

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. IPR2022-01574
U.S. Patent No. 11,254,491

**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. 11,254,491 (the “’491 Patent”), the applications to which it claims priority, and certain issues raised in IPR2022-01574.

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 am a Professor of Radiology at the Duke University Medical Center and have previously been a Professor of Marine Science and Conservation at the Duke University Marine Laboratory.

8. In addition, 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, acceleration gauges, and interferometers.

10. 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.

11. 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”.

12. I have served as an expert witness on more than 20 cases, have testified at trial on seven occasions, and have been deposed six 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.

13. My knowledge, experience, and training meet or exceed the level of a person of ordinary skill in the art 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).

14. 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

15. 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. 11,254,491
Ex. 1002	Prosecution History of U.S. Patent No. 11,254,491
Ex. 1003	Declaration of Michael Jobin

Exhibit	Description
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”)
Ex. 1012	National Coffee Association
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”)

Exhibit	Description
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.
Ex. 1027	https://www.italcoat.com/wp-content/uploads/2022/08/ITC-Coffee-Capusles.pdf
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.
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 (“Erlandson”)
Ex. 1039	U.S. Patent Pub. 2005/0150391A1 (“Schifferle”)
Ex. 1040	PCT Pub. WO2005/044067A1 (“Ruchonnet”)

Exhibit	Description
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 (the “third German application”)
Ex. 1046	Official English translation German application No. 102010031988.0 (the “first German application”)
Ex. 1047	Official English translation German application No. 102010044251.8 (the “second German application”)
Ex. 1048	<i>K-Fee System GmbH v. Nespresso USA, Inc. et al.</i> , Case No. 2:22-cv-00525 (Complaint)
Ex. 1049	<i>K-Fee System GmbH v. Nespresso USA, Inc. et al.</i> , Case No. 2:22-cv-00525 – Supplemental Disclosure of Infringement Contentions (July 11, 2022)
Ex. 1050	Excerpt from Prosecution History of U.S. Appl. No. 13/744,623
Ex. 1051	https://nestle-nespresso.com/our_products/product
Ex. 1052	<i>K-Fee System GmbH v. Nespresso USA, Inc. et al.</i> , Case No. 2:21-cv-3402; Dkt. 111 (Claim Construction Order)
Ex. 1053	Excerpt from Prosecution History of U.S. Appl. No. 16/438,818
Ex. 1054	<i>K-Fee System GmbH v. Nespresso USA, Inc. et al.</i> , 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”
Ex. 1056	Illy, Andrea, and Rinantonio Viani, eds. Espresso coffee: the science of quality. Academic Press, 2005

Exhibit	Description
Ex. 2002	Excerpts of prosecution history of Appl. No. 17/385,109
Ex. 2003	U.S. Patent No. 11,230,430
Ex. 2004	U.S. Patent No. 10,858,177
Ex. 2005	U.S. Patent No. 10,858,176
Ex. 2006	Excerpts of prosecution history of U.S. Patent No. 10,858,176
Ex. 2007	U.S. Patent No. 10,870,531
Ex. 2008	Excerpts of prosecution history of U.S. Patent No. 10,870,531
Ex. 2009	Excerpts of prosecution history of Appl. No. 17/547,363
Ex. 2010	Suggestion for Declaration of Interference, Appl. No. 13/697,297
Ex. 2011	Complete prosecution history of U.S. Patent No. 11,254,491
Ex. 2012	Transcript of deposition of Michael Jobin taken June 22, 2023 ("Jobin Depo. Tr.")
Ex. 2013	Examiner-Initiated Interview Summary for Appl. No. 17/324,182
Ex. 2014	Examiner-Initiated Interview Summary for Appl. No. 17/108,175
Ex. 2015	Notice of Allowance for Appl. No. 17/330,572
Ex. 2016	Applicant-Initiated Interview Summary for Appl. No. 17/963,392
Ex. 2017	Excerpts from Appl. No. 17/670,629
Ex. 2018	Excerpts from Appl. No. 17/670,765

Exhibit	Description
Ex. 2019	U.S. Patent No. 8,431,175
Ex. 2020	Declaration of Marc Krüger
Ex. 2022	U.S. Patent Appl. Pub. No. 2009/0007792
Ex. 2023	U.S. Patent Appl. Pub. No. 2008/0302252
Ex. 2024	WO Pub. No. WO2008100597A1
Ex. 2025	Bialetti Moka Express (https://www.bialetti.com/it_en/moka-express.html)
	IPR2022-01574, Paper 12
	IPR2021-01222, Paper 6, EX2002-1

16. My opinions are additionally guided by my appreciation of how a person of ordinary skill in the art would have understood the claims of the '491 Patent and its earlier-filed applications at the time of the invention, which is at least as early as September 2, 2010.

III. Understanding of Governing Law

17. 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.

18. I have been informed and understand that a Person of 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.

A. Priority

19. 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.

B. Anticipation

20. 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.

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. 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). 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

21. 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.

22. 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, or may come from the reference(s) themselves, the knowledge or “common sense” of a POSITA, or from the nature of the problem to be solved, and this reason 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

23. 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.

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

24. I have reviewed the qualifications that Petitioner contends that a person having ordinary skill in the art (“POSITA”) in the ’491 Patent would have. I note that the Board, in its Decision Granting Institution, adopted Petitioner’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. IPR2022-01574, Paper 12 at 14-15.

Additional education might substitute for some of the experience, and substantial experience might substitute for some of the educational background. For the purposes of this Declaration, I adopt this definition with respect to the '491 Patent.

25. 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 '491 Patent.

V. Claim Construction

26. For the purposes of this Declaration, I understand that Petitioner has not proposed formally construing any term of the '491 Patent, and therefore, the claim terms should be given their plain and ordinary meaning to a person of skill in the art.

A. An Identifier, which includes a repeat pattern, provided on the bottom side of the flange

27. In its decision instituting the IPR, the Board stated:

“[w]e are also not convinced that the toothed ring represents a repeat pattern as that term is used in the second German application. As Petitioner argues, the use of the phrase ‘repeat pattern’ is associated with an ink-printed

identifier. Prelim. Reply 7; Ex. 1007, 33. It is not clear, on the current record, that the term “repeat pattern” would encompass a physical arrangement of gear-like teeth, as neither party has offered a construction of the claim term.”

IPR2022-01574, Paper 12 at 25. The term “repeat pattern” is entitled to its plain and ordinary meaning, consistent with the broad description of “identifiers” in the ’491 Patent, and my interpretation of this limitation is consistent with both the specification of the ’491 Patent and the disclosure in the second German application. It simply means a pattern that is repeated.

28. The term identifier is broadly used in the ’491 Patent. The specification describes that the identifier is used “to individualize the capsule” (Ex. 1001 at 1:33-34 and 1:61-62) and recites numerous different examples, including printed, radio identification, electromagnetic, shape and mechanical identifiers. For example, the Summary section of the ’491 Patent discloses that an identifier may be “composed of surface areas having different optical properties,” *id.* at 2:26-27. It may be “encoded in the recess and/or bulge,” and read as “a result from a mechanical and/or optical method.” *Id.* at 2:46-49.

29. The identifier is also further described in the ’491 Patent as preferably being “a machine-readable imprint,” which can be “a print in food approved color,” “[f]luorescent material,” “a barcode, a logo, or a repeat pattern.” *Id.* at 3:1-6. As yet another example, the identifier is described as being “an electrically

conductive section,” “a ferromagnetic material,” “a RFID chip,” or a “weakening” in the bottom area of the capsule. *Id.* at 3:7-19, 3:42-43.

30. As Mr. Jobin readily admits, the second German application provides “several distinct embodiments of identifier.” Ex. 1003 at ¶ 158. This includes, “several raised areas” (*id.*); “a barcode on the edge area of the base element” (*id.* at ¶ 160); “identifiers consisting of indentations, barcodes, bulges, reflective and blunt zones, widened rings, ferromagnetic material, or a metallic built-in element like a sieve.” (*id.* at ¶ 161); and “a ‘toothed ring’ around the ‘outer regions’ of the flange or peripheral region 2.4.” Mr. Jobin concedes that all of these are different forms of “identifiers,” and that each can be used for purposes of individualizing the portion capsule, as disclosed in the second German application.

31. When discussing other references that also disclosed alternative identifiers, Mr. Jobin admitted that a POSITA at this time would know that these different identifiers could each be applied to the subject capsule of the reference. *See* Ex. 2012 at 87:10-88:20 (characterizing “indents, cutouts, protrusions or holes which can be identified by a mechanical sensor” as “identifiers”) (all objections omitted); 88:22-90:6 (characterizing “a barcode printed onto the body of the package, a pattern of through holes in the package, a pattern of contrasting tones or colours printed onto the package” as “alternate identifier means”); 90:7-92:1 (characterizing “strips of a magnetic material applied to the body of the package”

and “one or more shaped or divided areas of metal foil” as “magnetic or inductive alternatives to the previous recognitions means that were discussed”); 91:10-92:25 (“[I]t’s my view in the reading of these paragraphs that the recognition means and the alternatives discussed apply to the capsule or package that is the subject of this invention.”).

32. The added description of a “repeat pattern” is just that. The identifier is repeated. The Board is correct that the second German application explicitly uses the term “repeat pattern” in describing certain machine-readable print. This confirms that the identifier can be repeated. Simply because that term is used in the second German application in connection with machine-readable print, does not mean that the physical identifier disclosed and described with respect to Figures 16, 17 and 18 are not repeated on the flange of the capsule. The “toothed ring” pattern is plainly repeated in those Figures.

VI. Overview of the Prior Art

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

33. 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].

34. 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.” *Id.* 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].

35. 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.” *Id.* 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.”).

36. Yoakim further describes an identification means and control means for operating the device according to predetermined brewing parameters. *Id.* 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 929 (U.S. Patent Pub. No. 2013/0064929)

37. Jarisch 929 generally relates to a “coding support” to be used as part of a single-serve beverage capsule. Ex. 1006 at [0001]. Specifically, the support

“comprises a section on which at least one sequence of symbols is represented so as that each symbol is sequentially readable” when being rotated about a central axis of rotation. *Id.* at [0016]. The support may contain information about the capsule, including “parameters for preparing a beverage with the capsule,” and “information related to the manufacturing of the capsule.” *See, e.g., id.* at [0020]-[0024]. The support is read by a “reading means arranged for reading the sequence of symbols in the section when the capsule is rotated along [its] axis.” *Id.* at [0038]. The symbols may “represent an integer number of bits” or “arranged in the sequence using a modulation scheme.” *Id.* at [0026]. The extraction system described in Jarisch 929 operates via centrifugation by rotating the beverage capsule to extract the beverage, and the symbols may be read at a different rotational speed. *Id.* at [0039].

