

Declaration of Regan Zane, Ph.D. in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 8,610,397 B2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NINTENDO CO., LTD., and
NINTENDO OF AMERICA INC.,
Petitioner,

v.

MALIKIE INNOVATIONS LTD.,
Patent Owner

Case IPR2026-00006
U.S. Patent No. 8,610,397 B2
Issue Date: December 17, 2013

Title: BATTERY CHARGER FOR PORTABLE DEVICES AND RELATED
METHODS

DECLARATION OF REGAN ZANE, PH.D.

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I, Regan Zane, Ph.D., declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

A. Qualifications and Professional Background

1. My name is Regan Zane. I am currently the David G. and Diann L. Sant Endowed Professor of Electrical and Computer Engineering at Utah State University (USU), and I have over 25 years of experience in the power electronics industry, including experience with AC-to-DC and DC-to-DC power conversion, battery chargers, and battery management and device protection circuitry. A copy of my curriculum vitae is attached as **Appendix A**. Appendix A also includes a list of the publications I have authored and a list of the other cases in which I have testified during the last 5 years.

2. I have been retained by counsel for Petitioner Nintendo Co., Ltd. and Nintendo of America Inc. (collectively, “Nintendo” or “Petitioner”) as an expert to provide opinions concerning whether claims 1-22 in U.S. Patent No. 8,610,397 (“the ’397 patent”) (**EX1001**) are valid. The ’397 patent is titled “Battery Charger for Portable Devices and Related Methods.”

3. This declaration contains statements of my opinions formulated to date, and the bases for each of these opinions. I may amend or supplement my opinions in this declaration as appropriate in response to further review of materials, including

opinions and/or testimony of other expert witnesses.

4. I have been compensated at my standard rate for time spent on this matter, plus reimbursement for any expenses. My compensation is in no way dependent on any results or any proceedings relating to the '397 patent.

5. I have substantial experience as an electrical engineer in the fields of power electronics, integrated circuit design and packaging, discrete and integrated gate drivers, and control **battery charger for a portable wireless** circuits for isolated and non-isolated power converters and switched-mode power supplies. For example, my research has covered design, modeling and control of high efficiency, high frequency, high power density, and high performance AC and DC power converters and power integrated circuit design for energy efficient systems. My work has covered a wide range of applications including battery charging systems for portable electronics, energy efficient lighting and building systems, wireless power transfer and ambient and directed energy harvesting for wireless devices, bidirectional power converters for hybrid AC and DC systems and micro-grids, DC power distribution and high efficiency step-down converters for data centers, power converters for grid-integration of batteries and renewable energy sources, battery management systems for electric vehicles and grid energy storage, and wireless and wired power converter systems for electric vehicle charging.

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6. I received my Bachelor of Science degree in Electrical Engineering (BSEE) from the University of Colorado at Boulder in 1996. In 1998, I received a Master of Science degree in Electrical Engineering (MSEE) from the University of Colorado at Boulder. In 1999, I received a Doctor of Philosophy (Ph.D.) degree in electrical engineering from the University of Colorado at Boulder. My Ph.D. dissertation research focused on the design of low-cost, high performance custom integrated circuit (IC) controllers and gate drives for isolated AC-to-DC power converters and power management circuitry.

7. In 1999, I joined the Corporate Research and Development Center at General Electric (GE) as a Senior Research Scientist. At GE, I developed and commercialized custom integrated circuits for a wide range of power applications including multiple generations of integrated power controllers for compact fluorescent and high intensity discharge lamps and portable medical devices. These designs included gate drive and control circuits for primary and secondary side controllers.

8. In 2001, I joined the Department of Electrical, Computer, and Energy Engineering at the University of Colorado at Boulder as an Assistant Professor. I received tenure and was promoted to Associate Professor in 2008. In 2012, I became a Full Professor with a USTAR endowment in the Department of Electrical and

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Computer Engineering at Utah State University. There, I founded and continue to direct the Electric Vehicle & Roadway (EVR) Research Facility and Test Track, the USU Power Electronics Lab (UPEL), and the Battery Limits and Survivability Test (BLAST) lab. The BLAST lab is the first of its kind in the multi-state region uniquely developed to safely test new battery charging technologies and battery packaging systems under accelerated aging and extreme conditions for validation testing. The BLAST lab is built in a concrete bunker to support full scale destructive testing of large battery packs and includes state-of-the-art characterization equipment for detailed electrical and thermal evaluation.

