documents, suggestions for interference, and cited documents and exhibits). Examiner Smith indicated that he had considered all of these submissions by signing the IDSs with a statement that “ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.W.J/.” *See* Ex. 1002, Part 2 at 348-351, 356-82.

38. I believe Examiner Smith was well aware of the prior art landscape, including the now-cited art, in the ’923 Patent application and related applications. Shortly after the application resulting in the related ’176 Patent was transferred to Examiner Smith from a different Examiner, Applicant called him to discuss claim

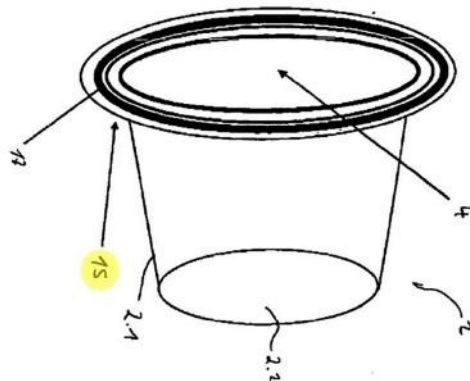
26 of the pending application, “and to advise that they intended to file a translation of their foreign priority document to overcome the Jarisch reference.” Ex. 2002 at 2. Independently of Patent Owner bringing Jarisch to his attention during the interview, Examiner Smith had relied on a prior publication of Jarisch in combination with other references to reject claims of the related pending ’531 Patent application as obvious months before he mailed the Notice of Allowance for the ’923 Patent at issue here. Ex. 1062 at 15 (explaining that “Jarisch further discloses that it was well established to place barcodes...on the bottom side of the flange of a portion capsule (fig. 2 and 3).”). A few days later, on July 17, 2020, the Applicant called Examiner Smith “to discuss the claims of the ’923 Patent application in general and particularly the placement of the barcode on the peripheral region...of the basic element prior to the submission of an amendment.” Ex. 1002, Part 2 at 384. Applicant amended the claims to include, among other limitations, radially spaced and vertically oriented grooves and ribs. Ex. 1002, Part 2 at 338. The Examiner then allowed the claims based on the amendments and arguments and issued a Notice of Allowance on November 4, 2020. Ex. 1002, Part 6 at 48.

VI. The German Priority Applications

39. The first German application teaches a “portion capsule” which contains a beverage raw material, such as ground coffee, wherein the portion capsule has an “identifier” that “makes it possible to individualize the respective portion

capsule.” Ex. 1046 at 22. In one embodiment, the portion capsule “is provided with an electrically conductive coating, for example...an aluminum foil.” Ex. 1046 at 30:21-25. The identifier indicates that the portion capsule is “suitable only for a specific coffee machine.” Ex. 1046 at 3. The disclosed invention thus prevents “serious safety problems and/or damage to the coffee machine” that may arise from the use of a capsule that is “not suitable” for a particular coffee machine. *Id.* The first German application specifies the invention as follows: “A sensor/detection medium provided on the coffee machine detects this identifier and preferably compares it with a stored identifier. Preferably, ***the coffee machine can only be put into operation***, especially its pressure pump, which provides the water, ***if the determined identification corresponds to the reference identification***. Otherwise, the coffee machine cannot be put into operation.” *Id.* at 4 (emphases added).

40. The identifier may take a variety of forms, including a barcode. Ex. 1046 at 5, 7, Fig. 2. “[T]he barcode can be provided on the side of the edge area of the base element facing away from the membrane [4], as symbolized by arrow 15.” *Id.* at 7 (emphasis added). The identifier can be used to control the operation of the



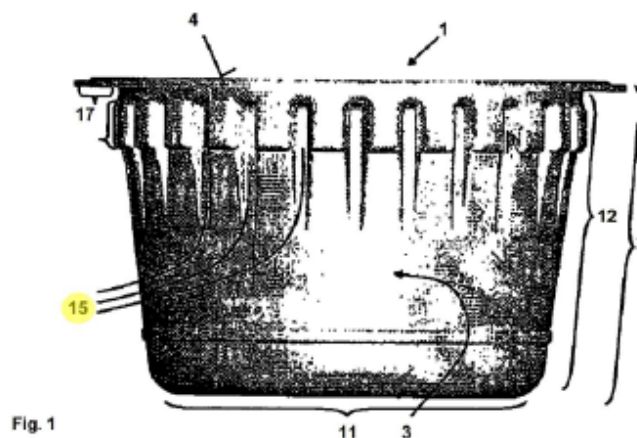
coffee machine: “With the portion capsule according to the invention, it is possible to prevent that portion capsules, which are not intended for a certain coffee machine, are introduced into this machine. Furthermore, it is possible for the coffee maker to recognize which type of capsule is in its brewing chamber and to adjust the beverage or food production process, for example the amount of water, its pressure and/or its temperature accordingly.” *Id.* at 5. The identifiers of the various embodiments are linked by common subject matter, namely, that they are configured for use in a coffee machine with a brewing chamber.

Ex. 1046 and Ex. 1047 at Fig. 2 (annotated)

41. The second German application introduces an additional embodiment of the identifier that relies on a mechanical feature of the capsule. In particular, the second German application discloses teeth on the rim of the capsule with a corresponding detector on the coffee machine that interacts with the capsule and/or provides support via two holding arms. Ex. 1047 at 8-9. The second German application also describes an optional filter element for the portion capsule. *See id.* at 12:17-19 (“The raw material and, ***if appropriate***, inserts, in this case a filter, are provided in this basic element.”) (emphasis added).

42. The third German application discloses that the cavity of the portion capsule may be closed by a metal cover. Ex. 1045 at 28:32-33 (“The membrane 4 preferably comprises...an aluminum foil.”). The third German application further

discloses a plurality of vertical grooves that are designed to (1) prevent buckling of the walls of the capsule and (2) optimize the extraction of the liquid that results from the production process. Ex. 1045 at 2:14- 3:9; *see also id.* at 3:26-35 (the grooves “optimize the flow of the extraction liquid along the basic-element region” and allow for “more pronounced turbulence of the extraction liquid in the cavity”). The “grooves 15 are formed in particular as grooves which are introduced into the wall region 12 and extend substantially longitudinally between the flange 17 and the base region 11 in the form of grooves which face the cavity 3 (i.e. extend substantially perpendicularly in the representation according to Figure 1).” *Id.* at 8:21-25. As pictured at least in Figure 1, the grooves do not extend entirely to the bottom region of the capsule.



Id. at Fig. 1 (annotated)

VII. Overview of the Prior Art

A. Yoakim (U.S. Patent Pub. No. 2010/0239734)

43. Yoakim is titled “Method for Preparing a Beverage or Food Liquid and System Using Brewing Centrifugal Force” and was published on September 23, 2010, from an application filed May 7, 2010. Ex. 1004 at (54), (43), (22).

44. Yoakim generally relates to a capsule-based system and method for preparing a liquid food or beverage through centrifugation. Ex. 1004 at Abstract. Specifically, Yoakim describes a method of brewing or extraction that uses centrifugal forces to rotate a capsule so that “the centrifugal rotation of the capsule urges the liquid to flow through the ingredient(s) in a radial or centrifugal flow path to prepare the liquid food.” *Id.* at [0020].

45. The device described in Yoakim can introduce water into the capsule after the capsule is pierced “at substantially no pressure” such as by “a hot water feed mechanism using a principle of aspiration or vaporization;” a “low-pressure pump such as a peristaltic pump or a diaphragm pump and the like;” or some other “water feed means for introducing water in the capsule.” Ex. 1004 at [0132], [0133], [0149]; *see also id.* at [0180] (“A fluid transport means such as a low pressure pump 6 can be provided in the water circuit to transport water from the reservoir to the module . . . Water can be fed into the module 4 at low or substantially no pressure.”); [0428] (“Water can be fed in the beverage preparation module 124 at low pressure

or even at gravity pressure.”). The device described in Yoakim also contains a “control unit” that can be programmed to vary the centrifugal rotation speeds used to drive the capsule in rotation. *Id.* at [0153].

46. Yoakim teaches a filter inside the capsule made of “a series of slits” where “the brewed liquid can pass through the slits whereas the solid particles are retained in the capsule.” Ex. 1004 at [0171]; *see also id.* at [0271] (“Preferably, the capsule comprises an **internal filter portion** placed at the periphery of the enclosure. The **internal filter portion** can be an internal perforated lid and/or a portion of porous material.”), [0375] (“Preferably, the outlet openings of the enclosure of the capsule have an average diameter or width which is Smaller than the average size of the particles forming the food Substance.”), [0376] (“Therefore, **the openings can have a filtering function** ‘per se.’”); *see also* Figs. 28, 29, 39. It further teaches that “[a]n additional filtering layer can be used to filter liquid depending on the size of the outlets” and “depending on the size of the outlets,” it may be necessary to provide additional filtering to ensure the solid particles are retained in the capsule. *Id.* at [0171]. The figures in Yoakim further teach a filter inside the capsule – for example, Figures 41 and 42 include a porous wall 180, which is a filter and depicted within the cavity of the capsule. *Id.* at [0451] (“According to FIGS. 41 and 42, the capsule in the system of the invention may also comprise an enclosure which is formed of a dished body 102 and a porous wall 180. The dished body comprises a main cavity

182 for storing the food substance and a peripheral recess 181 for receiving the liquid extract that traverses the porous wall 180 during the centrifugation process.”), [0452] (“The porous wall 180 can have openings (i.e., pores) along its whole surface...”).

47. Yoakim describes that compared to “known methods using brewing water pressurized by a pump,” “surprising improved brewing results are obtained” because “water flow is more uniformly distributed by centrifuge effect and it creates less or no preferential flow paths in the coffee bed as compared to traditional methods using a positive pressure obtained by a pressure pump.” Ex. 1004 at [0124]; *see also id.* at [0443] (“Consequently, the water distribution is also more uniform compared to known methods using a pressure pump to provide a water piston through the coffee in the capsule.”); *see also id.* at [0132], [0180] (stating that without the use or activation of a pump, “hot water is introduced into the capsule at substantially no pressure. Water can be brought by a hot water feed mechanism using a principle of aspiration or vaporization”). Moreover, Yoakim describes that “flow rates [] are influenced by two key parameters: the rotational speed of the capsule in the device and the back-pressure exerted on the centrifuged liquid.” *Id.* at [0521]. “The back-pressure can be varied by varying the closing force of a flow restriction valve placed downstream of the enclosure of the capsule and/or by varying the cross-section of the restriction outlets.” *Id.*; *see also id.* at [0523] [0136]; [0429]; [0501].

48. Yoakim teaches indentations on the “outer surface” of the capsule—specifically, Yoakim teaches the enclosure has “a widening side wall located between top and bottom walls, and an outer surface or structure for engaging external rotational driving means of a centrifugal device with the outer surface or structure configured to offer resistance....” Ex. 1004 at [0016].

49. Yoakim further describes an identification means and control means for operating the device according to predetermined brewing parameters. Ex. 1004 at [0485]-[0488]. The identification means comprises “capsule recognition means” which can be recognized by sensing means connected to the control means. *Id.* at [0025] (“identification means comprising capsule recognition means which are recognized by sensing means connected to the control means of the device to control the preparation parameters accordingly.”), [0487], [0495]. As an example, the recognition means can be differentiable by an “identifiable shape,” or a visual code. *Id.* at [0496]; [0525] (“The recognition means can be any mechanical, topical, magnetic or radio-frequency recognition means capable of delivering information to the brewing device, via a sensing device 231, as to which type of capsule is inserted in the device. For example, the recognition means is a barcode, a colour code, a RFID tag, a magnetically sensitive element, or a mechanical key or shape.”); [0192] (“A recognition system uses a code on the capsule and recognized by the device, such as . . . shapes and combinations thereof.”).

B. Jarisch (U.S. Patent Pub. No. 2013/0064937)

50. Jarisch is titled “Capsule, System and Method for Preparing a Beverage by Centrifugation” and published March 14, 2013 from an application filed May 12, 2011. Ex. 1005 at (22), (43), (54).

51. Jarisch is directed to a capsule for the preparation of a beverage comprising a container and beverage ingredient therein, wherein the container comprises a code adapted for being identified or read by external readings means. Ex. 1005 at Abstract. The code is arranged on the contained to be read while the capsule is rotated around an axis. *Id.* Jarisch particularly focuses on the detection of the capsule. *Id.* at [0001].

C. Rapparini (US2012/0269933A1)

52. Rapparini is titled “Filtering and Permeable Container for Substances Suitable for the Preparation of Beverages” and published October 25, 2012, from an application filed October 19, 2010. Ex. 1008 at (22), (43), (54).

53. Rapparini is directed to a filtering and permeable container for substances suitable for the preparation of beverages, the container being made by means of thermoforming starting from a flat strip of permeable, filtering and thermoformable material, wherein the body of the container comprises longitudinal stiffening ribs wherein the length of the ribs is variable along the surface of the body. The container can be adapted to contain water-soluble products or coffee, tea, herbal

tea, or similar substances adapted to obtain hot or cold beverages. Ex. 1008 at Abstract.