C. Rossi (WO 2010/099806)

38. Rossi relates generally to a process and system for controlling the operation of an edible-product making machine that uses single-use capsules. *E.g.*, Ex. 1041 at cl. 1. The process described in Rossi consists of a first step of recognizing an identifying element and validation element on the capsule; a second step of validating the validation element; and a third step of activating a cycle of production only after recognizing the identifying element and the now-validated validation element. *Id.* at 6. The use of a validation element is described to “help to

prevent the use of an already-used single load element,” and the identification element “preferably contains information about the contents of the load element.” *Id.* at 7-8.

39. Specifically, the first step may consist of “unlocking the machine when both the identification element and the unvalidated validation element are recognized.” *Id.* at 9. The second step of validation of the validation element may consist of “mechanical destruction of the validation element,” which ensures that the validation element cannot be re-recognized. In the third activation step, the machine “activates a cycle of edible-product production” after it recognizes on the capsule the same identifying element and the validated validation element. *Id.* at 8-10.

D. Castellani (U.S. Patent Pub. No. 2008/0105131)

40. Castellani generally describes a “delivery head” for an espresso machine that allows for the easy loading and ejecting of single-use capsules. Ex. 1009 at [0010]. A capsule can be placed in the delivery head, and the delivery head closed by pressing a lever downward. *Id.* at [0045]-[0046]. The top of the capsule is then perforated and “pressurized water is delivered which, through the delivery duct 20 and the hole formed by the top perforating element 18 can enter the coffee capsule and diffuse there-through owing to the provision of suitable channels formed inside said capsule 10.” *Id.* at [0049].

VII. Summary of Opinions

41. Based on my review of the Petition, Mr. Jobin's declaration, and the prior art references relied on for the Petitioner's invalidity grounds, my opinion is that claims 1-13 are not invalid over the grounds asserted by Petitioner:

- **Ground 1:** Claims 1 and 4-6 allegedly would have been obvious over Yoakim in view of Jarisch 929 and Rossi
- **Ground 2:** Claims 2-3 and 7-13 allegedly would have been obvious over Yoakim, Jarisch 929, Rossi and in further view of Castellani

42. In particular, none of Yoakim, Jarisch 929, Rossi, or Castellani, alone or in combination, disclose a "pump controlled to supply water into the single-serve capsule only upon detection of the identifier by the sensor/detector and a determination by the beverage machine that the single-serve capsule is suitable for use with the beverage machine;" a "groove that is laterally offset from the chamfered mandrel;" or "a seal that is at least partially seated in the groove and configured to bear against a top side of the cover in a region between a peripheral edge of the cover and the region of the cover that is pierced by the chamfered mandrel." Nor do Petitioner's references disclose a "ledge at an upper region [of the inside wall], the ledge projects from the inside wall towards the central longitudinal axis."

VIII. K-fee's Second German Priority Application Supports the '491 Patent's Claims

43. I have been informed that in order for the '491 Patent to be entitled to at least the September 2, 2010 filing date of German application DE 10 2010 044 251.8 (the “second German application”), the claims must find support in that application. In other words, the description in the second German application must indicate to a POSITA that the inventor was in possession of the claimed invention at the time the application was filed.

44. It is my opinion that the second German application provides priority support for at least the independent claim of the '491 Patent for two reasons: (1) a POSITA would have understood that the embodiment disclosed in Figures 16, 17, and 18 of the second German application recite each and every limitation in at least independent claim 1 of the '491 Patent; and (2) a POSITA would have understood that based on at least the disclosure of the second German application the inventor was in possession of the claimed invention.

A. The Embodiment of Figures 16, 17, and 18

45. It is my opinion that Figures 16, 17, and 18 of the second German application and their accompanying descriptions, which show “embodiments of the portion capsule according to figure 16,” recite each and every limitation of at least independent claim 1 of the '491 Patent. Ex. 1047 at 36:33-34.

46. For example, the preamble of claim 1 (“[a] beverage system for making a beverage”) finds support in the text accompanying Figures 17a-17c, which describes various aspects of the beverage system, including a “portion capsule,” “retaining arms,” “brewing chamber,” and “waste container.” Ex. 1047 at 42:5-14. The second German application’s description of the inventor’s goals: further supports the preamble: “[t]he present invention relates to a portion capsule for making a beverage” *See, e.g.*, Ex. 1047 at 30:29-30. Additionally, the general description of the second German application states “[t]he object is achieved by a portion capsule for making a beverage” *Id.* at 30:21-22; *see also id.* at cl. 1 (“A portion capsule (1) for making a beverage”); *id.* at Abstract (“The present invention relates to a portion capsule for making a beverage”). Thus, a POSITA would have understood that the second German application supports the preamble of Claim 1 of the ’491 Patent.

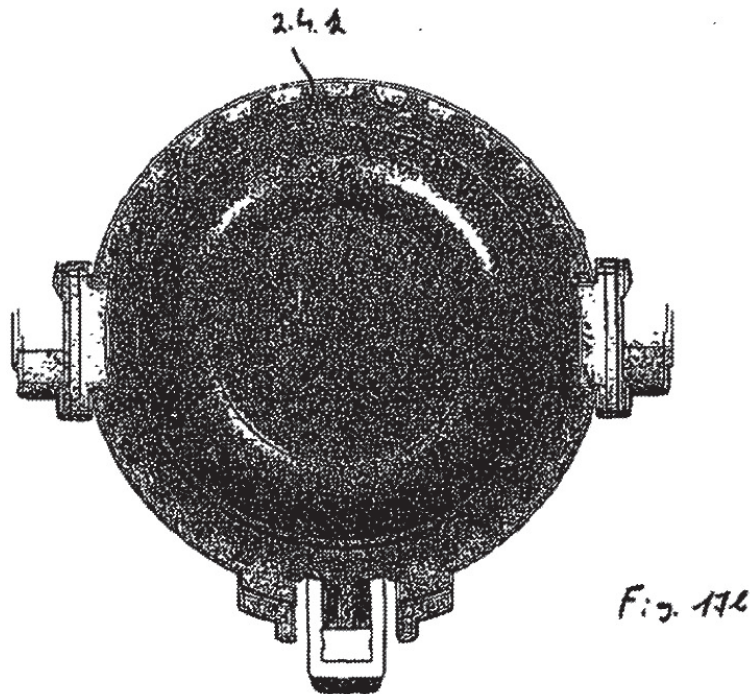
47. Figure 16 of the second German application (duplicated below) provides support for claim limitation [1.a], “a single-serve capsule comprising: (i) a base element with a cavity, in which a raw beverage material is provided,” when it discloses “a basic element 2, which in the present case is essentially conical and has a wall 2.1 and a base region 2.2. The raw material . . . [is] provided in this basic element.” Ex. 1047 at 41:14-19. A POSITA would have easily understood that the conical basic element necessarily constitutes a cavity in which the raw

beverage is located. Moreover, earlier in the description of the invention, the basic element is described as having “a cavity, in which a raw beverage material is provided.” Ex. 1047 at 30:1-7.

48. The general description and claims of the second German application further confirm this understanding. For example, the objective of the invention is described as “relat[ing] to a portion capsule for making a beverage, having a basic element with a cavity, in which a raw beverage material is provided” Ex. 1047 at 30:3-5; *see also id.* at 30:21-23 (“The object is achieved by a portion capsule for making a beverage, having a basic element with a cavity, in which a raw beverage material is provided”); *id.* at 30:29-31 (“The present invention relates to a portion capsule for making a beverage or food, having a cavity, in which raw beverage material is provided.”). Later in the general description, the second German application describes “a membrane for closing the basic element [which] may be arranged on this peripheral region once the raw material has been introduced into the portion capsule.” *Id.* at 34:18-21. Claim 1 provides further support for claim element [1.a] of the ’491 Patent. *Id.* at cl. 1 (“A portion capsule (1) for making a beverage, having a basic element (2) with a cavity (3), in which a raw beverage material is provided”).

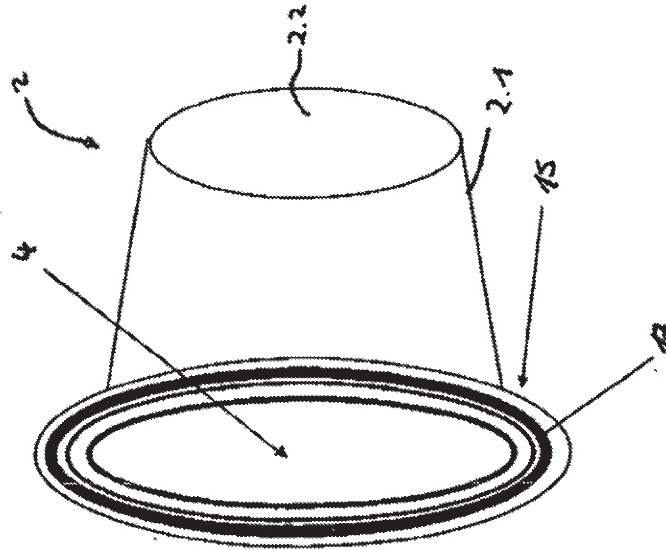
49. The limitation [1.b], “the base element being symmetrical about a central longitudinal axis thereof,” is supported by several drawings in the second

German application. For example, Figure 17c depicts a view of the capsule from below, showing that the base element or capsule is symmetrical about a central axis that runs through the center of the circular bottom portion of the base.



Ex. 1047 at FIG. 17c.

50. The second German application also provides support for the capsule “having a rounded bottom” (element [1.c]). For example, Figure 2 provides an angle of the portion capsule that depicts the rounded bottom portion 2.2. The bottom of Figure 2 is depicted as circular. Additionally, the bottom area 2.2 depicted in Figure 16a is also rounded. It is circular, as is evident from the additional views in Figures 17 and 18, and includes a bulged area in the center.



Ex. 1047 at FIG. 2.

51. As depicted in Figures 16(a) and 16(b), the beverage capsule contains “[a]n annular peripheral region 2.4,” which is “arranged at that end of the basic element which is located opposite the base region 2.2.” Ex. 1047 at 41:19-22. The recitation of this feature supports limitation [1.d], “ii) a flange extending outwardly from the base element, the flange comprising a top side and an opposing bottom side.” As depicted in Figure 16(b), the peripheral region or flange has an upper side and an opposing bottom side which extend outwardly from the based element. Figure 2 further confirms that the invention includes a flange extending outwardly from the base element.

