EX 1003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ASCEND ELEMENTS, INC.,
Petitioner,

v.

DUESENFELD GMBH,
Patent Owner.

Case No. PGR2025-00037

U.S. Patent No. 12,119,463

DECLARATION OF MARC JUZKOW

TABLE OF CONTENTS

I. BACKGROUND AND QUALIFICATIONS 1

II. MATERIALS REVIEWED 4

III. LEGAL PRINCIPLES 6

A. Person Having Ordinary Skill in the Art 6

B. Claim Construction 7

C. Legal Standards for Anticipation 8

D. Legal Standards for Obviousness 9

E. Indefiniteness 13

F. Analogous Art 13

IV. RELEVANT ART AND LEVEL OF ORDINARY SKILL 13

V. CLAIM CONSTRUCTION 15

VI. TECHNOLOGY BACKGROUND 16

A. General Principles of Lithium-ion Batteries 16

B. Materials Used in Li-Ion Batteries 17

C. Background on Recycling Lithium-ion Batteries 24

D. Summary of the '463 Patent 27

VII. EFFECTIVE FILING DATE 30

VIII. OVERVIEW OF THE PRIOR ART 30

A. Tomioka (Japanese Patent Application Publication No. JPH10255861) 31

B. Hanisch (U.S. Patent Application Publication No. US 2014/0290438 A1) 33

C. Yosuke (Japanese Patent Application Publication No. JP2016080284A) 34

1. Motivation to Combine Yosuke with Tomioka or Hanisch.....35

D. Hayashi (U.S. Patent No. 9,843,077).....38

1. Motivation to Combine Hayashi with Tomioka or Hanisch 40

E. LithoRec (Kwade et al. *LithoRec: Recycling Lithium-ion Batteries*) .45

1. Motivation to Combine LithoRec with Tomioka or Hanisch 46

F. Perry (Perry et al., *Perry's Chemical Engineers' Handbook* (7th ed.)) 50

1. Motivation to Combine Tomioka and Perry or Hanisch and Perry.....50

IX. SUMMARY OF OPINIONS.....53

X. GROUNDS OF UNPATENTABILITY 54

A. Ground 1: Claims 1-3, 8, 10-12 Are Disclosed or Rendered Obvious by Tomioka 54

1. Claim 1.....54

2. Claim 2: "The method according to claim 1, wherein: the organic solvent comprises dimethyl carbonate, or ethyl methylcarbonate, or both; and the drying process further continues the drying until the vaporizing removes at least 90 percent by weight of the dimethyl carbonate, or ethyl methylcarbonate, or both, from the electrolyte. 65

3. Claim 3: "The method according to claim 1, further comprising: capturing and condensing gases created from the vaporizing of organic carbonate in the electrolyte during the drying process.....66

4. Claim 8: "The method according to claim 1, wherein: comminuting the used lithium batteries is performed within a container; and the drying is performed within the container."....67

5. Claim 10: "The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes components of comminuted material, and at least 90% by weight of the components of the comminuted material have a sieve size that is not more than 50 mm." 69

6. Claim 11: "The method according to claim 1, wherein receiving the used lithium-ion batteries further includes receiving used lithium-ion batteries that further comprise carrier foil and binder that binds active material to the carrier foil, and the temperature of the vaporizing pressure-temperature being not more than 80° C., lower than a decomposition temperature of the binder, and lower than the decomposition temperature of the fluorine salt." 71

7. Claim 12: "The method according to claim 11, further comprising a high temperature drying of the inactivated comminuted material, the high temperature drying being configured to decompose binder." 74

B. Ground 2: Claim 4 Is Rendered Obvious by Tomioka in View of Yosuke 75

1. Claim 4: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; continuous monitoring, by a controller, of at least one progress parameter that is indicative of a progress of the drying, the at least one progress parameter comprising a pressure in the interior of the drying device or a pressure of a gas flow out of the interior of the drying device drying process, and not terminating the drying process until the progress parameter reaches a pre-determined progress parameter threshold value." 75

C. Ground 3: Claims 5 and 9 Rendered Obvious by Tomioka in View of Hayashi 79

1. Claim 5: "The method according to claim 1, wherein the [the] pressure is not more than 30 hPa for at least 50% of a duration of the drying, or the pressure does not exceed 50 hPa during the drying, or both." 79

2. Claim 9: "The method according to claim 3 wherein condensing is performed at an ambient pressure, or condensing is performed at a temperature within a temperature range that extends from 0° C. to 50° C., or both." 82

D. Ground 4: Claims 6 and 7 Are Rendered Obvious by Tomioka in View of LithoRec 82

1. Claim 6: "The method according to claim 1, further comprising: feeding the comminuted material, through an airlock, into an interior of a drying device; and performing the drying within the interior of the drying device. 82

2. Claim 7: "The method according to claim 6, further comprising: vacuum sucking away of gases created from vaporized organic carbonate during the drying process and/or wherein the batteries comprise current collector foils having a coating material and movement using the agitator is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away." 85

E. Ground 5: Claims 13 and 14 Are Rendered Obvious by Tomioka in view of Perry 87

1. Claim 13: "The method according to claim 1, further comprising: moving by an agitator, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both; and supplying, during the drying, a vaporization heat to the comminuted material, wherein the supplying includes the agitator supplying at least 35% of said vaporization heat." 87

2. Claim 14: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; and agitating, by an agitator, the inactivated comminuted material when removing the inactivated comminuted material from the drying device." 91

F. Ground 6: Claims 1-3, 5 and 9-12 Are Disclosed or Rendered Obvious by Hanisch in view of Hayashi.....93

1. Claim 1.....93

2. Claim 2: "The method according to claim 1, wherein: the organic solvent comprises dimethyl carbonate, or ethyl methylcarbonate, or both; and the drying process further continues the drying until the vaporizing removes at least 90 percent by weight of the dimethyl carbonate, or ethyl methylcarbonate, or both, from the electrolyte. 101

3. Claim 3: "The method according to claim 1, further comprising: capturing and condensing gases created from the vaporizing of organic carbonate in the electrolyte during the drying process.....102

4. Claim 5: "The method according to claim 1, wherein the [the] pressure is not more than 30 hPa for at least 50% of a duration of the drying, or the pressure does not exceed 50 hPa during the drying, or both." 103

5. Claim 9: "The method according to claim 3 wherein condensing is performed at an ambient pressure, or condensing is performed at a temperature within a temperature range that extends from 0° C. to 50° C., or both." 103

6. Claim 10: "The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes components of comminuted material, and at least 90% by weight of the components of the comminuted material have a sieve size that is not more than 50 mm." 103

7. Claim 11: "The method according to claim 1, wherein receiving the used lithium-ion batteries further includes receiving used lithium-ion batteries that further comprise carrier foil and binder that binds active material to the carrier foil, and the temperature of the vaporizing pressure-temperature being not more than 80° C., lower than a decomposition temperature of the binder, and lower than the decomposition temperature of the fluorine salt." 104

8. Claim 12: "The method according to claim 11, further comprising a high temperature drying of the inactivated comminuted material, the high temperature drying being configured to decompose binder." 105

G. Ground 7: Claim 4 Is Rendered Obvious by Hanisch in view of Hayashi and/or Yosuke 106

1. Claim 4: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; continuous monitoring, by a controller, of at least one progress parameter that is indicative of a progress of the drying, the at least one progress parameter comprising a pressure in the interior of the drying device or a pressure of a gas flow out of the interior of the drying device drying process, and not terminating the drying process until the progress parameter reaches a pre-determined progress parameter threshold value." 106

H. Ground 8: Claim 6 Is Rendered Obvious by Hanisch in View of Hayashi and/or in further view of LithoRec 107

1. Claim 6: "The method according to claim 1, further comprising: feeding the comminuted material, through an airlock, into an interior of a drying device; and performing the drying within the interior of the drying device. 107

I. Ground 9: Claims 7, 13, 14 Are Rendered Obvious by Hanisch in view of Hayashi and in further view of LithoRec and/or Perry 107

1. Claim 7: "The method according to claim 6, further comprising: vacuum sucking away of gases created from vaporized organic carbonate during the drying process and/or wherein the batteries comprise current collector foils having a coating material and movement using the agitator is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away." 107

2. Claim 13: "The method according to claim 1, further comprising: moving by an agitator, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both; and supplying, during the drying, a vaporization heat to the comminuted material, wherein the supplying includes the agitator supplying at least 35% of said vaporization heat." 109

3. Claim 14: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; and agitating, by an agitator, the inactivated comminuted material when removing the inactivated comminuted material from the drying device." 110

J. Ground 10: All Challenged Claims are invalid for indefiniteness 110

1. All Challenged Claims – "inactivating the comminuted material and obtaining inactivated comminuted material as a result" 110

2. 7. "wherein . . . movement using the agitator is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away." 112

3. The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes

components of comminuted material, and at least 90% by weight of the components of the comminuted material have a sieve size that is not more than 50 mm..... 114

XI. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS..... 114

XII. CONCLUSION 115

I, Marc Juzkow, hereby declare as follows:

I. BACKGROUND AND QUALIFICATIONS

1. My name is Marc Juzkow, and I have been retained on behalf of Ascend Elements, Inc. to provide my opinions on the patentability of the claims of United States Patent No. 12,119,463 ("the '463 Patent"). I understand that this declaration may be submitted to the Patent Trial and Appeal Board at the United States Patent and Trademark Office as part of a post grant review proceeding related to the '463 Patent. I am being compensated at my customary rate of $400/hour for the time I spend on this matter. My compensation is not contingent on the content of my opinions nor the outcome of the post grant review proceeding. I have no direct financial interest in any of the parties or this proceeding.

2. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field, which I have summarized below. My *curriculum vitae*, which includes a more detailed summary of my background, experience, and publications, is attached to this declaration as Appendix A.

3. I am a Managing Partner of Lithiumion Expert Services, LLC. I am also Cell Supplier Lead of Joby Aviation, LLC. I am an expert in the field of lithium-ion cells. I have studied, researched, and practiced in the field of electrochemical cells and packaging for more than 40 years.

4. I received my Bachelor of Science (BSc) degree in the field of Chemistry from Simon Fraser University in Burnaby, British Columbia in 1985. I received my Master of Science (MSc) degree in the same field from the same university in 1989.

5. I began my career as a Research Scientist with Moli Energy Limited in Vancouver, British Columbia in 1985. Initially, my work involved lithium metal cells. But, by the early 1990's the work I was doing transitioned to developing lithium-ion cells. I worked at Moli Energy between 1985 and 1996. During this time, I had various titles and leadership positions. I was a research technologist and scientist, a Manager of Product Evaluation, a Manager of Product Development, and a Manager of Sales & Marketing. While I was at Moli Energy the company became the first North American company to commercialize lithium-ion technology. Among the projects I was involved in was the development, preparation and purification of electrolyte solvents and salts; as well as development and preparation of active materials and assembling lithium cells with these components.

6. Between 1996 and 2000 I was Director of Sales and Marketing for PolyStor Corporation out of California. During my time at PolyStor, I was involved with the development of the BB-2590/U lithium-ion battery for the United States Army.

7. Between 2000 and 2003, I transitioned into electrochemical double layer capacitor devices. During this time, I was with Cooper Electronic Technologies, PowerStor Corporation and was involved with development of spirally wound can cells and flat pouch cells.

8. I have had various high-level roles in companies over the last 20 years. The details of these roles can be found in my attached CV, but I summarize a few of them here. For instance, between 2007 and 2014 I was Vice President of Research and Development at Leyden Energy. At Leyden we designed and assembled lithium-ion cylindrical and pouch cells. Leyden subcontracted the manufacturing of both polymer pouch and cylindrical cells and over 2 million cells were assembled. I had responsibility for all R&D efforts including the development of novel lithium-ion cells, including the components: electrolyte salt and solvents, cathodes, anodes, separators and current collectors.

9. After my time at Leyden Energy, I hired five engineers and assembly technicians, purchased equipment and die sets, and started a contract services company, Iontensity. Our typical customer was either a start-up or a large industrial chemical company that had new lithium-ion cell components but were not skilled in the art of lithium-ion cell assembly, nor had the equipment required. We also subcontracted on several U.S. Department of Energy (DOE) contracts, providing cell design, assembly and testing services. At Iontensity, we assembled and tested coin

cells and Al foil-polymer laminate packaged lithium-ion cells for our customers who typically provided us with one of the many components that make up a lithium-ion cell. We were responsible for chemical and mechanical cell design, assembling electrodes, final cell assembly and testing. During this time, I developed a cell design modeling tool to calculate matching electrode formulations and structures, adjusting the specific areal capacities of the electrodes to provide high capacity and specific energy lithium ion cell designs.

10. As I was the leader of a small group of engineers and technicians, it was important to be hands-on in my role as a team member and for training additional personnel we hired. I personally mixed cathode and anode slurries, coated electrodes on a 2m long roll-to-roll coater, punched electrodes, assembled coin cells and pouch cells, and ran performance testing. Following Iontensity, I was the Principal Cell Specialist at NIO, responsible for the lithium-ion cell technology for this electric vehicle company and Cell Supplier Lead at Joby Aviation, responsible for the lithium-ion cells and cell technology we use in our eVTOL aircraft.

11. All told, I have over four decades of experience with secondary batteries including lithium metal and lithium-ion secondary batteries.

II. MATERIALS REVIEWED

12. In developing my opinions, I have considered and relied upon the materials cited herein, including the following materials:

Exhibit	Description
1001	U.S. Patent No. 12,119,463 ("'463 Patent")
1002	Patent Prosecution History for U.S. Patent No. 12,119,463
1004	Japanese Patent App. Pub. JPH10255861 ("Tomioka")
1005	Translation of Tomioka
1006	Certification for translation of Tomioka
1007	Japanese Patent App. Pub. JP2016080284A ("Yosuke")
1008	Translation of Yosuke
1009	Certification for translation of Yosuke
1010	U.S. Patent No. 9,843,077 ("Hayashi")
1011	Kwade et al., *LithoRec: Recycling lithium-ion batteries*, published in 2012 by Cuvillier Verlag Göttingen ("LithoRec")
1012	Translation of LithoRec
1013	Certification of translation of LithoRec
1014	U.S. Patent Appl. Pub. No. US 2008/0050295 A1 ("Uchida")
1015	Perry et al., *Perry's Chemical Engineers' Handbook* (7th Ed.) published in 1997 by McGraw-Hill ("Perry")
1016	U.S. Patent No. 11,050,097 ("'097 Patent")
1017	RESERVED
1018	*Ascend Elements Inc. v. Duesenfeld GmbH*, IPR2024-00948, Paper 10 (Decision Granting Institution of *Inter Partes* Review for U.S. 11,050,097) ("'097 Institution Decision")
1019	*Ascend Elements Inc. v. Duesenfeld GmbH*, IPR2024-00948, Paper 19 (Patent Owner Response [REDACTED]) ("'097 POR")
1020	Declaration of Sylvia Hall-Ellis, Ph.D.
1021	U.S. Patent App. Pub. No. US 2014/0290438 A1 ("Hanisch")
1022	*Duesenfeld GmbH v. Ascend Elements Inc.*, 1:23-cv-01194-JFM, Stay Order, ECF No. 169 (D. Del. Jan. 17, 2025)
1023	Han *et al.*, *Lithium-ion hopping weakens thermal stability of LiPF6 carbonate electrolytes*, Cell Reports Physical Science 5, 101768 (Jan. 17, 2024).
1024	Nitta *et al.*, *Li-ion battery materials: present and future*, 18 Materials Today 252 (June 2015)
1025	Solef® PVDF Typical Properties, Solvay Brochure
1026	Lu et al., *Thermal behavior and decomposition kinetics of six electrolyte salts by thermal analysis*, 156 J. Power Sources 555 (2006)

Exhibit	Description
1027	Yang et al., *Thermal stability of $LiPF_6$ salt and Li-ion battery electrolytes containing $LiPF_6$*, 161 J. Power Sources 573 (2006)
1028	U.S. Patent No. 5,691,077
1029	*URT Umwelt und Recyclingtechnik GmbH v. Duesenfeld GmbH*, IPR2024-00887, Paper 18 (Patent Owner Response [REDACTED])

III. LEGAL PRINCIPLES

13. I am not an attorney, and I do not expect to offer any opinions regarding the law or legal principles in this proceeding. I have been given certain instructions regarding the law and have been asked to apply those instructions in rendering my opinions. I have done so. I outline those legal principles below.

A. Person Having Ordinary Skill in the Art

14. I understand that patents and publications are to be understood from the perspective of a POSITA. I further understand that the words of the claims are to be understood from the perspective of a POSITA. Finally, I understand that the questions of anticipation and obviousness of a patent claim are evaluated from the understanding of the POSITA.

15. I understand and have been informed that the factors I should consider in determining the ordinary level of skill in the art include: the levels of education and experience of persons working in the field; the types of problems encountered in the field; and the sophistication of the technology.

16. I understand that a POSITA is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors above. This hypothetical person has knowledge of all prior art in the relevant field as if it were arranged on a workshop wall and takes from each reference what it would teach to a person having the skills of a POSITA.

B. Claim Construction

17. I understand that in an inter partes review, claim terms are to be given their ordinary and customary meaning as understood by a POSITA in the context of the entire disclosure at the time of the invention. I understand that one must be careful not to read a specific embodiment appearing in the written description into the claim if the claim language is broader than the embodiment. I further understand that any special definition for a claim term must be set forth with reasonable clarity, deliberateness, and precision. I also understand that a patentee may provide definitions of claim terms within the specification that may differ from the plain and ordinary meaning of those terms, and that this is often referred to as "lexicography."

18. Unless I explicitly state that I applied a specific claim construction in performing my analysis, I am applying the ordinary and customary meaning of claim terms as they would have been understood by the POSITA based on the specification of the patent unless otherwise noted. I understand that this standard is the same as that used in United States district courts, in which claim terms are given their

ordinary and customary meaning as would be understood by a POSITA at the time of the invention and have taken into consideration the language of the claims, the specification, and the prosecution history of record.

C. Legal Standards for Anticipation

19. I understand that for a claim to be anticipated under §102, every limitation or feature of the claimed invention must be found in a single prior art reference, either expressly or inherently. The reference must also enable a person of ordinary skill in the art to make and use the subject matter claimed.

20. I understand that a claim element is inherently present in a prior art reference if the element is "necessarily present" in the device, structure, or method described in the reference. I understand that inherent anticipation does not require that a PHOSITA would have recognized the inherent disclosure at some specific point in time.

21. I have been informed that it may be appropriate in certain circumstances to look at multiple references when considering the question of whether a claim is anticipated. Additional references may inform an anticipation evaluation: (1) to prove that the primary reference has an enabling disclosure, (2) to explain the meaning of a term used in the primary reference, or (3) to show that a characteristic not expressly called out in a reference is inherent.

D. Legal Standards for Obviousness

22. I understand that a claim may be invalid under §103(a) if the subject matter described by the claim as a whole would have been obvious to a hypothetical person of ordinary skill in the art in view of a prior art reference, or in view of a combination of references at the time the claimed invention was made. Therefore, I understand that obviousness is determined from the perspective of a hypothetical person of ordinary skill in the art, and that the asserted claims of the patent should be read from the point of view of such a person at the time the claimed invention was made. I further understand that a hypothetical person of ordinary skill in the art is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent in suit and all analogous prior art. I understand that the standard for obviousness in a post grant review proceeding is by a preponderance of the evidence, meaning that a fact must be more likely true than not true.

23. I also understand that an analysis of whether a claimed invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the claimed invention, and the level of ordinary skill in the pertinent art involved. I understand as well that a prior art reference should be viewed as a whole. I understand that in considering whether an invention for a claimed combination would have been obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the

manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the marketplace, and/or the background knowledge possessed by a person of ordinary skill in the art. I also understand that other principles may be relied on in evaluating whether a claimed invention would have been obvious, and that these principles include the following:

- A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results;
- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a person of ordinary skill in the art can implement a predictable variation, the variation is likely obvious;
- If a technique has been used to improve one device, and a person of ordinary skill in the art would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;
- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing a teaching, suggestion, or motivation to combine;

Ascend Elements EX1003 Page 18

- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- In determining whether the subject matter of a patent claim would have been obvious, I understand that it is not a relevant matter what reasons or motivations caused the inventor to take a particular action or to include particular components;
- One of the ways in which a patent's subject can be shown to be obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims;
- Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed;

24. "Common sense" teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a POSITA will be able to fit the teachings of multiple patents together like pieces of a puzzle;

25. A POSITA is also a person of ordinary creativity, and is not an automaton;

26. A patent claim can be proved obvious by showing that the claimed combination of elements was "obvious to try," particularly when there is a design need or market pressure to solve a problem and there are a finite number of

identified, predictable solutions such that a POSITA would have had good reason to pursue the known options within his or her technical grasp; and one should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

27. I understand that, in making a determination as to whether or not the claimed invention would have been obvious to a POSITA, the Board may consider certain objective factors if they are present, such as: commercial success of product(s) practicing the claimed invention; long-felt but unsolved need; teaching away; unexpected results; copying; and praise by others in the field. These factors are generally referred to as "secondary considerations" or "objective indicia" of nonobviousness. I understand, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a "nexus") between the claim and the evidence. I also understand that this nexus must be based on a novel element of the claim rather than something in the prior art. I also understand that there are instances when secondary considerations are unable to overcome primary evidence of obviousness (e.g., motivation to combine with predictable results) that is sufficiently strong.

