

PROTECTIVE ORDER MATERIAL

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COLLEGE PRODUCTS, INC.,

Petitioner,

v.

INTIRION CORPORATION,

Patent Owner.

Case No. PGR2024-00003 and PGR2024-00004

Patent Nos. 11,674,745 and 11,674,746

DECLARATION OF EMAD Y. TANBOUR, PH.D.

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I, Emad Y. Tanbour, Ph.D., hereby declare and state as follows:

1. I have been retained by Intirion Corporation (“Intirion”), the owner of U.S. Patent Nos. 11,674,745 (the “’745 Patent”) and 11,674,746 (the “’746 Patent”) (collectively, the “Patents-at-Issue”), to provide my independent expert opinions in this matter. I understand that the U.S. Patent Trial and Appeal Board (the “Board”) has instituted post-grant review (“PGR”) of certain claims of the Patents-at-Issue.

2. I make this declaration in support of Intirion’s Response to College Products, Inc.’s (“CP”) Petitions based on my personal knowledge, education, experience, and training. I am competent to make this declaration and, if called to testify, could and would do so.

I. PERSONAL BACKGROUND

3. I summarize my educational background and career history in the following paragraphs. My complete qualifications are set forth in my curriculum vitae, which is attached hereto as **Appendix A**.

4. I received a Bachelor of Science degree in mechanical engineering from Jordan University of Science and Technology (“JUST”) in 1987. I later received a Master of Science degree in mechanical engineering from JUST in 1990. While I worked toward earning my Master of Science degree, I also worked as a teaching and research assistant at JUST and taught several mechanical engineering courses.

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Between 1990 and 1992, I taught several mechanical engineering courses at National College in Amman, Jordan.

5. From 1992 to 1997, I attended the University of Iowa to earn my Doctor of Philosophy degree in mechanical engineering, which I received in 1997. While I was a Ph.D. student, I also served as a teaching and research assistant in the University of Iowa's College of Engineering. I also taught undergraduate- and graduate-level mechanical engineering courses at the University of Iowa as an adjunct professor from 2000 to 2005.

6. From 1997 to 2005, I worked as a Senior Research and Development Manager at HNI Corporation in Muscatine, Iowa, where I led research and development projects utilizing computational mechanics. During the same period, I also served the State of Iowa as Co-Chair to Advanced Technical Training at the Iowa Department of Economic Development.

7. Between 2005 and 2009, I managed product development engineering for Whirlpool and A. O. Smith, where I led the development of energy efficient residential appliances, including water heaters, and gained practical experience in designing residential-use appliances.

8. From 2009 to 2013, I served as the Dean of Quality and Accreditation and Professor of Mechanical Engineering at Prince Mohammad Bin Fahd University ("PMU") in Al-Khubar, Saudi Arabia. I taught several mechanical and general

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engineering courses at PMU, including capstone design courses for graduating students, and served in several leadership capacities.

9. From 2014 to 2016, I served as a Visiting Professor of Mechanical Engineering, and later as an Assistant Professor of Mechanical Engineering Technology, at Central Michigan University (“CMU”). At CMU, I also primarily taught undergraduate- and graduate-level courses in mechanical engineering, and I served as the Coordinator for the Master in Engineering Technology and Master in Engineering Management Programs.

10. I am currently a tenured Professor of Mechanical Engineering in the School of Engineering at Eastern Michigan University (“EMU”), where I have been a faculty member since 2016. In my faculty role, I primarily teach undergraduate- and graduate-level mechanical engineering courses. Additionally, I am the Chair of Mechanical Engineering and the Acting Director of the School of Engineering at EMU, and I previously served as the Interim Associate Dean of the College of Engineering at EMU for one year.

11. I am a named inventor on seven issued U.S. patents, as well as several corresponding patents in foreign countries. I am also a named inventor on several pending U.S. patent applications and other publications.

12. I have prior experience as an expert witness in patent litigation matters, including in *inter partes* review and International Trade Commission proceedings.

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13. I am being compensated at \$500 per hour for my time spent on this matter, which is my standard rate for this type of consulting. My compensation is not contingent on the results of these or any other legal proceedings.

II. MATERIALS CONSIDERED

14. In forming my opinions, I have reviewed the following documents, and any other document cited in this declaration

Exhibit	Description
1001	U.S. Patent No. 11,674,745
1002	Expert Declaration
1003	Prosecution File History, U.S. Patent No. 11,674,745
1004	Original Intirion Complaint Filed on June 8, 2022.
1008	U.S. Application No. 14/262,290 (“the ’290 Application”), published as U.S. Publication 2014/0251982.
1009	Exemplary embodiment Claim chart 1 sent by Intirion related to U.S. Patent No. 11,274,876
1011	U.S. Application No. 12/317,632 (“the ’632 Application”) published as U.S. Publication U.S. Pub. 2009/0188911 (“Emma”)
1012	“ISDU: Integrated Smoke detector Unit for Commercial Microwave Ovens”, Cory Lloyd <i>et. al</i> , Northeastern University (2007). (“ISDU”)
1014	U.S. Patent No. 4,496,817 to Smith (“Smith”)
1015	U.S. Patent No. 8,446,048 to Butt (“Butt”)
1016	Redline Comparison between 290 and Emma
1020	U.S. Application No. 13/094,747 (“the ’747 Application”) published as U.S. Publication U.S. Pub. 2012/0276763A1 (“Quezada”)

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1021	Scheduling Order for <i>Intirion Corporation v. College Products, Inc.</i> , 5:23-cv-04023-KEM, Dkt. 75.
1022	Amended Complaint filed by Intirion Corporation, 5:23-cv-04023-KEM, Dkt. 62.
1023	Supplemental Expert Declaration related to the 11,674,745 Petition
2002	Transcript of Deposition of Mark N. Horenstein, Ph.D., taken on June 27, 2024
2003	Prosecution history, U.S. Patent No. 4,496,817 (Smith)
2004	Declaration of Jared Amy
2005	MicroFridge Sell Sheet regarding model 3.1MF7-7B1 [MF004429-30]
2006	MicroFridge Instruction Manual [MF003462-78]
2007	MicroFridge Service Manual [MF015179-94]
2008	College Products email regarding [REDACTED] [CP_010613]
2009	College Products email regarding attached [REDACTED] [CP_014083-94]
2010	College Products email regarding attached [REDACTED] [CP_025787-97]
2011	RFP from [REDACTED] [CP_027587-89]
2012	College Products email regarding attached [REDACTED] [CP_028171-78]
2013	[REDACTED] Scope of Work Contract [CP_029081-87]
2014	College Products FOIA request to [REDACTED] [CP_010496-98]
2015	Eric Henning's email with Vivian Lu regarding [REDACTED] [CP_017792-93]

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2016	Eric Henning's email with Vivian Lu regarding [REDACTED] [CP_016392-94]
2017	Screenshot of www.microfridge.com/patents/
2018	MicroFridge sell sheet regarding model 4.8RMF4H-7B1 [MF004453-54]
2019	MicroFridge sell sheet regarding model 10.ORMF4-9B1X [MF004485-86]
2020	Email from [REDACTED] to College Products regarding their non-responsive bid [CP_025810-11]
2021	Shipping instructions provided by Vivian Lu to Eric Hennings for MicroFridge sample [CP_017595-603]
2022	Email exchange between Eric Hennings and Vivian Lu regarding failed microwave test [CP_021545-49]
2023	College Products email attaching letter to Vivian Lu regarding smoke sensor [CP_012938-39]
2024	Emails between Vivian Lu and Eric Hennings regarding [REDACTED] [REDACTED] [CP_011613-19]
2025	Eric Henning email to himself attaching Energy Star Specifications for the MicroFridge with Safe Plug and 1 st Defense Smoke Sensor product [CP_017776-77]
2026	Internal College Products email attaching specifications and Instruction Manual for the MicroFridge Microwave with smoke sensor, model MFM-7D1S [CP_017606-23]
2027	MicroFridge Packing List for shipment of a MicroFridge combo appliance to College Products' Veronica Colyer [CP_009695]
2028	Email from Vivian Lu and Eric Hennings attaching photo of Danby microwave [CP_013776-78]
2029	Email from Vivian Lu to Eric Hennings requesting more videos of smoke sensor testing [CP_012620-25]

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2030	Smoke Sensor Comparison Chart [MF003487]
2031	Microwave Power Logic [MF006004]
2032	Photo of rear of MicroChill microwave [CP000253]
2033	MicroChill Sell Sheet [CP000256-57]
2034	MicroChill Sell Sheet [CP000258]
2035	Declaration of Gary Hand
2036	

15. I have also considered and attached the following appendices:

Appendix	Description
A	C.V. of Dr. Emad Y. Tanbour
B	Claim Nexus Chart – '745 Patent
C	Products Comparison Chart

III. LEGAL STANDARDS

16. I am not an attorney, and I have not independently researched the law on patentability. My knowledge of the legal standards below is based on information I learned from counsel and through my prior experience in patent litigation.

17. I understand that a patent claim is unpatentable if the claimed invention was anticipated by a prior art reference or would have been obvious to a person of ordinary skill in the art ("POSITA") at the time of the purported invention.

A. Claim Construction

18. I understand that patent claims are to be interpreted in view of a patent's specification and prosecution history. I understand that claim construction starts with the plain language of the claims as understood by a POSITA at the time the patent was filed.

19. I understand that a patentee may be its own lexicographer, so long as the definition of a specific term is clearly set forth in the specification, and it is clear the inventor intended to define the term.

B. Prior Art

20. I understand that in order to obtain a patent, the claimed invention must be new and nonobvious from the perspective of a POSITA at the time of the invention. I further understand that the information available to a POSITA as of the time of the invention is referred to as the "prior art."

21. I have been informed by counsel that information is only considered prior art if it falls within one of the specific categories of prior art identified in the patent statutes. I further understand that for purposes of this proceeding before the United States Patent Trial and Appeal Board, only patents and other documents that have the legal status of a "printed publication" may be relied upon as prior art.

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22. I have been informed by counsel that a patent or a published U.S. patent application is generally considered to become prior art as of the date the patent application is filed.¹

23. I have been informed by counsel that a printed publication qualifies as prior art based on the date when it becomes “publicly accessible.” I have been informed that information is publicly accessible as of the date it was disseminated or otherwise made available such that members of the relevant public interested in the subject matter could, using reasonable diligence, locate it.

24. I have also been informed that the determination of public accessibility is a case-by-case analysis particular to an individual publication. I also understand that one way a printed publication can be deemed publicly accessible if it is catalogued and indexed by a library such that a member of the public interested in the subject matter could locate it exercising reasonable diligence.

¹ I have been informed that a patent or published patent application may also become prior art based on its date of conception or its date of publication. I have been informed that the different rules related to those statutory provisions are not relevant to this proceeding, and accordingly this Declaration treats patents and published patent applications as entering the prior art based on the filing date of the underlying patent application.

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25. I understand that the burden is on the Petitioner to identify with particularity evidence sufficient to establish a reasonable likelihood that the reference was publicly accessible before the critical date of the challenged patent, and therefore that there is a reasonable likelihood that it qualifies as a printed publication. I understand that Petitioner must establish public accessibility by a preponderance of the evidence.

26. I have been instructed to assume in my analysis, that, for the purpose of determining what qualifies as “prior art,” the effective filing date for each of the Challenged Claims (“Effective Filing Date”) is April 25, 2014. In other words, patents or publications that were publicly available prior to the Effective Filing Date, as well as any patent application filed in the United States before the invention, may be considered.

27. I understand that Dr. Horenstein’s analysis was stated to have been based on an April 25, 2014, Effective Filing Date.

C. Anticipation

28. It is my understanding that anticipation is a question of fact determined from the perspective of a POSITA at the time of the claimed invention. I also understand the standard for anticipation in a PGR proceeding is “by a preponderance of the evidence.” My understanding of this burden of proof is that it requires there be a greater than 50% chance that something is true. Further, it is my understanding

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that a claim is anticipated only if each and every element in the claim is found, expressly or inherently, in a single prior art reference.

29. I understand that if a prior art reference does not expressly set forth a particular claim element, the prior art may still anticipate a claim if that element is “inherent” in its disclosure. My understanding of the inherency standard is that there can be no inherency unless the evidence makes it clear the missing descriptive matter is necessarily present in the thing described in the reference. It is also my understanding that inherency may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient to establish inherency.

30. I understand that Petitioner has not challenged any claims of the Patents-at-Issue on the grounds that the inventions claimed are anticipated by any prior art reference.

D. Obviousness

31. I understand that Petitioner has challenged several claims of the '745 and '746 Patents on the grounds that the invention claimed would have been obvious to a POSITA at the time the applications were filed. I also understand the standard for obviousness in a PGR proceeding is “by a preponderance of the evidence.” In other words, I understand that the party challenging validity (here, CP) bears the

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burden of establishing the obviousness of the invention by a preponderance of the evidence.

32. I have been informed that there are two types of claims: (1) independent claims; and (2) dependent claims. I understand that independent claims stand alone and do not reference or depend from other claims. I understand a dependent claim is a claim that refers to at least one other claim in the patent. For example, claim 12 of the '745 Patent is a dependent claim because it refers to claim 1. I understand a dependent claim includes all of the limitations recited in the dependent claim, as well as all of the limitations of the claim(s) upon which it depends. Thus, I have been informed that to establish anticipation or obviousness of a dependent claim, the prior art must teach or render obvious each and every limitation of the dependent claim as well as the independent claim from which it depends.

33. I understand that the factors for an obviousness analysis include: (1) the scope and content of the prior art; (2) the differences between each of the claims of the patent and the prior art; (3) the level of ordinary skill in the art at the time the invention was made; and (4) objective indicia (or “secondary considerations”) of nonobviousness.

34. I understand that the objective indicators of nonobviousness (sometimes referred to as “secondary considerations” or “secondary indicia”) which must be considered in evaluating obviousness include commercial success of the

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claimed invention, whether others copied the invention, whether there was a long-felt but unmet need in a particular industry, and whether others in the field praised the invention. I understand secondary considerations can be evidence that patent claims were not obvious. I understand that secondary considerations of nonobviousness support a finding of nonobviousness if the evidence of secondary considerations is sufficiently tied to the patented features. Where a patent claims a combination of features, I understand that the evidence of secondary considerations may be tied to the claimed combination as a whole. I understand secondary considerations of nonobviousness may overcome primary evidence of obviousness even if such primary evidence is strong.

35. I also understand that a POSITA is presumed to be a person who would have known about all relevant prior art, and that in examining the prior art, both what the art discloses and anything that inherently occurred as a result of practicing what was expressly disclosed in that prior art should be taken into account.

36. I understand that there must be a reason, suggestion, or motivation to modify a single prior art reference, or to combine multiple references, to achieve the claimed invention. I understand that this motivation may come from a teaching, suggestion, or motivation to combine. I also understand that a specific teaching, suggestion, or motivation is not required.

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37. I understand the reason, suggestion, or motivation to modify or combine the teachings of a reference to the claimed invention can be either express or implied, and may be derived (for example) from the prior art reference itself, from the knowledge of a POSITA, or from the nature of the problem to be solved. I understand a claimed invention also is obvious if it would have been obvious to a POSITA to try a course of conduct—for example when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, and where a person of ordinary skill has a reason to pursue the known options within his or her technical grasp.

38. I also understand that the use of hindsight is not appropriate in determining whether a claimed invention would have been obvious. In other words, one cannot use the patents as a guide through the prior art references to assist in combining the right references in the right way so as to achieve the result of the claims of the patent. Rather, I understand one must consider only the thinking of a POSITA with knowledge of all the prior art at the time of the invention. I have been informed that the U.S. Court of Appeals for the Federal Circuit has explained that “[t]o imbue one of ordinary skill in the art with knowledge of the invention in suit when no prior art reference . . . of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the

inventor taught is used against its teacher.” *W.L. Gore & Assoc. v. Garlock, Inc.*, 721 F.2d 1540, 1553 (Fed. Cir. 1983).

39. I understand that, in consideration of all those factors, a patent is not obvious unless the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSITA to which said subject matter pertains.

E. Indefiniteness

40. I understand that Petitioner has challenged the claims of the '745 and '746 Patents on the grounds that “a smoke sensor . . . in operative connection with the cooking area” renders the claimed invention indefinite. *See* Petition at 89-90.

41. I understand that the claims must particularly point out and distinctly claim the subject matter which the applicant for patent regards as his invention. I further understand that a claim may fail this requirement and be indefinite if, when read in light of the specification delineating the patent and the prosecution history, it fails to inform a POSITA about the scope of the invention with reasonable certainty. I understand that this does not require that a patent disclose information that is already well known to POSITAs. I also understand this does not require the claims define the invention with mathematical precision. I understand definiteness is measured from the viewpoint of a POSITA at the time the patent was filed.

42. [INTENTIONALLY LEFT BLANK.]

F. Enablement

43. I have been informed and understand that to meet the enablement requirement, an applicant is required to disclose sufficient information to allow a POSITA to make and use the claimed invention without undue experimentation. I further understand that the enablement requirement must be satisfied at the time the patent application was filed.

44. I have also been informed and understand that a POSITA may determine whether a disclosure calls for undue experimentation considering the following factors: (a) the quantity of experimentation necessary; (b) the amount of direction or guidance presented; (c) the presence or absence of working examples; (d) the nature of the invention; (e) the state of the prior art; (f) the relative skill of those in the art; (g) the predictability or unpredictability of the art; and (h) the breadth of the claims.

45. I have also been informed and understand that these factors are illustrative, not mandatory. Thus, I understand that not all of these factors need to be reviewed when determining whether a particular disclosure is enabling.

46. I have been informed and understand that a prior art disclosure must satisfy the enablement requirement to be anticipatory or render a claimed invention obvious.

G. Written Description

47. I have been informed and understand that a patent specification must contain an adequate written description to convey to a person of ordinary skill in the art that the applicant had possession of the claimed invention as of the filing date of the application. I also understand examples are not required to demonstrate possession of the claimed invention, but it is not sufficient that any undisclosed subject matter would have been obvious to a person of ordinary skill. Rather, the written description must demonstrate that the inventors invented what they claimed to have invented at the time they claimed to have invented it. I also understand that to satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that a POSITA can reasonably conclude that the inventor had possession of the claimed invention.

IV. SCOPE OF OPINIONS

48. I have been asked only to provide my independent opinions and analysis of the issues I specifically discuss in this declaration. I note that the Petition, including the evidence it cites, appears to refer to other issues regarding which I have not been asked to provide my opinions.

V. PERSON OF ORDINARY SKILL IN THE ART

49. I understand that the Petitioner and Dr. Horenstein have proposed a definition of a POSITA: “*a POSITA would have had at least a bachelor’s degree in*

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electrical engineering or computer engineering. Alternatively, a POSITA could have had a bachelor's degree in mechanical engineering, industrial engineering, physics, or a related engineering discipline, plus at least two years of experience working with control circuits, sensors, kitchen appliances, or similar fields.” E.g., Ex. 1002,

¶ 50. While I do not necessarily agree with this proposed definition, my opinions below are provided with respect to this definition of a POSITA.

50. I have undergraduate, graduate, and doctoral degrees in mechanical engineering and more than fifteen years of industry experience, including approximately four years of experience designing residential appliances such as water heaters. Therefore, I meet the definition of a POSITA provided by the Petitioner and Dr. Horenstein.

51. I also understand that in its Preliminary Response, Intirion proposed a slightly different definition of a POSITA: “*a POSITA would have had (a) a bachelor's degree in mechanical engineering or electrical engineering or the equivalent; and (b) one [to] two years working experience designing appliances, including microwaves or comparable appliances. Equivalent experience and technical training might substitute for education, and advanced degrees might substitute for experience.*” E.g., [’745 Preliminary Response at 4]. Although, as noted above, my opinions below are provided with respect to Petitioner’s and Dr. Horenstein’s definition of a POSITA, I believe Intirion’s definition is more

appropriate based on my review of the patents and understanding of the technology. My conclusions expressed in this Declaration would be the same if I applied Intirion's definition of a POSITA rather than CP's definition.

52. I understand that when considering the validity of the claims challenged by the Petitioner, I am to analyze the patents, the prior art, and any other references from the perspective of a POSITA at the time of invention. I understand that this date is April 25, 2014, the date on which the earliest patent application for the family of patents including the Patents-at-Issue was filed. Therefore, when I provide my opinions, I note that they are from the perspective of a POSITA, as defined by Petitioner and Dr. Horenstein, in April 2014.

VI. THE PATENTS-AT-ISSUE

53. I have reviewed the claims, specifications, and prosecution histories of the Patents-at-Issue.

54. The Patents-at-Issue are in the same patent family and have similar specifications. As relevant in these proceedings, the earliest priority date for the challenged claims in both Patents-at-Issue is April 25, 2014, the date on which U.S. Patent Application No. 14/262,290—now U.S. Patent No. 9,657,974—was filed.

55. Both of the Patents-at-Issue are titled "Multiple Linked Appliance with Auxiliary Outlet." Intirion's patents teach linked appliances that can manage the current supplied between the appliances to avoid overload conditions. In many

embodiments, these appliances are a linked microwave and mini-refrigerator. Both Patents-at-Issue teach a smoke sensor within the microwave that is operatively connected to a power control circuit which is configured to disable power to the microwave's magnetron (i.e., the component which heats food during normal microwave operation) prior to the set cooking time in the event the smoke sensor detects excessive smoke during the cooking session.

56. The combination appliance units described in the Patents-at-Issue are often used in high-occupancy buildings such as dormitories and hotels, where full-size appliances are impractical. *E.g.*, Ex. 1001, '745 Patent, at 1:13–20.²

57. At their peaks, the combined power demands of the microwave and mini-refrigerator may exceed the capacity of a standard electrical outlet in environments such as dormitories and hotels and cause an overload condition. *E.g.*, *id.* at 4:5–17. Thus, in exemplary embodiments, the power control circuit is configured to monitor the power demands of each component, withdraw power from the refrigerator compressor while the microwave demands cooking power, and restore power to the compressor once the microwave ceases demanding cooking power. *E.g.*, *id.* at 4:52–65.

² Because the '745 and '746 Patents share a specification, my references in this section should be understood as applicable to both the '745 and '746 Patents.

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58. A key innovation in the Patents-at-Issue is the inclusion of a safety sensor (hereinafter referred to as a “smoke sensor”) that is operatively connected to the microwave. The smoke sensor may be an alcohol sensor coupled with a thermistor, an infrared sensor, a light sensor, an optical motion sensor, sensors designed to detect volatile organic compounds (VOCs), or a combination of one or more of these types of sensors. *E.g., id.* at 14:40–18:40. The smoke sensor operates in connection with the power control circuit to withdraw power from the microwave’s magnetron upon detection of excessive smoke in the microwave’s cooking area, which could be indicative of a potentially dangerous condition like a fire. *E.g., id.* at 14:12–19.

59. The Patent also describes a fault indicator, which may be coupled to the control circuit, and activating a fault indicator in response to the smoke detector tripping, such as by activating a buzzer and/or fault message (e.g., “E-1”).

60. The combination appliances also include a reset function whereby the power control circuit will re-enable delivery of cooking power to the microwave once the condition that triggered the smoke sensor has been resolved, enabling a subsequent cooking session. *E.g., id.* at 15:23–28, 17:27–35, 19:29–35.

61. The smoke sensor “may be reset automatically responsive to the [sensor]. . . no longer detecting gas indicative of the dangerous condition. Alternatively, or in addition, the [sensor] . . . may be reset upon a sensor sensing

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opening of the door[] of the microwave oven .” . *E.g., id.* at 15:5-32. These teachings ensure safe, low-power-draw appliances that are convenient for use in college dormitories, hotels, offices, and other establishments.

62. Placing a smoke sensor inside the microwave oven allows for faster and more accurate detection of potentially dangerous conditions, and withdrawing cooking power from the microwave may prevent fires and damage to the appliance. Additionally, in environments such as dormitories and hotels, where each unit may contain a combination appliance, it is preferable to withdraw power from the microwave unit (even in a false alarm scenario) than to allow the cooking process to continue, which may trigger external fire alarms and force large-scale and potentially unnecessary evacuations.

63. The Patents-at-Issue also teach an auxiliary power outlet, which may include USB ports and/or a traditional three-prong outlet, that may be included in certain embodiments to provide low power suitable for charging small external electronic devices such as cellular phones and laptops. *E.g., id.* at 4:40-46. The power control circuit in such an embodiment is also configured to monitor the power demands of the auxiliary outlet, withdraw power from the auxiliary outlet while the microwave demands cooking power, and restore power to the auxiliary outlet once the microwave ceases demanding cooking power. *E.g., id.* at 4:47-51. The power

control circuit may also withdraw power from the auxiliary outlet if the power demanded by the auxiliary outlet exceeds a threshold value. *E.g., id.*

VII. CLAIM CONSTRUCTION

64. I understand the Board has construed “level of smoke” or “amount of smoke” in the claims generally as a predetermined level of smoke “indicative of a dangerous condition” and did so “based on the plain language of the claims in light of the specification.” A POSITA would understand the plain language of the claims. As used in the specifications of the ’745 and 746 Patents, “level of smoke,” or “amount of smoke” is generally a predetermined level of smoke—a predetermined trip point—which is indicative of a dangerous condition—the traditional function of a smoke sensor. The Board’s construction does not conflict with my analysis here.

65. The specifications of the ’745 and ’746 Patents note certain parameters that may serve as the threshold “amounts” or “levels” of smoke sensed by the smoke sensor that could trigger an alarm or cause power to the microwave to be disabled, such as the “smoke point of oil.” *See* ’745 Patent, at 15:57–62; ’746 Patent, at 15:52–57 (an exemplary infrared sensor “may use the smoke point of oil ... as the basis for its threshold amount”).

66. A POSITA would understand the common cooking oils used when cooking food in microwaves.

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67. The specification also notes the known difference between “normal smoke emitted during the cooking or heating of food or beverages” (Ex. 1001, 15:57-62) and “excessive smoke generated from overcooked food” (*id.* at 14:15-19). This is consistent with the Board’s construction, which reinforces that the “level of smoke” is directed to the turning off at a predetermined trip point. (’745 Institution Decision at 11; ’746 Institution Decision at 11).

VIII. PETITIONER’S REFERENCES

A. Emma (Ex. 1011)

68. U.S. Patent Publication No. 2009/01889117 (“Emma”) (Ex. 1011), is a preceding and related parent to the Patents-at-Issue. Emma is titled “Multiple Linked Appliances with Auxiliary Outlet”, was published on or about July 30, 2009. For the purposes here, I understand Emma is prior art to the Patents-at-Issue.

69. Emma discloses “[a] combination microwave and refrigerator system [that] is constructed having a single plug input supply.” Ex. 1011, Emma, Abstract, Fig. 1.

70. Emma illustrates and generally describes a combined microwave 2 and refrigerator 3 with a control model whereby power to a compressor is monitored to sense operation of the compressor, such that when power to the microwave is demanded, the compressor is disabled for a preset minimum period. When the

microwave demand ceases, refrigerator power is restored provided that the minimum period has expired. Ex. 1011, Emma, ¶ 11, Fig. 1.

71. Emma also includes a control unit circuit shown in Figure 4, including certain relays 19 controlling power auxiliary outlets 11 and 12, as well as relay 20 controlling a refrigerator outlet 15. Ex. 1011, Emma, ¶ 33, Fig. 4. Emma teaches to “avoid overload conditions,” with the current demands of the microwave being generally most significant to overload, power to the outlets is disabled during microwave operation. *Id.*

72. Emma also discloses other control models to selectively limit power to the refrigerator during microwave operation. *Id.*, ¶ 33, Figs. 4 and 6.

B. ISDU (Ex. 1012)

73. ISDU: Integrated Smoke Detector Unit for Commercial Microwave Ovens, Cory Lloyd et al, (“ISDU”) is a non-patent literature reference, which I understand Petitioner and Dr. Horenstein allege to be published on a Northeastern University digital archive, “IRis,” on April 17, 2007. Petition at 20; Ex. 1002, ¶ 96.

74. ISDU appears to be a student project paper, with an April 17, 2007, submission date indicated on the first page. Ex. 1012 at 1. This is consistent with the timeline for the document attached at the end of the student project. Ex. 1012.

75. I understand Petitioner and Dr. Horenstein have not offered any first-hand knowledge of ISDU’s public accessibility. I also understand Petitioner and Dr.

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Horenstein have not offered any first-hand knowledge regarding the IRis digital archive. I understand that Dr. Horenstein collected the ISDU reference from Northeastern's current "Digital Repository Service" ("DRS"), which from my analysis of Northeastern library website did not exist prior to 2015—after the Effective Date.

76. I have reviewed the purported brochure attached as Appendix B to Ex. 1002 with limited information, and Exhibit D, a purported presentation with a November 2005 date and which appears to (at least in part) predate the IRis system and discusses what the system may be, including a "Committee Charge" related to "explor[ing] whether establishing an institutional repository . . . is desirable and feasible." Ex. 1002 at Page 222. Certain screenshots include documents bearing 2003 dates. *E.g.*, Ex. 1002 at Page 231. The purported brochure also appears to include partial images and incomplete information. The brochure notes that certain course, curriculum support, and teaching materials may be appropriately included in a repository. This is consistent with a slide describing the ability to access via Blackboard, which requires a user to log in with a username and password in order to access certain sections. Additionally, the system appears to have intended to include a "confidential" restriction that can be applied to communities, which is consistent with my understanding of similar systems. Ex. 1002 at Appendix D.

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77. I agree with the Board that Petitioner and Dr. Horenstein have “no corroborating testimony from a person with first-hand knowledge as to how, or when, papers were catalogued, indexed, or by what search methods, and by whom, they could be found and accessed within IRis,” related to ISDU. (’745 Institution Decision at 43; ’746 Institution Decision at 41–42).

78. As analyzed in depth below, Petitioner and Dr. Horenstein have not identified with particularity evidence sufficient to establish a reasonable likelihood that the reference was publicly accessible before the critical date of the challenged patent. Additionally, I do not consider ISDU to be prior art to the challenged claims in the Patents-at-Issue.

79. ISDU teaches a smoke detector wherein a portion of the smoke detector (including the sensitivity adjustment) is located *outside of* the microwave. Ex. 1012 at 23. ISDU also discloses that the design did not function as expected and was not operational.

C. Smith (Ex. 1014)

80. U.S. Patent No. 4,496,817 (“Smith”) (Ex. 1014) is titled “Automatic Fire Detection for Microwave Oven” and includes an issuance date of January 29, 1985.

81. Smith generally discloses “a method and apparatus for anticipating the occurrence of a fire in the cooking cavity of a microwave oven.” Ex. 1014, 1:55-57.

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Smith describes using a sensor normally used for “automatic cooking,” which is responsive to water vapor and other gases. Ex. 1014, 1:32-50, 3:15-16. A POSITA would understand that humidity sensors were traditionally used for automatic cooking, which is consistent with Smith’s disclosure.

82. Smith discloses that using its simple sensor normally used for automatic cooking works satisfactorily and is a lower-cost solution than previous approaches, such as that disclosed in U.S. Patent No. 4,133,995 to Buck where both “a humidity sensor and temperature sensor are employed to monitor the relative humidity and temperature in the cavity.” Ex. 1014 at 1:31-52.

83. Smith’s sensor is described as the Model TGS No. 186 in an illustrative embodiment. I have reviewed the prosecution history (Ex. 2003), which consistently uses “186,” and other Smith patents, which do the same.

84. Smith described Smith’s sensor 52 monitors for the “drying out” period, and the transition from long “drying out” phase to pre-combustion phase—i.e., “before food begins to char, smoke or smolder.” Smith describes this is a relatively rapidly increasing gas concentration in the circulating air. Ex. 1014 at 3:26-4:25. Thus, Smith describes “[u]pon detection of the characteristic rate of change [i.e., detection of the transition out of the drying out phase], means responsive to the sensor monitoring means de-energizes the oven and provides an indication to the user that a combustion condition in the oven cavity is imminent.” *Id.* at 1:68–2:4.

D. Butt (Ex. 1015)

85. U.S. Patent No. 8,446,048 (“Butt”) (Ex. 1015) is titled “Controller for a safety shut-off system” and lists a May 21, 2013, issuance date. Butt discloses a controller located in a standard electrical outlet box (or socket and housing) that interrupts a supply of electricity to an electrical appliance upon detecting a triggering. Ex. 1015 at 1:15-18, 2:22-35. The trigger signal can be based on a traditional wired or wireless smoke sensor located in a home, a panic button, a tremor detector (that detects earthquakes), or a lockout passcode (like a wireless keypad for a garage door opener). *Id.* at 4:27-52, 7:64-8:6.

86. Butt describes that it can exist in wired and wireless embodiments. In wired embodiments, the controller fits into a standard size outlet box, and wires connect it together with the standard smoke detector and panic/reset button 12. *Id.* at 4:40-49, 5:1-6. Butt states that “[t]he wiring can be performed by the user alone” due to the use of standard size and no need to cut cry wall, by a professional in a completed home, or by a professional during the construction of the home.” *Id.* at 4:40-49, 5:1-6, 8:7-21.

87. In wireless embodiments, radio frequency (RF) signals are transmitted to the controller.

88. In addition to noting this outlet is to be installed in the home, Butt describes using standard smoke detectors. Butt notes that “[e]xemplary wireless

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smoke detectors 14 include the ADEMCO 5806 detector, the SecureLinc (73942) detector, and the Wisdom 433 Mhz Wireless Smoke Detector.” *Id.* at 4:49-52. I have reviewed an installation manual for the ADEMCO 5806, which states the locations to install and not to install the standard smoke detector, as well as other limitations such as temperature limits, including the following:³

³ I understand the “Wisdom 433 Mhz Wireless Smoke Detector” appears to be a predecessor to the Risco smoke detector, as Risco appears to have acquired Wisdom at some point following the filing of the Butt application. However, based on the description, it also appears to be a standard smoke detector communicating through 433 MHz band, typical for wireless smoke detector systems. The current Risco smoke detector includes similar instructions as the ADEMCO 5806.