52. The second German application’s depiction and recitation of an “annular peripheral region 2.4, onto which for example a cover sheet is sealed, [] arranged at that end of the basic element which is located opposite the base region

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outwardly-bowed cover because of, for example, differential pressure inside and outside of the capsule. Indeed, Mr. Jobin agrees that “[a] person of ordinary skill in the art would understand that including an inert gas in a gastight capsule that is sealed by a thin foil membrane cover would result in the cover bowed outwardly in a central region of the cover relative to a peripheral region of the cover under the pressure of the gas.” Ex. 1003 at ¶ 224. A POSITA would also understand that once the capsule’s top is pierced by the mandrel and/or the water inlet feature, air would escape and the foil cover could then become flattened, which Figure 16 depicts.

54. Mr. Jobin himself relies on a single drawing in Jarisch 929, which he admits is not described in the written description of the reference, for the purported disclosure of this claim limitation. *See* Ex. 2012 at 96:14-98:5. In particular, Mr. Jobin testified that “Figure 5 forms the basis of my understanding that the foil or membrane in this capsule is – is depicted here, and the – the foil or membrane or cover in this instance is bowed outwardly in a central region.” *Id.* A POSITA would have similarly interpreted the curved shape of Figure 16 of the second German application to support the same limitation.

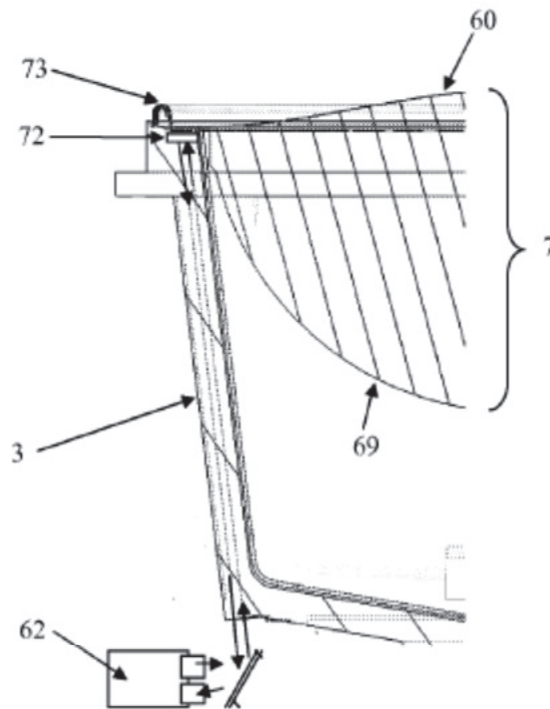


Fig. 5

Ex. 1006 at FIG. 5.

55. The second German application also provides support for element [1.f], “the cover includes a region configured to be pierced at a location that is offset from the central longitudinal axis” when it depicts the cover being pierced by a “spike” (29) at a location offset from the center of the cover in Figure 16.

56. A POSITA would have understood the second German application’s recitation of “[a]n annular peripheral region 2.4, onto which for example *a cover sheet is sealed*” to support limitation [1.g], “a barrier layer to prevent moisture or aroma from escaping out of the single-serve capsule.” Ex. 1047 at 41:19-22 (emphasis added). A POSITA would have understood that the sealing of the cover sheet onto the peripheral region 2.4 is one way to prevent the escape of moisture or

aroma. Additionally, the general description itself describes that “any barrier layer which may be present in the portion-capsule material [], for example, prevents moisture or aroma from escaping from the capsule.” Ex. 1047 at 32:20-23.

57. In my opinion, a POSITA would have understood the embodiment depicted in Figures 16, 17, and 18 and the descriptions accompanying the figures to provide support for claim limitation [1.h], “an identifier, which includes a repeat pattern, provided on the bottom side of the flange.” With respect to Figure 16, the application discloses that the “peripheral region 2.4 has, in its outer region, a *form-fitting and/or friction-fitting means and/or a detection means 2.4.2*.” Ex. 1047 at 41:22-24 (emphasis added); *see also* Figure 16 (above). As Mr. Jobin testified, this peripheral region 2.4 is the flange of the capsule. *See* Ex. 2012 at 169:5-170:4 (“It has been and continues to be my understanding peripheral region 2.4 is the feature of the capsule described generally – the capsules use that language to describe what I understand to be the flange of the capsule.”).

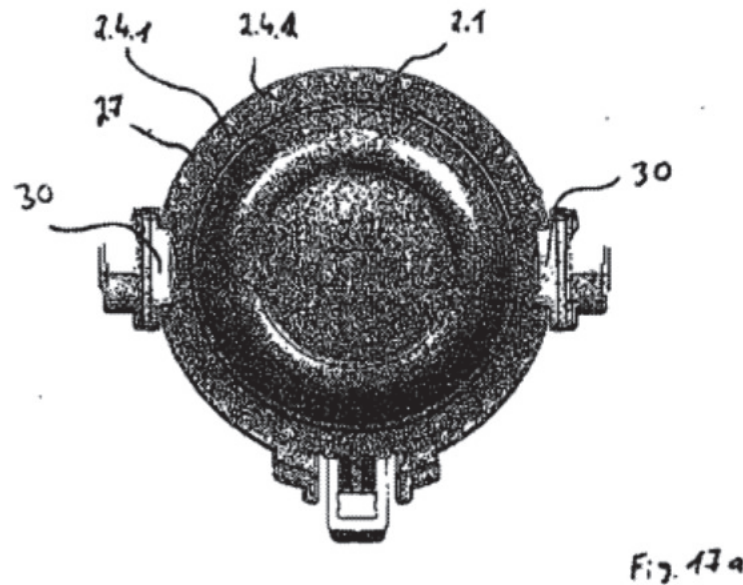
58. While the means 2.4.2 can be a toothed ring as depicted in Figures 16 and 17(a), 17(b), and 17(c), a POSITA would have understood that that other “detection means,” such as a barcode, could be used interchangeably in the same location. At the very least, a POSITA would have understood from this description of alternative “detection means” that various types of identifiers, such as a repeat

pattern or barcode, could be placed under the flange of the embodiment of Figures 16-18.

59. Moreover, a POSITA would have understood that a variety of materials and arrangements could form the “identifier, which includes a repeat pattern” claimed in the ’491 Patent. While one example of a repeat pattern is a barcode, a POSITA would have understood the toothed-ring or toothed-ring segment depicted in Figure 17a to also be a “repeat pattern.” In the general description of the second German application, the teeth are described as “preferably triangular, rectangular, square, undulating, or involute” but they could be “of any desired shape which is familiar to the person skilled in the art – for example *from a construction of gearings and gear mechanisms*.” Ex. 1047 at 35:11-17 (emphasis added). A POSITA would have known that gears or toothed rings necessarily consist of a repeating pattern of teeth, whether they be “triangular, rectangular, square, undulating.”

60. In particular, Figures 17a, 17b, and 17c depict toothed ring identifiers 2.4.2 located on the bottom side of the flange. Mr. Jobin agrees that a POSITA would have understood Figure 17a (and the other drawings) to be a view of the bottom of a portion capsule, or base region 2.2, looking up at the toothed ring on the bottom side of the flange, where the retaining arms 30 are holding the portion capsule in place. Ex. 2012 at 186:10-20 (“Q: Would you agree that Figures 17A, B

and C depict the capsule from the bottom? A: It's hard to tell from these images, but it is my understanding that we are reviewing the capsule from the bottom.”).



Ex. 1047 at Fig. 17a.

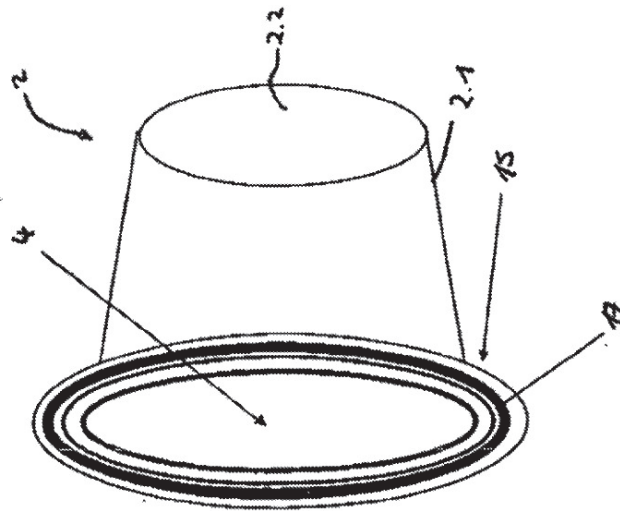
61. To the extent that one might argue that the toothed ring is not a repeat pattern, a POSITA would have understood that the toothed ring could easily be replaced by a “detection means 2.4.2” or other repeat identifier such as a barcode that could be detected by the sensor in the insertion shaft. *See* Ex. 1047 at 43:11-14; *see also* Ex. 2012 at 184:22-185:4 (“Q: So there’s a series of identifiers disclosed on pages 32 and 33 of Exhibit 1047, and they’re not associated with any particular embodiment, correct? A: I view this section as sort of overview section, and then later specific embodiments are described.”). Indeed, in a general description of the different identifiers that could be used with the portion capsule

(not associated with any particular embodiment), the application describes that “[t]he identifier is further preferably a machine-readable print,” and the “print is preferably a barcode, a logo or a repeat pattern.” Ex. 1047 at 33:1-7.

62. The general description of the second German application, which Mr. Jobin admits is not limited to any particular embodiment, confirms that both mechanical and optical identifiers described could be used as the identifier placed on the bottom side of the capsule’s flange. *See* Ex. 2012 at 184:22-185:4. Specifically, the mechanical “form-fitting and/or friction-fitting means can be used to drive for example complementary means,” which itself drives a sensor such as a gearwheel to “transmit[] a signal to a machine-control means depending on whether the portion capsule is the correct or incorrect one.” Ex. 1047 at 34:27-35:1. On the other hand, the second German application describes that both mechanical and optical identifiers (such as a barcode or logo), i.e., “form-fitting, friction-fitting *and/or detection means to be sensed by a detector*,” could be used to “establish whether the respective portion capsule is suitable for the respective coffee machine.” *Id.* at 35:1-6 (emphasis added). Thus, the second German application envisions that both mechanical and optical identifiers could be used to determine whether a capsule is suitable for use.

63. Figure 2 confirms that the toothed ring repeat pattern depicted in Figures 17a, 17b, and 17c are on the bottom side of the flange. As the second

German application explains, “[a]s an alternative, it is possible, as symbolized by the arrow 15, for the barcode to be provided on that side of the peripheral region of the basic element which is directed away from the membrane.” Ex. 1047 at 38:21-24. As I explained above, a POSITA would have understood that a different type of repeat pattern could easily replace the barcode described. Thus, a POSITA would have understood that Figures 17a, 17b, and 17c support this claim limitation.