VIII. Summary of Opinions

54. In my opinion, Petitioner's arguments fail because: (1) Petitioner relies on a reference that is not prior art. The '923 Patent is entitled to a priority date that predates the Jarisch reference upon which Petitioner relies in the Petition; (2) Petitioner cannot demonstrate that Yoakim teaches the cavity "is free of a filter" limitations of independent claim 1 and dependent claim 10; (3) Petitioner cannot demonstrate that Yoakim alone and/or in combination with Rapparini teaches "the wall region includes radially spaced and vertically oriented grooves that are free from extending entirely to the bottom region" limitations of independent claims 1 and 9; (4) Petitioner cannot demonstrate that Yoakim alone and/or in combination with Rapparini teaches "generat[ing] turbulence of water in the cavity" limitations of claims 7 and 13; and (5) Petitioner cannot demonstrate a person of ordinary skill in the art ("POSITA") would have been motivated to combine the teachings of Yoakim, Jarisch, and Rapparini to arrive at the novel single-serve capsules of independent claims 1 and 9.

IX. K-fee's German Priority Applications Antedate Jarisch

55. The '923 Patent properly claims priority to the German applications. It is my understanding that in the three previous Petitions filed by Petitioner against

this family of patents (IPR2021-01221, IPR2021-01222 and IPR2021-01223), Petitioner argued that the German applications collectively failed to provide priority support. Petitioner continues to advance the same unsuccessful argument when it argues that “[t]he Board has already found that the Office determined Patent Owner should not receive priority to its foreign applications.” Pet. at 39. That is incorrect.

56. My understanding is that, at most, the Board made a finding that the examiner of the application leading to the ’176 Patent “expressly considered whether Jarisch was prior art, given the dates of the German priority application, and was not persuaded that Jarisch was not prior art.” IPR2021-01223, Paper 11 at 5. However, I understand that when the Examiner of the applications leading to the challenged ’177, ’531, ’491, and ’430 Patents was recently presented with status updates regarding the prior and pending IPRs, the Examiner acknowledged that “[t]he priority dates of the applications, and prior art cited, under Pre-AIA were verified.” Ex. 2007 at 2; Ex. 2008 at 2. Moreover, a different Examiner similarly stated that he “did not find any issue with patent owner’s foreign priority date” after discussing the IPR filings with Applicant on March 24, 2023. Ex. 2011 at 2. As such, Examiners continue to affirm Patent Owner’s entitlement to the priority date of its German applications.

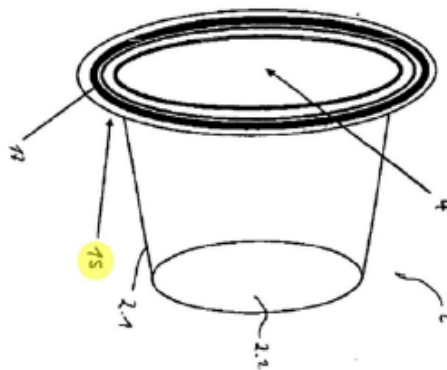
57. I understand that Petitioner bases its argument that priority was unavailable on the allegation that no single foreign priority application disclosed

each and every feature of the claims. However, Petitioner does not challenge the fact that each and every limitation of the '923 Patent claims was conceived of, possessed by the inventor, or is disclosed in the three German priority documents. Even despite Patent Owner's conception of the subject matter of the '531 Patent claims before Jarisch, Petitioner argues that Patent Owner should not be entitled to the benefit of this conception, thus allowing Jarisch to be considered as prior art. This is also incorrect in my opinion.

58. Petitioner relies upon Jarisch as disclosing a barcode located on the bottom side of a flange. Pet. at 56. In particular, Petitioner cites to Figure 5 and ¶¶ [0022], [0014]-[0015], in addition to the Jobin declaration. *Id.* Petitioner argues that this satisfies the [1.j] and [9.h] limitation of claims 1 and 9 of the '923 Patent. In my opinion, the first German application demonstrates that Patent Owner had possession of what Jarisch discloses. Ex. 2001.

59. The first German application demonstrates that Patent Owner had conceived of an identifier such as a barcode, located under the flange of the capsule, which could be read by the coffee machine to provide instructions as to coffee machine operation. Ex. 2001 at ¶¶ 10-18; Ex. 1046 at p. 4, ¶ 1 ("A sensor/detection medium provided on the coffee machine detects this identifier and preferably compares it with a stored identifier."); p. 4, ¶ 2 ("the identifiers are surface areas with different optical properties, for example reflection properties"); p. 5, ¶ 1 ("the

imprint is a barcode”); p. 5, ¶ 5 (“Furthermore, it is possible for the coffee maker to recognize what type of capsule is in its brewing chamber and to adjust the beverage or food production process, for example the amount of water, its pressure and/or temperature accordingly”); p. 7, ¶ 2 (describing Figure 2, “the barcode can be provided on the side of the edge area of the base element facing away from the membrane, as symbolized by arrow 15”). Moreover, the first German reference discloses a “code” under the flange, specifically a barcode.



Ex. 1046, Fig. 2 (annotated).

60. I understand that, even if Petitioner were to argue that the barcode disclosed in the first German application is somehow not a code, the law states that an applicant should not be prevented from obtaining a patent to an invention where a compound described in a reference would have been obvious to one of ordinary skill in the art in view of what the affiant proves was completed with respect to the invention prior to the effective date of the reference. Therefore, the species that is disclosed by the first German application would have at least rendered the specific

elements of the species disclosed by Jarisch – a code under the flange of a capsule – obvious from the perspective of a person having ordinary skill in the art.

61. Moreover, Petitioner does not dispute that the third German application has “vertical grooves and ribs on the exterior and interior of the capsule body wall.” Pet. at 40. Additionally, Petitioner does not dispute that the first and second German application “discloses a barcode located on the capsule flange.” Pet. at 41.

62. Overall, Jarisch discloses no more than what was already known by the inventor and Patent Owner, and constructively reduced to practice by virtue of the first German application on July 22, 2010 – more than 9 months before Jarisch’s effective date of May 12, 2011. Therefore, the German applications antedate Jarisch. Petitioner’s Ground 1 hinges on Jarisch. *See, e.g.*, Pet. at 55-56, 58, 65. Accordingly, Jarisch should be removed as a reference from Ground 1.

X. The ’923 Patent Is Not Unpatentable As Obvious

63. In my opinion, there is little to no evidence that a POSITA would have arrived at the claimed inventions merely through the teachings of Yoakim, Jarisch, and Rapparini (Ground 1) presented in the Petition.

A. Yoakim Fails to Disclose a Capsule Free of a Filter (Claims 1, 10)

64. Claim element [1.b] and claim 10 each require a cavity that “is free of a filter.” According to Petitioner, “Yoakim discloses a portion capsule with a cavity that does not include a filter, and expressly confirms that a filter is optional.” Pet. at

50. In my opinion, Petitioner is incorrect – Yoakim expressly teaches that his capsules contain a filter, and that such filter is inside the cavity, for the purpose of filtering the brewed liquid from the solid particles in the capsule. Indeed, this is evident from the passages and figures Petitioner cites, which lack any express statement that Yoakim’s capsule lacks a filter.

65. Specifically, Yoakim at [0171] teaches a filter made of “a series of slits” where “the brewed liquid can pass through the slits whereas the solid particles are retained in the capsule.” Yoakim teaches sizing these slits “to also filter the brewed liquid and maintain solid particles of the substance in the capsule.” Ex. 1004 at [0131]. Yoakim at [0171] further teaches that “[a]n *additional* filtering layer can be used to filter liquid depending on the size of the outlets.” *Id.* A POSITA would have understood this “additional filtering layer” to be additive to the slits already described in the same paragraph. Indeed, Yoakim explains that “depending on the size of the outlets,” it may be necessary to provide additional filtering to ensure the solid particles are retained in the capsule. *Id.* Smaller outlets would not need such additional filtering, whereas larger outlets likely would in order to separate (filter) brewed liquid from the solid particles. Ex. 1004 at [0210] (“The slits are sized so as *to act as a filter* for retaining the solid particles such as the ground coffee particles but let the liquid leave the capsule.”). Mr. Jobin testified that “[a]ccording to 0171 [of Yaokim] and my general understanding in Yoakim, it depends on the size of the

holes and that one can add a filter to -- to change the characteristics of the -- of the filtering function.” Ex. 2019 at 59:17-22. As a practical matter, large outlets *without* an additional filtering layer would result in particles of beverage material in the final beverage product—which would negatively impact the drinking experience and would be contrary to Yoakim’s teachings and stated purpose of “better ... controlling quality of the final brewed beverage or food liquid product” (Ex. 1004 at [0010]; *see also id.* at [0011], [0012], [0210]). Yoakim at [0171] thus teaches the capsule has a filter. Ex. 1004 at [0171].

66. Other portions of Yoakim support this conclusion. *See id.* at [0131] (“[T]he capsule comprises a plastic lid welded on a cup-shaped body whereas a series of premade peripheral outlets are provided in the lid and/or body for the brewed liquid to leave the capsule under the effect of the centrifugal forces. The premade peripheral outlets may be a series of small slits of small size to also filter the brewed liquid and maintain solid particles of the substance in the capsule”), [0334] (“Depending on the size of the openings, the plurality of openings may also be given a function to filter the liquid from the solid particles that may be contained in the enclosure such as coffee particles.”), [0337]-[0338] (“Preferably, each of the outlet openings has a diameter or width which is smaller than the average size of the particles forming the food substance....Therefore, the openings can have a filtering function ‘per se’”), [0343] (“In a possible mode, the portion of wall with the outlet

openings can be formed from a paper filter or woven, non-woven fibres, meshed material, porous polymer membrane or combination thereof”), [0375]-[0376] (“Preferably, the outlet openings of the enclosure of the capsule have an average diameter or width which is smaller than the average size of the particles forming the food substance....Therefore, the openings can have a filtering function ‘per se’”), [0444] (“These outlet openings 118 of the enclosure of the capsule are sized as a function of the substance stored in the capsule. Small openings such as slots of small width or holes of small diameter tend to provide a filtering function to retain the solid particles in the enclosure of the capsule while allowing only the liquid extract to pass the openings”), [0448] (“[T]he outlet openings are formed by a filter paper, a woven or non-woven filtering portion or another meshed or porous membrane 720. Thus, the lid 108 which is inserted in the dished body 102 comprises a circumferential band of a porous material. The porous material provides restriction of the flow, creating a certain pressure drop, *e.g.*, between 0.5 and 4 bar, and leading to a filtering of the solid particles.... The lid also comprises an annular recess 116 for collecting the centrifuged liquid which travels through the peripheral filter band”).

67. The fact that Yoakim’s capsules use filters is confirmed by other paragraphs in Yoakim. *See, e.g.*, Ex. 1004 at [0271] (“Preferably, the capsule comprises an *internal filter portion* placed at the periphery of the enclosure. The

internal filter portion can be an internal perforated lid and/or a portion of porous material.”), [0375]-[0376] (“Preferably, the outlet openings of the enclosure of the capsule have an average diameter or width which is smaller than the average size of the particles forming the food substance....Therefore, *the openings can have a filtering function* ‘per se’”), [0255] (“The liquid delivered from the capsule can also be *filtered by filtering means provided in the capsule*. Such a configuration has many advantages because the device is simplified, the filter does not require cleaning since it is discarded with the capsule.”), [0265] (“In order to *filter* the liquid in the capsule before it is centrifuged out through the (e.g., pierced) outlets, a *filter part* is positioned in the capsule to separate a cavity containing the substance and a cavity for collecting the centrifuged liquid.”), [0272] (“The capsule can also comprise a collecting recess forming an annular portion below the puncturable membrane. The collecting recess is positioned to collect the centrifuged liquid passing through the *filter portion*.”), [0300] (“The capsule may comprise a *filter means to filter* the centrifuged before the liquid is released from the outlets at the sidewall. Preferably, the *filter* is distant from the sidewall along the median transversal plane inside the capsule. The *filter* can be a *cylindrical filter* extending from the upper wall to the lower wall.”).

68. And even more paragraphs. Yoakim at [0424] (“It can also be noticed that a *filter wall* can also be placed inside the enclosure against the inside surface

112 of the lid. A *filter wall can provide an improved filtration*, for example, for substance of very thin particle size and/or for delaying the release of the centrifuged liquid out of the enclosure by creating a higher pressure drop. A *filter wall* can be a paper filter or thin plastic film which is glued onto the surface 112 of the lid”), [0460] (“In FIG. 44...[a]n internal lid 1810 is also provided to demarcate an internal enclosure with the body 102 and secure a *filter part in the capsule*”), [0461] (Describing Fig. 45 as showing that “the capsule may comprise a *filter part* 708 delimiting the cavity 709 for the substance and a collecting recess 710 peripherally placed relative to the central cavity. The *filter part* may, for instance, be an integral part of the body 705 or a part which is added in the capsule, *e.g.*, a *filter cylinder*”), [0462] (Describing Fig. 46 as including “a *filter part* 807 [that] can be provided in the capsule which also delimits a cavity 808 for receiving the substance and a collecting recess 809 for the centrifuged liquid”), [0465] (“A *filter part* 912 can be inserted in the capsule to delimit the enclosure for the substance 913 and the collecting recess 914. For instance, *the filter part* can be a porous tubular member which can form a support ring for maintaining the upper and lower walls of the shelves at distance”), [0107] (“the invention provides for a method for preparing a beverage or food liquid from a food substance contained in a *filtering receptacle by passing water through the substance using brewing centrifugal forces*”); [0113] (“The method more particularly relates to the preparation of a food liquid or

beverage, in a beverage preparation device, from a food substance contained in a *filtering receptacle by passing water through the substance using brewing centrifugal forces*”).

