

IPR2024-00948
U.S. Patent No. 11,050,097

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ASCEND ELEMENTS, INC.,
Petitioner,

v.

DUESENFELD GMBH,
Patent Owner.

Case No. IPR2024-00948
U.S. Patent No: 11,050,097

DECLARATION OF VANI DANTAM

TABLE OF CONTENTS

	<u>Page</u>
I. ASSIGNMENT.....	1
II. BACKGROUND AND QUALIFICATIONS.....	2
III. LEVEL OF SKILL IN THE ART AND BASIS FOR OPINIONS	6
IV. RELEVANT LEGAL PRINCIPLES	8
A. Claim Construction.....	8
B. Anticipation	10
C. Obviousness.....	11
V. BACKGROUND OF THE '097 PATENT	13
A. Technology Overview: EV Batteries	13
B. '097 Patent Overview	22
C. Related District Court Litigation.....	24
VI. ANALYSIS OF HANISCH '419 AND THE COMBINATION OF HANISCH '419 WITH DUNAGAN (GROUND 1)	25
A. Overview of Hanisch '419.....	25
B. Hanisch '419 Does Not Teach All Limitations of '097 Claim 1, Either Alone or in View of a POSITA	28
1. Hanisch '419 does not teach “inactivating the comminuted material such that an inactivated comminuted material is obtained” in the pre-dryer	28
2. Hanisch '419 does not teach inactivating as part of the pre- drying step	28
3. Hanisch '419 does not teach “wherein the drying occurs at a maximum pressure of 300 hPa”	36
4. Hanisch '419 does not teach “The method according to claim 1 wherein drying occurs at a temperature of less than 80° C” of Claim 9	39
C. Hanisch '419 Does Not Teach All Limitations of '097 Claim 12	40
1. Hanisch '419 does not teach “an inactivation device comprising a drying device configured to inactivate the comminuted material”	40

2.	Hanisch '419 does not teach “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device.”	40
D.	Summary of Opinions Regarding Hanisch '419 and the Combination of Hanisch '419 with Dunagan (Ground 1).....	44
VII.	ANALYSIS OF THE COMBINATION OF HANISCH '419 WITH DUNAGAN, MEADOR, SHIN, AND/OR HAYASHI (GROUND 2)	45
A.	Hanisch '419 in view of Dunagan, Meador, Shin, and/or Hayashi Does Not Render Unpatentable Claims 1, 2, 3, 7, 8, 9, 10, 12, 13, or 19	45
B.	Hanisch '419 alone or in view of Hayashi, Meador, or Shin does not teach “wherein the drying occurs at a maximum pressure of 300 hPa”	52
1.	Hanisch '419 alone or in view of a POSITA does not disclose this limitation.....	52
2.	A POSITA would not combine Hanisch '419 and Dunagan with Meador, Shin, or Hayashi.....	52
i.	A POSITA Would Not Be Motivated to Combine Meador with Hanisch '419.....	52
ii.	Hayashi teaches away from Hanisch '419, and a POSITA would not be motivated to combine these references	63
iii.	Shin Teaches Away from Hanisch '419, and a POSITA Would Not Be Motivated to Combine	75
C.	Hanisch '419 alone or in view of Hayashi, Meador, or Shin does not render obvious the requirement of Claim 12 for “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device”	78
VIII.	SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS	79
A.	Objective Indicia of Nonobviousness as to the '097 Invention	80
1.	Long-felt but unmet need and unexpected results	80
2.	Nexus between secondary considerations and the claims of the '097 Patent.....	82
IX.	ADDITIONAL REMARKS	84

I, Vani Dantam, of Fishers, Indiana, declare that:

I. ASSIGNMENT

1. I have been retained by Robins Kaplan LLP on behalf of Duesenfeld GmbH (“Duesenfeld”) as an expert with regard to this matter. I understand that the Patent Trial and Appeal Board (“Board”) instituted inter partes review (IPR) of U.S. Pat. No. 11,050,097 (“the ‘097 patent”) (Ex. 1001) requested by Petitioner Ascend Elements. (Paper 10).

2. In my capacity as an expert, I have been asked to provide my independent analysis and opinions regarding the ‘097 patent, the prosecution history of the ‘097 patent and related applications as applicable, the alleged prior art relied upon by Petitioner, the meaning of various claim terms from the ‘097 patent from the perspective of a person of ordinary skill in the art (“POSITA”), the opinions offered by Petitioner’s expert, Dr. Walter van Schalkwijk, in his declaration (“van Schalkwijk Declaration”) (Ex. 1003), and the Board’s November 22, 2024 Institution Decision. My opinions and conclusions are fully discussed in later sections of this declaration.

3. I am an independent consultant, and I am not, and have never been, an employee of Duesenfeld or Ascend. I received no compensation for this declaration beyond my normal hourly compensation (\$250/hr) based on my time spent analyzing the ‘097 patent, the prosecution history of the ‘097 patent and

related applications, the prior art publications relied upon by Petitioner, the van Schalkwijk Declaration, and other related materials. I will not receive any added compensation based on the outcome of any IPR or other proceedings involving the ‘097 patent.

II. BACKGROUND AND QUALIFICATIONS

4. My Curriculum Vitae (“CV”) is attached as **Appendix A**. I highlight here a few experiences in my career that are particularly germane to my opinions discussed herein, which give a basis of my opinions of a person of ordinary skill in the art at the time of invention (*i.e.*, approximately 2015).

5. In 1979, I obtained a Bachelor of Technology degree with a focus in Metallurgical Engineering from the Indian Institute of Technology — Banaras Hindu University (Varanasi, Uttar Pradesh, India), graduating with high honors at the top of my class.

6. In 1982, I obtained a Masters of Science (MS) degree in Mechanical Engineering from Vanderbilt University, under a U.S. Navy Scholarship.

7. In 1987, I obtained a Masters in Business Administration (MBA), specializing in Finance and International Business from Kelley School of Business, Indiana University, under a GM Fellowship.

8. I have certifications and continuing education, including QES Quality Engineering Certification, GM Quality Institute, Kettering University (Flint, MI).

9. From 2008 - 2010, I worked as the Director of Global Sales at Remy Electric, managing sales of Hybrid/EV motors/generators. These motors/generators operated using energy supplied by lithium ion batteries. Through my work at Remy Electric, I became familiar with the performance characteristics of different lithium ion batteries. Lithium ion batteries had just begun to proliferate in the industry.

10. From 2010 - 2012, I worked with the Indiana-based company EnerDel as their VP of Sales. EnerDel is a company that pioneered Lithium ion battery technologies. Through my capacity as VP of sales, I developed a thorough understanding of lithium ion battery technology and the materials that went into these batteries. I managed the design of battery modules and packs for different applications, based on customer inputs. Because of my technical background, I was able to talk to a customer, and translate those needs into a proposed module and pack design. I also worked as a team member scaling up the production of cells/modules/packs from the pilot plant in Fishers, IN to a GWh scale production plant in Greenfield, IN.

11. From 2012 - 2015, I worked for Axion Power as its Senior Vice President of Sales, Business Development, and Marketing. Axion Power is a company that specialized in manufacturing lead-carbon batteries, which is a technology that competed with lithium ion batteries. At Axion Power, I supervised Application Engineering and Module and Pack Development to reflect the

customer needs. As I competed for business, my work at Axion Power helped me understand the tremendous advantages lithium ion batteries have, how advanced the material and process technology was set to become, and the areas where additional work was needed-from a customer perspective. Customers would show us their lithium ion battery packs, and asked us to design a lead-carbon battery that could outperform the lithium-ion battery, and I would supervise the application engineering personnel. Through this experience I became increasingly well-versed in both kinds of battery technologies.

12. In 2015, I joined Landis+Gyr (a division of Toshiba, Japan) as their V.P. of North American Sales. I managed the sales of LTO batteries (LTO batteries use Lithium Titanate anodes and LFP or NMC cathodes). During my five-year employment with Landis & Gyr, I often visited Toshiba headquarters in Tokyo and their plant in Kashiwazaki (north of Tokyo) and received coaching and training from my colleagues in Japan on different battery chemistries and material preparation as well as production line design. One area of my focus was understanding the electrode preparation and how the plant prepared the rejects for recycling by recruiting special material recyclers for plant waste and returned battery packs.

13. Starting in 2019, I worked for Lucas TVS (Chennai, India) and 24m Technologies (Cambridge, MA) as their Chief Project Consultant, focusing on

feasibility, finance, Engineering, Procurement, and Construction (“EPC”), operations, and customer development. In this role, I managed plant feasibility studies regarding production of semi-solid state lithium ion battery technology conducive to Indian ambient conditions. Through this capacity I helped design a plant directed to produce new cell formats for batteries using LFP and /or NMC chemistries, BMS integration and module/pack/charging infrastructure design and architecture.

14. From 2022 - 2023, I served as the Chief Operating Officer of Nextech Batteries in Carson City, Nevada. I was responsible for all functional areas, including logistics, engineering, and production, which included setting up global manufacturing facilities for lithium sulfur chemistry-based cells.

15. From 2023 - 2024, I was Chief Executive Officer and Chairman of the Board for Nevada Technology Corporation, which specializes in lithium ion battery recycling, including repurposing used batteries into second life batteries and developing advanced cell technologies to overcome current rechargeability, cost, and life limitations.

16. I was the Chief Advisor to Lohum Americas from 2022 to 2024, which is a provider of advanced recycling technologies for lithium ion batteries using principles of Hydrometallurgy. They currently operate a recycling plant in India with a capacity of 800MWh. This will be scaled up to over 2GWh in the next

2-3 years. They also signed agreements to establish recycling facilities in the Middle East, Eastern Europe and Africa.

III. LEVEL OF SKILL IN THE ART AND BASIS FOR OPINIONS

17. I understand that that the Board has determined in its Institution Decision that one of ordinary skill for purposes of this case “would have had at least a Bachelor’s degree in electrical engineering, materials science, chemical engineering, or an equivalent field, as well as at least 2 to 3 years of academic or industry experience in the recycling or processing of lithium-ion batteries.”

Institution Decision at 7-8. I agree with this definition of a POSITA

18. Dr. van Schalkwijk opined that a POSITA in the field of the ‘097 patent would have “at least a master’s degree in chemical engineering, mechanical engineering, materials science/engineering, or a related field, and three to five years of experience in design and implementation of battery recycling processes,” and I understand that Ascend has adopted that definition of a POSITA. Ex. 1003, 15; Petition at 15-16.

19. I disagree with Dr. van Schalkwijk’s definition, for at least two reasons. First, the field of battery recycling was still relatively nascent as of the 2015 effective filing date of the ’097 patent. Few people in the world would have had “three to five years of experience” in that field by 2015. I note that Dr. van Schalkwijk himself, based on a review of his CV, does not appear to have had

extensive experience in battery recycling processes as of 2015. In my opinion, however, experience in battery processing could substitute for experience with recycling, as a person with processing experience would understand battery chemistry and composition as well as processing steps such as discharge, comminution, and heating.

20. Second, in my opinion a person with a Bachelor's degree and sufficient experience in either industry or academia would also qualify as a POSITA. I have been informed that some named inventors on the '097 patent were graduate students at Technical University of Braunschweig in Germany when they conceived of the inventions, and they would likely meet this condition as they would not yet have the advanced degree that the Petitioner argues for in its proposed definition of a POSITA.

21. In my opinion, the Board's ruling properly reflects this background.

22. I believe that I am qualified to render opinions regarding the technology described and claimed in the '097 patent under either party's proposed definition of a POSITA, based on my experience and education. Based on my expertise and qualifications, I believe that I am qualified to provide opinions as to the state of the art and what a POSITA would have understood, known, or concluded as of the filing date of the '097 patent (i.e., April 28, 2015). I have been working in the lithium battery field, including supervising the processing of

lithium-ion batteries, since 2008. My career has continued in the battery recycling field, and I have participated in various industry organizations relating to battery recycling technologies. I have familiarized myself with the state of the art at the time of invention as it relates to battery recycling technology, as set forth herein. I have provided my declaration herein from the perspective of a person of ordinary skill in the art, under either party's proposed definition, in the time frame of the invention of the '097 patent, *i.e.*, as of April 28, 2015.

23. In reaching my opinions and conclusions, I have relied upon my education, my work experience in the relevant field, and my training, and considered and relied upon my review and analysis of the materials listed in **Appendix B.**

IV. RELEVANT LEGAL PRINCIPLES

24. I am not an attorney and I will offer no opinions on the law. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my analysis and opinions. I have applied these legal principles in rendering my opinions below.

A. Claim Construction

25. I understand that the ordinary and customary meaning of a claim term is the meaning that the term would have to a POSITA at the time of the invention.

26. In the absence of an express intent on the part of the inventor to give a

special meaning to the claim terms, the words are presumed to take on the ordinary and customary meanings attributed to them by a POSITA.

27. I understand that it is the use of the words in the context of the written description, and as customarily used by those skilled in the relevant art, that accurately reflects both the ordinary and the customary meaning of the terms in the claims.

28. I understand that the basis for a term's ordinary and customary meaning may be derived from a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art at the time of the invention.

29. I have been instructed that dictionary definitions or definitions from technical references can be used to inform or confirm the ordinary and customary meaning of words found in a claim, but that in construing claim terms, the general meanings gleaned from reference sources, such as dictionaries, must always be compared against the use of the terms in the context of the claim itself.

30. I understand that a patent applicant is entitled to be his or her own lexicographer (in other words, provide his or her own meaning to a word or phrase) and may rebut the presumption that claim terms are to be given their plain and ordinary meaning. To do so, the applicant must clearly set forth a definition of the

term that is different from its ordinary and customary meaning. Where the applicant provides an explicit definition for a term, that definition will control interpretation of the term as it is used in the claim in which it appears. I understand that the specification can also be relied on for more than just explicit lexicography to determine the meaning of a claim term. For example, I understand that the meaning of a particular claim term may also be determined by implication, that is, according to the usage of the term in the context of the specification.

B. Anticipation

31. I understand that a prior art reference “anticipates” an asserted claim, and thus renders the claim invalid, if all elements of the claim are disclosed in that prior art reference, either explicitly or inherently (i.e., necessarily present or implied). I understand that, although references cannot be combined for anticipation, additional references may be used to interpret an anticipating reference and shed light on what it would have meant to those skilled in the art at the time of the invention.

32. I understand that in order to serve as a “printed publication,” a document must be generally available, that is, available to the public without restriction. I have been informed that the dissemination and public accessibility of a document are the keys to the legal determination of whether or not that document was “published” and hence can serve as prior art to a patent. I understand that

“publication” must be in such a manner as to be generally available, and cannot be accomplished by limited dissemination or availability in, e.g., obscure journals.

33. I understand that a patent cannot be invalidated based on one person’s testimony alone without corroborating evidence, particularly without documentary evidence. Moreover, I understand that corroboration is required of any witness whose testimony alone is asserted to invalidate a patent, regardless of the witness’s level of interest in relation to that patent. Accordingly, even if the testifying individual has no interest in the litigation, I understand that that corroboration of their testimony is still required in order to invalidate a patent claim.

C. Obviousness

34. I understand that under U.S. patent law, 35 U.S.C. § 103, a claim is invalid as obvious if the differences 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 person having ordinary skill in the art to which said subject matter pertains.

35. I am informed that an obviousness analysis requires an assessment of the scope and content of the prior art, the differences between the art and the claims at issue, and the level of ordinary skill in the art. I am told that it is against this backdrop that obviousness is assessed.

36. I have also been informed and understand that objective indicia of

nonobviousness must be addressed in the obviousness analysis. I understand that certain objective considerations may be examined to determine whether a certain invention would have been obvious to one of ordinary skill in the art.

37. I understand that objective indicia of non-obviousness can be used to overcome an obviousness rejection or challenge under § 103, and that some examples of objective indicia include:

- any long-felt and unmet need in the art that was satisfied by the invention of the patent;
- any failure of others to achieve the results of the invention;
- any commercial success or lack thereof of the products and processes covered by the invention;
- any deliberate copying of the invention by others in the field;
- any taking of licenses under the patent by others;
- whether the invention was contrary to the accepted wisdom of the prior art;
- any expression of disbelief or skepticism by those skilled in the art upon learning of the invention;
- any unexpected results achieved by the invention;
- any praise of the invention by others skilled in the art;
- any lack of contemporaneous and independent invention by others;

and

- any acceptance of the invention by the industry.

38. I understand that the fact finder must determine whether potential evidence of objective indicia is relevant. In particular, the fact finder must ascertain whether a nexus connects, e.g., commercial success to a claimed invention and determine the probative value of objective indicia evidence for rebutting a prima facie case of obviousness.