Ex. 1047 at FIG. 2.

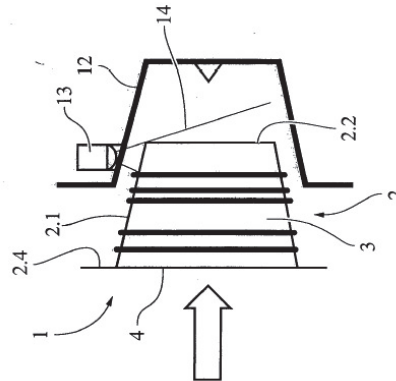
64. Claim limitation [1.i], “a beverage machine comprising: (i) a sensor/detector,” finds support in the second German application’s description of the embodiment depicted in Figures 16 and 17, which states that “[a] person skilled in the art is also aware that for example the insertion shaft may also contain a sensor.” *Id.* at 43:11-14. Specifically, “it would be possible, in the present case, for the shape of the teeth and/or the spacing between the same to be sensed.” *Id.* at

43:14-16. The general description further provides that the means 2.4.2 can “be sensed by a detector, in order to establish whether the respective portion capsule is suitable for the respective coffee machine.” Ex. 1047 at 35:1-6. Alternatively, the form-fitting and/or friction-fitting means can “be used to for example complementary means which are located in the region of the coffee machine . . . in order to drive a sensor, for example a gearwheel, which transmits a signal to a machine-control means depending on whether the portion capsule is the correct or incorrect one.” Ex. 1047 at 34:31-35:1. Figure 2 and the associated description provides additional support for the location of the detector. *Id.* at 38:25-27 (“This barcode is read by a detector 13, for example in an insertion shaft.”).

65. The second German application also provides support for claim limitation [1.j] (“ii) a receptable configured to receive the single-serve capsule”) in Figure 16. Figure 16 depicts a brewing chamber 27 and a seal 21, “which is arranged on the brewing chamber 27.” Ex. 1047 at 41:27-31. A POSITA would have understood from this description and from Figure 16 that the brewing chamber is a “receptable configured to receive the single-serve capsule.”

66. Figure 1 provides further support for this limitation when it states that the coffee capsule “is introduced into a brewing chamber 12 (illustrated schematically here).” Ex. 1047 at 37:9-12. The brewing chamber depicted here, which a POSITA would understand to be a receptable, similarly receives the base

element, as indicated by the large arrow at the bottom of the figure. The end portion or bottom of the brewing chamber does indeed oppose the bottom side of the flange.



Ex. 1047 at Fig. 1.

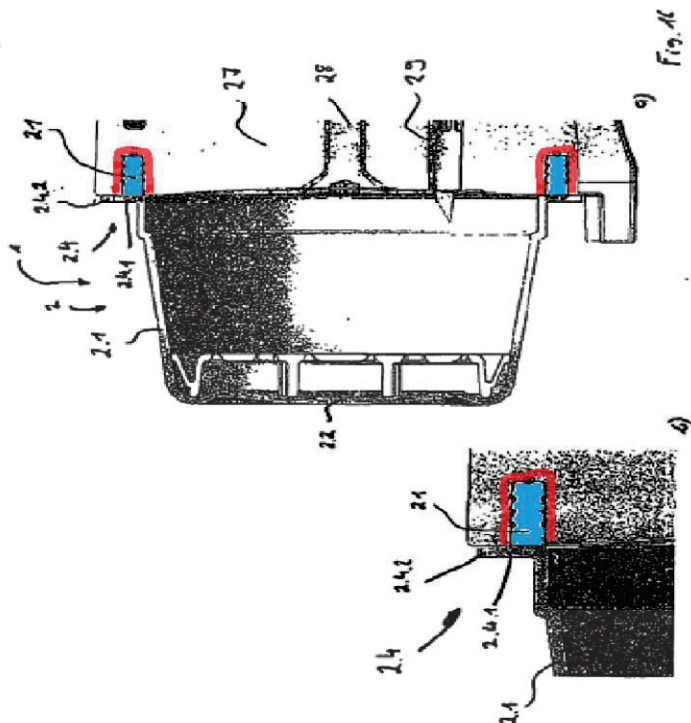
67. The description accompanying Figure 16 describes a pump controlled to supply water into the single-serve capsule only upon detection of the identifier by the sensor/detector and a determination by the beverage machine that the single-serve capsule is suitable for use with the beverage machine (limitation [1.k]). Specifically, the accompanying text describes the flow of water through a water inlet 28 and into the capsule, and then out through the opening made by a mandrel or piercing spike. Ex. 1047 at 41:31-35. Further, the general description in the application describes a “pressure pump” of a coffee machine “which makes the water available” to the capsule “only when the identifier determined coincides with the reference identifier. Otherwise, the coffee machine cannot be operated.” *Id.* at 31:31-38; *see also id.* at 38:3-6 (“For the case where these identifiers do not

coincide, in particular operation of the pump which forces, for example, hot water through the brewing is prevented.”); 33:25-30 (“the identifier makes it possible for the coffee machine . . . to set the beverage-making or food-making process, i.e. for example the quantity of water, the pressure thereof and/or the temperature thereof.”).

68. The general description of the invention further describes that the “identifier” can be a “form-fitting and/or friction-fitting means” that can either “drive a sensor, for example a gearwheel, which transmits a signal to a machine-control means depending on whether the portion capsule is the correct or incorrect one,” or “be sensed by a detector, in order to establish whether the respective portion capsule is suitable for the respective coffee machine.” *Id.* at 34:31-35:1. I previously discussed my opinion that a POSITA would have understood the “form-fitting, friction-fitting and/or detection means [2.4.2] to be sensed by a detector” to encompass repeat patterns such as a barcode or the toothed ring explicitly illustrated in Figures 16, 17, and 18. *See supra* ¶¶57-64. The description of Figure 16 further describes that the insertion shaft may detect the shape of the form-fitting, friction-fitting, and/or detection means 2.4.2, and the “signal, in turn, is passed to a **control means**, which frees, for example, the brewing chamber if the capsule is the correct one.” Ex. 1047 at 43:11-19 (emphasis added).

69. Further, the limitation [1.1], “iv) a chamfered mandrel that is configured to pierce the cover at the location that is offset from the central longitudinal axis” is supported by the depiction in Figure 16 of a spike 29 that produces an opening in the capsule through which water can flow at a location set off to the side from the central axis. Ex. 1047 at 41:31-35, Fig. 16.

70. Finally, the limitation [1.m], “v) a groove that is laterally offset from the chamfered mandrel; and (vi) a seal that is at least partially seated in the groove and configured to bear against a top side of the cover in a region between a peripheral edge of the cover and the region of the cover that is pierced by the chamfered mandrel,” is supported by the description of Figure 16 of “a sealing surface 2.4.1” on the peripheral region 2.4, that “interacts with sealing action with a seal 21, which is arranged on the brewing chamber 27.” Ex. 1047 at 41:27-31. As depicted in Figure 16, the seal bears against the top side of the cover in a region between the edge of the flange and the piercing spike. A POSITA viewing Figure 16 would understand that the seal 21(blue) is a rubber O-ring type structure that is seated at least partially within the groove (outlined in red) within the brewing chamber 27.



Ex. 1047 at FIG. 16 (annotated).

71. Thus, for at least the reasons I explained above, it is my opinion that a POSITA reading the second German application would have understood each limitation of claim 1 of the '491 Patent to be recited in at least Figure 16, 17, and 18 and/or their associated descriptions.

B. Possession of the Claimed Invention

72. In my opinion, each and every one of the claim limitations in the '491 Patent are supported by a single embodiment depicted in Figures 16, 17, and 18 and their accompanying descriptions. To the extent that one might argue that a single embodiment does not show all of the claim limitations, it is my opinion that a POSITA reading the second German application would have understood that it

describes a capsule having various features that are intended to work in each of the described embodiments.

73. The declaration of Marc Krüger, the inventor of the '491 Patent, further confirms my opinion that the inventor was in possession of the claimed invention at least as of the time the second German application was filed. *See generally* Ex. 2020. For example, by the time the second German application was filed on September 2, 2010, Mr. Krüger had already conceived of an outwardly-bowed cover for the capsule (which he describes as a capsule with “a convex upper end portion”) and the use of interchangeable form-fitting, friction-fitting, and/or detection means that could be used as identifiers placed on the bottom of the capsule’s flange. *See* Ex. 2020 at ¶¶ 20-21. Additionally, I have reviewed the prosecution histories of the '491 Patent and several related applications in this patent family, and I agree with each Examiner’s allowance of the claims over the prior art, including Jarisch and Jarisch 929. For example, in discussing the status of the numerous IPR filings and co-pending applications in this patent family, Examiner Jennison concluded with respect to Appl. No. 17/108,175 that “[t]he priority dates of the applications, and prior art cited, under Pre-AIA were verified.” Ex. 2014 at 2; *see also* Ex. 2013 at 2. As another example, in two related applications, U.S. Application Nos. 17/670,629 (the “’629 Application,” now U.S. Patent No. 11,465,829) and 17/670,765 (the “’765 Application,” now U.S. Patent

No. 11,465,830), Examiner Chou and Patent Owner discussed the claim of priority to the German applications, and Examiner Chou concluded that “[t]he support can be found in the above drawing objection section.” Ex. 2018 at 2; Ex. 2017 at 2.

74. Additionally, as Mr. Jobin testified, a POSITA would have been well aware of numerous types of capsule identifiers and how they could be interchangeably used in a capsule. For example, Mr. Jobin testified that in his experience with consulting on the design of identification means for a home beer-dispenser system, he evaluated several ways of identifying and verifying that the correct beer cartridge was being used, including through the shape of the capsule or its “ribs or features” that would result in “physical exclusion related to deactivation of the valve to prevent dispensing.” Ex. 2012 at 63:11-64:10 (“I think a variety of these features could be used to the physical exclusion ends, cartridge shapes or ribs, grooves, bosses. You know, all of those features of a cartridge have that in mind, I think.”); *id.* at 64:11-16 (“Q: How does a cartridge shape act as an identification system? A: It – it – if a cartridge doesn’t fit, it’s obviously not designed to be used with the system, is how I would put it.”); *id.* at 64:18-65:6 (describing the use of ribs as “exclusionary” or “fit features” that could act as an identification system).