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False alarms occur when smoke detectors are installed where they will not work properly. To avoid false alarms, do not install smoke detectors in the following situations:

- Combustion particles are by-products of something burning. Do not install smoke detectors in or near areas where combustion particles are present, such as kitchens with few windows or poor ventilation, garages where there may be vehicle exhaust, near furnaces, hot water heaters and space heaters.
- Do not install smoke detectors less than 6 meters (20 feet) away from places where combustion particles are normally present, like kitchens. If a 20-foot distance is not possible, e.g. in a mobile home, try to install the detector as far away from the combustion particles as possible, preferably on the wall. To prevent false alarms, provide good ventilation in such places.



IMPORTANT:

Never try to avoid false alarms by disabling the detector.

- Do not mount smoke detectors in the path of fresh air intake. The flow of fresh air in and out can drive smoke away from the smoke detector; thus reducing its efficiency. Figure 6 indicates the correct and incorrect locations concerning this problem.
- Near paint thinner fumes.
- In close proximity to an automobile exhaust pipe; this will damage the detector.
- In damp or very humid areas or near bathrooms with showers. Moisture in humid air can enter the sensing chamber, then turns into droplets upon cooling, which can cause false alarms. Install smoke detectors at least 3 meters (10 feet) away from bathrooms.

Where Not to Locate Detectors

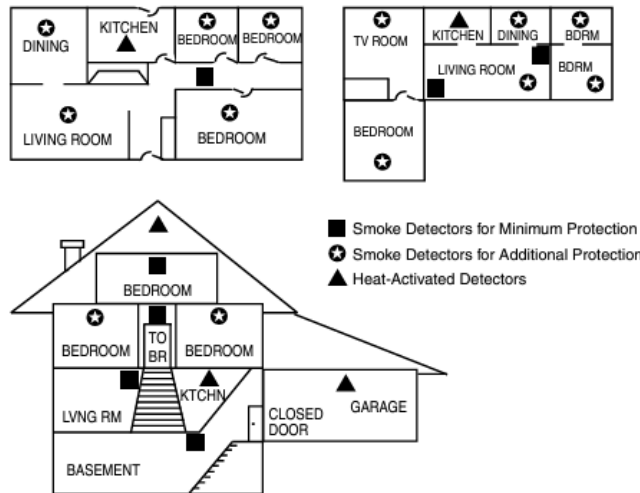
To avoid false alarms and/or improper operation, avoid installation of smoke detectors in the following areas:

- KITCHENS - Smoke from cooking may cause a nuisance alarm. LOCATE DETECTORS AT LEAST 20 FEET (6m) FROM KITCHENS, IF POSSIBLE.
- IN AIRSTREAMS PASSING BY KITCHENS - Smoke from cooking may enter normal air movement paths between outlets and returns if these paths run by kitchens, causing a nuisance alarm. LOCATE DETECTORS AWAY FROM SUCH AIRSTREAMS, IF POSSIBLE.
- BATHROOMS - Excessive steam from a shower may cause a nuisance alarm. LOCATE DETECTORS AT LEAST 10 FEET (3m) FROM BATHROOMS, IF POSSIBLE.
- NEAR FORCED-AIR DUCTS used for heating or air conditioning - Air movement may prevent smoke from reaching the detector.
- NEAR FLUORESCENT LIGHT FIXTURES - "Noise" generated by these fixtures may cause a nuisance alarm.
- NEAR FURNACES OF ANY TYPE - Air and dust movement and normal combustion products may cause a nuisance alarm.
- THE PEAK OF AN "A" FRAME TYPE OF CEILING - "Dead air" at the top may prevent smoke from reaching the detector.
- GARAGES - Products of combustion are present from running automobile engines and may cause a nuisance alarm.

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- UNHEATED BUILDINGS - Temperature limits are 40°–100°F (5°–38°C). The detector will not function properly in locations where the normal ambient temperature exceeds these limits.
- INSECT INFESTED AREAS - Insects entering the sensing chamber may cause a nuisance alarm.

IF YOU EXPERIENCE NUISANCE ALARMS, CAREFULLY CHECK YOUR DETECTOR'S LOCATION FOR POSSIBLE CAUSES AS LISTED ABOVE. RELOCATE AND CLEAN YOUR DETECTOR, IF NECESSARY. REMEMBER THAT THE MAJOR CAUSES OF NUISANCE ALARMS ARE DIRTY OR IMPROPERLY LOCATED DETECTORS.



(Ex. 1002, Appendix E (also available at <https://advancedsecurityllc.com/wp-content/uploads/Honeywell%205806%20Installation-Instructions-Manual.pdf>.)

E. Quezada (Ex. 1016)

89. U.S. Patent Pub. No. 2012/0276763 (“Quezada”) (Ex. 1020), titled “Wall Mountable Universal Serial Bus and Alternating Current Power Sourcing Receptacle,” states it was published on November 1, 2012. Ex. 1020, (12), (43), (54).

90. Quezada teaches a wall mountable USB and AC power receptacle capable of providing AC voltage of at least 120 volts. Ex. 1020, Abstract, ¶¶ 0002, 0013. Quezada is described as being installed without special considerations, and in the same manner as prior art wall sockets. Ex. 1020, Abstract, ¶¶ 0013.

IX. OPINIONS ON INVALIDITY

A. GROUNDS 1 AND 5-8: PETITIONER CANNOT ESTABLISH A PRIMA FACIE CASE OF OBVIOUSNESS BASED ON ISDU

91. I have reviewed ISDU, Ex. 1012, as well as the information cited by Petitioner and Dr. Horenstein to argue it was published in 2007, including Ex. 1002 Appendices B and D. It is my opinion that Petitioner has not shown sufficient evidence of public accessibility. Petitioner does not rely on anyone with first-hand knowledge of ISDU's public accessibility. Petitioner and Dr. Horenstein have not offered any evidence of actual pre-critical date access of the ISDU reference. Petitioner also does not rely on evidence of those with first-hand knowledge of the system on which ISDU was allegedly published—IRis.

92. ISDU appears to be a student project paper, with an April 17, 2007, submission date indicated on the first page. Ex. 1012 at 1. This is consistent with the timeline for the document attached at the end of the student project indicating that testing was set to conclude in early April 2007. Ex. 1012 at 33. This is also consistent with ISDU's conclusion: "We had set an ambitious goal of completing our integration by spring break of classes to ensure ample time for testing and completing our final report, as well as compiling our final presentation and as we reported to our advisor, we were able to meet that deadline." *Id.* at 27. In my experience, this is also consistent with the typical timeline of capstone engineering

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classes. Thus, the date on the paper is not helpful in determining when the public could have gained access to ISDU.

93. I have reviewed the undated brochure attached as Appendix B to Ex. 1002 titled “IRis: Digital Scholarship, Publishing, and Preservation at Northeastern University” (“IRis Brochure”) which has very limited and generic information. This does not include any policies or evidence showing that ISDU, specifically, was published. I have also reviewed Exhibit D, a purported presentation titled “Iris at Northeastern University: Why, What, How” (“IRis PowerPoint”) with a November 2005 date and which appears to (at least in part) predate the IRis system and discusses what the system may be, including a “Committee Charge” related to “explor[ing] whether establishing an institutional repository . . . is desirable and feasible.” Ex. 1002 at Page 222. Certain screenshots include documents bearing 2003 dates. E.g., Ex. 1002 at Page 231. The purported brochure also appears to include partial images and incomplete information. The brochure notes that certain course, curriculum support and teaching materials may be appropriately included in a repository. This is consistent with a slide describing the ability to access via Blackboard, which requires a user to log in with a username and password in order to access certain sections. Additionally, the system appears to have intended to include a “confidential” restriction that can be applied to communities, which is consistent with my understanding of similar systems. Ex. 1002 at Appendix D.

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94. Neither Appendix B nor D mention ISDU. The documents also at most show that metadata may be submitted, or it may later be edited/added. The documents do not include any information regarding what metadata, if any, was added to ISDU, and when that information was added, such as during the post-2015 transition to the current “Digital Repository Service.”

95. Appendix D, and my understanding of similar systems, are consistent with the option that IRis papers, course materials, working papers, teaching modules, and other information may have been submitted in a way where the submission was kept confidential. *See* Ex. 1002 at 237 (noting “not published” information), 238 (noting “fairly restrictive access to preprints”), 240 (noting access restrictions), 260 (same). For example, I am aware of similar systems in which information may be limited to certain communities, such as particular engineering departments or particular courses. I have personally limited access to class materials and prior exemplary student projects (or graded assignments) to students enrolled in a particular class years later.

96. I am aware that after submitting his Declarations, Ex. 1002 and Ex. 1023, Dr. Horenstein testified to his belief that capstone papers, like ISDU, must be published. That statement is not included in Dr. Horenstein’s written expert opinion.

97. It is also not accurate. Since 2008, in my various positions as an assistant, associate, and now tenured professor, I have taught capstone courses and

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seen capstone papers written by students that were never published. Based on my knowledge and experience in academia, I believe Dr. Horenstein has confused the requirements for undergraduate students (where undergraduate students typically assemble a paper or presentation related to their design project to submit and/or present to limited faculty) with doctoral dissertations or doctoral studies for Doctoral candidates.

98. I am familiar with the Accreditation Board for Engineering and Technology (ABET) guidelines that Dr. Horenstein referenced in his deposition, Ex. 2002, Horenstein Depo., 114:9-116:7, and they do not contain any requirement that capstone papers be published.

99. Regardless, Dr. Horenstein's statements in his deposition do not change the fact that he failed to meaningfully analyze whether ISDU was publicly accessible.

100. I have been informed that Ex. 1024 is not properly in the record. For completeness, I have reviewed Ex. 1024. The purported librarian confirmed she had no first-hand knowledge of the paper, and generally lacked personal knowledge. She also confirmed there is no metadata from IRis, and nothing that can prove ISDU was publicly accessible. Additionally, she confirmed the 2007 date cannot be the date on which ISDU was published. I understand the remaining to be largely unhelpful here, and to not demonstrate any public accessibility.

B. GROUND 1: THE PETITION DOES NOT SHOW THAT EMMA AND ISDU RENDER OBVIOUS ANY CLAIMS.

101. In my opinion, the combination of Emma and ISDU does not render any of the independent claims of the '745 and '746 Patent obvious, and also does not render any dependent claims obvious.

“Smoke Sensor.”⁴

102. Based on my review of ISDU, the smoke detector of ISDU is not inside the microwave and is instead in operative connection with the secondary housing containing the vent fan. ISDU noted the smoke floating in the air was more random process than a deterministic one in their design.

⁴ For simplicity, I address the limitations as organized by Dr. Horenstein and Petitioner, as listed in Petition Appendix A. For example, in the '745 Patent, Claims 1 and 24 include:

*wherein the microwave oven includes a smoke sensor,
wherein the smoke sensor is positioned in operative connection with a
cooking area inside the microwave oven,
is in operative connection with the at least one power control circuit,*

Ex. 1001, claims 1, 24. Claim 15 has similar limitations, requiring “*a smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area, wherein the smoke sensor is in operative connection with the at least one electrical power control circuit.*” Ex. 1001, claim 15.

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103. ISDU teaches a smoke detector wherein a portion of the smoke detector (including the sensitivity adjustment) is located *outside of* the microwave. Ex. 1012 at 23. ISDU's Figure 4 shows the "smoke detector" outside of the "interior microwave compartment." *Id.* Even the pictured "vent fan" is not within the microwave compartment, but in a "secondary housing." *Id.* at 11, 23.

104. It would not have been obvious or obvious to try placing ISDU's smoke detector inside the microwave oven.

105. To the contrary, ISDU specifically teaches against placing the smoke sensor inside of the microwave oven because of its warnings of dangers and false alarms: "[i]t is known that cooking foods that include oils and sugars generate more non-threatening smoke than other foods and would trigger a standard detection device [...]." Ex. 1012, ISDU at 3, 7-8. The paper explains design problems, such as noise emitted during the microwave process, and transient pulses, and goals (including not modifying existing off-the-shelf microwaves). A POSITA would have understood these teach away from the placement of the smoke detector inside the microwave.

106. In my opinion, the likelihood of false alarms that was identified as a problem in ISDU would be even greater if the smoke detector was placed inside the microwave oven.

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107. Similarly, ISDU teaches a “photoelectric smoke detector,” which ISDU recognizes are “more prone to isolated particulate triggering.” Ex. 1012, ISDU at 11, 15. ISDU also teaches that certain aspects of this detector are “nearly impossible” to implement.

108. In light of the prior art and ISDU, a POSITA would understand that it would not be appropriate to use a photoelectric smoke detector in operative connection with the inside of a microwave oven because the ever-present particles in a microwave would constantly trigger false alarms.

109. Petitioner’s arguments that there are a “finite” number of locations for the microwave, and that those are “inside” or “outside” the smoke detector, is clearly an over simplification.

110. Additionally, the “smoke sensor” limitation itself requires that the sensor be in operative connection with the power control circuit. Petitioner and Dr. Horenstein argue Emma discloses the claimed power control circuit, they do not allege Emma against the smoke sensor claim limitation. Further, while they contend ISDU’s smoke detector is in operative connection with *a* circuit, it does not allege that circuit is the *claimed* control circuit.

“Shut-down function.”⁵

111. ISDU does not disclose that at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn.

⁵ For simplicity, I address the limitations as organized by Dr. Horenstein and Petitioner, as listed in Petition Appendix A. For example, in the ‘745 Patent, in Claims 1, 15 and 24 this includes:

Claim 1:

wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,

Claim 15:

wherein the smoke sensor is in operative connection with the at least one electrical power control circuit, and wherein the at least one electrical power control circuit is configured to cause cooking power to be withdrawn from a magnetron of the microwave oven prior to a set end time of a current cooking session responsive at least in part to the smoke sensor sensing an amount of smoke,

Claim 24:

wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session.

Ex. 1001, ‘745 Patent, at claims 1, 15, 24 (emphasis added).

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112. ISDU teaches that microwave operations are “temporarily disabled” and the “cessation” of magnetron operation. Ex. 1012, ISDU at 1, 8. ISDU further states that the alarm will “suspend the operation of the microwave by triggering the factory designed stop/cancel function.” *Id.* at 24. ISDU does not teach that cooking power is withdrawn from the magnetron. The circuitry shown in ISDU does not show any ability to shut off the magnetron.

113. ISDU does not teach that the cooking power to the microwave is withdrawn “prior to a set end time,” as the claims of the ’745 Patent require. Under ISDU’s teaching, the system may just pause the current cooking system instead of withdrawing power before the set end time.

114. ISDU does not teach withdrawing power to the magnetron responsive to sensing a level of smoke “continuously for a predetermined time,” as the claims of the ’746 Patent require.

115. ISDU has no teaching that the system determines that smoke is present by sensing smoke for a “predetermined” period of time before withdrawing power to the magnetron.

“Reset enable function.”⁶

116. Petitioner cites to portions of ISDU that teach “reset[ting] the *smoke detector circuit* for further use” after an alarm has been triggered. Ex. 1012, ISDU at 8-9 (emphasis added). ISDU does not teach the *claimed control circuit* being

⁶ For simplicity, I address the limitations as organized by Dr. Horenstein and Petitioner, as listed in Petition Appendix A. For example, in the ’745 Patent, this includes

Claim 1:

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one power control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session,

Claim 15:

wherein the at least one electrical power control circuit is configured such that after ending the current cooking session prior to the set end time due to sensing the amount of smoke, to enable cooking power to again be available to the magnetron in a next subsequent cooking session,

Claim 24:

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session.

Ex. 1001, ’745 Patent, at claims 1, 15, 24.

operative to enable the magnetron to receive cooking power in a next subsequent cooking session.

117. ISDU does not teach a cooking session ending prior to the set end time based on a sensed “predetermined” level of smoke. ISDU teaches a “user-adjustable sensitivity control” that allows the “user to change the sensitivity of the detection device depending on what is being cooked.” Ex. 1012 at 4, 6. ISDU further requires the detection setting be adjustable *mid-cooking*: “If the food begins to trigger a false alarm, the user will also be able to change the sensitivity level while microwaving because the sensitivity adjustment is dynamic.” *Id.* at 10. ISDU teaches that this feature is desirable to avoid false alarms. *Id.*

Petitioner Fails to Establish Any Motivation to Combine Emma and ISDU or a Reasonable Expectation of Success

118. A POSITA would not have been motivated to combine Emma with ISDU.

119. Petitioner and Dr. Horenstein attempt to support their allegation of motivation to combine by alleging that all of the references, including ISDU, are analogous in that they “pertain[] to the field of electrical cooking appliances and/or relate[] to powering electrical appliances.” Ex. 1023 at 38. This is not accurate.

120. Emma does not mention smoke sensors, smoke, or fire. *See generally* Ex. 1011. Emma is limited to monitoring current in the combination appliance. I note that certain claims of the Patents-at-Issue do not require a refrigerator. *See*

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PGR2024-00003, Ex. 1001, '745 Patent, independent claim 15; PGR2024-00004, Ex. 1001, '746 Patent, independent claims 1, 15, 22.

121. Also, a POSITA would not simply look to general cooking appliances to arrive at the inventions in the '745 Patent. The issues faced with cooking appliances varies between appliances. For example, a gas oven and stove raise far different considerations than a microwave.

122. Monitoring current to avoid overload current draw from an outlet due to an issue specific to the combination appliance described in Emma is unrelated to the student paper's discussion of smoke sensors. Instead, a POSITA would understand the addition of a smoke sensor of ISDU and any additional functionality would have *increased* the most current draw most problematic for overload conditions—draw during cooking.

123. Moreover, a POSITA reviewing ISDU would not be motivated to add the non-functional proposed design into the intended commercial product of Emma. A POSITA would also not have a reasonable expectation of success, including because ISDU mentioned it did not work and had not resolved numerous expected issues and others they discovered along the way.

124. ISDU teaches a smoke sensor outside of the microwave and teaches against adding a smoke sensor inside a microwave. Ex. 1012, ISDU at 3, 7-8 (“Another concern inherent in the design of this system is the propensity of the

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smoke detector towards false alarms.”). In addition, the “photoelectric smoke detector” taught in ISDU would not be appropriate to use in operative connection with the inside of a microwave oven because the ever-present particles in a microwave would constantly trigger false alarms.

125. Thus, absent solving the specific problem that the ’745 Patent was designed to address, a POSITA would not seek to modify Emma to include the smoke sensor of ISDU, because doing so would result in annoying false alarms.

126. A POSITA also would not be motivated to add the ISDU smoke detector to the microwave-refrigerator combination in Emma because of the relevant energy standards applicable to microwaves. The ISDU smoke detector is “powered by the integrated low-voltage power supply.” Ex. 1012, ISDU at 9, 12. As such, the ISDU smoke detector requires a continuous power draw, which would likely cause a combined appliance to exceed the stand-by draw maximum set by the standards at its time of publication. The Department of Energy in October 2008 set out the proposed Energy Conservation Standard for Cooking Products, including a maximum standby power draw for microwave ovens of 1.0 watt. 73 Fed. Reg. 62034 at 62036 (Oct. 17, 2008). Adding any functions to the front display of a microwave, would likely exceed this limit. Placing a smoke sensor within a microwave was seen

as not possible under these standards, as that system would exceed the allowable maximum standby power.⁷

127. A POSITA would not have a reasonable expectation of success combining ISDU and Emma because the ISDU itself was non-functional. It is unreasonable to expect a POSITA to read about the failure of ISDU and think that combining it with Emma—a more complex system—would make it successful.

128. Further, ISDU highlights the problems with false alarms with its smoke detectors, making it highly unreasonable that a POSITA would have a reasonable expectation of success in achieving the claimed invention that placed the smoke sensor in operative connection with the inside of the microwave oven.

129. Petitioner and Dr. Horenstein do not appear to have analyzed whether ISDU provided a disclosure that would enable the portions of the disclosure on which they attempt to rely. I have been asked to analyze this. By its own admission, ISDU did not function. On its face, ISDU purports to be a student paper, with the goal of completion by “spring break.” Ex. 1012, ISDU at 27. Despite the students’ efforts, ISDU encountered “implementation issues,” and the students did not

⁷ By the time the standard became enforceable in 2016, it applied to stand-alone microwaves, such as the microwave of ISDU. 78 Fed. Reg. 36316 at 36316-17 (June 17, 2013) (stating the date of compliance is “June 17, 2016”).

produce a working model. *Id.* at 25-26. Indeed, the students experienced forced resets of the magnetron, and their attempts to fix the issue resulted in “disable[ment of] our reset function.” *Id.* at 26. Petitioner and Dr. Horenstein attempt to rely on ISDU for the “smoke sensor,” “shutdown function,” and “reset enable function.” (See, e.g., Petition at 46-47, 52-53, 56). Yet the “shut-down function” and “reset enable function” are *precisely* what ISDU’s student writers indicated did not work. Ex. 1012 at 26. Petitioner and Dr. Horenstein do not address this lack of enablement, which is not rectified by Emma.

C. GROUND 2: EMMA AND SMITH.

1. Petitioner Fails to Demonstrate that the Claimed Apparatuses Are Obvious

130. In my opinion, the combination of Emma and Smith does not render any of the challenged independent claims of the ’745 and ’746 Patents obvious, and also does not render any challenged dependent claims obvious.⁸

“Smoke Sensor.”

⁸ Petitioner has challenged claims 1, 13, 15, 20, 22, and 24-25 of the ‘745 Patent and claims 1-3, 5-6, 8-11, 13-17, and 20-24 of the ‘746 Patent on the grounds that they are obvious in view of Emma combined with Smith. PGR2024-00003, Petition at 12; PGR2024-00004, Petition at 12.

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131. Smith does not teach the “smoke sensor” limitation described in independent claims 1, 15, and 24 of the ’745 Patent, and 1, 15, and 22 of the ’746 Patent.

132. Dr. Horenstein’s supplemental declaration—the declaration submitted in this matter—merely cross references his prior report, which itself cross references other claims. Ex. 1023, ¶¶ 71-72 (citing Ex. 1002 ¶¶ 289-290 and citing unspecified other paragraphs). In Exhibit 1002, Dr. Horenstein discusses his opinion that Smith discloses portions of the “Smoke Sensor” limitation. Dr. Horenstein’s opinion for Smith not only relies on a separate “TGS-816” sensor and data sheet from “September 1999”, but he also relies on a discussion of a similarly unrelated “Ueda” reference that is not at issue and was not submitted here. *See, e.g.*, Ex. 1002 ¶¶ 167-169, 159-161.

133. Dr. Horenstein’s analysis appears to pull all of these references together, despite the teachings not existing in each of the references, and the Grounds involving Smith (including Ground 2 as well as Ground 4 and Grounds 5-8 discussed further below) are not disclosed as including Ueda and TGS-816. While the IPR in which Exhibit 1002 was submitted included combinations of Smith and Ueda, the same is not true here. Dr. Horenstein’s analysis is fatally flawed for at least this reason.

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134. Smith discloses only gas sensor 52, which is specifically described as being responsive to “water vapor and other gases.” *See* Petition at 47-48; Ex. 1014, 1:32-50, 3:15-16. A POSITA would understand that Smith discloses a humidity sensor.

135. The understanding that Smith discloses sensor 52 is a humidity sensor is consistent with Smith’s description that the disclosed sensor is normally used for “automatic cooking.” Ex. 1014, 3:18-21. Indeed, cooking sensors used at that time for automatic cooking were humidity sensors. Dr. Horenstein appears to acknowledge such. Ex. 1002 at 93-94, 100 (describing use of vapor/humidity sensors in automatic cooking), at 139 (arguing Ueda and Smith “use the same” sensor). Smith itself notes it was simplifying and decreasing the cost associated with a design in “U.S. Pat. No. 4,133,995 to Buck,” which utilized both a humidity sensor *and* a temperature sensor, monitoring both relative humidity and temperature in the cavity. Ex. 1014, 1:31-52. Smith then describes how it uses this typical sensor used for automatic cooking—the humidity sensor—without the need for the temperature

sensor of Buck.⁹ Smith notes it sought to decrease the cost by only utilizing a humidity sensor to detect the transition out of the drying-out phase.

136. Smith repeatedly describes that its sensor is detecting the cooking food “drying out,” and attempting to detect the transition from “drying out phase” into the “pre-combustion phase.” Ex. 1014, 3:49-62.¹⁰

137. Smith’s teaching of a humidity sensor, rather than a smoke sensor, is reinforced by the simplified curve shown in Figure 3 of Smith, which is consistent with the understanding for a humidity sensor’s resistance during a cooking cycle at that time. (*See, e.g.*, U.S. Patent No. 4,080,564 Figs. 2-3, U.S. Patent No. 4,097,707, Figs. 1a-1b.)

138. Smith’s reference to “gas” and/or “gases” is immaterial and does not change humidity sensor into a smoke sensor. More specifically, a POSITA would not understand “gas” to mean “smoke”.

⁹ Smith’s sensor is described as the Model TGS No. 186 in an illustrative embodiment. I have reviewed the prosecution history (Ex. 2003), which consistently uses “186,” and other Smith patents, which do the same.

¹⁰ I discuss additional relevant information in Section IX.C, above.

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139. Contrary to Petitioner's and Dr. Horenstein's suggestion,¹¹ a POSITA would understand that "water vapor" and "various organic gases" are not synonymous with volatile organic compounds (VOCs). Smith does not disclose a VOC sensor.

140. Regardless, simply being a VOC sensor or gas sensor does not make something a smoke sensor. Not all VOC sensors are smoke sensors. Relatedly, not all VOC are something that can be sensed with a smoke sensor.

141. However, Dr. Horenstein and Petitioner appear to rely on the improper assumption. A POSITA would understand a VOC sensor is not inherently a smoke sensor. In other words, even if Smith disclosed a VOC sensor—it does not—it is not a smoke sensor.¹²

142. Dr. Horenstein and Petitioner do not address the gas sensor—the humidity sensor—which consistently disclosed in Smith, the Figaro TGS Model No. 186. *See* Ex. 1014, 3:14-16, 4:16, 5:58. Instead, Dr. Horenstein identifies, and

¹¹ The latter may have been based on his improper connection and comingling of Ueda, Smith, and TGS-816.

¹² For example, I am aware of a TGS-813 is not a smoke sensor, only working in temperature ranges up to 104 degrees Fahrenheit.

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Petitioner relies on, an entirely different gas sensor, the Figaro TGS Model No. 816 (“TGS-816”). The Figaro Model No. 816 gas sensor, however, is not disclosed anywhere in the prosecution history for Smith. *See* Ex. 2003.

143. Dr. Horenstein concludes in his declaration that “Figaro Model No. 186” was a typographical error, based on a conclusory statement that TGS-186 does not exist. Dr. Horenstein offered no support in his declaration for this statement. I understand that during his deposition, Dr. Horenstein stated his opinion that this Model 186 did not exist relies on running a “Google” search. Ex. 2002, 118:10-119:11. This is not an appropriate method to determine the availability of a sensor in the late 1970’s and early 1980’s, when such information may have been available only in non-English resources due to the Figaro Engineering Company’s origins. Dr. Horenstein’s searches are not reasonable nor consistent with that of a POSITA.

144. Dr. Horenstein has also not shown the TGS-816 could have been what was referred to in Smith. Dr. Horenstein does not offer any evidence the TGS-816 was available at the time of Smith’s filing or issuance, in the early-to-mid 1980’s. Dr. Horenstein relies instead on a datasheet he admits was “Published in September 1999.” Ex. 1002, ¶ 159. This does not support that a POSITA would have understood Smith to be referring to the TGS-816.

145. Dr. Horenstein argues that the TGS-816 measures VOCs and Carbon Monoxide and is consistent with the teachings of Smith. Ex. 1002, ¶ 159. Notably,

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the TGS-816 documents referenced in Dr. Horenstein declaration do not state that it can measure “VOCs” generally and does not list “Carbon Monoxide” in the list of gases it is well suited for. Ex. 1002 at Appendix B. This is a conclusory assertion made by Dr. Horenstein that is unsupported by any documentation. There is also no support to show that a POSITA would have understood a TGS-816 sensor to measure these compounds.

146. These teachings in the TGS-816, contrary to Dr. Horenstein’s description, are inconsistent with Smith’s sensor, and confirm that Smith did not reference the TGS-816, which a POSITA would understand. Smith only notes its humidity sensor is capable of sensing water vapor and “various organic gases.” Ex. 1014, 3:16-17. Smith does not state its sensor can detect Carbon Monoxide, and Carbon Monoxide would not be understood as “some organic gases.” Carbon Monoxide is an inorganic chemical compound—not an organic gas.

147. Smith not referencing VOCs (let alone the specific compounds in the TGS-816) or Carbon Monoxide undercuts the idea that Smith meant to or was referring to the TGS-816 sensor when the patent explicitly discloses the Figaro TGS Model No. 186. Dr. Horenstein acknowledges the TGS-816 sensor is targeted toward “Methane,” “Butane,” and “Propane” and “other combustible gases.” (Ex. 1002, ¶ 160; *id.* at n.11 (citing websites)). Water vapor—what Smith’s sensor indisputably has to measure—is not a VOC and it is not a “combustible gas.”

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148. The “Temperature/Humidity Dependency” graph that is reproduced in paragraph 161 of Dr. Horenstein’s IPR report confirms that (contrary to the teachings of Smith) the TGS-816 is not intended to be a humidity sensor. Rather than showing its sensing of humidity, the graph actually shows that the accurate detection of other compounds (such as methane) depends on having constant humidity and temperature levels. A POSITA would understand that this is not the same as a “humidity sensor” and would not be suitable to detect humidity inside a microwave, where temperature will increase over time.

149. Therefore, I disagree that Smith discloses the TGS-816 sensor, a similar sensor, a “combustible gas sensor.”

150. Dr. Horenstein and Petitioner rely on the TGS-816 for their argument that Smith discloses a smoke sensor. Because Smith does not disclose the TGS-816, Dr. Horenstein has not shown that Smith discloses a smoke sensor.

151. As described above, based on Smith’s own teachings, and not Ueda’s or the TGS-816’s disclosure, a POSITA would not understand Smith to have disclosed a smoke sensor.

152. With respect to this limitation, Dr. Horenstein again fails to describe or support that Smith discloses a smoke sensor in operative connection with the *claimed* power control circuit. While it appears that Petitioner and Dr. Horenstein argue Emma discloses the claimed power control circuit, they do not argue Emma discloses

a smoke sensor and do not argue Emma discloses the claimed control circuit in operative communication with a smoke sensor. Instead, they seek to rely on Smith, arguing Smith meets this limitation because the purported “smoke sensor” in Smith is in operative connection with a microprocessor in *Smith*. *See, e.g.*, ’745 Petition at 49. Petitioner is not relying on Smith to disclose the claimed “control circuit.” *Id.* at 38-41. And nowhere does Petitioner allege a combination wherein the purported “smoke sensor” of Smith is in operative connection with the control circuit of Emma. It is therefore unclear what combination they seek.

153. Regardless, the combination of Emma and Smith does not disclose the “smoke sensor” limitation as described above.

“Shutdown function.”

154. The combination of Emma and Smith put forward in Ground 2 also does not render the Claims in the Patents-at-Issue obvious, because Emma and Smith do not teach the “shutdown function” required by all independent claims at issue. Dr. Horenstein and Petitioner rely on Smith for this limitation—and Dr. Horenstein does not even mention Emma in this entire section—including the requirement of withdrawing power from a magnetron prior to a set end time. However, Smith does not explicitly or inherently teach withdrawing power from a magnetron prior to a set end time. Therefore, it would not have been reasonably clear to a POSITA that there

was any end time or that power would be removed to end a current cooking session prior to the cooking session's set end time.

155. For example, Dr. Horenstein ignores that Smith discusses automatic cooking, meaning the system may not have any pre-set “time,” or may change the current time to the time of completion, as taught by Ueda and shown in Figure 5 of Dr. Horenstein's Ex. 1002. Ex. 1014, 3:18-21; Ex. 1002, ¶ 179 (setting $T = T_c$, which is time of completion). In other words, when the system senses the change in water vapor reflective of the end of the drying out phase, the system may deem the cooking session complete—not end early. This is consistent with certain automatic cooking microwaves at the time of Smith.

156. Even if Smith taught the setting of time—it does not—there is no teaching or suggestion in Smith that the current cooking session is ended prior to the set end time—Smith is wholly silent as to what happens next. Thus, Smith and Emma do not render this claim element obvious.

“Reset enable function.”

157. The combination of Emma and Smith put forward in Ground 2 also does not render the Claims in the Patents-at-Issue obvious, because Emma and Smith do not teach the “reset enable function” required by all independent claims at issue. Dr. Horenstein does not content Emma discloses this limitation, and appears to rely solely on Smith. However, Smith does not mention a reset or enabling power in a

subsequent session after a current cooking session has been caused to end based on sensing smoke, or how such a process would be completed.

158. While Smith does reference to a power control relay that can be open and withdraw power, Smith does not teach shutting the power control relay to re-energize the magnetron. Smith also does not teach that shutting a power control relay would be completed to enable cooking power in a subsequent cooking session after removing cooking power upon sensing a dangerous condition. Likewise, a POSITA would not understand that Smith discloses these aspects of the claimed invention.

159. This is consistent with Dr. Horenstein's recent testimony, in which he testified that Smith does not teach or disclose the reset relay or function. Ex. 2002, Horenstein Depo. at 128:3-12 ("Q. But there is no disclosure of a reset relay in Smith, correct? A. That's correct.").

160. Thus, Smith does not teach or disclose the "reset enable function."

161. For example, to the extent Smith does disclose a smoke sensor (it does not), a POSITA would understand that restarting a microwave after a fire has occurred inside the microwave (a closed small vessel with electrical components), would not be appropriate. At the very least, additional manual intervention may be necessary. In the latter option, there is no teaching that such would be performed by

the control circuit and could instead be completed via a manual circuit breaker or fuse. Regardless, none of this is taught in Smith.

162. A POSITA would not be motivated to further modify Smith and/or the Emma-Smith combination to contain the “Reset enable function.” Petitioner claims that there is only a “finite number” of ways to restart the microwave after shutdown, but fails to explain what those finite ways are. This is also not true.