69. And even more. Yoakim at [0139], [0173] (“The invention also concerns a system for preparing a beverage or food liquid from a food substance contained in a *filtering receptacle by passing water through the substance using centrifugal forces*”), [0288] (“The capsule may comprise a *filter means to filter* the centrifuged before the liquid is released from the outlets at the sidewall”), [0016] (describing a “capsule further comprising a collecting cavity for receiving the prepared liquid food with the cavity positioned adjacent to the largest perimeter of the flared design of the enclosure, and a *filter part* separating the extractable or infusible ingredient(s) and the collecting cavity food with the *filter part* optionally spaced from the top wall by a gap”), [0266] (“In order to promote the exit of the liquid through the capsule, the *filter part* can be inclined relative to the widening sidewall. In a particular mode, *for a larger filtering area, the filter part can extend across the whole thickness of the enclosure*. For instance, the *filter part* can be substantially cylindrical. More specifically, the *filter part* can be an integral extension part of an internal lid of the capsule. The capsule can be designed with a limited number of pieces and can be assembled in a more economical and simpler manner. In a different mode, the *filter part* is substantially parallel to the upper wall.

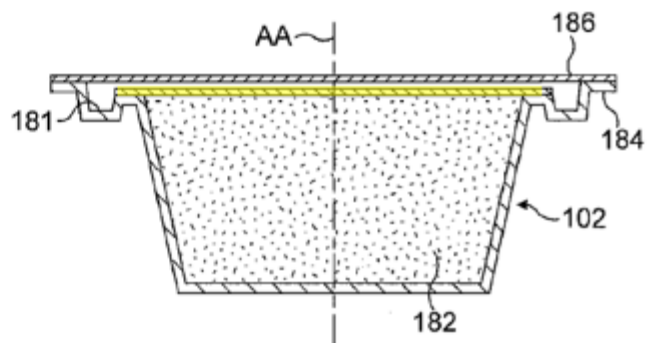
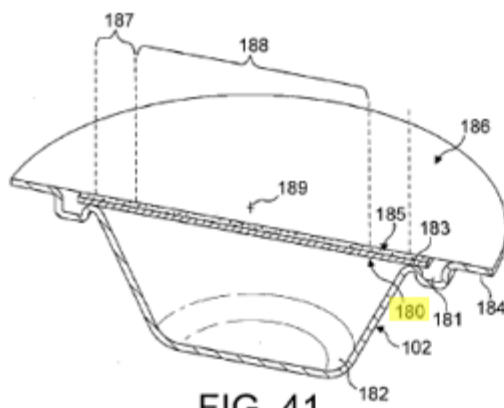
In this case, the *filter part* is spaced from the upper wall by a small gap”), [0210] (“The brewed liquid that is centrifuged is allowed to pass through a series of slits 810 provided on the upwardly protruding edge 880 of the body. The slits are sized so to act as a *filter* for retaining the solid particles such as the ground coffee particles but let the liquid leave the capsule.”), [0450] (“In another preferred embodiment, the lid comprises a recess 116 which can be filled by a porous compressible material to provide a *filtering function* as well. For example, the material could be sponge or fabric”).

70. The figures in Yoakim are consistent with the above discussions of a filter in Yoakim’s capsule. *See, e.g.*, Figs. 16-19, 28, 29, 39, 41, 42, 44. As well as Yoakim’s claims 4 and 6, which teach filters.

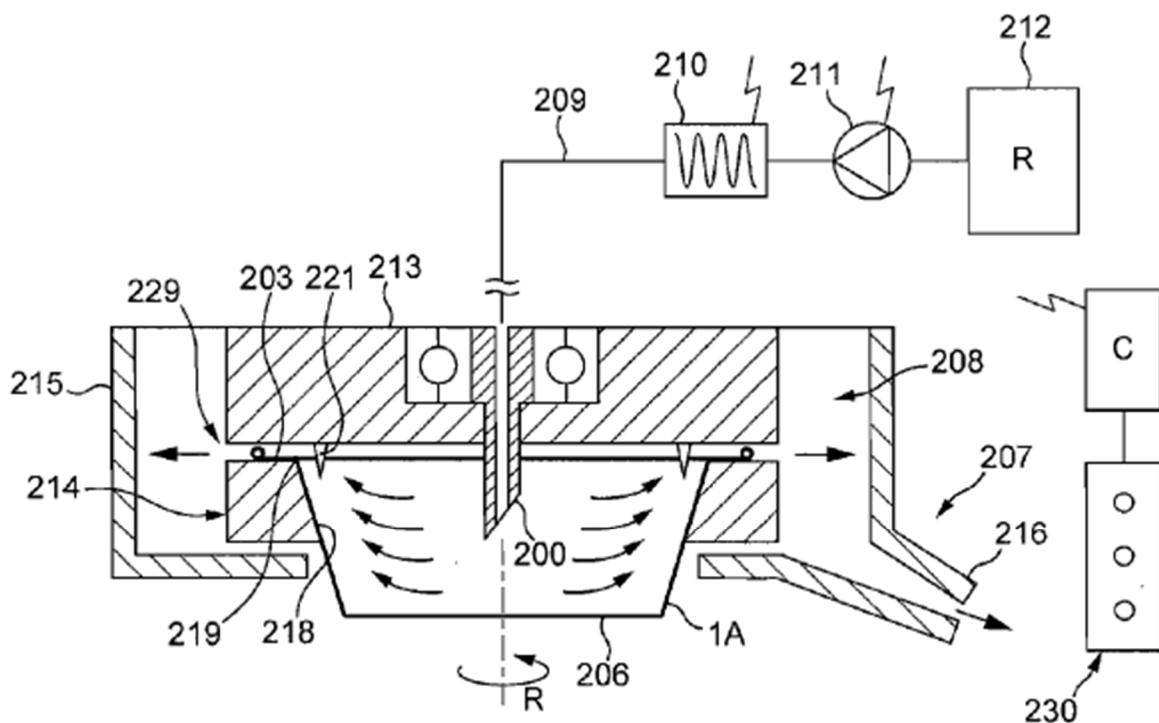
71. Petitioner also cites [0343] but then admits that this paragraph expressly discloses the use of filters within Yoakim’s capsule – this disclosure is contrary to Petitioner’s argument. Petitioner also cites Paragraph [0288] and [0461], which are similarly filter embodiments of Yoakim. Paragraph [0288] states “a filter means to filter the centrifuged before the liquid is released from the outlets at the sidewall” – a POSITA would have understood that the “filter means” here is additive to the filter provided by the outlets at the sidewall. Paragraph [0461] states “[t]he side wall 700 may comprise outlets 704, 706 for release of the liquid when centrifuged in the beverage preparation device around central axis AA of the capsule. . . . The filter

part, may for instance, be an integral part of the body 705 or a part which is added in the capsule, e.g., a filter cylinder. . . . The size of the outlets can be small enough to provide a flow restriction to the liquid.”). Ex. 1004 at [0461]; *see also id.* at Fig. 45 (depicting filter part 708 and outlets 704, 706). The Petition thus fails to identify any teaching in Yoakim of a capsule free of a filter that is located inside of the cavity.

72. Petitioner also cites two figures to support its position, but these figures also do not support Petitioner's argument. For example, Figure 42 depicts a porous wall 180, which is a filter for separating the liquid from the food substance. Ex. 1004 at [0451] (“According to FIGS. 41 and 42, the capsule in the system of the invention may also comprise an enclosure which is formed of a dished body 102 and a porous wall 180. The dished body comprises a main cavity 182 for storing the food substance and a peripheral recess 181 for receiving the liquid extract that traverses the porous wall 180 during the centrifugation process.”), [0452] (“The porous wall 180 can have openings (i.e., pores) along its whole surface...”), Figs. 41, 42; Ex. 2019 at 14:13-15:22 (Mr. Jobin admitting that porous wall 180 provides “a filtering function”). Porous wall 180 is depicted in both Figs. 41 and 42 (annotated in yellow below) and is within the cavity.



73. Moreover, Figure 54—the final disclosure relied upon by Petitioner—is provided to illustrate “the centrifugal device into which is inserted the capsule of Fig. 51.” Ex. 1004 at [0083].



74. Figure 54 depicts one of many different capsule shapes for Yoakim's brewing system, but its primary purpose is to teach aspects of the brewing system. A POSITA would have understood the capsules depicted in Figure 54 (as well as Figs. 52, 55, 61, 62, 63) are the same as those in the rest of Yoakim's teachings and thus exhibit the same filter. They each depict a "schematic" view, which does not contain every detail. Ex. 2019 at 50:24-56:1 (Mr. Jobin admitting that Yoakim's schematic views are "at a very high level," "drawn with less detail," and "there are details which are excluded in this view because it's intended to represent particular information"). Tellingly, Figure 54 reflects a "schematic side view of a capsule of small volume" (i.e., simplified) and not a cross sectional view like figures 41 and 42. *See* Ex. 1004 at [0080], [0083]; *see also* Fig. 1, [0030] ("FIG. 1 is a schematic representation"). Indeed, it does not depict any of the detailed features of the capsule, such as the food substance and lid. A POSITA would thus have not concluded from Figure 54 that Yoakim's capsules are free of a filter. Moreover, any suggestion by Petitioner that the figures teach a capsule free of a filter is inconsistent with the disclosures of Yoakim that consistently and repeatedly describe a capsule having a filter.

75. In his November 28, 2023 deposition, Mr. Jobin testified that his declaration (Ex. 1003 at ¶215) in this proceeding incorrectly identified Figure 42 of Yoakim (and should have instead included Figure 52) for the free of filter limitation.

He characterizes this as a “typo.” Ex. 2019 at 11:22-12:7. But while he claims that he “noted that the figure was different from what I recollect” (*id.* at 12:13-14), the table at the end of his declaration cites to and depicts Figure 42—not Figure 52. Ex. 1003 at 152-53. Moreover, the Petition makes no reference to Figure 52 and instead relies upon Figure 42. See Pet. at 50. To the extent Petitioner is permitted to rely on Figure 52 here, it is also a schematic view. Ex. 1004 at [0081], Fig. 52. Accordingly, the shortcomings described above with respect to Figure 54 apply equally to Figure 52.

76. Overall, Petitioner’s disclosure argument fails on this ground because Yoakim teaches a filter inside the cavity of the portion capsule, and nowhere does Yoakim state that his capsule is without a filter inside the cavity.

B. Rapparini Fails to Disclose or Render Obvious a “wall region includes radially spaced and vertically oriented grooves that are free from extending entirely to the bottom region” (Claims 1, 9)

77. Claim element [1.h] and claim 9 require “the wall region includes radially spaced and vertically oriented grooves that are free from extending entirely to the bottom region.” According to Petitioner, “Rapparini *discloses* this feature.” Pet. at 53. This is incorrect.

78. The Petition relies on Rapparini’s Fig. 6bis (shown below) for such disclosure.

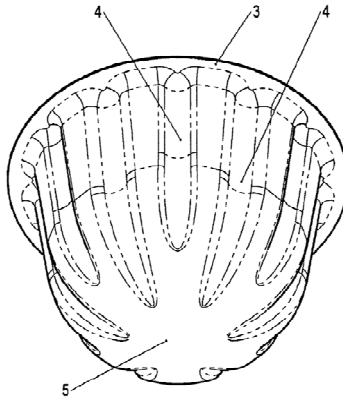
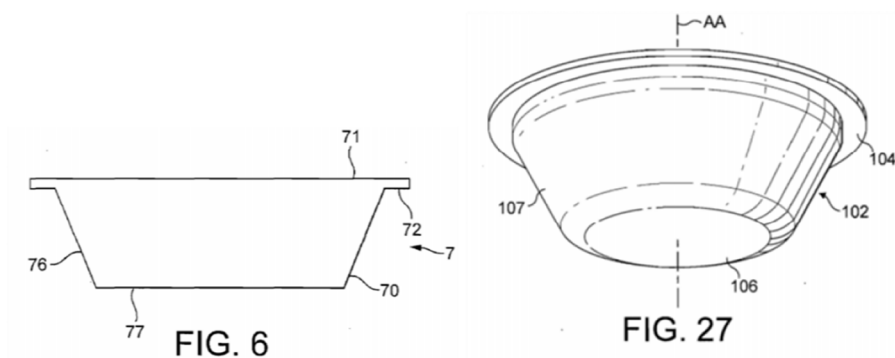


FIG. 6 bis

But that figure depicts a container (with a rounded bottom) unlike the capsule (with a flat bottom and flange) Petitioner relies upon in Yoakim and that Petitioner suggests to modify to achieve the claimed inventions. *See, e.g.*, Pet. at 53 (citing Yoakim’s Figs. 6, 27 embodiment); *see also* Ex. 1003, ¶ 209. The Yoakim capsules Petitioner relies upon are reproduced below.