V. BACKGROUND OF THE '097 PATENT

A. Technology Overview: EV Batteries

39. The technology at issue in this case relates to the recycling of electric vehicle “EV” batteries. To appreciate the state of the art at the time of invention, an understanding of the structure of EV batteries is important.

40. Figure 1 below is an image of an EV battery, as published in 2009. Ex. 2002 at 5. At the bottom right of this diagram is a cutaway cross-section of a battery cell, showing the layers of electrodes and separators making up the cell. To the left is an illustration of the primary components of the cell.

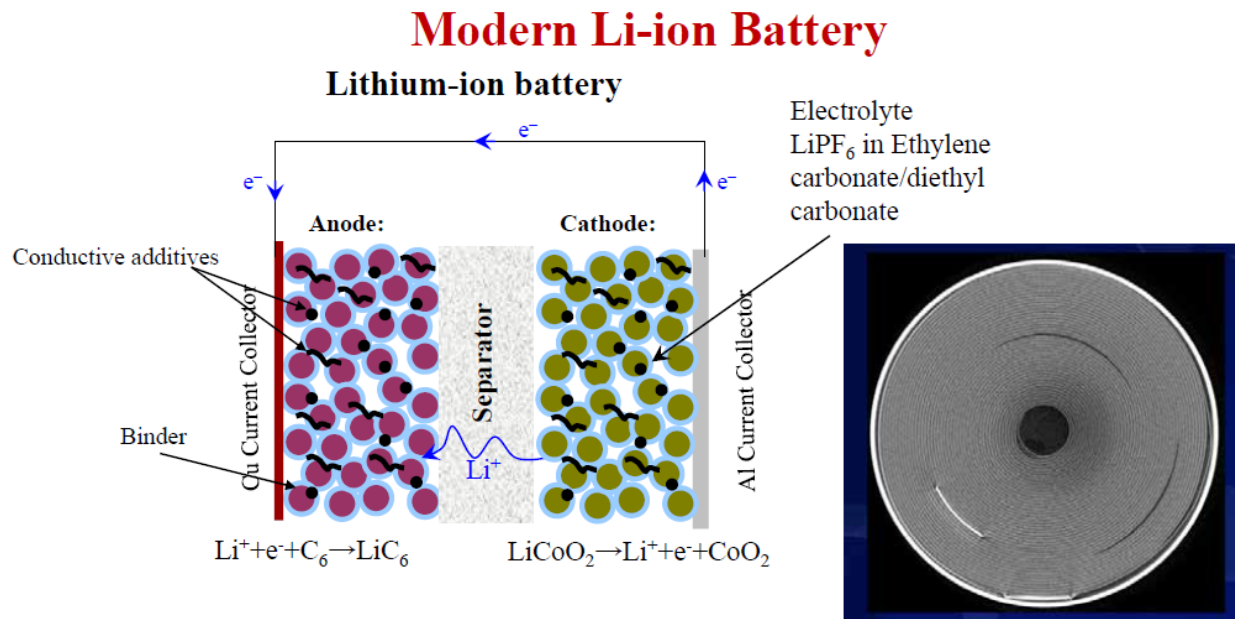


Figure 1: Diagram of lithium ion battery components.

Ex. 2002 at 5.

41. The cathode is the positive electrode. Ex. 2002 at 5. The cathode is formed on a support, which is typically aluminum foil. *Id.* Metal oxides are pasted onto the support foils. *Id.* These metal oxides include lithium cobalt oxide (LCO), lithium iron phosphate (LiFePO_4), or nickel manganese cobalt oxide (NMC) or nickel manganese aluminum oxide (NMA). Ex. 1004, 3:11-13 (“On the cathode side, for example, lithium nickel manganese cobalt oxide, lithium nickel aluminum oxide and lithium iron phosphate.”). A binder (light blue line shown in Figure 1) is used to affix the metal oxides onto the copper foil support. Ex. 2002 at 5.

42. The anode is the negative electrode. Ex. 2002 at 5. The anode is formed on a support, which is usually copper foil. *Id.* Onto the copper foil is pasted

graphite, again using a binder. Ex. 2002 at 5.

43. Between the cathode and the anode there is a thin membrane called a “separator.” Ex. 2002 at 5. This separator is porous, allowing lithium ions to pass back and forth between the anode and cathode. *Id.* Without the separator, there would be a short circuit from contact between the anode and cathode. The lithium ions need to be dissolved in a liquid solvent in order to be able to flow between the electrodes during discharging and recharging processes.

44. The lithium ions are dissolved in a solvent, which is commonly one or more of the following: ethylene carbonate, dimethyl carbonate, ethyl methyl carbonate, propylene carbonate or diethyl carbonate. Ex. 2002 at 5. The form of lithium used is typically lithium hexafluorophosphate (LiPF₆). *Id.* When the LiPF₆ is dissolved in the solvent, this solution is referred to as an “electrolyte” solution. The lithium ions in the electrolyte transit back and forth between the positive cathode and the negative anode as the battery is charged and discharged. *Id.*

45. The metal oxides are affixed onto the foils by means of a binder. Ex. 2002 at 5. The binder is a polymer, and frequently polyvinylidene fluoride (PVDF) is used. Ex. 1004, 3:17-18 (“The binder can, for example, be polyvinylidene fluoride (PVDF)”). The binder embeds the metal oxide particles and fixes them onto the foils, which provides for the structural integrity of the electrodes. Ex. 1004 at 1 (“The galvanic cell includes an active material, a support for the active material

and a binder for bonding the active material and the support.”). The binder is chemically stable, and helps the battery maintain its durability over the battery’s chemical environment and the mechanical stresses undergone by the battery over its lifetime.

46. The most valuable components of the battery are the metal oxides in the cathode. However, these metal oxides are embedded in the binder, which must be dissociated in order to liberate the metal oxides. Ex. 1004, 2:31-36 (“The invention is based on the knowledge that the heating of the cell fragments up to the decomposition temperature would theoretically have to be enough to destroy the binder to the extent that the active material is set free, but such that the active material is nevertheless difficult to remove from the support.”). Because of the stability of the binder, a high heat furnace/oven may be used to decompose the binder. Temperatures on the order of 350° to 800°C may be sufficient to decompose the binder. Ex. 1004, 4:25-27 (“The decomposition temperature is preferably at least 350°C and at the most 800°C. It has been found that at these temperatures the binder is certain to decompose.”). Once the binder is decomposed, the metal oxides in shredded material are reduced to black powder along with pieces of metal foil substrate pieces.

47. The high temperatures of these furnaces/ovens can generate unwanted by-products. For example, LiPF_6 and PVDF may decompose into a toxic gas,

including hydrogen fluoride (“HF”). Ex. 1006 at 1:22-27 (“In addition, when LiPF_6 reacts with water, LiPF_6 is hydrolyzed and generates toxic hydrogen fluoride.”).

Hydrogen fluoride may corrode glass, break seals on industrial machinery, and if inhaled, can be fatal.

48. In order to facilitate the breakdown of these batteries, it is advantageous to shred them. The term “comminuting” is used to describe the shredding of batteries. By shredding the batteries, the individual components are exposed, to better allow the extraction of the underlying materials. Shredding the batteries yields an unstructured bulk of fragments of battery components. *Id.* A hazard arises when there are residual charges left in the batteries. Ex. 2003, 2:[0004] (“When crushing electrolytic cells under normal atmosphere, the electrolyte or a solvent containing electrolyte can easily ignite due to released electrical charges and associated arcing. In the case of lithium-ion cells, such a fire is accompanied by a release of hydrogen fluoride.”). These residual charges may spark, triggering a chemical reaction. Ex. 1018, 1:29-31 (“The danger lies in the charge that some of these cells may still contain, which could lead to causing a fire.”). Explosions and fires may result. Ex. 2003, 2:[0004].

49. A fundamental problem with the recycling process is the difficulty of transporting batteries to a central facility for processing. To extract the metal oxides and other materials from the batteries, high heat furnaces/ovens have

conventionally been used, and these high heat furnaces/ovens make sense to build in centralized locations. Thus, there is a logistics problem of getting these used batteries transported to a centralized facility for processing.

50. The transportation problem is heightened by the toxic nature of the used batteries (whether shredded or whole). Ex. 2003, 2:[0002] (“However, if electrolytic cells are damaged, chemical compounds with high environmental and health hazards can develop from the electrolyte in interaction with the electrodes, the housing, and/or ambient air.”); *see id.* (“Similar hazards can emanate from aged electrolytic cells.”). Thus, there was a need to “inactivate” the batteries prior to transportation.

51. Many companies have experimented with techniques to inactivate spent or shredded batteries. These prior art techniques typically relied on adding foreign substances to the batteries as a way to neutralize their chemical hazards, such as using fire retardants, brines, pressurized fluids, etc. These prior art approaches include the following:

52. **Ecobat.** In 2007, Ecobat LLC filed for patent protection on a technique for safely handling shredded lithium-ion batteries. Ex. 2004. Ecobat focused on flushing the electrolyte out of the batteries using a pressurized solvent. Ex. 2004, 3:3-5. According to this invention, batteries are sealed in a high-pressure extraction container, which is then filled with an extraction fluid, such as CO₂. Ex.

2004, 5:41-45. Various additives are then added to the fluid to enhance extraction of electrolyte. Ex. 2004, 6:1-14. The pressure and temperature of the fluid are then increased until the battery casings are breached. Ex. 2004, 6:39-46. The fluid then enters the breached cell and begins to dissolve the electrolyte. Ex. 2004, 7:10-15. Once the electrolyte is dissolved, the solution is moved to a precipitation vessel for further extraction of electrolyte components. Ex. 2004, 8:3-10.

53. **LiMotive.** In 2009, LiMotive Company Ltd. filed for patent protection on a method for safely preparing batteries for disposal. Ex. 2005, 2:23-25. A true and correct copy of the LiMotive patent (in German) is attached hereto as Exhibit 2006. A certified English translation of the LiMotive patent is attached hereto as Exhibit 2005, upon which I rely for my opinions. LiMotive's technique teaches shredding the batteries in the presence of a metal flame retardant and one binding agent. Ex. 2005, 3:6-8. According to the invention, lithium-ion batteries are shredded through a stream of high-pressurized water containing abrasive materials. *Id.*, 6:7-10. Adding water is used in conjunction with fire retardant agents to prevent, suppress, reduce, or extinguish fire during the shredding process. *Id.*, 3:6-20. Fire retardants are used to put out localized fires in order to prevent thermal runaway (explosion). Ex. 2005, 3:9-11. In view of the likelihood of HF formation, the method discloses sequestering the emerging HF with a binding agent (*i.e.*, calcium oxide (CaO), calcium chloride (CaCl), and/or calcium hydroxide

(Ca(OH)₂). *Id.*, 3:11-15. Any hydrolyzed discharge from the shredding process is filtered off to remove the insoluble components of the discharge of the liquid components during the shredding process. *Id.*, 12:11-13. The filtrate is then dried to reduce the weight of the filtrate before transport. *Id.*, 12:16-18.

54. **Electrocycling.** In 2009, Electrocycling GmbH filed for patent protection on a technique for processing batteries for transport. Ex. 2003. A true and correct copy of the Electrocycling patent (in German) is attached hereto as Exhibit 2007. A certified English translation of the Electrocycling patent is attached hereto as Exhibit 2003, upon which I rely for my opinions. The Electrocycling patent disclosed two alternative embodiments for deactivation of batteries: one by aqueous solution, another via a deactivating powder. Ex. 2003, 5:[0034]-[0035]. According to the first embodiment of the invention, crushed lithium-ion battery cells fragments are filled into a plastic drum pre-filled with aqueous lithium hydroxide (LiOH) solution. Ex. 2003, 3:[0017], 5:[0034]. In another embodiment of the invention, shredded cells are dusted with deactivation powder before they reach the collection drum. Ex. 2003, 3:[0018], 3:[0035].

55. **Hayashi.** In 2013, Hiroshi Hayashi, Koichiro Hirata, Hidenori Tsurumaki, and Hisashi Hoshina filed for patent protection on a method for processing fluorine-containing electrolyte solution in lithium-ion batteries. Ex. 1006. According to Hayashi's method, a whole battery is first depressurized and

immersed in an oil heater for 2 hours. Ex. 1006, 11:13-17. The organic components of the battery are then volatilized by heating the electrolyte past the boiling point of the organic ingredients. Ex. 1006, 4:38-45. Hayashi's method purposefully decomposes lithium hexafluorophosphate to release the hydrogen fluoride gas. Ex. 1006, 4:45-47. The method teaches adding water or mineral acids (such as sulfuric acid) to the electrolyte before heating to accelerate the gasification and the decomposition reactions. Ex. 1006, 5:18-52. The released gasses are then captured and separated: the organic solvent components are recovered while the fluorine compound is immobilized as calcium fluoride. Ex. 1006, 5:64-67.

56. **Dunagan.** In 2014, Dennis Dunagan and Teague Ostrander filed for patent protection for a system for recycling volatile battery sources. Ex. 1018. Dunagan's process teaches neutralization of comminuted lithium batteries in a neutralizing brine solution. Ex. 1018, 5:4-11. The comminuted material must remain in the neutralizing brine for at least 24 to 48 hours, until the "chemical reactions are substantially neutralized." Ex. 1018, 5:18-25, 5:31-34. The wet comminuted material is then air dried before the second round of comminution. Ex. 1018, 5:31-34, 5:40-42. The second comminution step transforms the shredded batteries into a homogenous material, which allows workers to take a sample of the material to identify the potential value of the precious metal oxides in the material. Ex. 1018, 5:63-6:5. The homogenous material is then transported to a processing

plant for reclamation of battery components. Ex. 1018, 5:63-6:5.

57. There was a drawback to using foreign substances to inactivate the batteries. Adding these additional compounds introduced further contaminants into the battery material, thus complicating the recycling process. *See* Ex. 1001, 2:6-12 (teaching that avoiding the addition of foreign substances has great benefits because it “decreases the complexity of the battery processing, reduces the weight of the inactivated comminuted material and increases the purity in the subsequent separation and recycling steps”); *see also id.* (“In particular, in potential subsequent hydrometallurgical processing steps, a high degree of product purity that does not require the input of foreign ions is advantageous.”). Additional hazards could result; for instance, treatment with aqueous solutions risks partial electrolysis, which could lead to the formation of hydrogen fluoride gas.

B. '097 Patent Overview

58. The '097 patent describes an important advance for inactivating shredded batteries for transportation. Instead of introducing foreign substances to inactivate the shredded batteries, the '097 patent is directed to inactivating the shredded batteries by simply drying them under vacuum, particularly at a maximum pressure of 300 hPa. Ex. 1001. Preferably, the method of the '097 patent avoids the use of high temperatures during the drying process as a way to inhibit the formation of toxic gases, especially HF. Ex. 1001, 2:5-12.

59. Through this process, the technique of the '097 patent results in dried, shredded battery material, which is chemically inert and safe for storage and transport. Ex. 1001 at 1:63-2:4 (“The comminuted material is therefore largely inert and can be transported.”).

60. Once inactivated, the shredded battery material can be shipped to a centralized facility for additional processing steps, like decomposing the binder and harvesting the metal oxides from the support foils. Ex. 1001, 6:27-31.

61. The '097 patent describes and claims methods and installations that provide an efficient, low-cost way of recovering spent battery material with high purity and rendering it safe for transport by inactivating the comminuted battery material using a vacuum drying process.

62. Claim 1 of the '097 patent is as follows:

1. A method for the treatment of used batteries, comprising the steps:
 - (a) comminuting the batteries such that comminuted material is obtained;
 - (b) inactivating the comminuted material such that an inactivated comminuted material is obtained, wherein the inactivating step is performed during or after the comminuting step; and
 - (c) filling a transport container with the inactivated comminuted material;wherein the inactivating step is performed by drying the comminuted material, and

wherein the drying occurs at a maximum pressure of 300 hPa.

EX1001, 10:44-59.

Dependent Claims 2–11 add additional limitations. *Id.* at 10:60-11:47.

63. Claim 12 of the '097 patent is as follows:

12. A battery processing installation for treatment of used batteries,
comprising:
 - (a) a comminution unit configured to comminute the batteries such that
comminuted material is obtained;
 - (b) an inactivation device comprising a drying device configured to
inactivate the comminuted material, wherein the inactivation device is
configured to perform the inactivating step during or after the
comminuting step of the comminution unit;
 - (c) a filling device configured to fill a test transport container with the
inactivated comminuted material; and
 - (d) a vacuum installation connected to the drying device and configured to
generate a vacuum in the drying device.

EX 1001, 11:50-62.

Dependent Claims 13–21 add additional limitations. Ex. 1001, 11:62-12:62.

C. Related District Court Litigation

64. I am aware of a related District Court case involving the same parties,

and where the '097 patent has been asserted and validity of the '097 patent claims has been challenged.