163. There is also no disclosure or teaching within the references that after what they characterize as “fire detection” circuit is triggered, the system should be turned back on. Rather, the purpose of the invention in Smith is to prevent or cease feeding a fire. This is evidenced by the fact that the alarm is for “an imminent fire condition in the cooking cavity.” *See* Ex. 1014, 5:14–15. It would be counter to the stated purpose of Smith—preventing or ceasing the feeding of a fire—to allow the system to be re-enabled. This is especially true here because Smith discloses turning off power to the blower.

164. There is no teaching in Smith or Emma that it would be okay to re-enable power to the microwave or deliver power in a subsequent cooking session. In my opinion, Emma in view of Smith does not teach or render obvious the “reset enable function” limitation.

2. Petitioner's Obviousness Theories Rely Additional References Outside Ground 2 and Hindsight.

165. By improperly reading the separate TGS-816 into Smith, Dr. Horenstein and Petitioner also failed to address or attempt to show any motivation of a POSITA to combine a separate type of sensor (i.e., the TGS-816), which performs a wholly different function and purpose, and use it inside a microwave. Thus, even considering the TGS-816, Ground 2 fails.

166. A POSITA would not have combined the TGS-816 and used it inside a microwave because the standby power consumption would exceeded the maximum energy-draw allowance set by law. The TGS-816 sensor includes a heater, which constantly draws power in order to be prepared to operate. The TGS-816 sensor would draw approximately 0.9 watts of energy, which would cause the microwave exceed above the 1 watt proposed threshold and exceed the .78 watt threshold adopted. *See, e.g.*, 42 U.S.C. § 6291 (1 & 2), -6292 (10); 78 Fed. Reg. 36327-28; 73 Fed. Reg. 62034 (73 Fed Reg 62034, at 43); IEC standard 62301 (2nd Ed.): 78 Fed. Reg. 4015 (Jan 18, 2013).

167. As noted, I have reviewed Dr. Horenstein's deposition transcript. During the deposition, he noted he did not consider and seemed unaware of standby power consumption limitations for microwaves. Ex. 2002, Horenstein Depo. at 123:3-126:12. However, he was able to calculate the power consumption and

confirmed it would have been approximately 0.9 watts. Ex. 2002, Horenstein Depo at 124:8-20.

Petitioner Fails to Demonstrate Dependent Claims Are Obvious

168. Dr. Horenstein and Petitioner have now shown obviousness of the independent claims 1, 15, and 24 for Ground 2, and thus also fails to demonstrate invalidity of the dependent claims 13, 20, 22, and 25. Additionally, Emma and Smith do not disclose that the smoke sensor “includes at least one of a radiation emitter and radiation receiver, a photosensor, a motion sensor, an ionization sensor, and a VOC sensor,” as required by Claim 22. Smith is not a smoke sensor and does not disclose a VOC sensor. For this reason too, Ground 2 fails.

D. GROUND 3: EMMA COMBINED WITH BUTT

169. In my opinion, the combination of Emma and Butt does not render any of the challenged independent claims of the '745 and '746 Patents obvious, and also does not render any challenged dependent claims obvious.¹³ Additionally, a POSITA

¹³ Petitioner has challenged claims 1, 13, 15, 20, 22, and 24-25 of the '745 Patent and claims 1-3, 5-6, 8-11, 13-17 and 20-24 of the '746 Patent on the grounds that they are obvious in view of Emma combined with Butt and/or, alternatively obvious, in view of Emma combined with Butt and Smith. PGR2024-00003, Petition at 12; PGR2024-00004, Petition at 12.

would not have been motivated to combine Emma into Butt, and not as Petitioner and Dr. Horenstein suggest.

1. Petitioner Fails to Demonstrate that the Claimed Apparatuses Are Obvious Due to Ground 3

170. Petitioner and Dr. Horenstein rely on Butt for the “smoke sensor”, “shut-down function”, and “reset-enable function” limitations for Ground 3. As explained below, Butt does teach or disclose the elements missing in Emma.

171. Butt, alone or with Emma, does not disclose a microwave, a microwave having a smoke sensor, nor a smoke sensor in operative connection with a microwave (let alone a microwave’s cooking area).

No smoke sensor in operative connection with a microwave.

172. As addressed above, each independent claim of the Patents-at-Issue requires a smoke sensor inside the microwave and specify that it must be positioned in operative connection with the microwave’s cooking area.

173. Butt, either alone or in combination with Emma, does not disclose a microwave, a microwave having a smoke sensor, nor a smoke sensor in operative connection with a microwave.

174. The smoke detector of Butt is not included in any appliance, nor would a POSITA understand a combination of Emma and Butt to have disclosed a smoke detector inside an appliance. Butt teaches a “a controller for a safety shut-off system” installed in/as part of an ordinary electrical outlet or socket “within a wall,”

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using separate generic wireless smoke detectors used in a home or residence. *E.g.*, Ex. 1015 at 4:27-52; *see also* Section IX.D. There is no teaching or suggestion in the Butt reference that this functionality should be somehow moved inside any appliance, let alone inside a microwave.

175. There is no teaching or suggestion in Butt that “a controller for a safety shut-off system” that is installed in or as part of an ordinary electrical outlet or socket “within a wall” should be moved inside any appliance. *See* Ex. 1015, Butt, 4:27-52.

176. Moving the controller for a safety shut-off system in Butt from a standard outlet into the inside of a microwave goes against the teaching of Butt, as the use of a standard circuit box is foundational to the invention.

177. To the extent Butt and Emma would be combined by a POSITA, the microwave of Emma would simply be plugged into the controller/outlet of Butt, and the wireless smoke sensor (or smoke sensor wired into the house) would still be located somewhere else (disclosed as preferably outside the kitchen). Therefore, the smoke sensor would not include a microwave, which is required by the claims.

178. Butt does not disclose the smoke detector in operative connection with any appliance. Dr. Horenstein does not meaningfully dispute this and instead suggests “operative connection” means within the vicinity of the microwave. That is not consistent with the specification as explained below.

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179. Under the appropriate construction, Butt also does not disclose or suggest a smoke detector in operative connection with a cooking area inside an oven. As noted above, Butt discloses its standard smoke detector can be wireless or wired into the home (during or after the home's construction) and gives examples including the ADEMCO 5806. The only evidence in Butt comes from the referenced standard wireless smoke detectors including the ADEMCO 5806. Ex. 1015, Butt at 4:49-52, 5:1-6. Dr. Horenstein attached what he stated are installation instructions for an ADEMCO5806. Ex. 1002 at Appx E, 303-307. I reviewed Appendix E and an identical document, with higher quality image. The ADEMCO 5806 instructions disclose that "[d]etectors should be located as close to the center of the ceiling as possible," and "not install[ed] near forced-air . . . ducts." In fact, the ADEMCO 5806 detector states it should not be located in "KITCHENS," but rather "AT LEAST 20 FEET (6m) FROM KITCHENS," and further should not even be located "IN AIRSTREAMS PASSING BY KITCHENS." Consistent with standard smoke detectors, the ADEMCO 5806 even describes that to the extent it is not installed on the ceiling, it should be installed on the wall between 4 and 10 inches of the ceiling. Ex. 1002, Appx E, 303-307.

180. A POSITA would understand a smoke detector placed outside of the kitchen is not in operative connection with an appliance, nor the internal cooking area of an appliance.

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181. Dr. Horenstein admitted during his deposition to not previously reviewing these warnings. Ex. 2002, Horenstein Depo. at 131:12-133:18.

182. This is reinforced by the ADEMCO 5806 detector referenced in Butt also describing that it has temperature limits of 40-100 degrees Fahrenheit. A POSITA would understand a microwave would exceed 100 degrees Fahrenheit during operation. Dr. Horenstein conceded as much during his deposition. Ex. 2002, Horenstein Depo. at 133:4-12.

183. A POSITA would understand location of the smoke detectors identified in Butt, e.g., the ADEMCO 5806, to not be in operative connection with an appliance, nor the internal cooking area of an appliance. Butt and its detectors at best teach that detectors should be distanced apart from the kitchen and sources of smoke, and moreover cannot be placed near or inside the microwave. I understand this to be teaching away from the proposed combination of Emma and Butt.

No “smoke sensor,” “shutdown function,” and thus the “reset enable function” limitations.

184. The Claims require in response to the smoke sensor sensing smoke in the cooking area, the claimed control circuit operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time. *See e.g.*, '745 Patent, Claim limitations [1(h)]. Dr. Horenstein and Petitioner rely solely on Butt for these limitations, as is unsurprising because they do not contend Emma discloses a smoke sensor, ending a cooking session, withdrawing power from

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a magnetron, or withdrawing power from the magnetron prior to a set end time. *See generally* Ex. 1011. Butt does not teach causing cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time after sensing dangerous condition inside the cooking area.

185. Butt teaches, Butt may stop *all* power to a range in the event of a fire, low battery notification, panic, or other general hazard such as an earthquake, to make it so that “the energy that would otherwise act as an accelerant for the fire is eliminated.” Ex. 1015, 4:27-52, 4:55-60, 7:64-8:6. Butt also does not require or teach operation of the range (not microwave) or delivering cooking power. A POSITA would understand this Butt and Emma do not disclose withdrawing cooking power to a magnetron, a set end time of a current cooking session, or withdrawing power prior to a set end time.

186. Combining Butt with Emma also would not teach that the smoke detector of Butt would in operative connection with the at least one power control circuit, which has to be “supplied with electrical power only through the single power cord” which is releasably connected to a source of power. By contrast, Butt is the power source/outlet, or includes multiple plugs. Ex. 1015, 2:37-41. Therefore, Butt would be connected by multiple electrical lines, receive power cords and not be supplied with electrical power only through the single a power cord. Petitioner and

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Dr. Horenstein do not support this element is satisfied, and a POSITA would understand this is not satisfied.

187. The independent claims of the Patents-at-Issue would not have been obvious over Emma in view of Butt.

2. A POSITA Would Not Have Been Motivated to Combine and Would Not Have a Reasonable Expectation of Success in Combining Butt with Emma, as Proposed in Ground 3.

188. I have reviewed Dr. Horenstein's asserted "motivation" to combine Butt and Emma, and do not agree. Dr. Horenstein appears to pull on hindsight and from thin air that a POSITA would combine the additional kitchen appliance safety features of Butt into the Emma microwave/refrigerator combination namely to enable the Emma microwave to shut down upon the detection of smoke. To be clear, A POSITA would not have been motivated to combine Emma and Butt.

189. As noted above, Butt and its detectors at best teach that detectors should be distanced apart from the kitchen and sources of smoke, and moreover cannot be placed near or inside the microwave. Ex. 1015, Butt, 4:49-52, 5:1-6; Ex. 1002 at Appx E, 303-307. A POSITA would understand moving Butt's smoke detector away from the ceiling is directly contrary to Butt and the smoke detectors disclosed therein. In other words, Butt teaches away from being combined into Emma.

190. A POSITA would not have been motivated to combine Emma and Butt. Emma is described as a combination appliance, attractive for use "in dorm rooms,

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hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations.”

In other words, Emma’s combination appliance was envisioned for use in places without kitchens.

191. Butt is described as a controller, located in a standard outlet, installed into a standard circuit box/outlet, and meant to be installed by a “user alone, by a professional in a completed home, or by a professional during the construction of the home.” Ex. 1015, Butt, 5:4-6. Butt is the standard outlet, for example, in a kitchen with an oven range plugged into it, using a separate standard wireless smoke detector located in a different room in the home (or, e.g., an earthquake sensor). A POSITA would understand that Butt is intended for interoperability and easy DIY addition to homes, using standard electrical outlets and smoke detectors. The entire claimed invention in Butt relates to adding the invention to a home or residence, and not into an appliance. Butt discloses one of its purposes being to turn off power to an outlet when you are not home and accidentally leaving your oven turned on. That same issue is not inherent in microwaves, which commonly cook for short periods of time. A POSITA would understand Butt is a fundamentally different technology than Emma, and the combination into Emma is antithetical to Butt’s teachings.

192. For these reasons, a POSITA would not have looked to Butt’s outlet meant to address home and kitchen fires, or its disclosure of smoke detectors, for

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any reason, and would not have looked to Butt to remove from a home in order to add into Emma.

193. The references themselves also teach away from combining Butt into Emma. For example, Butt teaches that having this function in the outlet itself is beneficial in the event of a power outage. E.g., Ex. 1015, 6:44-52 (“If power to the appliance 18 has previously been interrupted as a result of a power failure, the user may have left the appliance “on” forgetting that, when the power failure ends and power is restored some time later, the appliance 18 could be untended and therefore could create a fire hazard”). Butt also teaches away from integrating the smoke sensors within any appliance. For example, the standard residential wireless smoke detectors disclosed in Butt state they are not able to function at the high temperatures within an oven due to their relatively low temperature thresholders as set forth in the exemplary ADEMCO 5806, which a POSITA would understand. E.g., Ex. 1002 at 303-307. Additionally, if placed inside the microwave (and thus non-functional, but regardless) the standard smoke detector would also no longer be able to detect smoke from the house itself, the purpose of the smoke detectors in Butt. The combination would also no longer meet one of the other foundational aspects of Butt, to place the controller in a standard electrical outlet box.

194. Because the proposed combination of Emma and Butt would remove the functionalities of the smoke detector in Butt, a POSITA would not have been

motivated to make this combination nor had a reasonable expectation of success in doing so.

195. To the extent there would be any motivation to combine Emma and Butt, the combination would have meant simply plugging Emma into Butt. Notably, this was not proposed by Dr. Horenstein because that would not render the claims obvious.

196. For at least these reasons, a POSITA would not understand there to be a motivation to combine Emma and Butt as proposed by Dr. Horenstein and Petitioner.

E. GROUND 4: EMMA IN VIEW OF BUTT AND FURTHER IN VIEW OF SMITH.

197. I see that the Petitioner and Dr. Horenstein rely on their analysis of Grounds 2 and 3 for Grounds 4. Because those grounds fail, it is my opinion that evidence identified with respect to Grounds 2 and 3 also does not show any challenged claim is obvious in view of Emma, Butt, and further in view of Smith.

1. A POSITA Would Not Have Been Motivated to Combine, and Would Not Have a Reasonable Expectation of Success in Combining, Emma, Butt and Smith, as Proposed in Ground 4.

198. I have reviewed the evidence provided by the Dr. Horenstein and Petitioner, and in my opinion, it does not show that a POSITA would have been motivated to arrive at the device recited by claims 1, 15, and 24 of the '745 Patent

or claims 1, 15, and 22 of the '746 Patent, nor any dependent claim, with a reasonable expectation of success. My opinion is based on several things.

199. Emma's combination microwave-refrigerator appliance (Ex. 1011), Butt's smoke detector controller (Ex. 1015), and Smith's humidity sensor (Ex. 1014) are very different components with very different purposes and use cases. In my opinion, because of these incompatible differences, a POSITA would not have been motivated to combine them to make the claimed invention.

200. Petitioner and Dr. Horenstein propose altering both Emma and Butt in view of Smith, including by moving Butt's smoke detector internal to Emma's microwave. Institution at 21-22 (citing Petition at 78).¹⁴ As explained above with respect to Ground 3, a POSITA would not have been motivated to do such a

¹⁴ In my opinion, Petitioner's proposed combination is ambiguous. As the Board recognized in its Institution Decision, Petitioner seems to be arguing that a POSITA would include the humidity sensor of Smith and the smoke detector of Butt to reach the claimed invention. Institution Decision at 21-22 (citing Petitioner at 78). However, Petitioner identifies no motivation for a combination of the sensors of Butt and Smith. Regardless, I address all apparent versions of the ambiguous combinations.

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combination (and would have been motivated not to do such), and regardless such would be inoperable.

201. While a POSITA would not add Butt into Emma, let alone the (inoperable) smoke detector of Butt and the humidity sensor of Smith (which teaches only using one sensor), the addition of Smith's humidity sensor alone, as explained above, does not add a smoke sensor. See Ground 2. In my opinion, a POSITA would not be motivated to combine both sensors of Smith and Emma, and regardless, such do not satisfy the claim language as explained above.

202. Regardless, as explained above in Section IX.D, a POSITA would not have been motivated to combine Emma and Butt because Butt teaches that its outlet controller and smoke detector are not to be used inside an appliance, but rather in a standard electrical outlet box (or socket and housing). Ex. 1015 at 1:15-18, 2:22-35. A POSITA would understand that Butt is intended for interoperability and as an easy DIY addition to homes, using standards electrical outlets and smoke detectors, or is installed into a home during the construction of a home.

203. A POSITA would also understand that Butt would not function inside Emma's combination appliance. As explained above, Butt teaches that detectors should be distanced apart from the kitchen and sources of smoke, and moreover cannot be placed near or inside the microwave. Thus, a POSITA would not have

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looked to Butt's outlet as means to address home and kitchen fires, or its disclosure of smoke detectors, and would not have considered integrating it with Emma.

204. A POSITA would not have been motivated to combine Emma, with Butt and Smith because the teachings of Butt contract the teachings of Smith. The smoke detector of Butt is not to be used near combustible sources and would not work inside the microwave. Ex. 1002, Appendix D, at 202-307. In fact, adding Butt's smoke detector inside of Emma, alone or in combination with Smith, would be contrary to the foundational purpose of Butt, as described with respect to Ground 3 in the Section IX.D above. See also Ex. 1015, Butt, 1:25-27. For example, even ignoring the smoke detector of Butt would not work inside Emma, removing the smoke detector from the house and placing it inside Emma would then miss most if not all cooking fires in a house.

205. A POSITA would also recognize that Smith teaches away from being combined with Butt. As explained in Section IX.C above regarding Ground 2, Smith teaches using a humidity sensor because of the low cost and avoiding the need for a more expensive sensor and/or multiple sensors. Ex. 1014, 1:48-52 (describing how a humidity sensor "eliminates the need for the relatively costly thermal cutout switch"). Butt's smoke detector would be far more expensive, thus contravening the express purpose of Smith. Also, the smoke detector of Butt would not be able to detect humidity levels necessary to detect the "drying out phase" identified in Smith.

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Ex. 1014, 1:43-63 (describing the use of a sensor to measure humidity levels to detect the “transition from the drying out phase to the pre-combustion phase”). Shutting down the microwave of Emma after a fire has been detected inside Emma’s cooking cavity, would likely render the microwave of Emma inoperable.

206. A POSITA would also not be motivated to combine a reset feature of Butt with Emma and in view of Smith, as this would not be applicable to the combination proposed in Ground 4 or Smith. Butt describes how the controller in the outlet may receive an RF signal and re-enable power to the outlet after a user panics or following an alarm unrelated to the oven or appliance that is plugged into the outlet containing the controller. Ex. 1015, Butt, 4:53-67. Butt does not teach resetting an appliance after that has been a fire detected within that specific appliance. A POSITA would understand that would be wholly improper when you are sensing fire inside of a microwave.

207. For example, unlike in Butt, where the shut off is intended to avoid adding fuel to a potentially unrelated fire (or due a panic, earthquake, or unattended children), Petitioner’s and Dr. Horenstein’s proposed combination of Emma, Butt, and Smith would be allegedly shutting off after detecting a fire inside a small, closed compartment surrounded by electrical components. A POSITA would understand the microwave should not be re-enabled with electricity because, as the Examiner

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previously recognized during prosecution of the related U.S. Patent No. 9,664,436, a fire inside a microwave would result in damage to the electricals.

208. Butt's teachings are also not applicable to Smith and/or Emma because combination into Smith and Emma contravene the underlying purpose of Butt. See also Section IX.D above regarding Ground 3. The controller identified in Butt is located in the wall—it is part of the house. Ex. 1015, Butt, 4:40-44 ("The housing of the controller comprises a standard Leviton™ circuit box, or any other suitable and commercially available circuit box, fits within a wall and is flush with the exterior of the wall.") This is not applicable to Smith, which seeks to use a simple humidity sensor for the purpose of identifying the drying out of food in a microwave during the cooking process. Ex. 1014, 1:43-63. The underlying purposes in Butt and Smith is directly at odds with one another—adding functionality to and creating a smart home able to function with standard smoke detectors, versus creating a microwave using low-cost humidity sensors to detect the drying out phase.

209. Further, a POSITA would understand, smoke detection in a house is far different than detecting smoke in an appliance, having different risks, and considerations.

210. In addition to not combining the sensors as Dr. Horenstein and Petitioner propose, a POSITA would also not be motivated to combine a reset feature

of Butt with Emma and in view of Smith (as understood by Petitioner),¹⁵ because the purported TGS-816 sensor Petitioner claims is disclosed by Smith would not be functional upon being reset. A POSITA would understand that the TGS-816 contains an internal heater and must be pre-heated to function. The TGS-816 specification sheet states, the TGS-816 should be preheated for “More than 7 days” prior to testing. Ex. 1002, Appendix C, pages 217-219. After removing power to any application (including a microwave) including the TGS-816, a POSITA would understand the sensor would not function for an extended period of time. Because a POSITA would understand the TGS-816 sensor to not be functional in any subsequent cooking session (and thus potentially led to additional hazardous conditions such as cooking fires), a POSITA would not be motivated to combine the reset feature of Butt (as Petitioner has described it) with Emma in view of Smith.

2. Emma in View of Butt and Further in View of Smith Does Not Disclose, Teach, or Suggest the “Smoke Sensor”, “Shutdown Function”, or “Reset Enable Function” Limitations

211. In my opinion, the combination of Emma, Butt, and Smith does not disclose a smoke sensor in operative connection with the cooking area and the

¹⁵ Again, in my opinion, as addressed above, Smith does not teach the TGS-816 or any smoke sensor.

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control circuit as described in independent claims 1, 15, and 24 of the '745 Patent and 1, 15, and 22 of the '746 Patent.

212. For the reasons explained in Section IX.D, Emma in view of Butt, any combination of Emma in view of Butt does not disclose or suggest a smoke sensor in operative connection with the oven, a microwave, or the cooking area inside the microwave. The smoke detector of Butt is not included in any appliance, nor would a POSITA understand a combination of Emma and Butt to have disclosed such.

213. For the reasons explained in Section IX.A.i, Smith does not teach a smoke sensor at all nor a smoke sensor in operative connection with a cooking area inside the microwave oven.

214. Based on their individual failures above, adding Smith to Emma and Butt does not disclose or suggest a smoke sensor in operative connection with the oven, a microwave, or the cooking area inside the microwave. The addition of Smith to Emma and Butt does not disclose or suggest that the smoke detector of Butt be placed inside the microwave oven in operative connection with the cooking area. For example, a POSITA would understand, Butt's smoke detector cannot function inside the microwave, and moving it away from the ceiling is directly contrary to Butt and the smoke detectors disclosed therein.

Where Not to Locate Detectors

To avoid false alarms and/or improper operation, avoid installation of smoke detectors in the following areas:

- KITCHENS - Smoke from cooking may cause a nuisance alarm. LOCATE DETECTORS AT LEAST 20 FEET (6m) FROM KITCHENS, IF POSSIBLE.
- IN AIRSTREAMS PASSING BY KITCHENS - Smoke from cooking may enter normal air movement paths between outlets and returns if these paths run by kitchens, causing a nuisance alarm. LOCATE DETECTORS AWAY FROM SUCH AIRSTREAMS, IF POSSIBLE.
- BATHROOMS - Excessive steam from a shower may cause a nuisance alarm. LOCATE DETECTORS AT LEAST 10 FEET (3m) FROM BATHROOMS, IF POSSIBLE.
- NEAR FORCED-AIR DUCTS used for heating or air conditioning - Air movement may prevent smoke from reaching the detector.
- NEAR FLUORESCENT LIGHT FIXTURES - "Noise" generated by these fixtures may cause a nuisance alarm.
- NEAR FURNACES OF ANY TYPE - Air and dust movement and normal combustion products may cause a nuisance alarm.
- THE PEAK OF AN "A" FRAME TYPE OF CEILING - "Dead air" at the top may prevent smoke from reaching the detector.
- GARAGES - Products of combustion are present from running automobile engines and may cause a nuisance alarm.

Ex. 1002, Appendix E, at Page 303-307.

215. Petitioner and Dr. Horenstein do not demonstrate that Emma, Butt, or Smith teach, responsive in part to a level of smoke sensed by the smoke sensor, the control circuit operative to withdraw power from a magnetron to end a current cooking session prior to a set end time, required by all independent claims.

216. As described above with respect to Ground 3, Section IX.D. Emma in view of Butt, any combination of Emma in view of Butt does not disclose or suggest causing cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time after sensing dangerous condition inside the cooking area. Butt teaches that the smoke detector may stop *all* power to a stove in the event of a fire, low battery notification, panic, or other general hazard such as an

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earthquake, to make it so that “the energy that would otherwise act as an accelerant for the fire is eliminated.” Ex. 1015, Butt, 4:35-37, 55-60.

217. As described above with respect to Ground 2, Section IX.C, Smith lacks a smoke sensor and is silent as to the other portions of the “shut down function.” Smith, therefore, cannot rectify the failure of the other prior art.

218. Just as they fail to teach the “shut down function” individually discussed above, the combination of Emma, Butt, and Smith Based does not disclose or suggest responsive in part to a level of smoke sensed by the smoke sensor, the control circuit operative to withdraw power from a magnetron to end a current cooking session prior to a set end time.

219. As addressed in Sections IX.C. and IX.D, neither of Emma and Smith nor Emma and Butt teach or render obvious this limitation. Regardless, “Petitioner relies upon” Butt for this element. (Institution Decision at 34.) As explain above, Butt’s teachings do not relate unrelated to microwaves, magnetrons, and cooking sessions. Ex. 1015, 3:63-67, 6:36-37, 7:15-21. The “control unit” of Butt is located in a wall of a house, specifically in a standard outlet. This does not and cannot disclose enabling a magnetron to receive cooking power. This also does not disclose, teach, or suggest anything about a “subsequent cooking session.” For the reasons described above, a POSITA would not be motivated to combine, have reasonable

expectation of success in combining Emma, Butt, and Smith, and regardless, the combination does not disclose the “Reset Enable” limitation.

220. In my opinion, a POSITA would not understand any challenged claim is invalid as obvious in view of Emma, Butt, and Smith.

F. GROUND 5-8: EMMA COMBINED WITH EITHER ISDU AND SMITH, IN FURTHER VIEW OF THE KNOWLEDGE OF POSITA.

221. As the Board recognized, “Grounds . . . 5–8 all rely upon the ISDU non-patent literature reference.” Thus, Grounds 5-8 fail because ISDU does not qualify as prior art.

222. Regardless, Grounds 5 and 6 are directed to dependent claims 12, 14, 19, 23, and 26, and solely rely on the knowledge of a POSITA to “substitute one or more of Emma’s auxiliary low power receptacles / outlets for a USB port for power delivery to small electronic devices.” Petition at 81. A POSITA would not understand the claims to be invalid as obvious in light of the references in Grounds 5 and 6 fail for the same reasons explained with respect to Grounds 1 and 2, because Emma and ISDU or Smith do not disclose or render obvious any independent claim.

223. Additionally, with respect to Grounds 5-6 Petitioner’s and Dr. Horenstein’s proposed further modification of Emma, ISDU, and Smith is based on the knowledge of a POSITA. Petitioner’s bare assertion that there were a “finite

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number of potential solutions” for charging lacks any support, and does not even attempt to identify the “finite” number of options available at the time.

224. Contrary to their position, it would not have been obvious, as replacing an outlet of Emma would have reduced the functionality of the Emma. For example, it would not have been obvious to a POSITA to replace an outlet of Emma with USB ports because doing so would have reduced the functionality of Emma, decreasing the number of devices that could connect to the combination appliance.

225. With respect to Grounds 7-8, the addition of Quezada, yet another reference, is improper. As Petitioner and Dr. Horenstein appear to acknowledge, the alleged motivation to combine Quezada is not found in the references themselves. Instead, they argues that claims 12, 14, 19, 23, and 26 are obvious, in part, because “it would have been obvious to a POSITA to combine USB ports, as taught by Quezada, for charging electronic devices with the Emma microwave/refrigerator combination auxiliary lower power receptacles / outlets.” Petition at 85. Petitioner and Dr. Horenstein rely on the knowledge of a POSITA.

226. I disagree with this conclusion. Quezada is not related to appliances, cooking appliances, or combination appliances, let alone a microwave. Moreover, it would not have been obvious to a POSITA to combine Quezada with Emma, because replacing the auxiliary ports of Emma would have reduced the functionality and decreased compatibility, as noted above. Additionally, a POSITA would have

understood that a USB port may not provide sufficient power to power/charge many devices.

G. GROUNDS 9: INDEFINITENESS (Claims 1-28).

227. “In operative connection”—the only term Petitioner and Dr. Horenstein argue is indefinite in this proceeding—is sufficiently definite. This term is not technical; it is a general descriptive term. When read in light of the specification, this term plainly describes that the cooking area is connected to the smoke sensor such that the smoke sensor is able to operate, *i.e.* sense smoke in the cooking area.

228. I agree with the Board that, “from a plain reading of the claim language we understand that the smoke sensor is either within, *i.e.*, ‘inside’ the interior cooking area of the microwave or, in a connecting air passage or region connected to the interior cooking area.” Institution Decision at 44.

229. Petitioner and Dr. Horenstein’s position that they do not understand “whether the connection is such that the smoke sensor somehow operates in the area or the smoke sensor operates based on being connected to the area” is unsound. The first proposed meaning gives no effect to the “connection” portion of the term, and therefore cannot be correct.

230. In my opinion, the second proposed meaning gives effect to both “operative” and “connection,” and is consistent with the plain language. A POSITA would understand this to be the plain meaning. Ex. 1001, at 14:27–33, 16:62–17:5

H. GROUNDS 10 AND 11: INDEFINITENESS, WRITTEN DESCRIPTION, AND ENABLEMENT (CLAIMS 10 AND 14 OF THE '746 PATENT).

231. Regarding Ground 10, I understand that Petitioner argues and Dr. Horenstein opines that claim 10 of the '746 Patent does not have adequate written description, and/or is not enabled, and/or is indefinite. I note their exact arguments vary between documents, and even within the same document. I disagree on all points. Petitioner and Dr. Horenstein have made no showing of lack of possession or of undue experimentation. Their lack of enablement and written description arguments are therefore not supported. Regarding definiteness, their issue appears to relate to the claim term “continuously.” However, “continuously” is not a technical term. In my opinion, it is a term that a POSITA would readily understand with reasonable certainty. Petitioner’s indefiniteness argument should therefore be rejected

232. Regarding Ground 11, I understand that Petitioner argues and Dr. Horenstein opines that claim 14 of the '746 Patent does not have adequate written description, and/or is not enabled, and/or is indefinite, specifically related to a “preset minimum period after the magnetron becomes inoperative.” I note their exact arguments vary between documents, and even within the same document. I disagree on all points.

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233. Petitioner and Dr. Horenstein ignore the specification of the '746 Patent, including written description support for claim 14 in column 4, lines 55-61:

When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the at least one control circuit for a preset minimum period. When power demand to the magnetron ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

234. The specification also describes using undesirable rapid on/off cycles for the compressor, which a POSITA would may occur after a magnetron becomes inoperative in light of the specification. The claim term “preset minimum period” is not a technical term and a POSITA would understand it with reasonable certainty in light of the example provided in the specification at column 6, lines 43-51:

In another exemplary arrangement, a clock function 21 included in the at least one power control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which the compressor of the refrigerator 3 will remain disabled, even if microwave use is only for a short period.

235. No more information is necessary. Additionally, contrary to Petitioner and Dr. Horenstein's attempt, there is no need to claim a specific “period of time.” Petitioner and Dr. Horenstein are wrong not met its burden of proving that claim 14 lacks written description, is not enabled, or is indefinite and Ground 11 should therefore be rejected.

I. OBJECTIVE INDICIA CONFIRM NON-OBVIOUSNESS OF THE CLAIMED COMBINATION APPLIANCES

236. I have been informed that objective, real-world evidence, such as a long-felt but unmet need, failure of others, commercial success, teaching away, unexpected results, and copying, can be evidence that patent claims were not obvious. I have been asked to consider and explain the nature and import of any such evidence in view of at least claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent. I have also been asked to provide my opinion as to how this objective evidence should be weighed against the evidence that the Petitioner contends shows the claims are unpatentable.

237. As described in **Appendix B**, the MicroFridge Products embody at least claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent, and there is strong and compelling objective evidence that these products solved a long-felt need that others failed to solve, overcame teaching away and unexpected results, and prompted copying at least from Petitioner. It is also my opinion, as I explain below, that this evidence is the direct result of the combination of features claimed by claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent.

238. Based on this, it is my opinion that even if the Board was to find that any of the claims 1, 12, 14, 15, 23, 24, 25, and 26 appeared to be obvious in view of the prior art and the arguments provided by the Petitioner and Dr. Horenstein, the robust real-world objective evidence demonstrating that these claims were not

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actually obvious to those working in the field at the time would clearly outweigh such a finding.

239. Intirion's MicroFridge Products provided a unique solution to the longstanding problems of safety and energy overload in combination microwave-refrigerator appliances, which are often used in dormitories, hotels, and offices.

240. The MicroFridge Products place the smoke sensor inside the microwave oven, and so can more precisely and quickly sense a potentially dangerous condition. The MicroFridge Products then disable power to the combination appliance to effectively prevent fire and damage to the appliance. *See, e.g.*, Ex. 2005, MF004429. These Products are designed to trigger an alert to the user early, "before any damage is done" and so "help[] prevent unnecessarily fire alarms" in buildings and avoiding unnecessary evacuations. Ex. 2005, MF004429.

241. The MicroFridge Products include a reset function. This function allows the system to reset after no longer detecting a potentially dangerous condition and also immediately enables a subsequent cooking session—a highly useful feature to a user. *See, e.g.*, Ex. 2006, MF003462, at 15.

242. The MicroFridge Products combine the above safety features with a control circuit configured to limit overall power draw to the combination unit, and auxiliary outlets like USB ports that provide low power for charging. *See, e.g.*, Ex. 2006, MF003462, at 15.

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The MicroFridge Embodies At Least Claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent.