Yoakim Figures 6 and 27



79. Rapparini teaches that for container shapes like those that are relied upon by Petitioner (as depicted in Figures 6 and 27 of Yoakim (above)), it is “particularly advantageous” to extend the grooves to the bottom region. Ex. 1008 at

[0061], Fig. 10; *see* Ex. 2019 at 34:24-35:17 (Mr. Jobin admitting the shape of Rapparini’s Figure 10 capsule “could be termed frustoconical” and that excluding the grooves the bottom “otherwise appears to be flat”). As depicted in the “particularly advantageous” configuration, Rapparini provides short ribs that extend to the bottom and long ribs that extend into the bottom. Rapparini explains “[t]he short ribs run along the entire height of the side wall of the container 2A” while “[t]he long ribs extend beyond the side wall of the container 2A in the bottom portion of same so as to meet substantially at the centre of the bottom portion of the container 2A.” Ex. 1008 at [0061]. Thus, for the capsule shape in Yoakim for which Petitioner relies, Rapparini teaches extending the grooves entirely to the bottom. The teachings with respect to Figure 10 would have guided a POSITA in modifying Yoakim’s similarly flat-bottomed capsule—not Figure 6bis, which is of a distinctly different design than the capsule disclosed and depicted in Yoakim. In fact, despite Mr. Jobin’s reliance upon Rapparini for this limitation and his claims regarding the use of grooves in capsules, when asked about whether there were any advantages to using the capsule shape of Figure 10, Mr. Jobin testified that “I don’t have any opinion on the form of Figure 10 at this time.” Ex. 2019 at 37:23-25; *see also id.* at 42:17-19 (“Well, I haven’t cited to Figure 10, and so I haven’t drawn any opinions related to Figure 10.”).

Rapparini Figure 10

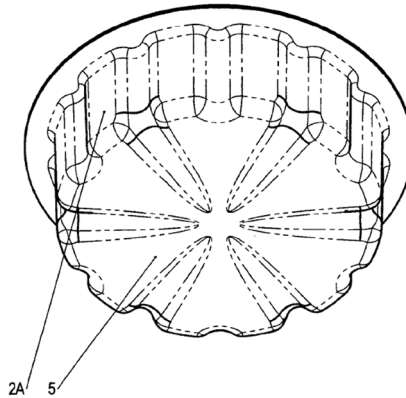
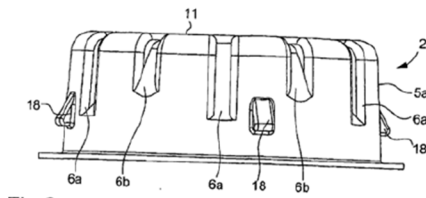
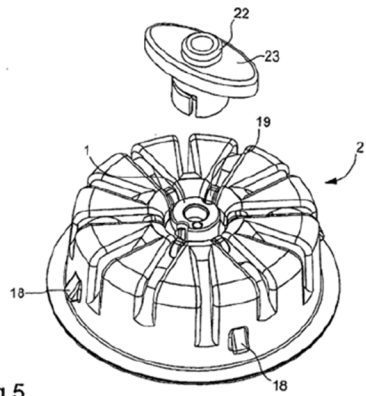
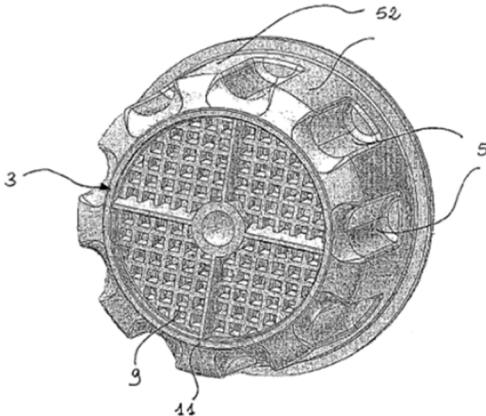


FIG. 10

80. Petitioner further contends it would have been obvious to not extend the grooves to the bottom. Pet. at 54. But this contention is directly contradicted by Rapparini, which teaches it is “particularly advantageous” to extend the grooves to the bottom region for flat-bottomed capsules. Tellingly, every flat-bottom capsule example Petitioner identifies extends the grooves to the bottom and cites advantages of doing so. For example, Ex. 1033 discloses the grooves “are strategically positioned to enhance resistance to buckling.” Ex. 1033 at 2:20-25. These “particularly advantageous” and strategically-placed enhancements for flat-bottomed capsules suggest extending the grooves to the bottom regions. Indeed, Mr. Jobin, admits that “[a] capsule would be designed for a particular application.” Ex. 2019 at 36:2-3. As such, taking the frustoconical, flat bottomed capsules from Yoakim that Petitioner relies upon for the single-serve capsule limitations, a POSITA would *not* have been motivated by Rapparini’s teachings of rounded-

bottom capsules and instead would have looked at the Figure 10 capsule of Rapparani. In this embodiment, Rapparani teaches extending the grooves to the bottom regions and that it is “particularly advantageous” to do so. Therefore, a POSITA would find this to suggest that Patent Owner’s invention would not have been obvious. This conclusion is supported by the additional references that Petitioner identified in the Petition that also disclose flat bottomed capsules with grooves that extend all the way to the bottom of the capsule.

Date	Capsule	Description
2001	FIG. 2 FIG. 3	“circumferentially spaced flutes which are strategically positioned to <i>enhance resistance to buckling</i>” EX1033, 2:20-25. Grooves and ribs “serve to efficiently direct the brewed beverage downwardly ... with an accompanying <i>beneficial increase in turbulence.</i>” <i>Id.</i> 2:30-35.

Date	Capsule	Description
2006	 Fig. 2  Fig. 5	“A first series of ribs 6a plays a part in <i>reinforcing the capsule</i> 2. . . . A second series of ribs 6b is designed to <i>prevent the nozzle from rotating</i> in the packaging.” EX1011, [0077].
2007	 FIG. 2	Grooves and ribs on the capsule wall and cavity. EX1034, [0009]. “the internal grooves of the capsule attain <i>optimal flow conditions</i> for the liquid passing through the capsule itself, to the advantage of the quality and repeatability of the end beverage and also of the correct operation of the associated machines...” <i>Id.</i> [0009], [0019], [0020].

Pet. at 6-7.

81. Petitioner offers the conclusory testimony of Mr. Jobin that it would have been obvious to combine Yoakim with Rapparini, but he too does not identify any motivation for having the grooves not extend to the bottom region. *See* Ex. 1003 at ¶ 238. It is only with impermissible hindsight of the '923 Patent that Petitioner

can even suggest this would have been obvious in view of Rapparini – I understand that such hindsight is not permissible to sufficiently argue or show any motivation for a POSITA to not extended the grooves to the bottom, as required by K-fee’s patent claims.

82. As such, a POSITA would *not* find that Rapparini discloses or renders obvious a “wall region includ[ing] radially spaced and vertically oriented grooves that are free from extending entirely to the bottom region” and Petitioner’s argument fails.

C. The Art Fails to Disclose or Render Obvious “generat[ing] turbulence of water in the cavity”

83. Claims 7 and 13 require that “the grooves in the cavity generate turbulence of water in the cavity.” Petitioner’s arguments that any art discloses or renders this language obvious are incorrect.

84. According to Petitioner, a POSITA would have understood that Rapparini’s grooves would induce turbulent flow in Yoakim’s portion capsule. Pet. at 63. But Rapparini makes no reference whatsoever to turbulent flow. Ex.1008. And to make that logical leap, Petitioner relies upon Yoakim to argue that fluid is guided and distributed into separate grooves promoting flow while spinning. Pet. at 63 (citing Ex. 1004 at [0218]). However, a POSITA would have understood from Yoakim that the water flow in the Yoakim capsule and resulting from Yoakim’s perforators (what Petitioner argues are grooved) is *laminar*—not *turbulent*. Ex. 1004

at [0509] (“Since many perforators are placed evenly at the periphery of the upper wall, liquid can also exit by making a *laminar* flow of beverage dispersed radially along the whole periphery of the upper wall”) (emphasis added) ; Ex. 2019 at 43:9-10 (Mr. Jobin admitting that “[t]urbulence is the opposite of smooth or laminar flow”). Petitioner presents no evidence that adding Rapparini’s grooves to Yoakim’s portion capsule would have resulted in turbulent flow within the capsule. Moreover, Petitioner does not explain how or why a POSITA would have been motivated to modify Yoakim to achieve turbulent flow in view of Yoakim’s express teachings that the use what Petitioner alleges are grooves (the disclosed perforators) promotes laminar flow. *See* Ex. 1004 at [0218], [0509].

85. Petitioner then argues that it would have been obvious to POSITA that a capsule with Rapparini’s grooves and Yoakim’s water flow would generate turbulent flow. *Id.* (citing Ex. 1003 at ¶¶278-79). In so doing, Petitioner’s expert relies upon references that are not part of the combination for Ground 1 – Sweeney (Ex. 1033) and Rubino (Ex. 1034). Petitioner’s purported expert argues, without factual support or citation, that “[d]iscontinuities such as ribs and grooves of the type shown in Rapparini would cause the fluid to move in various directions, resulting in turbulence and mixing in the capsule.” Ex. 1003 at ¶ 278. This conclusory statement is made without reference to the underlying structure, direction, speed, pressure, volume flow, or any of the other parameters which determine whether a flow is

laminar or turbulent. Petitioner's purported expert does not cite to any experimentation or modeling he conducted or papers which show, under identical conditions to those disclosed by Yoakim and Rapparini, that turbulent flow necessarily would result. I understand from counsel that such expert testimony is entitled to little or no weight. Mr. Jobin's conclusory analysis is problematic and fails to demonstrate obviousness. In his merely conclusionary statement, Mr. Jobin offers no analysis, experiment, measurement, or simulation to support his unfounded assertion that Rapparini's grooves and Yoakim's water flow would generate turbulent flow in Yoakim's capsule. Indeed, Mr. Jobin does not explain why turbulent flow would result as opposed to the other flow regimes. For these reasons, Petitioner's arguments as to claims 7 and 13 fail to demonstrate unpatentability.

86. A POSITA with experience in flows in saturated porous media, such as in beverage brewing, would know that turbulence results, generally, when the flow is dominated by inertial forces rather than by viscous forces. While this is also generally true for flows in bulk fluids, the methods for characterizing and measuring turbulence in fluid-saturated porous media depart substantially from those in bulk fluids. For fluid-saturated porous media, the flow regime is generally characterized by the *Pore Reynolds Number* which is related to the ratio of inertial to viscous forces. Ex. 2026 at 172. In the fluid-saturated medium, the flow regimes, from lower to higher *Pore Reynolds Numbers*, are the Darcy (viscous, creeping), laminar

inertial, laminar unsteady, and chaotic, turbulent regimes. Ex. 2026 at 177. In his merely conclusionary statement, Mr. Jobin offers no analysis, experiment, measurement, or simulation to support his unfounded assertion that Rapparini's grooves and Yoakim's water flow would generate turbulent flow.

D. A Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Yoakim and Jarisch and Rapparini

87. Petitioner argues that a POSITA would have combined Yoakim with Jarisch and Rapparini, thus rendering the invention of the '923 Patent obvious. Pet. at 43- 48. This is incorrect. The German applications antedate Jarisch and therefore Jarisch is not applicable prior art. As an initial matter, Petitioner suggests that Jarisch's placing of the code on the bottom of the flange would result in the reading being more reliable. Pet. at 56. But Petitioner does not explain why such teachings in Jarisch would have motivated a POSITA to modify Yoakim in that way. Indeed, there is no reason to believe that Yoakim's placement of a "barcode" on the top of the membrane would suffer from readability issues given Yoakim's device reads the "barcode" before brewing when a capsule would not be soiled by beverage residues. Ex. 1004 at [0525], [0526]. Moreover, as illustrated below the barcode (ID4 in the yellow region) is inboard of the outlet perforators 221 (annotated in red) so the centrifugal forces when the capsule is spinning would drive the fluid away (annotated in green) from the barcode—not towards it. *See id.* at Figs. 61, 62, [0507].

Thus, the barcode would not be soiled and such a modification to Yoakim would be unnecessary.