9. In 2016, I formed and launched the multi-campus industry sponsored Center for Sustainable Electrified Transportation (SELECT), and in 2020, I led the team to receive the National Science Foundation's (NSF's) highest award for international center level research and became the Director of the NSF Engineering Research Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE ERC). The ASPIRE ERC includes 10 universities, more than 80 faculty and 250 students, and over 60 industry and innovation sponsors from automotive OEMs, Tier 1 component suppliers, utilities, battery manufacturers, national laboratories, and a wide range state, government, and non-profit agencies. In 2018, I received the David G. and Diann L. Sant

Endowed Professorship at Utah State University.

10. Since 2006, I have served as an Associate Editor with IEEE Transactions on Power Electronics. In addition, since 2013 I have served as an Associate Editor for the IEEE Journal of Emerging and Selected Topics in Power Electronics. I have served as conference chairman, co-chair, session chair, and committee member for numerous professional conferences in power electronics over the past 20 years and maintained active participation as a journal article reviewer and elected professional society leader. I have served as a member of multiple standards committees through the IEEE and the Society of Automotive Engineers (SAE), and currently serve as co-chair of the SAE J2954/3 subteam on wireless power transfer for battery charging on electric vehicles. In 2025, I was elected an IEEE Fellow, which is the highest grade of membership offered by the IEEE. This distinction recognizes individuals who are among the top one-tenth of one percent (0.1%) of IEEE membership for extraordinary accomplishments in the field of electrical engineering.

11. I have led numerous large-scale R&D and commercialization programs on technologies for battery systems and battery charging for a wide range of applications. As one example, I was the lead principal investigator (PI) for a multi-million dollar, multi-year project funded by the Department of Energy's Advanced

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Research Program Agency-Energy (DOE-ARPA-E) titled “Robust cell-level modeling and control of large battery packs.” The project was in partnership with key industry and national lab partners where I led the development of new concepts for advanced active battery charging systems that were conceived, modeled, and simulated, then developed into hardware prototypes, integrated into commercial battery packs for a leading automaker, evaluated for over one year of testing, and finally transitioned for commercialization. The work resulted numerous peer reviewed articles and in three issued U.S. patents on “Battery Control,” “Autonomous Battery Control and Optimization,” and “Model Predictive Control and Optimization for Battery Charging and Discharging.”

12. As additional examples, I led similar work supported by the Office of Naval Research (ONR) titled “Robust plug-and-play expeditionary battery system,” for NASA titled “Active battery management system with physics based life modeling,” and for industry partners in applications including robust battery solutions for electric aircraft, high power fast charging battery packs for electric vehicles, and battery management systems for second life application of batteries that provide support to the electric utility grid. This work has received numerous awards, including the Utah Innovation Award in Clean Technology and Energy for "Robust and Efficient Battery Management Systems" and the USU Campus

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Research of the Year Award.

B. Materials Considered

13. As noted above, I have been retained by Petitioner as an expert to provide opinions concerning the validity of the claims of the '397 patent. The analysis I provide in this Declaration is based on my education, background, research, and experience, as well as the materials I have considered. In forming my opinions, I have read and considered U.S. Patent No. 8,610,397 B2 (**EX1001**) and its prosecution history. I have cited to the following documents in my analysis below:

Exhibit No.	Description of Document
EX1001	U.S. Patent No. 8,610,397 B2 to Michael L. Purdy, et al. (filed January 24, 2012, issued Dec. 17, 2013) (“’397” or “’397 patent”)
EX1003	Japanese Patent Application Publication No. JP 2000-323181A to Hisashi Keirinbou (filed on May 13, 1999, published November 24, 2000) (“Keirinbou”)
EX1004	Certified Japanese-to-English translation of Keirinbou (EX1003)
EX1005	U.S. Patent No. 5,998,966 to Brian Scott Gaza (filed March 20, 1998, issued December 7, 1999) (“Gaza”)
EX1006	U.S. Patent No. 6,437,543 B1 to Val Oler et al. (filed November 20, 2000, issued August 20, 2002) (“Oler”)
EX1007	Japanese Patent Application Publication No. JP 2000-134816A to Masatada Tanaka (filed October 27, 1998, published May 12, 2000) (“Tanaka”)