243. For the purposes of this Response, I have been asked whether the MicroFridge Products embody claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent. I have analyzed the list of MicroFridge models set out in Paragraph 2 of the Declaration of Jared Amy, which I refer to in this Response collectively as the "MicroFridge Products." Based on my review of the above-listed claims, the information provided to me in connection with these PGRs, and my familiarity with the MicroFridge Products, my conclusion is each of claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent cover the MicroFridge Products.

244. The details of my analysis are set forth in **Appendix B**, which a claim chart in which I set forth my opinion regarding each element of the challenged claims. I do not intend for my statements in Appendix B to be weighed any differently than my statements here.

245. The claimed combination of features recited in claims 1, 12, 14, 15, 23, 24, 25, and 26 of the '745 Patent is the entire MicroFridge Product that Intirion makes and sells, not just one component or subset of components of the product.

246. In addition, it is the claimed combination of features recited in claims 1, 12, 14, 15, 23, 24, 25, and 26 that are what directly provide the benefits that make the MicroFridge Products so successful. The smoke detector in operative connection with microwave allows for quicker and more effective alarms, that alert the user

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before any fire or damage has occurred. The reset function, in turn, allows for the unit to be quickly reused after an alarm has gone off.

247. The MicroFridge Products for the first time combined a microwave-refrigerator appliance with a smoke sensor within the microwave, a reset function that enabled subsequent cooking sessions, a control circuit that prevented power overdraw, and auxiliary outlets for charging such as USB ports. *See* App’x B.

248. These are the same features recited in independent claims 1, 15, and 24 and their dependent claims.

249. Based on my review of Petitioner’s prior art references, as I have detailed above, no other product in the prior art had this combination of features, which significantly improved the safety and energy efficiency of these combination microwave-refrigerator appliances.

250. Intirion’s marketing materials that I reviewed consistently emphasized that its combination microwave-refrigerator included Intirion’s 1st Defense Smoke Sensor™ that is “internal” and “automatically shuts microwave operation and alerts user of smoke before any damage is done”, a “USB Charging Station,” “Safe Plug™ Technology” for “one-plug to the wall operation,” and “current limiting technology.” Ex. 2005, MF004429; *see also* Ex. 2018, MF004453 (2015 version); Ex. 2019, MF004485 (2023 version).

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251. The claimed combination of features covers the MicroFridge Products as a whole; those products do not include unclaimed features that significant impact or account for the compelling objective evidence of non-obviousness I have reviewed and discussed in this Response.

Failure of Others and Long-Felt Need

252. The MicroFridge Products solved a long-felt but previously unmet need improving the safety and reliability of combination appliances in dormitories, offices, and apartments without the drawbacks associated with unnecessary evacuations caused by false fire alarms.

253. Placing a smoke sensor inside the microwave was not seen as a viable option before the MicroFridge Products, given the high likelihood of false alarms that would require unnecessary evacuations. For example, the commercial smoke detector Petitioner and Dr. Horenstein have cited (the ADEMCO 5608) specifically warned users not to locate the detector even in “kitchens” because of the likelihood of false alarms, much less *inside* a kitchen appliance. *See* Ex. 1002 at 306 (App’x E).

254. For my review of the documents, I also understand that Petitioner itself tried many times but failed to arrive at Intirion’s solution, which was to locate the smoke sensor within the microwave in a combination microwave-refrigerator unit

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and have a functioning reset function that enabled subsequent cooking sessions. It is my opinion that this further supports the non-obviousness of Intirion's invention.

255. For example, in May 2015, Petitioner wrote in an e-mail that [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Ex. 2021, CP_017595 at CF_017596-97. In January and February 2018, Petitioner [REDACTED]

[REDACTED] Ex. 2022, CP_021545-48. [REDACTED]

[REDACTED]

[REDACTED] *Id.*

256. Later in November 2018, Petitioner [REDACTED]

[REDACTED]

[REDACTED] Ex. 2023, CP_012938-39. Petitioner [REDACTED]

[REDACTED] *Id.*

257. In July 2020, Petitioner's President, Eric Hennings, stated regarding his combination units: [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Ex. 2024, CP_011613-19. The MicroFridge Products solved these problems through the claimed smoke sensor and reset functions.

Teaching Away and Unexpected Results.

258. I also believe there is evidence that references taught away from Intirion's solution, which resulted in unexpected results.

259. For example, as I discussed above, the ISDU reference specifically taught away from incorporating a smoke detector in a microwave oven. ISDU describes placing a smoke sensor outside of the microwave and teaches against adding a smoke sensor inside a microwave, acknowledging, "[i]t is known that cooking foods that include oils and sugars generate more non-threatening smoke than other foods and would trigger a standard detection device[...]." Ex. 1012, ISDU at 3, 7-8 ("Another concern inherent in the design of this system is the propensity of the smoke detector towards false alarms."). ISDU also teaches a "photoelectric smoke detector," which ISDU recognizes are "more prone to isolated particulate triggering." Ex. 1012, ISDU at 11, 15. It would not be appropriate to use a photoelectric smoke detector in operative connection with the inside of a microwave oven because the ever-present particles in a microwave would constantly trigger false alarms.

260. In addition, there was also an industry regulation that taught away from placing a smoke sensor inside a microwave oven. The Department of Energy in

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October 2008, set out the proposed Energy Conservation Standard for Cooking Products, including a maximum standby power for microwave ovens of 1.0 watt. 73 Fed. Reg. 62034 at 62036 (Oct. 17, 2008).

261. In my experience, based on that proposed regulation, placing an off-the-shelf smoke sensor inside the microwave would not be seen as a viable option, because that system would necessarily exceed the allowable maximum standby power.

262. In my experience, a company would not go through the process of developing a product in light of a proposed regulation that prevented them from their end result. So the proposed regulation would have discouraged the industry from taking Intirion's path of designing a product with a smoke sensor in operative connection with a microwave.

263. By the time the regulation became enforceable, it only applied to microwave units solely intended for use as a stand-alone microwave. *See* 78 Fed. Reg. 36316 at 36316-17 (June 17, 2013) (stating the date of compliance is "June 17, 2016").

264. In addition, it was unexpected that placing a smoke sensor in the microwave of a combination appliance would work. As I have mentioned in this Response, the conventional wisdom was that the problem of false alarms would be enhanced if a smoke sensor was in operative connection with the microwave. The

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ADEMCO 5608 smoke detector referenced in Butt (Ex. 1015 at 4:49-50), specifically warned users to *not* locate smoke detectors in “kitchens” because “[s]moke from cooking may cause a nuisance alarm. LOCATE DETECTORS AT LEAST 20 FEET (6m) FROM KITCHES, IF POSSIBLE.” Ex. 1002, App’x E at 306.

265. The MicroFridge Products solve for the problem of nuisance fire alarms caused by placing smoke detectors in kitchens by shutting off power to the microwave *before* a fire has occurred, thus preventing unnecessary fire alarms and unnecessary evacuations in dormitories and apartments.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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Ernest Anton

Emad Y. Tanbour, Ph.D.

APPENDIX A

EMAD Y. TANBOUR, Ph.D.

CURRICULUM VITAE

Associate Professor of Mechanical Engineering
College of Engineering & Technology, School of Engineering
Eastern Michigan University
Cell [REDACTED]

SUMMARY

Dr. Emad Tanbour has more than 36 years combined experience in Mechanical Engineering in both academia and industry. His industry experience spans over 18 years in the areas of product development, energy efficient appliances and sustainability, thermal systems design and engineering management. He is an expert researcher in industry and had been leading industry-academia funded research since 1997. Dr. Tanbour is an innovator with over 17 US pending and issued patents all of which resulted in products sold in North America. Most of his innovations are in the field of sustainable design of domestic and commercial appliances. Dr. Tanbour has advanced knowledge of computer aided engineering, CFD and computational mechanics. He is an expert user and trainer of computer aided design using solid modeling. He has conducted research in the areas of heat transfer, thermal-fluids, and energy systems and led many years of research and development projects in the interdisciplinary areas of Mechanical Engineering. He received his bachelor's degree in Mechanical Engineering and ranked third over his cohort and received full scholarship to pursue graduate studies towards his Ph.D. in Mechanical Engineering from the University of Iowa. During his studies at Iowa, Dr. Tanbour led the thermal design of all control circuits for NASA Cassini spacecraft that was launched to Saturn. Dr. Tanbour is the recipient of Arch T. Colwell Award from Society of Automotive Engineers and had served for five years as ABET industry consultant. He also received EMBA training courses at the University of Iowa.

In recent years, Dr. Tanbour served as technical expert for multiple litigation cases involving patent infringement and field failures. Two cases resulted in favorable judgement to Dr. Tanbour's clients and the third and fourth case are in progress. Dr. Tanbour's tech expert services focus on products and services related to energy, thermal fluids, heat transfer, cooling, and thermal management of consumer products and devices. Dr. Tanbour has experience in deposition during patent infringement litigation. Dr. Tanbour has testified in court defending a successful case resulting in favorable judgement.

In August 2016, Dr. Tanbour Joined Eastern Michigan University, School of Engineering As professor and coordinator of the Mechanical Engineering program. Dr. Tanbour also assumed coordinator position for Mechanical Engineering Technology upon joining EMU until fall 2017 when he assumed coordinator position for the Graduate Program in Engineering Management. Dr. Tanbour is teaching undergraduate junior and senior courses in Mechanical Engineering and has taught dynamics for Mechanical Engineering Technology. He also teaches graduate courses in Engineering Management. Dr. Tanbour currently serves as program coordinator for both Mechanical Engineering and Master of Engineering Management Programs. Upon joining Eastern Michigan, Dr. Tanbour successfully designed and build a state of the art Virtual Reality (VR) lab. The VR lab consists of four-wall fully immersive active stereoscopic system that is 14ft by 14 ft floor plan. The VR lab successfully received funding from Ford Motor Company Fund. Dr. Tanbour is actively conducting research and teaching using the VR lab and is supervising doctoral and undergraduate students conducting research and development in the VR field. The VR lab is also utilized as a

Design review and visualization facility for senior capstone design students in the School of Engineering.

In July 2023, Dr. Tanbour was awarded a \$368,000 research grant from industry focusing research on computer vision integration with industrial robotics for manufacturing process improvement and control. The 3-years grant will be conducting research on deploying laser enabled sensory, 3D computer vision and high speed scanning, sensors and technologies to increase manufacturing process capabilities.

In Jan 2014, Dr. Tanbour joined Central Michigan University (CMU) as a visiting scholar and served as tenure track assistant professor of Mechanical Engineering Technology in the School of Engineering and Technology (SET) since July 2014. During his first year at Central Michigan University, Dr. Tanbour taught engineering mechanics courses for both Engineering and Engineering Technology majors, Thermodynamic for ME major, Applied Fluid Mechanics, Machine Design and Capstone Projects for Senior Engineering Technology cohort. He also served on the SET Graduate Committee where he led the process to develop the Assessment Plan for the new Master of Science in Engineering (voted as best assessment plan in the history of CMU-currently used as a benchmark for new programs at CMU). Dr. Tanbour built a state of the art Virtual Reality laboratory at CMU which employed several undergraduate and two graduate students from SET. He contributed to MET Assessment Committee and was serving as MET Program Coordinator. During the spring of 2015 and 2016, Dr. Tanbour taught the Senior Capstone Industrial Design course for all BSET graduating seniors where he managed to attract several externally sponsored design projects and supervised four internally sponsored ones. Details of some of these Projects are added at the end of this CV. Dr. Tanbour is active in research and has published and presented engineering conference papers, and many journal papers.

In 2009, Dr. Emad Tanbour joined Prince Mohammad Bin Fahd University (PMU) faculty of Mechanical Engineering. He has led the university's strategic plans to achieve total quality assurance. He also led the university's compliance system with ABET (USA), NCAAA (National) and SACS (USA) accreditation. Dr. Tanbour served in several leadership capacities at the university including his membership of the University Council reporting to the Board of Trustees. He was also a member of the Senior Management Group of PMU and has served as a member of the University Deans' Council. He served also as a member of the University IT Council. All such councils were chaired by PMU Rector. He was a member of the College of Engineering Council and served as Senior Advisor to the Rector on Accreditation and was promoted to Dean of Quality and Accreditation reporting directly to the Rector. As Dean of Quality and Accreditation, Dr. Tanbour managed PMU's readiness works to successfully receive NCAAA national accreditation in 2013 (Equivalent to US regional university accreditation such as HLC). During five years at PMU, Dr. Tanbour taught many Mechanical and General Engineering courses more notably, the capstone graduation design projects. Dr. Tanbour brings to his classroom real-life industry experience especially in product design and development and interdisciplinary Mechanical Engineering. He was an instrumental member in the College of Engineering curriculum development committee for master's degrees in Mechanical Engineering and Energy Systems and has served for three years as member of the College Curriculum and Accreditation standing committee.

During 2005 to 2009, Dr. Tanbour managed product development engineering for Whirlpool and AO Smith-USA water heaters (a division of 45 engineers and technicians). He led the development of several energy efficient residential water heaters. He was successful in developing the world first ultra-low NOX water heater and the production of many DOE-rated Energy Star power-vented water heaters. His experience included utilization of CFD and state of the art CAD deployment through the industry. He also established industry-largest development & reliability labs for residential water heaters at Whirlpool-AO Smith. While at Whirlpool, Dr. Tanbour maintained industry-academia collaboration with Clemson University, Virginia Tech and University of Tennessee, Knoxville. His engineering

department in industry-hosted internship program with these three universities and was home for doctoral and graduate student engineering fellows from Clemson and University of Toledo. During 1997 to 2005, Dr. Tanbour worked as R&D senior manager at HNI Corporate Technical Center, the second largest manufacturer of office furniture and hearth systems in North America. He led R&D projects utilizing computational mechanics and founded the Hearth Lab at the corporate center. His 8 years at HNI included numerous industry-academia funded research projects and strong collaboration relationship with the University Of Iowa College Of Engineering and the Center for Computer Aided Design. During the same period, Dr. Tanbour was active in service in the State of Iowa where he served as Co-Chair to Advanced Technical Training at the Iowa Department of Economic Development and several industry-academia service capacities.

During 1993 to 1997, Dr. Tanbour was leading Gail Industry's high pressure pumps manufacturing where he successfully developed hydrostatic testing piston pumps and mud pumps for oil and gas operations in California and Texas.

Dr. Tanbour has proven teaching and research record. He served as adjunct assistant professor at the University of Iowa (2000 to 2005) teaching undergraduate and graduate Mechanical Engineering curriculum and as full time faculty (2009 to Present). He was principal investigator in several HNI - U of Iowa funded research projects. He managed to secure \$300,000 seed funding of the Virtual Reality lab jointly at HNI/Allsteel and U of Iowa. This seed funding attracted over \$18 million in research grants over the past 19 years to the Center for Computer Aided Design at Iowa where he is still an affiliate research scholar. His record of service and research is evident in the list of publications in Thermo- Fluids and interdisciplinary Mechanical Engineering. Dr. Tanbour is still active in consulting projects for manufacturers in USA in the area of Mechanical Engineering design. Most recently, Dr. Tanbour was retained as expert infringement analyst in an ongoing litigation regarding intellectual property infringement case in water heater industry.

EDUCATION

Ph.D. in Mechanical Engineering

The University of Iowa, Iowa City, IA (1997)

M.Sc. in Mechanical Engineering

Jordan University of Science and Technology (1990)

B.Sc. in Mechanical Engineering

Jordan University of Science and Technology (1987)

EMBA, Executive MBA Program Training (courses only, no degree)

The University of Iowa, Iowa City, IA (2004-2005)

Courses completed Managerial Economics, Managerial Accounting, Organizational Behavior, Data and Decision (Managerial Data, Decision and Statistical Analysis), Marketing Management, Human Resource Management and International Economic Environment of the Firm (Managerial Macroeconomics).

PROFESSIONAL EMPLOYMENT (MAJOR POSITIONS)

ACADEMIC APPOINTMENTS

Eastern Michigan University:

School of Engineering, College of Engineering & Technology

August 31, 2016 - Present:

- Associate Professor (tenured and promoted July 2019), and Chair of Mechanical Engineering, School of Engineering and Acting Director of the School of Engineering.
- School of Engineering ABET Coordinator (Summer 2018-present)
- Supervisor and Founder of EMU Virtual Reality lab.
- Served as Interim Associate Dean of the College of Engineering for one year term

Central Michigan University:

School of Engineering and Technology, College of Science and Technology.

Jan 2014 – August 15, 2016:

- Visiting Professor of Mechanical Engineering (Jan to Jun 2014)
- Tenure Track Assistant Professor of Mechanical Engineering Technology (July 2014-August 2016)
- Coordinator for MET Program
- Coordinator for the Master in Engineering Management Program.

Prince Mohammad Bin Fahd University (Al-Khubar, Saudi Arabia)

Aug 2009- Dec 2013 Dean of Quality and Accreditation and Professor of Mechanical Engineering

The University of Iowa, Iowa City, Iowa 52241, USA

2005-present Affiliate Research Scholar Center for Computer Aided Design

2000-2005 Adjunct Professor of Mechanical Engineering

1992-1997 Teaching/Research, College of Engineering, Department of Mechanical and Industrial Engineering

National College, Amman Jordan (Technical Community College)

1990-1992 Lecturer, Mechanical Engineering

Jordan University of Science & Technology, Irbid, Jordan

1987-1990 Teaching/Research Assistant. Taught and assisted in teaching undergraduate Mechanical Engineering classes including manufacturing processes, fluid mechanics lab, heat transfer lab, instrumentation lab, Engineering and Mechanical Engineering Drawing.

INDUSTRIAL/MANUFACTURING APPOINTMENTS

2019-Present: Expert Witness Experience:

- 1- A. O. Smith vs Bradford White: Patent infringement case: Result: Winning the case of my client and favorable judgement. Was deposed and testified in court.
- 2- SPG vs Evapco: IPR Case in the US Patent Office. Was deposed and outcome was winning the US Patent validation of my client's patent- Case has moved to court after failed mandatory mediation.
- 3- Confidential Case: serving as tech expert for a supplier of devices used in heat transfer appliances. Case resulted in a settlement in mediation process.
- 4- Serving as Tech Expert in the case of Certain Marine Air Conditioning systems – A patent infringement case in The United States International Trade Commission, Washington, D.C. I was deposed and prepared expert declaration reports and assisted in preparing claim charts and supporting reports.

1993-1997 Director of Engineering
Gail Industries, Cedar Rapids, Iowa, USA
***Manufacturer** of high pressure pumps for hydraulic testing of pipelines*

1997-2005 Senior R&D Manager
S. M. Howe Tech Center, HNI Corporation, Muscatine, Iowa, USA
***Manufacturer** of office systems and hearth products*

2005- 8/2009 Manager, Product Development Engineering
A.O. Smith Corporation, Water Product Company, Johnson City, Tennessee, USA
***Largest Manufacturer** of Residential and Commercial water Heaters in North America with brands like Whirlpool and Sears Water Heaters*

TEACHING EXPERIENCE

Eastern Michigan University

- EM 509 Engineering Project Management (6 times)
- EM 649 Manufacturing Process Planning (3 times)
- EM 520 Engineering Value and Economic Analysis (5 times)
- EM 670: Design for Manufacture and Assembly
- ME 312: Dynamics (4 times)
- ME 316: Thermodynamics (multiple times)
- ME 317: Fluid Mechanics
- ME 313: Mechanics of Materials (several times)
- ME 330: Machine Design (3 times)
- ME 492: Senior Capstone I (5 times)
- ME 493: Senior Capstone II (5 times)
- MET 312: Applied Dynamics Principles (2 times)

Central Michigan University

- IET 454 Machine Design (twice)

- IET 279 Applied Statics (twice)
- EGR 251 Engineering Statics (twice)
- IET 499 Industrial Projects Capstone (twice)
- EGR 356 Thermodynamics I (twice)
- IET 352 Applied Fluid Mechanics (twice)
- IET 501 Industrial Management (Graduate online)
- IET 524 Technology and the Environment (Graduate online)
- IET 680 Sustainability and Green Technology (Graduate online)

Prince Mohammad Bin Fahd University

- Fluid Mechanics (4 academic years)
- Engineering Economy (4 academic years)
- Power Generation (4 academic years)
- Computer Aided Design (ME Senior year course) (4 academic years)
- Mechanical Engineering Design I (Kinematics and dynamics of machinery) (4 academic years)
- Mechanical Engineering Design II (Automatic control) (4 academic years)
- Mechanical Engineering Design III (Machine Design) (4 academic years)
- Assessment III (Mechanical Engineering Capstone Design Project) (4 academic years)

The University of Iowa

Adjunct Faculty (2000-2005)

- Intermediate Thermodynamics (Graduate course)
- Dynamics
- Principles of Design 1 (Optimization)

Graduate Teaching Assistant (1992-1997)

- Thermodynamics I (4 academic years)
- Heat Transfer (4 academic years)
- Fluid Mechanics (4 academic years)
- Fluid Mechanics Lab (4 academic years)
- Experimental Engineering (4 academic years)

National College, Technical Community College (2 academic years)

- | | |
|---|----------------------------------|
| • Air-Conditioning Engineering | • Heat Transfer |
| • Refrigeration Technology | • Strength of Materials |
| • Service of HRA System | • Engineering Drawing |
| • Fluid Mechanics and Hydraulic Machinery | • Calculus for Engineers |
| • Engineering Mechanics, Statics and Dynamics | • Mechanical Engineering Drawing |

PUBLICATIONS

1. Tanbour, H., Tanbour, E. "A four-wall virtual reality visualization of patient-specific anatomy: Creating full user immersive experience from computed tomography scans" Turkish Journal of Engineering 7 (2023): 134-140
<https://dergipark.org.tr/en/pub/tuje/issue/69578/1072285>
2. Al-Jundi, H.A., Tanbour, E.Y. Design and evaluation of a high- fidelity virtual reality manufacturing planning system. *Virtual Reality* (2022). <https://doi.org/10.1007/s10055-022-00683-x>
3. Al-Jundi, H.A., Tanbour, E.Y. A framework for fidelity evaluation of immersive virtual reality systems. *Virtual Reality* **26**, 1103–1122 (2022). <https://doi.org/10.1007/s10055-021-00618-y>

4. M. Dado, M. Alrbai, E. Tanbour and J. Al Asfar, Performance Assessment of a Novel Mechanism Design of Spark ignition Internal Combustion Engine, *Applied Energy*: Published. 16 Sep 2020, Accepted 05 Feb 2021, Published online: 26 Feb 2021.
<https://doi.org/10.1080/15567036.2021.1889076>
5. M. Aldadou and E. Tanbour, Slider-Crank Mechanism for Eliminating Side Forces, **US Patent**. Issues and Published by US Patent Office May 16, 2019. Patent Number US 2019/0145507 A1. <https://www.freepatentsonline.com/y2019/0145507.html>
6. Kasim A. Korkmaz and Emad Y.H. Tanbour, Augmented Reality Technology for Highway, Presented by co-author Kasim Korkmaz at ICVARS 2018 held during February 24-26, 2018, in Brisbane, Australia, Paper ID : RS0018
7. Barry, Oumar Rafiou, Tanbour, Emadeddin Y., Vaja, Nitish Kumar, and Tanbour; Hesham, Asymmetric Aeolian vibration damper, USA Patent Office, Patent No.: US 9,948,081 B1, Date of Patent: Apr. 17, 2018. <http://www.freepatentsonline.com/9948081.html>
8. Emadeddin Y. Tanbour, Moh'd-Eslam Dahdolan, Mahmoud R. AlOmari, Oumar R. Barry, Characterization of Aerogel Based Thermal Insulation Blankets, Economics, and Applications for Domestic Water Heaters, *Journal of Thermal Engineering*, 4-5-July, 2018. <http://eds.yildiz.edu.tr/journal-of-thermal-engineering/Submission/MyManuscripts>
9. M. Bukhari, Oumar Barry and Emadeddin Tanbour, On the vibration analysis of power lines with moving dampers, *Journal of Vibration and Control*, Published July 4, 2017.
<http://journals.sagepub.com/doi/abs/10.1177/1077546317719194>
10. M. C. Greenfield, Emad Y. Tanbour, 2017, Gap Analysis of a Newly Developed Electrical Engineering Program using NCEES FE Exam, *International Journal Of Engineering Research & Technology (IJERT)* Volume 06, Issue 01 (January 2017).
11. Oumar Barry and Emadeddin Tanbour, Resonant Frequencies of Perforated Plates with Rectangular Slots, *Journal of Mechanical Engineering Science*, UK Institute of Mechanical Engineers, December 13, 2016, manuscript ID is JMES-16-0518.R1.
<http://journals.sagepub.com/doi/10.1177/0954406216683974>
12. Nitish Kumar Vaja, Oumar Barry, Emadeddin Y. Tanbour, On the Dynamic Modeling and Analysis of an Asymmetric Stockbridge Damper, *Proceedings of the Sixth International Conference on Structural Engineering, Mechanics and Computation*, Cape Town, South Africa, 5-7 September 2016. <https://www.crcpress.com/Insights-and-Innovations-in-Structural-Engineering-Mechanics-and-Computation/Zingoni/p/book/9781138029279>
13. M. Freund, E. Joubaneh, O. Barry and E. Tanbour, Study Of Vibration Of Electric Power Steering Systems Using A Continuous System Model. *International Mechanical Engineering Congress and Exhibition, ASME IMECE 2017*, November 3-9, 2017, Tampa, Florida, USA. <https://mail.google.com/mail/u/0/#search/barry1o%40cmich.edu/WhctKHTKgrdpWgzdWsfKGjggNldcqHgBhkZbdgLSQFwSPGnLRBfRDIJvBQxMKDSMFMPzPKQ?projector=1&messagePartId=0.2>
14. N.K. Vaja, O.R. Barry, E.Y. Tanbour, On the Dynamic Modeling and Analysis of an Asymmetric Stockbridge Damper, Presented at SEMC 2016: The 6th International Conference on Structural Engineering, Mechanics and Computation, September 5-7, 2016, Cape Town, South Africa.

15. Emadeddin Y. Tanbour and Oumar R. Barry, Free Vibration of flame Arrestors: Theoretical and Numerical Analysis, submitted to AMSE Journal of Vibrations and Acoustics, September 2015
16. Emad Tanbour and Suleiman Ashur, Gap Analysis of Engineering Course Learning Outcomes using NCEES FE Exam, accepted for publication and presentations ASME 2015 International Mechanical Engineering Congress and Exposition, Huston, Texas Nov.13-19, 2015
17. Emadeddin Y. Tanbour, Molu Olumolade and Oumar R. Barry, Newly Introduced Capstone Design Course for Mechanical Engineering Technology – Lessons Learned From Two Cohorts and Two Types of Projects, presented at the 123rd ASEE Annual Conference & Exposition. June 26 - 29, 2016 New Orleans, LA
18. E. Y. Tanbour, Design Optimization and Frequency Analysis of Blast Resistant Doors for 30 G-Force Rating, Canadian Journal on Mechanical Sciences & Engineering, vol. 2, No. 7, November 2011, pp. 157 - 162
19. M. F. Alzoubi, E. Y. Tanbour and R. Al-Waked, Compression and Hysteresis Curves of Nonlinear Polyurethane Foams under Different Densities, Strain Rates and Different Environmental Conditions. Accepted for publication and will appear in: Proceedings of IMECE11 2011 ASME International Mechanical Engineering Congress & Exposition November 11-17, 2011, Denver, Colorado, USA
20. E. Y. Tanbour, "Institutional Effectiveness, The Point Of View Of Southern Association Of Colleges And Schools (SACS)," Presented in the conference of the Vice Rectors for Quality in Saudi Universities, King Saud University, February 27-28, 2011
21. Emad Y. Tanbour, Rafat Al-Waked and Mohamed F. Alzoubi, Experimental Study of a Waste Heat Recovery System for Supplemental Heater, *proceedings of 3rd International Conference on Energy and Sustainability*, 11 - 13 April 2011, Alicante, Spain
22. Ramin K. Rahmani, Anahita Ayasoufi, Emad Y. Tanbour and Hosein Molavi, "Enhancement of Temperature Blending in Convective Heat Transfer by Motionless Inserts With Variable Segment Length" *Journal of Thermal Science and Engineering Applications*, September 2010, Vol. 2
23. Ramin K. Rahmani, Emad Y. Tanbour, Anahita Ayasoufi and Hosein Molavi, "Enhancement of Convective Heat Transfer in Internal Compressible Flows by Stationary Inserts" *Journal of Thermal Science and Engineering Applications* MARCH 2010, Vol. 2
24. Emad Y. Tanbour, Ramin K. Rahmani and Anahita Ayasoufi (2009), "Large-Eddy Simulation of Turbulent Flow Through Small Gage Gas Appliance Orifice," *Proceedings of IMECE 2009, 2009 ASME International Mechanical Engineering and Exposition, November 13-19, 2009, Lake Buena Vista, Florida, USA*
25. Emad Y. Tanbour and Ramin K. Rahmani, (2009), "Enhancement of Temperature Blending in Convective Heat Transfer by Motionless Inserts with Variable Segment Length ," *Proceedings of IMECE 2009, 2009 ASME International Mechanical Engineering and Exposition, November 13-19, 2009, Lake Buena Vista, Florida, USA*

26. Emad Y. Tanbour and Ramin K. Rahmani, (2009), "A Numerical Study of The Thermal Performance of Two Stationary Insert Design in Internal Compressible Flow," *Proceedings of 2009 ASME Summer Heat Transfer Conference, HT2009, July 19-23, 2009, San Francisco, Ca, USA*
27. Emad Y. Tanbour and Ramin K. Rahmani, (2008), "Enhancement Of Natural Convection Heat Transfer Rate In Internal Compressible Flows By Inserting Stationary Inserts," *Proceedings of 2008 ASME Summer Heat Transfer Conference, HT2008, August 10-14, 2008, Jacksonville, Florida USA*
28. Emad Y. Tanbour and Ramin K. Rahmani, (2008), "Experimental Study Of Convective Heat Transfer In A Vertical Pipe With Stationary Inserts," *Proceedings of 2008 ASME Summer Heat Transfer Conference, HT2008, August 10-14, 2008, Jacksonville, Florida USA*
29. K. Abdel-Malek, J. Yang, R. Brand, M. Vannier, and E. Tanbour. Towards understanding the workspace of human limbs. *International Journal of Ergonomics*, Oct 22, 2004; 47(13): pp. 1386-1405
30. Butler, P. B., Tanbour, E., Rahman, S., and Smith, T. F., "Virtual International Design Teams," *Proceedings of 2002 ASME Midwest Section Meeting, Madison, WI, September 2002*
31. Abdel-Malek, K., Yang, J., Brand, R., and Tanbour, E., (2002), "Towards Understanding the Workspace of The Upper Extremities," 2001 SAE Transactions, *Journal of Passenger Cars: Mechanical Systems*, Vol. 110, Section 6, pages 2198-2206.
32. Mi, Z., Kim, J., and Abdel-Malek, K., Nebel, K., Tanbour, E., "Optimization Based Posture Prediction," *Seventh International Symposium on the 3-D Analysis of Human Movement*, Newcastle, United Kingdom, July 10 - 12 2002
33. Abdel-Malek, K., Yang, J., Brand, R., and Tanbour, E., "Towards Understanding the Workspace of the Upper Extremities," *Proceedings of SAE Digital Human Modeling for Design and Engineering*, 2001-01-2095, June 26-28, Arlington, VA, USA. [2001 Arch T. Colwell Merit Best Paper Award]
34. Abdel-Malek, K., Yu, W., Tanbour, E., Jaber, M., (2001), "Posture Prediction versus Inverse Kinematics," *Proceedings of the ASME 27th Design Automation Conference*, 2001 ASME Design Engineering Technical Conferences, Pittsburgh, Pennsylvania, U.S.A. September 9-12, 2001
35. K. Abdel-Malek, Y. Wei and E. Tanbour, "Inverse Kinematics using Cost Functions," *IASTED International Conference, Robotics and Manufacturing (RM 2001)*, Cancun, Mexico, May 2001
36. Tanbour, E. Y., and Ahmarow, M. E., "Design and Optimization of Fire-tube Boilers for Large Dairy Processing Plants," *Caroline Dairy Company, Amman, Jordan, Final Report*, ME Department, Yarmouk University, Irbid Jordan, 1987.
37. Tanbour, E. Y. and Ahmarow, M. E., "Design Calculations for Cooling Systems of Industrial Gas Turbines," *ME final Report*, Yarmouk University, Irbid, Jordan, 1987.
38. Tanbour, E. Y., "Pressure Distribution on Rotating Cylinders in Cross Flows," *ME final Report*, Graduation Project, ME department, Jordan University of Science and Technology, Irbid, Jordan, 1987.