VI. ANALYSIS OF HANISCH '419 AND THE COMBINATION OF HANISCH '419 WITH DUNAGAN (GROUND 1)

65. Dr. van Schalkwijk opines that claims 1-3, 7, 8, 9, 10, 12-13, and 19 of the '097 patent would have been obvious in view of Hanisch '419 and the knowledge of a POSITA (Ground 1). I disagree with Dr. van Schalkwijk's conclusions regarding the combination of Hanisch '419 and the knowledge of a POSITA, for the reasons discussed below.

A. Overview of Hanisch '419

66. Hanisch '419 is directed to retrieving active materials from lithium batteries. Ex. 1004, 1:8-10 ("The invention concerns a method for retrieving active material, in particular lithium or lithium compounds, from a galvanic cell..."); *see also id.* at 1:42-45 ("The object of the invention is to improve the retrieval of active material, in particular lithium or lithium compounds, from old batteries or accumulators."); *id.* at 3:9-10 ("The active material is understood in particular to mean a bond which can reversibly take up and release lithium ions.").

67. Hanisch '419 recognizes a problem in the art of incomplete separation of the active material from its support material. Ex. 1004, 1:32-36. In particular, Hanisch '419 notes that while it was known to shred a cell into fragments and then heat those fragments to decompose the binder that bonds the active material to the

support, the active material was extremely difficult to remove from the support.

Ex. 1004, 2:31-42. Hanisch '419 is directed to solving this problem of incomplete removal, and it teaches doing so by “air jet sieving”: smashing the heat-treated cell fragments into an air jet sieve at high speeds to separate the active material from the support. Ex. 1004, 2:39-55

68. Given the problem that Hanisch '419 seeks to solve, the patent focuses on techniques for achieving a more complete separation of active material from the support. To achieve separation, Hanisch '419 teaches heating the crushed battery material to extremely high temperatures—350°C to 800°C—to decompose the binder that binds the active material to the support. Ex. 1004, 4:25-27. The high temperature oven is operated “under inert gas or in a vacuum” to prevent the aluminum and copper supports from oxidizing. *Id.* at 4:6-8 & 4:8-10. Hanisch '419 teaches that by preventing aluminum and copper oxidation, the anode and cathode can be processed together, resulting in copper recovery “with a high degree of purity” (*Id.* at 4:8-18) as well as reducing the cost of subsequent processing of the active material due to lower aluminum oxide contamination. Thus, Hanisch '419 discloses using inert gas or vacuum for ventilation purposes to reduce the amount of oxygen to avoid oxidizing the material. *Id.*

69. Hanisch '419 then teaches an air-jet sieving step, in which “the support, with the active material still adhered to it, powerfully impacts upon the

sieve.” Ex. 1004, 2:39-40. According to Hanisch ’419, the impact “removes the active material hitherto adhered to the support so that it can be retrieved.” *Id.* at 2:40-42.

70. In addition to the decomposition and air-jet sieving steps, Hanisch ’419 teaches an optional pre-drying step, which is set up “behind the cell crushing device and before the oven.” Ex. 1004, 5:54-56. According to Hanisch ’419, the purpose of the pre-drying step is to retrieve additional electrolyte. As the patent explains, “the cell fragments are dried at a drying temperature, so that dry cell fragments and drying vapours are formed, whereby the drying vapours are at least partly condensed. This has the advantage that the electrolyte solvent can be retrieved.” Ex. 1004, 3:65-4:4.

71. Hanisch ’419 is therefore concerned with improved techniques for separating active material from carrier films. As I discuss further below, Hanisch ’419 is not concerned with, and does not even address, drying comminuted battery material for the purpose of inactivating it and rendering it safe for transport.

72. These processes in Hanisch ’419 are done through a continuous process. Ex. 2004 at 3:27-28 (“The method according to the invention is preferably performed as a continual process and not in batches”).

73. Hanisch ’419 does not show any vacuum pump connected to either the pre-dryer or the decomposition oven and there is no discussion about how

strong the vacuum in any step of the disclosed process would be. Ex. 1004 (Figure 1). Hanisch '419 does not show any condenser coupled to the high temperature oven (*Id.*), which confirms that electrolyte solvents are not recovered from that oven.

74. As I describe below, I disagree with Dr. van Schalkwijk that the teachings of Hanisch '419 render obvious certain claim elements of the '097 patent.

B. Hanisch '419 Does Not Teach All Limitations of '097 Claim 1, Either Alone or in View of a POSITA

1. Hanisch '419 does not teach “inactivating the comminuted material such that an inactivated comminuted material is obtained” in the pre-dryer

75. I agree with the Board's determination that neither Hanisch '419 alone, nor Hanisch '419 in combination with the view of a POSITA teach “inactivating the comminuted material such that an inactivated comminuted material is obtained.” Paper 10 at 13 (“Although Hanisch teaches the removal of some volatile electrolyte through heating and condensing the resulting vapor in its low-temperature drying process, Petitioner does not direct us to evidence to show [inactivation].”).

2. Hanisch '419 does not teach inactivating as part of the pre-drying step

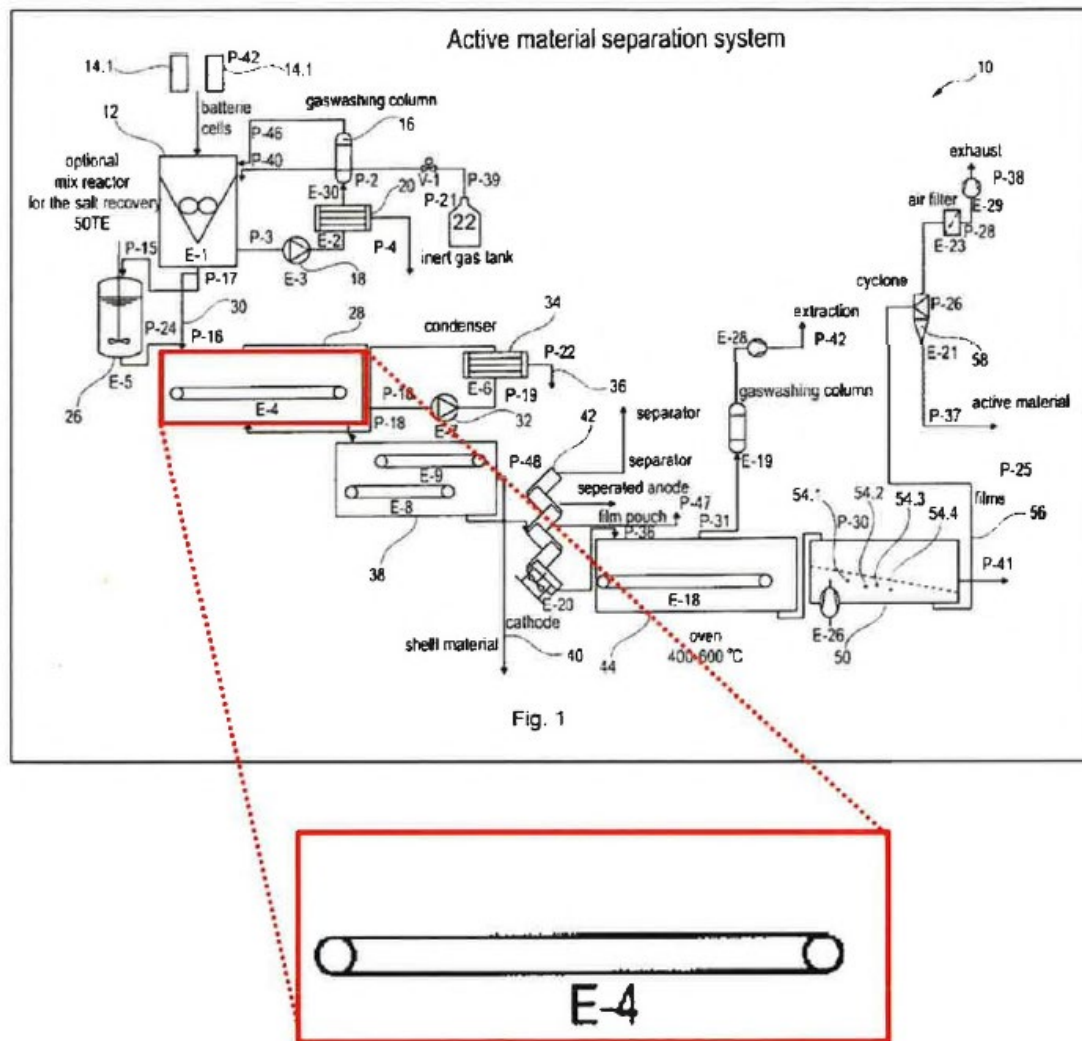
76. I agree with the Board's determination that that the low-temperature

pre-dryer of Hanisch '419, either alone or in combination with the view of a POSITA, does not teach “inactivating the comminuted material such that an inactivated comminuted material is obtained.” Paper 10, at 13 (“Although Hanisch teaches the removal of some volatile electrolyte through heating and condensing the resulting vapor in its low-temperature drying process, Petitioner does not direct us to evidence to show [inactivation].”).

77. A POSITA would not have understood the “pre-drying” step in Hanisch '419 to teach “inactivating the comminuted material such that an inactivated comminuted material is obtained.” Hanisch '419 explains that “the cell fragments are dried at a drying temperature, so that dry cell fragments and drying vapours are formed, whereby the drying vapours are at least partly condensed. *This has the advantage that the electrolyte solvent can be retrieved.*” Ex. 1004, 3:65-4:4 (emphasis added). In view of this disclosure, a POSITA would have understood that the purpose of the pre-drying step in Hanisch '419 is not to inactivate the comminuted material, but rather to condense out additional electrolyte for recovery. Ex. 1004 at 4:3-4 (“This has the advantage that the electrolyte solvent can be retrieved.”). Hanisch '419 has no express teaching of inactivating the material in this pre-drying step, and it provides no guidance whatsoever as to how much of the electrolyte solvent to retrieve. As I explain below, a POSITA would not have understood Hanisch '419 to teach drying the comminuted material for

long enough to remove a sufficient amount of the electrolyte solvent to achieve inactivation.

78. To the contrary, a POSITA would have understood Hanisch '419 to be concerned with speed and more particularly with maintaining a high throughput in extracting electrolyte and separating the active material from the support. Hanisch '419 expressly teaches that the method is “preferably performed as [sic] continual process and not in batches.” Ex. 1004, 3:27-28. Consistent with this disclosure, Figure 1 of Hanisch '419 (reproduced below) illustrates the pre-dryer (28) as having a conveyer belt, on which comminuted material would pass through the dryer at a constant rate in a continuous manner. A POSITA would have understood the conveyer belt to move material through the dryer continuously, again consistent with processing at high throughput.



Ex. 1001, Fig. 1 (annotations added).

79. A POSITA would have understood the advantages of using a continuous process, rather than a batch process, in Hanisch '419. Shredded battery material is toxic, and Hanisch '419 clearly wanted to avoid accumulation of this toxic material, which could undergo various undesired reactions, and could potentially catch fire, or explode, or release toxic hydrogen fluoride gas. By using

a continuous process, Hanisch '419 minimized the hazard, by promptly removing electrolyte and sending the material to the pyrolytic furnace as fast as possible. A continuously operating dryer reduces the risk of explosions because it ensures that only small quantities of undried, comminuted batteries are present in the pre-dryer at any given time.

80. That Hanisch '419 refers to the dryer 28 as a “pre-dryer” would also have indicated to a POSITA that comminuted material is not dried for a sufficiently long time to inactivate it. *See* Paper 10, at 13. Rather, a POSITA would have understood the pre-dryer to perform a short treatment step prior to decomposition.

81. Further, Hanisch '419 teaches that the battery material goes from the pre-dryer to the decomposition oven, where it will be subjected to temperatures of at least 350°C. A POSITA would have understood that whatever solvent remains in the comminuted battery material through the pre-dryer will be destroyed in this furnace. *See* Paper 10, at 13. Thus, a POSITA would understand that there is no need to take the caution and incur the cost to dry the material to the endpoint result of inactivation.

82. Hanisch '419 does not overtly state at which pressure the pre-dryer operates. However, a POSITA would recognize that the pre-dryer runs at an overpressure, not under vacuum. This is evident because the pre-dryer is coupled

to the cell crushing device 12. Hanisch '419 does not show any gas flow blocking systems between cell crushing device 12 and pre-dryer 28, and accordingly, they must operate at the same pressure. A POSITA would recognize that the cell crushing device 12 operates at an overpressure. This is evident because the inert gas tank 22 is utilized to regulate the inert gas pressure in the cell crushing device 12, which must be maintained at an overpressure because there is no vacuum pump. The overpressure is necessary to prevent air from entering cell crushing device 12, thereby reducing the risk of explosion. And because the pre-dryer is at the same pressure as the cell-crushing device 12, consequently the pre-dryer also must be operated at an overpressure.¹

83. Hanisch '419 does not include the necessary technical detail to instruct how to achieve inactivation of battery material using the pre-dryer. Specifically, the patent lacks any disclosure regarding the duration of time the material must spend in the pre-dryer or the pressure conditions required to achieve inactivation. Additionally, Hanisch '419 does not provide any guidance on how to assess whether the material has reached a sufficiently dry state. Furthermore, it

¹ I note that the use of sufficient airflow would work to evaporate solvents even if the temperature of the pre-dryer is below the boiling point of those solvents. This is the basic principle of a tumble dryer. This is especially effective when the material being dried has a high surface-to-volume ratio, as is the case with comminuted battery material.

fails to address the variability in electrolyte solvents that would be encountered depending on the types of batteries being processed, nor does it include any discussion of the specific drying conditions needed to ensure the complete evaporation of these solvents (*e.g.*, dimethyl carbonate evaporates at around 90°C at atmospheric pressure, Ex. 2032, while ethyl methyl carbonate is harder to evaporate because its boiling point is only reached at around 107°C at atmospheric pressure, Ex. 2033. A POSITA would have understood that this lack of detail renders the pre-dryer unsuitable for achieving inactivation, as it fails to address the fundamental parameters and conditions necessary to ensure the material is adequately processed to become inactivated.

84. The pre-dryer operates as a continuous process, introducing inherent challenges in maintaining precise control over parameters such as temperature and pressure. Continuous systems are prone to leaks at interfaces and junctions, which can result in fluctuations in pressure and inconsistencies in temperature regulation. Ex. 2025 (teaching challenges of using rotary airlocks to feed solid material continuously into a vacuum environment). Unlike batch systems, which allow for controlled and isolated conditions, continuous processes are less suited for achieving the uniform and stable environment required for precise drying. A POSITA would have understood that these limitations make the pre-dryer unsuitable for reliably achieving inactivation of the comminuted material.

85. Further, a POSITA would have understood that the rate of electrolyte extraction is inversely proportional to the volume of electrolyte extracted. In other words, as more electrolyte is extracted in the pre-drying process, it takes longer and longer to extract additional electrolyte. Given these indications that Hanisch '419 is concerned with speed at the pre-dry stage — describing a “pre”-dryer rather than a dryer and recommending a continuous, rather than batch, process — a POSITA would not have understood Hanisch '419 to teach leaving the comminuted battery material in the pre-dryer for the substantial amount of time required to evaporate enough electrolyte to achieve inactivation. A POSITA would have understood Hanisch '419 to teach, at most, partial removal of the electrolyte in this low-temperature, pre-drying process. A POSITA would not have understood Hanisch '419 to teach removing a sufficient amount of electrolyte in the pre-drying process to inactivate the comminuted battery material and make it safe for transport. Hanisch was concerned with energy consumption, and it would have run counter to this goal to extract electrolyte solvent to the point of inactivation. Ex. 1004 at 4:51-54.

86. Therefore, a POSITA would not have understood Hanisch '419 to teach “wherein the inactivating step is performed by drying the comminuted material” at the pre-dry step.

3. Hanisch '419 does not teach “wherein the drying occurs at a maximum pressure of 300 hPa”

87. Dr. van Schalkwijk opines that the disclosure of a “vacuum” in Hanisch '419 could apply to either the pre-dryer or the high-temperature decomposition oven (Ex. 1003, ¶ 111), but I disagree. Considering the disclosures on which Dr. van Schalkwijk relies in context, a POSITA would have understood the “vacuum” to refer only to the decomposition oven, and not to the pre-dryer.

88. First, I note that Hanisch '419 nowhere expressly states that vacuum should be applied in the pre-drying step. The entire Hanisch '419 disclosure contains only six instances of the term “vacuum,” and none describe the pre-drying step.

- The abstract teaches applying vacuum during the crushing step: “The method includes . . . crushing the cells, in particular under inert gas or in a *vacuum*.” Ex. 1004, p. 1.
- The abstract also teaches the option (along with inert gas) of using vacuum in the decomposition step: “heating the solid cell fragments up to the decomposition temperature (T_z), which is high enough to make the binder decompose so that it loses its binding properties, preferably under inert gas or in a *vacuum*.” Ex. 1004, pp. 1-2.