75. Describing his experience with beer-dispenser systems, Mr. Jobin testified that barcodes were also used in order to “activate the machine or allow [it]

to be used.” *Id.* at 67:16-68:4. Mr. Jobin agreed that a POSITA would have understood that all of the aforementioned types of identifiers, including “[s]hapes, ribs, screws, bosses[,] receptacles, barcodes and RFID tags,” would be available for use as identifiers of beer cartridges. *Id.* at 69:23-70:19 (“All of the other associated technology for interfacing with those, like RFID antennas or sensors or switches to interact with ribs and grooves, for example, were known. And I was able to leverage that understanding in applying those types of solutions to this project.”).

76. Mr. Jobin further testified that references such as EU Patent App. EP0455337B1 (“Bentley”) (Ex. 1036) also disclose a variety of beverage capsule qualities or elements that a POSITA would have understood could be used interchangeably as identifiers. For example, Mr. Jobin testified that “indents, cutouts, protrusions or holes which can be identified by a mechanical sensor in the beverage preparation machine,” the presence or absence of which is registered by the mechanical sensor, are examples of “identifiers which visualize the capsule and allow the machine to know what capsule is inserted.” *Id.* at 87:8-88:20. Other qualities sensed by optical sensors such as “a bar code, . . . a pattern of through-holes in the package, a pattern of contrasting tones or colors printed onto the package” and magnetic and inductive identifiers are alternate examples of identifier means. *Id.* at 88:22-89:20. Mr. Jobin agreed that all of “the recognition

means and the alternatives discussed apply to the capsule or package that is the subject of this invention” described in Bentley. *Id.* at 92:12-25.

77. In describing the recognition means disclosed in paragraph 192 of Yoakim, including “a code on the capsule and recognized by the device, such as a color, a barcode, an RFID, a magnetic code, ferromagnetic microwires or labels, shapes and combinations thereof,” Mr. Jobin admits that each recognition means could be generally applied to the embodiments of Yoakim. *See id.* at 131:19-132:7, 132:8-18, 134:25-135:14. Specifically, Mr. Jobin testified that with respect to the recognition means disclosed in paragraph 192, “I think that it’s generally applicable, and of course there may be examples when it wouldn’t be logical, but that’s why there’s different embodiments illustrated.” *Id.* at 138:1-11. As Mr. Jobin repeatedly admits with respect to his own work with beer-dispensing cartridges, and with respect to his understanding of references such as Bentley and Yoakim, a POSITA would have readily understood that various identifiers could be used in the alternative in their respective cartridges.

78. In teaching that “[w]hat has been said in relation to the identifier applies to all other examples,” the second German application provides specific disclosure of how this specific element, the identifier, can be combined with different capsule embodiments. Ex. 1047 at 38:8-9. A POSITA would have

understood this teaching to encourage a mix-and-match approach to combining the elements, and particularly the identifiers, of various capsule embodiments.

79. For example, in describing Figures 16, 17, and 18, the second German application states that “a form-fitting and/or friction-fitting means and/or a detection means 2.4.2” is located on the outer region of the peripheral region 2.4 and functions as an identifier. Ex. 1047 at 41:22-24. While the figures particularly depict a toothed ring “form-fitting means” located on the underside of the flange, which Mr. Jobin himself admits is an identifier, the application specifically discloses and a POSITA would have understood that other “detection means” (such as a barcode, logo, repeat pattern, or other machine-readable print) could be used in the same location and for the same purpose. *See* Ex. 2012 at 185:10-186:9 (“And if the teeth were not present, then the retaining arms couldn’t retain the capsule, and it would drop through into a waste container instead of being introduced into the brewing chamber. So by having a mechanical interface here, the capsule is identified. And if it doesn’t have the identifier, it doesn’t function with the brewer.”). Indeed, Mr. Jobin agreed that the machine-readable print identifiers are not associated with particular embodiments of the second German application, but rather part of the “overview section” of the specification and “not referring to the figures.” Ex. 2012 at 184:22-185:4. As another example, in describing the form-fitting means in Figure 18, the application specifically recites

that “[a] person skilled in the art is aware that the capsule periphery may also have provided on it friction-fitting means.” Ex. 1047 at 43:3-8. This friction-fitting means movement is sensed and the brewing chamber is released, similarly to the process described with respect to the toothed ring. *Id.*

80. A POSITA would have further understood that the capsule periphery could also have provided on it a detection means located on the bottom of the flange, just like the form-fitting and friction-fitting means described in Figures 16, 17, and 18. *See* Ex. 2012 at 186:10-15 (“Q: Would you agree that Figures 17A, B and C depict the capsule from the bottom? A: It’s hard to tell from these images, but it is my understanding that we are reviewing the capsule from the bottom.”). A POSITA would have understood that one example of a detection means could be a barcode. *See* Ex. 1047 at 33:1-7 (“The identifier is further preferably a machine-readable print,” and the “print is preferably a barcode, a logo or a repeat pattern”). The second German application’s specific intention and guidance to combine the teachings regarding the identifier with all other examples, demonstrates that the inventor had possession of the claims at the time of the second German application’s filing.

81. Additionally, a POSITA would have understood the claims of the second German application to show how features from across the scope of examples could be included in the various examples. For example, claim 11 of the

application recites “[t]he portion capsule (1) *as claimed in one of the preceding patent claims*, characterized in that the identifier is a barcode (17).” Ex. 1047 at cl. 11 (emphasis added). This is similarly the case with claim 2 and/or claim 6. When those claims are read in combination with claims 13 and 14 (which claims 13 and 14 encourage), for instance, the POSITA would have understood that the inventor was in possession of the embodiments of Figures 16, 17, and 18 with any of the other disclosed embodiments. That is, a POSITA would have understood these claims to encourage replacing the identifier in any previously-claimed embodiment with a barcode identifier. The claims thus demonstrate possession by the inventor of subject matter arising from combinations of embodiments, and in particular the identifier element. Finally, there are only a relatively small number of alternatives, and they are consistent with each other. Nothing in the embodiment of Figures 16, 17, and 18 would have prevented the use of any of the other identifiers, and a POSITA immediately would have envisaged a combination that used the system of Figures 16, 17, and 18 with any of the other identifiers.

IX. Ground 1: Yoakim in view of Jarisch 929 and Rossi (Claims 1 and 4-6)

A. A Person of Ordinary Skill in the Art would not have been motivated to combine Yoakim, Jarisch 929 and Rossi

82. In my opinion, a POSITA would not have been motivated to add the separate validation element of Rossi to the centrifugal brewing systems of Yoakim and Jarisch 929.

83. As an initial matter, a POSITA would not have been motivated to look beyond the disclosure of Yoakim, as Yoakim already discloses a safety mechanism for confirming that the correct capsule is used in the disclosed brewing system. In particular, Yoakim discloses the use of a specific “gripping structure” (Figures 12 and 13) that “forms a lock into which a complementary engaging structure 450, i.e., a key, of the capsule holder 451. The complementary shapes of the capsule and capsule holder enable the device to fulfill both the gearing function for driving the capsule at high speeds in rotation *and a safety function for ensuring that only capsules adapted to the system can be used and brewed successfully.*” Ex. 1004 at [205] (emphasis added). A person of ordinary skill in the art would have no reason to turn to the purported safety mechanism of Rossi, as Yoakim already disclosed a safety mechanism (albeit a different one) for ensuring that only capsules adapted to the system can be used and brewed successfully. Mr. Jobin agreed in his testimony that this was indeed a safety mechanism that was described in Yoakim, but provides no explanation as to why a POSITA would reject this already disclosed safety mechanism for the disclosure of Rossi. Ex. 2012 at 138:12-140:22.

84. In addition, a POSITA would not have looked to Rossi for the purported disclosure of a pump controlled to supply water because Rossi does not disclose controlling a pump, and Rossi is directed to a different type of high-pressure coffee machine than the low-pressure, centrifugal brewing systems of

Yoakim and Jarisch 929. Mr. Jobin claims that Rossi describes an “espresso machine[] that ha[s] high-pressure, high-temperature water primarily,” Ex. 2012 at 164:25-165:22, and that the validation and identification element solutions described in Rossi are “directed towards, in part, addressing the safety hazard that could be caused by incorrect use of those machines.” *Id.* at 165:23-166:5. As an initial matter, the Rossi reference never once describes the coffee machine as an “espresso” machine. Nonetheless, in contrast to the high-pressure system of Rossi, which dispenses water at a pressure of around 15 to 18 bars, Ex. 2012 at 166:6-14, Yoakim discloses a method “wherein hot water is introduced into the capsule at ***substantially no pressure***,” such as a pressure between zero and two bars above atmospheric pressure. Ex. 1004 at [0132], [0180]; [0133] (“Alternatively, for a higher flow consistency, hot water can be introduced using ***a low pressure pump*** such as a peristaltic pump or a diaphragm pump and the like.”) (emphasis added); [0428] (“Water can be fed in the beverage preparation module 124 at low pressure or even at gravity pressure.”) (emphasis added). A POSITA would not have turned to literature such as Rossi that discloses a pressurized water delivery method.

85. Additionally, a POSITA would not have been motivated to implement the validation element of Rossi to the brewing systems of Yoakim and Jarisch 929. First, the validation element disclosed in Rossi is separate from the identification element that is used to control the operation of the machine. It is the identifying

element that is used to “allow[] the machine to recognize the load element and, hence, its contents.” Ex. 1041 at 7; 8 (“The identification element preferably contains information about the contents of the load element.”); 10 (“the same identifying element as that recognised in the first step . . . must be recognized in combination with the validation element as validated.”); 11 (“The load element of the system comprises an identifying element for its recognition and a validation element for its validation.”).

86. Second, the validation element is used to determine whether a load element has already been used. “Validation ensures that the validation element can no longer be recognised as an unvalidated validation element.” *Id.* at 9-10; *see also id.* at 7 (use of “validation element help[s] to prevent the use of an already-used single use load element in the machine.”).

87. Third, the validation element disclosed in Rossi preferably takes the form of the mechanical destruction of the validation element. For example, the element can be validated by “ripping, cutting, scratching or piercing.” *Id.* at 9; *see also id.* at 11 (“The machine of the system further comprises means for validating the validation element, this preferably comprising a mechanical destruction tool have a plurality of tips adapted to rip, cut, scratch or pierce said validation element.”); 13 (“a mechanical tool 11 having a plurality of tips for destroying the validation barcode 5, for example by ripping, cutting, scratching or piercing, such

that the barcode reader 7 cannot recognise it as an unvalidated validation barcode.”).

88. Fourth, the validation element is described as advantageous if the validation is visible to the user, such that it is clear that the load element is validated and cannot be reused. *Id.* at 10 (“It may also be advantageous if said validation is visible to the user, such that it is clear if a load element has been validated and can therefore not be re-used in the process as it would not pass the first step.”).