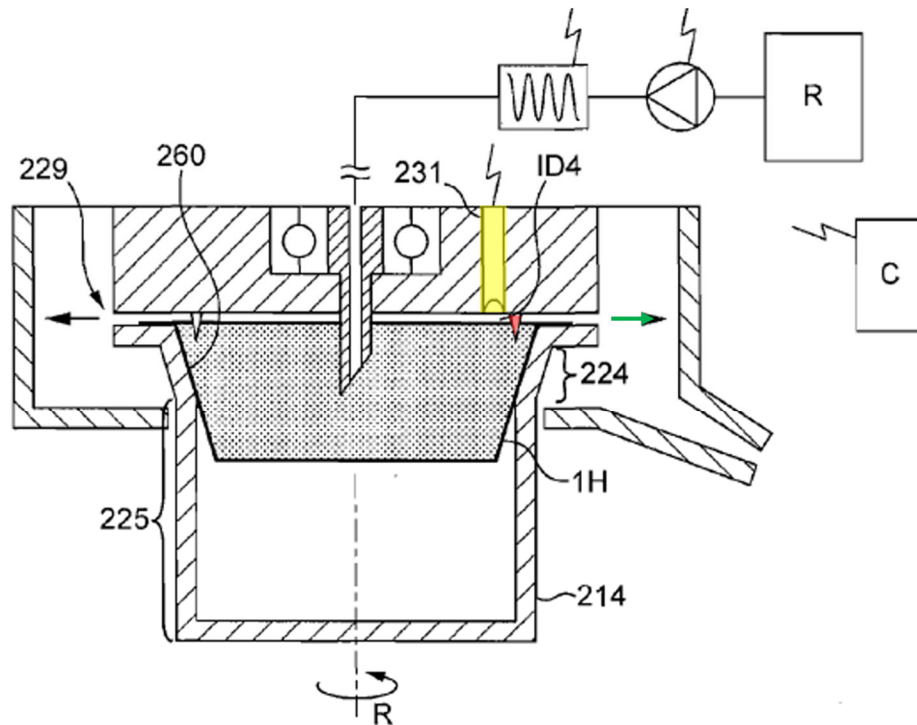


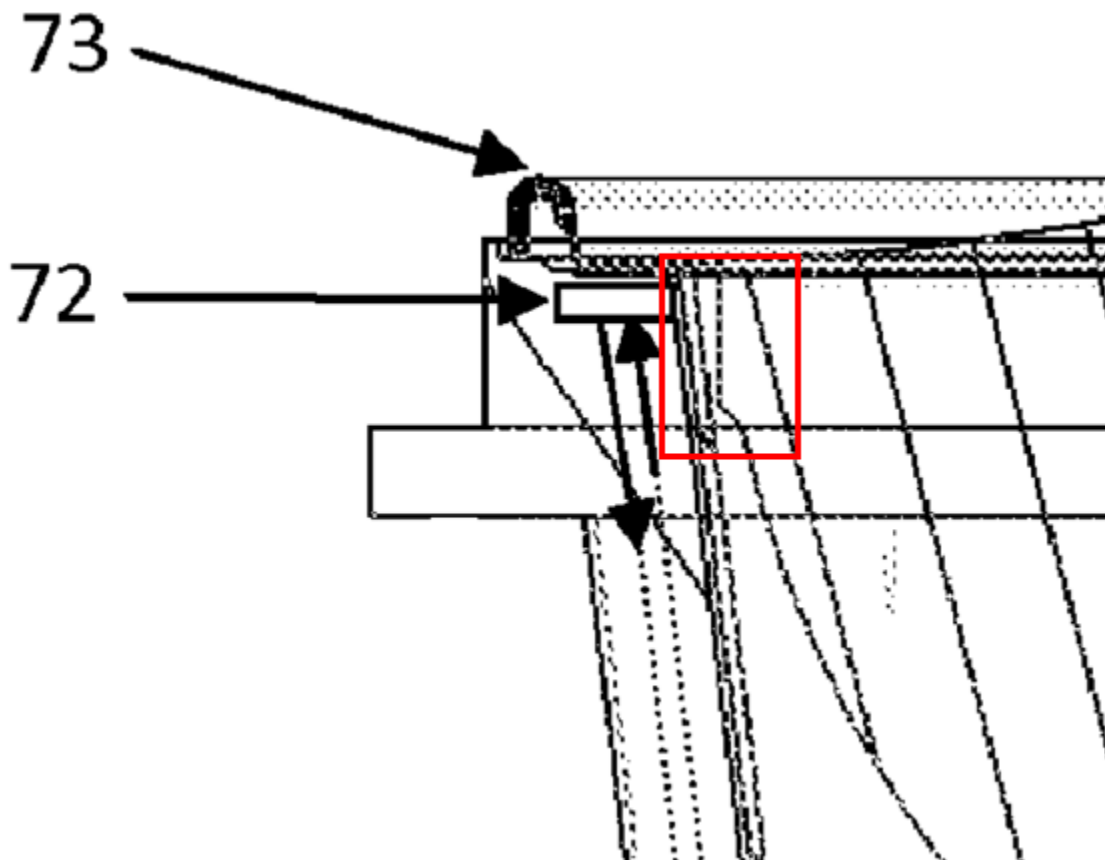
FIG. 61

88. Yoakim and Jarisch have a common owner, Societe des Produits Nestle S.A., an affiliate of Petitioner, and a common inventor, Alexandre Perentes. Pet. at 44. This alone does not establish a motivation to combine. Indeed, other facts undermine the alleged combination. As an initial matter, Jarisch's priority document was filed days after Yoakim. Yet, Jarisch make no mention of Yoakim in the background or otherwise. This suggests the inventors of those references did not themselves any clear relation between the two references. Tellingly, during

prosecution of the Jarisch reference, however, a parent application to Yoakim was cited against Jarisch (WO 2008/148601, “Yoakim ’601”). In attempting to overcome a rejection based on Yoakim ’601, Petitioner disparaged the ability of Yoakim ’601 to be combined with other references describing single-serve coffee capsules, stating that “the skilled artisan would not have combined these cited references [including Yoakim ’601] to arrive at a capsule comprising a code arranged on a bottom of the flange-like rim.” Ex. 2009 at 393. Petitioner continued, stating that the other references do not “provide any reason or motivation for the skilled artisan to modify Yoakim [’601] alone or in combination with *Boyd* (even if they are combinable) to include the claimed code on a bottom of the flange-like rim of a capsule as required by independent claim 1.” *Id.* at 395-96. Patent Owner acknowledges that Yoakim (Ex. 1004) is a continuation-in-part of the Yoakim ’601 reference and that Figure 23 of Yoakim ’601 is identical to Figure 23 of Yoakim. When prosecuting its own application, Petitioner argued that different references describing single-serve coffee capsules were non-combinable. Petitioner should not be permitted to argue the opposite now.

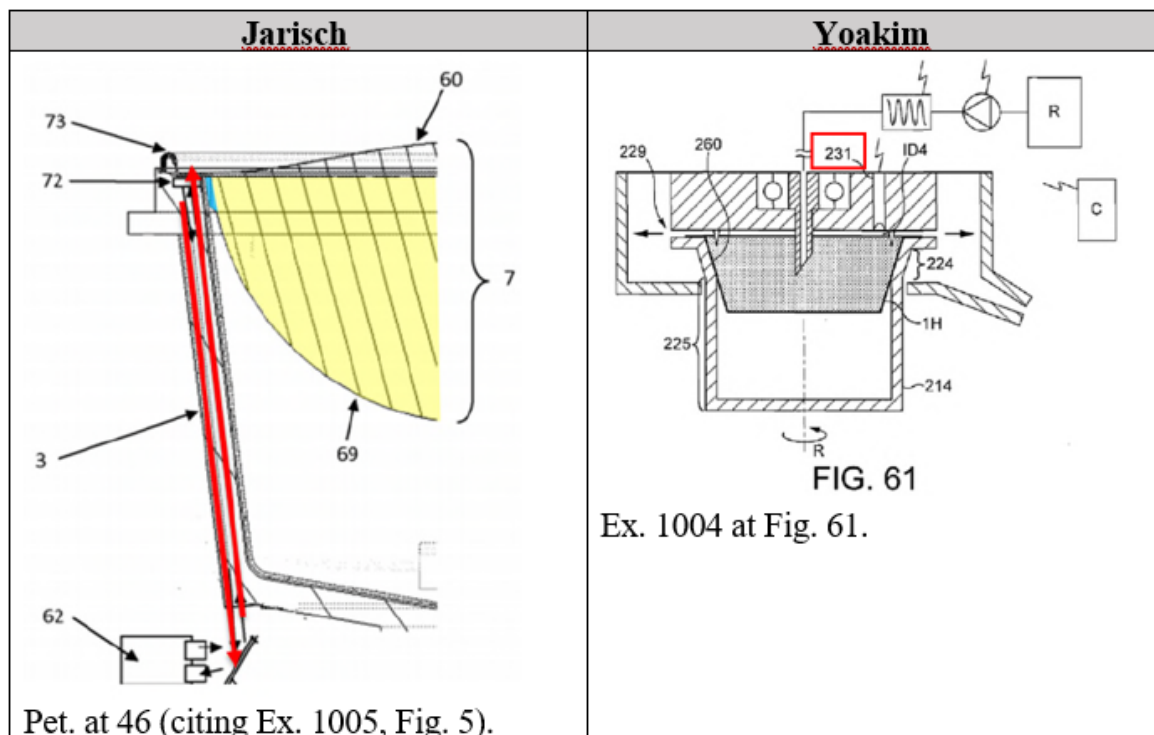
89. There are other important differences between Yoakim and Jarisch that undermine the combination of the two that Petitioner fails to address. For example, Yoakim teaches that the capsule holder “advantageously has an interior surface or structure for engaging the capsule with the interior surface or structure configured

to offer resistance to torque during rotation or for frictionally engaging or receiving a complimentary surface or structure of the capsule to enable the driving means to rotate the capsule.” Ex. 1004 at [0024]; *see also id.* at [0205], [0216], [0512], Figs. 61, 62. Yoakim thus teaches, and depicts, the capsule side wall advantageously engaging with the capsule holder. In contrast, Jarisch’s capsule does not engage with the interior of cell 3. As can be seen in Figure 4 of Jarisch (zoomed in below), there is a gap between the capsule and the cell. Petitioner’s images obscure this gap with a blue line. But this further demonstrates the challenges of incorporating the teachings from Jarsich into Yoakim.



90. In addition, Petitioner has not demonstrated how (or why) Yoakim and Jarisch could be combined without a substantial reconstruction and redesign of elements within the skill level of a POSITA. Here, as Petitioner explains, “[t]he Jarisch optical reader configuration is depicted below [in the annotated Figure 5] in order to read the code on the capsule (yellow) with the light path (red) shown from detector (62) to capsule rim (73).” Pet. at 48-49. However, the “sensor/detector (231) [] enabled to identify and read a barcode” as described in Yoakim is positioned to read a code on the opposite side of the capsule. Pet. at 58; *see also* Ex. 1004 at [0525], Figs. 61, 62. Because the combination of Jarisch and Yoakim would have required a significant redesign of the elements, including in moving the location of the sensor or detector (ostensibly directly into a flow path of the brewed coffee), a POSITA would not have been motivated to combine the teachings of the two references.

Comparison of Sensor Placement in Jarisch and Yoakim



91. A POSITA would not have had a reasonable expectation of success in moving the sensor to the bottom of Yoakim's brewing device. For example, unlike the cell 3 in Jarisch which has a straight chamber transparent material between the code and the sensor, Yoakim's capsule holder 214 (above right) is comprised of lower portion 225 and first portion 224, which are connected by a bend (or flare) in the structure. Ex. 1004 at Fig. 61, [0512]. For the sensor/detector to pass light through this flare, Yoakim would require extensive modifications, including mirroring or index-of-refraction matching within the flared structure. This would have been particularly challenging given the fact that the barcode of Yoakim would be read while the capsule holder is rotated. The use of Jarisch's transparent material

would also have contributed to undesired refraction from anisotropy in the material, Fresnel effects, internal reflection, transmission loss along the wall of the holder, and other impairment to the light available for detection.

92. This combination would thus require extensive experience with optics and more than ordinary skill. At his deposition, Mr. Jobin stated that “[b]odily incorporation is not required, in my understanding” to combine Jarisch and Yoakim. Ex. 2019 at 108:13-14. But he fails to demonstrate that a POSITA would have had the requisite experience to utilize those teachings with a reasonable expectation of success. In fact, in my opinion, it would take *extraordinary skill* to achieve the combination for at least the reasons presented above. A POSITA with the requisite skill level required in this matter would not have the proper electro-optics training to have the knowledge or understanding to combine Jarisch and Yoakim as Mr. Jobin proposes. In fact, Mr. Jobin provides no details on how a POSITA may come to the conclusion that these references are combinable such that the present invention is rendered obvious. Given all of this, Yoakim and Jarisch would lead a POSITA away from combining these two references in the manner Mr. Jobin claims. On the present facts, the complicated optics assembly required in a harsh operating environment required more than conclusory assessment that the POSITA could have combined Jarisch and Yoakim. The analysis requires an explanation of how such combination would have been made within the skills of the POSITA.

93. A POSITA would have recognized that Fig. 4 of Jarisch shows that the transparent material (*see* Ex. 1005 at [0082]) is the same about the circumference of the capsule holder. It is generally a transparent structure that is much longer than it is thin, has a thickened base relative to the side walls, and is conical. A detector in such system, to be effective, would necessarily have required (among other things) that it be able to avoid an optical aberrations during the transmission of light along its length, to the capsule rim and then back to the detector. In such a system, some examples of effects that could influence the quality of the light received by the detector are undesired birefringence, Fresnel effects, internal reflection and scatter, and transmission loss.

94. Using the proposed structure of the capsule holder of Jarisch would have added significant costs and complexity. This is due to selection of the proper material, the method of making the capsule holder, and how it could be incorporated into a harsh environment of a coffee making machine.