28. I have also been informed that when a range in the prior art discloses a range that overlaps with a claimed range, the range in the prior art renders the claimed range prima facie obvious. I understand that this means that if overlapping

ranges are shown between the prior art and the patent claims, that the patentee must show that the range encompassed by the claim exhibits some unexpected or surprising results or that the differences between the ranges disclosed in the prior art and those recited in the patent claim are critical to the operation of the claimed subject matter.

E. Indefiniteness

29. I have been informed that a patent claim is invalid for indefiniteness if it fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention.

F. Analogous Art

30. I understand that a consideration for an obviousness analysis is whether the prior art being relied upon is "analogous art." I understand that to be analogous art, a prior art reference must either be (1) from the same field of endeavor as the patent, or (2) if not from the same field, then it must still be reasonably pertinent to the particular problem with which the inventors were concerned.

IV. RELEVANT ART AND LEVEL OF ORDINARY SKILL

31. I have been asked to provide my opinion on the qualifications of the POSITA in the field of the '463 patent. I provide my opinion below. To reach my opinion, I have applied the legal framework summarized above. *Supra* §III. I have

been instructed that the qualifications of a POSITA should be defined as of October 20, 2016.

32. I have reviewed the '463 Patent, considered the prior art cited herein, and used my personal experience and education in formulating my opinions. The ’463 patent relates to methods of recycling lithium-ion batteries.

33. Based on my education, experience, the '463 Patent, and the state of the art, it is my opinion that a POSITA in the field of the '463 Patent would have had at least a Bachelor's degree in electrical engineering, material 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. Additional formal education focusing on processing of lithium batteries may substitute for practical experience and additional practical experience can substitute for less education. Those skilled in the art would have been familiar with the principles I discuss below in the technical background and generally throughout this Declaration.

34. At the time of the alleged invention, I was at least a POSITA in the art relevant to the '463 Patent. Further, I understand and know of the capabilities of a POSITA in 2016, based on my experience. I am also familiar with how a POSITA would have understood and used the terminology in the '463 Patent and the

Challenged Claims at the time of filing. I am also familiar with the state of the art at that time.

35. The statements herein regarding the knowledge of a POSITA and what would have been obvious to a POSITA are from the perspective of a POSITA at the relevant priority date.

V. CLAIM CONSTRUCTION

36. The '463 Patent expressly states that "[w]ithin the scope of the present description, the term drying should be understood particularly to mean the removal of at least one solvent in the conducting salt." (EX1001, 2:44-46.) I understand that this is an example of lexicography, and accordingly, I have applied this definition of "drying" in my analysis.

37. As discussed further below in Section X.J.1, it is my opinion that the term “inactivate” (and “inactivated” / “inactivating” / “inactivation”) as used in the claims of the '463 Patent fails to provide reasonable certainty to a POSITA as to when used battery material is considered "inactivated." For purposes of analyzing the prior art, I have applied PO's proposed construction ("the endpoint of drying") set forth in the co-pending IPR on the '097 Patent, IPR2024-00948. (EX1019.) I understand that the Board's preliminary construction in that proceeding was "the removal of sufficient amounts of dimethyl carbonate and/or ethyl methyl carbonate from the comminuted material to make an electrochemical reaction either no longer

possible or only possible to a negligibly small extent." (EX1018, 12.) It is my opinion that the prior art relied on in this declaration meets the definition of "inactivat[ed]" even under the Board's preliminary construction in that proceeding.

38. I understand that all other terms in the Challenged Claims should be given their plain and ordinary meaning and do not need further construction for the purposes of this Petition.

VI. TECHNOLOGY BACKGROUND

A. General Principles of Lithium-ion Batteries

39. I base this section in part off a description provided by the U.S. Department of Energy related to "How Lithium-ion Batteries Work"[1] and cite some additional materials herein. These principles were known in the field by the 1990s.

40. Lithium-ion batteries are generally made up of a positive electrode (often called a cathode) consisting of an active material coated onto a current collector, a negative electrode (often called an anode) consisting of an active material coated onto a current collector, an electrolyte, a separator, and a container or cell case.

41. Lithium ions in the electrolyte are transported back and forth from the anode to cathode and back to anode, and so on. When connected to a load, an electronic device as an example, electrical current flows from the anode terminal to

[1] *See* https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work.

the cathode terminal and in parallel, lithium ions flow from the anode to the cathode. When connected to a charge, electric current moves from the cathode to the anode and in parallel lithium ions are driven from the cathode to the anode.

B. Materials Used in Li-Ion Batteries

42. Those working in the field of L-ion batteries knew that the key components were the cathode and anode active materials; conductive additives and binders used in the coatings on aluminum and copper current collector foils: an electrolyte consisting of one or more lithium salts dissolved in liquid solvents, typically carbonates: a polyolefin separator, and a packaging container, either a metal can or an Al-polymer foil laminate.

43. Intercalation cathodes include metal chalcogenides, transition metal oxides and polyanion compounds. Transition metal oxides include $LiCoO_2$, the first layered cathode used by Sony in a commercial lithium-ion battery in 1991. We started with $LiNiO_2$ in the early 1990's at Moli Energy, then moved to $LiCoO_2$ due to the poor thermal stability of $LiNiO_2$. Low thermal stability can lead to an exothermic release of oxygen from the cathode at a lower temperature than alternative cathodes that were later developed. (EX1024.)

44. At Moli we developed a process to synthesize $LiMn_2O_4$, a cathode in a spinel structure with high thermal stability. Additional benefits included low cost

and abundant Mn compared to Co or Ni but Mn dissolution of the cathode into the electrolyte during normal operation limited its use.

45. Given that $LiNiO_2$ has the highest capacity per mass of these compounds, researchers began substituting other elements into this layered structure to increase its thermal stability but maintain its high capacity. The elements Co and Al were introduced, and the result was $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$. This cathode material has been popular but the thermal stability was still not as high as $LiMn_2O_4$. (EX1024.)

46. [RESERVED]

47. Another group of multi-transition metal oxides was developed to incorporate the high capacity of Ni, good stability of Co and excellent safety of Mn, the result was $LiNi_{1-x-y}Co_xMn_yO_2$. With strong demand for high energy cells, developers began increasing the Ni content from the initial 33% to 80% by 2015, sacrificing the safety provided by Mn. These combinations were very common. (EX1024.)

48. [RESERVED]

49. Finally, polyanion compounds were discovered to intercalate lithium ions. Olivine structured compounds included various metal phosphates, including $LiMnPO_4$, $LiCoPO_4$, $LiNi_{0.5}Co_{0.5}PO_4$ and $LiFePO_4$, the latter being the most used.

$LiFePO_4$ has a lower voltage (3.3V vs. 3.6~3.8V) of the transition metal oxides and lower energy by mass but superior thermal stability. (EX1024.)

50. On the anode side, materials that intercalate and store lithium ions are required, and they need to have a low potential close to the voltage of Li/Li^+ reference to ensure the widest gap between the positive cathode voltage and negative anode voltage which is the cell voltage. The anode active materials need to be as stable as possible during repetitive lithium ion intercalation and deintercalation. Early lithium ion cells, including the one we used in the early 1990's at Moli Energy were hard carbons. However, we moved to a graphitic carbon shortly thereafter which increased our cell capacity by 20% and increased the cell voltage at the lower states-of-charge, a win-win. Graphite carbon was widely used thereafter.

51. Binders are used to "adhere" the active material particles to a current collector foil that as its name explains, collects charge from one electrode and moves it to the other electrode. Polyvinylidene difluoride, PVDF was a common binder that was easy to handle, had good thermal stability and provided very good adhesion between the active materials with the current collectors, and good cohesion or internal bonding strength of the particles and conductive additives. PVDF polymer has a melting point of 177ºC and decomposes above 375ºC via dehydrofluorination, where the structure changes and among other new compounds, HF gas is evolved. (EX1025.)

52. Due to the high resistivity of some of the active materials, conductive additives were introduced in low percentages to improve the conductivity between particles thereby increasing the electrode conductivity leading to improved electrical performance of the cell. These additives were typically high surface area carbons that did not intercalate lithium ions.

53. For current collection, the positive electrode uses aluminum foil, a low cost, lightweight material. The aluminum foil is passivated by the HF by-products of the electrolyte salt to prevent corrosion. Copper foil is used for the anode current collector, although it is more expensive and heavier than aluminum. If Al was used as the negative current collector it would alloy with the lithium ions at the low voltage, reducing the available lithium ions in the electrolyte. Copper foil is not used for the cathode current collector as it is not stable at the high voltage of the cathode and would corrode. Each metal foil is ideal for each electrode.

54. A porous polyolefin separator is used between the electrode sheets to (1) electrically insulate and prevent contact and (2) hold liquid electrolyte, allowing the transport of lithium ions between the electrodes. Separately, polyethylene and polypropylene were used. Each has tortuous porosity preventing lithium metal dendrites from connecting the electrodes. The polyethylene pores melted closed when the cell was exposed to unsafe temperatures of ~135ºC which halted the flow of lithium ions as desired but if the heat exposure continued the polyethylene

Ascend Elements EX1003 Page 28

separator continued to melt and shrink. At this point, physical contact could occur between the electrodes leading to a dangerous shorting condition. The polypropylene pores did not melt at the desired lower temperature of 130-135ºC. Polypropylene was stable up to ~160ºC and in most cases prevented the electrodes from contacting each other. Two improvements were made: (1) a ceramic layer was coated onto the separator to prevent shrinkage when exposed to temperatures above their melting point and (2) tri-layer separators were developed with two higher temperature capable polypropylene outer layers for structural integrity and a polyethylene layer on the inside to melt, close its pores and stop lithium ion flow at lower but abusive temperatures. (EX1028.)

55. Lithium-ion cells are sensitive to moisture and must be hermetically sealed. Initially, cylindrical cans used crimped custom headers to seal the cell with the can typically at the negative voltage and the header cap at the positive voltage. As applications such as mobile phones became smaller and thinner, prismatic metal cans were developed to house the lithium ion components. Prismatic cans had laser welded headers. The can was one polarity and a second metal terminal was in the header with a plastic gasket or glass-to-metal seal for electrical isolation. As devices continued to become smaller, thinner and lighter, the metal cans were replaced with Al-polymer laminate. This is a multi-layered material with (starting from the outside) PET, nylon, aluminum and polypropylene. The PET and nylon are for

Ascend Elements EX1003 Page 29

strength and to protect exposure of the aluminum foil to the outside. The aluminum foil prevents moisture ingress. The opposite side of the flat cell has the same layers but reversed. The two inner layers of polypropylene are melted together to form a seal along the edges of the cell and over external electrical tabs connected to the current collectors.

56. Lithium ion transport is the key to lithium ion cells. As lithium ions move from one electrode to the other, electrons flow (in parallel) through an external electrical circuit either providing power to a load or through a charger in the reverse direction. Lithium salts dissolved in non-aqueous solvents provide the lithium ions. Typical lithium salts used in cells are, in decreasing order of thermal stability: $LiClO_4$ > $LiCF_3SO_3$ > LiTFSI > $TEABF_4$ > $LiBF_4$ > $LiPF_6$. (EX1026.) Despite its low thermal stability, LiPF6 is very effective at passivating the aluminum foil current collector and provides high electrical conductivity. As such it was the most used lithium salt. In an inert atmosphere, dry LiPF6 was stable to 107ºC as measured by the thermogravimetric analysis technique. When dissolved in electrolyte solvents, LiPF6 exhibits decomposition between 80ºC and 100ºC, depending on the solvent composition and their interactions, and the test method. (EX1023, EX1027.)

57. As a dry solid, the decomposition products are:

$$LiPF6\ (s) \rightarrow LiF\ (s) + PF5(g).$$

Ascend Elements EX1003 Page 30

However, if water is present, a set of catalytic reactions evolving HF gas, starting with:

$$PF5(g) + H2O(l) \rightarrow POF3(g) + 2HF(g)$$

58. The electrolyte solvents provide several roles including ion transport and passivating the active anode material (together with $LiPF_6$) to generate a solid-electrolyte interface (SEI) layer to prevent continuous decomposition of the electrolyte on the active surface. Multiple solvents are used as no one solvent provides all the requirements.

59. Cyclic ester carbonates, such as ethylene carbonate (EC) are thermally stable and contribute to the formation of a strong SEI layer. Vinylidene carbonate (VC) is also used in small quantity as an additive to enhance the SEI layer. Propylene carbonate (PC) has been used but is more common in lithium metal anode cells.

60. Linear ester carbonate co-solvents were needed for increased ionic conductivity, particularly at lower operating temperatures. They are typically less viscous and have lower boiling points. Examples of these linear ester carbonates, include dimethyl carbonate (DMC), ethyl methyl carbonate (EMC) and diethyl carbonate (DEC). Key boiling points: DMC is 90ºC, EMC is 109ºC, DEC is 127ºC,

Ascend Elements EX1003 Page 31

PC is 240ºC and EC is 244ºC.[2] The decomposition temperatures vary based on solvent ratios, interactions between the co-solvents, purity and presence of impurities, among others. Typical decomposition range for the linear ester carbonates: DMC, EMC and DEC are 150~200ºC and for the cyclic ester carbonates: EC is 250~300ºC.

C. Background on Recycling Lithium-ion Batteries

61. Batteries can be recycled for environmental reasons and/or a positive return based on valuable components. Lead-acid batteries have a very high rate of recycling and are primarily recycled for environmental reasons, as lead is dangerous to your health but not expensive. Alkaline primary cells (1.5V Energizer, Duracell, etc.) are recycled at an extremely low rate as they do not contain components that would provide a positive return, and the internal components are relatively benign. Lithium-ion batteries however, are recycled not only for environmental reasons but the valuable internal components that make it financially viable. In fact, since the late 1980's Moli Energy, in B.C. Canada, sold scrap lithium metal and lithium-ion batteries by the barrel full to a U.S. recycler, demonstrating the profit margins.

---

[2] Boiling points are listed for each of these compounds at the National Library of Medicine website (https://pubchem.ncbi.nlm.nih.gov). DMC (https://pubchem.ncbi.nlm.nih.gov/compound/12021); EMC (https://pubchem.ncbi.nlm.nih.gov/compound/522046) ; DEC (https://pubchem.ncbi.nlm.nih.gov/compound/7766); EC (https://pubchem.ncbi.nlm.nih.gov/compound/7303); PC (https://pubchem.ncbi.nlm.nih.gov/compound/7924).

62. The primary components in a lithium-ion battery that can be recycled include the active cathode material, active anode material, Al and Cu current collectors and electrolyte. The active cathode material may contain nickel, cobalt and / or manganese. The electrolyte contains a fluorine-based electrolyte salt and various solvents, including cyclic and linear ester carbonates. Other components including steel or aluminum cans, separator and binder can also be separated during recycling.

63. Recycling typically starts with a pretreatment process. This is the most dangerous process for workers as they must handle lithium-ion batteries in unknown states, possibly full EV battery packs with high voltages or batteries with lithium plating resulting in lower thermal stability. In some cases, the batteries are discharged, either in a brine solution or with a resistor before they are shredded in a comminution step. In this step the batteries can go into thermal runaway, therefore this process is usually done under an inert gas, such as N_2. HF gas is also a concern from the thermal degradation of the $LiPF_6$ electrolyte salt or the PVDF binder. Following comminution, the shredded material can be separated using magnets for steel cans, sieves for active materials, flotation for lighter components, etc. [https://doi.org/10.1016/j.rser.2015.12.363]

64. Industrial lithium-ion battery recycling processes are based on two technologies: pyrometallurgical and hydrometallurgical processing.

65. Pyrometallurgical recycling is a smelting process where either the entire battery or the black mass from a pretreatment process is placed in a furnace in excess of 1000°C. The material is transformed into alloys that contain various metallic elements and slags containing lithium. If starting from spent lithium-ion batteries without pretreatment, the electrolyte, cases, conductive carbon, binder and anode materials are lost as fuel in the smelting process. Compare this to starting with the black mass output of a pretreatment process, where the cases and current collectors are first separated. Only small amounts of aluminum, iron or copper end up in the resulting slags and metal alloys. The metal alloys then undergo hydrometallurgical processing at lower temperatures to yield pure metals. Pyrometallurgical recycling is energy intensive and can lead to HF and CO_2 emissions. The subsequent hydrometallurgical refining step can also be costly. Only valuable metals such as cobalt and nickel can be economically extracted through pyrometallurgical processing. [https://doi.org/10.1016/j.jpowsour.2004.03.083] [https://doi.org/10.1016/j.jpowsour.2003.12.026]

66. Hydrometallurgical recycling is a second lithium-ion battery recycling method, where chemical reactions are used at lower temperatures, typically under 200°C. Lithium-ion cells are pretreated to obtain a black mass, which is then leached in an acid to extract the valuable metals, lithium, nickel and cobalt, then separated by various chemical methods. The electrolyte and binder are lost in the acid leaching

process but the active anode material, graphite remains in the black mass and can be purified at the end of the process. Hydrometallurgical processing requires less energy than pyrometallurgical processing but involves extra pretreatment steps, the recovery process is complex and there are environmental and safety concerns. [https://doi.org/10.1016/j.jpowsour.2003.12.026].

D. Summary of the '463 Patent

67. The '463 Patent specification describes various methods known in the art for recycling batteries, including heated drying, deactivation, and comminution of battery material. (EX1001, 1:19-57.) While the '463 Patent specification purports to have invented the idea of low-temperature, low-pressure drying, such drying was already well known in the art as a beneficial method of recycling lithium- ion batteries, as drying the electrolyte at low temperatures and low pressures reduces the likelihood of the formation of hydrofluoric acid, a toxic gas. (*See, e.g.*, EX1001, 4:11-25.) Also, the '463 Patent describes known methods "for processing used batteries in which the batteries are heated prior to the comminuting step" and also methods "for transferring transport-critical electrolyte cells, in which they are initially comminuted under inert gas and then dusted with a deactivation powder so as to prevent the electrochemically active material from spontaneously combusting." (EX1001, 1:19-24, 1:35-39.) The '463 Patent states that there were certain disadvantages to the prior art techniques, including where the batteries are heated

prior to the comminuting step, "thereby destroying plastic components in the batteries" and potentially "contaminat[ing]" the "remaining components of the batteries … with degradation products of the plastic." (EX1001, 1:19-24.) As for the method where the comminuted material is dusted with a deactivation powder, "[t]he disadvantage of this is that the resulting material still poses a comparatively high hazard potential" and "the dusting power itself poses a risk of exposure" and "the formation of a flammable and explosive atmosphere in the transport container cannot be ruled out." (EX1001, 1:25-34.)

68. The '463 Patent also admits that another method of battery recycling was known, that was "well-suited to the efficient recycling of larger amounts of galvanic elements." (EX1001, 1:36-45.) In that method, the "galvanic cells are initially mechanically comminuted, then pre-dried and subsequently sifted. Finally, the binder is broken down in an oven." (EX1001, 1:36-45.) The '463 Patent does not suggest any disadvantages to that known technique, instead stating that "[t]his type of device is very well-suited to the efficient recycling of larger amounts of galvanic elements" but that "for partial load operation, the construction of this installation is comparatively complex." (EX1001, 1:36-45.) The claims of the '463 Patent do not recite limitations directed to a "partial load operation."

69. The '463 Patent claims a method for treating used lithium batteries, including comminuting them and inactivating at least by drying. (EX1001, Cl.1.)

The '463 Patent explains that "[t]he drying occurs under a vacuum" and that "[a]t … low pressures, considerable parts of the most electrolytes vaporize, especially dimethyl carbonate and ethyl methyl carbonate, and do so at temperatures of less than 80°C." (EX1001, 4:11-25.) The '463 Patent also teaches high-temperature drying "during which the binder decomposes." (EX1001, 9:37-43.)

70. Independent claim 1 and its dependent claims are generally directed to methods and apparatuses for recycling batteries by comminuting the batteries and drying the comminuted material under reduced pressure and reduced temperature to inactivate it.