39. Tanbour, E. Y., "Design and manufacturing of new pressure measurement mechanism on rotating bodies in cross flows," Final Report, ME Department, Jordan University of Science and Technologies, Irbid, Jordan, 1988.
40. Tanbour, E. Y., "Wind Energy in Jordan," Department of Energy, Jordan, and Jordan University of Science and Technology, Irbid, Jordan, 1989. Project was funded by United Nations
41. Tanbour, E. Y., "Heat Transfer to Gas-Solid Suspension Flows in Vertical Pipes," M.S. Thesis, Jordan University of Science and Technologies, Irbid, Jordan, 1990.
42. Tanbour, E. Y., "Modeling non-isothermal multiphase-multicomponent flow and transport in porous media using the two phase mixture approach," Ph.D. Thesis, The University of Iowa, Iowa City, Iowa, USA, 1997.
43. Tanbour, E. Y., "Modeling spillage from an open door gas fired fire place using ANSYS Flotran module," Final Report - HNI Corporation, Muscatine, Iowa, USA, 2001
44. Tanbour, E. Y., "CFD and Heat Transfer Simulation of flow in co-axial elbows with internal baffles. Application to venting of zero-clearance fireplace chimney pipes." Hearth and Home Inc., Lakeville, MN, USA, 2000
45. Tanbour, E. Y., Ryan B. and Smith, T., "*Development of a Waste Heat Recovery Heat Exchanger for Supplemental Heaters*," Technical Report ME-01-002, Department of Mechanical Engineering, The University of Iowa, Iowa City, Iowa, 52242, USA, Feb. 2001
46. Tanbour, E. Y., Hu, J. and Smith T., "*Waste Heat Recovery Heat Exchanger for Supplemental Heaters*," Technical Report ME-01-006, Department of Mechanical Engineering, The University of Iowa, Iowa City, Iowa, 52242, USA, July 2001
47. Tanbour, E. Y., Yu, X. and Smith, T., "*Literature Review of Flexible and Adaptive HVAC Distribution Systems for Office Buildings*," Technical Report ME-01-005, Department of Mechanical Engineering, The University of Iowa, Iowa City, Iowa, 52242, USA, July 2001
48. Tanbour, E. Y., "Prince M. Bin Fahd University, Strategic Plan for National Commission for Academic Accreditation and Assessment". August 2009
49. Tanbour, E. Y., "Prince M. Bin Fahd University, College of Engineering Strategic Plan for ABET Accreditation". August, 2009 to February 2011
50. Tanbour, E. Y., "Prince M. Bin Fahd University, College of Engineering Academic Catalog, Revision". August, 2009 continuing
51. Tanbour, E. Y., "Prince M. Bin Fahd University, Strategic Plan for (Sothern Association of Colleges and Schools) SACS Accreditation". August, 2009 continuing.
52. Tanbour, E. Y. (Joint author with Professor Jamal Nayfeh, Dean of College of Engineering)," Master of Science in Mechanical Engineering, Program Specifications, Courses Specification and Syllabi in compliance with National Commission for Academic Accreditation and Assessment (NCAAA). Prince M. Bin Fahd University, December 2011.

53. Tanbour, E. Y. (Joint author with Professor Jamal Nayfeh, Dean of College of Engineering),” Master of Science in Energy Systems Engineering, Program Specifications, Courses Specification and Syllabi in compliance with NCAAA. Prince M. Bin Fahd University, December 2011.
54. Tanbour, E. Y. (contributing author with Professor Jamal Nayfeh, Dean of College of Engineering),” Master of Science in Electrical Engineering, Program Specifications, Courses Specification and Syllabi in compliance with NCAAA. Prince M. Bin Fahd University, December 2011.

USA AND INTERNATIONAL PATENTS

Total 11+ issued and pending patents and a total of 17 prior arts and patents:

No.	US Patent Ref. Number	Patent Title
1	US 2019/0145507 A1	Slider-Crank Mechanism For Eliminating Side Forces
2	D607094	Air Intake For A Water Heater
3	US20090308332	Water Heater With Forced Draft Air Inlet
4	US20100065203	Sealable Water Heater Manifold Doors
5	D614680	Sight Glass And Frame
6	US20100101510	Water Heaters With Sealed Door Assembly
7	US20100154724	Water Heater Burner Tube And Door Assembly
8	8490580	Water Heaters With Sealed Door Assembly
9	US20100101508	Water Heaters With Sealed Door Assembly
10	US20130284118	Water Heaters With Sealed Door Assembly
11	US20100101509	Water Heaters With Sealed Door Assemblies
12	US20100101507	Water Heaters With Fuel Line And Door Assembly
13	8596226	Water Heater Burner Tube And Door Assembly
14	US20090084328	Water Heaters With Combustion Air Inlet
15	US20040011348	Apparatus And Method For Cooling A Surface Of A Fireplace
16	6848441	Apparatus And Method For Cooling A Surface Of A Fireplace
17	9,948,081	Asymmetric Aeolian Vibration Damper

COMPUTING AND CAD SKILLS

CAD: Advanced in: SolidWorks (2005-present), PRO/ENGINEER (CREO 1995-2005), PolyWorks (2016-Present). Working experience in AutoCAD, Inventor, Bentley and Revit.

SIMULATION: Advanced in: SolidWorks Simulation (SimulationWorks), Lab View (Core 1 and Core 2 certified, National Instruments® 2011), Unity 3D and Middle VR

FEA: ANSYS (1996-present), SimulationWorks (2005-present), Cosmos Works (2005-2009), PRO/MECHANICA (1997-2005)

CFD: ANSYS-FLOTTRAN (1997) and ANSYS (Fluent) (2003-present)

PROGRAMMING: FORTRAN Programming 1984-present

MICROSOFT: Microsoft Office (Word, Excel, Power Point, Outlook and Visio), Microsoft Project (1997-present)

MANAGEMENT: Product Data Management (PDM), PDM Works, Enterprise Software, production mainframe software, strategic planning and implementation.

MANAGERIAL FINANCE:

Advanced practical experience in financial analysis for project management and departmental budgeting and planning. Completed Advanced Financial Analysis Executive MBA course work with Professor John Spitzer, Senior Analyst-Board of Governors, Federal Reserve, at the University Of Iowa-Tippie School of Business.

LEARNING (LMS): Blackboard®, SMART Notebook for SMART interactive whiteboard, Banner (Academic ERP system)

Panopto® for online course development and delivery

Wiley Plus® by Wiley, McGraw-Hill Connect® and Pearson Mastering Engineering ®

CANVAS: 2016-present: self-trained-Using Canvas on all my online and in-class courses

OTHERS: Certified Training on FARO® Arm Laser Scanner (2016), 3DSTUDIO MAX, Maya and LaTeX® (introductory)

PROFESSIONAL ACTIVITIES AND CERTIFICATIONS

LICENSES AND OTHER TRAINING

- Engineer-in-Training State of Iowa, 1998
- Certificate of Completion: Failure Mode and Effect Analysis
- Apples and Oranges (Corporate Finance Training)

ACTIVE MEMBERSHIP

- Member of the founding body at Aramco Combustion Institute - Chapter, 2010-present
- Professional Member of the American Society of Metals (ASM), 2004-present.
- Member of Combustion Institute, 1998-present.
- Member of the American Society of Mechanical Engineers (ASME) 1992-present.

- Member of Jordan Society of Engineers, Mechanical Engineering, 1987-present.
- Member of the Pioneers' Committee, American Institute of Sustainable Science and Technology, UI Oakdale Research Campus, Iowa City, Iowa, 1999-present
- Member of the Advisory Board of the Digital Human Lab-Center for Computer Aided Design (CCAD), The University of Iowa, Iowa City, Iowa, 2000-present

CERTIFICATION

- OSHA Certified Safety Manager, 2001-present.
- First Aid Certified, American Red Cross 1999-present.
- CPR Certified, American Red Cross 1999-present.

HONORS & AWARDS

- Principal Investigator, Coherix® – Eastern Michigan University research grant award of \$368,000 (2023-2025)
- ***Ford Company Foundation Community Service Technology Grant***-Delivering design of the ambulance of the future for the Huron Valley Ambulance system-Eastern Michigan - \$50,000 Principal Investigator research grant with Eastern Michigan University School of Engineering
- ***Arch T. Colwell Merit Award***, Society of Automotive Engineers (SAE) USA: Author of best paper voted among over 3000 papers in the field of dynamics and ergonomics in the proceedings of SAE.
- ***Ph.D. Scholarship Award***, Jordan University of Science and Technology, 1992-1997.
- ***Teaching/Research assistantship***, 1990-1997 through M.Sc. and Ph.D. programs.
(This was concurrent with my Ph.D. Scholarship Award from Jordan University of Science and Technology)

ACADEMIC SERVICE ACTIVITIES

Eastern Michigan University, Mt. Pleasant, Michigan, USA

- Serving as Program Coordinator for Mechanical Engineering Technology, starting the fall of 2016 until Fall 2018
- Serving as Program Coordinator for Mechanical Engineering, starting the fall of 2017
- Serving as Program Coordinator for Master of Engineering Management, starting the fall of 2017
- Representing CET at the University Budget Council, Eastern Michigan University-Faculty Senate, 2-years Appointment (2016-2018) - Still serving as alternate member.
- Serving member of the SET Strategic Planning committee, 2016-2018 cycle
- Serving member SET Finance Committee, 2016-2018 cycle
- Serving member School of Engineering Personnel Committee (2018-present)
- Serving member College of Engineering and Technology Assessment Committee (2018-

- present)
- Serving member of Faculty Council, College of Engineering and Technology (2018-present)
- ABET coordinator for SE (Summer 2018-present)
- Chaired faculty search committee for Mechanical Engineering resulted in hiring Dr. Andrew Mansfield
- Served as member of search committee for Information Assurance

Central Michigan University, Mt. Pleasant, Michigan, USA

Served as Program Coordinator for MET starting the fall of 2015 - Summer 2016

Served as Member of the MET Assessment Committee

Served in the School of Engineering and Technology Graduate Committee September 2014 until present. In charge of developing the assessment plan for the MSE program. Presented the assessment plan to the CMU Assessment Council

Assisted SET in the preparation for ABET accreditation visit for the Mechanical Engineering Technology Program.

Conducted semester-long weekly training session on SolidWorks for Graduating Cohort of MET students (Spring 2014 and Spring 2016)

Conducted semester-long weekly training session on SolidWorks for MET and ME Sophomore students (Fall 2014)

Conducted Weekly training session on SolidWorks for CMU-Art Department Faculty and Students (Fall 2014)

Served in search committee resulted in hiring Dr. Oumar Barry and Dr. Ernur Karadogan for the MET program.

Prince M. Bin Fahd University, KSA

- 1) Department of Mechanical Engineering
 - Member of Curriculum Review Committee, 2009-2013
 - Member, Assessment Committee, 2009-2013.
- 2) College of Engineering
 - Member of College of Engineering Council, 2009-2013
- 3) University
 - Member of University Council, 2010-2013.
 - Member of Senior Management Board, 2009-2013.
 - Member of several University-wide committees in Quality, Accreditation, Internationalization and Research, 2009-2013
 - Director of Quality Center and Institutional Relations, 2010

- Member of Rector's advisory committee, 2010-2013

Department of Economic Development, State of Iowa, USA

- Co-Chair, Advanced Technology Board, 1999-2001

University of Iowa: Center for Computer Aided Design, Iowa City, Iowa, USA

- Member of the Advisory Board, 2001-present

ABET, Accreditation Board of Engineering and Technology, USA

- Industry Consultant, 2000-2005-Worked closely with Dr. George Peterson, ABET Emeritus President. Continuing to work with Dr. Peterson during his international accreditation activities.

Conferences and Processional Meetings

- Chair of "Practical Combustion" session of the Combustion Institute, George Washington University, Washington DC 1998
- Session Chair, Engineering Criteria 2000 workshop of ABET EC2000, Accreditation Board of Engineering and Technology, Newton, Iowa, Sept. 23-24, 2000 – This workshop was funded by Maytag Corporation.
- Keynote Speaker, Davinci Conference, Iowa Department of Economic Development, Des Moines, Iowa Feb 2001

Habitat for Humanity

- Volunteer Home Builder, Muscatine, Iowa 1998.

TALKS, SEMINARS AND PRESENTATIONS:

1. **Emad Tanbour**, The Faculty Forum Seminar on Sunday "Computer Aided Engineering," Sunday, December 20, 2009, Learning Resource Center Room, Prince M. Bin Fahd University, Al-Khobar, KSA
2. **Emad Tanbour**, Al-Zamil Company: Design of Quick-Connect floor-to-wall partition system for Saudi Aramco, 2011

3. **Emad Tanbour**, Design of Penstock and Sluice Gates Using SolidWorks and SolidWorks Simulation®, Presentation to Al-Kuhaimi Metal Industries, Special Projects Division, Second Industrial City, Dammam, KSA, Feb 5, 2011
4. **Emad Tanbour**, “Overview of Prince M. Bin Fahd University and an Update on Accreditation Projects,” A Short lecture presented to the Annual Meeting of Vice Rectors for Quality and Development in Saudi Universities, King Saud University, Riyadh, KSA, Feb, 27, 2011
5. **Emad Tanbour**, Eight introductory workshops on “Requirements of National Commission for Academic Accreditation and Assessment,” presented to Faculty of All departments at Prince M. Bin Fahd University during Spring 2010 and Fall, 2010/2011
6. Represented Prince M. Bin Fahd University (PMU) during the Summer Annual Conference of Accreditation Board of Engineering and Technology (ABET) during the Month of July 2011 in Washington DC, USA
7. Attended 20-hours Workshop on Business Planning at Saudi Aramco During the Month of October 2011
8. Represented PMU in the pre-applicant workshop for Southern Association of Colleges and Schools (SACS), held in Decatur, Georgia, USA, April 2010

HIGHLIGHTS OF DESIGN AND MANUFACTURING EXPERIENCE

Energy Systems Experience

- Over 19 years of experience managing cross-functional teams of product development engineering, serving residential energy efficient fireplaces, stoves, water heaters (Gas fired, wood fired and Electric).
- Development of new generation of FVIR (flammable vapor ignition resistant) Water Heaters.
- Experience in developing and manufacturing of Power-Vented residential water heaters and methods of improved combustion.
- Managed and implemented the production of the world first Ultra Low NOX residential water heater compliant to California, USA emission requirements.
- Managed and designed a high efficiency Combustion Water Heater. US DOE designated Energy Star ® water heater.
- Developed a patented combustion air diverting system for power vented residential water heaters. System is in production and successfully achieved cost effectiveness and performance improvement goals. System was recently qualified for the Department of Energy program of Energy Star designation for meeting high energy factor required for water heating equipment.
- Managed and implemented into production the Energy-Smart Gas® water heater. An intelligent gas water heater that utilizes control algorithms enabling water heaters to adapt to household hot water consumption pattern. This product is in production and is sold under Whirlpool Brand throughout North America.

- Designed and implemented into production a new manifold door and burner assemblies for sealed combustion flammable vapor resistant water heaters.
- Thermal Analyst, NASA Cassini Space Mission to Saturn, Physics Department, The Univ. of Iowa, Iowa City, Iowa (1993-1996)

Interdisciplinary Mechanical Engineering Experience:

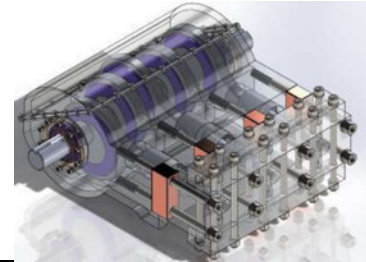
- Seating design, seating mechanism design, seating structural optimization, seating comfort and ergonomics applications in seating. Major seating projects: Allsteel #19 Chair ® (award winning signature product) and Allsteel Sum® Chair (award winning ergonomic signature office product).
- Storage systems design and sheet-metal applications in office storage systems. Alternative materials for office furniture.
- Office system design and development. Major projects: Allsteel Concensys®, Terrace 2.6, Reach and HON Initiate systems.
- Finite Element Analysis of seating, storage and office systems.
- Acoustics testing and optimization of office systems.
- Material development and inventiveness for green buildings of the future. A major project to utilize sustainable and renewable natural fiber to develop paneling alternative materials for construction applications. This panel system is in production since 2005.

SELECTED SENIOR CAPSTONE PROJECTS SUPERVISED

I have utilized my solid industrial background in senior design courses. The following are samples of students' designs:

Project title	Presentation
1. CMU- Morbark Corporation, Winn, MI, Design of Robotic Welding Fixture for Morbark Boxer Ride-on earth movement machines. Spring 2016	

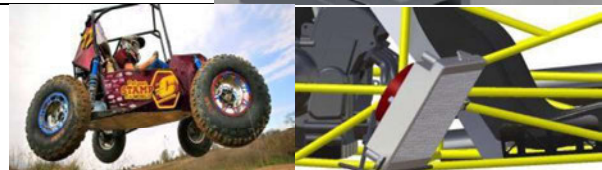
2. CMU- Gail Industries, Cedar Rapids, Iowa, Design and rapid prototyping of bearing-size-driven triplex plunger pump, Spring 2016



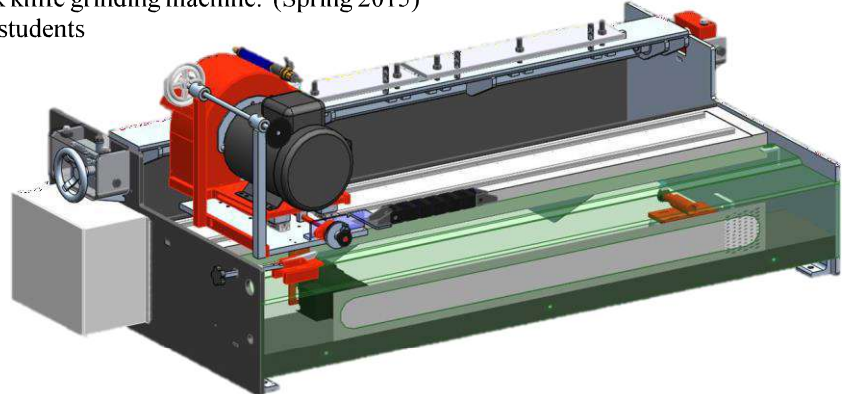
3. CMU- Vantage Plastics, Standish, MI, Design and testing of toggle mechanism clamping system for rotary thermoforming process, Spring 2016



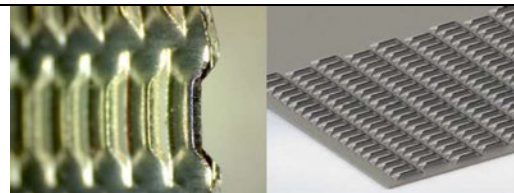
4. CMU- SAE Baja and SAE Formula team (co-advised with Oumar Barry), Spring 2016



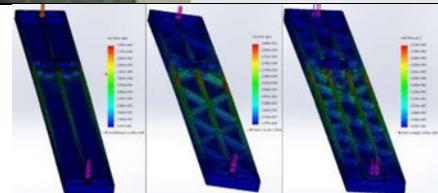
5. CMU - Redesign of Morbark knife grinding machine. (Spring 2015)
6 – Senior MET and IET senior students



6. CMU - Reverse Engineering of Flame Traps used in flammable vapor resistant water heaters – Sponsored by A. O. Smith – Milwaukee, WI (Spring 2015 – In progress)
5- MET and IET senior students

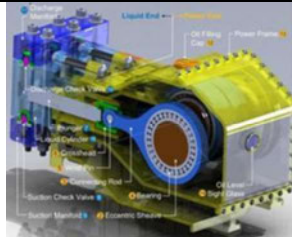
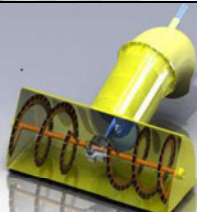
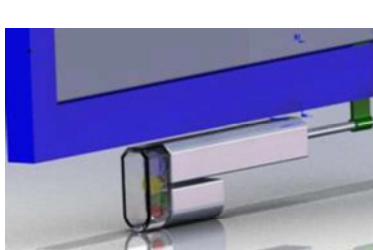


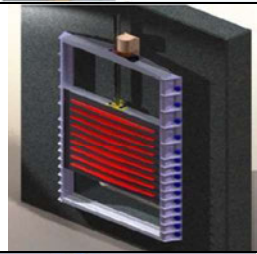
7. CMU - Converting machined steel office furniture components into die cast aluminum design and simulation of failure. Sponsored by Valley Design – Iowa (In progress)
2 MET senior students



8. CMU Baja Project: Redesign and building of new suspension system (Spring 2015 – In progress)
5 MET and IET senior students



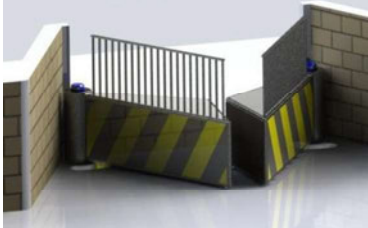
9. CMU Formula One Car: Redesign and manufacturing of the differential system for Formula One car. (Spring 2015 – In progress)	5- MET and IET senior students	
10. Design of High Pressure Triplex Pump, Spring 2010		
11. Design of a 30 KW Wind Turbine, Spring 2010		
12. Single Passenger Solar Car, Spring 2010		
13. Design of Highway Sand Scoop, Fall 2010		
14. Design of Rain/Dust storm-sensitive window, Fall 2010		
15. Design of Aluminum Can Crushing Mechanism for recycling beverage cans, Fall 2010		

16. Design of Solar Car II, Spring 2011 Objective: This is a continuation to Spring 2010 solar car project. Students to enhance suspension system of the solar car frame and to design a light weight body.	
17. Design of a 4m² Penstock-Dam Door, Spring 2011 Objective: Students to utilize fluid statics along with mechanical engineering design knowledge to design a remotely operated penstock dam-door (sluiceway). This project was aimed at using such gates to control flash flooding and prevent catastrophic cases repeated at the second largest city in the country (Jeddah)	
18. Design of a New Concept Wheelchair, Spring 2011 Objective: Students to design a new concept wheelchair where ratchet-driven wheels are replacing traditional wheel operated chairs. The project was led by one of senior students whose father is handicapped and received excellent sponsorship from a local manufacturer who is conducting feasibility studies on the design outcome.	
19. Design of a Date-Picking elevator, Spring 2011 Objective: Students to design an elevator to be used to harvest and serve palm trees in Al-Hasa oasis region (12 million palm trees). The aim is to expedite harvesting and improve safe handling of dates done manually most of the time. The elevator to be easy to operate using hydraulic actuators and maneuvered via farm tractors.	
20. Design of a Spiral Escalator, Spring 2011 Objective: Students to design and virtually prototype a spiral escalator system to be used in application where space is limited.	
21. Design of a Low Cost Hospital Bed, fall 2012: Students to design a low cost hospital be to be used in the field hospitals serving in disaster areas.	

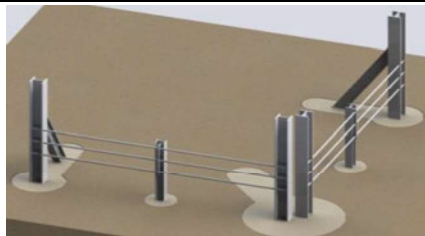
22. Design of a truck-mounted Date Harvesting Implement, fall 2012: Students to design implement that can be mounted on a flatbed truck to be used to harvest dates from palm trees.



23. Design of a road blocker, fall 2012: Students design a road blocker used to prevent unauthorized vehicles from entering high security areas.



24. Design of a Crash Resistant Fence, Fall 2012: Students designed a crash resistant fence according to US Department of State requirements to prevent crashing of hostile vehicles intruding into industrial, petrochemical and defense installations.



25. Characterization of drive belt tensioner for Ford Company. Team of four senior Mechanical engineering students.

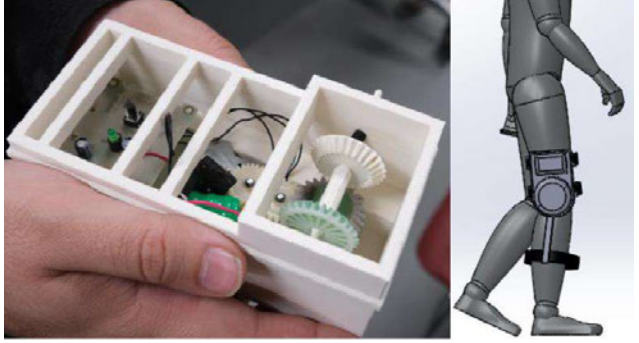
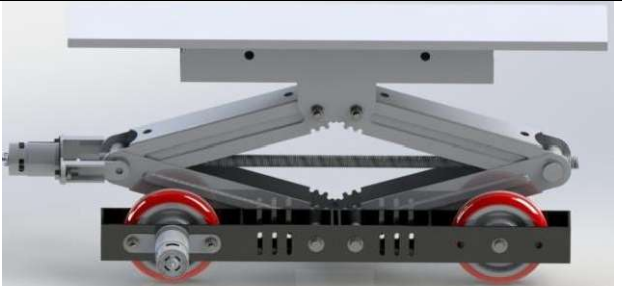


26. Design and build of a lifting walker. Team of four Mechanical Engineering Seniors.



27. Design and build of a drone mounted gutter cleaner. Team of three senior Mechanical Engineering students.



28. Design and build of a wearable charging system.	
29. Design and build of Under-Vehicle Parallel Parking System (UVPPI). Team of 4-Senior ME students.	
30. Design and build of a surf-wave generator mounted on a surf boat.	

ASSESSMENT & QUALITY IN HIGHER EDUCATION (HIGHLIGHTS):

- Served as member of the Graduate Committee of the School of Engineering and Technology, Central Michigan University (CMU) (2014-2016). I was in charge of developing the Assessment plan for the newly developed Master of Science in Engineering planned to start fall 2015.
- Served in the MET Assessment Committee at CMU which is focused on improving program level and course level assessment for the MET program as well as prepare for the readiness to ABET ETAC Commission accreditation
- Served for 5 Years in the State of Iowa, USA as industry consultant to ABET (Accreditation board of Engineering and Technology). Chaired training sessions on ABET criteria in the State of Iowa.

- Designed and implemented ABET readiness program for the college of engineering (Mechanical, civil and electrical engineering)
- Strong experience in outcome-based assessment, curriculum development and course/program specification to comply with accreditation standards.
- 4+ Years' experience leading strategic implementation of ABET, NCAAA and SACS compliance at Prince M. Bin Fahd University (PMU) (NCAAA is National Commission for Academic Accreditation & Assessment). Trained university-wide faculty and staff on NCAAA protocol. Developed strategic plans to comply with NCAAA and is leading the process to Quality and Accreditation at PMU
- Served as ABET Committee Chair for the Mechanical Engineering Program at Eastern Michigan University and secured full accreditation of the program 2019-2026.

DETAILED INDUSTRIAL EXPERIENCE

1. (1988-1989) **Technical Support Engineer**, Dar-Al-Riyadh Engineering, Dhahran. Conducted field-training sessions for customers on instrumentations and gas detection equipment. Held weekly seminars at customer locations on gas detection technology, maintenance and operation of various gas detection instruments. Collaborated with manufacturers of equipment to enhance, develop and troubleshoot gas detection equipment.
2. (1993-1997) **Director of Engineering**, Gail Industries, Cedar Rapids, Iowa, USA. Managed the engineering department of Gail Industries, a major manufacturer of light weight, energy efficient high-pressure triplex pumps. Implemented CAD introduction and applied CAM to three new generation high-pressure lightweight pumps. Top-down designed and managed the launch of Model 10000 and Model 20000 high-pressure triplex pumps for oil drilling applications. Designed a new-concept injection pump for the use in process applications. Designed and managed the manufacturing of 500hp mud pumps (Gail model 80) for the use in oil-well service applications and oil drilling industry in Bakersfield, California. Model 80 is a lightweight and high efficiency family of mud pumps designed for helicopter delivered pumps for offshore oil drilling applications.
3. (1997-2005) **Senior Project Manager (R&D)**, HNI Technologies, Stanley M. Howe Technical Center. Muscatine, Iowa, USA. Managing research and development projects for six company divisions (Allsteel[®], Hon Company[®], Gunlocke[®], Maxon[®], Quadra Fire[®], Heat-N-Glo[®] and Heatilator[®])
4. (2005-2009): **Manager, Product Development Engineering**, A. O. Smith Corporation, Johnson City, Tennessee, USA. A. O. Smith is the second largest manufacturer of residential and commercial high efficiency energy star[®] water heaters in North America with global

operations in USA, Mexico, Canada, Europe and China. I was managing the product development engineering department for residential water heater division. My department group is responsible for designing new water heaters and improvement/development projects for existing water heating technologies. The department is responsible for providing design and engineering leadership to 4.5 million residential water heating products produced annually across the globe. The group employs the state of the art experimental lab and cutting edge computational fluid dynamics and computational mechanics techniques. Computer Aided Design and CAM is fully deployed for all product platforms. Company produces energy star® water heaters for industry under the brand names of Whirlpool®, A. O. Smith®, State® and American Water Heaters® and other brands. A. O. Smith is a mid-cap blue chip company with annual revenue of over \$2.3 Billion

CAREER EXPERTISE AND SKILLS

<i>Technical</i>	<i>Industrial, Business & Management</i>
• Design and Product Development • Failure Mode and Effect Analysis (FMEA) • Engineering Change Request/Notice (ECN/ECR) • Sheet Metal Forming and Production Processes • Manufacturing Engineering • Finite Element Analysis: Structural and Thermal/Fluids applications. • Computational Fluid Dynamics • Virtual Reality Engineering Applications • Digital Human Modeling • Alternative materials/sustainability • Engineering Education • Computer Aided Design/Consumer Products • Engineering mechanics and materials • Industrial Applications of Thermo-fluids • Data and Decision (Statistical Analysis)	• Design and Manuf. Of Mud Pumps • Project Management • Managerial Financial Analysis • R&D Project Management • Strategic planning, Institution Building • New product end user research • Engineering-Marketing interfacing • Presentation/public speaking • Competitive strategies/cost effectiveness • Product launch and introduction • Business negotiation skills • Coaching/Mentoring and training • Organizational Behavior • Engineering/Business supervision • Managing product development cross-functional teams • GD&T ASME Y14.5-2009 revision

MAJOR CONSULTING EXPERIENCE:

1. Design of a fireproof hatch door for KSA (2022-2023): Project included 3D modeling of all hatch door components, subassemblies and thermal resistance parts. Simulation of fireproof testing and finite element analysis of the entire hatch door system as mounted. The project also delivered detailed manufacturing drawings and process development.
2. Energy and sustainability assessment of thermoforming machines, Vantage Plastics, Standish, MI,

Summer 2016

3. Design of Vibration Testing Platform for ISTA standards shipping testing, Vantage Plastics, Standish, MI, summer 2016
4. Design of heat transfer enhancement baffle system for EF models of high efficiency triple pass water heaters, Bradford White Corporation, Middleville, MI, summer 2016
5. Delivered short course (two-weekend days) in strategic planning for Oman Department of Dams (held in LA, CA, 2015)
6. (1993-1996) Thermal analyst, Cassini Spacecraft, NASA's Mission to Saturn, Jet Propulsion Lab and The University of Iowa Physics and Astronomy Department. Applied my Ph.D. thesis research code to simulate cooling of electronic components of Cassini Spacecraft. Won JPL's Award of outstanding thermal analysis application to electronic packaging. Cassini was launched in 1998. This is a three year consulting work conducting electronic packaging (cooling) of components under vacuum conditions for space applications. Theoretical and experimental approaches were utilized. This work spanned over three years during my Ph.D. study at the University of Iowa. While working as a consulting graduate engineer at the physics department. The work was funded by NASA to develop electronic controls for the CASSINI probe that was launched to Saturn in the late 1998. My responsibilities were in the area of thermal management of electronic controls under vacuum. I engineered experimental heat transfer (conduction and radiation) under vacuum conditions. I also utilized FORTRAN numerical code to simulate heat dissipation in electronic controls of CASSINI spacecraft.
7. 1994 Swirling Mixer Design, MiT-M Corporation, Peosta, IA, USA. This was a design and development of a swirling pre-mixer for oil-fired portable boilers that are used on pressure washing equipment. Flame stabilization mechanisms were optimized to provide customer needs.
8. 1998 Combustion Aerodynamics Design of Water Boilers for High Pressure Washers, MiT-M Corporation, Peosta, IA, USA. This was another design consultation for another MiT-M pressure washing system.
9. Several consulting services for Gail Industries (former employer) since 1997 in the areas of high-pressure triplex water pumps.
10. Structural analysis and failure diagnosis of aluminum extrusions for use in high-end office tables. The Gunlocke Company, New York , May-August 2005
11. CAD design of sheet metal and plastic components and assemblies of residential water heaters, using Solid Works®
12. Design and failure analysis of sluice gates for flood control applications, Kuhaimi Metal Industries, KSA, 2009-present.
13. Design of Channel type sluice gates for Dammam Port Authority and Water Treatment Plants, , Kuhaimi Metal Industries, Dammam, KSA 2009-present

14. Design, failure and frequency analysis of explosion-proof doors for petrochemical, defense and security applications, Kuhaimi Metal Industries, SPD-Division, Dammam, KSA 2010-present
15. Design and Implementation of Parametric CAD assemblies for Hollow-Metal doors and Specialty Doors, Kuhaimi Metal Industries, SPD-Division, Dammam, KSA August 2011-in progress. Most Notable design achievements are: Design of fire exit doors for Al-Haramain Railroad Line between Medina and Mecca, design of fire-rated doors for Riyadh Metro, design of swing gates for Aramco-Bgaig Water Treatment Plant, design of explosion-proof doors for petrochemical plants in Jubail, and design of crash resistance barriers for residential compounds.

INDUSTRY-ACADEMIA COLLABORATIVE ACHIEVEMENTS

1. Co-chair of Advanced Technology Board, Department of Economic Development, State of Iowa, USA. The board mission is to deploy mechanisms and establish clusters of collaboration within the State of Iowa manufacturers to enable advanced technologies utilization. Board leadership constitutes of representatives from major Iowa industry and research and development institutions. The outcome of the Board efforts was translated into many successful establishments of rapid prototyping clusters within the state. These clusters were operated by major Iowa industry players but were made available to all regional manufacturers. Board has also succeeded in leading regular advanced manufacturing training programs with the state that targeted industry leadership to deploy state of the art manufacturing and process techniques. The outcome of these programs was translated into collaborative efforts between major industry players to disseminate the know-how of Rapid Continuous Improvement (RCI) process. RCI is a version of the TOYOTA production system tailored for small to medium manufacturers that is solely based on Lean Manufacturing principles. The Board provided leadership and strategic planning services to industry clusters and established metrics to measure the progress of each initiative within the state.
2. Leading the research and development efforts at HNI Corporation in the areas related to Virtual Reality (VR) Simulation and Ergonomic Design of Consumer Products/Office Furniture. VR Projects were collaborated with the Digital Human Modeling Lab at the University of Iowa (2001-2005)
3. Collaborative research in the area of energy optimization of hearth systems (fireplaces and stoves) was conducted with Iowa Energy Center, Ankeny, Iowa (1999-2000)
4. Lead Engineer, Program for Enhanced Design Experience (PEDE), a collaboration program between HNI Corporation and The University of Iowa College of Engineering Senior Design Projects. (1998-2002)
5. Leading research projects at HNI Corporation related to personal climate control in office spaces and systems. Lead engineer from HNI Corporation in the Virtual International Design (VID) program collaborated between HNI Corporation, The University of Iowa and IUSTI – France (1999-2001)
6. Several lead engineer role in University-Industry initiatives and undergraduate senior design projects (1997-2005)

7. Project Manager of Allsteel Virtual Reality Facility (2001-2003). Allsteel, a division of HNI Corporation, Collaborated with The University of Iowa Center for Computer Aided Design to build the industry first virtual reality facility. The facility is used for visualization applications for product development and for marketing purposes.
8. Delivered a 40 hrs. Intermediate SolidWorks® training program for 15 engineers in Industrial City 1 – Dammam, KSA, March 2012
9. Delivered a 32 hrs. Advanced SolidWorks® training program for 15 engineers in Industrial City 1 – Dammam, KSA, April 2012
10. During spring 2015 Supervising three industry-sponsored Capstone Design Projects for undergraduate students in Mechanical Engineering Technology.
 - a. Redesign of a knife grinding machine for Morbark (Michigan)
 - b. Converting machined steel office furniture components into lower cost die cast aluminum design in compliance with BIFMA standards
 - c. Reverse Engineering and frequency analysis of flame traps used in Flammable Vapor Ignition Resistant gas-fired water heaters.
11. Virtual Reality Design and Optimization of the Ambulance Patient Compartment. A Ford Motor Company sponsored project in collaboration with Huron Valley ambulance organization - Ann Arbor Michigan, July 2017 – August 31, 2018 (\$50,000 equipment funding)
12. Developed collaborative research relationship with EMU School of Nursing. Currently (2020) pursuing funding to develop EMU 1st Virtual Patient Room for School of Nursing teaching and research application. Proposal was jointly submitted with College of Nursing faculty Dr. Meriam Caboral-Stevens.