89. Fifth, the validation element is generally described as taking place outside of the machine. For example, the validating step “may be performed by the machine, such as by a tool in or on the machine, *or independently from the machine*, such as by hand or by the user using a tool not associated with the machine.” *Id.* at 9 (emphasis added); *see also id.* at 10 (“As with the first and second steps, this step may take place inside or outside the machine.”); *id.* at 11 (“the user may manually engage the validation element with the validation means.”).

90. Finally, the validation element is used for the purpose of “unlocking” the machine. Specifically, the machine is only unlocked “when both the identification element and the unvalidated validation element are recognized,” this activating the production process. *Id.* at 9; *see also id.* at 11-12 (“The checking

means may be connected to unlocking means for unlocking the machine when said recognition takes place.”).

91. The Petition is silent in assessing how a skilled person would consider Rossi as a whole, and how Rossi could be reconciled with the systems of Yoakim and Jarisch 929.

92. Further, a POSITA would not have combined the teachings of Yoakim and Jarisch 929, as Petitioner suggests.

93. I have been informed that Yoakim and Jarisch 929 have a common owner, Societe des Produits Nestle S.A., an affiliate of Petitioner, and a common inventor, Alexandre Perentes. I have been informed that during prosecution of a similar Jarisch reference (U.S. Patent No. 10,800,600), a parent application to Yoakim was cited by the Examiner (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.” IPR2021-01222, Paper 6, EX2002-1 at 393.

94. 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 the bottom of the flange-like rim of a capsule as required by independent claim 1.” *Id.* at 395-96. Yoakim (Ex. 1004) is a continuation-in- part of the Yoakim ’601 reference and that the references have different disclosures. But the fact remains that when prosecuting its own application, Petitioner argued that different references describing single-serve coffee capsules were non-combinable.

95. Further, Petitioner has not demonstrated how (or why) Yoakim and Jarisch 929 could be combined without a substantial reconstruction and redesign of elements. Specifically, as Petitioner explains, “[t]he Jarisch 929 optical reader configuration is depicted below left [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 46, 59. However, the “sensor/detector (231) [] enabled to identify and read a code on a capsule” 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.

B. Yoakim, Jarisch 929, and Rossi fail to disclose or render obvious “a pump controlled to supply water into the single-serve capsule

only upon detection of the identifier by the sensor/detector and a determination by the beverage machine that the single-serve capsule is suitable for use with the beverage machine” as required by claim 1.

96. Yoakim, Jarisch 929, and Rossi fail to disclose at least “a pump controlled to supply water into the single-serve capsule only upon detection of the identifier by the sensor/detector and a determination by the beverage machine that the single-serve capsule is suitable for use with the beverage machine” as required by claim 1. Because claims 4-6 depend from claim 1, Yoakim, Jarisch 929, and Rossi also fail to invalidate those claims.

97. Petitioner points to disclosures in Yoakim and Rossi as allegedly disclosing this limitation. In Yoakim, Petitioner identifies the “low pressure pump 6” as disclosing a pump controlled to supply water into the capsule, and the “identification means for identifying the different capsules” as disclosing the identifier required by claims 1, 7, and 10. Tellingly, Petitioner points to no disclosure in Yoakim regarding the determination that the capsule is “suitable for use with the beverage machine” (claims 1, 10) or that “the detected identifier agrees with a stored reference” (claim 7). That is because Yoakim does not disclose this element.

98. Specifically, Yoakim’s description of an “identification means for identifying the different capsules, and control means capable of operating the device . . . according to predetermined liquid food preparation parameters,

including the flow rate and the volume of liquid to be injected into the capsule, with the 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” does not disclose or render obvious that the pump supplies water into the capsule only when a sensor or detector detects it. Ex. 1004 at [0025].

99. As an initial matter, a POSITA would not have understood controlling the flow rate of liquid to occur by control of the machine’s water pump, as Mr. Jobin contends. *See* Ex. 1003 at ¶ 255. In fact, 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.” Ex. 1004 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] (“the rotational speed and the back-pressure in the capsule are adjustable/adjusted by the control means (C)”); [0136] (“The number of outlets can be chosen to control the flow rate of the brewed liquid.”); [0429] (“the flow rate is controlled by varying the rotational speed and/or the back-pressure exerted on the centrifuged liquid by flow restriction means of the device and/or capsule”); [0501] (“The method

contemplates the adjustment of the flow rate by way of adjusting the rotational speed and/or the back-pressure exerted on the centrifuged liquid.”).

100. Nor does the volume of liquid supplied to the capsule in Yoakim necessarily occur by control of the pump. Yoakim describes a method in which “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,” without a pump. *Id.* at [0132]; *see also id.* at [0180] (“It can be noted that water could be heated in the reservoir itself and water could be transported from the reservoir by effect of vaporization.”). Yoakim also does not teach that its pump, when it is used, is controlled to supply water into the capsule ***only when an identifier is detected***. Indeed, many embodiments described in Yoakim lack an identifier, *see* cls. 1-17, and there is nothing to suggest that an identifier is required for the pump to operate.

101. Rossi does not disclose the limitation “a determination by the beverage machine that the single-serve capsule is suitable for use with the beverage machine” that Yoakim lacks. As an initial matter, Rossi does not disclose a pump, and a pump is not inherent in view of other techniques for supplying heated water under pressure. Indeed, many capsule machine systems at the time of the invention were known to operate without a pump. *See, e.g.*, Exs. 2022, 2023, 2024. One such example of a pump-less espresso machine is the Moka Pot, a

coffee maker “suitable for use on gas, electric and induction hobs” or stovetops.

Ex. 2025. While Rossi describes that “the load element is generally pierced to allow water to pass through it,” and “[t]he contents of the load element are brewed or dissolved in the water in order to make the edible product,” nowhere does it use the word “pump.” *See* Ex. 1041 at 3. And as Yoakim describes above, a pump is not necessary to supply water into a capsule, because other means such as vaporization are sufficient. Indeed, Mr. Jobin readily admits that during his work on coffee machines design, he worked on a machine that did not use a pump to move fluid from the reservoir to the brew basket. Ex. 2012 at 50:12-25 (“Q: Was there a pump in the coffee maker that you worked on for Mr. Coffee while you were at Altitude? . . . A: This machine moved forward using a vaporization principle, not a pump.”); Ex. 2021 at ¶ 101.

102. The process described in Rossi consists of a first step of recognizing an identifying element and validation element on the capsule; a second step of validating the validation element; and a third step of activating a cycle of production only after recognizing the identifying element and the now-validated validation element. *Id.* at 6. The use of a validation element is described to “help to prevent the use of an already-used single load element,” and the identification element “preferably contains information about the contents of the load element.” *Id.* at 7-8.

103. Specifically, the first step may consist of “unlocking the machine when both the identification element and the unvalidated validation element are recognized.” *Id.* at 9. This step does not teach the use of a pump to supply water into the capsule. *See also id.* at 6 (“allowing said edible-product making machine to take further steps only if it also recognises on said load element a validation element to be validated”); cl 1 (“a first step of recognition wherein said edible-product making machine recognises an identifying element on said load element allowing said edible-product making machine to take further steps only if it also recognises on said load element a validation element to be validated.”).

104. The second step of validating the validation element may consist of “mechanical destruction of the validation element,” which ensures that the validation element cannot be re-recognized. *See id.* at 9. This step also does not teach the use of a pump to supply water into the capsule.

105. In the third activation step, the machine “activates a cycle of edible-product production” after it recognizes on the capsule the same identifying element and the validated validation element. *Id.* at 8-9. “The use of an activation step of automatically activating the cycle of edible-product production only when the same identifying element is recognized in combination with the validated validation element ensures that the operating condition actually used are the correct conditions as selected by the machine in the first recognition step” so as to “help to

prevent the user from making the mistake of inserting into the machine a different load element to the one that was first recognized, for which the operating conditions are set.” *Id.* at 8. None of these steps listed actually describe a pump.

106. That “the activation means 10, connected to the barcode reader 7 through the control unit 9, automatically activate[s] a cycle of production of the edible product” does not necessarily suggest that a pump is controlled to supply water into the capsule. *Id.* at 13; *see also id.* at 11 (“The checking means allow the machine activation means 10 to be engaged only if the barcode reader 7 recognises the identification barcode 4 and the validation barcode 5.”); 12 (“This automatically activates the machine, but only if the identifying element is recognized, and in combination with the validation element as validated.”). Indeed, Yoakim teaches that centrifugal rotation, a step of the production cycle, can occur even before water is introduced into the capsule. *See, e.g.*, Ex. 1004 at [0440] (“The start of the centrifugal operation can be carried out at the same time as water injection start being introduced in the capsule or slightly after or before this water injection operation starts.”). “[I]n order to allow the machine to proceed to **activation**,” the machine must “recognise[] the identifying element and the unvalidated validation element.” *Id.* at 11 (emphasis added). Thus, activating the cycle of production may not necessarily involve controlling the pump to supply water to the capsule.

C. Yoakim, Jarisch 929, and Rossi fail to disclose or render obvious “a groove that is laterally offset from the chamfered mandrel” and “a seal that is at least partially seated in the groove and configured to bear against a top side of the cover in a region between a peripheral edge of the cover and the region of the cover that is pierced by the chamfered mandrel,” as required by claim 1

107. Yoakim, Jarisch 929, and Rossi further fail to disclose or render obvious “a groove that is laterally offset from the chamfered mandrel” and “a seal that is at least partially seated in the groove and configured to bear against a top side of the cover in a region between a peripheral edge of the cover and the region of the cover that is pierced by the chamfered mandrel,” as required by claim 1.

108. The “flow restriction means which is arranged after the outlet(s) of the capsule” of Yoakim does not disclose the seal or groove of this limitation. Unlike the ’491 Patent, which contains a seal that “makes sure that the water coming from a water inlet 28 flows through the portion capsule by passing an opening, which has been made by a mandrel 29, than [sic] around it,” Ex. 1001 at 10:31-34, the “flow restriction means” of Yoakim comprises a “valve means so that the liquid can release from the capsule out of the device.” Ex. 1004 at [0382]; *see also* Ex. 1047 at 41 (“Preferably a sealing surface 2.4.1 is provided . . . and interacts with sealing action with a seal 21 . . . This seal 21 ensures that water which flows through the water inlet 28 flows into the capsule through an opening in the latter produced by the piercing spike 29, and does not flow around the capsule.”). “Preferably, the flow restriction means of the device comprises a valve means of

the device, which is arranged at or after the outlet(s) of the capsule, for opening when a certain pressure is exerted on the valve means so that the liquid can release from the capsule out of the device.” *Id.* at [0382]; [0445] (“The opening of the valve system occurs by the pressing surface 159 of the valve system lifting as pressure of liquid increases on its internal surface.”).