95. By way of example, though it was known at the relevant time that some plastics having transparency could have been machined or molded, in order to achieve precision necessary for detecting a code while a capsule was rotating, it would have been required that there be no anomalies within the transparent body and on its surfaces. However, it was also known at the time that optical properties of a molded transparent material were dependent upon (for example) residual internal

stresses (e.g., caused by the thicker volume lower left corner of the holder in Fig. 4 of Jarisch and by flow and solidification differences during a molding operation and dependent on the mold sprues, runners, and gates) causing internal refraction differences, surface roughness occasioned by a molding tool, air traps, surface waviness resulting from any shrinking during cooling of a molded part, distortion occasioned by repetitive thermal expansion and contraction from exposure to thermal cycling in an environment near hot water in a coffee machine) any sub-surface deformation occasioned by secondary processing (e.g., machining or polishing). Any or all of the above would have contributed to undesired refraction from anisotropy in the material, Fresnel effects, internal reflection, transmission loss along the wall of the holder, and other impairment to the light available for detection. Further, an attempt to introduce the externally located Jarisch capsule holder into the embodiment of Figs. 61 and 62 of Yoakim would also require an expensive special sealed system that would protect the detector from the harsh environment of the machine during coffee making.

96. While it is possible that such a solution could have been realized in the relevant time frame, it is my opinion that to arrive at it would have taken hundreds of hours or more, and would have required enlisting a person with skills well beyond those of the POSITA. Further, the manufacturing process alone to develop and

implement such a specific type of capsule holder, would have involved significant complexity, with mold design, polymer processing parameters.

97. Thus, any attempts to combine Yoakim and Jarisch would lead a POSITA *away* from combining these two references as Mr. Jobin claims. Because the combination of Jarisch and Yoakim would have required a significant redesign of the elements, including in moving the location of the sensor or detector (ostensibly directly into a flow path of the brewed coffee), a POSITA would not have been motivated to combine the teachings of the two references. A POSITA would further have not sought to go through such efforts to implement a feature that is unnecessary in light of no apparent concern in Yoakim of reading the barcode on the top of the capsule.

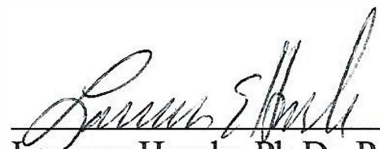
98. Additionally, the “bit code” described in the Jarisch reference teaches away from Petitioner’s proposed combination. I understand from counsel that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. Here, Yoakim uses the bare term “barcode,” without providing any information as to what that code would actually be. In relevant part, Mr. Jobin testified that the plain and ordinary meaning of barcode would “include a collection of bars of light and dark colors and of varying widths.” Ex. 2019 at 137:13-17. Neither he nor the

Petition identify such a disclosure in Yoakim. In contrast, Jarisch teaches “[a] problem with identifying a capsule in a beverage preparation machine,” including those that use “barcodes,” “is that retrieving or reading information from the capsule is not always reliable or convenient.” Ex. 1005 at [0008], [0009], [0011], [0013]. Jarisch’s solution is to use a “bit code.” *Id.* at [0017], [0064]. Indeed, Jarisch makes no mention of barcodes in describing “the present invention.”

99. A POSITA would therefore be left with the “bit code” described in Jarisch, which Petitioner agrees is not a “barcode.” Jarisch further adds complexity in requiring the code be read while rotating, which Yoakim does not require. Ex. 1005 at [0048]. As a result, a POSITA would not have been motivated to combine the Yoakim and Jarisch references to achieve K-fee’s claimed inventions. Even if a POSITA was so motivated, the outcome would be the employment of a “bit code,” does not meet the “barcode” limitation of the claim.

100. Overall, a POSITA would not have been motivated to combine Yoakim and Jarisch and Rapparini.

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



Laurens Howle, Ph.D., P.E.

12/06/2023
Date

Appendix A

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PROFESSIONAL HISTORY

2020-present Professor of Mechanical Engineering, Duke University
2000-2020 Associate Professor of Mechanical Engineering, Duke University
1993-2000 Assistant Professor of Mechanical Engineering, Duke University
1989-1993 Research Assistant, Duke University
1983-1989 V.P. of Manufacturing and Plant Manager, Kaye Products, Hillsborough, NC
1980-1983 U.S. Army, 82nd Airborne (Honorable discharge 1986)

ADDITIONAL EXPERIENCE (PARTIAL LISTING)

2008-present Owner/CEO, BelleQuant Engineering, PLLC, Mebane, NC
2020-2022 Professor of Radiology, Duke University Medical Center, Durham, NC
2018-2022 Associate Professor of Marine Science and Conservation, Duke University, Beaufort, NC
2013-2020 Associate Professor of Radiology, Duke University Medical Center, Durham, NC
2013-2020 Founding Member, Pelagic Scientific, PLLC, Durham, NC
2008-2015 Founding Member, Technovation Consulting Group, Durham, NC
2007-2010 Chief Science Officer, Whalepower Corp, Toronto, ON, Canada
2007-2008 Visiting Professor, United States Naval Academy, Annapolis, MD
2003-2004 Chairman, Engineering Faculty Council, Duke University, Durham, NC
2001-2004 Associate Chair & DGS, Mechanical Engineering, Duke University, Durham, NC
2001-2002 Visiting Professor, United States Naval Academy, Annapolis, MD

1995-present Board of Directors, Franklin Sis Corporation, Durham, NC

HONORS AND AWARDS

2020	Fellow in Undersea and Hyperbaric Medicine
2012	Fellow of the American Society of Mechanical Engineers
2011	New Product Award, HVLS Fan Design for Envira-North, MCEE, Montreal.
2009	INDEX: Design Award, Finalist, Design to Improve Life, Copenhagen.
1999	Office of Naval Research Young Investigator Award, \$328,071.

EDUCATION

Ph.D.	Mechanical Engineering	Duke University	1993
M.S.	Mechanical Engineering	Duke University	1991
B.S.E.	Mechanical Engineering	Duke University	1989

PROFESSIONAL CERTIFICATIONS

Professional Engineer, North Carolina, 035790
Professional Engineer, Maryland, 37985 (inactive)
Dive Master (PADI)
Master Diver (PADI)
Technical Deep Diver (DSAT)

PROFESSIONAL MEMBERSHIPS

Fellow of the American Society of Mechanical Engineers
American Physical Society
Underwater and Hyperbaric Medical Society
Professional Engineers of North Carolina
National Society of Professional Engineers

RESEARCH INTERESTS

Transport in thermal, chemical, and biological systems. Probabilistic pharmacokinetics and pharmacodynamics. Decompression sickness. Oxygen toxicity. Experimental and computational fluid dynamics. Nonlinear and complex systems. Stability of fluid motions. Econophysics. Wind

power. Advanced computational methods for big data, complex systems, and stochastic systems. Expert witness testimony.

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i10-index: 40

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39. Hobbs, G.W., Murphy, F.G., Gault, K.A., Hexdall, E., Howle, L.E. & Walker, J.R. *Decompression risk evaluation for trimix dives derived from commercially available desktop decompression algorithms*. Proceedings of the 2012 Undersea and Hyperbaric Medical Society Meeting. Phoenix, AZ. 2012.
40. Vann, R.D. & Howle, L.E. *Describing decompression sickness (DCS) of the brain, spine, and joints by multinomial probability*. Proceedings of the 2012 Undersea and Hyperbaric Medical Society Meeting. Phoenix, AZ. 2012.
41. Vann, R.D., Howle, L.E., Pollock, N.W. & Moon, R.D. *Do arterialized VGE initiate cerebral or spinal decompression sickness (DCS)?* Proceedings of the 2012 Undersea and Hyperbaric Medical Society Meeting. Phoenix, AZ. 2012.
42. Howle, L.E., Weber, P.W. & Nichols, J.M. *Bayesian approach to decompression sickness model parameter estimation*. Proceedings of the 2011 Undersea and Hyperbaric Medical Society Meeting. Fort Worth, TX. 2011.
43. Shorter, K., Howle, L., Johnson, M., Nowacek, D., Hurst, T., Bocconcelli, A. & Moore M. *Modeling and analysis of fluid flow around a suction cup bio-logging tag*. Society for Marine Mammalogy. 19th Biennial Conference on the Biology of Marine Mammals. Tampa, FL. 2011.
44. Fish, F.E., Weber, P.W., Howle, L.E., Murray, M.M. & Reidenberg, J.S. *Hydrodynamic performance of the flippers of large-bodied cetaceans*. Secondary Adaptation of Tetrapods to Life in Water. San Diego, CA. 2011.
45. Husarik, D.B.B., Mashir, M.S.R., Weber, P.W., Nichols, E.B., Merkle, E.M., Howle, L.E. & Nelson, R.C. *Gadolinium-enhanced MR angiography: Effects of the contrast media dose on peak signal intensity relative to the injection rate of saline chaser*. 97th Scientific Assembly and Annual Meeting of the Radiological Society of North America. Chicago, IL. 2010.

46. Husarik, D.B.B., Bashir, M.S.R., Weber, P.W., Nichols, E.B., Howle, L.E. & Nelson, R.C. *Gadolinium-enhanced MR Angiography: Effects of volume and rate of the saline chaser on peak aortic signal intensity.* 97th Scientific Assembly and Annual Meeting of the Radiological Society of North America. Chicago, Il. 2010.
47. Husarik, D., Nelson, R., Weber, P., Howle, L.E., Nichols, E., Boll, D. & Marin, D. *Low kVp contrast-enhanced CT: Can imaging closer to the k-edge of iodine allow for a reduction in contrast media?* 110th Annual Meeting of the American Roentgen Ray Society. San Diego, CA. 2010.
48. Walker, J.R., Hobbs, G.W., Gault, K.A., Howle, L.W. & Freiburger, J.J. *The effect of final oxygen decompression stop depth in DCS risk: 20fsw vs. 10fsw.* Proceedings of the 2010 Undersea and Hyperbaric Medical Society Meeting. St. Pete Beach, Florida, 2010.
49. Walker, J.R., Hobbs, G.W., Gault, K.A., Howle, L.W. & Freiburger, J.J. *Decompression risk analysis comparing oxygen and 50% nitrox decompression stops.* Proceedings of the 2010 Undersea and Hyperbaric Medical Society Meeting. St. Pete Beach, Florida, 2010.
50. Vann, R.D., Weber, P.W., Di Muro, G. & Howle, L.E. *Adding venous gas emboli (VGE) to the linear-exponential (LE) decompression model.* Proceedings of the 2010 Undersea and Hyperbaric Medical Society Meeting. St. Pete Beach, Florida, 2010.
51. Husarik, D.B., Weber, P.W., Bashir, M.S.R., Nichols, E.B., Merkle, E.M., Howle, L.E. & Nelson, R.C. *Gadolinium-enhanced MR angiography: Optimization of contrast media doses for imaging patients with compromised renal function.* Society of Computed Body Tomography and Magnetic Resonance Meeting. San Diego, California. 2010.
52. Murray, M., Weber, P., Howle, E. & Fish, F. *Comparison of real and idealized cetacean flippers* American Physical Society Division of Fluid Dynamics Meeting. Minneapolis, Minnesota. 2009.
53. Howle, L.E., Weber, P.W., Vann, R.D., Denoble, P.J. & Campbell, M.C. *Probabilistic DCS models using hierarchical outcome severity.* Proceedings of the 2009 Undersea and Hyperbaric Medical Society Meeting. Las Vegas, Nevada. 2009.
54. Howle, L.E., Weber, P.W., Vann, R.D., Denoble, P.J. & Campbell, M.C. *The role of marginal outcomes in the fitting of probabilistic DCS models.* Proceedings of the 2009 Undersea and Hyperbaric Medical Society Meeting. Las Vegas, Nevada. 2009.

55. Vann, R.D., Denoble, P.J., Howle, L.E., Weber, P.W., Freiburger, J.J., Pieper, C.F. & Nord, D. *Decompression illness (DCI) and survival analysis*. Proceedings of the 2009 Undersea and Hyperbaric Medical Society Meeting. Las Vegas, Nevada. 2009.
56. Coursey, C., Nelson, R.C., Weber, P.W., Nichols, E., Marin, D. & Howle, L.E. *Ultrafast multidetector CT angiography of the chest and abdomen: How do alterations in rates of contrast media and saline chaser injection and alterations in cardiac output effect peak aortic enhancement?* 94th Scientific Assembly and Annual Meeting of the Radiological Society of North America. Chicago, IL. 2008.
57. Murray, M., Weber, P., Howle, L. & Fish, F. *Lift and Drag of Cetacean Flippers* 61st Annual Meeting of the APS Division of Fluid Dynamics, San Antonio, Texas. 2008.
58. Nichols, E., Nelson, R.C., Schindera, S.T. & Howle, L.E. *Mechanical power injection of iodinated contrast media: quantitative assessment of angiocatheter exit jet dynamics*. 37th Annual Postgraduate Course and Scientific Meeting of the Society of Gastrointestinal Radiologists. Rancho Mirage, California. 2008.
59. Nichols, E., Nelson, R.C., Schindera, S.T. & Howle, L.E. *Mechanical power injection of iodinated contrast media: quantitative assessment of angiocatheter exit jet dynamics using different injection rates and catheter sizes*. 104th Annual Meeting of the American Roentgen Ray Society. Washington, DC. 2008.
60. Dunford, R.G., Denoble, P.J., Vann, R.D., Shannon, J.S., Pollock, N.W. & Howle, L.E. *The relationship of age and BMI to Doppler-detected bubble grades*. Proceedings of the 2008 Underwater and Hyperbaric Medical Society Meeting. Salt Lake City, Utah. 2008.
61. Vann, R.D., Dunford, R.G., Denoble, P.D. & Howle, L.E. *The probabilities of DCS and VGE after nitrogen-oxygen diving*. Proceedings of the 2008 Undersea and Hyperbaric Medical Society Meeting. Salt Lake City, Utah. 2008.
62. Howle, L.E., Weber, P.W. & Vann, R.D. *Is marginal DCS ("niggles") real or random noise?* Proceedings of the 2008 Undersea and Hyperbaric Medical Society Meeting. Salt Lake City, Utah. 2008.
63. Vann, R.D., Howle, L.E., Pieper, C.F., Denoble, P.D., Freiburger, J.J. & Moon, R.E. *Statistical prediction of residual DCI symptoms after decompression*. Proceedings of the 2008 Undersea and Hyperbaric Medical Society Meeting. Salt Lake City, Utah. 2008.