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EX1008	Certified Japanese-to-English translation of Tanaka (EX1007)
EX1009	U.S. Patent No. 6,459,175 B1 to Patrick H. Potega (filed November 17, 1998, published October 1, 2002) (“Potega”)
EX1010	U.S. Patent No. 5,602,455 to Charles S. Stephens, et al. (filed November 4, 1994, published February 11, 1997) (“Stephens”)
EX1011	U.S. Patent No. 5,493,199 to Steven E. Koenck, et al. (filed October 6, 1992, published February 20, 1996) (“Koenck”)
EX1012	Excerpts from <i>Newton’s Telecom Dictionary</i> (17th ed. 2001)
EX1013	Excerpts from <i>Microsoft Computer Dictionary</i> (5th ed. 2002)
EX1014	Declaration of Tony Givargis, Ph.D. dated September 5, 2025
EX1015	U.S. Patent No. 6,242,893 to Robert P. Freedman (filed June 24, 1999, published June 5, 2001) (“Freedman”)
EX1016	U.S. Patent No. 6,282,433 B1 to Howard E. Holshouser (filed April 14, 1999, published August 28, 2001) (“Holshouser”)
EX1017	U.S. Patent No. 6,574,487 B1 to Steven W. Smith, et al. (filed February 23, 2000, published June 3, 2003) (“Smith”)

II. PERSON OF ORDINARY SKILL IN THE ART

14. I understand that, under the patent laws in effect before the America Invents Act (“AIA”) of 2011, the claims of the patent should be assessed in light of the perspective of a person of ordinary skill in the art (“POSITA”) as of the earliest priority date of the ’397 patent. I have been advised to assume this date to be

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February 11, 2004, the earliest patent application to which the '397 claims priority.¹

15. In my opinion, a POSITA relevant to the '397 patent would have possessed a bachelor's degree in electrical engineering or similar degree, with at least two to three years of experience designing, studying, or implementing power electronic systems that include rechargeable batteries and chargers. A person could also have qualified as a person of ordinary skill in the art with a combination of (1) more formal education such as a Master of Science degree and less technical experience, or (2) less formal education but more technical or professional experience. My opinion remains the same regardless of whether the time of the alleged invention is found to be February 2004, or some later time, such as January 24, 2012, the filing date of the '397 patent.

16. Based on my qualifications and experience, I am a POSITA and was a POSITA as of the alleged priority date for the '397 patent. And although my qualifications and experience exceed those of the hypothetical person having ordinary skill in the art defined above, my analysis and opinions are based on the perspective of a person of ordinary skill in the art as of the alleged priority date. For

¹ I understand that in the pending district court litigation, the Patent Owner has alleged that the '397 patent is entitled to the February 11, 2004 priority date. I express no opinion as to whether the '397 is entitled to such a date. This issue is not relevant here because all references relied upon predate that date.

example, I placed myself back in the relevant time period and considered the engineers that I had taught and worked with in that time period.

III. STATEMENT OF LEGAL PRINCIPLES

A. Claim Construction

17. I understand that claim construction is evaluated from the perspective of a person of ordinary skill in the art at the time of the alleged invention. As noted in a footnote above, I understand that the Patent Owner alleges that the priority date for the '397 patent dates back to the application for the '568 patent, which was filed on February 11, 2004. Without taking a position on whether or not the '397 patent is entitled to this alleged priority date, for simplicity, I have conservatively assumed the priority date is February 11, 2004.