- The term “vacuum” also appears twice in the claims of Hanisch ’419, once in reciting the crushing step (“(a) crushing the galvanic cell, under inert gas or in a *vacuum*, to form solid cell fragments”) and once in reciting the decomposition heating step (“[t]he method according to claim 1, wherein the heating of the solid cell fragments up to the decomposition temperature takes place under inert gas or in a *vacuum*.”). Ex. 1004, 7:6-7, 8:11-13.
- The term “vacuum” also appears in the patent specification in describing the decomposition step: “The heating of cell fragments up to the decomposition temperature is preferably carried out under inert gas or in a *vacuum*.” Ex. 1004, 4:6-8.
- Finally, the patent includes the following disclosure: “The heating up of solid cell fragments is understood in particular to mean heating up in gas-proof container, so that oxygen, for example, is prevented from the entering. In particular, the heating up takes place under inert gas or in a vacuum.” Ex. 1004, 3:4-8.

89. Dr. van Schalkwijk makes much of this last disclosure and opines that the reference to “vacuum” there could apply to either the decomposition heating step *or* the “electrolyte evaporation” (pre-dry) step. Ex. 1003, ¶111. Properly read in view of the entire specification, however, a POSITA would have understood this

disclosure of a “vacuum” to describe only the decomposition heating step.

90. First, this last disclosure to which Dr. van Schalkwijk points appears after disclosure in the specification of the decomposition step (at 2:31-42, e.g.) but well before any description of the pre-dry step, which is first addressed at column 4, line 55. Therefore, the only “heating” yet disclosed at column 3 of the specification is decomposition heating, and a POSITA would therefore naturally understand the “heating up of solid cell fragments” to refer to the decomposition heating.

91. Further, Hanisch ’419 explains that the pre-dryer “is flushed with inert gas by the circulation pump 32.” Ex. 1004, 5:61-63. A POSITA would have understood that a chamber being flushed with gas would ordinarily not be under a strong vacuum, as the provision of the flushing gas would compromise the vacuum. A POSITA reading this disclosure would further have understood that a vacuum would be unnecessary and wasteful where the container was already being flushed with inert gas to prevent entry of oxygen and potential ignition.

92. A POSITA would know that there are mechanisms that can be employed to maintain a vacuum in a continuous manufacturing process. However, Hanisch ’419 does not describe any sealing mechanisms that would allow a continuous process to operate under vacuum.

93. As I explained above, a POSITA would understand that the pre-dryer actually operates at an overpressure, not under vacuum. *See* ¶82, *supra*. This is because the pre-dryer is coupled to the cell-crushing device, without separation by any air block mechanism. A POSITA would recognize that the cell-crushing device, which is coupled to nitrogen tank 22, must run at an overpressure, to prevent oxygen from entering the shredder. Otherwise, the oxygen would be prone to cause explosions, in the presence of the electrolyte solvent being exposed through the crushing process along with the sparks caused by the metal-on-metal crushing. That hazard risk must be counteracted by a nitrogen atmosphere at an overpressure to prevent oxygen from entering.

94. Further, to the extent Hanisch '419 teaches operating the oven 44 under vacuum for the decomposition heating step, it does not teach “a maximum pressure of 300 hPa.” Therefore Hanisch '419 does not teach “wherein the drying occurs at a maximum pressure of 300 hPa,” whether in the pre-dry or decomposition heating steps.

4. Hanisch '419 does not teach “The method according to claim 1 wherein drying occurs at a temperature of less than 80° C” of Claim 9

95. It is my opinion that Hanisch '419 does not teach Claim 9 of the '097 patent: “the method according to claim 1 wherein drying occurs at a temperature of less than 80°C.” For the reasons above, it is my opinion that the pre-dryer in

Hanisch '419 does not inactivate the comminuted battery material. *See* ¶¶ 75-86, *supra*. Thus, while the pre-dryer may operate at less than 80°C (Ex. 1004 at 4:3-5), it does not inactivate the comminuted battery material.

96. Moreover, the decomposition oven of Hanisch '419 cannot be relied on for this element, because it operates at far higher temperatures. Ex. 1004 at 6:8-13 (teaching the operation of the decomposition oven at 400°C-600°C). Thus, neither instrumentality in Hanisch '419 discloses what is claimed in Claim 9.

C. Hanisch '419 Does Not Teach All Limitations of '097 Claim 12

1. Hanisch '419 does not teach “an inactivation device comprising a drying device configured to inactivate the comminuted material”

97. It is my opinion that the pre-dryer of Hanisch '419 does not meet the requirements of the limitation of Claim 12: “an inactivation device comprising a drying device configured to inactivate the comminuted material.” I reference my opinions above, explaining why the pre-dryer of Hanisch '419 is not configured to inactivate the comminuted battery material. *See* ¶¶ 75-86, *supra*.

2. Hanisch '419 does not teach “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device.”

98. The Board ruled that Petitioner failed to show “that Hanisch teaches or suggests a vacuum installation attached to Hanisch’s decomposition oven.”

Institution Decision at 19. I agree with the Board’s ruling in this regard.

99. Dr. van Schalkwijk further opines that Hanisch '419 discloses this limitation of claim 12 for the same reasons he discussed for claim limitation 1[e], citing back to ¶¶ 110–116 of his declaration. Ex. 1003, ¶ 134. I have responded to ¶¶ 110–116 of Dr. van Schalkwijk's declaration already at ¶¶87-94 above, pointing out where I disagree with his opinions.

100. Dr. van Schalkwijk offers additional reasons purportedly supporting his opinion that Hanisch '419 teaches this limitation, but I disagree that Dr. van Schalkwijk's additional reasons support his opinion. I address those reasons, and the flaws in Dr. Schalkwijk's conclusions, below.

101. First, Dr. van Schalkwijk notes that Hanisch '419 discloses a “pre-dryer” configured to heat the cell fragments to a “drying temperature,” and that Hanisch '419 teaches that “heating up takes place under inert gas under vacuum.” Ex. 1003, ¶ 135. Dr. van Schalkwijk then opines that a POSITA would therefore conclude that Hanisch '419 “discloses generating a vacuum in the drying device.” I disagree with Dr. van Schalkwijk. As I explained above at § VI.B.3, the “heating” that “takes place under inert gas or vacuum,” as taught in Hanisch '419, refers to the decomposition heating step in the oven 44 and does not refer to the pre-dryer 28, which a POSITA would have understood to be operated either at or above atmospheric pressure. It is my opinion that a POSITA would understand the pre-dryer to operate an overpressure, not under vacuum. *See* ¶¶ 82 & 93.

102. Dr. van Schalkwijk also points to the circulation pump and condenser associated with the pre-dryer and opines that a POSITA would understand them to be a “vacuum installation.” Ex. 1003, ¶ 136. But Dr. van Schalkwijk’s opinion is flawed. First, I note that Dr. van Schalkwijk’s opinion concerning the function of the circulation pump and condenser is informed by his reading of the ’097 patent itself, which I understand to result in impermissible hindsight in an obviousness analysis. As Dr. van Schalkwijk himself puts it,

In my opinion, a POSITA would understand the circulation pump and condenser of Hanisch [’419] to be a “vacuum installation” *in view of the examples in the ’097 patent* describing that a “vacuum pump should be understood particularly generally to mean a device that creates a vacuum,” (EX1001, 8:23-25), a “vacuum pump is a compressor which sucks in and compresses gas 31 that is present in the drying device 26,” (EX1001, 8:29-31), that the “vacuum installation comprises a condenser . . . arranged in the direction of material flow in front of a vacuum pump, by means of which the dryer is evacuated,” (EX1001, 6:44-51), and that the “vacuum installation comprises an injector or venturi pump, i.e. a jet pump with a pump liquid that is used to generate negative pressure.” (EX1001, 7:4-6.).

Ex. 1003, ¶ 136, emphasis added.

103. Dr. van Schalkwijk then opines that a POSITA would therefore “understand that where Hanisch discloses that the ‘pre-dryer 28 comprises a circulation pump 32 and a condenser’ (emphasis added), the circulation pump and condenser (i.e. a vacuum installation) would be ‘connected’ to the pre-dryer (a drying device), given the ‘comprising’ language used to modify ‘pre-dryer.’” Ex.

1003, ¶ 136. Dr. van Schalkwijk is therefore relying on the '097 patent disclosure of a “vacuum installation” comprising a condenser and a pump to conclude that a POSITA would have understood the condenser and pump in Hanisch '419 to be a “vacuum installation.” In other words, Dr. van Schalkwijk is relying on the '097 patent disclosure *itself* in opining as to what a POSITA would have understood Hanisch '419 to teach, rather than relying on any teaching in the prior art. I understand that this reliance on the invention itself in an obviousness analysis constitutes improper hindsight bias as, under a legally-proper analysis, a POSITA would be aware of the prior art but not the patent itself. Therefore a POSITA would not have concluded that Hanisch '419 taught a vacuum installation connected to the pre-dryer.

104. Furthermore, Hanisch '419 does not show any vacuum installation connected to the decomposition oven. Hanisch '419 has a detailed schematic. Ex 1004 at Fig. 1. Neither this figure, nor the supporting description in the specification, give any disclosure of a vacuum installation connected to the decomposition oven.

105. As there is no suggestion in Hanisch '419 of a vacuum installation connected either to the pre-dryer or to the decomposition oven, Hanisch '419 does not teach this claim element.

D. Summary of Opinions Regarding Hanisch '419 and the Combination of Hanisch '419 with Dunagan (Ground 1)

106. To summarize, then, it is my opinion that Hanisch '419, whether by itself or in combination with Dunagan, fails to teach all of the elements of claim 1 and claim 12 of the '097 patent and therefore does not render those claims obvious.

107. With regard to claim 1, the pre-dry step of Hanisch '419 fails to teach “inactivating the comminuted material.” *See* ¶¶75-86.

108. Further, the pre-dry step of Hanisch '419 fails to teach “wherein the drying occurs at a maximum pressure of 300 hPa,” not only because there is no express disclosure of this element, but also because a POSITA would have seen no need for a vacuum where the pre-dryer was being flushed with inert gas. *See* ¶¶87-94. Hanisch '419 therefore fails to teach “wherein the drying occurs at a maximum pressure of 300 hPa.” *Id.*

109. With regard to claim 12, the pre-dry step of Hanisch '419 fails to teach inactivating the comminuted battery material. And Hanisch '419 does not teach “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device” for reasons similar to those I discussed at above. Hanisch '419 does not teach a vacuum installation connected to the pre-dryer, nor to the decomposition oven. Hanisch '419 therefore fails to teach “a vacuum installation connected to the drying device and configured to generate a

vacuum in the drying device.” *See* ¶¶ 97-105.

110. I note that Dunagan, which Dr. van Schalkwijk alleges teaches the “filling a transport container” limitation, does not address these deficiencies of Hanisch ’419, and neither Dr. van Schalkwijk nor Ascend argues otherwise.

VII. ANALYSIS OF THE COMBINATION OF HANISCH ’419 WITH DUNAGAN, MEADOR, SHIN, AND/OR HAYASHI (GROUND 2)

A. Hanisch ’419 in view of Dunagan, Meador, Shin, and/or Hayashi Does Not Render Unpatentable Claims 1, 2, 3, 7, 8, 9, 10, 12, 13, or 19

111. Dr. van Schalkwijk further opines that Hanisch ’419 in combination with other alleged prior art references including Dunagan, Meador, Shin, and/or Hayashi render obvious claims 1-3, 7, 8, 9, 10, 12-13, and 19 of the ’097 patent (Ground 2). The addition of Meador (Ex. 1011), Hayashi (Ex. 1006), and Shin (Ex. 1010) in Ground 2 fails to render claim elements 1[e] and 12[d] obvious, nor does it address the deficiencies of Hanisch ’419 as discussed previously. These secondary references do not provide sufficient teaching or suggestion regarding the vacuum drying step claimed in elements 1[e] and 12[d], nor do they address other critical aspects of the claimed invention.

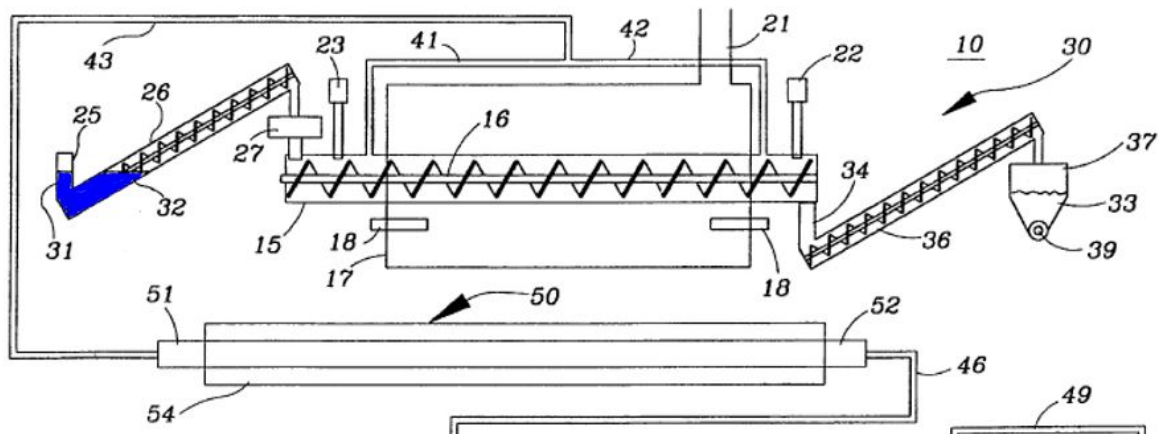
Overview of Meador

112. Meador discloses a process for reclaiming components of batteries. Meador uses a continuous pyrolytic process. Ex. 1011, 3:11-16; 4:9-16.

113. Meador teaches that the pyrolytic process is performed under a

slight vacuum. Ex. 1011 a 3:26 In order to maintain a vacuum in a continuous process, with solid material entering and exiting the pyrolytic chamber, there need to be a mechanism that allows this passage to occur while maintaining a vacuum. Meador teaches two mechanisms to fulfill this role.

114. First, Meador teaches the use of water seals. At the front end of the system, Meador teaches using a water seal to allow the battery material to enter into the pyrolytic oven. As depicted in Figure 1, batteries are introduced into the system through hopper 25, and fall down to enter an upwardly-directed screw conveyor 26. Ex. 1011 at Fig. 1. A liquid, such as water, fills this low point in the entryway, rising up to level 32 in the hopper and the screw conveyor, as annotated in solid blue in the figure below:



Ex. 1011 at Fig. 1 (annotated and cropped); *see also id.* at 4:50-53 (“A liquid 31, such as, water is maintained at level 32 in the hopper 25 and screw conveyor 26 to exclude oxygen or air entering into the crusher 27 and then,

into the pyrolysis chamber 15.”)

115. Once the batteries fall through the water seal and are conveyed up the screw, they fall into a crusher 27, and then fall into a pyrolysis chamber 15, through which they are conveyed with screw 16. 4:43-48 & Fig. 1. Vacuum pump 70 creates a “slight vacuum to withdraw the off-gases for further processing.” 3:26-27. Off-gases are vented through flow lines 41 and 42 and condensed with a cooling jacket 54. 5:1-12. The solid battery materials exit the pyrolytic chamber, and are collected with another screw conveyor 36.

116. Second, Meador teaches that the output end of the process should be sealed. Meador teaches either using another water seal, or using a pressure switch. Ex. 1011 at 3:37-40 (“The recovery auger may be water sealed or by using a closed hopper with a pressure switch, the dry, solid materials will serve as a discharge valve thus, maintaining a vacuum on the system.”). Meador states that the particular pressure switch should be the BIN-DICATOR device. *Id.* at 6:1-7. (“The pressure sensitive switch to operate a discharge valve (not shown) may be obtained from any material sales store, under U.S. Registered Trademark BIN-DICATOR, as utilized in collection system 30 of FIG. 1, to maintain the desired level of solid material 33 collected in closed bin 37 to ensure the system is sealed from air and oxygen entering the pyrolysis chamber.”).

117. Meador discloses a pyrolysis chamber operating at temperatures between 350°F and 650°F (which equates to between about 176°C and 343°C). Ex. 1011 at 4:30-47 & 5:59-60.

118. Meador states to maintain a vacuum of “about one half to one inch of mercury,” and also refers to “five inches of water.” Ex. 1011 at 5:60-62 & 6:58-59. Converted to hPa, these ranges equate to about 12 hPa to 34 hPa. Meador describes the vacuum being used to “withdraw the off-gases and vapors from the pyrolysis chamber for recovery of liquids and gases which are processed for safe environmental disposal or recovery and reuse.” Ex. 1011 at 4:1-8.