109. Nor do Figures 35 and 38 of Yoakim disclose a groove that is laterally offset from the chamfered mandrel, which the seal at least partially sits in. Petitioner contends that Figures 35 and 38 depict seals (in blue) and grooves (in red). As an initial matter, Mr. Jobin testified that “a groove that is laterally offset” is a concept that is “readily understandable without a technology background,” with “laterally offset” meaning “off to the side, for example, of a central axis.” Ex. 2012 at 35:8-11, 36:11-15. The “seal” identified in Figure 35 corresponds to a “**pressing surface 159**,” and an “**engaging portion 157**” that comprises an “internal base portion 160.” *Id.* at [0435]-[0436] (emphasis added). The “pressing surface 159 of the valve system lift[s] as pressure of liquid increases on its internal surface” to cause the valve system to open. *Id.* at [0445]; *see also id.* (“[T]he relative movement between the pressing surface and the capsule create a small annular passage for the liquid to escape out of the small interstice upstream of the valve system.”). Petitioner identifies the “capsule rotary engaging part 149” and part of an unidentified component in red to allegedly correspond to the claimed

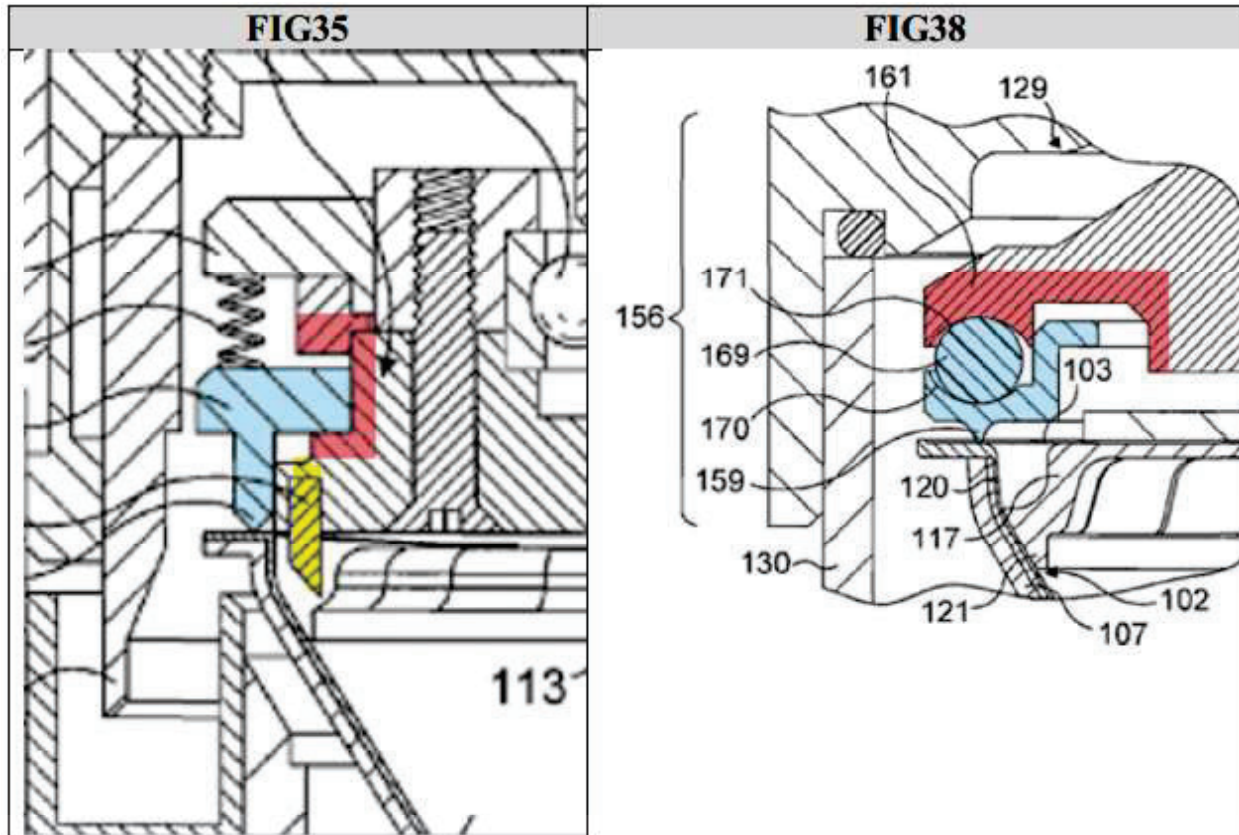
“groove.” However, the pictured “groove” is not laterally offset, or off to the side, from the piercing spike (annotated in yellow). Rather than positioned laterally (to the side), the groove is almost directly above and to the *medial* direction of what Petitioner argues is the chamfered mandrel.

110. Further, the “groove” identified in red does not “solidify the placement of the seal and improve its sealing stability and strength” as Mr. Jobin claims a groove should do. Ex. 1003 at ¶ 275. Indeed, the “groove” identified by Petitioner permits the “seal” to move within it to allow liquid to escape. Specifically, Yoakim describes that “at least one of said engaging portions of the valve means is spring loaded to move away relatively to the other engaging portion under the force of the centrifuged liquid. In particular, the engaging portion of the device can be associated to a spring loading member,” which can be an O-ring (as depicted in Figure 38) or a metal spring. *Id.* at [0387].

111. Figure 38 similarly does not disclose this limitation. The blue “seal” region identified by Petitioner in Figure 38 consists of “a rubber elastic O-ring 169” and “a lower member comprising a pinching surface 159.” *Id.* at [0446]. The O-ring 169 is the “elastic loading means” that is maintained in place between the pinching surface 159 and an “upper fixed portion 161 of the water injection subassembly 129,” which Petitioner has identified in red as the “groove.” *Id.* “[D]uring brewing, the pressure of liquid in the capsule tends to lift the pinching

surface 159 to create an annular passage between the rim 104 of the capsule at the pinching surface.” *Id.* Thus, the groove identified by Petitioner appears to permit the movement of the identified “seal,” instead of improving the seal’s stability and strength.

112. And Figure 38 does not depict a chamfered mandrel at all. The Yoakim reference is explicit about that, stating that “[i]n the embodiment shown in mode of FIGS. 37 and 38, the water injector can be a simple water outlet connectable to an inlet of the capsule *with no puncture means.*” Ex. 1004 at [447] (emphasis added). Mr. Jobin agreed. Ex. 2012 at 146:10-23 (“Q: And there are no piercing members in the embodiment of Figures 37 and 38, right? A: This particular embodiment in Figures 37 and 38 does not appear to have any outlet-piercing members illustrated.”); *id.* at 147:3-23 (describing that with respect to Figures 37 and 38, it “is a different embodiment from the piercing embodiment” that involves “sealing foil that’s removed by peeling”).



Pet. at 69 (annotated).

D. Yoakim, Jarisch 929, and Rossi fail to disclose or render obvious at least “a ledge at an upper region [of an inside wall], the ledge projects from the inside wall towards the central longitudinal axis,” as required by claim 5

113. Finally, Yoakim, Jarisch 929, and Rossi also fail to disclose or render obvious at least “a ledge at an upper region [of an inside wall], the ledge projects from the inside wall towards the central longitudinal axis,” as required by claim 5. Petitioner identifies the “collecting recess 116” of Yoakim as disclosing the ledge limitation. However, the collecting recess 116 is not a part of the inside wall of the cavity, as required by claim 5. Indeed, as Yoakim describes, it is the lid that

“further comprises a peripheral portion 110 including a collecting recess 116.” Ex. 1004 at [0416]. “The collecting recess forms a U-shape in transversal section (FIG. 28) which opens in the direction of the sealing foil.” *Id.*; *see also id.* (“The recess is preferably continuously extending at the periphery of the lid.”).

114. Petitioner identifies the ledge purportedly disclosed by Yoakim in red in annotated Figure 28. In describing Figures 28 to 31, Yoakim states that “the capsule of the invention comprises an inner member forming a lid 108 which is inserted in the dished body,” and that lid 108 and body 102 “delimit together an internal enclosure 114 for receiving the food substance 122.” Ex. 1004 at [0415]. The collecting recess 116 is, as Mr. Jobin admits, located on the outside surface of the internal enclosure 114, which Mr. Jobin understands to be the cavity of the capsule. *See* Ex. 2012 at 148:13-19 (“Q: Now, this internal enclosure 114, that would be the cavity of the capsule, right? A: It calls it the internal disclosure [sic], but the cavity inside the capsule is understood by me to be the same thing, I think, here.”); 153:12-20 (“Q: Would you agree that 116 is outside the internal enclosure 114? A: Based on the disclosure in 415 that the lid and the body to limit the enclosure, I view 116 as being on the outside surface of that lid at least in – within the collecting recess, which is – which is described.”). Thus, a POSITA would understand that the collecting recess 116 identified by Petitioner is not a ledge at an upper region of an *inside* wall, as the claim requires.

116. To the extent the collecting recess might be considered to be a ledge, the collecting recess identified by Petition in Figure 28 of Yoakim is, at best, a ledge at an upper region of an *outside* wall of the lid and is external to the cavity. For example, a sealing foil may cover the collecting recess, or may be part of “body [which] can be a thermoformed plastic member including the recess.” *Id.* at [0349]-[0350]; *see also id.* at [0018] (“the enclosure may include at least one peripheral recess that forms a collector for liquid food passing through the opening means or arrangement, wherein the collecting recess extends around the perimeter of the enclosure at its greatest circumference.”); [0332] (“The collecting recess is preferably closed on one side by the internal portion of wall and at another side by the sealing foil.”). Mr. Jobin confirmed that the outer peripheral region 119 is located on the outside surface of the lid. *See* Ex. 2012 at 152:6-12 (“Q: And 119 is on the outside of the capsule in Figure 29, right? A: 119 is the outer peripheral portion of the collecting recess, which is part of that lid.”). Further, Figure 29 of Yoakim depicts the collecting recess 116 as being a part of the outer surface of the capsule, not the inside wall of the cavity.