RECENT AND PAST R&D PROJECTS AND RESEARCH INTERESTS (1997-present)

1. Enhancing 3D computer vision and laser sensing and scanning applications and assessment utilizing VR visualization of industrial robotics adhesive dispensing systems – 2022
2. Free Vibration of Flame Arrestors: A theoretical and numerical study of perforated plate flame arrestors used in domestic appliance to enable flammable vapor ignition resistance (FVIR). This research resulted in one journal publication submitted in Sept 2015 and one more journal publication expected to be submitted in October 2015 where the square pattern of perforation is examined. An indirect goal of this research is to enhance interdisciplinary Mechanical Engineering collaborative research between thermal fluids and Engineering Mechanics within the SET faculty.
3. Integrating Unity #D game development software with Middle VR virtual reality content development software in a multiwall VR environment. This is an on-going effort in the VR lab at SET and currently employs three undergraduate students who are conducting system integration under the supervision of Dr. Emad Tanbour.

4. Enhancement of Machine Design teaching for MET seniors using project-based learning. This effort started in the spring of 2014 and continues to be utilized in teaching IET 454, the machine design course for MET seniors. The research is planned to be published in the upcoming ASEE 123rd annual conference in New Orleans, LA, USA, in 2016
5. Mechanism Designs for Seating Products: This project was conducted during my past industry experience at HNI Technical Center. The research was aimed at developing highly featured alternative chair mechanisms made of die-cast aluminum alloy. Finite element analysis and CAD using Pro-Engineer was used to develop the optimal chair mechanism. Mechanism provided features to allow ergonomic adjustment of the office chair for height, back tilt, seat tilt and slide and an innovative mechanism to adjust lumbar support in the back. The mechanism is based on user-weight activation principle developed at HNI and utilized in family of high-end office chairs.
6. Large-scale deformation modeling of irregular shaped cast aluminum parts. ANSYS® commercial finite element analysis software was utilized to predict failure and optimize components of office and storage mechanisms and platforms.
7. Computational modeling of fluid flow and heat transfer in 3D complex passages and applications to fireplace venting. FLOTTRAN module of ANSYS software was used to predict flow and heat transfer in co-axial vent pipe and vent connections of stoves and fireplaces. Experimental measurements were used to validate modeling. This project developed a baffled co-axial vent elbow for direct-vented fireplaces that meets building standards for zero-clearance construction requirements.
8. Waste heat recovery from supplemental heating system. This project was sponsored in part by the Iowa Energy Center, Energy Research Station in Ankeny, Iowa.
9. Design, prototyping and testing of cross-flow compact heat exchangers for waste heat recovery from gas-fired fireplaces. This research developed a finned-tube heat exchanger that recovers waste heat from residential heating devices such as gas fired fireplaces and stoves. The recovery heat exchanger reduces flue temperature and allows the utilization of PVC/CPVC as venting pipe material.
10. Heat transfer and fluid flow in co-axial fireplace chimney pipes. Experimental work that was conducted in the HNI heart lab in Muscatine, Iowa. The work was aimed at characterizing flow and heat transfer in co-axial vent pipes for direct vent fireplaces and stoves. This experimental testing utilized the state-of-art data acquisition software and hardware to develop minimum and maximum vent lengths. Wind effect on direct-vented stoves was also studied and venting guidelines were established and used for agency certification and product literature development.
11. Optimal design of insulated flue pipes for fireplaces and stoves. Ceramic fiber blanket material was utilized to provide insulation for vent pipes.
12. The use of recycled engineered plastic to replace aluminum components for office systems

applications. Connectors traditionally used for office cubical walls were replaced by plastic components that were extruded from recycled materials. The project aimed at cost reduction that achieved \$4 million annual savings during my industrial experience at HNI in Iowa.

13. Design and manufacturing of integrated mobile data acquisition systems for industrial hearth systems testing and applications. Data acquisition kiosks that houses hardware to enable large number of data logging channels and equipped with PC were manufactured for HNI hearth divisions Heatilator® and Heat-N-Glo®. These kiosks were used in agency certification labs and production lines to test fireplaces and stoves in real installation simulations.
14. Numerous FEA studies and applications to optimize the design of various industrial mechanical components. During my work at HNI (1997-2005), I led numerous finite element analyses of components used in office systems and hearth products. These simulations treated stress analysis due to mechanical loading and thermal effects. This represented a day-to-day design support activity and hundreds of FEA cases were completed annually.
15. CFD and heat transfer field applications for office environment
16. Virtual Reality (VR) Simulation and applications to ergonomic design of office furniture. This project was in collaboration with the University of Iowa Center for computer Aided Design (CCAD). The technology of virtual reality was utilized for product development visualization as well as for marketing purposes. The outcome of this project was a joint effort that built two VR facilities, one at HNI and one at CCAD. Each VR facility provided a 3-wall environment that enabled immersive VR experience. Work included developing stereoscopic CAD models of office equipment that was VR enabled and animated in these VR facilities. The HNI facility is still used to date as a product development and visualization tool and a powerful marketing demonstration tool for showing future products to major customers. Photo-realistic and high fidelity renderings enabled the company to show future products to customers before going into production. The University of Iowa facility was used as a seed to attract funding for VR research. This seed attracted a multimillion (\$17million) grant that was awarded to CCAD over 5 years. The VR facility at the CCAD now houses the world first 6-wall PC-based VR environment.
17. Digital Human Modeling for ergonomic studies. This effort was in collaboration with the University of Iowa and HNI Technical Center. Digital human modeling was utilized to optimize workplace ergonomics and VR technology was used to visualize designs.
18. Thermal and acoustical simulation of comfort in office spaces. Thermal comfort experimental studies were conducted on HNI cubical workplaces. The testing was conducted by engineering interns from the University of Iowa College of engineering inside the university offices. Acoustical testing of noise propagation inside cubical office systems was conducted inside the labs of HNI Technical Center.
19. Finite Element Analysis of hydrostatically pressurized water heater tanks. This work is aimed at simulation of pressurization of water heater tanks to meet ANSI requirements on one hand and to

optimize vessel wall thickness achieving cost reduction on the other hand.

20. Fatigue analysis of pulsation loaded water heater tanks. This work utilized Solidworks® COSMOS® FEA module to conduct fatigue analysis of water heater tanks. Water heater tanks experience pressure spikes due to water hammering and the use of other household devices that generate sudden pressure waves. This study provided in-depth analysis and characterization of the behavior of water heater tanks under cyclic loading. The outcome was implemented to predict reliability and to establish life expectancy of water heaters for warrantee purposes.
21. CAD design of sheet metal and plastic components and assemblies of residential water heaters, using Solid Works®
22. Design and failure analysis of sluice gates for flood control applications, Kuhaimi Metal Industries, KSA, 2009-present.
23. Design of Channel type sluice gates for Dammam Port Authority and Water Treatment Plants, , Kuhaimi Metal Industries, Dammam, KSA 2009-present
24. Design, failure and frequency analysis of explosion-proof doors for petrochemical, defense and security applications, Kuhaimi Metal Industries, SPD-Division, Dammam, KSA 2010-present
25. Design and FEA analysis of Crash Rated Fence (CRF) for Saudi Aramco, Kuhaimi Metal Industries, SPD-Division, Dammam, KSA 2011-present
26. Design and FEA analysis of Road Blockers, Kuhaimi Metal Industries, SPD-Division, Dammam, KSA 2011-present

REFERENCES

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2. Dr. Oumar Barry, Assistant Professor of Mechanical Engineering, Virginia Tech, 145 Durham Hall – 0710, 1145 Perry Street, Blacksburg, VA 24061, obarry@vt.edu
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5. Ramin Rahmani, Ph.D., Research Engineer at Char-Broil, rkrahmani@yahoo.com, 419-410-6478
6. Cameron LaCourt (former student), Design Release Engineer – Instrument Panel – Full Size Trucks & SUVs, phone: 586-980-1021, email: cameron.lacourt@gm.com

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Office Phone: (571) 533-3581

APPENDIX B

APPENDIX B: ‘745 PATENT NEXUS CLAIM CHART

The MicroFridge Combination Units that utilize power-switching technology, USB ports, an internal smoke sensor in the microwave, and reset functionality include the following model numbers:

2.3MF4-7B1, 2.3MF4-7B1S, 2.3MF4-7D1, 2.3MF4-7D1S, 2.3MF4-7D1W, 2.5MF4E-7B1, 2.5MF4E-7D1, 2.5MF4E-7D1, 2.6SM4-7A1, 3.0LMF4-7D1W, 3.0MF4-7D1X, 3.0RMF4-7D1W, 3.0RMF4H-7D1, 3.0RMF4H-7D1W, 3.1MF4-7D1, 3.1MF4-7D1S, 3.1MF4-7D1SX, 3.1MF4-7D1X, 3.1MF7-7A1X, 3.1MF7-7B1, 3.1MF7-7B1S, 3.1MF7-7B1SX, 3.1MF7-7B1W, 3.1MF7-7B1X, 3.1MF7-7D1, 3.1MF7-7D1S, 3.1MF7-7D1SX, 3.1MF7-7D1X, 3.1MF7-7D1X-PS, 3.1SM6-7A1, 3.1SM6-7A1X, 3.1SM6-7A1X-WG, 3.2SM4A-7A1, 3.3SM4-7A1, 3.6MF4A-7D1, 3.6MF4A-7D1S, 3.6MF4A-7D1W, 4.5MF1-7B1X, 4.5MF1-7D1, 4.5MF1-7D1X, 4.8MF4-7B1X, 4.8MF4-7D1, 4.8MF4-7D1WX, 4.8MF4-7D1X, 4.8MF4-9B1WX, 4.8MF4-9B1WX, 4.8MF4-9D1WX, 4.8MF4-9D1X, 4.8RMF4-7D1W, 10.1MF1-9B1X, 10.1MF1-9D1X, 10.1MF1-9D1X, 10.3LMF4-9B1X, 10.3LMF4-9D1, 10.3LMF4-9D1WX, 10.3LMF4-9D1X, 10.3RMF4-9D1, 10.3RMF4-9D1WX, 10.3RMF4-9D1X, MFM-7B1, MFM-7B1S, MFM-7B1W, MFM-7D1, MFM-7D1-PS, MFM-7D1S, MFM-7D1W, MFM-9B1, MFM-9D1, MFM-9D1W.

Ex. 2004 (Declaration of Jared Amy), ¶ 2; Ex. 2035 (Declaration of Gary Hand), ¶ 2. The documents cited below refer to different model numbers of the MicroFridge, but their descriptions and depictions of the technology are applicable to all the MicroFridge model numbers listed above. For that reason, I refer generally to the “MicroFridge” in the descriptions below.

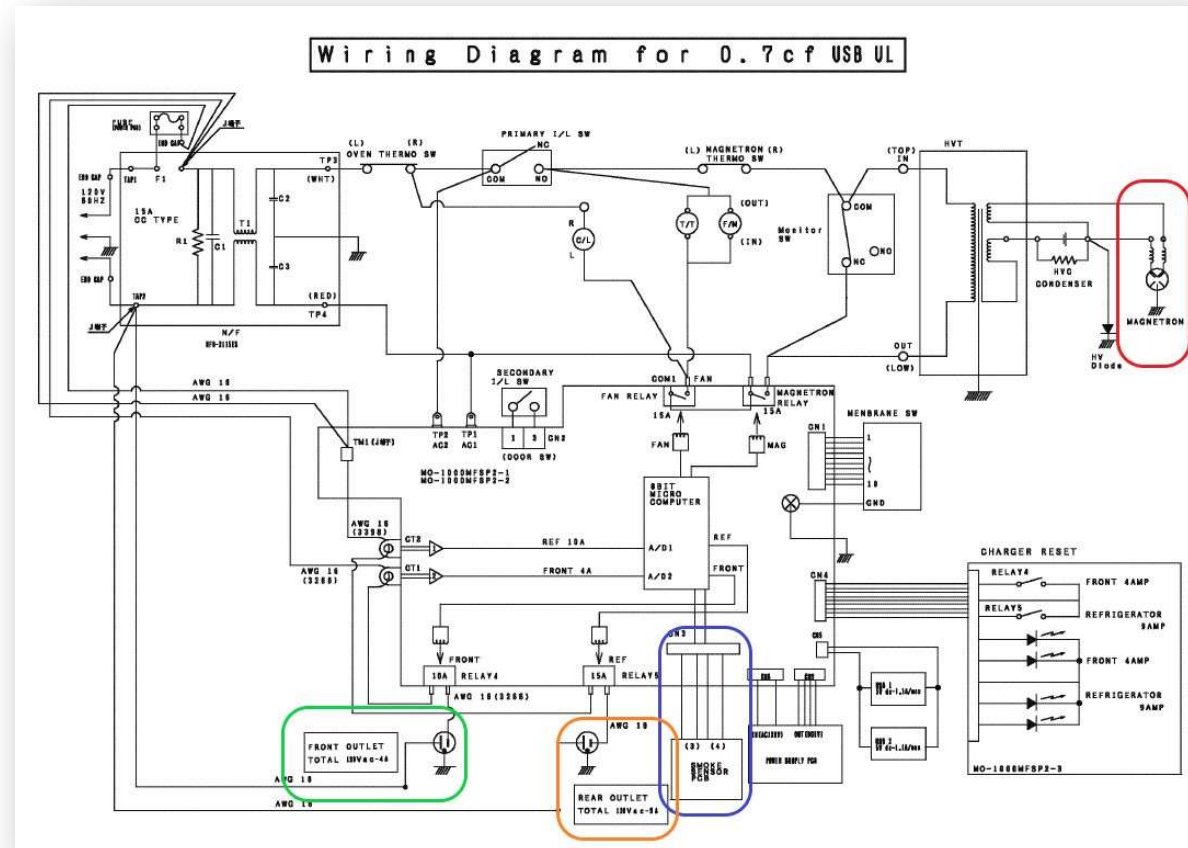
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
1. Apparatus comprising: an appliance including a microwave oven,	The MicroFridge is an appliance including a microwave oven. Ex. 2005 (MF004429 at 1).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a refrigerator,	The image shows a black, compact refrigerator with a microwave oven mounted on top. A red circular badge with the word 'NEW' is positioned to the left of the unit. Another red circular badge at the bottom right of the unit states 'Highest Energy Efficiency Available' with '100 kWh' written below it. The background is a gradient from blue at the top to white at the bottom. The MicroFridge is an appliance including a refrigerator. Ex. 2005 (MF004429 at 1).

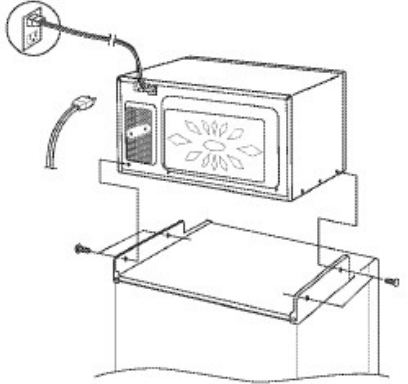
**Claim of U.S. Patent
No. 11,674,745 C5**

at least one power control circuit, wherein the at least one power control circuit is in operative electrical connection with the microwave oven and the refrigerator,

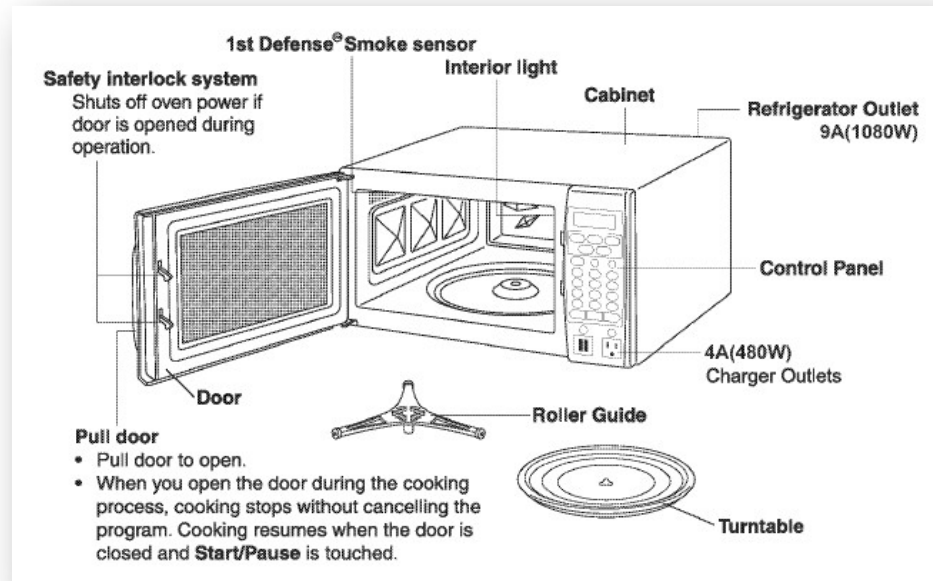
MicroFridge Products



The MicroFridge contains a power control circuit that is in operative connection with the microwave oven (marked in red) and the refrigerator (marked in orange). Ex. 2007 (MF015179 at 11).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a single power cord, wherein the single power cord is configured to be releasably connected to a source of electrical power, wherein the at least one power control circuit is supplied with electrical power only through the single power cord,	 Safe Plug™ Technology Provides protection against circuit overloads for user safety and convenience. Blue plug on refrigerator plugs into back of microwave for energy efficient one-plug to the wall operation.  MicroFridge® with Safe Plug® Assembly Diagram. The MicroFridge has a single power cord that can be releasably connected to a source of electrical power and which supplies power to at least one power control circuit through that single power cord. Ex. 2005 (MF004429 at 2); Ex. 2006 (MF003462 at 6).
wherein the at least one power control circuit is operative to cause electrical power to be withheld from at least one component of the refrigerator when a magnetron of the	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current.

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
microwave oven draws cooking power, and	The owner's manual for the MicroFridge 3.1MF7-7B1 describes how the power control circuitry within the microwave "works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use." Ex. 2006 (MF003462 at 4).
electrical power to be delivered to the refrigerator when the magnetron does not draw cooking power,	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. The owner's manual for the MicroFridge 3.1MF7-7B1 describes how "power to the refrigerator and microwave resumes" once the microwave is finished drawing cooking power. Ex. 2006 (MF003462 at 4).
wherein the microwave oven includes a smoke sensor,	



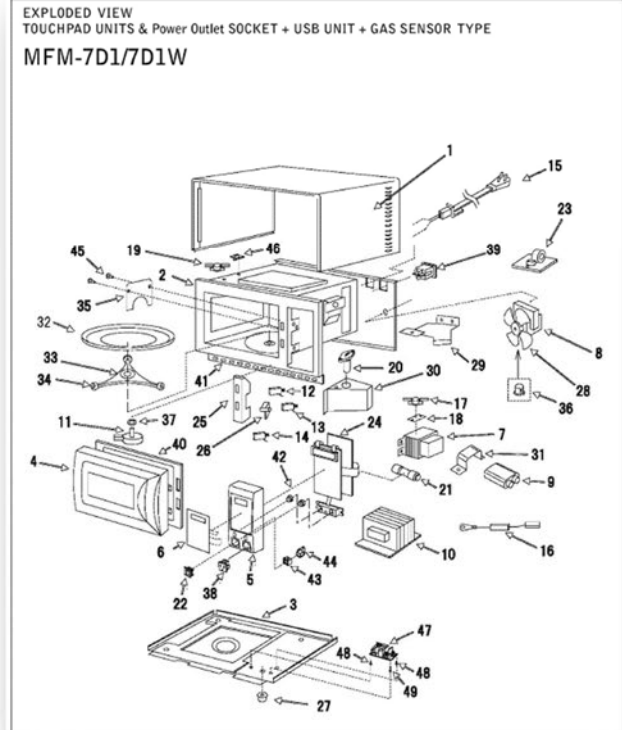
The MicroFridge has a microwave oven that includes a smoke sensor. Ex. 2005 (MF004429 at 2.); Ex. 2030 (MF003487); Ex. 2006 (MF003462 at 7).

**Claim of U.S. Patent
No. 11,674,745 C5**

MicroFridge Products

wherein the smoke sensor is positioned in operative connection with a cooking area inside the microwave oven,

On the left side of outer cavity

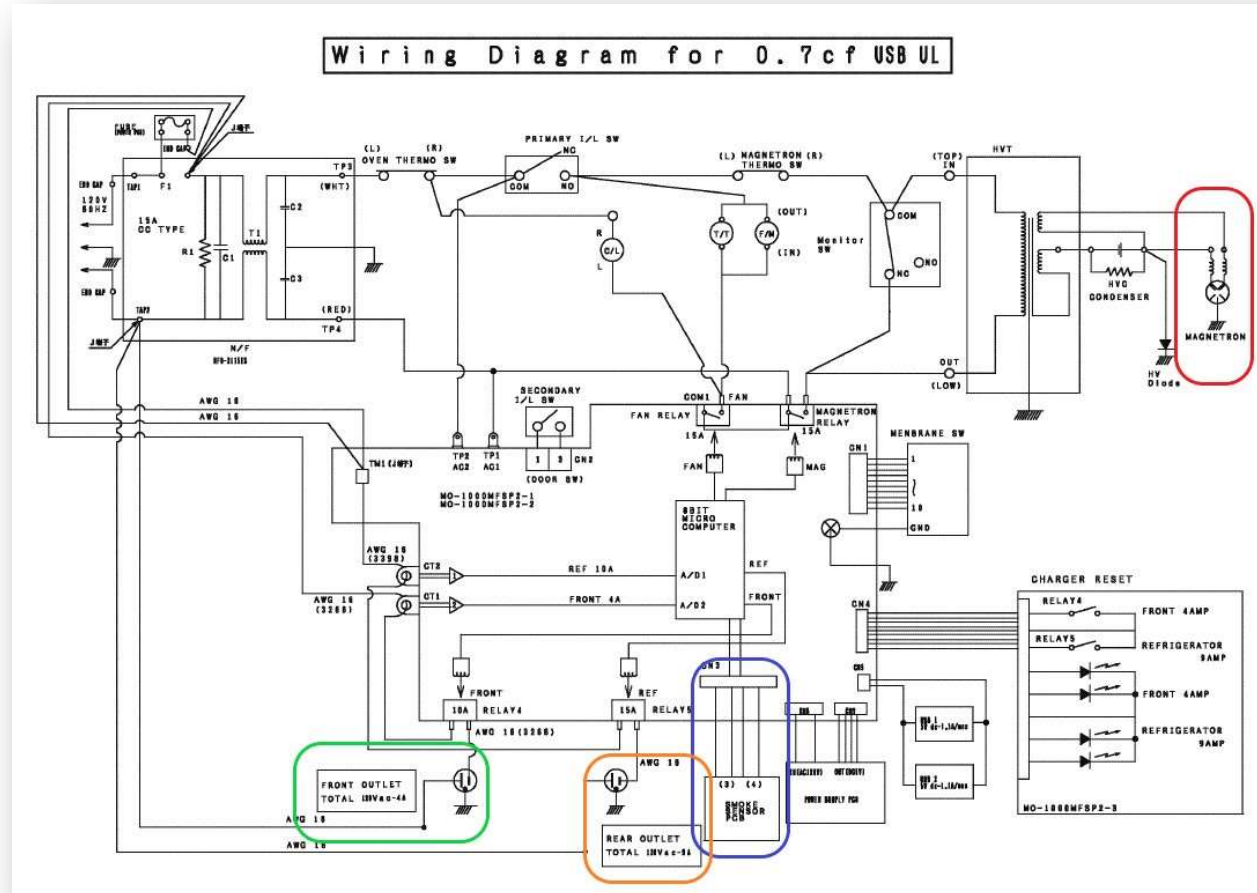


The smoke sensor is positioned in operative connection with the cooking area (i.e., the cooking cavity) inside the microwave oven. Ex. 2030 (MF003487). The smoke sensor is denoted in the exploded view diagram above with the number 46. Ex. 2007 (MF015179 at 12).

**Claim of U.S. Patent
No. 11,674,745 C5**

is in operative
connection with the at
least one power
control circuit,

MicroFridge Products



The circuit diagram above shows the smoke sensor (marked in blue) in operative connection with at least one power control circuit. Ex. 2007 (MF015179 at 11).

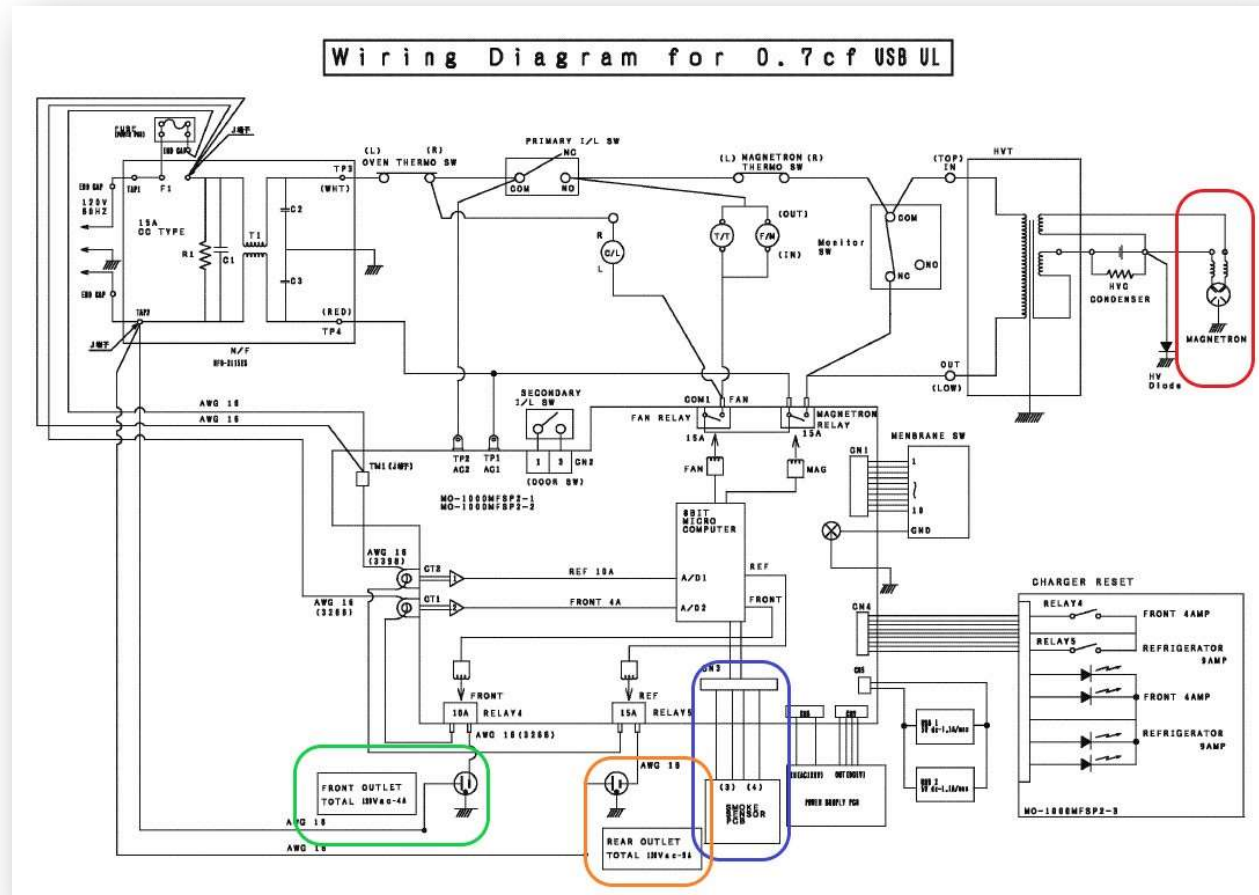
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,	1ST DEFENSE SMOKE SENSOR This microwave oven is equipped with a patent-pending, built in 1st Defense™ Smoke Sensor to automatically shut off the oven before a cavity fire can occur. Should the oven shut off due to excessive smoke the display will show "Err1" and the oven will beep 3 times. The MicroFridge utilizes a smoke sensor combined with a power control circuit that is operative to withdraw cooking power from the magnetron (i.e., shut off the oven) due to a level of excessive smoke prior to the set end time of the cooking session. Ex. 2007 (MF015179 at 10); Ex. 2035, ¶ 5.
wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one power control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session.	To re-start the oven with another food item touch the Clear / Off pad, insert the food item into the oven and close the door. Select the desired cooking program for the new food item and touch the Start / Pause pad. Should the oven immediately shut off, display "Err1" and beep 3 times. Open the oven door to allow the smoke from the previous cooking session to clear before attempting to re-start the oven. After an automatic shut off causes the cooking session to end prior to set end time due to excessive smoke, the power control circuit in the MicroFridge will be operative to allow the magnetron to receive cooking power in the next subsequent cooking session as indicated above. Ex. 2007 (MF015179 at 10); Ex. 2035, ¶ 6.

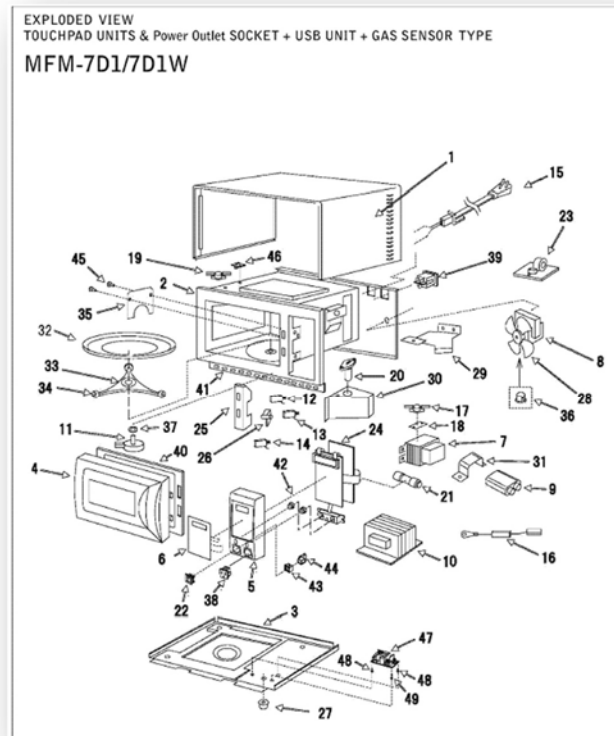
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
12. The apparatus according to claim 1	See discussion above regarding claim 1.
wherein the microwave oven includes a USB port,	NEW USB Charging Station 4 AMPS MAX FRONT 9 AMPS MAX REAR Next generation charging station offers two USB ports and one traditional outlet to conveniently charge small electric devices. The MicroFridge has a microwave oven that includes a USB port. Ex. 2005 (MF004429 at 2).

**Claim of U.S. Patent
No. 11,674,745 C5**

wherein the USB port
is in operative
connection with the at
least one power
control circuit,

MicroFridge Products





The MicroFridge contains a power control circuit that is in operative connection with a USB port in the front outlet (marked in green). Ex. 2007 (MF015179 at 11.) The USB port on the front outlet is denoted in the exploded view diagram above with the number 22. Ex. 2007 (MF015179 at 12).