119. I have a fundamental disagreement with what Dr. van Schalkwijk stated in his declaration (Ex. 1003) about the significance of these vacuum ranges. In his declaration, Dr. van Schalkwijk assumed that these vacuum ranges are absolute vacuum ranges. I disagree with what Dr. van Schalkwijk stated in his declaration. A POSITA would have understood that these ranges refer to a negative pressure of about 12 hPa to 34 hPa. Because ambient pressure (at sea level) is 1013.25 hPa, this means that Meador is disclosing operating the system at an absolute pressure of about 979 hPa to 1001 hPa. I explain my reasoning below.

120. I note that Dr. van Schalkwijk revised his opinions in his

deposition, and agreed that it was appropriate to interpret the vacuum levels stated in Meador to be pressure relative to ambient, and not an absolute pressure. Ex. 2024 at 68:18-73:4 & 112:25-114:13. He confirmed his opinion that the pressure in Meador's system would be a slight underpressure of about a half-inch of mercury (or an absolute pressure of 29.5 inches of mercury). See Ex. 2024 at 71:1-73:4. This equates to an absolute pressure of about 999 hPa. It appears then, that Dr. van Schalkwijk and I are now in agreement on the pressure level taught by Meador.

Further Overview of Hayashi

121. Further to the comments above regarding Hayashi, Hayashi discloses a process for removing hydrogen fluoride from lithium batteries to facilitate the safer recovery of remaining electrolyte solvents (Ex. 1006, 11:59-66). The method involves hydrolyzing lithium salts into hydrogen fluoride gas (HF) by adding water to the cells, and subsequently capturing the HF either through wet processing as calcium fluoride or through dry processing using solid calcium-containing structures (Ex. 1006, 5:33-35; 6:1-8:3).

122. Hayashi's process is conducted on individual battery cells from EV batteries weighing approximately 1.6 kg, which are heated in an oil bath and subjected to vacuum pressures to promote volatilization of fluorine and solvents (Ex. 1006, 9:37-47; 11:38-39).

123. Hayashi teaches removing the safety valve of the cell, adding water, and then putting a pipe on top of the opening for ventilating the vapors that will begin to emanate. These vapors include hydrogen fluoride, which is highly toxic. In view of the toxic gas being generated, Hayashi uses a moderately strong vacuum level. Hayashi's examples employed a range of pressures from 50 hPa to 200 hPa. Ex. 1006 at 4:48-5:17, 10:50-60.² Hayashi states that pressures on the lower end of this range (stronger vacuum) are preferred in order to volatilize the solvents. Ex. 1006 at 4:61-5:3.

124. Hayashi's process is conducted on a single battery cell at a time. It is a batch process (with each "batch" being a single battery cell). Hayashi's process is not amenable to a continuous process. It is a slow and expensive single-battery processing approach. It would be labor-intensive to pull off the safety seals, add the water, and properly affix the pipe for driving off the hydrogen fluoride gas (while taking all appropriate safety precautions when working with this toxic compound).

125. Hayashi does not disclose comminuting batteries or drying them for transportation safety. Instead, Hayashi teaches adding water to facilitate chemical reactions as a precursor to comminution, to detoxify the batteries

² 5 kPa equals 50 hPa, and 20 kPa equals 2000 hPa.

before grinding them. Ex. 1006, 5:19-21.

Overview of Shin

126. Shin discloses a process for introducing whole batteries into a “reaction reservoir,” where the whole batteries are heat-treated. The apparatus in Shin is a heavily reinforced unit, which is built to shield from potential explosions as these whole batteries are subjected to high heat. *See, e.g.*, Ex. 1010 at 4:63-67 (steel frame); *id.* at 5:27-36 (soundproof materials).

127. The unit is initially subject to a strong vacuum (10^{-4} torr, which is 0.000133 hPa), in order to purge oxygen from the system. Ex. 1010 at 8:4-15. Then, the system is flooded with nitrogen gas. 8:16-22. Thus, the added nitrogen gas neutralizes the vacuum. The result is an inert environment, essentially free of oxygen. The resulting environment is not under vacuum.

128. Small batteries (like household batteries) are fed serially through “inlet 33.” *Id.* at Fig. 1 (#33). Larger batteries are introduced into the reaction reservoir by loading them into a basket on a separate unit which is wheeled into and coupled with the main unit. *Id.* at Fig 4. After the atmosphere is rendered inert, as discussed above, the whole batteries are then heated at a temperature range from 470°C to 550°C. Ex. 1010 at 8:28-34. This high heat will rupture the batteries, resulting in poisonous gases emanating from the heat-treated batteries. This release of poisonous gas would also diminish any

vacuum. There is the potential for explosions in this approach, which necessitates the purging of oxygen and the use of nitrogen gas discussed above. Shin teaches to vent and exhaust the poisonous gases generated through this process, rather than trying to suppress their creation. *Id.* at 4:4-9. After the heat treatment, then Shin teaches crushing and grinding the batteries. *Id.* at 9:21-26 & Fig. 5 (Step S80).

B. Hanisch '419 alone or in view of Hayashi, Meador, or Shin does not teach “wherein the drying occurs at a maximum pressure of 300 hPa”

1. Hanisch '419 alone or in view of a POSITA does not disclose this limitation

129. Petitioner’s arguments relying solely on Hanisch '419 and/or in view of a POSITA fail for the same reasons discussed above in Ground 1.

2. A POSITA would not combine Hanisch '419 and Dunagan with Meador, Shin, or Hayashi

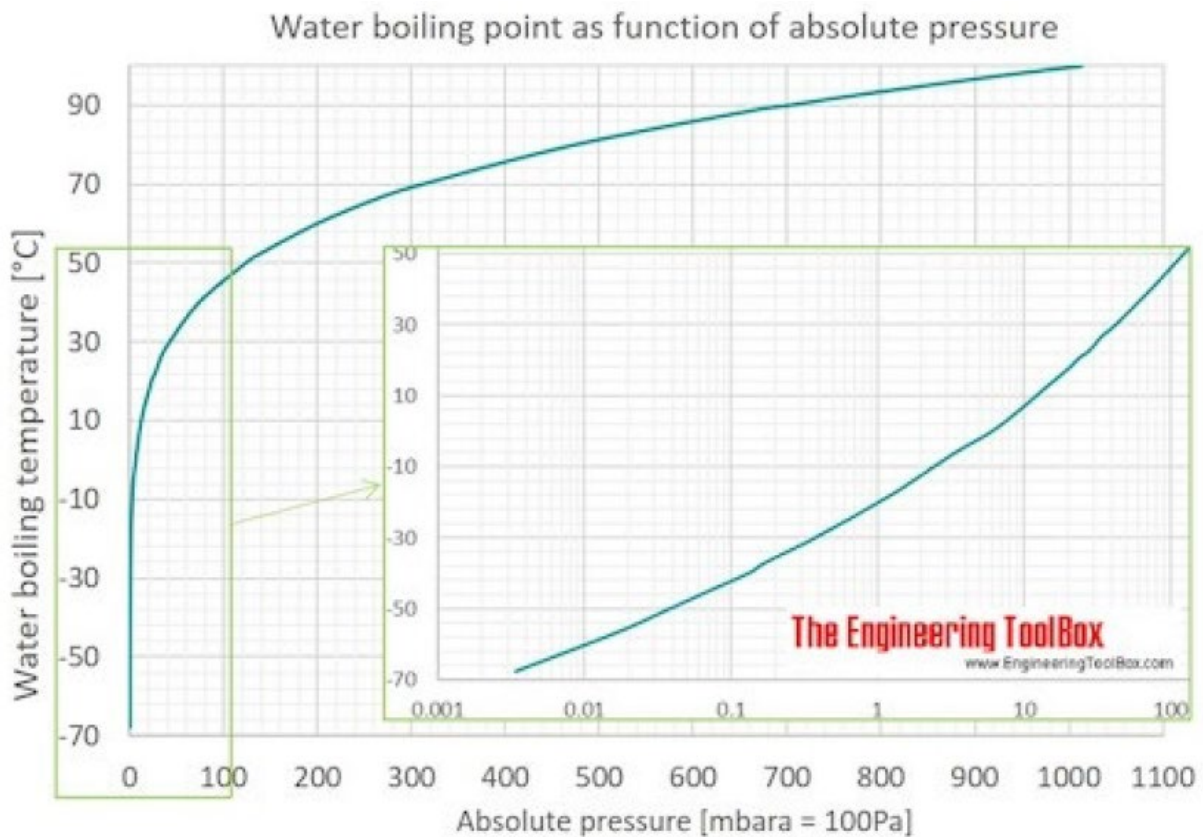
i. A POSITA Would Not Be Motivated to Combine Meador with Hanisch '419

130. Petitioner argues that Meador could be combined with Hanisch '419 to teach the claimed vacuum drying step in claim elements 1[e] and 12[d]. I disagree.

131. I fundamentally disagree with the assertions by Dr. van Schalkwijk in his declaration as to the pressure levels that Meador teaches. In his declaration, Dr. van Schalkwijk appears to assume that the vacuum levels in Meador are absolute

vacuum levels. Ex. 1003 at ¶ 146. However, that interpretation is impossible, for at least four reasons.

132. First, if the pressure inside Meador's system were in the range of 12-34 hPa, the water seals would boil off. The boiling point of water drops as the pressure drops. Attached as Exhibit 2026 is a graph showing the boiling point of water as a function of pressure.



(https://www.engineeringtoolbox.com/water-evacuation-pressure-temperature-d_1686.html)

Ex. 2026 (source: https://www.engineeringtoolbox.com/water-evacuation-pressure-temperature-d_1686.html)

133. Using the same website, I determined the following boiling points. At 12 hPa (*i.e.*, about 9 mm Hg), the boiling point of water is 9.4° (or 48.8°F). At 34

hPa (i.e., about 25mm Hg), the boiling point of water is about 26.5°C (or 79.6°F).

134. Given the lowered boiling point of water under the pressures that Dr. van Schalkwijk presumes in his declaration, Meador's water seals would boil off. Even at the pressure of 34 hPa, the boiling point of water is sufficiently depressed (79°F) that the water would boil off in the hot environment of Meador's plant, which includes a pyrolytic furnace. And if the water seals boil off, Meador's plant would be unable to maintain a vacuum.

135. **Second**, it would take an enormous column of water to maintain a pressure differential between the ambient, exterior environment and a chamber that is maintained at an absolute pressure of 12-34 hPa. In order for the column of water to restrain this pressure differential, the column of water would have to be over 393 inches tall (*i.e.*, about 3 stories tall). I compute this by determining the pressure differential that would exist across the water column, which would range from 979 hPa to 1001 hPa. Using a freely-accessible conversion tool, a pressure differential of 979 hPa equates to a column of water of 393 inches of water (over 32 feet).³ Likewise, a pressure differential of 1001 hPa equates to a column of water of 401 inches (over 33 feet). Plainly, a three-story column of water is not what is shown in Meador.

³ <https://www.unitconverters.net/pressure/hectopascal-to-inch-water-4-176-c.htm>

And regardless, it would be futile to erect this 3-story tall water column, because the water would just boil off.

136. **Third**, Meador’s illustration of the water seal, as confirmed by the supporting text, shows that the water level is essentially flat across the seal. Ex. 1011 at Fig. 1 (showing an even water level 32 both below the hopper 25 and in the screw conveyor 26) & 4:50-53 (“A liquid 31, such as, water is maintained at a level 32 in the hopper 25 and screw conveyor 26 to exclude oxygen or air entering into the crusher 27....”) (emphasis supplied). However, if the absolute pressure inside the chamber were 12-34 hPa (and the ambient pressure outside the plant was 1013 hPa), then there would be an imbalance between the two ends of the water seal. That is, the ambient pressure would press down on the water level below hopper 25, and the water level would rise along screw conveyor 26. Given the need for a 3-story tall water column, this discrepancy would be immediately noticeable. However, Meador shows essentially a flat water level across the seal, confirming that Dr. van Schalkwijk’s interpretation in his declaration is incorrect.

137. **Fourth**, Meador’s description of the vacuum is inconsistent with maintaining an absolute vacuum of 12-34 hPa. Meador characterizes the vacuum level as “slight.” Ex. 1011 at 3:24-26. However, according to the treatise submitted by Petitioner URT in IPR2024-00887, a “rough” vacuum is

categorized as having a range from 1000 hPa to 1 hPa, and a “medium” vacuum level is categorized as having a range from 1 hPa to 0.001 hPa. Ex. 2027 at 1 [DIN English Translation].⁴ If Meador’s vacuum was operated at an absolute pressure of 12-34 hPa, this would be at the low end of the “rough” vacuum, and nearly a “medium” vacuum. A POSITA would not characterize this as a “slight” vacuum.

138. A POSITA would understand that Meador does not teach the use of an absolute vacuum level of 12-34 hPa. Rather, a POSITA would understand that Meador is teaching the use of a negative pressure of 12-34 hPa. That is, Meador is teaching the use of an absolute pressure range of 979 hPa to 1001 hPa (if at sea level). At this pressure range, the water seals would not boil off. And at this pressure range, the water column would only have to be about one foot tall to withstand the pressure differential.⁵ This height is consistent with what Meador depicts. At a pressure differential of 12-34 hPa, the two ends of the water seal would be essentially flat, as Meador depicts in Figure 1. And, this pressure differential would qualify as “slight,” as Meador

⁴ The original German-language version of DIN 28400 is attached hereto as Ex. 2028, and the certificate of translation obtained by Petitioner URT in IPR2024-00887 is attached hereto as Ex. 2029.

⁵ <https://www.unitconverters.net/pressure/hectopascal-to-inch-water-4-176-c.htm>

characterizes it.

139. Thus, it is my opinion that Dr. van Schalkwijk misinterpreted Meador in his declaration, and that the proper reading of Meador is that it teaches the use of an absolute pressure of about 979 to 1001 hPa. Thus, it is my opinion that Meador does not teach the use of a pressure below 300 hPa. Indeed, in his deposition, Dr. van Schalkwijk testified that the pressure in Meador's furnace would have been a negative pressure of a half-inch of mercury relative to ambient (i.e., about 999 hPa). Ex. 2024 at 71:1-6. Therefore, a POSITA would not combine Hanisch '419 with Meador to arrive at a device that meets the requirement of Claim 1 of the '097 patent to inactivate by drying "at a maximum pressure of 300 hPa." Rather, Meador teaches away from using a vacuum level as strong as 300 hPa in a continuous process.

140. **Meador's Bin-Dicator pressure switch.** Similarly the pressure switch taught by Meador would not work at the vacuum levels presumed by Dr. van Schalkwijk. Exhibit 2030 is a product manual for a Bin-Dicator pressure switch. Although this particular manual post-dates Meador, it describes the device consistently with Meador's teachings. I am personally familiar with Bin-Dicator pressure switches, having used them to maintain the raw material levels in the feeder bins for cathode and anode active material

mixers in lead acid battery plants during my days as a lead acid battery product engineer at Delco-Remy working in six different North American plants and a French Plant and later as Operations Director managing the construction and launch of two separate plants in South Korea and Brazil. (Bin-Dicator is somewhat of an acronym for Bin Level Indicator, where if the material level drops below a preset value in a bin – it automatically triggers activation of a feeder line/conveyor to fill the bin to the preset level. These can function at the same pressure and/or between different levels of pressure differential due to the weight on the pressure switch). These devices have remained fundamentally the same for the past four to five decades. Ex. 2030 at 3 (“Bin-Dicator controls eliminate bin overflow, empty bins, clogged conveyors, choked elevators and the resulting damage and waste.”). The manual’s description of the device confirms that it is designed to work at atmospheric pressures, and that its mechanism of action relies on pressure exerted by bulk material against a diaphragm:

The Bin-Dicator control is a pressure actuated switch for use with free flowing bulk materials at atmospheric pressures. Actuation of the switch is the result of pressure exerted by the bulk material against the diaphragm assembly. De-actuation or switch release is a result of the bulk material clearing away from the diaphragm.

Ex. 2030 at 3.

141. The Bin-Dicator device would work in Meador's system by mounting the Bin-Dicator switch at a desired height in bin 37 for maintaining a minimum level of battery material. A port at the bottom of the bin 37 empties into a screw conveyor 39. Ex. 1011 at 5:45-56. If the accumulated material in the bin drops below the level of the mounted switch, then the port would close. Ex. 1011 at 5:33-37 ("Closed bin 37 has a pressure sensitive release for maintaining a minimum level of solid material 33 in closed bin 37, thereby to exclude air or oxygen flowing from the collector system 30 into the pyrolysis chamber 15."). The pressure of the mass of the accumulated material atop the port would seal that opening, allowing a negative pressure to be maintained in the pyrolysis chamber.