71. The '463 Patent has 14 claims, with only one of those being independent. I have reproduced independent claim 1 below:

1. A method for treating used lithium batteries , comprising:

receiving, into a comminuting device, used lithium batteries that include a cathode, anode, separator, and electrolyte comprising a fluorine salt and a solvent, the solvent including an organic carbonate;

comminuting the used lithium batteries, by the comminuting device, and obtaining comminuted material as a result; and

inactivating the comminuted material and obtaining inactivated comminuted material as a result, wherein the inactivating includes a drying process, comprising drying the comminuted material by removal of organic carbonate from the

electrolyte by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate, the pressure being not more than 300 hPa, and the temperature being not more than 80° C. and lower than a decomposition temperature of the fluorine salt.

72. The dependent claims add additional detail to the limitation of claim 1, including specifying particular organic solvents and that "the drying process further continues . . . until the vaporizing removes at least 90 percent by weight" of the solvent (claim 2); specifying that the gases created from the vaporizing are captured and condensed (claim 3); and specifying additional structures and details for those structures within the drying system, such as a controller (claim 4), an airlock (claim 6), and an agitator (claims 13 and 14). Other dependent claims provide additional temperature and pressure limitations (claims 5, 9, 11, and 12). Finally, other dependent claims provide additional detail on the claimed vacuum (claim 7) and the claimed comminution (claims 8 and 10).

VII. EFFECTIVE FILING DATE

73. I have been asked to assume that the '463 Patent is entitled to an effective filing date of no earlier than October 20, 2016. I have further been asked to assume that this is the date of the invention for purposes of my obviousness analysis.

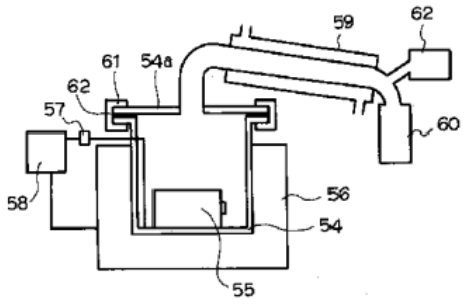
VIII. OVERVIEW OF THE PRIOR ART

A. Tomioka (Japanese Patent Application Publication No. JPH10255861)

74. Tomioka is analogous art to the '463 Patent. It is in the same field of endeavor and is reasonably pertinent to the problems addressed by the '463 Patent. Like the ’463 Patent, Tomioka is directed to "a method for processing waste, particularly concerning methods or recycling techniques for used lithium-ion batteries and nickel-metal hydride batteries." (EX1005, [0001].) Specifically, Tomioka discloses that "the invention of claim 1 comprises" steps including "dismantling the collected batteries, a step of cleaning the dismantled parts, a step of heating the cleaned dismantled parts, a step of peeling and separating the active material layer of the electrode elements from the heated dismantled parts and crushing them, a step of immersing the powdered active material layer in an acidic solution to elute the acid-soluble components, a step of separating undissolved components from the acidic solution, and a step of precipitating and recovering metal components from the acidic solution." (EX1005, [0011].)

75. Figure 19 is described and shows "an example of one embodiment for the removal and recovery of the solvent constituting the electrolyte." (EX1005, at [0090].)

【図19】



(EX1005, at FIG. 19.)

76. In Figure 19, "54 is the container body that houses the recovered battery 55, 54a is the lid, 56 is a heater for heating the aforementioned container body 54, 57 is a temperature measuring device for measuring and detecting the temperature inside the container body 54, 58 is a controller that controls and adjusts the heating by heater 56 based on the information from the aforementioned temperature measuring device 57, 59 is a condenser that cools and condenses the generated and evaporated gas, and 60 is a container for recovering the condensed components. Moreover, 61 is a sealing seal, and 62 is a fixture that secures the lid 54a to the container body 54." (EX1005, [0090].)

77. In Figure 19, "a form is adopted where a vacuum pump 62 is attached to the recovery container 60 side, and when the interior of the container body 54 is reduced to about 100 mmHg, the efficiency of removing and recovering the solvent inside the battery can be increased." (EX1005, at [0092].) Tomioka also discloses that the "when the solvent was recovered using the embodiment illustrated in Fig.

20 (with the temperature inside the container body 54 being below 40°C), the recovery rate was 99%, and the risk of ignition during the battery dismantling operation was eliminated." (*See* EX1005 at [0093].)

B. Hanisch (U.S. Patent Application Publication No. US 2014/0290438 A1)

78. The '463 Patent acknowledges that the German priority application for Hanisch (DE 10 2011 110 083) is prior art and discloses known methods of recycling batteries, stating that Hanisch discloses "a method for recovering active material from a galvanic cell, in which the galvanic cells are initially mechanically comminuted, then pre-dried and subsequently sifted. Finally, the binder is broken down in an oven." (EX1001, 1:35-39.)

79. Hanisch is analogous art to the '463 Patent. It is in the same field of endeavor and is reasonably pertinent to the problems addressed by the '463 Patent. Like the '463 Patent, Hanisch discloses methods and systems for "retrieving active material, in particular lithium or lithium compounds, from a galvanic cell, which comprises an active material, a support for the active material, a binder for bonding the active material and the support and if necessary an electrolyte." (EX1021, [0001].) Hanisch discloses such a method "with the steps: (a) crushing the cells, in particular under inert gas, so that solid cell fragments are also formed, (b) heating the solid cell fragments up to the decomposition temperature, which is high enough

to make the binder decompose and/or evaporate, such that heat treated cell fragments are formed, and (c) classifying the heat treated cell fragments." (EX1021, [0001].)

80. In addition, Hanisch discloses a first step "that, before heating the cell fragments up to the decomposition temperature, the cell fragment 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," where this "has the advantage that the electrolyte solvent can be retrieved." (EX1021, Abstract, [0001], [0025].) Specifically, Hanisch discloses that "[i]t is therefore advantageous for the drying temperature to be below 100°C., in particular below 80°C." (EX1021, [0025].) Hanisch discloses that "[t]he method according to invention is ***preferably*** performed as continual process and not in batches." (EX1021, [0020].) Hanisch does not otherwise discourage from use of its method with batch processing or provide any reason that its method would be inconsistent with batch processing.

C. Yosuke (Japanese Patent Application Publication No. JP2016080284A)

81. Yosuke is analogous art to the '463 Patent. It is in the same field of endeavor and is reasonably pertinent to the problems addressed by the '463 Patent. Yosuke discloses "a vacuum drying device, a vacuum drying system, a vacuum drying method, and a manufacturing method for battery electrodes." (EX1008, [0001].)

82. Yosuke is specifically directed to a method with the "aim to accurately determine the completion of vacuum drying, thereby suppressing occurrences of excessive drying and insufficient drying" because "[a]lthough this challenge of optimally completing vacuum drying has existed historically, various improvements continue to be made, and no satisfactory technology for determining the completion of vacuum drying has emerged so far." (EX1008, [0004].) Yosuke specifies that "[i]n particular, when drying electrodes for secondary batteries such as lithium-ion batteries, if the electrodes are not sufficiently dried, there is a risk that the batteries produced using those electrodes will fail to demonstrate the desired performance." (EX1008, [0004].) Yosuke discloses use of a vacuum drying device arranged in a drying furnace that comprises, a "pressure measurement means" that measures the pressure inside the oven of a vacuum drying apparatus, and a "determination means" for "determining whether the pressure measured by the…pressure measurement means has decreased to below or less than a predetermined target pressure." (EX1008, [0007].) The vacuum drying apparatus of Yosuke continues drying for a predetermined time after the pressure reaches a certain threshold value. (EX1008, [0007].)

1. Motivation to Combine Yosuke with Tomioka or Hanisch

83. A POSITA would have been motivated to incorporate Yosuke's teachings of monitoring a progress parameter (including pressure, as taught by

Ascend Elements EX1003 Page 43

Yosuke) during a drying process into other known drying processes to improve those processes using known and obvious techniques. For example, a POSITA would have understood that Yosuke teaches remedial details regarding monitoring of parameters during drying, and a POSITA would have been motivated to incorporate those teachings into Tomioka and Hanisch.

84. So too for the methods of drying lithium-ion batteries disclosed in each of Yosuke, Tomioka, and Hanisch. Yosuke describes "a vacuum drying device, a vacuum drying system, a vacuum drying method, and a manufacturing method for battery electrodes," which includes lithium ion batteries. (EX1008, [0001], [0004].) Tomioka meanwhile discloses that, in order to "enhance the efficiency of subsequent processing," it is "preferable to conduct a vacuum drying process to remove the electrolyte" prior to performing an additional heat treatment. (EX1005 at [0014].) And, Hanisch discloses that battery "cell fragments are dried at a drying temperature, so that dry cell fragments and drying vapours are formed." (EX1021, [0025].) Accordingly, Yosuke teaches remedial steps (e.g., use of a pressure monitor and controller) that Tomioka and Hanisch leave to a POSITA.

85. It would have been obvious to a POSITA to apply known techniques, such as Yosuke's use of a pressure measurement means and controller to determine when to terminate drying, to improve similar devices, such as the drying process disclosed in Tomioka and Hanisch, to provide predictable results in the same way,

such as by more thoroughly drying the comminuted material. That POSITA would have moreover had a reasonable expectation of success in implementing the teachings of Yosuke in Tomioka's system or Hanisch's system. As to the former, Tomioka recognizes the benefits of measuring various parameters, including temperature, while drying takes place; it discloses with respect to Figure 18, for example, a "controller" 58 "that controls and adjusts the heating by the heater 56 based on information from the temperature measuring device 57." (EX1005, [0090].) In teaching using a "pressure measurement means," a "determination means," and a "vacuum drying control means" to assess whether the pressure drops below a certain target and thereby "accurately determin[ing] the completion of vacuum drying" so as to "suppress[] occurrences of excessive drying and insufficient drying," Yosuke similarly recognizes the benefit of monitoring a parameter (here, pressure) during the drying process. (EX1008, [0004].) It would have been obvious to a POSITA to incorporate this teaching of Yosuke into the drying device of Tomioka. (EX1008, [0007].)

86. A POSITA would have also found it obvious to incorporate Yosuke's teaching of a way to "accurately determin[e] the completion of vacuum drying" (i.e., using a "pressure measurement means," a "determination means," and a "vacuum drying control means" to assess whether the pressure drops below a certain target into the drying device of Hanisch. A POSITA would have recognized that Yosuke

teaches a way to determine when the desired end-result of drying is reached. With the disclosure of the desired end-result of the low-temperature drying process—the formation of "dry cell fragments and drying vapours"—, that this drying process takes place "below 80° C," and that "the heating takes place…in a vacuum," (EX1021, [0016], [0025]), a POSITA would have found it obvious to incorporate this straightforward teaching of Yosuke into the drying device of Hanisch. (EX1008, [0007].) This remains the case regardless of whether Hanisch is implemented as a continuous process or a batch process; in the first instance, the progress monitors would influence the speed in which the material moves through Hanisch's pre-dryer, and in the second, the progress monitors would influence when to terminate a batch of drying.

87. It would have been obvious and within the skill of a POSITA to make simple modifications to the dryer in Tomioka/Hanisch by adding features and devices (such as a pressure monitor and controller) to improve the drying process disclosed in Tomioka/Hanisch.

D. Hayashi (U.S. Patent No. 9,843,077)

88. Hayashi is a U.S. Patent entitled "Method for Processing Fluorine-Containing Electrolyte Solution." Hayashi is analogous art to the '463 Patent. It is in the same field of endeavor and is reasonably pertinent to the problems addressed by the '463 Patent. Hayashi is directed to "a safe method for processing a

nonaqueous electrolyte solution which is used in a lithium ion battery or the like." (EX1010, 1:7-9.) Hayashi discloses methods "for processing fluorine-containing electrolyte solution … includ[ing] a gasification step of gasifying a fluorine compound by heating the electrolyte solution under reduced pressure; a fluorine immobilization step of immobilizing the fluorine component included in the gasified gas as calcium fluoride by allowing the fluorine component to react with calcium; and an organic solvent component collection step of collecting an organic solvent component in the gasification gas." (EX1010, 4:1-11.)

89. Hayashi also discloses that the "electrolyte solution used in a lithium ion battery" can include "a fluorine compound of the electrolyte and an organic solvent" where the "[t]he fluorine compound is mainly lithium hexafluorophosphate ($LiPF_6$)," and the organic solvent can include DMC and EMC. (EX1010, 4:12-23.) Hayashi discloses boiling points for the organic solvents and teaches that "[t]he volatile component . . . is gasified by heating the electrolyte solution to a temperature higher than these boiling points." (EX1010, 4:33-36.) Hayashi teaches that the organic solvents used in the electrolyte solution of lithium-ion batteries have boiling points of 90℃ for dimethyl carbonate and 109℃ for ethyl methyl carbonate. (EX1010, 4:38-45.) Hayashi also discloses that reduced pressure in a volume can affect the boiling point of these volatile organic solvents, such that they can be evaporated under controlled conditions and teaches examples in which heating is

carried out at pressures "less than or equal to 1 kPa" over temperatures ranging from 80℃ to 150℃. (EX1010, 3:20-25, 4:38-67.)

1. Motivation to Combine Hayashi with Tomioka or Hanisch

90. A POSITA would have been motivated to incorporate Hayashi's teachings into the drying processes of Tomioka and Hanisch to improve those processes using known and obvious techniques and principles.

91. For claims 5 and 9, for example, Tomioka discloses a "vacuum drying process to remove the electrolyte," which takes place at a low temperature and facilitates increasing "the efficiency of removing and recovering the solvent inside the battery." (EX1005, [0014], [0092].) It would have been obvious to a POSITA that more reduced pressures during the drying process, taught by Hayashi, would further increase the efficiency of Tomioka's drying process, including by volatilizing solvents at lower temperatures. For example, Hayashi teaches that the organic solvents used in the electrolyte solution of lithium-ion batteries have boiling points of 90ºC (for DMC) and 109ºC (for EMC). (EX1010, 4:38-45.) Hayashi further discloses that certain reduced pressure conditions can facilitate the evaporation of these volatile organic compounds under controlled conditions. (EX1010, 4:38-67.) A POSITA would have recognized that using such reduced pressures would have allowed for use of lower temperatures to volatilize particular solvents (and higher efficiencies in the drying process).

92. With respect to all challenged claims, Hanisch moreover discloses a low-temperature drying process that takes place "below 80° C" and that "the heating takes place…in a vacuum." (EX1021, [0016], [0025]). Hanisch omits discussions of the pressure levels necessary to conduct such low-temperature drying under vacuum, but a POSITA would have recognized that Hayashi's teachings of using a vacuum and lower temperatures to volatilize particular solvents would aid in the efficiencies in the drying process.

93. A POSITA would have been motivated to apply Hayashi's teachings of standard battery compositions, the relationship between pressure and temperature when drying, and the inference to be drawn of the benefits of drying under reduced pressure—in implementing Hanisch's lithium battery recycling process as well.

94. For example, each of Tomioka, Hanisch, and Hayashi disclose methods of processing electrolyte solution as is used in lithium-ion batteries. Tomioka discloses that a method for "processing waste" that includes, among other steps, "dismantling the collected batter[ies]" as well as "a step of heating the cleaned dismantled parts." (EX1005, [0011].) Tomioka also discloses that, in order to "enhance the efficiency of subsequent processing," it is preferable to conduct a vacuum drying process to remove the electrolyte" prior to performing an additional heat treatment. (EX1005 at [0014].) And, Tomioka discloses a condenser that

"cools and condenses the generated and evaporated gas" during the drying process. (EX1005 at [0090].)

95. Hanisch discloses "a method for retrieving active material, in particular lithium or lithium compounds, from a galvanic cell." (EX1004, 1:8-10). Further, Hanisch specifies that this method may be used to "retriev[e] active materials, in particular lithium and/or lithium bonds[/compounds], for example from used batteries." (EX1021, [0040].) Hayashi additionally discloses the composition of common lithium ion batteries, including, *e.g.*, that "[a]n electrolyte solution used in the lithium ion battery or the like includes a fluorine compound which is an electrolyte ($LiPF_6$, $LiBF_4$, or the like) and a volatile organic solvent, and the organic solvent is a flammable substance which is mainly ester carbonates," necessitating a "safe processing method." (EX1010, 1:22-28.) Hayashi also describes processing lithium-ion batteries by, for example, heating the battery containing the electrolyte under reduced pressure so as to "gasify" (i.e., evaporate) the organic solvents of the electrode. (EX1010, 4:33-36.) Hayashi also teaches that the boiling points for the organic solvents used in the electrolyte solution of lithium-ion batteries include 90ºC (for DMC) and 109ºC (for EMC), and that that reduced pressure in a volume can affect those boiling points, such that the volatile organic solvents can be evaporated under controlled conditions. (EX1010, 4:38-67.) Finally, Hayashi discloses that, after heating battery cells and vaporizing the generated gas, "[t]he generated gas was

condensed in the cooling pipe (4°C.), and was captured in a capturing bottle." (EX1010 at 10:27-44; *see also* 9:37-10:26, 10:50-11:7.)

96. Thus, Hayashi teaches the remedial steps (e.g., use of particular pressures while drying or particular pressures and temperatures while condensing the evaporated solvent) that Tomioka leaves, to a POSITA. The application of known techniques (e.g., Hayashi's use of certain pressures while drying or certain pressures and temperatures while condensing the evaporated solvent) to improve similar devices (e.g., the drying process disclosed in Tomioka) to provide predictable results in the same way (e.g., to better dry the comminuted material or better condense the evaporated solvent) would have been obvious to a POSITA.

97. A POSITA would have been motivated and would have found it straightforward, obvious, and advantageous to apply Hayashi's teachings to Hanisch. A POSITA would have recognized the advantages of control over toxic hydrogen fluoride production and potentially flammable compounds and gases generated during the heating process (EX1010, 4:12-36), as well as the advantage of improved electrolyte evaporation at a given temperature when lower ambient pressures are used (EX1010, 4:43-67, Table 1.) The application of known techniques (e.g., Hayashi's teachings of evaporating electrolyte under pressure) to improve similar devices (e.g., the drying process disclosed in Hanisch) to provide predictable

results in the same way (e.g., to safely and efficiently evaporate electrolyte) would have been obvious to a POSITA.

98. A POSITA would have had a reasonable expectation of success implementing the pressure elements of the drying system and the pressure and/or temperature elements of the condensing system disclosed in Hayashi with Tomioka's system. Tomioka discloses both that "it is preferable to conduct a vacuum drying process to remove the electrolyte" (*see* EX1005 at [0014]), and that the pressure inside the container body 54 used in its vacuum drying step is "reduced to about 100 mmHg." (*See* EX1005 at [0092].) Accordingly, Tomioka recognizes that there are advantages in vacuum drying the battery material at low pressures to remove the electrolyte. (*See id.*) Likewise, Hanisch discloses that "the heating takes place…in a vacuum," that the evaporation of electrolyte preferably occurs "below 80° C," and that the dryer is the dryer is gas-proof. (EX1021, [0016], [0025].) Accordingly, despite omitting a particular pressure for its vacuum, Hanisch recognizes the benefits of low-temperature drying and drying under a vacuum.

99. In disclosing a "method for processing a fluorine-containing electrolyte solution…in which the electrolyte solution is heated at 80°C to 150°C under reduced pressure of less than or equal to 1kPa," Hayashi too recognizes the benefit of drying under low vacuum pressures. (EX1010 at 3:20-25; *see also* EX1010 at 4:49-5:18.) Lastly, Tomioka discloses the benefit of condensing vaporized gases during drying

so as to recover them (EX1005, [0089]-[0093]), with Hayashi specifying condensation at 4°C (EX1010, 10:27-44; *see also* 9:37-10:26, 10:50-11:7.) A POSITA would have found it straightforward and obvious to implement Tomioka or Hanisch by applying these teachings.

100. The addition of additional features and devices to improve the drying process disclosed in Tomioka (*e.g.*, pressures not exceeding 50 hPa or 30 hPA during the drying process, and/or certain pressure or temperature conditions during condensation) include simple modifications to the dryer of Tomioka and would have been obvious and well within the skill of a POSITA. Similarly, the addition of additional features and devices to improve the drying process disclosed in Hanisch (*e.g.*, battery compositions and vacuum pressure levels) include simple modifications to the pre-dryer of Hanisch and would have been obvious and well within the skill of a POSITA.

E. LithoRec (Kwade et al. *LithoRec: Recycling Lithium-ion Batteries*)

101. LithoRec is a publication entitled *LithoRec: Recycling lithium-ion batteries* by Prof. Dr. -Ing. Arno Kwade and Gunnar Barwäldt, published in 2012. (EX1012, 1.) LithoRec describes the project "Litho-Rec – Recycling of lithium-ion batteries," in which "several processes for recycling traction batteries were evaluated." (EX1012, 1.) LithoRec states that the project involved "[p]rocesses for disassembling the cells and separating the active materials from the metal foils."