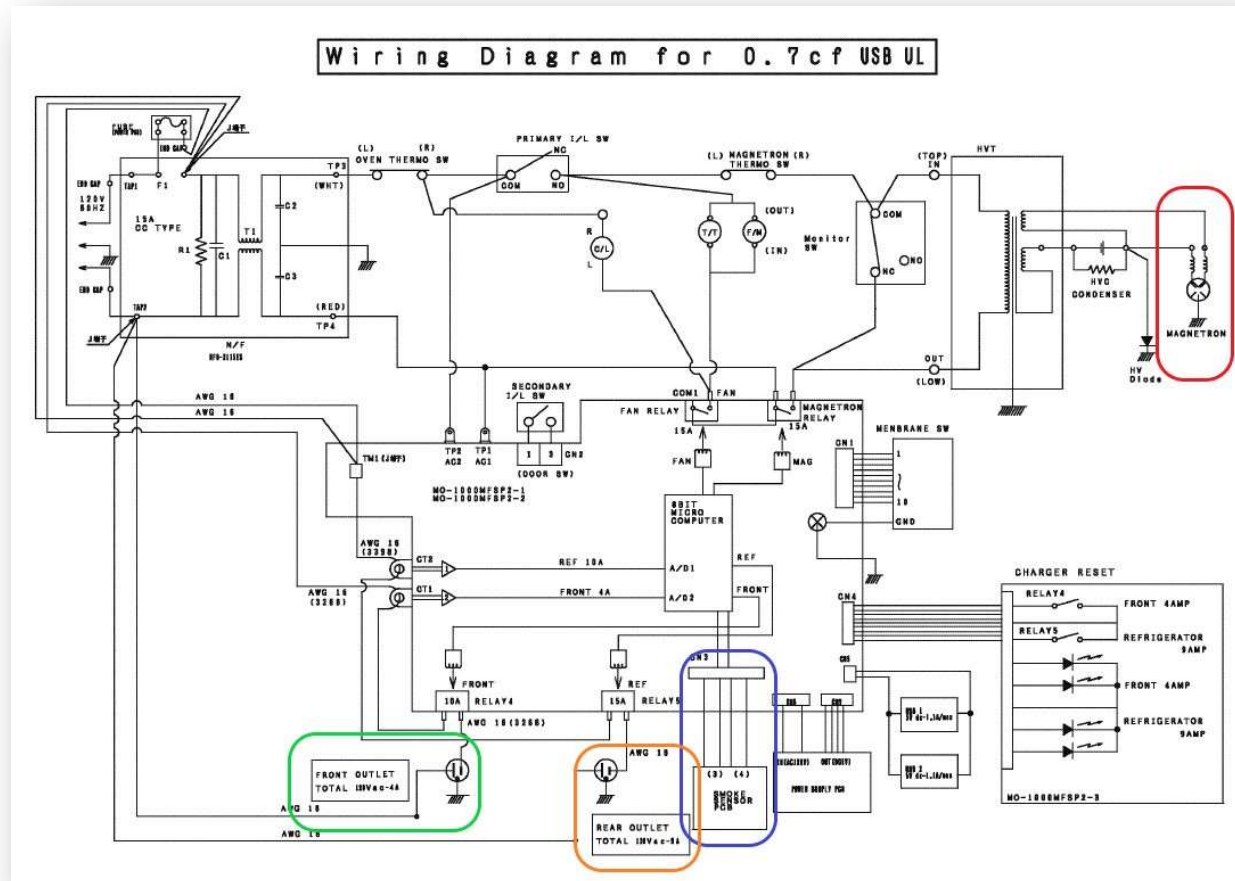
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products								
wherein the USB port is not operative to deliver electrical power from the USB port when the magnetron draws cooking power.	Power scenario #1: Turning the microwave on will route power to the microwave and shut off all other components so that the total amp draw is not over 15amps. <table> <tr> <td>Microwave =</td> <td>power supply FULL</td> </tr> <tr> <td>One Rear outlet, 120V 14A max =</td> <td>power supply OFF</td> </tr> <tr> <td>One Front outlet, 120V 12A max =</td> <td>power supply OFF</td> </tr> <tr> <td>two USB ports are 5VDC, 5A =</td> <td>power supply OFF</td> </tr> </table> NOTE: The MicroFridge® with Safe Plug® brand refrigerator and charging outlets will not operate when the microwave oven is on. This is part of the patent-pending MicroFridge® with Safe Plug® technology that prevents wiring overload. If your oven does not operate properly, unplug it from the 120 volt household outlet and then plug it back in. This unit is not designed for 50Hz or any circuit other than 120 volt/60Hz AC current. The power logic for the MicroFridge describes how turning the microwave on, which involves the magnetron drawing cooking power, will cause the power supply to the USB ports to be turned off. Ex. 2031 (MF006004). The MicroFridge instruction manual makes clear that the “charging outlets will not operate when the microwave oven is on.” Ex. 2006 (MF003462 at 5).	Microwave =	power supply FULL	One Rear outlet, 120V 14A max =	power supply OFF	One Front outlet, 120V 12A max =	power supply OFF	two USB ports are 5VDC, 5A =	power supply OFF
Microwave =	power supply FULL								
One Rear outlet, 120V 14A max =	power supply OFF								
One Front outlet, 120V 12A max =	power supply OFF								
two USB ports are 5VDC, 5A =	power supply OFF								
14. The apparatus according to claim 1	See discussion above regarding claim 1.								

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein the microwave oven includes a USB port,	The MicroFridge has a microwave oven that includes a USB port. Ex. 2005 (MF004429 at 2).

**Claim of U.S. Patent
No. 11,674,745 C5**

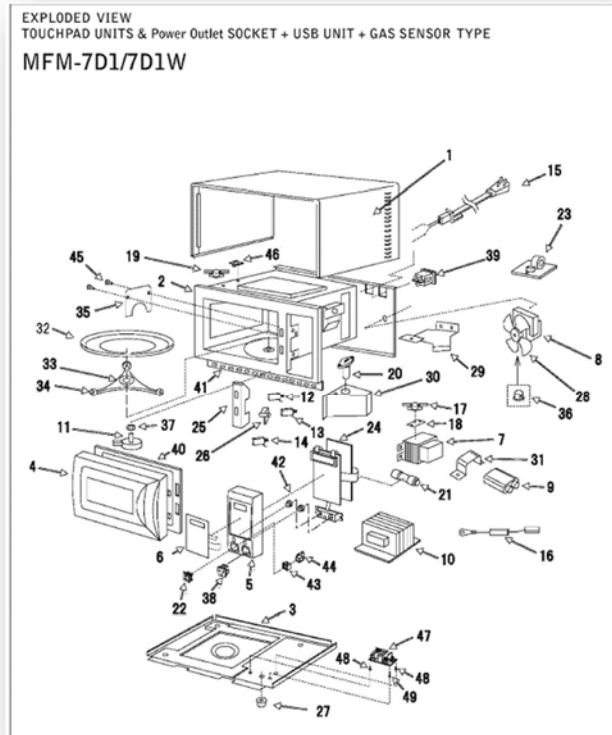
wherein the USB port is in operative connection with the at least one power control circuit,

MicroFridge Products



**Claim of U.S. Patent
No. 11,674,745 C5**

MicroFridge Products



The MicroFridge contains a power control circuit that is in operative connection with a USB port in the front outlet (marked in green). Ex. 2007 (MF015179 at 11.) The USB port on the front outlet is denoted in the exploded view diagram above with the number 22. Ex. 2007 (MF015179 at 12).

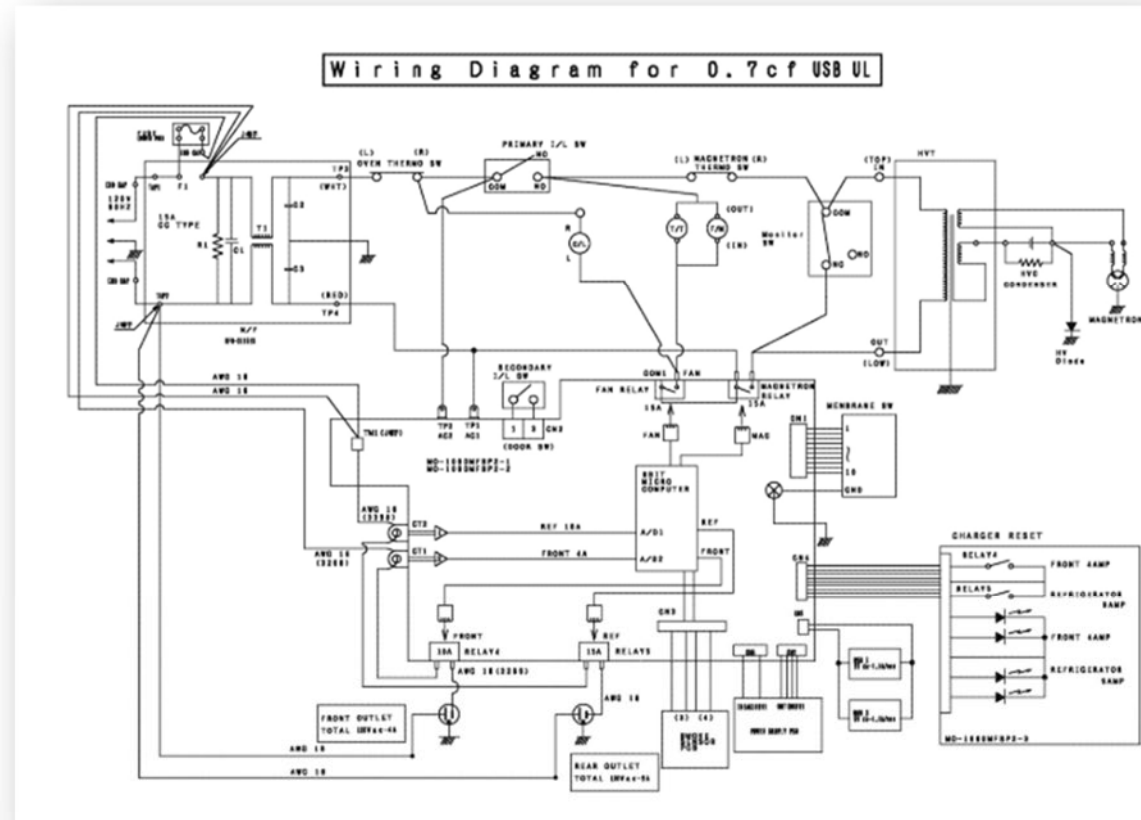
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein the USB port is operative to deliver electrical power.	The MicroFridge has a USB port is operative to deliver electrical power to “charge small electric devices.” Ex. 2005 (MF004429 at 2).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
15. Apparatus comprising: an appliance including	The image shows a black, compact refrigerator with a microwave oven mounted on top. A red circular badge with the word 'NEW' is positioned to the left of the unit. Another red circular badge on the right side of the refrigerator reads 'Highest Energy Efficiency Available' with 'ENERGY STAR' below it. The unit is set against a white background with a blue horizontal band at the top. The MicroFridge is an appliance. Ex. 2005 (MF004429 at 1).

**Claim of U.S. Patent
No. 11,674,745 C5**

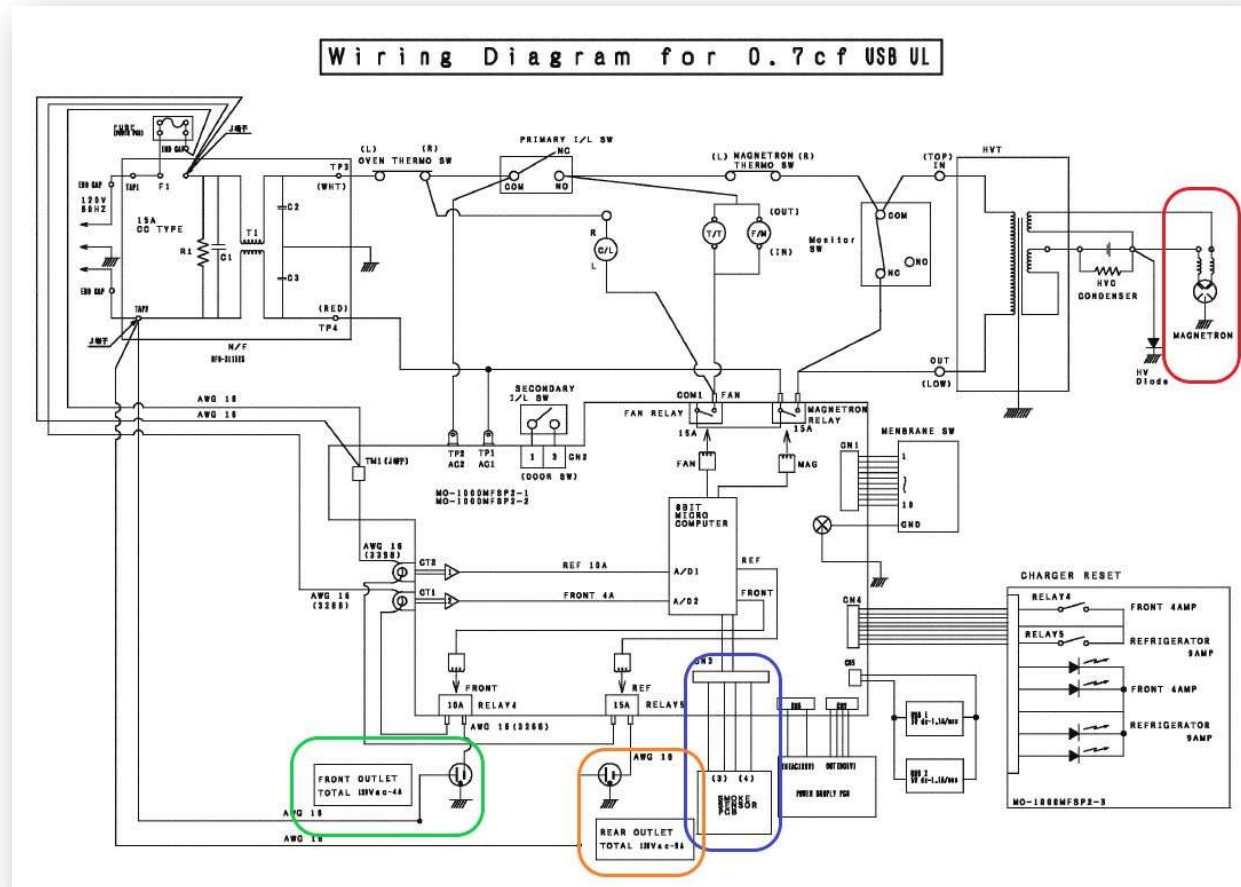
at least one electrical
power control circuit,

MicroFridge Products



The MicroFridge contains an electrical power control circuit. Ex. 2007 (MF015179 at 11).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a microwave oven, wherein the microwave oven is in operative electrical connection with the at least one electrical power control circuit,	

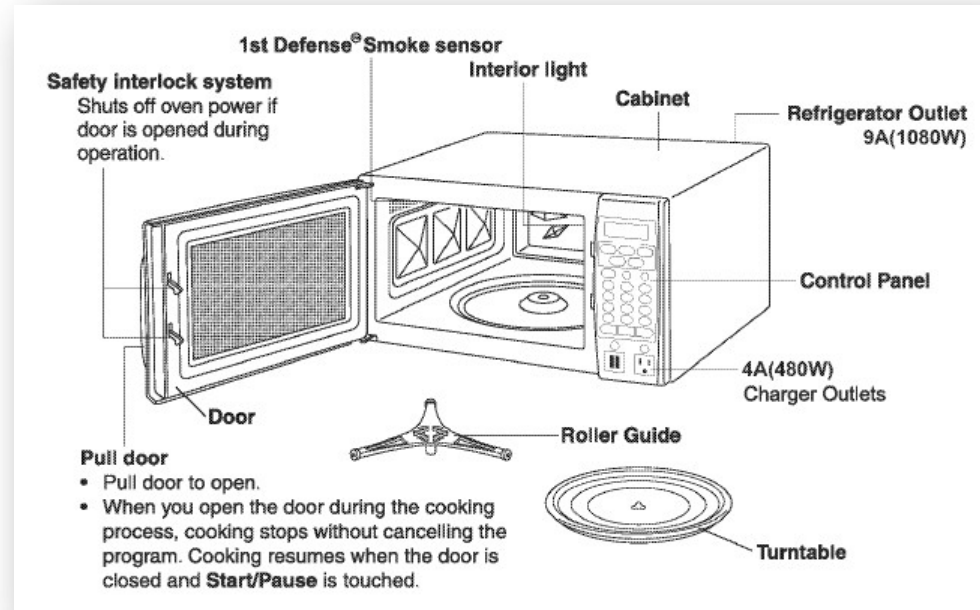


The MicroFridge includes a microwave oven that is connected to an electrical power control circuit (marked in red). Ex. 2005 (MF004429 at 1); Ex. 2007 at 11 (MF015179).

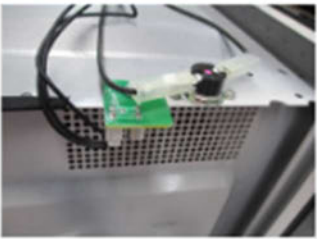
**Claim of U.S. Patent
No. 11,674,745 C5**

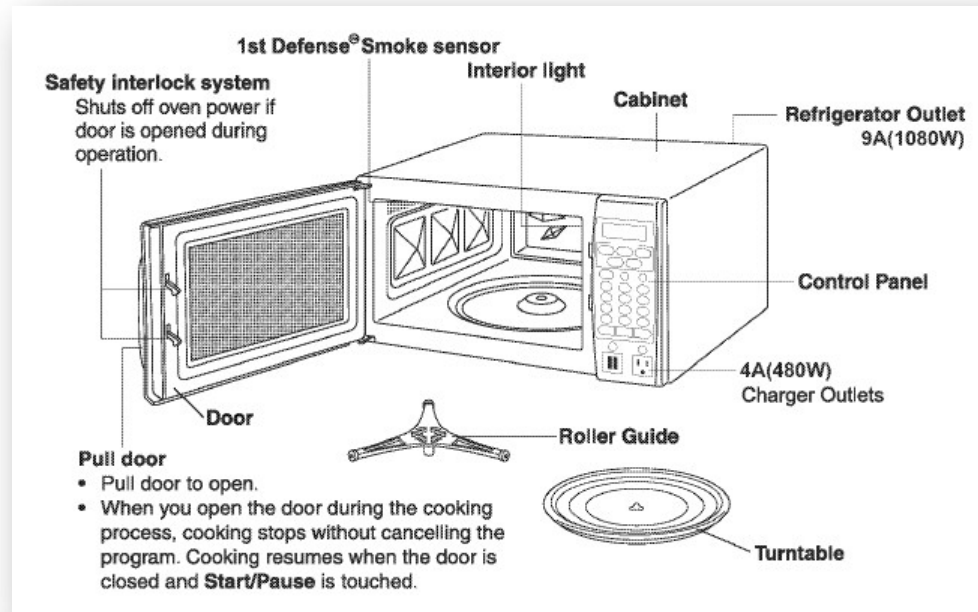
MicroFridge Products

wherein the
microwave oven
includes an interior
cooking area,



The MicroFridge microwave oven includes an interior cooking area. Ex. 2005 (MF004429 at 2).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area,	NEW 1st Defense™ Smoke Sensor  The patented internal smoke sensor automatically shuts microwave operation and alerts user of smoke before any damage is done. On the left side of outer cavity 

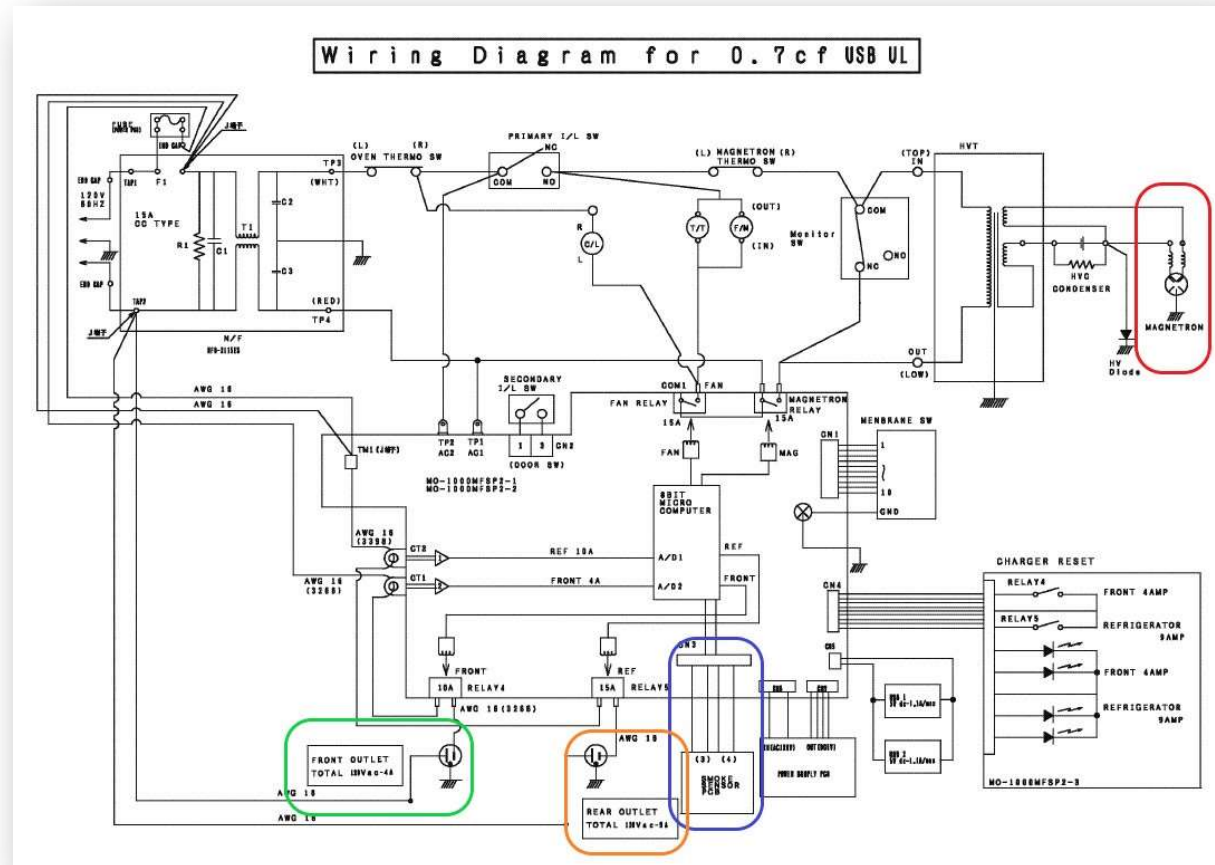


The microwave component of the MicroFridge includes a smoke sensor that is positioned in operative connection with the microwave's cooking area (i.e., the cooking cavity). Ex. 2005 (MF004429 at 2); Ex. 2030 (MF003487); Ex. 2006 (MF003462 at 7).

**Claim of U.S. Patent
No. 11,674,745 C5**

wherein the smoke sensor is in operative connection with the at least one electrical power control circuit, and wherein the at least one electrical power control circuit is configured to cause cooking power to be withdrawn from a magnetron of the microwave oven prior to a set end time of a current cooking session responsive at least in part to the smoke sensor sensing an amount of smoke,

MicroFridge Products



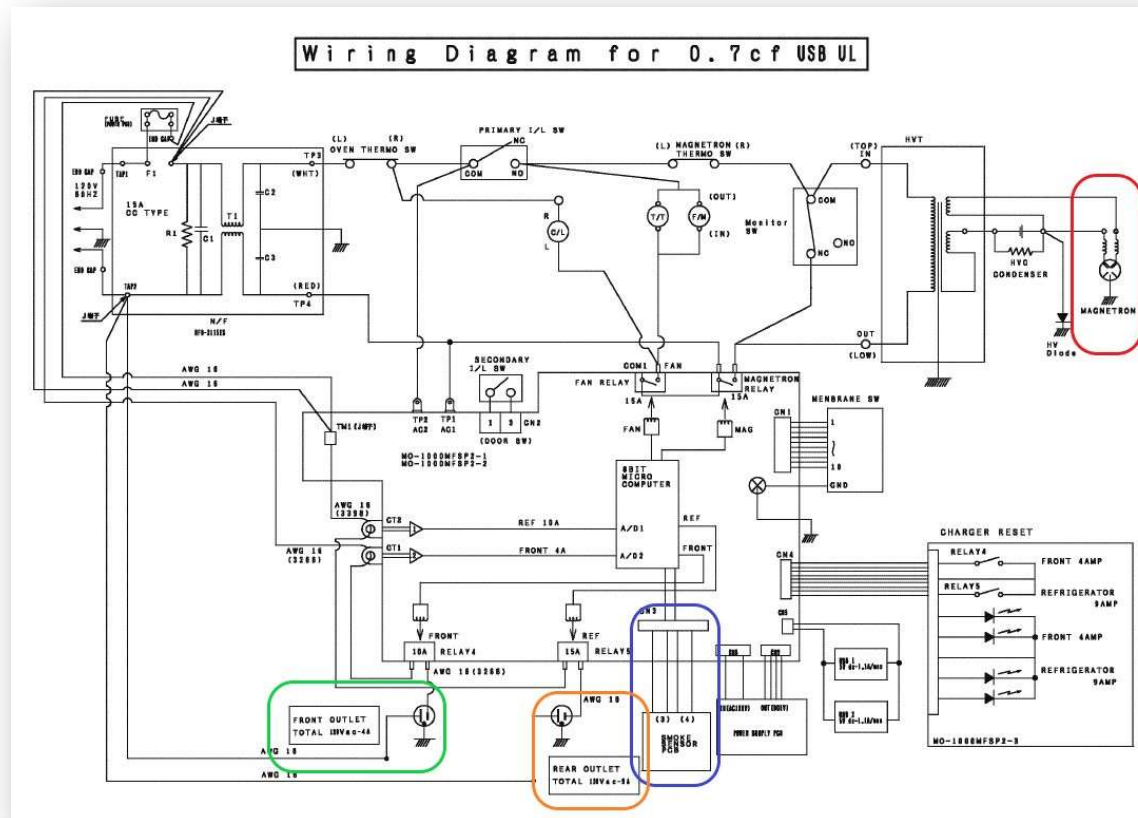
The circuit diagram above shows the smoke sensor (marked in blue) in operative connection with at least one power control circuit. Ex. 2007 at 11 (MF015179).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein the at least one electrical power control circuit is configured such that after ending the current cooking session prior to the set end time due to sensing the amount of smoke, to enable cooking power to again be available to the magnetron in a next subsequent cooking session,	To re-start the oven with another food item touch the Clear / Off pad, insert the food item into the oven and close the door. Select the desired cooking program for the new food item and touch the Start / Pause pad. Should the oven immediately shut off, display "Err1" and beep 3 times. Open the oven door to allow the smoke from the previous cooking session to clear before attempting to re-start the oven. After an automatic stuff off due to excessive smoke, power control circuit in the MicroFridge will be operative to allow the magnetron to receive cooking power in the next subsequent cooking session as indicated above. Ex. 2007 at 10 (MF015179).

**Claim of U.S. Patent
No. 11,674,745 C5**

a refrigerator, wherein the refrigerator is configured to be in operative electrical connection with the at least one electrical power control circuit,

MicroFridge Products



The MicroFridge contains a power control circuit that is in operative connection with a refrigerator (marked in orange). Ex. 2007 at 11 (MF015179).

wherein the refrigerator includes a plurality of

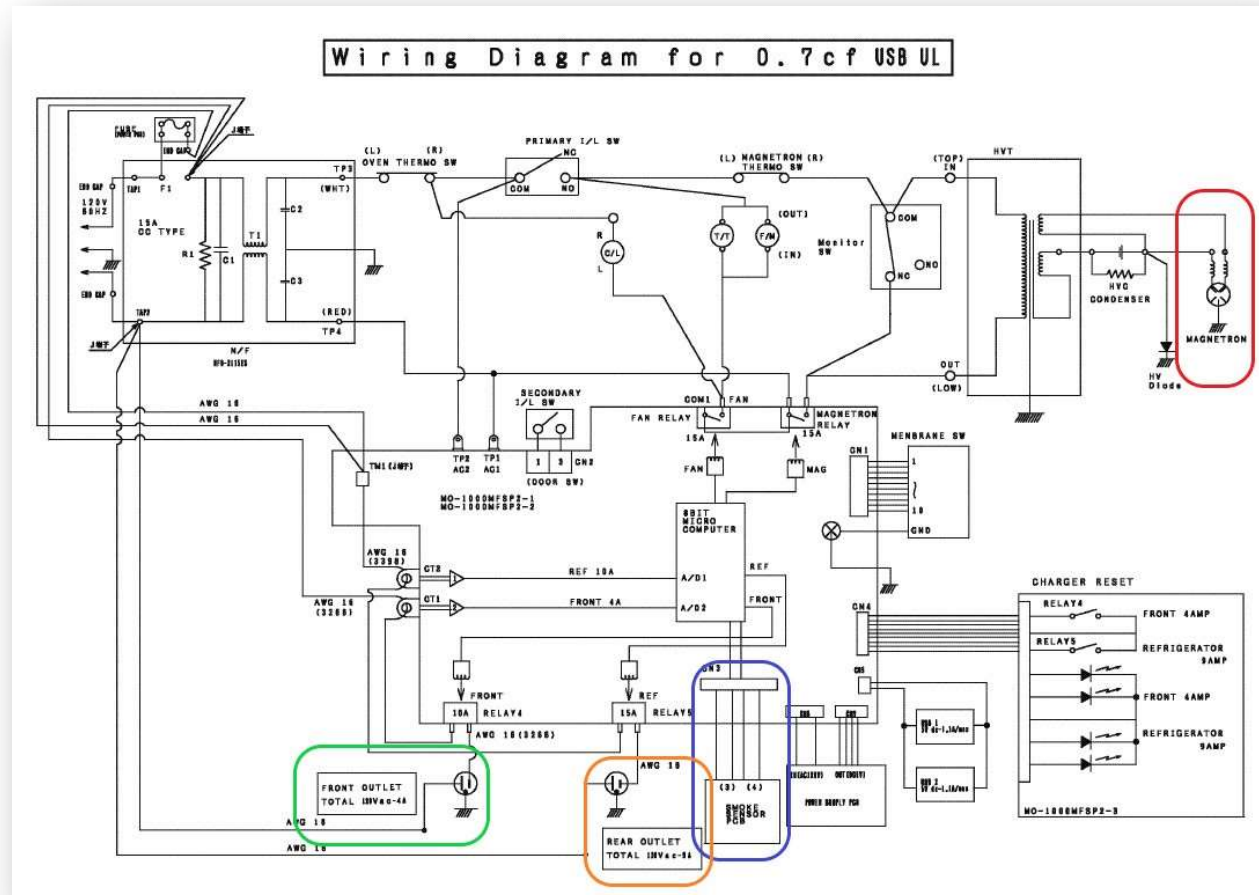
The refrigerator of the MicroFridge includes a plurality of electrically powered refrigerator components. Ex. 2035, ¶ 3.

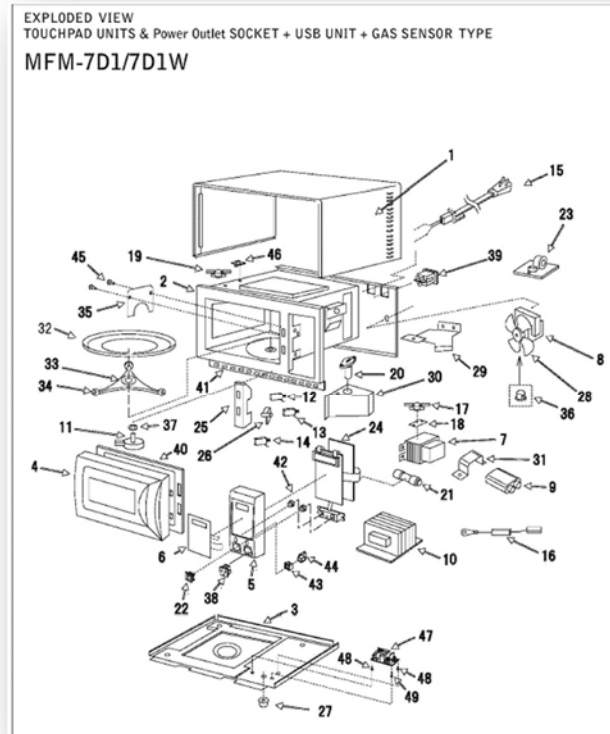
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
electrically powered refrigerator components,	
wherein the at least one electrical power control circuit is operative to cause electrical power to be unavailable to at least one electrically powered refrigerator component when the magnetron draws cooking power, and	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. The owner's manual for the MicroFridge 3.1MFM-7D1 describes how the power control circuit “works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use.” Ex. 2006 (MF003462 at 4) (emphasis added).
electrical power to be available to the at least one electrically powered refrigerator component when the magnetron does not draw cooking power.	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. The owner's manual for the MicroFridge 3.1MF7-7B1 describes how “power to the refrigerator and microwave resumes” once the microwave is finished drawing cooking power. Ex. 2006 (MF003462 at 4).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
19. The apparatus according to claim 15	See above discussion regarding claim 15.
wherein the microwave oven includes a USB port,	The MicroFridge has a microwave oven that includes a USB port. Ex. 2005 (MF004429 at 2).

wherein the USB port is in operative connection with the at least one electrical power control circuit,

MicroFridge Products





The MicroFridge contains a power control circuit that is in operative connection with a USB port in the front outlet (marked in green). Ex. 2007 (MF015179 at 11.) The USB port on the front outlet is denoted in the exploded view diagram above with the number 22. Ex. 2007 (MF015179 at 12).