18. I am not a lawyer, but my understanding is that claim construction is a legal question to determine what a person of ordinary skill in the art would have understood the claim terms to mean at the time of the effective filing date (i.e., the February 11, 2004 priority date). I understand that the claims of a patent define the alleged inventions. I also understand that in construing a claim, a person of ordinary skill in the art would consider not only the context of the particular claim, but also the patent itself, including the specification. I understand that the patent specification, under the applicable legal principles, is considered to be the best guide

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to the meaning of a claim term, and is thus highly relevant to the interpretation of a claim term. And I understand for claim terms that do not have a customary meaning in the art, that the specification will be the best reference in understanding how the claim term should be interpreted.

19. I understand that statements made by an applicant during prosecution can also be used to interpret claims because it may show how the applicant understood the alleged inventions and whether terms or claim elements were defined or narrowed in order to obtain allowance. Similarly, I understand that the prosecution history of related patent family members may also be considered. I also understand that other relevant sources such as dictionaries and textbooks may be considered. I understand that the testimony of experts may also be considered, both to assist the legal authority in understanding the relevant technology and in determining how one of ordinary skill in the art would have understood specific claim terms as of the priority date. I understand that the words of the claims themselves, the specification, and the prosecution history are all considered “intrinsic” evidence, and “extrinsic” evidence includes dictionaries, textbooks, and expert testimony.

20. I understand that a terminal disclaimer may be filed by an applicant to relinquish a portion of a patent’s term in exchange for overcoming a nonstatutory

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double patenting rejection. I understand that a nonstatutory double patenting rejection is issued when the pending claims of a patent application being examined are not patentably distinct from claims in a prior patent or co-pending application.

21. I understand that in an *Inter Partes* Review (IPR), the claims of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action filed in the U.S. district court (which I understand is called the “*Phillips*” claim construction standard), including construing the claims in accordance with the ordinary and customary meaning of each such claim as understood by a person of ordinary skill in the art and the prosecution history pertaining to the patent.

22. I have been instructed to apply the “*Phillips*” claim construction standard for purposes of interpreting the claims in this proceeding, to the extent they require an explicit construction. The description of the legal principles set forth above thus provides my understanding of the “*Phillips*” standard as provided to me by counsel.

23. I understand that the term “charging rate” appearing in the challenged claims have been the subject of dispute in the district court litigation. Petitioner contends the “charging rate” is the “current expressed in amperes at which a battery is charged.” Patent Owner contends “no construction” is necessary. Patent Owner’s

expert, though, “agree[s] with Dr. Zane’s general description of ‘charging rate’” and that “‘charging rate’ is commonly understood by a POSITA to describe how quickly a battery can be charged.” (EX1014). Petitioner’s proposed construction in the district court is consistent with my understanding of “charging rate.” For purposes of my analysis here, I adopt Petitioner’s construction but note that the prior art renders the claim obvious under the claim constructions proposed by either party in the district court litigation.

B. Obviousness

24. I understand that a patent claim is obvious if, as of the effective filing date of the patent, a person of ordinary skill in the art in the field of the technology (the “art”) would have found the subject matter to be obvious.

25. I understand that the following factors are considered when determining obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; and (3) the level of ordinary skill in the pertinent art. I also understand that “secondary considerations” may influence this analysis. These include: (1) commercial success; (2) unexplained results; (3) long felt but unresolved need; (4) industry acclaim; (5) simultaneous invention; (6) copying by others; (7) skepticism by experts in the field; and (8) failure of others. I understand that “secondary considerations” must be connected, or have a “nexus,”

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to the invention claimed in the patent at issue.

26. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. The test for determining what art is analogous is: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

27. I understand that a person of ordinary skill in the art is assumed to have knowledge of all prior art. I understand that one skilled in the art can combine various prior art references based on the teachings of those prior art references, the general knowledge present in the art, or common sense. I understand that a motivation to combine references may be implicit in the prior art, and there is no requirement that there be an actual or explicit teaching to combine two references. Thus, one may take into account the inferences and creative steps that a person of ordinary skill in the art would employ to combine the known elements in the prior art in the manner claimed by the patent at issue. I understand that one should avoid "hindsight bias" and ex post reasoning in performing an obviousness analysis. But this does not mean that a person of ordinary skill in the art for purposes of the obviousness inquiry does not have recourse to common sense.