(EX1012, 1.) LithoRec teaches dismantling of the batteries as well as "new approaches to electrolyte recovery (solvent and conducting salt) were identified in LithoRec" and "[i]nitial successes [were] achieved by means of vacuum condensation and extraction using supercritical carbon dioxide on a very small laboratory scale." (EX1012, 1-2.) LithoRec also teaches a drying process that utilizes an airlock and a fluidized vibratory bed dryer in a "possible recycling pilot plant". (EX1012, 1, 227.)

1. Motivation to Combine LithoRec with Tomioka or Hanisch

102. With respect to claims 6-7 and 13-14, a POSITA would have been motivated and would have found it obvious to incorporate LithoRec's teachings of using an airlock and/or an agitator into the drying processes of Tomioka and Hanisch to improve those processes using known and obvious techniques.

103. Tomioka, Hanisch, and LithoRec each disclose systems for recycling lithium-ion batteries, which systems include shredding the batteries and drying the shredded material so as to evaporate electrolyte. First, Tomioka discloses that the invention comprises "steps that include "dismantling the collected batteries," "cleaning the dismantled parts," and "heating the cleaned dismantled parts." (EX1005, [0011].) Hanisch discloses "crushing [galvanic] cells…so that solid cell fragments are [] formed" and then drying those cell fragments "at a drying temperature, so that dry cell fragments and drying vapours are formed," which presents the "advantage that

the electrolyte solvent can be retrieved." (EX1021, Abstract, [0001], [0025].) LithoRec similarly describes a "[r]ecycling of lithium-ion batteries' project" in which the batteries are "dismantl[ed]" by "mechanical comminution and separation of the cell," which process further involves "eliminat[ing] the potential hazard of flammable solvents" by "evaporat[ing]" the electrolyte prior to "dry treatment processes." (EX1012, p. 1:1-13, 222:25-33, 223:6-9, 226:30-33.) LithoRec also discloses that "[d]rying must take place in a protective gas atmosphere (nitrogen), just like the crushing process beforehand" and that the "dryer gases are circulated in a closed circuit and cleaned using a filter and condenser." (EX1012 at 227.) To facilitate the closed circuit for the nitrogen gas, the comminuted material is fed on the inlet side of the dryer, which is "gas-tight to the outside." (EX1012 at 227.) "After closing, the airlock is inerted with nitrogen." (EX1012 at 227.) The cell packs are then fed through a buffer container, through a rotary valve, through a tubular screw conveyor, and into the dryer. (EX1012 at 227.) LithoRec also discloses use of an agitator within the dryer, because "the material to be dried is a very inhomogeneous material with a very wide range of unit sizes (from coarse metal parts to fine powder), only dryers that can ensure material transport by exciting the flow bottom are suitable" and that "[t]he choice of dryers should therefore be a vibratory fluidized bed dryer." (EX1012 at 227.)

104. LithoRec thus teaches the remedial steps (e.g., use of an airlock and/or an agitator), that Tomioka and Hanisch leave to a POSITA. The application of known techniques (e.g., LithoRec's implementation of an airlock for safety reasons and/or an agitator to move the material around and allow for better drying) to improve similar devices (e.g., the drying process disclosed in Tomioka/Hanisch) to provide predictable results in the same way (e.g., to more safely feed comminuted material into the dryer and/or to allow for better drying and more free movement of the comminuted material within the dryer) would have been obvious to a POSITA.

105. In implementing the airlock and agitator teachings from LithoRec with Tomioka's and Hanisch's system, a POSITA would have had a reasonable expectation of success. Tomioka discloses, for example, that in the embodiment of Figures 19-20, "54a is the lid, 56 is a heater for heating the…container body 54,…61 is a sealing seal, and 62 is a fixture that secures the lid 54a to the container body 54." (EX1005 at [0090].) Tomioka therefore recognizes the benefits in ensuring, for safety reasons, that the dryer gasses are contained within the dryer by sealing the dryer device 54. (*See id.*) In disclosing that its low-temperature dryer is gas-proof and that "heating takes place…in a vacuum," (EX1021, [0016]), Hanisch likewise recognizes the benefits of sealing the dryer, noting that heating fragments in the "gas-proof container" ensures "that oxygen, for example, is prevented from the [sic] entering." (*See id.*) LithoRec too recognizes the benefit of circulating dryer gases

within a closed circuit, stating that "dryer gases are circulated in a closed circuit and cleaned using a filter and condenser," and "[d]rying must take place in a protective gas atmosphere (nitrogen), just like the crushing process beforehand." (EX1012 at 227.) LithoRec teaches that to facilitate this closed circuit, the comminuted material is fed on the inlet side of the dryer, which is closed "gas-tight to the outside." (EX1012 at 227.) "After closing, the airlock is inerted with nitrogen." (EX1012 at 227.)

106. As further example, Tomioka discloses that in one embodiment, "a portion of the recovered battery is opened by cutting," and the "liquid inside the battery is vaporized for condensation and recovery," and describes the associated drying procedure. (*See* EX1005 at [0093].) Tomioka thereby recognizes that it is beneficial to dry the battery material after the battery has been opened and cut into smaller pieces. (*See id.*) A POSITA reading Tomioka/Hanisch would have understood that it was further beneficial to move, or agitate, the smaller pieces of comminuted material within the dryer so as to dry the material evenly all sides. So too for LithoRec, which teaches that due to the "very inhomogenous material" to be dried, "only dryers that can ensure material transport by exciting the flow bottom are suitable," and thereby recognizes that it is beneficial to agitate the material within the dryer. (EX1012 at 227.)

107. The addition of known features and devices to improve the drying process disclosed in Tomioka/Hanisch (*e.g.*, an airlock) include simple modifications to the dryer of Tomioka/Hanisch and would have been obvious and well within the skill of a POSITA.

F. Perry (Perry et al., *Perry's Chemical Engineers' Handbook* (7th ed.))

108. Perry is titled "Perry's Chemical Engineers' Handbook (Seventh Edition)" and is a well-known engineering reference manual by Robert H. Perry and Don W. Green, published in 1997. A POSITA would have been familiar with Perry and would have looked to Perry for details on well-known concepts at the time, including use of agitators in dryers.

109. Among other topics, Perry teaches the fundamentals of drying solids. (EX1015, 12-1.) Perry further teaches various types of drying equipment used to dry "wet solids." (EX1015, 12-36, 12-37.) Perry also discloses and discusses various types of dryers, such as agitated dryers, gravity dryers, direct-heat vibrating conveyor dryers, and dispersion dryers. (EX1015, 12-64-12-77.)

1. Motivation to Combine Tomioka and Perry or Hanisch and Perry

110. With respect to claims 7, 13, and 14, to the extent PO argues that Tomioka, Hanisch, and/or LithoRec do not explain in detail the features of using an agitator during the drying process, a POSITA would have been motivated to modify

Tomioka's/Hanisch's drying process to incorporate such features as disclosed by Perry.

111. Each of Tomioka, Hanisch, and Perry disclose methods of drying lithium-ion batteries. First, Tomioka discloses that, in order to "enhance the efficiency of subsequent processing," it is "preferable to conduct a vacuum drying process to remove the electrolyte" prior to performing an additional heat treatment. (EX1005 at [0014].) Tomioka also discloses that "it is preferable to conduct a pre-treatment such as vacuum suction drying using, oil rotary pumps with gas collection mechanisms, piston pumps, multi-stage steam ejectors, a Roots pumps, etc. before vaporizing and dissipating the liquid inside the battery." (EX1005 at [0037].) Hanisch similarly discloses that "cell fragments are dried at a drying temperature, so that dry cell fragments and drying vapours are formed." (EX1021, [0025]) Perry meanwhile teaches various types of drying equipment used to "produc[e] a dry, solid product from a wet feed" or "wet solid," including dryers designed for continuous processing as well as dryers designed for batch processing. (EX1015, 12-36, 12-37.) Perry also teaches that "[a]n agitated dryer is defined as one on which the housing enclosing the process is stationary while solids movement is accomplished by an internal mechanical agitator," and that "[m]any forms are in use, including batch and continuous versions." (EX1015, 12-64.)

Ascend Elements EX1003 Page 59

112. Perry, a well-known technical handbook that a POSITA would have known to look to for basic details on drying technology, therefore teaches the remedial steps (e.g., use of an agitator) that Tomioka/Hanisch leave to a POSITA. The application of known techniques (e.g., Perry's disclosures regarding various agitators for use with dryers) to improve similar devices (e.g., the drying process disclosed in Tomioka/Hanisch) to provide predictable results in the same way (e.g., to better dry the comminuted material) would have been obvious to a POSITA.

113. A POSITA would have had a reasonable expectation of success implementing the agitator of Perry with Tomioka's/Hanisch's system. For example, Tomioka discloses that "it is preferable to carry out a pre-treatment such as vacuum suction drying using, oil rotary pumps with gas collection mechanisms, piston pumps, multi-stage steam ejectors, a Roots pumps, etc. "before vaporizing and dissipating the liquid inside the battery." (EX1005 at [0037].) And Hanisch discloses that crushed cell fragments are dried "so that dry cell fragments and drying vapours are formed," permitting the "electrolyte solvent [to] be retrieved," and that the pre-dryer comprises "a circulation pump 32 and a condenser 34 for condensing electrolyte, which can be removed via the pipe 36." (EX1021, [0025], [0046].) Hanisch further discloses that heating up of the solid cell fragments may take place "in a vacuum." Accordingly, a POSITA would have understood that an agitator would have assisted in the drying process of Tomioka/Hanisch and, in particular, that

using an agitator would have assisted in speeding up the drying process. (*See id.*) Accordingly, Perry teaches use of an agitator during drying, and a POSITA would have found it obvious to incorporate this straightforward teaching of Perry into the drying device of Tomioka/Hanisch. (EX1008, [0007].)

114. The addition of additional features and devices to improve the drying process disclosed in Tomioka/Hanisch (*e.g.*, use of an agitator) include simple modifications to the dryer of Tomioka and would have been obvious and well within the skill of a POSITA.

IX. SUMMARY OF OPINIONS

115. Based on my consideration of the materials identified above, my perspectives about the knowledge of a person having ordinary skill in the art ("POSITA") in the field of recycling or processing of lithium-ion batteries and assessment of the '463 Patent including its claims, I have formed the following opinions:

116. Below is a table summarizing my opinions:

Ground	Claims	Basis and Reference(s)
1	1-3, 8, 10-12	Obvious over Tomioka
2	4	Obvious over Tomioka in view of Yosuke
3	5, 9	Obvious over Tomioka in view of Hayashi
4	6, 7	Obvious over Tomioka alone or in view of LithoRec
5	13, 14	Obvious over Tomioka in view of Perry
6	1-3, 5, 9-12	Obvious over Hanisch in view of Hayashi
7	4	Obvious over Hanisch in view of Hayashi and Yosuke

8	6	Obvious over Hanisch in view of Hayashi and LithoRec
9	7, 13, 14	Obvious over Hanisch in view of Hayashi, LithoRec and/or Perry
10	1-14	Indefinite

X. GROUNDS OF UNPATENTABILITY

117. The claimed invention of the '463 Patent of treating used lithium batteries by comminuting them and drying the comminuted material under low temperatures and low pressures was known prior to the earliest possible priority date of the '463 Patent. Accordingly, it is my opinion that the Challenged Claims would have been obvious. It is also my opinion that the Challenged Claims are also invalid as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor regards as the invention.

A. Ground 1: Claims 1-3, 8, 10-12 Are Disclosed or Rendered Obvious by Tomioka

1. Claim 1

a) Claim 1[pre]: "A method for treating used lithium batteries, comprising:"

118. Tomioka discloses this limitation. Specifically, Tomioka teaches that the "invention relates to a method for processing waste, particularly concerning methods or recycling techniques for used lithium-ion batteries and nickel-metal hydride batteries." (*See* EX1005, [0001].)

b) Claim 1[a]: "receiving, into a comminuting device, used lithium batteries that include a cathode, anode, separator, and electrolyte comprising a fluorine salt and a solvent, the solvent including an organic carbonate;"

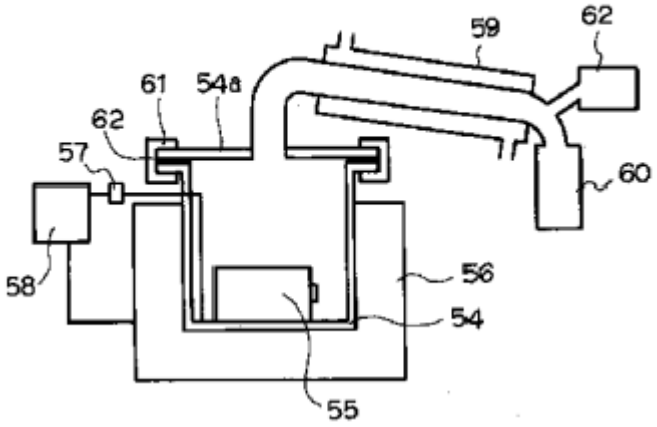
119. Tomioka renders this limitation obvious. Tomioka discloses that the used lithium batteries include a cathode, anode, and a separator where it states that "dismantling" "means cutting the outer casing of the individual battery or the battery pack to extract the electrode element components such as the positive electrode, negative electrode, and separator, and if necessary, cutting them into strip-like pieces." (*See* EX1005 at [0012].) A cathode is a negative electrode, and an anode is a positive electrode.

120. Tomioka also discloses that the used lithium batteries include electrolyte comprising a fluorine salt and a solvent, the solvent including an organic carbonate. For example, Tomioka goes on to explain that "[t]he separation of the electrode element components may involve immersing them in a liquid (water, solvent, acidic, or alkaline liquid) after opening the casing of the battery, allowing them to separate by buoyancy, while concentrating and recovering ***electrolyte components like lithium hexafluorophosphate, ethylene carbonate, and dimethyl carbonate*** from the liquid used for immersion, and employing magnets to recover metal components floating in the aforesaid liquid. (EX1005, [0012] (emphasis added).) Lithium hexafluorophosphate is a fluorine salt, and ethylene carbonate,

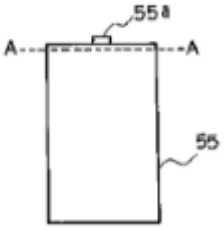
ethyl methyl carbonate, dimethyl carbonate, and diethyl carbonate are organic carbonates that can be solvents.

121. Tomioka also renders obvious receiving the used lithium batteries into a comminuting device. For example, Tomioka discloses dismantling of the used batteries, where "'dismantling' means cutting the outer casing of the individual battery or the battery pack to extract the electrode element components such as the positive electrode, negative electrode, and separator, and if necessary, cutting them into strip-like pieces." (EX1005 at [0012].) A POSITA would have understood that "dismantling" used batteries comprises comminuting the batteries, including by "cutting." Further, Figures 19 and 20 show an embodiment of the invention in which the battery is dismantled by cutting, such that it is comminuted, and the electrolyte is dried under pressurized conditions. Figures 19 and 20 are shown below.

【図１９】



【図２０】



(EX1005 at Figs. 19, 20.)

122. Tomioka explains that Figure 20 is "an explanatory diagram to describe another embodiment of the dismantling and separation of recovered batteries" and that "when the solvent was recovered using the embodiment illustrated in Fig. 20 (with the temperature inside the container body 54 being below 40°C), the recovery rate was 99%, and the risk of ignition during the battery dismantling operation was eliminated." (EX1005, [0093].) As discussed further below with respect to claim 8, a POSITA would have found it obvious to dismantle and dry the batteries within the same container based on Tomioka's disclosure of "carrying out the extraction and recovery of the solvent . . . during the battery dismantling process." As Tomioka suggests, it would have been obvious to a POSITA to perform the dismantling and drying in the same container to improve the safety environment, where both dismantling and drying could be performed in an inert environment to avoid thermal runaway. (*See* EX1005, [0094] ("[B]y carrying out the extraction and recovery of the solvent within the battery during the separation and recovery of the battery body as well as after the discharge processing and during the battery dismantling process, the working environment and safety for battery disassembly operations are significantly improved.".) Accordingly, a POSITA would have understood Tomioka to render obvious receiving the used batteries into a comminuting device.

123. Tomioka discloses another embodiment in which a battery pack may be passed between "several rolls that have different rotational speeds," such that "shear

forces and twisting actions are simultaneously applied by the rotating rollers to break and peel off the resin package, thereby separating the enclosed battery body." (*See* EX1005, [0026]; *see also id.*, [0025]-[0030]). Tomioka provides additional detail on this comminuting device, stating that "one can establish multiple pairs of rolls with varying gaps and utilize a sorting device located before the roll mechanism to either distribute the batteries to the processing rolls or direct to them to a section where the gap between the rolls is gradually widened from one end to the other." (EX1005, [0027].) Tomioka also states that "[t]he introduction of waste batteries into the roll apparatus is not particularly restricted as long as it is directed according to the settings of the roll gap" and that "[g]enerally, it is preferable to install a rectifying plate at the inlet so that the standardized direction by thickness does not get interchanged." (EX1005, [0028].) To the extent that PO argues that Tomioka's disclosures of "dismantling" the batteries by "cutting" them does not disclose this limitation, it would have been obvious to a POSITA to look to Tomioka's other disclosures of comminuting the used batteries, including by receiving the used batteries into the comminuting device disclosed by Tomioka with rotating rollers. (*See* EX1005, [0025]-[0030].)

124. Accordingly, a POSITA would have found it obvious that Tomioka teaches receiving the used batteries into a comminuting device and comminuting them, either through cutting or with rotating rollers.

c) Claim 1[b]: "comminuting the used lithium batteries, by the comminuting device, and obtaining comminuted material as a result; and"

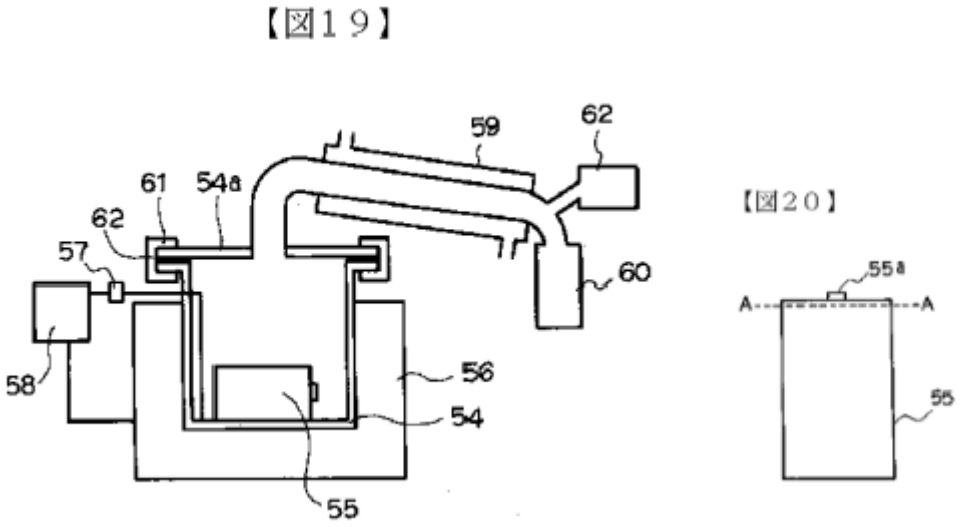
125. Tomioka renders this limitation obvious. As explained above with respect to element 1[a], Tomioka renders obvious receiving the used batteries into a comminuting device that will perform the cutting disclosed by Tomioka, either through cutting or with rotating rollers. (*See* EX1005 at [0012], [0093].) For example, as explained above, Tomioka discloses dismantling of the used batteries, where "dismantling means cutting the outer casing of the individual battery or the battery pack to extract the electrode element components . . . and, if necessary, cutting them into strip-like pieces." (*See* EX1005 at [0012].) Tomioka also discloses that, in one embodiment, a battery pack may be passed between "several rolls that have different rotational speeds," such that "shear forces and twisting actions are simultaneously applied by the rotating rollers to break and peel off the resin package, thereby separating the enclosed battery body." (*See* EX1005 at [0026]; *see also id.* at [0025]-[0030]). Cutting the used batteries or passing them through "several rolls that have different rotational speeds" comminutes the batteries and would obtain comminuted material as a result.

d) Claim 1[c]: "inactivating the comminuted material and obtaining inactivated comminuted material as a result,"

126. Tomioka discloses this limitation. In particular, Tomioka discloses the use of a vacuum drying step "to remove the electrolyte," which a POSITA would

have understood discloses this limitation under any construction for "inactivating." For example, the dried material is inactivated because it is "the endpoint of drying." Further, a POSITA would have understood that an electrochemical reaction is no longer possible because the electrolyte (e.g., EMC and DMC) is "remove[d]." Thus, a POSITA would have understood Tomioka's dryer to produce inactivated comminuted material.

127. Figures 19-20 of Tomioka show a vacuum drying process to remove the electrolyte, including a container body 54 for vacuum drying and a cylindrical secondary battery 55:



(EX1005 at Figs. 19, 20, [0090], [0092].)