142. This mechanism would only work at a slight underpressure in the pyrolysis chamber. If there was a large pressure differential (as Dr. van Schalkwijk opines), then the accumulated battery material would not drop through the port into the screw conveyor (or alternatively a blast of ambient air would thrust up through the bin, negating the vacuum). Moreover, the Bin-Dicator manual confirms that the device should not be in a vacuum. Ex. 2030 at 3 ("for use with free flowing bulk materials at atmospheric pressures"). Meador's instruction to use the Bin-Dicator device thus confirms that the pyrolysis chamber operates at only a modest underpressure, and not at an absolute pressure of 12-34 hPa. Again, as explained earlier (§140), I confirm this based on my personal

experience as a Delco-Remy battery product engineer for the six North American and a French lead acid battery plants and later as the Operations Director when I managed construction, launch and commission of two large lead acid battery plants (daily production rates of 10,000 to 12,000 batteries/plant) in South Korea and Brazil.

143. Furthermore, a POSITA would not have combined Meador with Hanisch '419 to teach a vacuum level of less than 300 hPa, because the purposes are fundamentally different. Meador uses the vacuum to prevent the exhaust gases from being released into the environment untreated and to enable liquids and gases to be recycled. Ex. 1011 at 3:25-26 & 4:2:8. This is important because Meador's system is designed to handle cadmium and mercury, which are toxic even at low concentrations, and so the environmental and regulatory concerns are significant. Meador teaches that an under pressure (pressure differential) of 12-34 hPa is sufficient for this role.

144. The decomposition oven of Hanisch '419 does not rely on vacuum to evaporate and recover the solvents. Hanisch '419 has a pre-dryer that recovers some of the solvents. Hanisch's high temperature furnace is not using the vacuum to recover solvents, which have already partially been recovered, and with the remaining solvents being destroyed in the decomposition furnace. Ex. 1004 at 6:8-13. The temperatures in Hanisch's

decomposition furnace (*i.e.*, 350°C to 800°C) are far in excess of the temperatures that would be needed to volatilize the organic carbonate solvents in lithium batteries, like DMC and EMC (*i.e.*, 90°C and 107°C, respectively). Ex. 2032 & Ex. 2033. There would be no need to employ a vacuum below 300 hPa to facilitate the evaporation of these organic solvents, because those solvents would already be destroyed by the pyrolytic heat of Hanisch's decomposition furnace. Applying vacuum would not meaningfully enhance the decomposition, which is driven by heat.

145. A POSITA would avoid using a vacuum below 300 hPa in the system of Hanisch '419 because doing so would be:

- **Costly.** It is costly to operate a vacuum pump to maintain high pressure differential and also to engineer seals to maintain this high pressure differential, particularly in the context of a continuous flow system. I refer to my discussion below regarding rotary airlocks, *see* ¶¶152-159, *infra*.
- **Unnecessary.** It would be unnecessary to use a vacuum of 300 hPa or lower to promote evaporation of the solvents in Hanisch '419, because the pyrolytic temperatures in the decomposition oven of Hanisch '419 would destroy the solvents, with no need for lower pressures to volatilize them.

- **Counterproductive.** It would be counterproductive to maintain a higher vacuum level than necessary, because the seals and valves to maintain a vacuum in a continuous process are fault-prone and would be a high maintenance/failure point for the facility, and would lead to vacuum pump fatigue and burnout. See ¶¶152-159, *infra*.

146. Furthermore, a POSITA would be motivated to use the mildest vacuum level (lowest pressure differential) possible to achieve the goal of reducing oxygen levels to avoid oxidation of the aluminum and copper foils, and would be motivated to use an inert gas like nitrogen to assist in purging the oxygen, which would be a lot less expensive. Ex. 1004 at 4:6-8; 4:51-54. A POSITA would understand the constraints of working in a continuous system, and would recognize that maintaining a strong vacuum in that environment is costly and fault-prone. A POSITA would understand from Meador that the highest vacuum level that would be practicable in a continuous system would be a negative pressure or pressure differential of about 34 hPa at the most, which is far weaker than the vacuum levels claimed in the '097 patent. Ex. 1011 at 5:61-63. A POSITA would have understood that Hanisch '419 is generally concerned with keeping “energy consumption as low as possible”

(4:51-54). A POSITA would have understood that the time and energy it takes a pump to attain vacuum increases exponentially with the strength of the vacuum. This is governed by the formula:

$$t = (V/S) \cdot \ln(P_0/P_1)$$

where V=chamber volume in Cubic Meters; S= average pump suction capacity in Cubic Meters per Hour; P_0 = initial pressure in millibar; and P_1 = final pressure in millibar. Ex. 2034. If the time goes up exponentially, the energy to run the pump similarly goes up exponentially. Thus, there is a strong incentive to use as weak a vacuum as possible to achieve the goals of the facility.

Hanisch '419 is generally concerned with keeping "energy consumption as low as possible" (4:51-54) in order to make the overall process economical while increasing the yields as well.

147. Thus, a POSITA would understand from Meador that running a continuous processing line at a negative pressure or pressure differential of about 12 hPa to 34 hPa (*i.e.*, at an absolute pressure of 979 hPa to 1001 hPa, at sea level) would be approximately the range of pressures that could be reasonably maintained in such an environment.

ii. Hayashi teaches away from Hanisch '419, and a POSITA would not be motivated to combine these references

148. A POSITA would not have combined Hanisch '419 with Hayashi.

The two references are not compatible with each other.

149. Hanisch '419 is a continuous process, which may include the use of a vacuum in the pyrolytic oven. Ex. 1004 at 3:27-28. For a POSITA considering the pressure to use in that oven, a foremost consideration would be how to manage that vacuum in a continuous process. In Hanisch '419, material flows laterally along a pyrolytic oven and is continuously removed via a discharge pipe. Ex. 1004 at 6:8-13 & Fig 1 (#44). Hanisch '419 is silent as to the devices that could be used to allow this continuous flow of materials into and out of the vacuum system. Nor does Hanisch '419 say what vacuum levels could be sustained in this system.

150. To allow battery material to enter and exit this oven continuously, it would be difficult to maintain a strong vacuum (rather than a slight underpressure), especially at high temperatures. There are limited options of mechanisms that would allow this functionality.

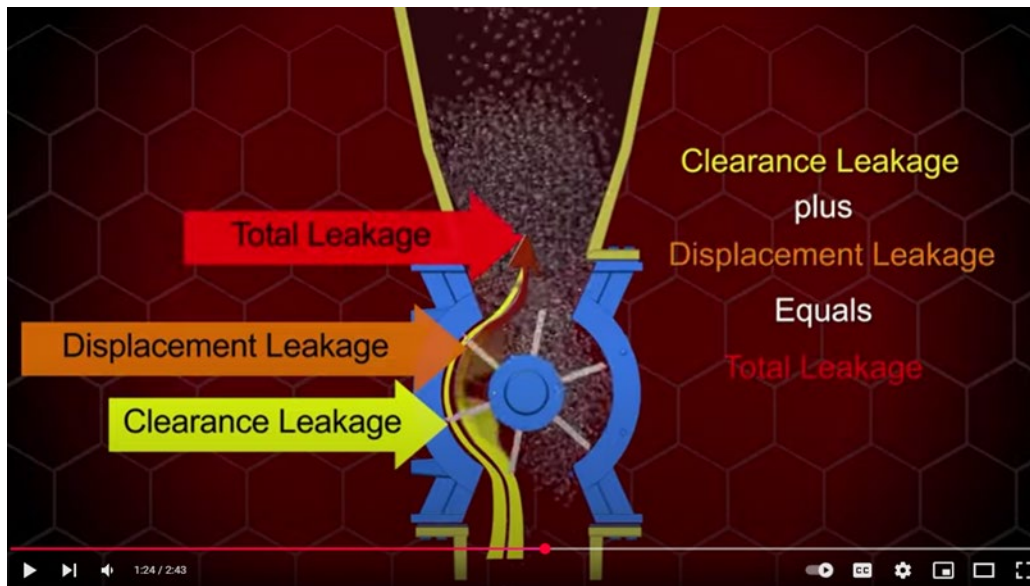
151. Meador teaches that a water seal can be used to allow solid material to continuously enter a chamber that is maintained under vacuum. Ex. 1011 at 4:50-53. But a water seal would be incompatible with Hanisch '419. Hanisch '419 deals with lithium batteries, which should not be dropped through a water seal, because the LiPF_6 could hydrolyze and create toxic hydrogen fluoride (or aqueous hydrofluoric acid). Also, a water seal is incompatible with low pressures, because the water would evaporate away, *see* ¶¶132-134, *supra*,

particularly in a factor environment where temperatures would be warm if not hot. Also, at low pressures, a massively tall water seal would be needed. *See* ¶135. For example, to maintain an absolute pressure of less than 300 hPa, a water seal of about 10 feet high would be needed.⁶ To maintain an absolute pressure of 16.9 hPa (0.5 inches of Mercury) a water seal of 33.3 feet would be needed. However to maintain a pressure differential of 16.9 hPa (absolute pressure of 996.35 hPa or 29.42 inches of Mercury) a water seal of only 0.56 feet (5 inches to 6 inches) will be needed (61-63, Column 5 Meador patent).

152. A more suitable mechanism would be rotary airlock. U.S. Patent No. 5,405,231 shows how a rotary airlock can be used to allow solid items to pass through a valve into a chamber that is maintained under vacuum. Ex. 2035.

153. However, rotary airlocks are leaky. The follow screenshot explains the leakage problem with rotary airlocks.

⁶ <https://www.unitconverters.net/pressure/hectopascal-to-inch-water-4-176-c.htm>



Ex. 2031. As shown here, a rotary valve separates two region of differing pressures. Solid material falls downward through a rotating set of vanes which are precisely machined to minimize air loss as the vanes spin around the valve. The material is able to fall through the rotating vanes and into the second chamber, largely preserving the pressure differential between the zones. However, air is able to escape around the edges of the vanes (*i.e.*, clearance leakage), and quantities of air pass through in the pockets defined by the vanes (*i.e.*, displacement leakage) as well as the pressure differential.

154. The leaks become pronounced over the usage of the airlock, because the material being conveyed (*e.g.*, the comminuted battery material) will damage the vanes, exacerbating the leakage. Furthermore, these devices are heat-sensitive, owing to the exacting tolerances of the vanes, and the expansion and contraction of the blades as they are heated and cooled.

155. The concerns of leakage were well known to a POSITA by the 2015 time frame. Ex. 2025 (“An improperly designed and applied rotary airlock valve can lead to poor efficiency, extra maintenance and operator manpower, low yields of product, equipment wear and replacement, and lost production due to process shutdowns.”). The Somsuk study documented the depletion of a pressurized system through a rotary airlock, confirming that a chamber pressurized to 1.5 bar was depleted to ambient pressure within 50 minutes. *Id.* at 74. Thus, these devices are not designed to handle strong vacuum levels.

156. Rotary airlocks would be challenging in the context of the Hanisch ’419 patent. The battery material is coarse, and so the material would not fill the pockets of the rotary valve fully, leading to high displacement leakage. Ex. 2025 at 75. The material is irregularly-shaped, jagged, metallic pieces, which would damage the vanes, causing further leakage. The working environment is hot, which requires additional clearance to account for expansion of the blade material, which also exacerbates leakage.

157. While a POSITA would likely turn to a rotary airlock for allowing a continuous flow of shredded battery material into the system of Hanisch ’419, a POSITA would be highly focused on managing the problem of leakage. The higher the pressure differential between the vacuum chamber and the

incoming stream, the higher the leakage of the rotary airlock or indeed any continuous airlock. The best way to manage leakage is to use as low a vacuum differential as possible. The other two variables that a POSITA would be aware of are how deeply to fill each pocket (shallower filling would minimize leakage) and the rotor rpm of the valve itself (lower rpm would minimize leakage). I have personally worked with rotary airlocks in both lead acid battery plants and Lithium ion battery plants as premeasured raw materials are fed into mixer feeders on their way to wet mixers.

158. In the context of Hanisch '419, the problem with leakage is that it would result in more oxygen entering the system, which Hanisch specifically sought to avoid. Ex. 1004 at 4:6-18. The most effective way to minimize the entry of oxygen would be to minimize the pressure differential between the pyrolytic oven and the ambient environment. The higher the pressure differential between the vacuum chamber and the incoming stream, the higher the leakage of the rotary airlock. Thus, more and more oxygen would bypass the airlock as the pressure differential increases. This would run counter to the goals of Hanisch '419 to exclude oxygen, to avoid oxidizing the copper and aluminum foils. Ex. 1004 at 4:6-18. Thus, a POSITA would want to use as low a vacuum differential as possible in Hanisch, particularly if the POSITA was using rotary airlocks or other such continuous flow devices. Meador's guidance is that using a negative

pressure, relative to ambient, of about a half-inch of mercury (*i.e.*, a negative pressure of about 17 hPa) would be sufficient to generate enough pressure gradient to do the job. Ex. 1011, 5:61-63.

159. In my own personal experience, I have worked in multiple engineering and consulting roles using rotary airlocks in analogous industrial production contexts. In Confidential Appendix C (Exhibit 2036), I provide details about these multiple consulting experiences. In all three of these contexts using rotary airlocks, we used a pressure differential of less than half an atmosphere. That is, the pressure differential across the rotary airlock was less than 500 hPa. Rotary airlocks are difficult to maintain, and those concerns escalate as the pressure differential increases. Therefore, my personal experience is that companies seek to avoid a high pressure differential, and that 500 hPa is on the high end of the negative pressure that a company would want to manage with a rotary airlock.

160. Meador also teaches using pressure switches, like the Bin-Dicator device. However, these devices are not good for low pressure applications. *See* ¶¶ 116 & 140-142, *supra*. Indeed, the Bin-Dicator manual confirms that it is meant to be used at ambient pressure. Ex. 2030. My personal experiences with “Bin-Dicators” confirm this.

161. In view of the teaching in Hanisch ’419 to use a continuous system to

allow solid material to flow into a chamber that can maintain a vacuum, and in view of the limitations of the mechanisms that could allow such a continuous flow, a POSITA would not look to Hayashi for guidance on which vacuum levels to use in Hanisch's system.

162. Hayashi is a batch process. Hayashi treats a single cell at a time, in a labor-intensive process involving pulling the safety seal off a battery cell, adding precisely specified amounts (+/- 0.1 ml) of water to liberate HF gas, and affixing a pipe to withdraw the HF vapors (this is extremely difficult in a commercial production setting when we have to process each cell or battery individually). Hayashi says nothing about how to permit a continuous flow of solid materials into a chamber while maintaining a vacuum. A POSITA would not look to vacuum levels from a batch process to inform how to determine the pressure levels to maintain in a continuous process. Furthermore, the vacuum levels taught in Hayashi are quite strong (*i.e.*, as low as 50 hPa). These vacuum levels are stronger than the levels that would be compatible with the requirement in Hanisch '419 to allow battery materials to continually enter and exit the pyrolytic oven while maintaining some level of vacuum. These vacuum levels are stronger than rotary airlocks what are generally recommended with rotary airlocks, as my own experience confirms. Ex. 2036 (Confidential Appendix C). The vacuum levels taught in Hayashi are far stronger than a water seal (as taught in Meador) would

allow to be maintained. *See* ¶¶132-134, *supra*. And these vacuum levels are stronger than a pressure switch, like the Bin-Dicator, could handle, particularly in light of the instruction to use these switches at atmospheric pressure. *See* ¶135, *supra*.

163. I understand that that the Board agreed to proceed based on the argument that a POSITA would have combined Hanisch '419 with Hayashi “because of the advantages of improved electrolyte evaporation at a given temperature when lower ambient pressures are used.” Institution Decision at 23. I wish to provide additional context to disagree with this ruling.

164. A POSITA would not be motivated to combine Hanisch '419 with Hayashi “because of the advantages of improved electrolyte evaporation at a given temperature when lower ambient pressures are used.” With respect to the decomposition oven of Hanish '419, that is a pyrolytic furnace operated at a temperature in excess of 350°C. Ex. 1004 at 4:25-28. At such high a temperature, there would be no need to seek guidance from Hayashi about to how to improve electrolyte evaporation. Rather, the electrolyte solvents would be destroyed in the furnace, with no need to facilitate their evaporation.

165. Likewise, with respect to the pre-dryer of Hanisch '419, a POSITA would not have looked to combine those teachings with Hayashi “because of the advantages of improved electrolyte evaporation at a given temperature when lower

ambient pressures are used.” The pre-dryer is not under vacuum, as I explained above. *See* ¶¶82, 93, *supra*. Applying a vacuum in the pre-dryer, which is coupled to the shredder, would likewise impose a strong negative pressure in the shredder 12, which would overwhelm the nitrogen tank 22 that is attempting to maintain an inert atmosphere in the shredder, sucking away the inert atmosphere. This would cause oxygen from the environment to seep into the shredder, where it could cause an explosion. *Id.* And the strong vacuum levels of Hayashi (preferably 1 hPa to 50 hPa) would be incompatible with the continuous system of the pre-dryer (which lacks any air flow blocking mechanisms). *See* Ex. 1004 at Fig. 1. A POSITA would not have looked to the vacuum levels in Hayashi to inform the proper pressure level to use in this very different architecture used in Hanisch ’419.