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28. I understand that when determining whether a patent claim is obvious in light of the prior art, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The primary inquiry has to do with the objective reach of the claims, and that if those claims extend to something that is obvious, then the entire patent claim is invalid.

29. I understand one way that a patent can be found obvious is if there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I understand that a motivation to combine various prior art references to solve a particular problem may come from a variety of sources, including market demand or scientific literature. I understand that a need or problem known in the field at the time of the invention can also provide a reason to combine prior art references and render a patent claim invalid for obviousness. I understand that familiar items may have obvious uses beyond their primary purpose, and that a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like the pieces of a puzzle. I understand that a person of ordinary skill is also a person of at least ordinary creativity. I understand when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her

technical grasp. If this finite number of predictable solutions leads to the anticipated success, I understand that the invention is likely the product of ordinary skill and common sense, and not of any sort of innovation. I understand that the fact that a combination was obvious to try might also show that it was obvious, and hence invalid, under the patent laws. I understand that if a patent claims a combination of familiar elements according to known methods, the combination is likely to be obvious when it does not more than yield predictable results. Thus, if a person of ordinary skill in the art can implement a predictable variation, an invention is likely obvious. I understand that combining embodiments disclosed near each other in a prior art reference would not ordinarily require a leap of inventiveness.

30. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may also be shown by demonstrating that it would have been obvious to combine the teachings of more than one item of prior art. I understand that a claimed invention may be obvious if some teaching, suggestion, or motivation exists that would have led a person of ordinary skill in the art to combine the invalidating references. I also understand that this suggestion or motivation may come from the knowledge of a person having ordinary skill in the art, or from sources such as explicit statements in the prior art. I understand that

when there is a design need or market pressure, and there are a finite number of predictable solutions, a person of ordinary skill may be motivated to apply common sense and his skill to combine the known options in order to solve the problem.

31. I understand the following are examples of approaches and rationales that may be considered in determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of a person having ordinary skill in the art:

32. Some teaching, motivation, or suggestion in the prior art that would have led a person of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;

33. Known work in one field of endeavor may prompt variations of it for use in the same field or a different field based on design incentives or other market forces if the variations would have been predictable to a person of ordinary skill in the art;

34. Combining prior art elements according to known methods to yield predictable results;

35. Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

36. Applying a technique or approach that would have been “obvious to

try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);

37. Simple substitution of one known element for another to obtain predictable results; or

38. Use of a known technique to improve similar products, devices, or methods in the same way.

39. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether one of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I understand the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

40. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. The test for obviousness, in other words, is not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole.

IV. THE '397 PATENT

A. Overview of the Specification

41. The written description of the '397 patent explains that the “invention relates to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods.” ('397, 1:20-22.)

1. Admitted Prior Art

42. The '397 patent discusses the “wide variety of portable devices such as laptop computers, cellular telephones, personal digital assistants (PDAs)” containing rechargeable batteries that may be charged with a battery charger. ('397, 1:26-30.) These rechargeable batteries may have different “battery types.” (*Id.*, 1:33.)

43. The '397 patent further discloses how the “use of standardized interface or connectors for portable devices,” such as the universal serial bus (USB) protocol, “allows a single battery charger to be used for charging different portable devices.” ('397, 1:35-45.) The '397 patent further states that “many portable devices now support the universal serial bus (USB) protocol, and include one or more USB connectors which allow them to be connected to personal computers (PCs)[.]” (*Id.*, 1:38-41.) “Thus, a charger having a USB connector could potentially be used to charge different portable USB devices.” (*Id.*, 1:45-47.)