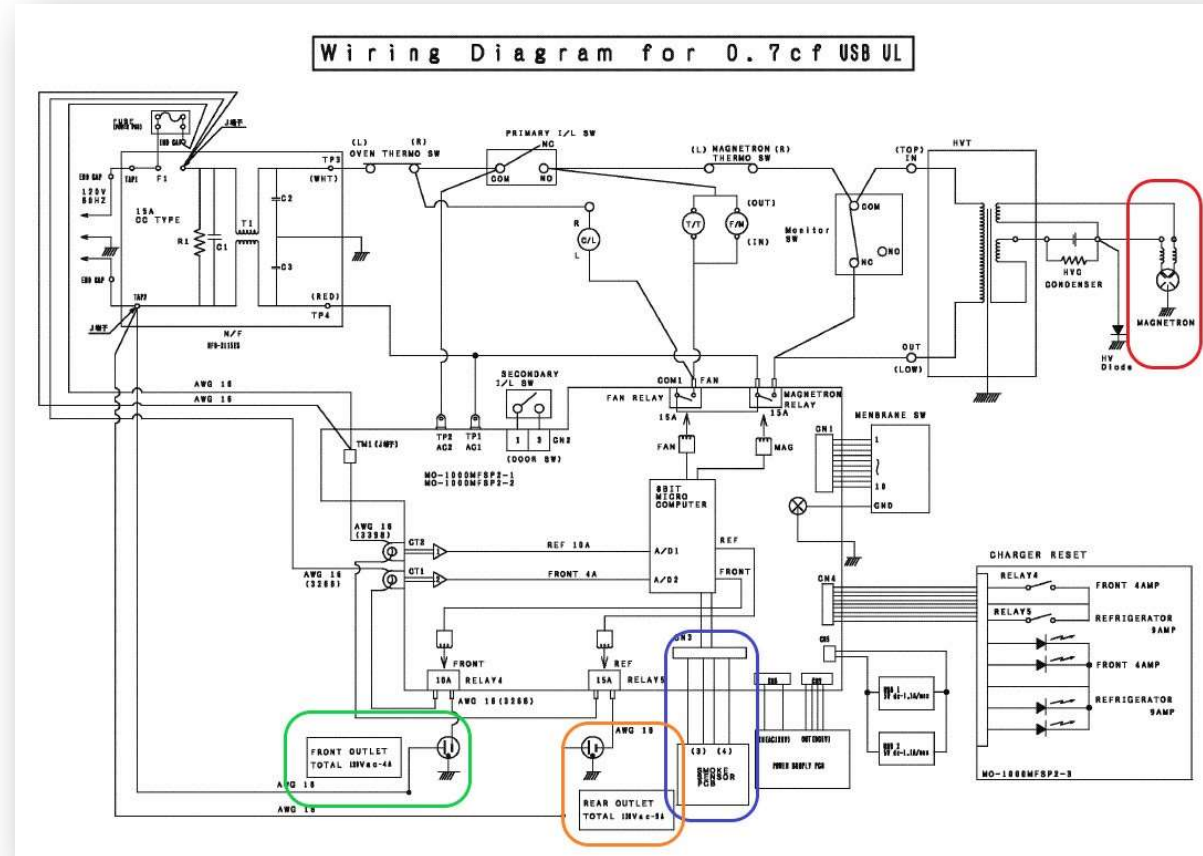
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products								
wherein the USB port is not operative to deliver electrical power from the USB port when the magnetron draws cooking power.	<u>Power scenario #1:</u> Turning the microwave on will route power to the microwave and shut off all other components so that the total amp draw is not over 15amps. <table> <tr> <td>Microwave =</td> <td>power supply FULL</td> </tr> <tr> <td>One Rear outlet, 120V 14A max =</td> <td>power supply OFF</td> </tr> <tr> <td>One Front outlet, 120V 12A max =</td> <td>power supply OFF</td> </tr> <tr> <td>two USB ports are 5VDC, 5A =</td> <td>power supply OFF</td> </tr> </table> NOTE: The MicroFridge® with Safe Plug® brand refrigerator and charging outlets will not operate when the microwave oven is on. This is part of the patent-pending MicroFridge® with Safe Plug® technology that prevents wiring overload. If your oven does not operate properly, unplug it from the 120 volt household outlet and then plug it back in. This unit is not designed for 50Hz or any circuit other than 120 volt/60Hz AC current. The power logic for the MicroFridge describes how turning the microwave on, which involves the magnetron drawing cooking power, will cause the power supply to the USB ports to be turned off. Ex. 2031 (MF006004). The MicroFridge instruction manual makes clear that the “charging outlets will not operate when the microwave oven is on.” Ex. 2006 (MF003462 at 5).	Microwave =	power supply FULL	One Rear outlet, 120V 14A max =	power supply OFF	One Front outlet, 120V 12A max =	power supply OFF	two USB ports are 5VDC, 5A =	power supply OFF
Microwave =	power supply FULL								
One Rear outlet, 120V 14A max =	power supply OFF								
One Front outlet, 120V 12A max =	power supply OFF								
two USB ports are 5VDC, 5A =	power supply OFF								

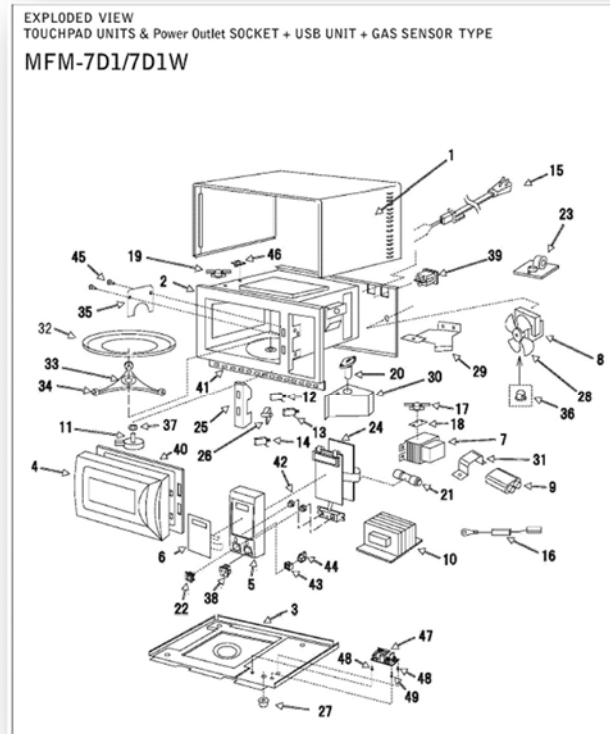
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
23. The apparatus according to claim 15	See discussion above regarding claim 15.
wherein the microwave oven includes a USB port,	The MicroFridge has a microwave oven that includes a USB port. Ex. 2005 (MF004429 at 2).

**Claim of U.S. Patent
No. 11,674,745 C5**

wherein the USB port is in operative connection with the at least one electrical power control circuit,

MicroFridge Products



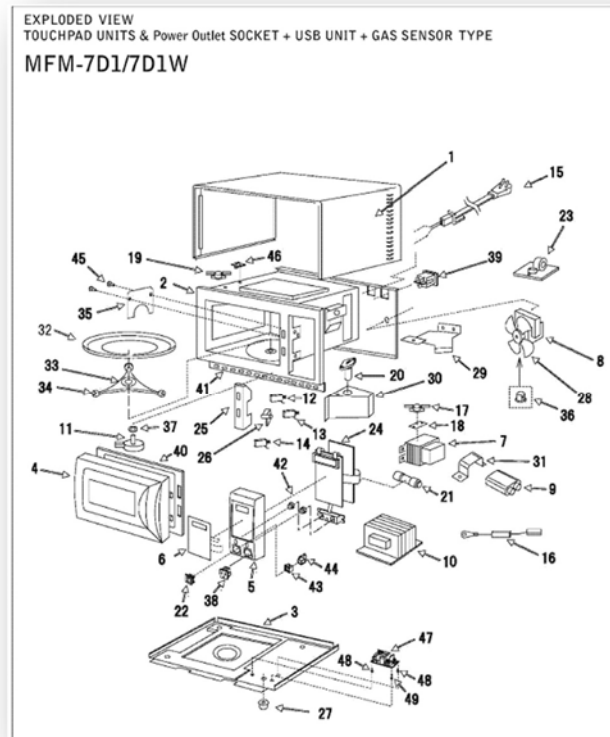


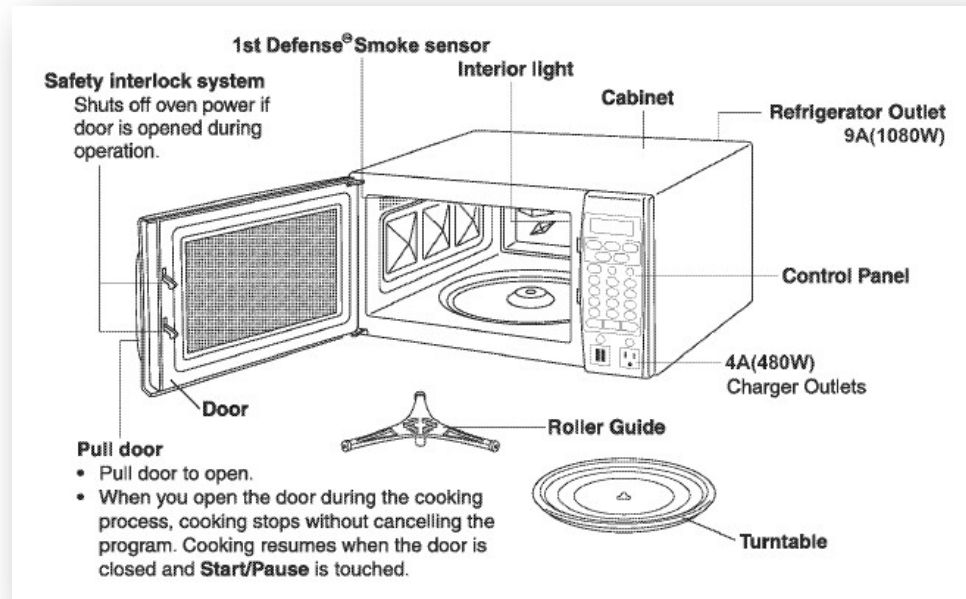
The MicroFridge contains a power control circuit that is in operative connection with a USB port in the front outlet (marked in green). Ex. 2007 (MF015179 at 11.) The USB port on the front outlet is denoted in the exploded view diagram above with the number 22. Ex. 2007 (MF015179 at 12).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein one USB port is operative to deliver electrical power.	The MicroFridge has a USB port is operative to deliver electrical power to “charge small electric devices.” Ex. 2005 (MF004429 at 2).

24. Apparatus comprising:

a microwave oven, including a magnetron and an externally accessible electrical connector, wherein the electrical connector is connectable to a plug,



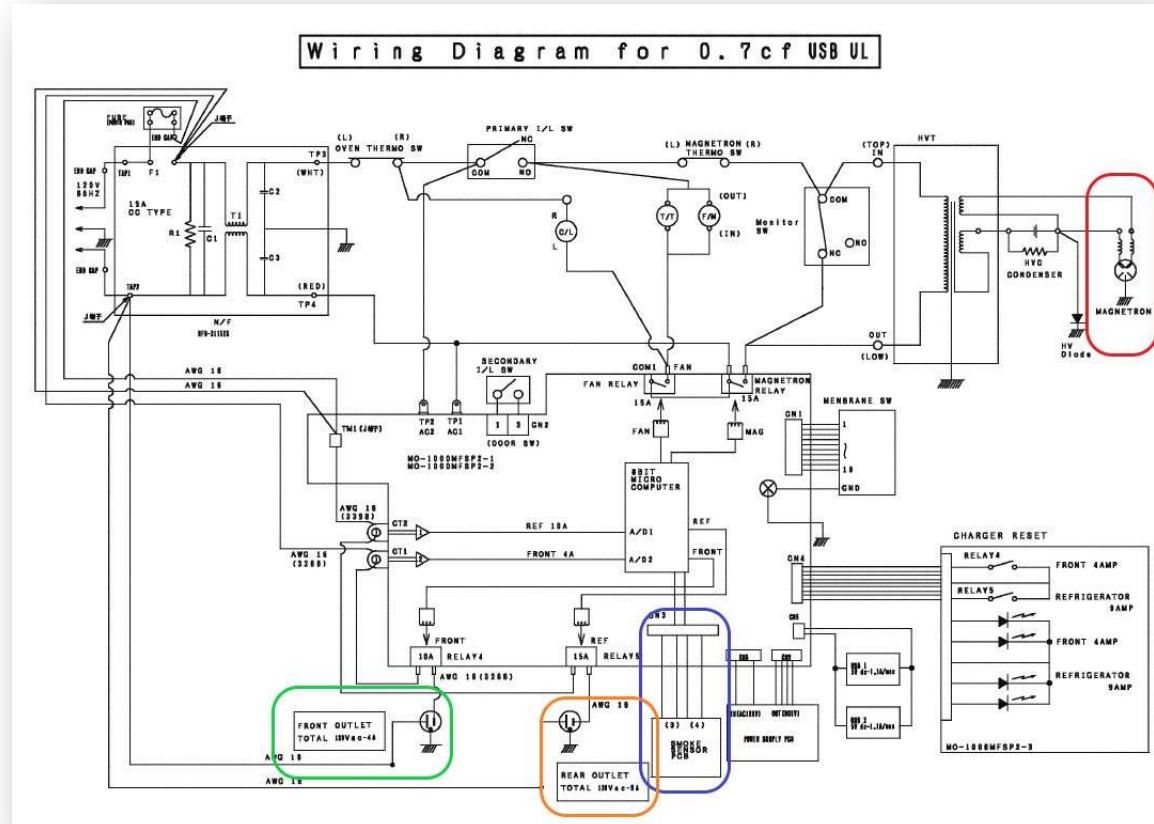


The MicroFridge has a microwave oven with a magnetron, which is denoted in the above exploded view diagram with the number 7. Ex. 2007 (MF015179 at 12.) The electrical connector has a traditional (i.e., three-prong) electric outlet on the front and back of the microwave, is externally accessible, and connectable to a plug. Ex. 2006 (MF003462 at 7).

**Claim of U.S. Patent
No. 11,674,745 C5**

at least one power control circuit,
wherein the at least
one power control
circuit is in operative
electrical connection
with the microwave
oven and the electrical
connector,

MicroFridge Products



The MicroFridge contains a power control circuit that is in operative electrical connection with the microwave oven (marked in red) and the electrical connectors (marked in green and orange). Ex. 2007 (MF015179 at 11).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a single power cord, wherein the single power cord is configured to be releasably connected to a source of electrical power, wherein the at least one power control circuit is supplied with electrical power only through the single power cord,	The diagram, titled "Safe Plug™ Technology", shows a blue plug connected to a microwave. A black plug is shown plugged into the back of the microwave. Below the image, text reads: "Provides protection against circuit overloads for user safety and convenience. Blue plug on refrigerator plugs into back of microwave for energy efficient one-plug to the wall operation." The MicroFridge has a single power cord that can be releasably connected to a source of electrical power and which supplies at least one power control circuit through that single power cord. Ex. 2005 (MF004429 at 2).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein the at least one power control circuit is operative to cause electrical power to be withheld from the electrical connector when the magnetron of the microwave oven draws cooking power, and	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. The owner's manual for the MicroFridge describes how the power control circuitry within the microwave "works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use." Ex. 2006 (MF003462 at 4).
electrical power to be delivered to the electrical connector when the magnetron does not draw cooking power,	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. The owner's manual for the MicroFridge describes how "power to the refrigerator and microwave resumes" once the microwave is finished drawing cooking power. Ex. 2006 (MF003462 at 4).

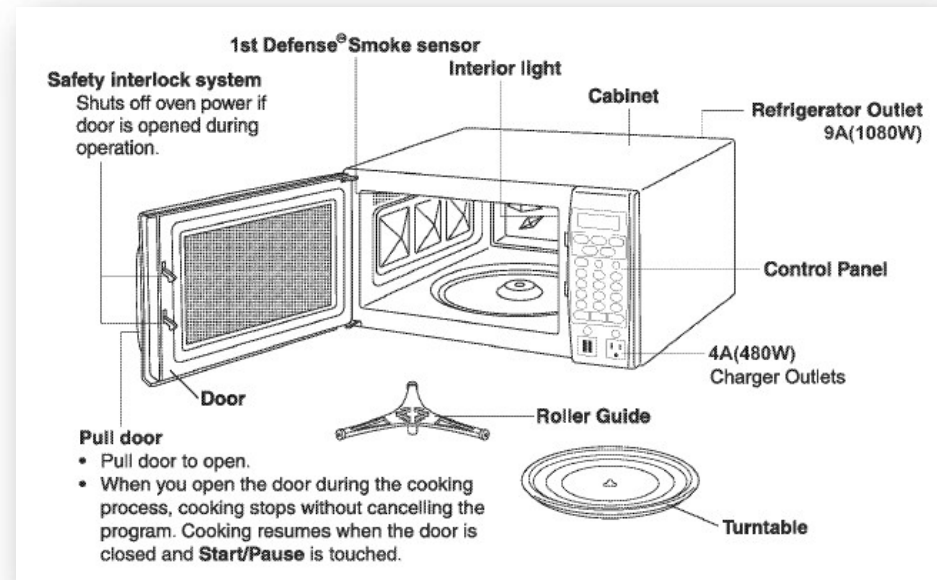
**Claim of U.S. Patent
No. 11,674,745 C5**

wherein the microwave oven includes a smoke sensor,

MicroFridge Products



On the left side of outer cavity

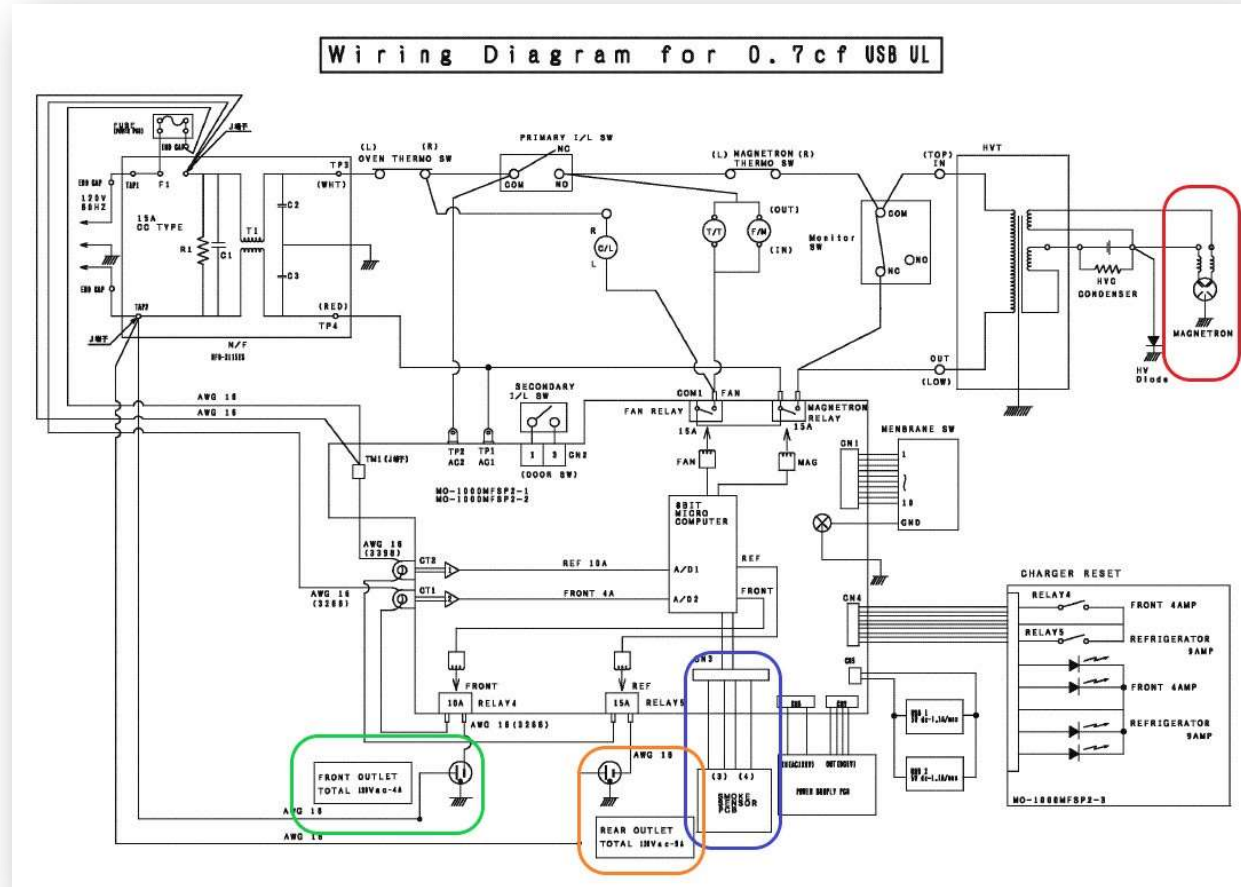


Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
	The MicroFridge has microwave oven that includes a smoke sensor. Ex. 2005 (MF004429 at 2.); Ex. 2030 (MF003487); Ex. 2006 (MF003462 at 7).
wherein the smoke sensor is positioned in operative connection with a cooking area inside the microwave oven,	On the left side of outer cavity The smoke sensor is positioned in operative connection with the cooking area (i.e., the cooking cavity) inside the microwave oven. Ex. 2030 (MF003487). The smoke sensor is denoted in the exploded view diagram above with the number 46. Ex. 2007 (MF015179 at 12).

**Claim of U.S. Patent
No. 11,674,745 C5**

is in operative connection with the at least one power control circuit,

MicroFridge Products



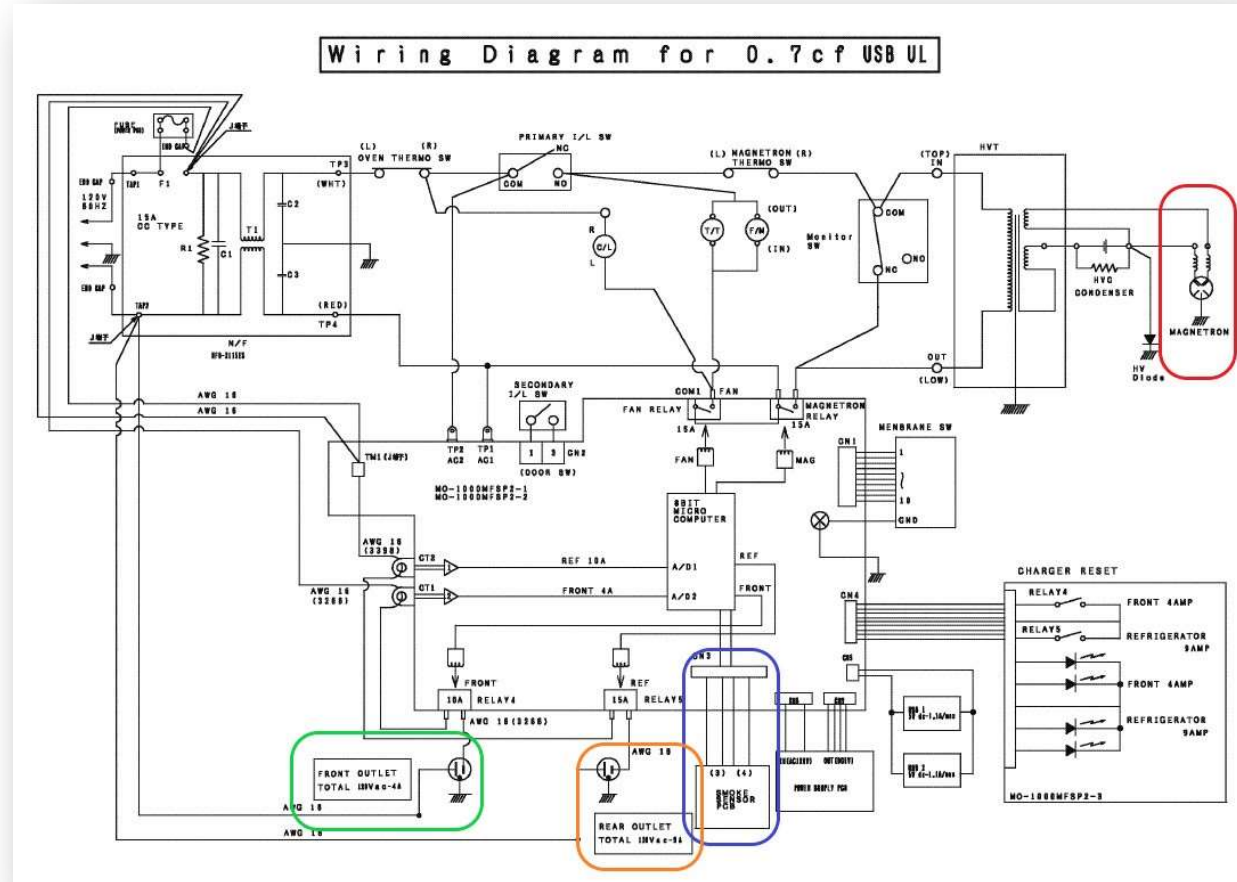
The MicroFridge contains a power control circuit that is in operative connection with a smoke sensor (marked in blue). Ex. 2007 (MF015179 at 11).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,	1ST DEFENSE SMOKE SENSOR This microwave oven is equipped with a patent-pending, built in 1st Defense™ Smoke Sensor to automatically shut off the oven before a cavity fire can occur. Should the oven shut off due to excessive smoke the display will show "Err1" and the oven will beep 3 times. The MicroFridge utilizes a smoke sensor that is operative to withdraw cooking power from the magnetron (i.e., shut off the oven) due to a level of excessive smoke prior to the set end time of the cooking session. Ex. 2007 (MF015179 at 10).

**Claim of U.S. Patent
No. 11,674,745 C5**

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session.

MicroFridge Products



The circuit diagram above shows the control circuit connected to the magnetron (marked in red). Ex. 2007 (MF015179 at 11).

Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
	To re-start the oven with another food item touch the Clear / Off pad, insert the food item into the oven and close the door. Select the desired cooking program for the new food item and touch the Start / Pause pad. Should the oven immediately shut off, display "Err1" and beep 3 times. Open the oven door to allow the smoke from the previous cooking session to clear before attempting to re-start the oven. After an automatic stuff off due to excessive smoke, control circuit in the MicroFridge will allow the magnetron to receive cooking power in the next subsequent cooking session as indicated above. Ex. 2007 (MF015179 at 10).
25. The apparatus according to claim 24 and further comprising	See discussion above regarding claim 24.

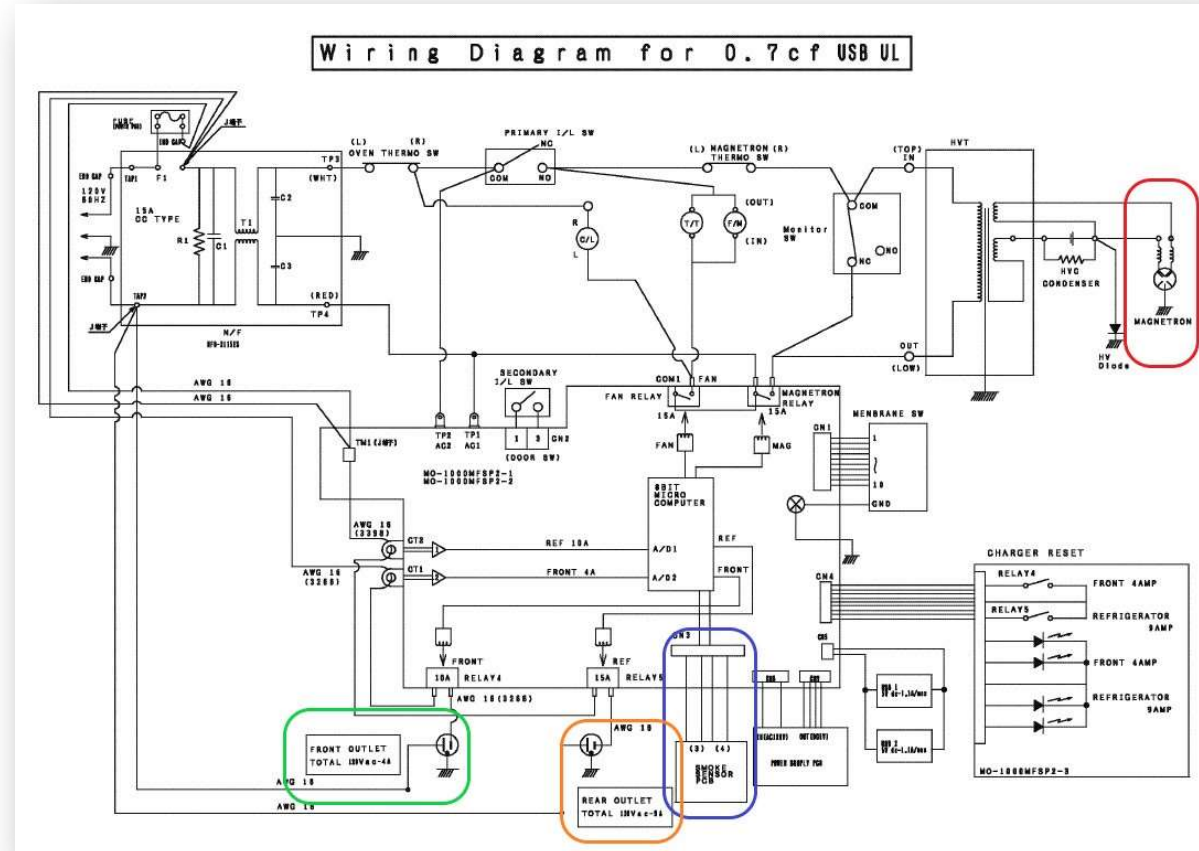
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
a refrigerator, wherein the refrigerator includes the plug, wherein the plug is connected to the electrical connector.	  Safe Plug™ Technology Provides protection against circuit overloads for user safety and convenience. Blue plug on refrigerator plugs into back of microwave for energy efficient one-plug to the wall operation. The MicroFridge includes a refrigerator with a plug that is connected to the electrical connector. Ex. 2005 (MF004429 at 1); Ex. 2005 (MF004429 at 2).
26. The apparatus according to claim 25	See discussion above regarding claim 24.

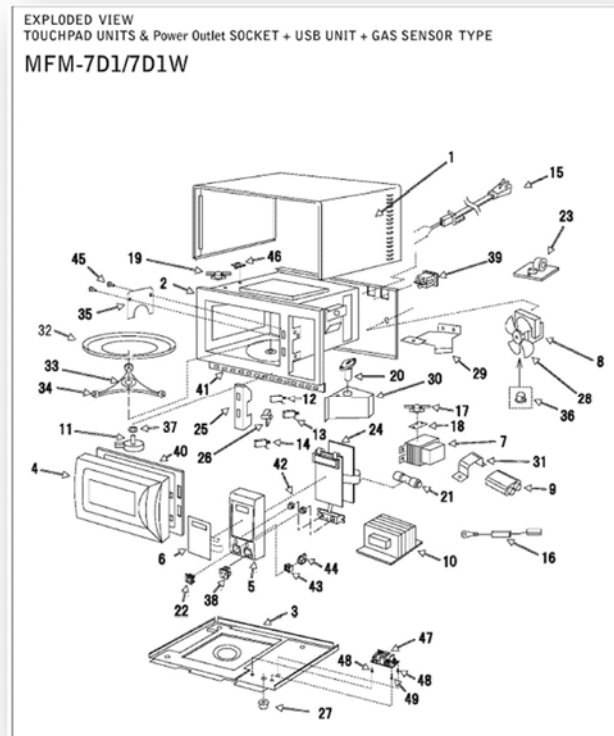
Claim of U.S. Patent No. 11,674,745 C5	MicroFridge Products
wherein the microwave oven further includes at least one USB port,	The MicroFridge has a microwave oven that includes a USB port. Ex. 2005 (MF004429 at 2).

**Claim of U.S. Patent
No. 11,674,745 C5**

wherein the at least one USB port is in operative connection with the at least one power control circuit.

MicroFridge Products





The MicroFridge contains a power control circuit that is in operative connection with a USB port in the front outlet (marked in green). Ex. 2007 (MF015179 at 11.) The USB port on the front outlet is denoted in the exploded view diagram above with the number 22. Ex. 2007 (MF015179 at 12).

APPENDIX C

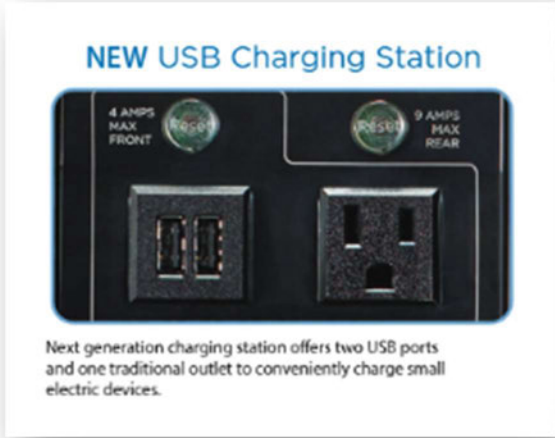
APPENDIX C: PRODUCT COMPARISON

Product Feature	Intirion's MicroFridge	College Product's MicroChill
A microwave-refrigerator combination appliance	 Ex. 2005 (MF004429 at 1).	 Ex. 2033 (CP_000256)

Product Feature	Intirion's MicroFridge	College Product's MicroChill
A linked control circuit that utilizes power allocation technology to conserve energy and protect against circuit overloads.	What is Safe Plug® Technology? MicroFridge® combination appliances utilize Safe Plug® technology, a revolutionary, patent pending design, to conserve electricity and reduce potential fire hazards that can be caused by overloaded circuits. This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use. When the microwave is finished, power to the refrigerator and charging outlets resumes. Engineered with unique one-plug-to-the-wall operation, our combination appliances never draw more than 11-15 amps of current. “This technology, built into the microwave, works by temporarily shutting off the power to the refrigerator and charging outlets when the microwave is in use.” Ex. 2006 (MF003462 at 4).	<u>Power Allocator</u> The Power Allocator switches power from Fridge when Microwave is in use. Power is restored to fridge when microwave door is open. Ex. 2034 (CP_000258)

Product Feature	Intirion's MicroFridge	College Product's MicroChill
An internal smoke sensor that is positioned in operative connection with the microwave's cooking area (i.e., the cooking cavity).	Ex. 2005 (MF004429 at 2) On the left side of outer cavity Ex. 2030 (MF003487)	Ex. 2034 (CP_000258) Photograph of MicroChill Unit provided by College Products

Product Feature	Intirion's MicroFridge	College Product's MicroChill
A plug from the refrigerator that plugs into an outlet located on the back, upper left-hand corner of the microwave to provide energy efficient one-plug to the wall operation.	Safe Plug™ Technology Provides protection against circuit overloads for user safety and convenience. Blue plug on refrigerator plugs into back of microwave for energy efficient one-plug to the wall operation. Ex. 2005 (MF004429 at 2).	Ex. 2032 (CP_000253)

Product Feature	Intirion's MicroFridge	College Product's MicroChill
Dual USB outlets to charge small electrical devices.	 NEW USB Charging Station 4 AMPS MAX FRONT 9 AMPS MAX REAR Next generation charging station offers two USB ports and one traditional outlet to conveniently charge small electric devices. Ex. 2005 (MF004429 at 2)	 Dual USB Port 2.0 Amp 2.0 Amp USB CHARGING PORTS Free up outlets and charge your phones, bluetooth speakers and many other deiv-ices with our Dual USB Ports. Ex. 2034 (CP_000258)