64. Howle, L.E., Weber, P.W. & Vann, R.D. *A parameter estimation system with computational advantages for fitting probabilistic decompression models to empirical data*. Proceedings of the 2007 Undersea and Hyperbaric Medical Society Meeting. Maui, Hawaii. 2007.
65. Weber, P.W., Howle, L.E., Vann, R.D. & Pieper, F.C. *Probability models of mild and serious decompression sickness (DCS)*. Proceedings of the 2007 Undersea and Hyperbaric Medical Society Meeting. Maui, Hawaii. 2007.
66. Howle, L.E., Lebental, S. & Vann, R.D. *An object-oriented system for optimizing probabilistic decompression models to empirical decompression data*. Proceedings of the 2006 Undersea and Hyperbaric Medical Society Meeting. Orlando, Florida. 2006.
67. Vann, R.D., Lebental, S. & Howle, L.E. *The relative roles of surface tension and the oxygen window in bubble resolution*. Proceedings of the 2006 Undersea and Hyperbaric Medical Society Meeting. Orlando, Florida. 2006.
68. Murray, M. & Howle, L.E. *Cavitation inception on rudder models with smooth and scalloped leading edges*. APS Division of Fluid Dynamics Meeting, Chicago, Illinois. 2005.
69. Fish, F.E., Miklosovic, D.S., Murray, M.M. & Howle, L.E. *Delayed stall due to leading edge tubercles of the humpback whale flipper*. Integrative and Comparative Biology. 43(6): 903, 2003.
70. Murray, M., Miklosovic, D., Fish, F. & Howle, L. *Stall delay by leading edge tubercle in humpback whale flipper*. APS Division of Fluid Dynamics Meeting, East Rutherfordton, New Jersey. 2003.
71. Howle, L.E. *Undulatory Flap Pair Propulsion*. APS Division of Fluid Dynamics Meeting, New Orleans, Louisiana. 1999.
72. Hasik, M.J., Howle, L.E. & Needham, D. *Effect of Contrast Agent's Lipid Carbon Chain Length on Backscattered Ultrasound Amplitude*. APS Division of Fluid Dynamics Meeting, New Orleans, Louisiana. 1999.
73. Gustafson, M.R. & Howle, L.E. *Experimental Control of Horton-Rogers-Lapwood Convection using Shadowgraphic Input*. APS Division of Fluid Dynamics Meeting, New Orleans, Louisiana. 1999.

74. Murray, M.M. & Howle, L.E. *Translational Spring Stiffness Influence on an Oscillating Propulsor*. APS Division of Fluid Dynamics Meeting, New Orleans, Louisiana. 1999.
75. Gustafson, M.R. & Howle, L.E. *Boundary Effects on the Onset of Convection in Porous Media*. APS Division of Fluid Dynamics Meeting, Philadelphia, Pennsylvania. 1998.
76. Murray, M.M. & Howle, L.E. *Reduced Order Hydroelasticity Modeling of a Flexible Propulsor*. APS Division of Fluid Dynamics Meeting, Philadelphia, Pennsylvania. 1998.
77. Howle, L.E. *Boundary Effects in Controlled Rayleigh-Bénard Convection*. APS Division of Fluid Dynamics Meeting, Philadelphia, Pennsylvania. 1998.
78. Meressi, T. & Howle, L.E. *Linear and Nonlinear Control of Rayleigh-Bénard Convection*. APS Division of Fluid Dynamics Meeting, Philadelphia, Pennsylvania. 1998.
79. Howle, L.E. & Behringer, R.P. *Floquet Stability Analysis of the Onset of Convection in Periodic Porous Media*. APS Division of Fluid Dynamics Meeting, Syracuse, New York. 1996.
80. Howle, L.E. *Suppression of Natural Convection in Small Aspect Ratio Containers*. APS Division of Fluid Dynamics Meeting, Atlanta, Georgia. 1994.
81. Howle, L.E., Behringer, R.P. & Georgiadis, J.G. *Convection in Porous Media: Visualization by a Novel Shadowgraphic Technique*. APS Division of Fluid Dynamics Meeting, Tallahassee, Florida. 1992.
82. Howle, L.E., Behringer, R.P. & Georgiadis, J.G. *Shadowgraphic Visualization of Natural Convection in Rectangular-Grid Porous Media*. ASME National Heat Transfer Conference, San Diego, California. 1992.

RESPONSE TO LETTERS TO THE EDITOR

1. Macha, D.B., Nelson, R.C., Howle, L.E., Hollingsworth, J.W. & Scindera, S.T. *Radiology*. **255(2)**: 662. 2010.

In response to:

Halpenny, D.F., Doody, O., McNeill, G. & Torreggiani, W.C. *Central venous catheter care during contrast-enhanced CT*. *Radiology* **255(2)**: 662. 2010.

FUNDING HISTORY

Number of Grants: 33

Total Funding: \$6,572,188

02/01/21-01/31/24	NAVSEA/OOC. <i>Probabilistic Decompression Sickness Model Development</i> . \$862,267. Lars Howle, P.I.
02/01/21-01/31/23	NAVSEA/OOC. <i>Perfluoromethane to Reduce Decompression Sickness after Heliox Dives</i> . \$894,910. Richard Moon, P.I.
10/01/17-09/30/18	NAVSEA/OOC. <i>Transfer of Duke University Dive Trial Data to U.S. Navy</i> . \$147,069. Lars Howle, P.I.
10/01/17-09/31/20	NAVSEA/OOC. <i>Altitude Diving Tables</i> . \$961,773. Richard Moon, P.I.
02/01/17-01/31/20	NAVSEA/OOC. <i>Evaluation of and Advances in Oxygen Toxicity Models</i> . \$523,211. Lars Howle, P.I.
06/01/14-05/31/15	DARPA. <i>Advanced Technologies for Reducing the Probability of Decompression Sickness</i> . \$280,000. Richard Moon, P.I.
10/01/13-09/30/17	ONR. <i>Pre-doctoral Fellowship to Strengthen Navy Capabilities in Probabilistic Decompression Modeling</i> . \$313,542. Lars Howle, P.I.
07/08/13-07/06/16	NAVSEA/OOC. <i>Advances in Probabilistic Decompression Models and Decompression Scheduling</i> . \$935,252. Lars Howle, P.I.
06/01/13-05/31/14	DARPA. <i>Accelerated Decompression with Multiple Inert Gases</i> . \$10,000. Richard Moon, P.I.
12/01/10-05/31/12	MGT Nemoto International. <i>Innovative Catheter Designs for Reducing Extravasation Risk During Injection of Iodinated Contrast Media</i> . \$90,703. Lars Howle, P.I.
04/01/09-07/31/09	NAVSEA/ONR. <i>Partitioned Decompression Risk Analysis</i> . \$17,414. Lars Howle, P.I.
02/17/09-09/30/12	NAVSEA/ONR. <i>Probabilistic Models of Decompression Sickness (DCS)</i> . \$758,331. Lars Howle, P.I.
10/01/08-09/30/09	Bracco Diagnostics, Inc. <i>Comprehensive Evaluation of the Effects of the Sequential Power Injection of Iodinated Contrast Media and Saline with Vascular Enhancement: Further Studies</i> . \$100,000. Rendon Nelson, P.I.
05/20/08-05/19/08	The Lord Foundation. <i>Generating Energy from Ocean Waves</i> . \$13,345. Brian Mann, P.I.

05/08/07-05/09/09	DARPA. <i>Enhancement of Oscillatory Flap Propulsors in Low-Speed Flows in Water</i> . \$99,999. Lars Howle, P.I.
04/01/07-03/31/09	National Science Foundation. <i>Comparative Experimental Hydrodynamics of Cetacean Flippers: Ecomorphology on an Aquatic Control Surface</i> . \$270,000. Frank Fish, P.I.
04/17/06-10/16/07	Bracco Diagnostics, Inc. <i>Comprehensive Evaluation of the Effects of the Sequential Power Injection of Iodinated Contrast Media and Saline with Vascular Enhancement</i> . \$100,000. Lars Howle, P.I.
04/01/06-03/31/09	NAVSEA/ONR. <i>Development of an Object-Oriented Numerical Modeling System for the Study and Development Decompression Models</i> . \$414,575 Richard Vann, P.I.
01/01/03-12/31/03	DARPA. <i>Morphing Aircraft Structures</i> . \$150,104. Robert Clark, P.I.
05/01/03-12/31/03	The Lord Foundation. <i>3rd Annual Engineering Design Contest</i> . \$10,000. Robert Kielb, P.I.
05/01/02-12/31/02	The Lord Foundation. <i>Wing Test Stand and Instrumentation</i> . \$5,000. Lars Howle, P.I.
05/01/00-12/31/01	The Lord Foundation. <i>Improving the Undergraduate Experience: Multipurpose Experimentation, Design and Presentations Laboratory Project</i> . \$15,000. Michael Gustafson, P.I.
07/01/00-12/31/01	North Carolina Biotechnology Center. <i>Triggered Release of Contents from Liposomes using Ultrasound</i> . \$55,000. David Needham, P.I.
01/01/00-12/31/00	National Science Foundation. <i>Investigations into Micro-Scale Heat Transfer and CAD Tools for Thermal Management in Deep-Submicron Integrated Circuits</i> . \$30,421. Krish Chakrabarty, P.I.
07/01/99-06/30/00	The Lord Foundation. <i>Innovations in Medical Ultrasound Imaging</i> . \$15,310. Lars Howle, P.I.
05/01/99-04/30/02	Office of Naval Research. <i>Undulatory Flap Propulsion - Reduction to Practice</i> . ONR Young Investigator Award . \$328,071. Lars Howle, P.I.
04/01/99-03/31/02	The Whitaker Foundation. <i>Imaging Methods for Ultrasound Contrast Agents</i> . \$205,895. Lars Howle, P.I.
05/01/98-09/30/98	North Carolina Space Grant Consortium. <i>Investigation of g-Jitter in Surface-Tension-Driven Convection in Micro-Gravity</i> . \$5,000. Lars Howle, P.I.

03/03/98-03/02/99 Nekton Technologies, Inc. *Analytical Study of Nektor Propulsion*. \$42,536. Lars Howle, P.I.

02/01/98-01/30/99 Mallinckrodt, Inc. *Stabilization of Ultrasound Contrast Agents*. \$42,536. Lars Howle, P.I.

09/01/97-08/31/99 Petroleum Research Fund. *Active Control of Convection in Porous Media*. \$25,000. Lars Howle, P.I.

05/01/97-09/30/97 North Carolina Space Grant Consortium. *Active Control of Surface-Tension-Driven Convection in Micro-Gravity*. \$5,000. Lars Howle, P.I.

07/01/96-06/30/97 The Lord Foundation. *Undergraduate Laboratory Renovations*. \$38,273. Lars Howle, P.I.

07/01/96-06/30/97 The Lord Foundation. *Duke University Mechanical Engineering Wind Tunnel Repairs*. \$20,000. Lars Howle, P.I.

INVITED PRESENTATIONS

01/25/23 *Entanglement Risk Simulator Study*. Bureau of Ocean Energy Management Leadership Outreach Meeting.

01/19/22 *Entanglement Simulations to Inform Sustainable Aquaculture and Offshore Wind Energy Development*. Entanglement Expert Roundtable Meeting. **Plenary Presentation.**

06/10/21 *Decompression Modeling*. Undersea and Hyperbaric Medical Society Annual Scientific Meeting. **Plenary Presentation.**

05/04/21 *Probabilistic DCS Model Development*. 2021 ONR Undersea Medicine and NAVSEA Deep Submergence Biomedical Development Program Review.

05/04/21 *Update on Advances in Oxygen Toxicity Prediction Models*. 2019 ONR Undersea Medicine and NAVSEA Deep Submergence Biomedical Development Program Review.

06/19/19 *The Whale Simulator: A Potential Tool for Predicting Entanglement Risk for Offshore Aquaculture*. **Saltonstall Kennedy Lecture.** NOAA Southwest Fisheries Science Center. La Jolla, CA.