44. For example, the Background of the Invention section of the '397 patent identifies U.S. Patent No. 6,184,652 to Yang, which is directed to a “mobile phone

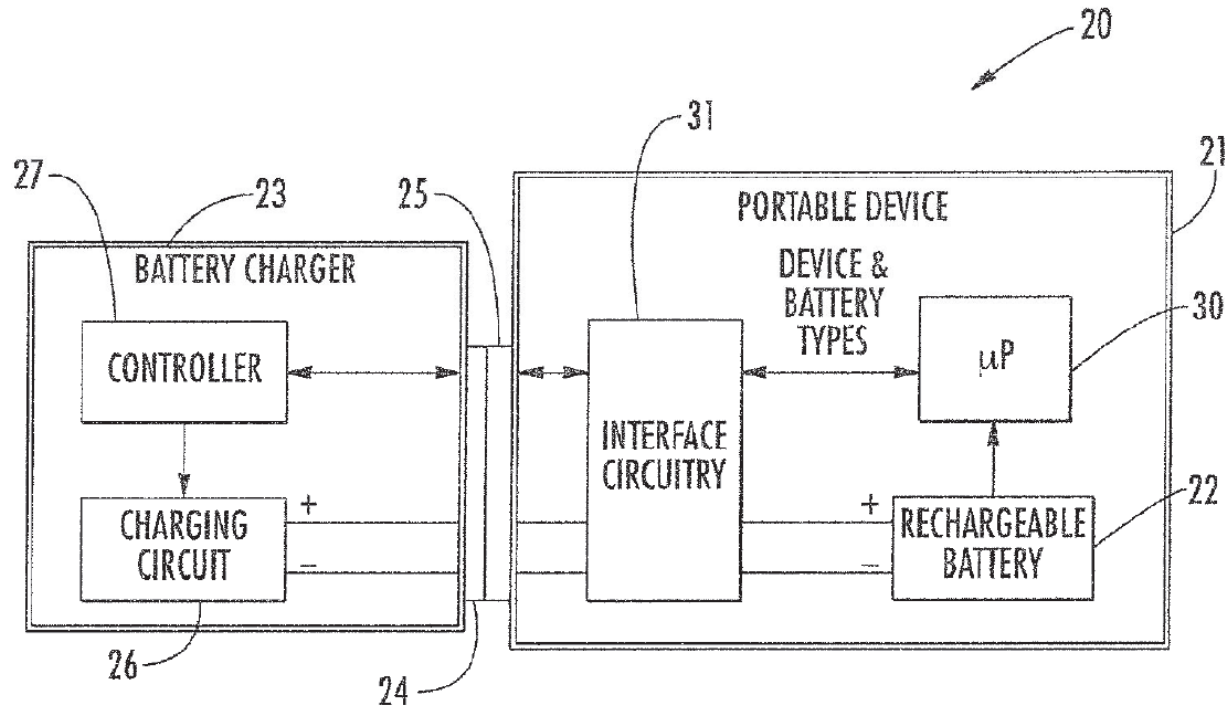
battery charger with a USB interface” that can receive electrical power when connected to the corresponding USB connector of a connector and “converts the electrical power into the necessary charging voltage, which is provided to the mobile phone.” (’397, 1:49-56.) “The battery charger may also detect the type of mobile phone battery (e.g., Li or Ni-MH), and the quantity of electricity stored in the battery.” (*Id.*, 1:57-59.) Thus, “a user accordingly need not purchase different kinds of chargers for different battery types.” (*Id.*, 1:59-61.)

45. In another example identified in the Background of the Invention, U.S. Patent No. 6,362,610 to Yang claims “a universal USB power supply unit” that charges an electronic product with the use of a voltage regulator. (’397, 1:62-2:2.) “A feedback control voltage output circuit compares the feedback voltage signal” and outputs “a preset voltage” associated with the particular electronic device. (*Id.*, 2:6-13.)

2. Disclosure of Embodiments

46. Referring to Fig. 1, the disclosed “battery charging system **20** includes a portable device **21** including a rechargeable battery **22** carried thereby, and a battery charger **23** for charging the rechargeable battery.” (’397, 4:36-39.) “The charger **23** illustratively includes a charger connector **24** to be coupled to a corresponding device connector **25** of the portable device **21**. The battery, charger

23 also illustratively includes a charging circuit **26** connected to the charger connector **24**, and a controller **27** connected to the charger connector and the charging circuit.” (*Id.*, 4:41-47.) Figure 1 is reproduced below:



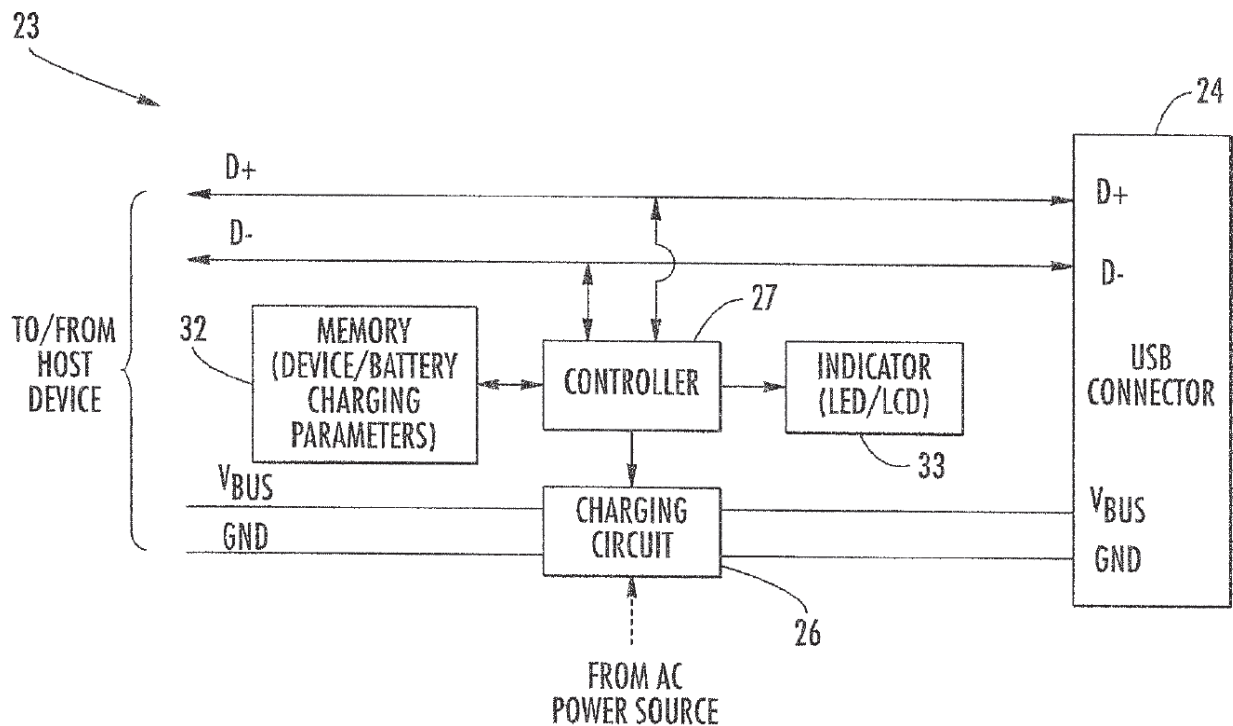
(’397, Fig. 1.)

47. The “portable device **21** could be any one of a laptop computer, personal digital assistant (FDA), mobile telephone, or other portable device having a rechargeable battery” and includes microprocessor **30** and “interface circuitry **31** for interfacing the microprocessor **21** with a data bus or cable.” (’397, 4:48-59.) This interface circuitry can perform “a variety of operations such as connecting high or low logic signals to the differential data lines D+ and D- during enumeration with a

host device, as will be appreciated by those skilled in the art.” (’397, 4:63-67.)