166. I understand that that the Board agreed to proceed based on the argument that a POSITA would have combined Hanisch ’419 with Hayashi to advance “the attenuation of toxic hydrogen fluoride production during the heating process.” Institution Decision at 23. I wish to provide additional context to disagree with this ruling.

167. Hayashi opens the safety seal on a battery cell and adds water to deliberately provoke the hydrolysis of LiPF_6 , to form hydrogen fluoride. Ex. 1006 at 4:38-5:21. This is the opposite of the supposed goal to attenuate the production of hydrogen fluoride. Thus, Hayashi teaches away from this goal. A POSITA

would not have considered Hayashi in attempting to attenuate the production of HF.

168. I understand that that the Board agreed to proceed based on the argument that a POSITA would have combined Hanisch '419 with Hayashi to promote “the control over potentially flammable compounds and gasses generated during such heating.” Institution Decision at 23. I wish to provide additional context to disagree with this ruling.

169. Hayashi does not provide any teachings about how gasses would be controlled in the context of the system of Hanisch '419. In the decomposition oven of Hanisch '419, flammable compounds are managed by pyrolyzing them. Ex. 1004 at 6:7-10. Hanisch '419 is not concerned with managing flammable compounds; the focus of Hanisch is avoiding oxidation of the copper and aluminum supports. Ex. 1004 at 4:6-18.

170. Likewise for the pre-dryer of Hanisch '419, a POSITA would not have combined Hanisch '419 with Hayashi to promote “the control over potentially flammable compounds and gasses generated during such heating.” The pre-dryer in Hanisch '419 is not under vacuum, as I explained above. See ¶¶82, 93, *supra*. Applying a vacuum in the pre-dryer, which is coupled to the shredder, would cause oxygen from the environment to seep into the shredder, where it could cause an explosion. *Id.* Thus, rather than controlling flammable compounds, applying

Hayashi to the pre-dryer of Hanisch '419 could instead cause an explosion hazard. And the strong vacuum levels of Hayashi (preferably 1 hPa to 50 hPa) would be incompatible with the continuous system of the pre-dryer (which lacks any air flow blocking mechanisms). See Ex. 1004 at Fig. 1. A POSITA would not have looked to the vacuum levels in Hayashi to inform the proper pressure level to use in this very different architecture used in Hanisch '419.

171. Furthermore, the point of Hayashi's disclosure teaches away from Hanisch '419. The point of Hayashi is that batteries should not be shredded as in the prior art Hayashi refers to, but rather need to be detoxified before recycling can proceed. Ex. 1006 at 1:30-50, 1:64-2:17, 9:4-8, 11:59-12:11. Hayashi distinguished the prior art by pointing out that the earlier approaches destroyed the batteries. Ex. 2011 at 1:30-50. Hayashi discloses adding water to the battery cell to off-gas the hydrogen fluoride, which is sequestered, after which the battery materials can be more safely recycled. Ex. 1006 at 5:19-25. By contrast, Hanisch '419 teaches that additional material should be avoided in order to achieve a high degree of purity. Ex. 1004 at 2:5-6. Hanisch '419 also teaches that this pre-treatment is not necessary, but rather that the batteries can be comminuted first, followed by the solvents being safely removed through processing. Ex. 1004 at Fig 1.

172. Hayashi uses vacuum to promote the evaporation of electrolyte

solvent. Ex. 1006 at 4:38-5:21. By contrast, Hanisch '419 recommends a vacuum to reduce the amount of oxygen in the decomposition furnace. Ex. 1004 at 4:6-18. Because Hanisch '419 was confronting a fundamentally different problem than Hayashi, a POSITA would not have combined the references.

iii. Shin Teaches Away from Hanisch '419, and a POSITA Would Not Be Motivated to Combine

173. Shin's teachings are fundamentally incompatible with Hanisch '419, and a POSITA would not be motivated to combine them.

Fundamentally, Shin does not teach processing batteries at a vacuum of less than 300 hPa.

174. Shin teaches using a high vacuum of 10^{-4} torr (*i.e.*, about 0.00013 hPa), running a rotary pump for about 5 minutes. Ex. 1010 at 8:4-12. This high vacuum purges the system of oxygen. *Id.* at 8:12-15. ("As a result, the oxygen in the treatment space S1 may be removed and the explosion possibility may be maximally suppressed in a heat treatment step.").

175. Shin does not maintain vacuum when batteries are processed. Rather, after purging the oxygen under vacuum, Shin then pumps nitrogen into the chamber. 8:16-17 ("In this [purged] state, the inert gas is injected into the treatment space S1 of the reaction reservoir 30 through the gas inlet 42."). And more gas is contributed to the reservoir during the processing, because batteries

rupture, emitting “poisonous gas” as they are heated to 470° to 550° Celsius very rapidly at the rate of 5 to 15 waste batteries per minute. *Id.* at 8:28-31 & 8:62-66. This interpretation is supported by the observation that the equipment is designed with very strong corrosion/oxidation resistant and high temperature tolerant nickel-chromium steel and also the placement of noise insulation material between the outer surface of reaction reservoir and inner surface of the frame to minimize the noise generated in the reaction reservoir (25-35, Column 5).

176. Shin makes no attempt to maintain a vacuum during the processing of the batteries. Whereas Shin initially employs a high vacuum to purge oxygen from the reaction reservoir, Shin subsequently fills the chamber with nitrogen and the discharged gases from the ruptured batteries. Shin makes no mention of a vacuum once the processing of the batteries begins. There is no teaching in Shin to vacuum dry comminuted batteries at a pressure of less than 300 hPa.

177. Shin does not attempt to suppress the formation of toxic gases, but rather focuses on exhausting these gases. *Id.* at 4:4-9. Shin teaches crushing and grinding the batteries after the heat-treatment process. *Id.* at 9:21-26 & Fig. 5 (Step S80).

178. Shin is not a continuous process in the sense of Hanisch '419. Shin does characterize itself as a “continuous heat treatment” process. Ex. 1010 at 3:41-46. However, Shin’s process is only continuous in the sense that

small consumer product batteries can be fed into the reaction reservoir in a serial manner during the course of a processing run. *Id.* at 8:28-34 (“the heat treatment is performed while inputting approximately 10 waste batteries per minute through the inlet 33.”). Shin teaches that this continuous feeding of batteries can be achieved by using a “gas blocking door 34” that prevent poisonous gas from escaping when new batteries are introduced. *Id.* at 8:42-51. However, this is all done in the context of a single batch, after which the accumulated battery material is removed from the reaction reservoir and transferred to a crusher. *Id.* at 9:21-26. Thus, Shin’s approach is essentially performed on a batch basis, not a continuous process, like in Hanisch ’419.

179. A POSITA would not have combined Shin with Hanisch. The approaches of these two references are fundamentally incompatible with each other. Whereas Shin ruptures whole batteries under high heat, Hanisch ’419 comminutes the batteries first. While Shin initially uses a high vacuum to purge oxygen, it negates that vacuum by flooding the chamber with nitrogen gas; by contrast, Hanisch ’419 states that the processing may be carried out under vacuum, which is not taught in Shin. There is no reason that a person of skill, when contemplating Hanisch ’419, would turn to Shin for its teachings. And there is no teaching in Shin to dry comminuted batteries at a pressure of less than 300 hPa.

C. Hanisch '419 alone or in view of Hayashi, Meador, or Shin does not render obvious the requirement of Claim 12 for “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device”

180. Petitioner argues that Meador, nor Hayashi, nor Shin can be combined with Hanisch '419 to teach “a vacuum installation connected to the drying device and configured to generate a vacuum in the drying device.” I disagree.

181. Meador's system employs water seals to facilitate the continuous flow of battery material into the pyrolytic chamber. Ex. 1011 at 4:50-53. Meador's system is designed for processing batteries with aqueous electrolyte solutions as well as lithium batteries that have been pre-treated with aqueous KOH. Ex. 1011 at 3:22-23 & 3:51-54. Consequently, these batteries are compatible with the water seals described by Meador. In contrast, Hanisch '419 teaches a system for processing lithium batteries, wherein the lithium batteries are comminuted and processed directly. Ex. 1004 at 3:19-4:18 & Fig. 1. These lithium batteries would react with the water seals of Meador, releasing toxic hydrofluoric acid, and potentially exploding or corroding and destroying the equipment. It would be hazardous to combine Meador's vacuum system with Hanisch '419 and a POSITA would not be motivated to make this combination.

182. Hayashi's vacuum system cannot be combined with Hanisch '419 as it operates on a batch process and lacks a mechanism to permit continuous flow of

battery material entering and exiting a chamber under vacuum. *See* ¶¶148-172, *supra*. Further, applying Hayashi's vacuum to the pre-dryer of Hanisch '419 would exacerbate the risk of explosion, by overwhelming the nitrogen tank, sucking off the inert atmosphere in the shredder, and pulling in oxygen from the environment that would ignite the electrolyte solvents in the spark-prone shredder. And there would not be a need to use the vacuum levels of Hayashi in the decomposition furnace of Hanisch '419, because those electrolyte solvents would be pyrolyzed, with no need for a vacuum to promote evaporation.

183. Shin's system cannot be combined with Hanisch '419 because it does not process battery materials under vacuum. Shin's apparatus creates a temporary vacuum solely to purge oxygen, then floods the system with nitrogen gas, eliminating the vacuum (Ex. 1010 at 8:4-15 and 16-22). Although Shin is described as a "continuous heat treatment" system, it does not continuously allow battery materials into a vacuum chamber as required by Hanisch '419. Therefore, Shin's vacuum system cannot integrate with Hanisch '419's continuous flow design.

VIII. SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

184. I understand the Patent Owner has provided such evidence of nonobviousness, including with respect to long-felt need, unexpected results, commercial success, and licensing, with respect to Duesenfeld's commercialization

of the '097 patent. In my view, such evidence supports my views, expressed herein, that the challenged claims are not unpatentable.

A. Objective Indicia of Nonobviousness as to the '097 Invention

1. Long-felt but unmet need and unexpected results

185. Companies tried and failed prior to the '097 invention to develop a process for inactivating depleted rechargeable batteries for safe storage and transport. Prior approaches included mixing various additional chemicals with the comminuted material to mitigate known hazards relating to the comminuted material, including: flame retardants (Ex. 2005 at 7-8); aqueous solution or a deactivating powder (Ex. 2003 at 5:[0034]-[0035]); water or mineral acids (Ex. 1006 at 5:18-52); brine solutions (Ex. 1018 at 5:4-11); and pressurized solvents (Ex. 2004 at 3:3-5). However, it was apparent that adding foreign substances to the comminuted battery material had deleterious effects on the recycling process. *See* Ex. 1001 at 2:6-12 (teaching that avoiding the addition of foreign substances has great benefits because it “decreases the complexity of the battery processing, reduces the weight of the inactivated comminuted material and increases the purity in the subsequent separation and recycling steps”). In addition, it was known that that treatment with aqueous solutions could cause partial electrolysis and produce toxic gases, which underscored the need for safe battery processing in such conditions. Ex. 1006 at 1:26-29 (“when LiPF_6 reacts with water, LiPF_6 is

hydrolyzed and generates toxic hydrogen fluoride. For this reason, a safe processing method is required.”).

186. The '097 patent allows batteries to be comminuted directly, and then inactivated by drying at a pressure below 300 hPa. The '097 patent eliminates contaminants from recycling by not requiring foreign substances. *See, e.g.*, Ex. 1001, 1:63-2:4, 2:5-12. The '097 patent provides a safer, more efficient method to recover spent battery material by safely inactivating electrolytes and solvents without producing hydrogen fluoride, ensuring high purity and safe transport. The solution of the '097 patent is deceptively simple, yet solved a stubborn problem in the industry.

187. The '097 invention demonstrated unexpected results. As previously mentioned, prior battery recycling methods involved the use of foreign substances or high temperatures that introduced significant hazards, such as freezing, incineration, melting, adding reactants, and shredding in water. The '097 patent adopted a fundamentally different and unforeseen approach to mitigating these hazards—by avoiding their creation altogether. The advantages and benefits of vacuum drying at pressures below 300 hPa without using foreign substances were notably superior. This method allows solvents to be recovered at a purity exceeding 99%, has low energy requirements, requires short drying times, eliminates the need for waste gas scrubbing, avoids the disposal of toxic filter

materials, requires no chemicals, and retains lithium in the black mass as LiPF₆ rather than as a breakdown product.

2. Nexus between secondary considerations and the claims of the '097 Patent

188. I understand that “the evidence of secondary considerations must have a ‘nexus’ to the claims, *i.e.*, there must be ‘a legally and factually sufficient connection’ between the evidence and the patented invention.” *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019).

189. I understand that Duesenfeld operates a battery comminution facility at its Wendeburg Plant. Ex. 2040 ¶¶6-8 (Declaration of Lydia Grote). I have reviewed materials regarding the Wendeburg Plant and have determined that it practices the '097 claimed invention. Ex. 2038; Ex. 2040, ¶¶1-9; Ex. 2041; Ex. 2053. Exhibit 2037 (Confidential **Appendix D**) is a chart illustrating, on a per-limitation basis, how Duesenfeld’s Wendeburg Plant practices Independent Claims 1 and 12 and various dependent claims. These claims directly address the functionality that drove customer demand and commercial success, and that frustrated others in the field.

190. From my review of the '097 patent specification, the Wendeburg Plant represents one of the preferred embodiments disclosed in the '097 patent. Ex. 1001, 3:4-12 (“According to a preferred embodiment, the drying occurs under

vacuum. The size of the vacuum is preferably selected such that the vapour pressure of dimethyl carbonate at 80° C., especially at 70° C., is not reached. It is beneficial if the drying occurs at a maximum pressure of 300 hPa, in particular a maximum of 100 hPa. At such low pressures, considerable parts of most electrolytes vaporise, especially dimethyl carbonate and ethyl methyl carbonate, and do so at temperatures of less than 80° C.”).

191. From my review of the trial record, I understand that Duesenfeld markets its battery recycling technology. The marketing materials that I reviewed reference the functionalities practiced by Duesenfeld’s Wendeburg Plant. Ex. 2053 (Duesenfeld Brochure), 3 (“we have developed and licensed processes that do not require melting down or high-temperature treatment of batteries”), 3 (“Patent: Drying below 80 degrees Celsius is only possible with the Duesenfeld patented process”); 5 (“During mechanical shredding and inactivation of the batteries, the drying process takes place below 80°C and at a low vacuum; Only under these conditions is no exhaust gas scrubbing necessary. Only in this temperature range can also the solvents of the electrolyte, the graphite and the lithium be recovered in a purity so that they can be reused. Through this technology, Duesenfeld combines environmental friendliness with maximum economic efficiency.”); Ex. 2012 (Duesenfeld website https://www.duesenfeld.com/recycling_en.html) (“... A low process temperature prevents the formation of toxic gases, so no exhaust gas

scrubbing is necessary. The separated solvent has a very high purity level because the production of hydrogen fluoride from reaction products is avoided.”).

IX. ADDITIONAL REMARKS

192. I reserve any right that I may have to supplement this declaration if further information becomes available or if I am asked to consider additional information or to submit an additional declaration if *inter partes* review is instituted. Furthermore, I reserve any right that I may have to consider and comment on any additional expert statements and testimony of Petitioners’ experts in this matter.

193. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Dated: February 14, 2025



Vani Dantam

Appendix A

VANI K. DANTAM

Ph: (765) 617-0658 | vanidantam@gmail.com | LinkedIn: <https://www.linkedin.com/in/vani-dantam>

EXECUTIVE SUMMARY

Accomplished global C-suite executive with 40+ years of strategic leadership experience in Energy Storage, Renewables, Utilities, Smart Grid, Electric Vehicle (EV) Infrastructure, and Defense industries. Managed multinational operations with substantial growth in highly complex and regulated sectors. Extensive expertise in managing large teams, design, construction and launch of global plants, and executing global mergers, acquisitions, and joint ventures. Proven ability to scale operations, increase profitability, and implement innovative technologies such as advanced energy storage solutions. Deeply involved in setting global industry standards for battery technologies as a member of SAE and UL committees. Fluent in Spanish, Portuguese, Hindi, and Telugu, with a strong international proficiency in key markets including North America, South America, Europe, and Asia. U.S. Navy veteran, recognized for public speaking and guest lectures at prestigious institutions.