128. Tomioka states that by reducing the pressure within container body 54 to about 100 mmHg, that "the efficiency of removing and recovering the solvent

inside the battery can be increased." (EX1005 at Fig. 19, [0092].) Tomioka further discloses that when "the solvent was recovered in the embodiment shown in FIG. 20 (with temperature inside the container body 54 being below 40℃), the recovery rate was 99%, and the risk of ignition during the battery dismantling operation was eliminated." (EX1005 at [0093].) Accordingly, a POSITA would have understood that Tomioka's Figure 19 embodiment discloses a drying mechanism in which 99% of the solvent is evaporated and recovered from the batteries.

129. Because Tomioka discloses that the solvent is evaporated and recovered at a rate of 99% in Tomioka's vacuum drying embodiments, a POSITA would have understood that Tomioka's vacuum drying renders obvious inactivating the comminuted material because it is "the endpoint of drying." Further, Tomioka discloses the use of a "vacuum drying" step "to remove the electrolyte." (*See* EX1005 at [0014].) A POSITA would have understood that an electrochemical reaction is no longer possible because the electrolyte (e.g., EMC and DMC) is "remove[d]." Accordingly, a POSITA would have understood Tomioka to render obvious this limitation through its disclosures of vacuum drying.

e) Claim 1[d]: "wherein the inactivating includes a drying process, comprising drying the comminuted material by removal of organic carbonate from the electrolyte by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate,"

130. Tomioka discloses this limitation. Tomioka discloses that the "inactivating includes a drying process, comprising drying the comminuted material by removal of organic carbonate from the electrolyte by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate." Specifically, Tomioka's vacuum drying step discloses this limitation.

131. As defined by the ’463 patent, the "drying” process is understood to mean "the removal of at least one solvent.” Because Tomioka discloses removing the solvent, Tomioka discloses this. Tomioka discloses that "it is preferable to conduct a vacuum drying process to remove the electrolyte." (*See* EX1005 at [0014].) As discussed with respect to the embodiments shown in Figures 19 and 20, Tomioka discloses that the container body 54 is heated to "below 40℃," and that through drying, the solvent is "vaporized for condensation and recovery." (EX1005 at Figs. 19, 20, [0092], [0093].) Tomioka also discloses specific pressure conditions, including that the pressure inside "the container body 54 is reduced to about 100 mmHg," and that "the efficiency of removing and recovering the solvent inside the battery can be increased." (EX1005 at Fig. 19, [0092].) Tomioka’s disclosures teach a POSITA that its vaporization is taking place above a boiling point of the organic carbonate, as claimed. This is because the boiling points of, for example, EMC and DMC are typically well above 90 degrees Celsius under normal atmospheric conditions, so a POSITA would have understood that efficient and effective

evaporation of these organic carbonates at below 40 degrees would suggest the use of a vacuum to create a temperature-pressure that is above the boiling point. At 40°C and 100 mmHg, the relevant pressure-temperature boiling point of dimethyl carbonate, for example, can be calculated as 39°C. Therefore, at a temperature at or above 39°C and below 40°C, as disclosed by Tomioka, DMC will vaporize. Accordingly, Tomioka discloses removal of organic carbonate from the electrolyte by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate.

132. To calculate the boiling point of a liquid solvent at a reduced pressure, one uses the Clausius-Clayperon equation:

$$\ln\left(\frac{P_1}{P_2}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Where:

- P_1 and P_2 are the vapor pressures at the temperatures T_1 and T_2
- ΔH_{vap} is the enthalpy of vaporization (latent heat of vaporization) (J/mol)
- R is the universal gas constant (8.314 J/mol·K)
- T_1 and T_2 are the absolute temperatures (in Kelvin)
- Each liquid solvent has its own measured latent heat of vaporization.

133. To calculate T_2 for DMC at 100 mmHg, I used the following values:

- DMC ΔH_{vap} =36400 J/mol

- DMC bp T_1 = 363.5K

134. The result for T_2 = 311.1K or 39.0ºC at 100 mmHg. Therefore, at a temperature at or above 39°C and below 40°C at 100 mmHg, as disclosed by Tomioka, DMC will vaporize.

135. To calculate T_2 for EMC at 100 mmHg, I used the following values:

EMC ΔH_{vap} =35000 J/mol

EMC bp T_1 = 379.2K

136. The result for T_2 = 309.3K or 37.2ºC at 100 mmHg. Therefore, at or above 37.2ºC and below 40ºC at 100 mmHg, as disclosed by Tomioka, EMC will vaporize.

137. Accordingly, Tomioka discloses that organic carbonate is removed from the electrolyte "by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate."

f) Claim 1[e]: "the pressure being not more than 300 hPa, and the temperature being not more than 80° C. and lower than a decomposition temperature of the fluorine salt."

138. Tomioka discloses this limitation. For example, Tomioka discloses that the pressure inside the container body 54 used in its vacuum drying step is "reduced to about 100 mmHg." (*See* EX1005 at [0092].) A pressure of 100 mmHg is

equivalent to a pressure of 133.32 hPa. Tomioka also discloses that the container body 54 is heated to 40℃ or less. (*See* EX1005 at [0092].)

139. A POSITA would have understood that 40℃ is less than a decomposition temperature of a fluorine salt, which depends on the conditions in which the fluorine salt exists but in all cases is higher than 40℃. Common lithium-ion electrolyte salts include: $LiPF_6$, $LiBF_4$, $LiAsF_6$, $LiCF_3SO_3$, LiC4F9SO_3, $LiN(CF_3SO_2)_2$, $LiC(CF_3SO_2)_3$. (EX1014, [0069].) The least thermally stable of the common lithium-ion electrolyte salts is LiPF6 which is stable up to 80°C. (EX1023; EX1027; EX1014, [0079].) Accordingly, a POSITA would have understood that a minimum decomposition temperature for $LiPF_6$ is 80°C and that 40℃ is less than a decomposition temperature of a fluorine salt.

2. Claim 2: "The method according to claim 1, wherein: the organic solvent comprises dimethyl carbonate, or ethyl methylcarbonate, or both; and the drying process further continues the drying until the vaporizing removes at least 90 percent by weight of the dimethyl carbonate, or ethyl methylcarbonate, or both, from the electrolyte.

140. Tomioka renders this limitation obvious. Tomioka discloses that the organic solvent comprises at least dimethyl carbonate, where it discloses that "the liquid within the battery may include materials such as methyl ethyl carbonate, dimethyl carbonate, diethyl carbonate, ethylene carbonate." (EX1005 at [0037].) A POSITA would have understood Tomioka to disclose that 99% of the solvent, such

as dimethyl carbonate, is vaporized under the conditions specified by Tomioka, where it states that "the solvent was recovered using the embodiment illustrated in FIG. 20 (with the temperature inside the container body 54 being below 40°C), the recovery rate was 99%." (EX1005 at [0093].) A POSITA also would have understood that Tomioka's reference to 99% could refer to 99% by weight or volume of the dimethyl carbonate, where the densities of methyl ethyl carbonate, dimethyl carbonate and diethyl carbonate are all within 1.00 +/- 0.07 g/ml, and at 1 g/ml, weight % and volume % are essentially the same.

3. Claim 3: "The method according to claim 1, further comprising: capturing and condensing gases created from the vaporizing of organic carbonate in the electrolyte during the drying process.

141. Tomioka renders this limitation obvious. Tomioka discloses capturing and condensing gases created from the vaporizing of organic carbonate in the electrolyte during the drying process. For example, Tomioka discloses that "the removal and recovery of the solvent that makes up the aforementioned electrolyte can be achieved through: (a) vaporizing the liquid inside the battery and using the pressure to open the safety valve, (b) opening a portion of the battery through cutting and then vaporizing the liquid inside the battery to allow it to evaporate, with the generated evaporated gas being cooled and condensed for recovery." (EX1005 at [0089].) Tomioka also depicts a condenser 59 which "cools and condenses the generated and evaporated gas" and a container 60 "for recovering the condensed

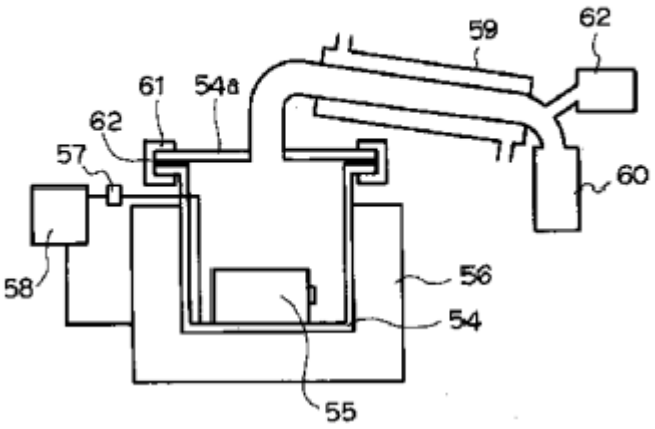
components" in the embodiments shown in Figure 19-20. (EX1005 at [0090]; *see also id.* at [0093]).

4. Claim 8: "The method according to claim 1, wherein: comminuting the used lithium batteries is performed within a container; and the drying is performed within the container."

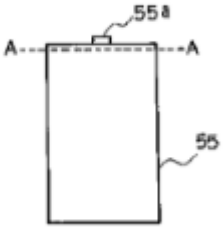
142. Tomioka renders this limitation obvious. Specifically, Tomioka renders obvious that the comminuting of used lithium batteries may be performed within a container and that drying may be performed within that container. For example, as explained above with respect to limitations 1[a] and 1[b], Tomioka renders obvious comminuting the used batteries in a comminution device. Tomioka discloses dismantling of the used batteries, where "dismantling means cutting the outer casing of the individual battery or the battery pack to extract the electrode element components . . . and, if necessary, cutting them into strip-like pieces." (*See* EX1005 at [0012].) Tomioka also discloses that, to reduce the risk of fire during the battery dismantling process, "it is effective to perform the cutting of the cylindrical secondary battery 55 while in a state cooled with liquid nitrogen or under an inert atmosphere." (*See* EX1005 at [0093].). A POSITA would have understood that "dismantling" used batteries comprises comminuting the batteries, including by "cutting."

143. Further, Figures 19 and 20 depict an embodiment of the invention in which the battery is comminuted, and the electrolyte is dried under pressurized conditions. Figures 19 and 20 are shown below.

【図１９】



【図２０】



(EX1005 at Figs. 19, 20.)

144. Tomioka explains that "when the solvent was recovered using the embodiment illustrated in Fig. 20 (with the temperature inside the container body 54 being below 40°C), the recovery rate was 99%, and the risk of ignition during the battery dismantling operation was eliminated. Additionally, to reduce the possibility of ignition, it is effective to perform the cutting of the cylindrical secondary battery 55 while in a state cooled with liquid nitrogen or under an inert atmosphere." (EX1005, [0093].) Tomioka further states that "[s]imilarly to the aforementioned Embodiment 1, ***by carrying out the extraction and recovery of the solvent within***

the battery during the separation and recovery of the battery body as well as after the discharge processing and during the battery dismantling process, the working environment and safety for battery dismantling operations are significantly improved." (EX1005 at [0094] (emphasis added).) While Tomioka does not explicitly say that the dismantling and drying of the batteries would occur in the same container, a POSITA reading Tomioka would have found it obvious that dismantling the batteries and drying the batteries as part of a singular process significantly improves the working environment and safety. In particular, an inert atmosphere can be used during both comminution and drying, which will prevent thermal runaway. Batteries are most susceptible to thermal runaway during the comminuting and drying phases of processing, and performing those operations all during a singular process would lead to fewer risks. A POSITA thus would have found it obvious to dismantle and dry batteries within the same container in light of Tomioka.

145. Accordingly, a POSITA would have found this limitation obvious in view of Tomioka.

5. Claim 10: "The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes components of comminuted material, and at least 90% by weight of the components of the

comminuted material have a sieve size that is not more than 50 mm."

146. Tomioka renders this limitation obvious. Tomioka explains that its claim 9 "relates to the method for processing waste as described in Claim 1 or Claim 2, wherein the step of peeling and separating the active material layer of the electrode element part is on a mesh of 10 mm or smaller and involves applying vibration." (EX1005 at [0041]). Claim 1 of Tomioka discloses a method in which the batteries are dismantled, cleaned, heated, and then the active material layer of the electrode elements is peeled and separated. (EX1005, [0011].) A POSITA would have understood that "peeling and separating the active material layer" would result in comminuted material that includes components of comminuted material. A POSITA would have also found it obvious to look to Tomioka's other disclosures of comminuting, including through dismantling and/or passing the battery material through rollers to crush the material. A POSITA would have found it obvious and advantageous to dismantle the material such that it had a sieve size of 10 mm or less, as smaller pieces of battery material would evaporate electrolyte faster.

147. A POSITA would have further understood that, because Tomioka discloses a net having a mesh size of 10 mm or less, at least 90% by weight of the components of the comminuted material would have a sieve size that is not more than 50 mm. It would be a common intent in the industry to choose a sieve size to capture 90% or more of the materials passing through the sieve. Capturing less than

90% may result in the loss of active material. If, as disclosed in Tomioka, a 10 mm mesh is used, it would have been obvious that at least 90% by weight of the components of the separated and pulverized material of Tomioka would have a sieve size that is not more than 50 mm.

148. Accordingly, a POSITA would have found it obvious to combine Tomioka's disclosures of dismantling the used battery material and its disclosures of using a mesh sieve size of 10 mm or less. Thus, Tomioka renders this limitation obvious.

6. Claim 11: "The method according to claim 1, wherein receiving the used lithium-ion batteries further includes receiving used lithium-ion batteries that further comprise carrier foil and binder that binds active material to the carrier foil, and the temperature of the vaporizing pressure-temperature being not more than 80° C., lower than a decomposition temperature of the binder, and lower than the decomposition temperature of the fluorine salt."

149. Tomioka renders this limitation obvious. Tomioka discloses receiving the used lithium-ion batteries that comprise carrier foil. For example, Tomioka discloses receiving batteries that include a current collector layer, which a POSITA would have understood to be a carrier foil. (EX1005, [0022]; *see also id.* at [0023]). For example, Tomioka discloses: "If the recovered battery is in an overcharged state or an excessively discharged state, a conductor made of the same material as the electrode current collector is connected to one of the battery electrode terminals via a conductive material, and discharge occurs based on differences in ionization

tendency. Here, the electrode current collector is preferably aluminum for the positive side and copper for the negative side, especially when there is a significant difference in ionization tendency." (EX1005, [0022].) Tomioka further discloses: "In the case of an overcharged lithium-ion secondary battery, when lithium uniformly adheres around the ***copper foil current collector*** on the negative side, the standard electrode potential becomes lower than that of pure copper. As a result, the copper side connected to the metal immersed in the external electrolyte becomes the positive electrode, allowing electric current to flow. Moreover, the rapid change in electric current occurs because the lithium adhering to the negative side's copper foil current collector detaches, leading to resistance in electric current being dominated by the inherent resistance of copper. Therefore, with a certain voltage, the resistance value increases compared to when lithium was attached." (EX1005, [0023].)

150. Tomioka further discloses that the used batteries include "binder components." (EX1005, [0014].) For example, Tomioka explains: "In addition, following this cleaning process, to achieve the separation (decomposition) of the ***binder*** from the electrode elements and to remove any remaining solvents or ***binder components***, a heat treatment is performed at a temperature of approximately 40 to 400°C. However, prior to this heat treatment, it is preferable to conduct a vacuum drying process to remove the electrolyte; this enhances the efficiency of subsequent processing." (EX1005, [0014].).

151. A POSITA would have understood that the binder binds the active material to the carrier foil. If carrier foil is present in the batteries, it would be necessary to have a binder to bind the active material to the carrier foil, also known as current collector foil.

152. Tomioka discloses that the temperature of the vaporizing pressure-temperature is not more than 80° C., lower than a decomposition temperature of the binder, and lower than the decomposition temperature of the fluorine salt. As discussed above with respect to limitation 1[e], Tomioka discloses that the pressure inside the container body 54 used in its vacuum drying step is "reduced to about 100 mmHg." (*See* EX1005 at [0092].) Converting 100 mmHg to hPA provides a pressure of 133.32 hPa. Tomioka also discloses that when "the temperature inside the container body 54 [is] below 40℃," the "recovery rate was 99%." (*See* EX1005,[0092].) A POSITA would have understood that 40℃ is less than a decomposition temperature of a fluorine salt, which depends on the conditions in which the fluorine salt exists but in all cases is higher than 40℃. Common lithium-ion electrolyte salts include: $LiPF_6$, $LiBF_4$, $LiAsF_6$, $LiCF_3SO_3$, $LiC_4F_9SO_3$, $LiN(CF_3SO_2)_2$, $LiC(CF_3SO_2)_3$. (EX1014, [0069].) The least thermally stable of the common lithium-ion electrolyte salts is LiPF6 which is stable up to 80°C. (EX1014, [0079].)

153. A POSITA also would have understood that this pressure-temperature is lower than a decomposition temperature of the binder. For example, a POSITA would have understood that polyvinylidene fluoride (PVdF) is a widely used binder, and that the decomposition temperature for PVdF is above 400°C, which is supported by Tomioka. (*See* EX1005 at [0015].) Accordingly, a POSITA would have understood that by heating the comminuted material to a temperature of 40°C or less, at a pressure of about 133.32 hPa, this pressure-temperature would be much lower than a decomposition temperature of a binder.

7. Claim 12: "The method according to claim 11, further comprising a high temperature drying of the inactivated comminuted material, the high temperature drying being configured to decompose binder."

154. Tomioka renders this limitation obvious. In particular, Tomioka describes that after the vacuum drying step, "to achieve the separation (decomposition) of the binder from the electrode elements and to remove any remaining solvents or binder components, a heat treatment is performed at a temperature of approximately 40°C to 400°C." (EX1005 at [0014].) Tomioka also discloses embodiments characterized by "heating the recovered and dismantled electrode element under a reducing atmosphere at a temperature below 600°C." (EX1005 at [0039].) A POSITA would have understood that Tomioka's heating treatment "to achieve the separation (decomposition) of the binder" would have been performed at a temperature appropriate to decompose binder, which would typically

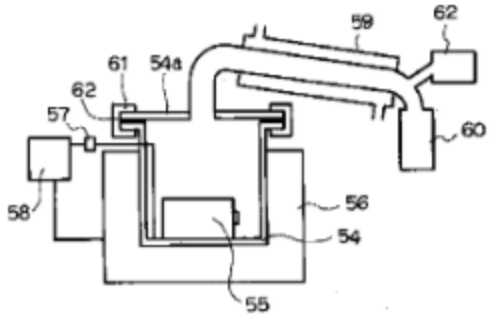
be on the higher range of between 40℃ to 400℃ and below 600℃. A POSITA would understood this heating treatment "to achieve the [decomposition] of the binder" to comprise the claimed high temperature drying.

B. Ground 2: Claim 4 Is Rendered Obvious by Tomioka in View of Yosuke

1. Claim 4: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; continuous monitoring, by a controller, of at least one progress parameter that is indicative of a progress of the drying, the at least one progress parameter comprising a pressure in the interior of the drying device or a pressure of a gas flow out of the interior of the drying device drying process, and not terminating the drying process until the progress parameter reaches a pre-determined progress parameter threshold value."

155. Tomioka in view of Yosuke renders this limitation obvious. As explained above, Tomioka discloses in the embodiments depicted by Figures 19-20 a "container body" 54 that contains "recovered battery 55" and in which the drying is performed, where the container body 54 is pressurized to "to about 100 mmHg" and "below 40℃." (EX1005 at [0090], [0092], [0093].) Accordingly, Tomioka discloses that the drying is performed within the interior of a drying device, which is container 54. Container 54 is shown in Figure 19, below.

【図19】

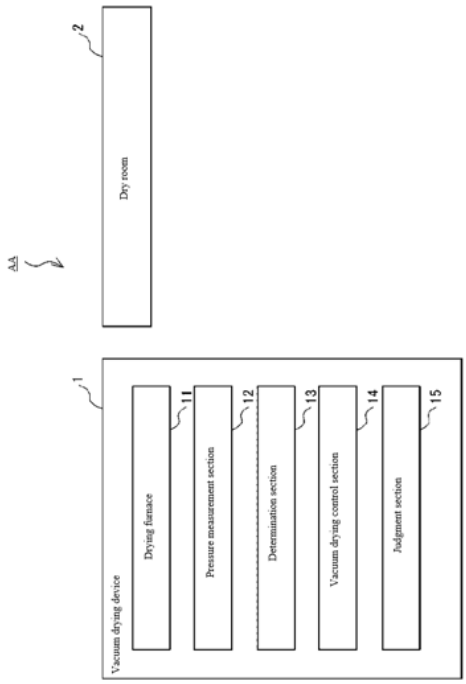


(EX1005 at Fig. 19.)