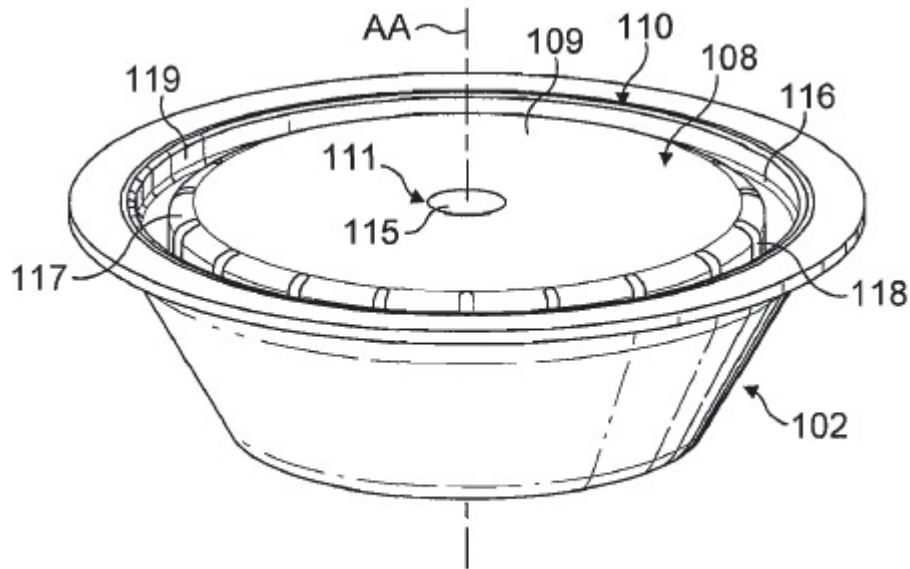


FIG. 29

Ex. 1004 at FIG. 29.

X. Ground 2: Yoakim, Jarisch 929, Rossi and in further view of Castellani (Claims 2-3, 7-13)

A. A Person of Ordinary Skill in the Art Would not have been Motivated to Combine the Yoakim, Jarisch 929, Rossi and Castellani references

117. Independent of Petitioner's failure to cite any prior art disclosure of the recited pump feature, which each of the claims in Ground 2 requires, it is my opinion that Petitioner also fails to demonstrate motivation to combine the prior art teachings for the same reasons as I explained in paragraphs 83-96 above.

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.

7/7/2023
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-present 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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Total Citations: 2907

h-index: 24

i10-index: 40

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22. Hada, E.A., Murphy, F.G. & Howle, L.E. *Delay differential equations as an explicit method of aligning DCS model prediction with dive trial outcome.* 2015 Annual Scientific Meeting of the Undersea and Hyperbaric Medical Society. Montreal, Canada. 2015.
23. Murphy, F.G., Hada, E.A. & Howle, L.E. *The case for mixed pharmacokinetic models as a descriptor of decompression sickness.* 2015 Annual Scientific Meeting of the Undersea and Hyperbaric Medical Society. Montreal, Canada. 2015.
24. Marin, D., Howle, L.E., Murphy, F.G., Hada, E.A., Nichols, E.B. & Nelson, R.C. *Comprehensive evaluation of the correlation between anatomical variates and enhancement in contrast-enhanced abdominal MDCT.* Annual Meeting of the Society of Abdominal Radiology. Coronado, CA. 2015.
25. Hada, E.A., Howle, L.E. & Murphy, F.G. *Depth scaling of several gas super-saturation models.* Proceedings of the 2014 Undersea and Hyperbaric Medical Society Meeting. St. Louis, MO. 2014.
26. Murphy, F.G., Hada, E.A. & Howle, L.E. *Perfusion-diffusion gas content models as a predictor of decompression sickness.* Proceedings of the 2014 Undersea and Hyperbaric Medical Society Meeting. St. Louis, MO. 2014.
27. Nelson, R.D., Howle, L.E. & Nichols, E. *Comprehensive evaluation of a novel patient-specific algorithm for determining the dose of iodinated contrast material for abdominal CT.* 100th Scientific Assembly and Annual Meeting of the Radiological Society of North America. Chicago, IL. 2014.

28. Nowacek, D.P., Bowers, M. Cannon, A., Hindell, M., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A. & Moore, M. *The next generation of multi-sensor acoustic tags: sensors, applications, and attachments*. 5th International Bio-Logging Science Symposium. Strasbourg, France. 2014. [cited 1 time].
29. Shorter, K.A., Giovanni, F., Murray, M.M., Johnson, M., Moore, M. & Howle, L.E. *Reducing impact: design features to minimize hydrodynamic forces for suction cup tags on swimming animals*. 5th International Bio-Logging Science Symposium. Strasbourg, France. 2014.
30. Andrews, R.D., Baird, R., Hanson, B.M., Howle, L., Mittal, R., Schorr, G. & Wilton, S. *Improving attachments of remotely-deployed dorsal fin-mounted tags: tissue structure, hydrodynamics, in-situ performance, and tagged-animal follow-up*. Proceedings of the 5th International Bio-Logging Science Symposium. Strasbourg, France. 2014.
31. Howle, L.E. & Nowacek, D.P. *Virtual Simulation of Right Whale Entanglement in Fishing Gear*. Proceedings of the 2013 North Atlantic Right Whale Consortium Meeting. New Bedford, MA. 2013.
32. Nowacek, D.P., Hindell, M., Shorter, K.A., Bowers, M., Rittschof, D., Howle, L.E., Murray, M. & Moore, M. *The next generation for multi-sensor acoustic tags: sensors, applications attachments*. Proceedings of the 166th meeting of the Acoustical Society of America. San Francisco, CA. 2013.
33. Wells, R.S., Balmer, B.C., Howle, L.E., Scott, M.D., Fauquier, D.A., Barlycorn, A.A., McHugh, K.A., Allen, J.B., Irvine, A.B., Townsend, F.I., Sweeney, J.C. & Wilton, S. *Experimental tests of small electronic tags for dolphins*. Proceedings of the 2013 meeting of the Society for Marine Mammalogy. Denedin, New Zealand. 2013.
34. Wells, R.S., Balmer, B.C., Howle, L.E., Scott, M.D., Fauquier, D.A., Barlycorn, A.A., McHugh, K.A., Allen, J.B., Irvine, A.B., Townsend, F.I., Sweeney, J.C. & Wilton, S. *Experimental tests of small electronic tags for dolphins*. Proceedings of the 2013 meeting of the International Association for Aquatic Animal Medicine. Sausalito, CA. 2013.
35. Andrews, R.D., Baird, R.W., Durban, J.W., Hanson M.B., Howle, L.E., Matkin, C.O., Mittal, R., Raverty, S. & Schorr, G.S., *The limpet tag and its use on small to medium-sized cetaceans*. Proceedings of the 2013 meeting of the International Association for Aquatic Animal Medicine. Sausalito, CA. 2013.

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38. Howle, L.E., Di Muro, G., Doolette, D.J. & Vann, R.D. *New classes of interconnected compartmental DCS models*. Proceedings of the 2012 Undersea and Hyperbaric Medical Society Meeting. Phoenix, AZ. 2012.
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.
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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.

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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.
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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.
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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. *Innovations in Medical Ultrasound Imaging*. \$15,310. Lars Howle, P.I.

05/01/99-04/30/02 Office of Naval Research. *Undulatory Flap Propulsion - Reduction to Practice*. **ONR Young Investigator Award**. \$328,071. Lars Howle, P.I.

04/01/99-03/31/02 The Whitaker Foundation. *Imaging Methods for Ultrasound Contrast Agents*. \$205,895. Lars Howle, P.I.

05/01/98-09/30/98 North Carolina Space Grant Consortium. *Investigation of g-Jitter in Surface-Tension-Driven Convection in Micro-Gravity*. \$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.

08/16/12 *Optimal blade design for a 30kW variable-pitch, constant tip speed ratio wind turbine.* Dakota Turbines. Cooperstown, ND.

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 Hyperbaric 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.
- Dakota Turbines. Cooperstown, ND.
- 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.
- Triangle Research Labs. Raleigh, NC.
- University of Alabama – Huntsville. Huntsville. AL.
- Williams Mullen Hofheimer Nusbaum. Norfolk, VA.
- WhalePower Corporation. Toronto, ON.
- Wildlife Computers. Bellevue, WA.
- Woods Hole Oceanographic Institution. Woods Hole, MA.

MEDIA COVERAGE (ABBREVIATED LISTING)

- “These whales will be extinct in 25 years scientists say – unless we act now to save them”. Sarah Kaplin. The Washington Post.
https://www.washingtonpost.com/national/health-science/these-whales-will-be-extinct-in-25-years-scientists-say--unless-we-act-now-to-save-them/2018/04/20/57bf89b2-4320-11e8-8569-26fda6b404c7_story.html?utm_term=.00fff052d37a
- “Predicting how bad the bends will be”. EurekAlert!
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- “Predicting how bad the bends will be. Model warns deep-sea divers on severity of decompression sickness”. Duke University.
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- “Large Whale Entanglements”. Consortium for Wildlife Bycatch Reduction.
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- “Large Whale Entanglement Simulator”.
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- "Whale-Inspired Wind Turbines. Mimicking the bumps on humpback-whale fins could lead to more efficient wind turbines". MIT Technology Review. <http://www.technologyreview.com/Energy/20379/?nlid=918>
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- “Mimicking humpback whale flippers may improve airplane wing design” *Innovations Reports* <http://www.innovations-report.de/html/berichte/verfahrenstechnologie/bericht-29118.html>
- “Wings Get Help From Whales” Science a GoGo. http://www.scienceagogo.com/news/20040412020237data_trunc_sys.shtml
- “New Airplane Wing Mimics Humpback Whale Flippers” AquaNews. <http://www.vanaqua.org/aquanew/fullnews.php?id=1284>
- “How Whales Swim” Abelard. <http://www.abelard.org/news/science040515.asp>
- “Biochemist: Mimicking Humpback Whale Flippers May Improve Airplane Wing Design; ‘No One Had Ever Analyzed Them’” UnderwaterTimes.com <http://www.underwatertimes.com/whales/whales.php>
- “Mimicking Humpback Whale Flippers May Improve Airplane Wing Design” *Apologetics.org* <http://www.apologetics.org/phpBB2/viewtopic.php?t=1215>
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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)
 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.

REVIEWER FOR

National Science Foundation

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

Euro Physics Letters

Experimental Thermal and Fluid Science

Experiments in Fluids

Undersea and Hyperbaric Medicine

Marine Mammal Science

PLoS One

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Francis Gregory Murphy IV, Ph.D.

Ashleigh Swingler, Ph.D.

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Clark McGehee, Ph.D. (co-advised with Prof. Brian Mann)

Paul Weber, M.S., Ph.D.
Rebecca Simmons, Ph.D.
Michael R. Gustafson, M.S., Ph.D.
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Mark Campbell, M.S.
Sidney Lebental, M.S.
Jessica McClay, M.S.
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