- 06/21/19 *The Whale Simulator: A Potential Tool for Predicting Entanglement Risk for Offshore Aquaculture.* NOAA Offshore Aquaculture Gear/Protected Species Interaction Workshop. NOAA Southwest Fisheries Science Center. La Jolla, CA.
- 05/16/19 *Transfer of Duke University Dive Trial Data to U.S. Navy.* 2019 ONR Undersea Medicine and NAVSEA Deep Submergence Biomedical Development Program Review. Durham, NC.
- 05/14/19 *Evaluation of and Advances in O2 Toxicity Models.* 2019 ONR Undersea Medicine and NAVSEA Deep Submergence Biomedical Development Program Review.
- 03/11/19 *The whale simulator: A tool for predicting entanglement risk for offshore aquaculture.* Aquaculture 2019. New Orleans, LA.
- 06/19/18 *Virtual Whale Entanglement Simulator. Lowell Lecture.* New England Aquarium. Boston, MA.
- 06/14/18 *Evaluation of and Advances in CNS Oxygen Toxicity and Decompression Sickness Models.* ONR-NAVSEA Undersea Medicine Program Review. Arlington, Washington, DC.
- 04/04/18 *Entanglement of Right Whales with Fixed Fishing Gear.* NOAA Whale release, Gear marking feasibility subgroup meeting. Warwick, RI.
- 06/31/17 *Fast, Near Optimal Iso-Risk Ascent Profile Algorithm for Air and Enriched Air Dives.* Naples, FL.
- 05/03/17 *Advances in Probabilistic Decompression Models and Decompression Scheduling.* ONR-NAVSEA Undersea Medicine Program Review. San Diego, CA.
- 05/01/17 *Evaluation of and Advances in Oxygen Toxicity Models.* Undersea Medicine Program Review. San Diego, CA.
- 05/12/16 *Decompression models – where are we? Where do we need to go from here?* Office of Naval Research Decompression Sickness and Hyperbaric Oxygen Toxicity Workshop. Arlington, VA.
- 08/05/15 *Probabilistic decompression modeling.* ONR-NAVSEA Undersea Medicine Program Review. Buffalo, NY.

08/06/15 *Advances in probabilistic decompression models and decompression modeling.* ONR-NAVSEA Undersea Medicine Program Review. Buffalo, NY.

08/05/14 *Patient-specific dosing for CT contrast studies.* Nemoto-Kyorindo Co, Ltd. Tokyo, Japan.

02/28/14 *Entanglement of North Atlantic right whales with fishing gear.* Maine Fishermen's Forum. Rockland, ME.

09/25/13 *Entanglement of North Atlantic right whales with fishing gear.* Duke University Marine Lab. Beaufort, NC.

03/25/12 *Modeling and analysis of fluid flow around a suction cup bio-logging tag.* Northwest Fisheries Service Center. Seattle, WA.

03/24/12 *Modeling and water tunnel testing of cetacean dart-mount data-logging tags.* Northwest Fisheries Service Center. Seattle, WA.

02/16/11 *Modeling Whale Entanglements (**Plenary Presentation**).* Dynamics of Large Whale Entanglements Workshop. Woods Hole Oceanographic Institution. Woods Hole, MA.

11/29/10 *Innovations in Contrast Enhanced Imaging.* MGT Nemoto International. Chicago, IL.

10/25/10 *Mathematical Modeling of Whale Entanglement Events.* New England Aquarium - Federal Reserve Bank. Boston, MA.

08/05/10 *Probabilistic Models of Decompression Sickness (DCS).* NAVSEA. ONR. NMRC (BUMED) Undersea Medicine Program Review. Seattle, WA.

11/16/09 *Hydro-biomimetics.* Chief of Naval Operations Strategic Studies Group. Durham, NC.

03/17/09 *Marine Hydromechanics.* ONR Cetacean Tagging Workshop. Arlington, VA.

07/15/08 *Predicted DCS probability, dive conditions, and DCS severity.* NAVSEA. ONR. NMRC (BUMED) Undersea Medicine Program Review. Arlington, VA.

04/30/08 *Technology Brief: Tubercle Technology.* General Dynamics - Electric Boat. Groton, CT.

01/10/08 *Fluid Dynamics Research Collaboration between Radiology and Engineering.* Department of Radiology Grand Rounds. Duke University Medical Center. Durham, NC.

07/18/07 *Predicted DCS Probability, Dive Conditions, and DCS.* NAVSEA. ONR. NMRC (BUMED). Undersea Medicine Program Review. Groton, CT.

04/27/07 *A Parameter Estimation System for fitting Probabilistic Decompression Models to Empirical Data.* University of Massachusetts at Dartmouth. Dartmouth, MA.

01/12/07 *Computer Aided Design and Manufacture of Hydrodynamic Control Surfaces.* Deka Research, LLC. Manchester, NH.

10/06/06 *Undulatory Propulsion.* Deka Research, LLC. Manchester, NH.

06/20/06 *Predicting DCS Severity, Dive Conditions and DCS.* ONR Underwater Medicine Program Review. Durham, NC.

05/30/06 *Hydrodynamic Propulsion.* Deka Research, LLC. Manchester, NH.

05/12/06 *Optimization of Probabilistic Decompression Sickness Models.* Oceanic, Inc. Durham, NC.

11/21/03 *Morphing Aircraft Structures – Systems integration and Control.* DARPA MAS. University review. Arlington, VA.

10/09/01 *Active control of convection,* United States Naval Academy. Annapolis, MD.

10/16/01 *Control of underwater gliding vehicles.* United States Naval Academy. Annapolis, MD.

10/20/00 *Biomimetic Propulsion Studies for Navy Applications.* United States Naval Academy. Annapolis, MD.

10/05/00 *Active control of Rayleigh-Bénard Convection.* CNCS-CNLS Workshop. Duke University. Durham, NC.

11/02/99 *Boundary Effects on Controlled Rayleigh-Bénard Convection.* Applied Math Seminar. Duke University. Durham, NC.

08/25/99 *Undulatory Flap Propulsion.* 11th International Symposium on Unmanned Untethered Submersible Technology. Durham, NH.

01/27/98 *Boundary Effects on Controlled Rayleigh-Bénard Convection.* Differential Equations Seminar. North Carolina State University. Raleigh, NC.

08/18/98 *Visualization and Control of Buoyancy-Driven Convection.* Shriners Burn Hospital, Massachusetts General Hospital, and Harvard Medical School. Boston, MA.

09/01/97 *Pattern Formation in Convection in Porous Media* Max Plank Institute. Dresden, Germany.

- 10/10/95 *Control of Rayleigh-Bénard Convection*. Center for Nonlinear and Complex Studies. Duke University. Durham, NC.
- 10/24/94 *Control of Buoyancy-Driven Convection*. University of Massachusetts at Dartmouth. Dartmouth, MA.
- 02/25/94 *Pattern Formation in Porous Media Convection*. Mechanics and the Environment. Duke University, Durham, NC.

CONFERENCE AND OTHER PRESENTATIONS

- 11/07/13 *Virtual Simulation of Right Whale Entanglement in Fishing Gear*. North Atlantic Right Whale Consortium Meeting. New Bedford, MA.
- 11/13/12 *Computer modeling of wright whale entanglements*. North Atlantic Right Whale Consortium Meeting. New Bedford, MA.
- 06/21/12 *New classes of interconnected compartmental DCS models*. Undersea and Hyperbaric Medical Society Meeting. Phoenix, AZ.
- 06/15/11 *Bayesian approach to decompression sickness model parameter estimation*. Undersea and Hyperbaric Medical Society Meeting. Fort Worth, TX.
- 11/03/10 *Computer modeling of right whale entanglement events*. North Atlantic Right Whale Consortium Meeting. New Bedford, MA.
- 06/25/09 *Probabilistic DCS models using hierarchical outcome severity*. Undersea and Hyperbaric Medical Society. Las Vegas, NV.
- 06/28/08 *Is marginal DCS ("niggles") real or random noise?* Undersea and Hyperbaric Medical Society. Salt Lake City, UT.
- 06/07/06 *Predicting DCS Severity, Dive Conditions and DCS*. Undersea and Hyberbaric Medical Society. Orlando, FL.
- 01/14/04 *Computational Fluid Dynamics in a Multidisciplinary context*. DARPA Helicopter Quieting Proposer's Day Meeting. Arlington, VA.
- 08/27/01 *Kinematics of Fish Midline Models*. Unmanned Underwater Submersible Technologies, 12th International Symposium. Durham, NH.
- 11/23/99 *Undulatory Flap Pair Propulsion*. APS Division of Fluid Dynamics Meeting. New Orleans, LA
- 11/23/98 *Boundary Effects in Controlled Rayleigh-Bénard Convection*. APS Division of Fluid Dynamics Meeting. Philadelphia, PA.

- 11/23/98 *Linear and Nonlinear Control of Rayleigh-Bénard Convection*. APS Division of Fluid Dynamics Meeting. Philadelphia, PA.
- 11/23/96 *Floquet Stability Analysis of the Onset of Convection in Periodic Porous Media*. APS Division of Fluid Dynamics Meeting. Syracuse, NY.
- 11/22/94 *Suppression of Natural Convection in Small Aspect Ratio Containers*. APS Division of Fluid Dynamics Meeting. Atlanta, GA.
- 11/30/93 *Visualization of Natural Convection in Ordered and Disordered Porous Layers*. ASME Winter Annual Meeting. New Orleans, LA.
- 11/23/92 *Convection in Porous Media: Visualization by a Novel Shadowgraphic Technique*. APS Division of Fluid Dynamics Meeting. Tallahassee, FL.
- 08/10/92 *Shadowgraphic Visualization of Natural Convection in Rectangular-Grid Porous Media*. ASME National Heat Transfer Conference. San Diego, CA.

PATENTS

Laurens Howle, Rendon Nelson, Eli Nichols, Sebastian Shindera, Courtney Coursey, & Paul Weber. *Jetless Intravenous Catheters and Mechanical Assist Devices for Hand-Injection of Contrast Media During Dynamic Computer Tomography and Methods of Using Same*. US 9,884,166. 02/06/2018.

CONSULTANT FOR (ABBREVIATED LISTING):

- Advanced Dynamics, Inc. Lexington, KY.
- Alaska Sealife Center. Seaward, AK.
- Alston & Bird, LLP. New York, NY, Charlotte, NC.
- American Cooling Systems, LLC. Grand Rapids, MI.
- Atlantic Productions, Ltd. London, UK.
- Bakos & Kritzer. New York, NY.
- Chicago Zoological Society. Brookfield, IL.
- DeLio, Peterson & Curcio, LLC. New Haven, CT.
- Defense Advanced Research Projects Agency. Alexandria, VA
- Envira-North Systems, Ltd. Seaforth, ON.
- Flexxaire. Edmonton, AB.
- Hendershot, Cannon & Hisey, P.C. Houston, TX.
- Lineage Logistics. Colton, CA.

- Lowe Graham Jones, PLLC. Seattle, WA.
- Mann Law Group. Seattle, WA.
- Mei & Mark, LLP. Washington, DC.
- Mote Marine Laboratory & Aquarium. Sarasota, FL.
- National Marine Fisheries Service. Washington, DC.
- National Oceanographic and Atmospheric Administration, Washington, DC.
- New England Aquarium. Boston, MA.
- Office of Naval Research. Alexandria, VA.
- PL MFG. Cooperstown, ND.
- SethLaw, LLP. Houston, TX.
- Shearwater Research, Inc. Vancouver, BC.
- SPX Cooling Technologies, Inc. Overland Park, KS.
- Strategic Analysis, Inc. Arlington, VA.
- Technology Development Associates, LLC. East Greenwich, RI.
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TEACHING EXPERIENCE

ME555.03 Introduction to Scientific Computing (graduate)
 ME639.01 Computational Fluid Dynamics and Heat Transfer (graduate)
 ME555.08 Probabilistic Pharmacokinetics and Pharmacodynamics (graduate)
 ME555.01 Design and Analysis of Wind Turbines (graduate)
 ME490.07 Design and Analysis of Wind Turbines (undergraduate)
 ME265.05 Introduction to Scientific Computing (graduate)
 ME265.01 Advanced Computational Fluid Dynamics (graduate)
 ME229 Computational Fluid Dynamics and Heat Transfer (graduate)
 CNS201 Topics in Nonlinear Dynamics (graduate survey course)
 ME391.04 Short time scale dynamics of the NASDAQ equities market (undergraduate)
 ME321.01 Analysis for Mechanical Design (undergraduate, with recitation)
 ME165.02 Advanced Manufacturing Engineering (undergraduate, with laboratory)
 ME165.01 Manufacturing Engineering (undergraduate, with laboratory)
 ME150L Heat and Mass Transfer (undergraduate, with laboratory)
 ME141L Mechanical Design and Machine Components (undergraduate, with laboratory)
 ME131R Analysis for Mechanical Design (undergraduate, with recitation)
 ME126L Fluid Mechanics (undergraduate, with laboratory)
 ME125L Modeling and Control of Dynamical Systems (undergraduate, with laboratory)

RESEARCH CENTER ACTIVITIES

Center for Nonlinear and Complex Systems Seminar Series Organizer, 1997-1998.
 Center for Nonlinear and Complex Systems steering committee, 1999-2003.

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Physica D
Journal of Aerospace Engineering
Journal of Applied Physiology

Journal of Applied Biotechnology & Bioengineering
Journal of Biomedical Engineering
International Journal of Heat and Mass Transfer
Numerical Heat Transfer
Journal of Heat Transfer
Physics of Fluids
Journal of Fluid Mechanics
Journal of Fluids & Structures
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Undersea and Hyperbaric Medicine
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