156. Figure 19 also depicts a "controller" 58 "that controls and adjusts the heating by heater 56 based on the information from the . . . temperature measuring device 57." (EX1005 at [0090].) Yosuke also discloses performing the drying within an interior of a drying device. For example, Yosuke discloses a drying furnace where lithium-ion batteries are to be dried. (EX1008, [0004], [0007], [0024].) For example, Yosuke states, "This invention is a vacuum drying device (for example, corresponding to the vacuum drying device 1 in Fig. 1) for performing vacuum drying on an object to be dried (for example, corresponding to the battery electrodes mentioned later) arranged in a drying furnace (for example, corresponding to the drying furnace 11 in Fig. 1)." (EX1008, [0007].) Yosuke further discloses continuous monitoring, by a controller, of at least one progress parameter that is indicative of a progress of the drying, the at least one progress parameter comprising a pressure in the interior of the drying device or a pressure of a gas flow out of the interior of the drying device drying process. For example,

Yosuke discloses "a pressure measurement means (for example, corresponding to the pressure measurement section 12 in Fig. 1) for measuring the pressure inside the aforementioned drying furnace." (EX1008, [0007].) Figure 1 of Yosuke is shown below, including drying furnace 11 and pressure measurement section 12.

[Fig. 1]



(EX1008, Fig. 1.)

157. Yosuke further discloses not terminating the drying process until the progress parameter reaches a pre-determined progress parameter threshold value. For example, Yosuke explains that the claimed apparatus also includes "a determination means (for example, corresponding to the determination section 13 in Fig. 1) for determining whether the pressure measured by the aforementioned pressure measurement means has decreased to below or less than a predetermined

target pressure." (EX1008, [0007]). Yosuke also teaches of "a vacuum drying control means (for example, corresponding to the vacuum drying control section 14 in Fig. 1) for continuing vacuum drying for a predetermined first period after it is determined by the aforementioned determination means that the pressure measured by the aforementioned pressure measurement means is below or less than the aforementioned target pressure," as well as "a judgment means (for example, corresponding to the judgment section 15 in Fig. 1) for determining that the vacuum drying of the aforementioned object to be dried is complete when the pressure measured by the aforementioned pressure measurement means after the aforementioned first period is determined by the aforementioned determination means to be below or less than the aforementioned target pressure." (EX1008, [0007]).

158. Claim 1 of Yosuke similarly discloses "[a] vacuum drying device" comprising "a pressure measurement means," "a determination means," "a vacuum drying control means," and a "judgment means that judges that the vacuum drying of the aforementioned object to be dried is completed when the pressure measured by the aforementioned pressure measurement means is determined by the aforementioned determination means to be below or less than the aforementioned targe pressure after the aforementioned first period of time has elapsed." (EX1008, cl. 1].) Accordingly, a POSITA would have understood that Yosuke's determination

Ascend Elements EX1003 Page 86

means, vacuum drying control means, and/or judgment means, alone or collectively, comprises a controller that continuously monitors the progress parameter of pressure interior to the drying device and does not terminate drying until the pressure "has dropped to below the target pressure." Therefore, Tomioka in view of Yosuke renders obvious claim 4.

C. Ground 3: Claims 5 and 9 Rendered Obvious by Tomioka in View of Hayashi

1. Claim 5: "The method according to claim 1, wherein the [the] pressure is not more than 30 hPa for at least 50% of a duration of the drying, or the pressure does not exceed 50 hPa during the drying, or both."

159. Tomioka in view of Hayashi renders this limitation obvious. Hayashi discloses a "method for processing fluorine-containing electrolyte solution according to any one of [3] to [6] described above, in which the electrolyte solution is heated at 80℃ to 150℃ under reduced pressure of 5 kPa to ordinary pressure, the volatile component is gasified, and the gasified gas is introduced to the wet processing step or the dry processing step." (EX1010 at 2:40-3:11, 3:13-19.) 5 kPa converts to 50 hPa, and accordingly, Hayashi discloses drying at 50 hPa.

160. Hayashi further discloses a "method for processing a fluorine-containing electrolyte solution according to [1] described above, in which the electrolyte solution is heated at 80℃ to 150℃ under reduced pressure of less than or equal to 1kPa, the volatile component is gasified, and the gasified gas is introduced to a dry processing step." (EX1010 at 2:24-33, 3:20-25.) Hayashi

provides further details on the relevant pressure-temperatures experienced by electrolyte compared to exposure temperatures, as summarized in Table 1 of Hayashi, below. These values are generated using the Clausius-Clapeyron equation.

TABLE 1

[Atmospheric Pressure Conversion Temperature]

Actual Temperature	Pressure: Atmospheric Pressure 101.3 kPa	15 kPa	10 kPa	5 kPa	1 kPa	0.1 kPa
0° C.	0° C.	49° C.	58° C.	74° C.	108° C.	152° C.
10° C.	10° C.	60° C.	70° C.	86° C.	120° C.	166° C.
20° C.	20° C.	71° C.	81° C.	98° C.	134° C.	180° C.
80° C.	80° C.	139° C.	151° C.	170° C.	210° C.	262° C.
150° C.	150° C.	217° C.	230° C.	251° C.	297° C.	354° C.

(EX1010, Table 1.)

161. Hayashi explains that "each electrolyte solution at 0℃. 10℃., 20℃., 80℃., and 150℃. under atmospheric pressure (101.3 kPa) is in a state of an atmospheric pressure conversion temperatures shown in Table 1 under reduced pressure conditions of 15 kPa, 10 kPa, 5 kPa, 1 kPa, and 0.1 kPa" and that "[a]ccordingly, under the reduced pressure conditions which are selected, the electrolyte solution is heated such that the atmospheric pressure conversion temperature of the electrolyte solution, for example, is higher than or equal to 244℃., and thus it is possible to volatilize DMC, EMC, DEC, PC, EC, or the like." (EX1010, 4:49-59.) Hayashi provides the example that "when the inside of the battery is depressurized to 5 kPa and is heated at 80℃. to 150℃., the electrolyte

Ascend Elements EX1003 Page 88

solution is in a state of 170℃. to 251℃. at the atmospheric pressure conversion temperature, and thus DMC, EMC, EC, PC, and EC included in the electrolyte solution, and the thermally decomposed fluorine compound are able to be volatilized." (EX1010, 4:60-67.) Hayashi provides another example that "the inside of the battery may be depressurized to be less than 5 kPa, for example, 1 kPa to 0.1 kPa and may be heated at 80℃. to 120℃." (EX1010, 4:60-5:3.) 1 kPa converts to 10 hPa.

162. Further, context from claims 1, 5, and 7 demonstrates that the drying pressure disclosed in Hayashi remains at that reduced pressure of less than or equal to 1kPa during the entirety of the drying process. For example, claim 1 of Hayashi discloses "a method for processing a fluorine-containing electrolyte solution . . . the method comprising" "a gasification step of gasifying volatile components included in the electrolyte solution by heating the electrolyte solution under reduced pressure which is lower than atmospheric pressure." (EX1010, Cl. 1.) Claim 7 depends from claim 5 and specifies that "wherein, in the gasification step, the electrolyte solution is heated at 80℃. to 150℃. under the reduced pressure of less than or equal to 1 kPa, thereby the volatile components are gasified." (EX1010, Cl. 5.) Because claim 7 of Hayashi specifies that "thereby the volatile components are gasified" through use of the "reduced pressure of less than or equal to 1kPa," a POSITA would have understood that Hayashi teaches using the reduced pressure for the entire period of

drying, so as to "gasify" the "volatile components." Accordingly, Hayashi discloses both utilizing a pressure of not more than 30 hPa for at least 50% of a duration of the drying, and utilizing a pressure not to exceed 50 hPa during the drying.

2. Claim 9: "The method according to claim 3 wherein condensing is performed at an ambient pressure, or condensing is performed at a temperature within a temperature range that extends from 0° C. to 50° C., or both."

163. Tomioka in view of Hayashi renders this limitation obvious. Hayashi discloses that condensing is performed at a temperature within a temperature range that extends from 0°C. to 50°C. For example, Hayashi discloses that, "the depressurization was performed up to 5 kPa by the vacuum pump, and the large-sized battery cell was immersed in the oil heater and was heated at 120°C for 2 hours," and that then "[t]he generated gas was condensed in the cooling pipe (4°C.) and was captured in a capturing bottle." (EX1010 at 10:27-44). The "organic phase [of the collected liquid] was analyzed, and the components of the solution were DMC, EMC, DEC, and EC." (EX1010 at 10:27-44; *see also* 9:37-10:26, 10:50-11:7.) Hayashi discloses condensing the captured gases via cooling pipe at 4°C., and accordingly Hayashi discloses that the condensing is performed at a temperature range that extends from 0°C. to 50°C.

D. Ground 4: Claims 6 and 7 Are Rendered Obvious by Tomioka in View of LithoRec

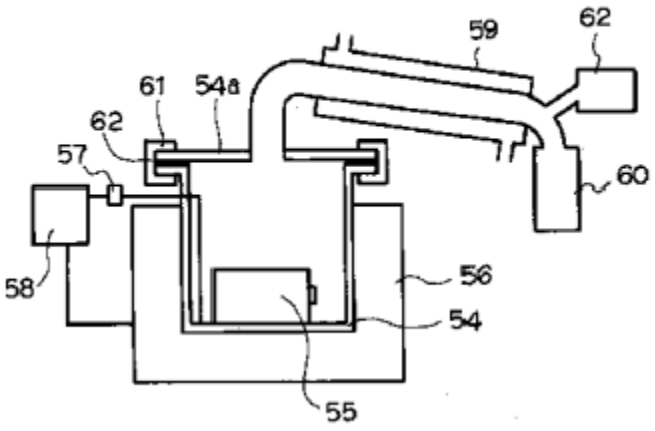
1. Claim 6: "The method according to claim 1, further comprising: feeding the comminuted material, through an airlock,

into an interior of a drying device; and performing the drying within the interior of the drying device.

164. Tomioka alone or in combination with LithoRec renders this limitation obvious. As discussed above with respect to claim 4, Tomioka discloses that the comminuted material is fed into the interior of a drying device, and the drying is performed within the interior of the drying device.

165. For example, in Figure 19, Tomioka shows a lid 54a to the drying device, 61 is a sealing seal, and 62 is a fixture that secures the lid 54a to the container body 54:

【図１９】



(EX1005 at Fig. 19, [0090].) The lid, sealing seal, and fixture secure the lid and reduce the amount of gas introduced into the dryer, so as to make the drying device gas-tight, consistent with the '463 Patent's description of an airlock. (EX1001, 11:33-38, 13:17-21.) For example, the '463 Patent states: "[t]he battery processing

installation preferably has an airlock between the comminution unit and the deactivation device, especially the drying device. For example, this refers to a rotary feeder or a flat slider. The airlock reduces the amount of gas introduced into the deactivation device, especially the drying device." (EX1001, 11:33-38.) The '463 Patent further describes the airlock as "airlock 28" that "is arranged between the comminution unit 18 and the drying device 26, the airlock being so gas-tight that the pressure device 26 is – to a good approximation – separated from the comminution unit 18 so as to be gas-tight." (EX1001, 13:17-21.) Accordingly, because Tomioka discloses that its drying device is gas-tight through the use of the lid, sealing seal, and fixture, Tomioka discloses and/or renders obvious an airlock.

166. To the extent that PO argues that Tomioka does not disclose an airlock, Tomioka in combination with LithoRec renders this limitation obvious. LithoRec discloses that the comminuted material is fed into the interior of a drying device through an airlock. For example, LithoRec discloses that "[d]rying must take place in a protective gas atmosphere (nitrogen), just like the crushing process beforehand" and that the "dryer gases are circulated in a closed circuit and cleaned using a filter and condenser." (EX1012 at 227.) To facilitate the closed circuit for the nitrogen gas, the comminuted material is fed on the inlet side of the dryer, which is "gas-tight to the outside." (EX1012 at 227.) "After closing, the airlock is inerted with nitrogen." (EX1012 at 227.) The cell packs are then fed through a buffer container,

through a rotary valve, through a tubular screw conveyor, and into the dryer. (EX1012 at 227.) Accordingly, a POSITA would have understood LithoRec to disclose that the comminuted material is fed on the inlet side of the dryer, through a gas-tight inlet or airlock. (EX1012 at 227.) The comminuted material travels through that airlock through a buffer container, through a rotary valve, and through a tubular screw conveyor, all of which are part of the airlock, into the dryer. The '463 Patent describes that an airlock may be "designed as a rotary airlock." (EX1001, 15:13-17; 11:38-41.) Accordingly, a POSITA would have understood that Tomioka in combination with LithoRec render this limitation obvious.

167. As discussed above in Section VIII.E.1, a POSITA would have been motivated to incorporate LithoRec's airlock to feed comminuted material into Tomioka's drying device. Tomioka recognizes that the drying device needs to be gas-tight and accordingly would have recognized the benefit in feeding the comminuted material under a gas-tight environment from the comminution device to the drying device. (*See* EX1005, [0090].) The addition of an airlock to feed the comminuted material to the drying device of Tomioka would have been a simple modification to the dryer of Tomioka and would have been obvious and well within the skill of a POSITA.

2. Claim 7: "The method according to claim 6, further comprising: vacuum sucking away of gases created from vaporized organic carbonate during the drying process and/or wherein the

batteries comprise current collector foils having a coating material and movement using the agitator is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away."

168. Tomioka alone or in view of LithoRec render this limitation obvious. Specifically, Tomioka discloses vacuum sucking away of gases created from vaporized organic carbonate during the drying process. For example, Tomioka discloses that "it is preferable to conduct a vacuum drying process to remove the electrolyte" prior to an additional heat treatment. (EX1005 at [0014].) Tomioka further discloses that "before vaporizing and dissipating the liquid inside the battery," "it is preferable to carry out a pre-treatment such as vacuum suction drying using, oil rotary pumps with gas collection mechanisms, piston pumps, multi-stage steam ejectors, a Roots pumps, etc." (EX1005 at [0037].)

169. In the embodiment of Figure 19, Tomioka discloses that "a vacuum pump 62 is attached to the recovery container 60 side, and when the interior of the container body 54 is reduced to about 100 mmHg, the efficiency of removing and recovering the solvent inside the battery can be increased." (EX1005, [0092].) In the embodiments disclosed by Tomioka, the vacuum pump is used during the drying process such that the vaporized organic carbonate is sucked away. This is supported by Tomioka's disclosure that, due to the pressure conditions in the container body 54, "the efficiency of removing and recovering the solvent inside the battery can be increased," where the solvent includes organic carbonate.

E. Ground 5: Claims 13 and 14 Are Rendered Obvious by Tomioka in view of Perry

1. Claim 13: "The method according to claim 1, further comprising: moving by an agitator, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both; and supplying, during the drying, a vaporization heat to the comminuted material, wherein the supplying includes the agitator supplying at least 35% of said vaporization heat."

170. Tomioka in view of Perry renders this limitation obvious.

171. As explained above with respect to claim 1, Tomioka discloses supplying, during the drying, a vaporization heat to the comminuted material.

172. In general, a POSITA would have understood that agitators are useful to incorporate into dryers, as moving the material assists in efficiently drying the material.

173. Accordingly, a POSITA would have looked to Perry and its disclosures of agitated dryers to incorporate Perry's teachings into the combination of Tomioka with LithoRec. Perry, a well-known handbook for chemical engineering, includes an entire section on different types of agitated dryers and their use cases. (EX1015, 12-64-12-71.)

174. Specifically, Perry discloses that "[a]n agitated dryer is defined as one on which the housing enclosing the process is stationary while solids movement is accomplished by an internal mechanical agitator," and that "[m]any forms are in use,

including batch and continuous versions." (EX1015, 12-64.) Perry discloses "[b]atch vacuum rotary dryers" and states that "[t]he more common type of vacuum rotary dryer consists of a stationary cylindrical shell, mounted horizontally, in which a set of agitator blades mounted on a revolving central shaft stirs the solids being treated." (EX1015, 12-65.)

175. Through Perry, a POSITA would have identified an agitated dryer for inclusion in the drying apparatus of Tomioka. A POSITA would have understood that the purpose of the agitator is to increase the efficiency of the drying of the comminuted material.

176. As discussed above in Section VIII.F.1 a POSITA would have been motivated to incorporate Perry's agitator into Tomioka's drying device. A POSITA would have recognized that Tomioka's dryer could benefit from an agitator, to speed up drying time and to assist in discharging the material from the dryer.

177. The use of an agitated dryer in the drying device of Tomioka would have been a simple modification to the dryer of Tomioka and would have been obvious and well within the skill of a POSITA. A POSITA would have selected an agitated dryer from the menu of options provided in Perry, and could have incorporated either a standalone agitator into the dryer of Tomioka or else could have adapted Tomioka's disclosures regarding temperature, pressure, and condensing of evaporated fluids to the dryers disclosed in Perry. Both would have been simple

modifications well within the skill of a POSITA. The combination would also have included the airlock disclosed in LithoRec for feeding the comminuted material into the dryer, which a POSITA would have recognized is beneficial for maintaining a gas-tight environment in the dryer.

178. A POSITA would have understood that one benefit to using an agitated dryer is the additional heat generated by an agitator. In particular, a high-powered agitator could contribute significant vaporization heat to the drying process. As one example, Perry explains that for agitators, "[t]he heat- and mass- transfer mechanisms are similar to those in batch tray dryers, except that constant turning over and mixing of the solids significantly improves drying rates." (EX1015, 12-67.) A POSITA would have understood that this "constant turning over and mixing of solids" could contribute significant heat and improve drying rates. (*See* EX1015, 12-67.) Accordingly, Perry teaches "moving by an agitator, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both."

179. The '463 Patent provides as an example embodiment that "[t]he agitator is preferably used to supply at least 35%, in particular at least 50%, of a vaporisation heat required for the drying of the comminuted material" and that "in an ideal situation, it is not necessary to provide an additional heater to heat the comminuted

material" but that "[i]f such a heater is provided, its power output is preferably smaller than the power output of the agitator." (EX1001, 8:4-13.) In this way, "[t]he introduction of energy into the comminuted material by way of an agitator is advantageous as it results in the separation of, for example, coating and carrier foil and other components of the battery." (EX1001, 8:4-13.) The '463 Patent also explains that exemplary power outputs provided by the agitator can be "at least 1 kilowatt per cubic meter of volume of the drying device," (EX1001, 8:4-15.), or 4kW or 5 kW per cubic metre of drying volume and that such "mechanical output is largely converted into thermal energy." (EX1001, 15:18-28.)

180. Perry provides a table with examples of common diameters, lengths, heating surfaces, working capacities, agitator speeds, drive in kW, weight, and purchase price as of 1995 of common agitator dryers at the time.

TABLE 12-27 Standard Rotary Vacuum Dryers*

Diameter, m	Length, m	Heating surface, m^2	Working capacity, m^3†	Agitator speed, r/min	Drive, kW	Weight, kg	Purchase price (1995)	
							Carbon steel	Stainless steel (304)
0.46	0.49	0.836	0.028	7½	1.12	540	$ 43,000	$ 53,000
0.61	1.8	3.72	0.283	7½	1.12	1,680	105,000	130,000
0.91	3.0	10.2	0.991	6	3.73	3,860	145,000	180,000
0.91	4.6	15.3	1.42	6	3.73	5,530	180,000	205,000
1.2	6.1	29.2	3.57	6	7.46	11,340	270,000	380,000
1.5	7.6	48.1	6.94	6	18.7	15,880	305,000	440,000
1.5	9.1	57.7	8.33	6	22.4	19,050	330,000	465,000

(EX1015, Table 12-27.)

181. As shown in the table above, agitated dryers with drives in kW ranging from 1.12 all the way to 22.4 kW were known in the art and considered "standard" rotary vacuum dryers. As stated above, Perry defines an "agitated dryer" as "one on

which the housing enclosing the process is stationary while solids movement is accomplished by an internal mechanical agitator," and accordingly, a POSITA would have understood that the motor drives listed in the table above power the agitator. (EX1015, 12-64.) Using a motor drive powered up to 22.4 kW, a POSITA would have understood that such agitator would be sufficiently high powered to supply at least 35% of the vaporization heat to the comminuted material. Perry provides a menu of options of agitated dryers with various drives, and choosing an appropriately high-powered motor would have been a straightforward and obvious choice to a POSITA from a menu of options.

182. Accordingly, this limitation is obvious by Tomioka in view of Perry.

2. Claim 14: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; and agitating, by an agitator, the inactivated comminuted material when removing the inactivated comminuted material from the drying device."

183. Tomioka in view of Perry renders this limitation obvious. As explained above with respect to claim 4, Tomioka discloses performing the drying within an interior of a drying device. As discussed above with respect to claim 7, Perry discloses numerous types of and use cases for agitated dryers. (EX1015, 12-64-12-71.) Perry specifically discloses batch vacuum rotary dryers, and states that "[t]he more common type of vacuum rotary dryer consists of a stationary cylindrical shell,

mounted horizontally, in which a set of agitator blades mounted on a revolving central shaft stirs the solids being treated." (EX1015, 12-65.)