CAREER HIGHLIGHTS

- **Global Leadership & Strategy:** Over 15 years of experience as VP and at C-Suite level and Board Advisor to leading global companies in the energy, materials, and defense sectors. Built a career on operational excellence, growth strategy, and business transformation across diverse geographies and industries.
- **IPO Experience:** Played a key role in leading the Initial Public Offerings (IPOs) for industry leaders like Landis+Gyr, Axion Power, and Remy International, raising significant capital.
- **Advanced Battery Technology Expertise:** Decades of experience in lead acid batteries, multiple lithium-ion chemistries and other advanced battery technologies. Successfully managed the full lifecycle of energy storage projects including project financing, feasibility studies, plant construction, and operations.
- **Global Operations/Partner Management:** Directed joint ventures and acquisitions in China, Brazil, Mexico, and India, managed OEM partnerships, large-scale manufacturing, and global energy storage/generator/motor plant (10) construction/launch in Mexico, Brazil, South Korea, France, Hungary, Poland and India. Deep expertise in energy management, smart grid technologies in utility sector.
- **Revenue Growth & Business Development:** Demonstrated success in building and managing business pipelines worth over \$200 million. Achieved a 670% increase in global sales at Remy Electric, growing international annual revenue from \$18M to \$120M in just six years.
- **Leadership & Industry Recognition:** Frequent speaker at major global conferences on advanced battery technologies, EV infrastructure, and energy storage solutions. Active member of global technical committees (SAE, UL) responsible for developing and implementing industry standards. Advisor and guest lecturer at multiple universities, including Purdue University and Harvard University.

PROFESSIONAL EXPERIENCE

- Vanderbilt University, Nashville, TN** **Present**
Advisor – School of Engineering
 - Provide advice on undergraduate & graduate curricula in Energy (Generation, Storage, & Management) Engineering and recruiting doctoral and post-doctoral candidates.
- Robins & Kaplan LLP (Global Law Firm)**
Duesenfeld (Li-ion Battery Recycling Firm) **Present**
Industry Expert/Advisor
 - Provide advice on lithium-ion battery recycling technology related intellectual property (IP) and patent infringement. Appraise technical documentation and prepare expert declarations.
- SAE & UL Committees** **Present**
Committee Member
 - Develop global standards for EV battery packs, recharging protocols, and second-life applications for energy storage technologies. Curricula development for engineering institutions and technical colleges, focused on EV infrastructure and battery technologies.
- NanoX (Rare-earth Materials Firm, Netherlands),**
B.K. Batteries (Non-Li-ion Battery firm, South Korea) **Present**
Chief Strategic Consultant & Board Member
 - Provide technical advice on rare earth and magnetic materials. Advise on market entry/plant construction and financing strategies, global partnerships to drive innovation and commercialization of new battery technologies.
- Capattery (Advanced Lithium-Graphene Materials/Battery Manufacturer)** **Present**
Chief Strategic Advisor & Board Member
 - Provide advice on financing, partnerships, development of new applications and market expansion strategies.
- Quantum Copper (University of Nevada, Las Vegas Startup)** **2023-2024**
Chief Advisor - Testing, Standardization & Certification -
 Lead initiatives to develop testing and certification protocols for advanced separator materials in energy storage applications. Collaborate with university researchers and industry stakeholders to standardize new technologies.
- UTILTYX - Cybersecurity software provider to utilities, (Milpitas, CA)** **2021-Present**
Chief Advisor - Financing & Business Development, Strategic Planning & Global Partnerships
- Nevada Technology Corporation (Battery Recycling & Repurposing Company)** **2023-24**
CEO & Chairman of the Board
 Managed technology providers, investor relations and strategic partnerships for the company's expansion.
- Lohum CleanTech - Noida, India** **2022-24**
 Provider of Advanced Recycling Technologies of Lithium-ion batteries
Chief Advisor - Strategy
- NexTech Batteries (Carson City, NV)** **2022-23**
Chief Operating Officer

- Responsible for managing all operational functions, including HR, procurement, logistics, engineering, production, business development and pilot projects with CAISO
- manage manufacturing facility design & development for lithium-sulfur battery technology.
- Collaborated with external partners such as IBM to develop hybrid electrode technology and raised funding for research projects.
- **Canadian Storage & Solar (Edmonton & Toronto, Canada) 2020- 21**
Developer and converter of Natural Gas PPPs to solar and storage
Chief Project Consultant
- Acquire Midwest PPP's (MISO territory), convert them to solar and storage-based units for smart grid integration with long term financing and PPAs
- **Lucas TVS (Chennai, India) & 24m Technologies (Cambridge, MA) 2019-21**
Chief Project Consultant
- Managed plant feasibility and project/product viability studies to develop semi-solid-state Li-ion battery technology in India on behalf of Lucas-TVS under license from 24m.
- Led the financing, design, and construction of pilot and commercial-scale manufacturing plants for energy storage systems.
- **Landis+Gyr (Toshiba), Alpharetta, GA 2015-19**
Vice President, Partner Relations & Strategic Planning 2017-19
- Member - IPO Team (Landis+Gyr divestiture). Rationalized and managed over 130+ partnerships with utilities and vendors across all product lines and services worldwide
- Oversaw development of scalable grid connected and islanded microgrid design and development, predictive and prescriptive analytics, integrating these into NOCs and coaching Sales Managers to develop multiyear service and maintenance contracts with utilities.
Vice President, Business Development & Sales 2015-17
- Managed grid energy storage, smart grid analytics & control system project design, development, pricing, financing and installation for utilities and private/institutional investors for energy arbitrage, with and without renewable integration with LTO (from Toshiba), LFP and NMC chemistries as appropriate in different ISO regions.
- Recruited, managed, and mentored Regional Sales managers, engineers, and analysts.
- Led partner development for lithium-ion batteries and power electronics.
- **Axion Power International (Start-up Manufacturer of Lead-Carbon Batteries) 2012-15**
Senior Vice President, Business Development & Sales
- Led business development, sales, and marketing efforts for grid energy storage, controls and analytics systems, company's IPO, capital raises from PE and venture capital firms.
- Developed revenue and cash flow models for large-scale energy storage arbitrage projects in different ISO/RTO territories, including integration with renewable energy sources.
- **Ener1 (Lithium Ion Battery Manufacturer), Indianapolis, IN 2010-12**
Vice President, Business Development & Sales
(EV/Hybrid Transportation, Renewables, & Smart Grid Networks)
- Directed business development and sales for lithium-ion battery systems in electric vehicles (EV), hybrid electric vehicles (HEV), and utility-scale energy storage projects.
- Managed relationships with major automakers and utility companies.

- **Remy International - Global Manufacturer of EV Motor/Generators, Starter Motors & Alternators (Anderson, IN)** **1994-2010**
Global Director - EV/Hybrid & Traction Motor Sales and Business Development **2008-10**
Global Director - Heavy Duty Sales & Marketing (Daimler, Volvo & PACCAR) **2003-08**
Global Director - Automotive Motor/Generator Sales & Marketing **2000-03**
Director - International Sales, Engineering & Operations **1994-2000**
- **Delco Remy (Division of General Motors)** **1991-94**
Operations Director
- **General Motors Truck & Bus** **1989-91**
Chief Resident Electrical Engineer
- **Delco Remy (Division of General Motors)** **1984-89**
Senior Product Manager **1987-89**
Test & Development Engineer **1984-87**
- **U.S. Navy & Reserves** **1982-91**
Lieutenant (Junior Grade)
- **Vanderbilt University, Nashville, TN** **1979-82**
Civilian Researcher
- **Tata Iron & Steel, Jamshedpur, India** **1978**
Summer Intern
- **Kolar Gold Fields, Kolar, India** **1977**
Summer Intern

EDUCATION

- **MBA - 1988 (Finance & International Business), Indiana University, USA**
- **MS - 1982 (Mechanical Engineering), Vanderbilt University, USA**
- **B.Tech - 1979 (Metallurgical Engineering), Indian Institute of Technology (IIT-BHU), India**
- **Churchill Scholar - Trinity College, University of Cambridge, UK**

CERTIFICATIONS & CONTINUING EDUCATION

- **APQP Quality Engineering Certification - GM Quality Institute, Kettering University**
- **Mercosur/NAFTA and Eurozone Certifications - Indiana University & Purdue University**
- **Continuing education in Contracts, Corporate Taxation, and Export/Import Classifications, Wharton School of Business**

VOLUNTEER EXPERIENCE

- **Board Member - Chirala Medical & Educational Trust** **2018-Present**
- **Advisor & Primary Benefactor - Our Children Our Planet (501c3)** **2016-Present**
- **Organic/Non-GMO Farmer - promoting sustainable farming practices through an agricultural cooperative** **2014-Present**
- **Board Member - Thrive Solar Private Ltd.** **2016**
- **Guest Lecturer - Indiana University, Harvard University, Purdue University & other institutions**
- **Board Member - YMCA of Madison County, IN** **2003-2008**

Appendix B

Appendix B**Materials Considered**

Petition for <i>Inter Partes</i> Review of U.S. Patent No. 11,040,097 and supporting exhibits
The '097 Patent (Ex. 1001)
The prosecution history of the '097 Patent (Ex. 1002)
Declaration of Walter van Schalkwilk (Ex. 1003)
U.S. Patent No. 9,780,419 ("Hanisch '419") (Ex. 1004)
U.S. Patent No. 6,447,669 ("Lain") (Ex. 1005)
U.S. Patent No. 9,843,077 ("Hayashi") (Ex. 1006)
Gao Liu <i>et al.</i> , <i>Binder Interactions in the Electrodes of the Lithium-ion Batteries</i> , TFUG Conference, February 17, 2009 (Ex. 2002)
DE 102012024876 A1 to Electrocyling GmbH ("Electrocyling") (English) (Ex. 2003)
U.S. Patent No. 7,198,865 to Sloop ("Ecobat") (Ex. 2004)
WO 2010/149611 A1 to LiMotive Company Ltd. ("LiMotive") (English) (Ex. 2005)
WO 2010/149611 A1 to LiMotive Company Ltd. ("LiMotive") (German) (Ex. 2006)
DE 102012024876 A1 to Electrocyling GmbH ("Electrocyling") (German) (Ex. 2007)
Yang <i>et al.</i> , <i>Thermal Stability of LiPF₆ Salt and Li-Ion Battery Electrolytes Containing LiPF₆</i> , Journal of Power Sources 161, 573 (2006) (Preprint) ("Yang") (Ex. 2008)

Gnanaraj et al., <i>A Detailed Investigation of the Thermal Reactions of LiPF₆ Solution in Organic Carbonates Using ARC and DSC</i> , Journal of the Electrochemical Society, 150(11), A1533 (2003) (“Gnanaraj”) (Ex. 2009)
Certification of Translation of the Electro cycling Patent (Ex. 2010)
Certification of Translation of the Limotive Patent (Ex. 2011)
Duesenfeld GmbH Website – Recycling [https://www.duesenfeld.com/recycling_en.html] (Ex. 2012)
Ascend Elements Press Release (Ex. 2013)
<i>Ascend Elements, Inc.’s Answer to Complaint</i> , Case No. 1-23-cv-01194 (D. Del.) (Ex. 2014)
Scheduling Order in Case No. 23-1194-JFM (Ex. 2015)
Email from J. Stiel to J. Ploger (dated Dec. 6, 2023)(German) (Ex. 2016)
Email from J. Stiel to J. Ploger (dated Dec. 6, 2023)(English) (Ex. 2017)
Certification of Translation of Email from J.Stiel to J.Ploger (dated Dec. 6, 2023) and of Kwade, et al. (Exs. 2018 and 2020)
Christian Hanish et al., <i>Recycling von Lithium-Ionen-Batterien – das Projekt LithoRec</i> , Recycling und Rohstoffe, January 2012 (“Kwade, et al.”) (German) (Ex. 2019)
Christian Hanish et al., <i>Recycling von Lithium-Ionen-Batterien – das Projekt LithoRec</i> , Recycling und Rohstoffe, January 2012 (“Kwade, et al.”) (English) (Ex. 2020)
Yang et al., <i>Thermal Stability of LiPF₆ Salt and Li-Ion Battery Electrolytes Containing LiPF₆</i> , Journal of Power Sources 161, 573 (2006) (Ex. 2021)
<i>Duesenfeld GmbH v. Ascend Elements, Inc.</i> , No. 1:23-cv-01194-JFM (D. Del. Oct. 30, 2024), ECF No. 62 (Ex. 2023)

IPR2024-00948

U.S. Patent No. 11,050,097

Deposition transcript of Walter van Schalkwijk, dated February 6, 2025 (Ex. 2024)
N. Somsuk et al., <i>Design and Development of a Rotary Airlock Valve for using in Continuous Pyrolysis Process to Improve Performance</i> , 2010 International Conference on Manufacturing Science and Technology (ICMST 2010) (Ex. 2025)
Water boiling point as function of absolute pressure available at: https://www.engineeringtoolbox.com/water-evacuation-pressure-temperature-d_1686.html (Ex. 2026)
DIN 24 800 (English) (Ex. 2027)
DIN 24 800 (German) (Ex. 2028)
Certificate of Translation for DIN 24 800 (Ex. 2029)
Bin-Dicator® Installation & Operation Manual (2013) (Ex. 2030)
Screenshot of Meyer Rotary Valve Basics video available at: https://www.youtube.com/watch?v=iwjyRePPIt4 (Ex. 2031)
Boiling point for DMC, available at: https://www.univarsolutions.com/dimethyl-carbonate-5004710?srsltid=AfmBOorjj92rfTGG8ShR_L1YJ7zHq_g7jd5HIM9uvXuqBookXSIVZw8a (Ex. 2032)
Boiling point for EMC, available at: https://www.msесupplies.com/products/high-purity-ethyl-methyl-carbonate-c-4-h-8-o-3-99-99-4n?srsltid=AfmBOoqUr1g_4hUH5zYLI-kjf8M3Z-cqlnYULkbD2h_WRok0GU30TOI (Ex. 2033)
Vacuum Guide, available at: https://www.vacuum-guide.com/english/equipment/evacuation_time_vacuum_pump_sizing.htm (Ex. 2034)
U.S. Patent No. 5,405,231 (“Kronberg”) (Ex. 2035)

Confidential Appendix C to Declaration of Vani Dantam (Ex. 2036)
Confidential Appendix D to Declaration of Vani Dantam (Ex. 2037)
Screenshots of YouTube Duesenfeld plant video found at https://www.youtube.com/watch?v=g1Ij4Emz8XQ (“How to recycle lithium-ion batteries? – Closing the loop in e-mobility”, Dec. 6, 2023) (Ex. 2038)
Meyer Rotary Valve Basics Video Transcript, available at: https://www.youtube.com/watch?v=iwjyRePPIt4 (Ex. 2039)
Declaration of Lydia Grote in support of Patent Owner’s Response to the Petition (“Grote POR Declaration”) (Ex. 2040)
Duesenfeld GmbH Wendeburg plant processing conditions (Ex. 2041)
German regulations available at https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/kreislaufwirtschaftsgesetz_en_bf.pdf (English translation) (Ex. 2042)
Certification from Braunschweig State Trade Supervisory Office to Duesenfeld (German) (Ex. 2043)
Certification from Braunschweig State Trade Supervisory Office to Duesenfeld (English) (Ex. 2044)
Translation Certification of Certification from Braunschweig State Trade Supervisory Office to Duesenfeld (Ex. 2045)
Duesenfeld GmbH Preliminary Financial Statements 2021 and 2022 (German) (Ex. 2046)
Duesenfeld GmbH Preliminary Financial Statements 2021 and 2022 (English) (Ex. 2047)
Translation Certificates - Duesenfeld GmbH Preliminary Financial Statements 2021 and 2022 (Ex. 2048)

IPR2024-00948

U.S. Patent No. 11,050,097

License Agreement (Ex. 2049)
License Agreement (Ex. 2050)
Press Release: <i>Seval and Riplastic will be the first industrial operators in Italy for the recycling of lithium-ion batteries</i> , dated June 11, 2024 (Ex. 2051)
Press Release: <i>Andritz and Duesenfeld sign cooperation agreement for battery recycling</i> , dated February 10, 2025 (Ex. 2052)
Duesenfeld Brochure: Ecofriendly Recycling of Lithium-Ion Batteries (Ex. 2053)
URT Umwelt Und Recyclingtechnik GmbH, Petition for <i>Inter Partes</i> review, IPR2024-00887 including all materials considered in support of Duesenfeld's response thereto
Declaration of Volker Spies in support of the URT Umwelt Und Recyclingtechnik GmbH Petition IPR2024-00887

Any other materials referenced in my Declaration.

Appendix C

Located at Exhibit 2036

Appendix D

Located at Exhibit 2037