184. Perry further discloses that "[t]he double-cone rotating vacuum dryer is a more common design," and that with the double-cone rotating vacuum dryer, "the sloping walls of the cones permit more rapid emptying of solids when the dryer is in a stationary position." (EX1015, 12-65.) However, for cylindrical shapes, they "require[] continuous rotation during emptying to convey product to the discharge nozzles." (EX1015, 12-65.) As a result, "a circular dust hood was frequently necessary to enclose the discharge-nozzle turning circle and prevent serious dust losses to the atmosphere during unloading." (EX1015, 12-65.)

185. A POSITA would have understood that it would be generally beneficial to utilize an agitator to facilitate material transport toward the exterior of the dryer during discharge. Further, it would be particularly beneficial to utilize an agitator during discharge with certain dryer designs where material may sit on the edges of the dryer, such as with cylindrical designs. A POSITA would have understood that an agitator may be used to facilitate material transport in addition to or instead of continuous rotation of a rotary dryer during discharge. As such, Tomioka in view of Perry renders this limitation obvious.

F. Ground 6: Claims 1-3, 5 and 9-12 Are Disclosed or Rendered Obvious by Hanisch in view of Hayashi

1. Claim 1

a) Claim 1[pre]: "A method for treating used lithium batteries, comprising:"

186. Hanisch discloses this limitation. Hanisch teaches that "[t]he invention concerns a method for retrieving active material, in particular lithium or lithium compounds, from a galvanic cell. . ." (*see* EX1021, [0001].). Hanisch also explains that "the object of the invention is to improve the retrieval of lithium or lithium compounds, from old batteries or accumulators." (*See* EX1021, [0004].) A lithium battery is a type of "galvanic cell."

b) Claim 1[a]: "receiving, into a comminuting device, used lithium batteries that include a cathode, anode, separator, and electrolyte comprising a fluorine salt and a solvent, the solvent including an organic carbonate;"

187. Hanisch alone and/or in view of Hayashi discloses this limitation. The '463 Patent itself discusses the German priority application for Hanisch (DE 10 2011 110 083), explaining that Hanisch teaches a method in which "galvanic cells are initially mechanically comminuted." (*See* EX1001, 1:43-45.)

188. Hanisch discloses and/or renders obvious the claimed battery composition. Specifically, Hanisch discloses the "galvanic cells preferably always comprise at least one anode and at least one cathode" (EX1021, [0024].) The

galvanic cell further comprises, "a support for the active material, a binder for bonding the active material and the support and if necessary an electrolyte." (EX1021, [0001].) Likewise, Hanisch explains that "The active material is understood in particular to mean a bond which can reversibly take up and release lithium ions. On the cathode side, for example, lithium nickel manganese cobalt oxide, lithium nickel aluminium oxide and lithium iron phosphate; on the anode side, for example, graphite." (EX1021, [0017].) A POSITA would have understood that a typical lithium battery as of 2011 (the foreign priority date for Hanisch) and 2016 (the claimed foreign priority date of the '463 patent) would have included separator and an electrolyte, and that the electrolyte was typically made with a fluorine salt, such as $LiPF_6$, and with a solvent having an organic carbonate, such as EMC and DMC. (*See* Section VI.B., above (Materials Used in Li-Ion Batteries)). Accordingly, a POSITA reading Hanisch's disclosure of recycling used lithium batteries would have understood and at least found it obvious that the batteries processed by Hanisch include common lithium ion battery components, including those claimed in the '463 patent.

189. Hanisch discloses receiving, into a comminuting device, the used Lithium batteries. Hanisch Fig. 1 discloses "a cell crushing device 12, to which galvanic cells 14.1, 14.2, . . . are supplied." (EX1021, [0044].) Hanisch also

explains that "the crushing of cells is understood in particular to mean cutting, shattering, chaffing or squashing." (EX1021, [0015].)

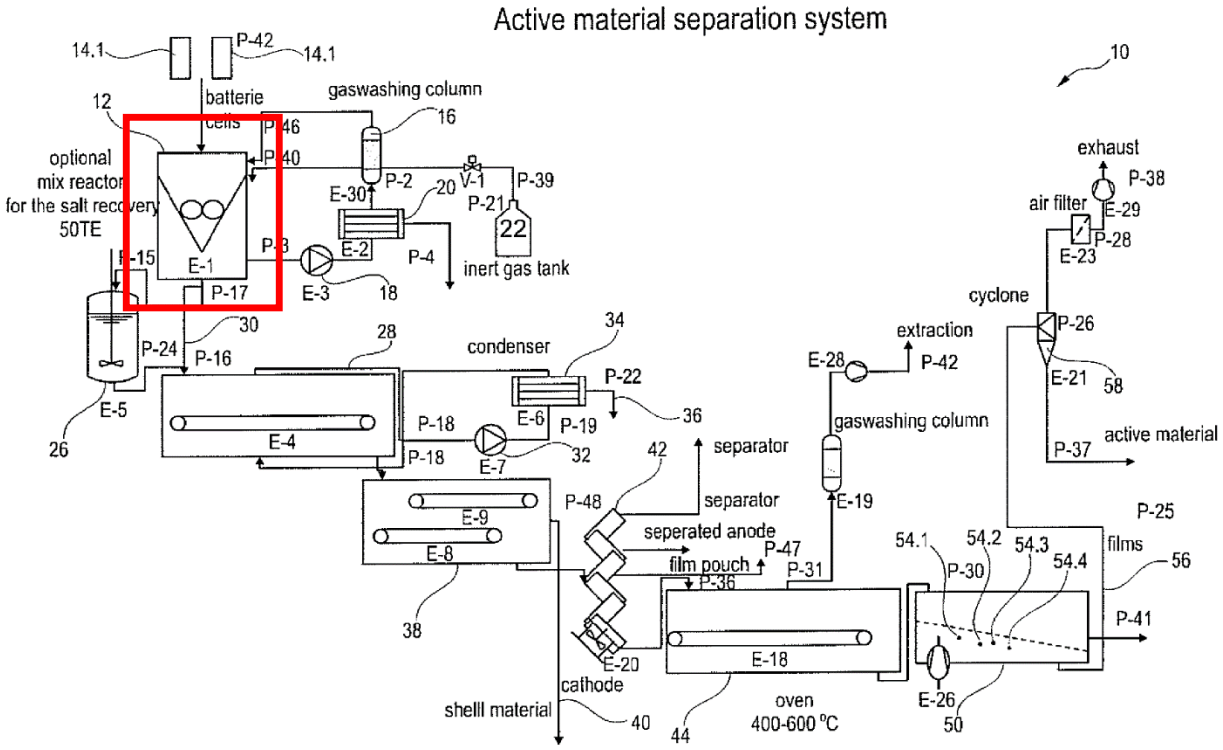


Fig. 1

(EX1021, Fig. 1 (annotated)).

190. To the extent the Board requires a reference expressly teaching the claimed battery composition, Hayashi discloses this. Hayashi teaches that "[a]n electrolyte solution used in the lithium ion battery or the like includes a fluorine compound which is an electrolyte ($LiPF_6$, $LiBF_4$, or the like) and a volatile organic solvent, and the organic solvent is a flammable substance which is mainly ester carbonates." (EX1010, 1:22-28.) Accordingly, a POSITA would have understood

that Hanisch's lithium battery recycling method would have obviously included processing lithium-battery components, such as electrolyte and organic solvent, as taught by Hayashi.

c) Claim 1[b]: "comminuting the used lithium batteries, by the comminuting device, and obtaining comminuted material as a result; and"

191. Hanisch discloses this limitation for the reasons explained above with respect to limitation 1[a], including that, as noted previously, the '097 Patent itself admits that Hanisch teaches a method in which "galvanic cells are initially mechanically comminuted."

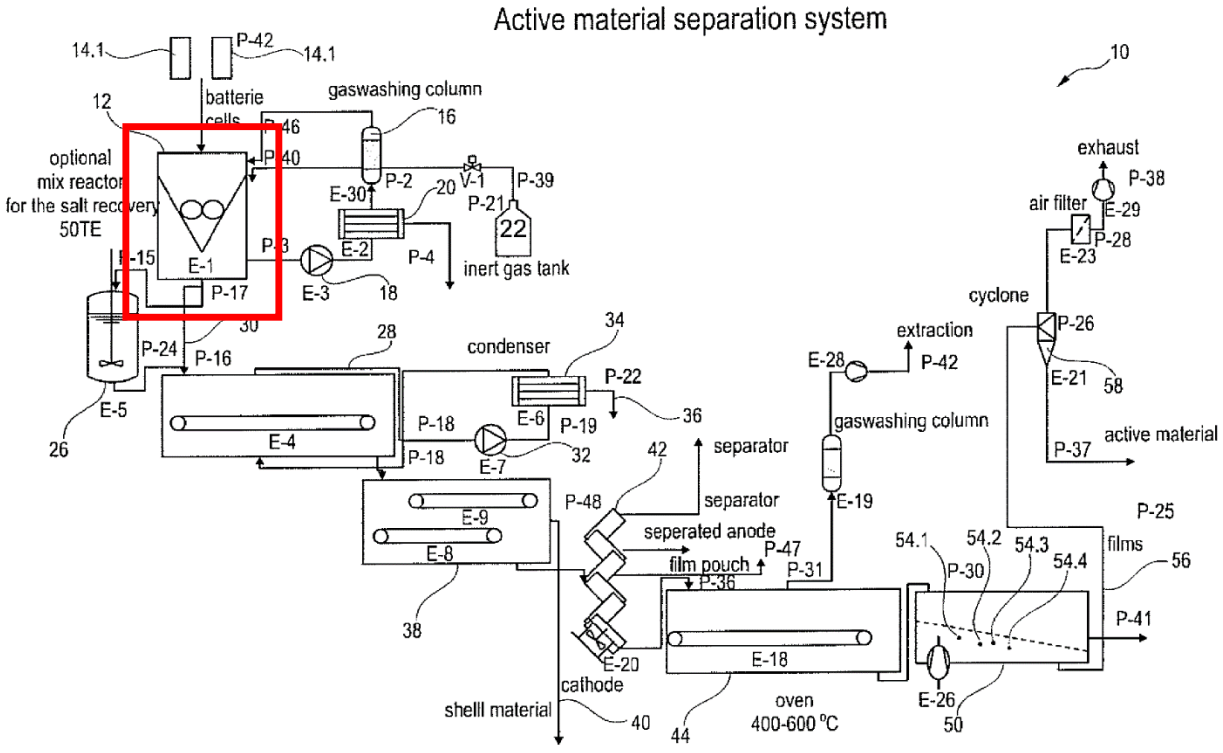


Fig. 1

d) Claim 1[c]: "inactivating the comminuted material and obtaining inactivated comminuted material as a result,"

192. Hanisch discloses this limitation. Hanisch discloses using a dryer (called a "pre-dryer" in reference to the first stage, low-temperature drying that precedes the second stage high temperature decomposition) which heats the comminuted material to 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." (EX1021, [0025].) Hanisch does not disclose a specific amount of time that the comminuted material sits in the pre-dyer; instead, Hanisch teaches a POSITA what should come out of the dryer: "dry" cell fragments and "drying vapours." (*Id.*) A POSITA would have understood that, by referring to the cell fragment as "dry" (and not, for example, "partly dry") Hanisch discloses "inactivated" cell fragments. This is because cell fragments that are "dry" have little to no liquid solvent (*i.e.*, electrolyte) remaining. Without the electrolyte solvent, the dry material is incapable of electrochemical reactions. Similarly, to the extent Patent Owner argues that "inactivated" refers to the end result of drying, these "dry" cell fragments are, by definition, the end result of Hanisch's pre-dryer. Thus, under any interpretation, the dry cell fragments formed by Hanisch's pre-dryer would be considered inactivated.

e) Claim 1[d]: "wherein the inactivating includes a drying process, comprising drying the comminuted material by removal of organic carbonate from the electrolyte by vaporizing the organic carbonate at a pressure-temperature above a boiling point of the organic carbonate,"

193. Hanisch discloses this limitation. As defined by the ’463 patent, the "drying” process is understood to mean "the removal of at least one solvent.” Because Hanisch discloses removing more than one solvent—in the form of drying vapours—Hanisch discloses this. Specifically, Hanisch discloses the claimed temperature/pressure drying process: "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.” (EX1021, [0025].) That Hanisch discloses forming "drying vapours" that can then be condensed for retrieval means Hanisch discloses the claimed "vaporizing the organic carbonate." (*Id.*) Hanisch's disclosure that the pre-dryer forms these dry cell fragments and drying vapours at a temperature "below 80° C” (EX1021, [0025].), together with its earlier disclosure that "the heating takes place…in a vacuum” (*Id.*, [0016].) teaches a POSITA that Hanisch's vaporization is taking place above a boiling point of the organic carbonate, as claimed. This is because the boiling points of, for example, EMC and DMC are typically well above 90°C under normal atmospheric conditions, so a POSITA would have understood that efficient and effective evaporation of these organic carbonates

at 80°C would suggest the use of a vacuum to create a temperature-pressure that is above the boiling point. This understanding of Hanisch is confirmed by Hayashi's temperature-pressure teachings. For example, Hayashi discloses that organic carbonates (e.g., EMC, DMC) will reach vapor pressure at temperatures below 80°C (e.g., at 70°C) with pressures below 300 hPA (e.g., "10kPA", which is equal to 100 hPA):

TABLE 1

[Atmospheric Pressure Conversion Temperature]

Actual Temperature	Pressure: Atmospheric Pressure 101.3 kPa	15 kPa	10 kPa	5 kPa	1 kPa	0.1 kPa
0° C.	0° C.	49° C.	58° C.	74° C.	108° C.	152° C.
10° C.	10° C.	60° C.	70° C.	86° C.	120° C.	166° C.
20° C.	20° C.	71° C.	81° C.	98° C.	134° C.	180° C.
80° C.	80° C.	139° C.	151° C.	170° C.	210° C.	262° C.
150° C.	150° C.	217° C.	230° C.	251° C.	297° C.	354° C.

(EX1010, Table 1.)

194. At 80°C (as disclosed by Hanisch) and 100 hPA (as disclosed by Hayashi), the relevant pressure-temperature boiling points, for example, can be calculated as 32.7°C for dimethyl carbonate and 30.8°C for ethyl methylcarbonate using the Clausius-Clapeyron equation as described in ¶¶132-136. Because the exposure temperature of 80°C is higher than the pressure-temperature boiling point of dimethyl carbonate of 32.7°C and ethyl methylcarbonate of 30.8°C at 100 hPa, Hanisch in view of Hayashi renders obvious removal of organic carbonates from the

electrolyte by vaporizing the organic carbonates at a pressure-temperature above a boiling point of the organic carbonates.

f) Claim 1[e]: "the pressure being not more than 300 hPa, and the temperature being not more than 80° C. and lower than a decomposition temperature of the fluorine salt."

195. Hanisch in view of Hayashi discloses this limitation. As discussed earlier, Hanisch discloses that the crushed cell fragments are dried in a "pre-dryer" at drying temperatures "below 80°C" to form "drying vapours" from the electrolyte solvent, which are then condensed and collected for retrieval: "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." (EX1021, [0025].) While Hanisch teaches that the decomposition temperature of the *binder* "is preferably at least 350° C. and at the most 800° C," (EX1021, [0028]), Hanisch does not expressly state the decomposition temperature of the fluorine salt (e.g., the $LiPF_6$). However, because LiPF6 is known to have a decomposition temperature *above* 80°C, Hanisch's disclosure of drying *below* 80°C necessarily means the pre-dryer temperature in Hanisch is lower than a decomposition temperature of the fluorine salt.

196. In addition, Hanisch teaches that "the heating up takes place…in a vacuum." (EX1021, [0016].) As a POSITA would have recognized, using a vacuum of less than 300 hPa would be a routine application of the natural thermodynamic properties of EMC and/or DMC, which specify that, in order to sufficiently and effectively vaporize these substances at temperatures "below 80°C," the pressure must be sufficiently low.

197. Further, as discussed above, Hayashi teaches EMC and DMC (i.e., the organic carbonates) will reach vapor pressure at temperatures below 80°C (e.g., at 70°C) with pressures below 300 hPa (e.g., "10kPa," which is equal to 100 hPa). (EX1010, Table 1.) A POSITA therefore would have been motivated to apply these teachings of Hayashi—that a vacuum level of 100 hPA allows for low-temperature vaporization—in implementing the low-temperature drying in Hanisch's pre-dryer.

2. Claim 2: "The method according to claim 1, wherein: the organic solvent comprises dimethyl carbonate, or ethyl methylcarbonate, or both; and the drying process further continues the drying until the vaporizing removes at least 90 percent by weight of the dimethyl carbonate, or ethyl methylcarbonate, or both, from the electrolyte.

198. Hanisch in view of Hayashi discloses and/or renders obvious this limitation. Hanisch discloses a method of treating used lithium batteries according to claim 1. *See, above*, Section X.F.1. Hanisch discloses a "pre-dryer" drying process in which "cell fragments are dried at a drying temperature, so that ***dry cell fragments and drying vapours are formed***,…[so] that the electrolyte solvent can be

retrieved." (EX1021, [0025].) Even though Hanisch does not set forth a specific amount of drying time, it clearly explains that the goal of the pre-dryer is to form "***dry cell fragments***" and electrolyte "***drying vapours***" from which the electrolyte is recovered. *Id*. Because Hanisch explains that the material processed by the pre-dryer is "dry," without qualification, a POSITA would have understood that plain language to mean that "dry" means ***dry***, such that Hanisch's pre-dryer is necessarily removing all or substantially all (in other words, nearly 100%) of the liquid electrolyte from the comminuted material. Otherwise, the material would not be classified as "dry." By extension, a POSITA thus would have understood, or at least found it obvious, that more than 90% by weight of the DMC and/or EMC must have been removed in order to result in "dry cell fragments."

199. And if further disclosure of the dimethyl carbonate, or ethyl methylcarbonate within the electrolyte is required, Hayashi discloses that common organic solvents in the electrolyte for lithium ion batteries includes dimethyl carbonate and ethyl methylcarbonate. (EX1010, 4:11-18.)

3. Claim 3: "The method according to claim 1, further comprising: capturing and condensing gases created from the vaporizing of organic carbonate in the electrolyte during the drying process.

200. Hanisch discloses this limitation. Hanisch teaches using the "pre-dryer" drying process to create "drying vapours" and that "the drying vapours are at least partly condensed. This has the advantage that the electrolyte solvent can be

retrieved." (EX1021, [0025].) Thus, because the gas is being "condensed" for "retriev[al]," a POSITA would have understood that Hanisch discloses "capturing and condensing gases" from the vaporization of the EMC and DMC.

4. Claim 5: "The method according to claim 1, wherein the [the] pressure is not more than 30 hPa for at least 50% of a duration of the drying, or the pressure does not exceed 50 hPa during the drying, or both."

201. Hanisch in view of Hayashi renders this limitation obvious. Hanisch teaches drying temperatures in the pre-dryer that are "below 80°C." (EX1021, [0025].) Hayashi further discloses this limitation for the reasons I explain in Section X.C.1 and those teachings are equally applicable to Hanisch.

5. Claim 9: "The method according to claim 3 wherein condensing is performed at an ambient pressure, or condensing is performed at a temperature within a temperature range that extends from 0° C. to 50° C., or both."

202. Hanisch in view of Hayashi renders this limitation obvious. Hayashi further discloses this limitation for the reasons I explain in Section X.C.2 and those teachings are equally applicable to Hanisch.

6. Claim 10: "The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes components of comminuted material, and at least 90% by weight of the components of the

comminuted material have a sieve size that is not more than 50 mm."

203. Hanisch discloses this limitation, because it teaches "air jet sieving" for separating the comminuted particles, in which "[t]he mesh size of the sieve is preferably a maximum of 250 μm [0.250 mm], in particular a maximum of 100 μm [0.100 mm]." (EX1021, [0023].) Hanisch expressly teaches that the mesh size is chosen to ensure that it corresponds to the diameter of more than 90% of the active material found in the lithium battery. (EX1021, [0022].) This is consistent with a POSITA's understanding that sieves are well-known and well-understood tools for separating solids of different dimensions.

7. Claim 11: "The method according to claim 1, wherein receiving the used lithium-ion batteries further includes receiving used lithium-ion batteries that further comprise carrier foil and binder that binds active material to the carrier foil, and the temperature of the vaporizing pressure-temperature being not more than 80° C., lower than a decomposition temperature of the binder, and lower than the decomposition temperature of the fluorine salt."

204. Hanisch discloses this limitation. In particular, Hanisch discloses that a galvanic cell "comprises an active material, a support for the active material, ***a binder for bonding the active material and the support*** and if necessary an electrolyte…" (EX1021, [0001]; *see also id.*, [0002].) Hanisch also teaches that "aluminum foil is frequently used as the support" (EX1021, [0010].) and the "support of the active material is understood in particular to mean a ***support foil***

upon which the active material is placed in the form of particles. . . . The binder can, for example, be polyvinylidene fluoride (PVDF)." (EX1021, [0018].) This accords with the way the '463 patent describes the "carrier foil": "The carrier for the active material should be understood particularly to mean a carrier foil to which the active material is applied in the form of particles. For example, the carrier foil refers to a foil made of aluminium or an aluminium alloy. The binder is the material which binds the active material with the carrier; for example, the binder contains polyvinylidene fluoride." (EX1001, 9:46-52.)

205. Hanisch also teaches that pre-drying is carried out "below 80°C" and that the "[t]he 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." (EX1021, [0025], [0028].) A POSITA would have understood from this explanation that Hanisch's disclosure of drying at "below 80°C" is lower than a decomposition temperature of the binder, which Hanisch discloses as between 350°C and 800°C, and lower than the decomposition temperature of the fluorine salt, which is above 80°C.

8. Claim 12: "The method according to claim 11, further comprising a high temperature drying of the inactivated comminuted material, the high temperature drying being configured to decompose binder."

206. Hanisch discloses this limitation. In particular, Hanisch discloses "heating the solid cell fragments up to the decomposition temperature, which is high

enough to make the binder decompose and/or evaporate." (EX1021, [0001], [0002].) Hanisch also explains that this 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." (EX1021, [0011].) Hanisch also discloses that "[t]he 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." (EX1021, [0028].)

G. Ground 7: Claim 4 Is Rendered Obvious by Hanisch in view of Hayashi and/or Yosuke

1. Claim 4: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; continuous monitoring, by a controller, of at least one progress parameter that is indicative of a progress of the drying, the at least one progress parameter comprising a pressure in the interior of the drying device or a pressure of a gas flow out of the interior of the drying device drying process, and not terminating the drying process until the progress parameter reaches a pre-determined progress parameter threshold value."

207. Hanisch in view of Yosuke renders this limitation obvious. Hanisch discloses that the drying is performed inside a drying device. For example, Hanisch discloses drying crushed cell fragments in a "gas-proof" "pre-dryer" until a desired end-result, when "dry cell fragments and drying vapours are formed." (EX1021, [0016], [0025], [0046].) Yosuke discloses this limitation for the reasons explained in Section X.B.1.

H. Ground 8: Claim 6 Is Rendered Obvious by Hanisch in View of Hayashi and/or in further view of LithoRec

1. Claim 6: "The method according to claim 1, further comprising: feeding the comminuted material, through an airlock, into an interior of a drying device; and performing the drying within the interior of the drying device.

208. Hanisch in view of Hayashi and/or further in view of LithoRec renders this limitation obvious. As discussed above with respect to claim 4, Hanisch discloses that the comminuted material is fed into the interior of a drying device (the "pre-dryer"), and the drying is performed within the interior of the drying device. Hanisch further discloses that "heating up of solid cell fragments is understood to mean heating up in gas-proof container, so that oxygen, for example, is prevented from the [*sic*] entering. In particular, the heating up takes place…in a vacuum." (EX1021, [0016].). A POSITA would have understood that using an airlock is an obvious and well-known method of making the pre-dryer "gas-proof" (and for the heating up to take place "in a vacuum").

209. To the extent that further disclosure of an airlock is necessary, LithoRec discloses this limitation for the reasons explained above in Section X.D.1.

I. Ground 9: Claims 7, 13, 14 Are Rendered Obvious by Hanisch in view of Hayashi and in further view of LithoRec and/or Perry

1. Claim 7: "The method according to claim 6, further comprising: vacuum sucking away of gases created from vaporized organic carbonate during the drying process and/or wherein the batteries comprise current collector foils having a coating material and movement using the agitator is conducted such that at least

50% by weight of the coating material of comminuted material is sucked away."

210. Hanisch in view of Hayashi and LithoRec render obvious claim 6 and this additional limitation is obvious in further view of Perry. Specifically, Hanisch discloses vaporizing and removing electrolyte "drying vapours" within a "pre-dryer." (EX1021, [0025].) This "has the advantage that the electrolyte solvent can be retrieved." [*Id*.] This retrieval is understood to occur through vacuum sucking of the "drying vapours," for example through "pipe 36" so the vapours can then be condensed and retrieved.

211. Further, Hanisch discloses using an "air jet sieve [that] is operated in such a way that the active material is also separated from the support by means of a collision with a sieve of the collision separation device and/or with a baffle plate." (EX1021, [0013].) This sieve separates the "current collecting foils" from the active material, "so [t]he foil fraction (aluminum and copper) is held back by the sieve element and can be obtained as a metal fraction and used again." (EX1021, [0024], [0049]). This air jet sieve is operated with a particle speed "high enough for the impact to bring about a high level of separation" and a cyclone, as shown in FIG. 2, "for the support air behind the air jet sieve to be sucked away." (EX1021, [0031]-[0032]). As Hanisch explains, "as a result of the air flow, the electrode fragments are whirled up and then placed under mechanical stress [which] assists in the separation of support foil and coating." (EX1021), [0049].) Hanisch teaches that

this method then allows for reducing impurities to as low as 0.03-1%. (EX1021, [0009]-[0010]). Based on these teachings, a POSITA would have understood Hanisch to disclose that more than 50% by weight of the coating material is sucked away in order to separate the support foil and active material with such a high degree of purity.

212. Perry discloses and/or renders obvious the agitator for moving the comminuted material during drying for the reasons discussed in Section X.E.1 above.

2. Claim 13: "The method according to claim 1, further comprising: moving by an agitator, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both; and supplying, during the drying, a vaporization heat to the comminuted material, wherein the supplying includes the agitator supplying at least 35% of said vaporization heat."

213. Hanisch in combination with Hayashi and Perry renders this limitation obvious. As explained above with respect to claim 7, Hanisch in view of Perry renders obvious an agitator for moving, over a duration of the drying, a not yet inactivated comminuted material among the comminuted material, or a mixture of inactivated comminuted material and not yet inactivated comminuted material, or both. Perry further discloses this limitation for the reasons explained above in Section X.E.1.

3. Claim 14: "The method according to claim 1, further comprising: performing the drying within an interior of a drying device; and agitating, by an agitator, the inactivated comminuted material when removing the inactivated comminuted material from the drying device."

214. Hanisch in combination with Hayashi and Perry renders this limitation obvious. As explained above with respect to claim 6, Hanisch discloses performing the drying within an interior of a drying device. Perry further discloses this limitation for the reasons explained above in Section X.E.2.

J. Ground 10: All Challenged Claims are invalid for indefiniteness

215. It is my opinion that all Challenged Claims are invalid under §112(b) for being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor regards as the invention.

1. All Challenged Claims – "inactivating the comminuted material and obtaining inactivated comminuted material as a result"

216. Independent claim 1 recites the step of "inactivating the comminuted material and obtaining inactivated comminuted material as a result." The meaning of this step is not reasonably clear because a POSITA would not understand from the claims or specification the particular point at which the comminuted material is considered "inactivated."

217. Claim 1 explains that "the inactivating includes a drying process, comprising drying the comminuted material by removal of organic carbonate from

the electrolyte by vaporizing the organic carbonate." However, "inactivating" merely "includes" the drying process, which suggests that inactivating could potentially be performed by another means.

218. But this apparent distinction (between "drying" and "inactivating") is made more confusing by the specification which provides guidance on how long to dry comminuted material but no guidance as to how a POSITA would know that comminuted material has reached the point of inactivation. (*See, e.g.,* EX1001, 7:21-29, 7:30-34, 7:39-42; 7:7-13.) There are various metrics by which *drying* may be measured, including whether there is a build-up of heat in the material (*see* EX1001, 7:21-29); the maximum value by weight of the electrolyte (*see* EX1001, 7:30-34); the content of the dimethyl carbonate reaches a certain threshold by volume (*see* EX1001, 7:39-42); or until an electrolyte content is so low that an electrochemical reaction is impossible," (EX1001, 7:7-13.) but none of these various metrics indicate whether the dried material is *inactivated*. As these varying examples demonstrate, and as a POSITA would have understood, the endpoint of drying can be very different depending on the goal and the particular threshold sought to be reached for the dried material, and none of those thresholds necessarily indicate whether the material is inactivated. Further, I understand that in parallel IPR proceedings for U.S. Patent No. 11,050,097 ("the '097 Patent") (a patent to which the ‘463 Patent is terminally disclaimed), PO (1) argued that the Board "selected a single metric as

defining the endpoint of inactivation" (thereby implying that "inactivated" is not a single state of being but encompasses a range) (EX1019, 9), and (2) expressly disavowed any notion that the specification's disclosed metrics for drying times, *or any metrics*, should govern the construction of "inactivating". (EX1019, 10 (asking the Board to "recognize that inactivation is the endpoint result of drying, but not specify the particular metric of drying that must be reached")). Further, I understand that in its Patent Owner Response in a separate concurrent proceeding, PO argued that "inactivated" should be understood as "safe for transport" (i.e., not synonymously with "drying"). (EX1029, 9.) Given all the inconsistencies in PO's position before the Patent Office in a related patent, and the '463 specification's lack of meaningful guidance, a POSITA would have no reasonable certainty as to when comminuted material is considered "inactivated."

219. Accordingly, it is my opinion that a POSITA would not have been able to ascertain the scope of claim 1 (and all challenged claims) with reasonable certainty.

2. 7. "wherein . . . movement using the agitator is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away."

220. Claim 7 recites "wherein . . . movement using *the agitator* is conducted such that at least 50% by weight of the coating material of comminuted material is sucked away." However, neither claim 1 nor claim 6 (from which claim 7 depends)

recites an "agitator," and thus "the agitator" as recited in claim 7 lacks antecedent basis.

221. Because claim 7 does not include antecedent basis for the term "the agitator," it is unclear whether claim 7 was intended to introduce a new recitation of an agitator (without explanation for what is being agitated), or whether the agitator in claim 7 was intended to refer to the agitator in claims 13 or 14, and each of these possibilities would give the claims greatly differing scopes. For example, claim 13 indicates that the agitator is used *within* the drying device, where it claims that the agitator is used "over a duration of the drying" to move "not yet inactivated" material or a mixture of inactivated and not yet inactivated material. But the agitator of claim 14 includes an agitator external to the drying device that agitates only inactivated material after drying, where claim 14 recites use of an agitator "when removing the inactivated comminuted material from the drying device." Because claim 7 does not include any such similar explanation or limitations, is unclear whether the agitator is within the drying device; at the edge of the drying device; or someplace else entirely. Because the term "the agitator" lacks antecedent basis, a POSITA would not understand the meaning of the term as used in the claimed limitation.

222. For purposes of interpreting these claims for the prior art rejections identified above (grounds 1-9), I have interpreted "the agitator" as referring to an agitator either within or outside the dryer.

3. The method according to claim 1, wherein comminuting of the used lithium batteries is configured such that the comminuted material includes components of comminuted material, and at least 90% by weight of the components of the comminuted material have a sieve size that is not more than 50 mm

223. It is my opinion that claim 10 fails to inform a POSITA as to how to determine what denominator is used to calculate the "90% by weight" limitation and accordingly is indefinite. The specification of the '463 Patent does not provide any examples of how to calculate the "90% by weight" limitation and instead merely restates the claim language. (EX1001, 4:61-65). Although the specification states that this limitation "should be understood to mean that 90% by weight of the components fall through a sieve which has a mesh width of 50 mm (or the respective given width)", this statement does not explain what differentiates the "components" of comminuted material from the entirety of "comminuted material." Accordingly, a POSITA would not understand with reasonable certainty how to calculate this percentage, where the specification fails to provide a way to identify the denominator of the 90% fraction, if other than the entire weight of the comminuted material.

XI. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS

224. I understand that Patent Owner has argued certain secondary considerations of non-obviousness in a parallel proceeding on U.S. Patent No. 11,050,097. As to long-felt but unmet need and unexpected results, I understand that

Patent Owner cites to only the specification of the '097 Patent and provides no objective evidence of such long-felt need (or that '097 Patent or '463 Patent solved this long-felt need). I am not aware of a long-felt need in the industry that the '463 Patent solved, as evidenced by the prior art discussed above that rendered obvious the alleged invention of the '463 Patent.

225. With respect to the other factors raised by Patent Owner in that proceeding, I have not had access to any sealed materials and therefore have not reviewed them or formed an opinion with respect to them.

226. I reserve the right to address any such evidence that Patent Owner may submit in the future.

XII. CONCLUSION

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 7th day of March, 2025 in Livermore, CA.

Marc Juzkow

Marc Juzkow (Mar 7, 2025 16:43 PST)

Marc Juzkow

Appendix A

Marc Juzkow, MSc, MBA

marc@lithiumion.expert 925-570-5194

SKILLS & ACCOMPLISHMENTS

Unique skill set including lithium battery and ultracapacitor R&D, application engineering, sales, marketing, team building and business management, with a complementary graduate education in science and business.

- 41 years in the battery industry; managed team that developed and commercialized the first lithium-ion battery in North America in the early 1990's.
- Expert witness for over 50 lithium-ion related cases including IP, product liability and commercial. Declarations: 26; Depositions: 10
- Cell assembly, performance and abuse lab installation. Procedure development and training.
- Assembled and led research, product development, testing and application engineering organizations; Established international sales and technical marketing teams
- Extensive Asian experience: worked for NIO, Mitsui and NEC with significant travel to Japan, Korea and China; subcontracting and joint R&D in China; audited and maintained relations with material suppliers and subcontractors throughout Asia.
- Leading edge of battery and supercapacitor technology resulting in many invitations to speak at major U.S. and international conferences. Over 45 presentations and publications to date.
- Strong presentation; reporting; organization (personal and team); and training skills.

PROFESSIONAL EXPERIENCE

Lithiumion Expert Services, LLC

Consulting in all areas of lithium-ion batteries and supercapacitors (since 2000), including expert witness for IP and commercial litigation, product liability incidents (i.e. e-cigarettes, medical devices, portable devices, stationary systems and vehicles). Corporate patent and technology due diligence. New technology development assistance. Failure analysis including battery autopsies, performance and safety/abuse testing. Cell assembly, performance and abuse lab design, installation and training. Business/technology planning, go-to-market strategies.

2021 to 2025 – Joby Aviation

Cell Supplier Lead

Responsible for lithium-ion cells and technology at Joby, an e-VTOL company. Cell and supplier qualification. Working with developers of new cell material and component technology.

2020 to 2021 – Feasible, Inc. (now Liminal)

Head of Product

Led development and commercialization of non-invasive ultrasound testing for battery cells.

2017 to 2020 - NIO, Inc

Principal Cell Specialist

Responsible for lithium-ion cells and technology at NIO, an autonomous EV company developing from the ground up a fully autonomous vehicle. Support the battery pack team. Cell and supplier qualification. Development of new technology for use in NIO EVs.

2014 to 2017 Iontensity, LLC

President and Founder

Founded Iontensity to fill an important niche in the lithium-ion industry. Hired a team of scientists, engineers and technicians and set up an R&D Model Plant Facility to assemble electrodes and

cells, and perform testing. Won two government DOE contracts totaling $1.4M. Transferred technology, trained and assembled cells for four multinational companies. Contracted with multiple start-up companies to support their efforts to bring new materials to market. Battery qualification and failure analysis for OEMs.

2008 to 2014 Leyden Energy (previously Mobius Power Inc.)

VP R&D

Responsible for all R&D efforts, technology roadmap and personnel in the development of novel lithium-ion cell and battery technologies: High Power (LMO/LTO); High Energy (Si anode); and Non-Flammable Electrolyte.

Assembled strong R&D and Engineering teams through a combination of hiring experienced scientists, engineers and technicians and mentoring new engineering graduates.

Worked directly with consumer electronics, industrial and EV customers (North America, Asia and Europe) to customize chemistry and cell/pack designs. Led development of 12V/48V batteries for industrial and micro-hybrid EV applications.

Audited many Chinese factories for material supply and subcontracting lithium-ion cell and pack manufacturing. Responsible for technology transfer for manufacturing.

Designed and implemented a Performance Testing Lab with 1800 automated testers and a Safety/Abuse Testing Lab capable of UN/DOT and UL1642 testing.

Won CEC (California Energy Commission), three DOE, and four USABC contracts worth $16M. PM for USABC contracts.

Responsible for IP portfolio. Prepared and submitted nine U.S. and four international patent applications. Five U.S. patents granted.

2005 to 2008 UNCAP, LLC

CTO, VP of Marketing and Founder

Founder of UNCAP, LLC, a U.S. based ultracapacitor company. Designed and developed a nickel based aqueous asymmetric ultracapacitor. Built 14V and 28V, 195kJ modules for use in diesel engine starting in cold weather, no-idle solutions and Silent Watch (military). Designed ultracapacitors for lead customers in uninterruptible power supplies. Developed an Excel model of the cell components to predict performance. Prepared seven patent invention disclosures. Also responsible for administration and financial management.

2004 to 2008 Mobile Power Solutions

CTO

Set up a battery and ultracapacitor testing laboratory. Designed equipment for UL and DOT/UN transportation testing. Trained personnel. Designed custom performance and safety test programs and oversaw technical elements. Provided expert opinions on performance, safety, abuse, shipping, packaging and recycling regulations for batteries. Audited Tier 1 China cell manufacturers for large U.S. consumer electronics OEM.

2003 to 2008 VoltSource, Inc.

President and Founder

A private consulting firm in the field of batteries, supercapacitors and associated industries, specializing in product (cell and pack level), IP development (prepared ten patent disclosures for one customer), market, applications and business development, market assessment, sales, energy source selection (developed three web based battery and ultracapacitor design programs), product testing and qualification, environmental, transport and safety issues, and battery-related investment and legal work.

marc@lithiumion.expert 925-570-5194

2000 to 2003 Cooper Electronic Technologies, PowerStor Products, Dublin, CA

Director of Sales and Marketing

Responsible for international sales and marketing, product/market development and application engineering. Identified / researched target markets enabled by this new technology. Designed and developed, evaluated and qualified ultracapacitors based on customer / application requirements.

Launched five new product lines including various cylindrical (0.22F ~ 100F) devices, higher voltage (5V ~ 20V) modules using balancing circuitry, ultra-thin flat low ESR devices using foil-polymer laminate packaging and very high capacitance (> 500F) cylindrical devices.

1996 to 2000 PolyStor Corporation, Dublin & Livermore, CA

Director of Sales and Marketing

Assembled customer service, application engineering, and sales and marketing organization.

Co-developed BB-2590/U Lithium-ion battery under US Army CECOM development contract.

1985 to 1996 Moli Energy Limited, Vancouver, B.C. Canada

Manager, Sales & Marketing
Manager of Product Development
Manager of Product Evaluation
Various Team/Project Leader Positions
Research Technologist / Scientist

Cell, product, application and market development of Moli Energy's Lithium Battery Technology.
Planned and managed various cell and battery development and product evaluation projects to successful completion, including development of first lithium-ion cell in North America.
Researched new cathode, anode and electrolyte materials for lithium metal and lithium-ion.
Co-developed the first BB-2847 Lithium-ion battery for U.S. Army CECOM.
Assembled a new Sales and Marketing team following development of lithium-ion 18650 cell.

EDUCATION

1993	Executive MBA	Simon Fraser University	Vancouver, BC, Canada
1989	MSc (Chemistry)	Simon Fraser University	Burnaby, BC, Canada
1985	BSc (Chemistry)	Simon Fraser University	Burnaby, BC, Canada

PATENTS

US 8,221,915 High performance lithium or lithium ion cell, July 17, 2012
US 8,465,871 Electrochemical cells with tabs, June 18, 2013
US 9,263,731 High performance lithium or lithium ion cell, February 16, 2016
US 9,343,745 Surface passivation of active material particles for use in electrochemical cells, May 17, 2016
US 9,350,017 High performance lithium or lithium ion cell, May 24, 2016
US 10,538,437 Liquid treatment using capacitive systems, January 21, 2020
US 10,756,391 Method and system for secondary internal current mechanisms for a lithium-ion cell, August 25, 2020
US 11,127,995 Lightweight thermal adsorption structure for lithium-ion cell module, September 21, 2021
US 11,205,809 Early detection of thermal incident in battery pack, December 21, 2021
US 11,233,272 Zero flammability electrolyte for lithium-ion cell, January 25, 2022
US 11,431,046 Lithium-ion cell using aluminum can, August 30, 2022
US 11,616,256 Abuse Tolerance in Battery Modules, March 28, 2023

PUBLICATIONS & PRESENTATIONS

Over 45 publications, seminars and presentations, including keynote, plenary and invited.