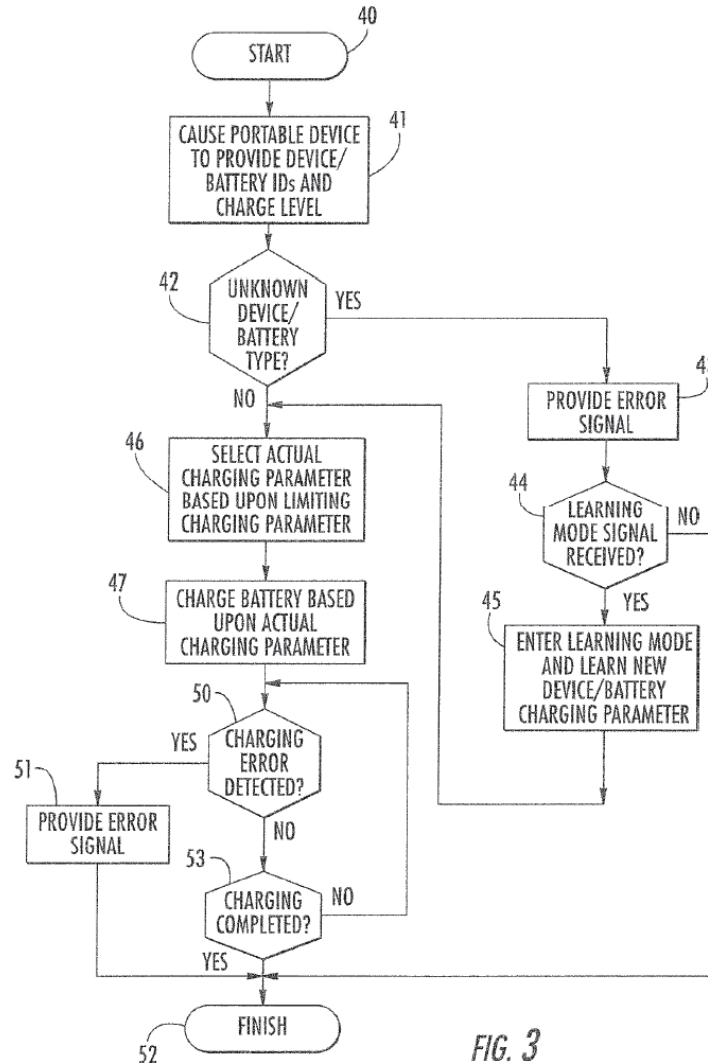
“[D]ifferent interface and control circuitry configurations may be used for the portable device **21** depending upon the given application.” (’397, 5:8-10.)

48. An exemplary embodiment is described in Figs. 2 and 3. Figure 2 describes a “battery charger **23** for USB devices”. (’397, 5:25-26.) Fig. 2 is reproduced below:



(*Id.*, Fig. 2.) Upon connection, the battery charger “controller **27** causes the portable device **21** (i.e., the microprocessor **30**) to identify its corresponding portable device type and its corresponding rechargeable battery type from among a plurality of different portable device types and different battery types.” (*Id.*, 5:29-33.) “The

charger **23** checks to see whether the device and battery types are known based upon the device and battery IDs returned by the portable device, at Block **42**. If so, the controller provides an error signal to the portable device **21**, at Block **43**, letting it know that it (or the battery **22**) is unknown and that cannot therefore cannot be performed.” (*Id.*, 8:10-15.) If the device and battery types are recognized by the controller **27**, it then selects actual charging parameters for charging the rechargeable battery **22** based upon a comparison” or limitation “of the different charging parameters for the portable device **21** and battery **22**, at Block **46**.” (*Id.*, 8:51-55.) “Once the actual charging parameters are established, the charger **23** then causes the charging circuit **26** to charge the battery **22** in accordance with these actual charging parameters, at Block **47**.” (*Id.*, 9:3-6.) This is exemplified in Fig. 3 reproduced below:



('397, Fig. 3)

B. The Challenged Claims

49. This Declaration addresses claims 1-22 of the '397 patent. Independent claim 1 is representative and recites:

1. A battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable

battery and a wireless communications transceiver coupled thereto, the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates, the battery charger comprising:

- [a] a charging circuit; and
- [b] a controller coupled to said charging circuit and configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.

(’397, 12:31-47 (Claim 1; bracketed notation (*e.g.*, [a]) added).)

50. I address the claims further in my detailed analysis in **Part V** below.

V. APPLICATION OF THE PRIOR ART TO THE CHALLENGED CLAIMS

51. I have reviewed and analyzed the prior art references and materials listed in **Part I.B** above. In my opinion, the challenged claims of the ’397 patent would have been obvious to a person of ordinary skill in the art based on the following prior art combinations.

Declaration of Regan Zane, Ph.D. in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 8,610,397 B2

Ground	Claims	Basis for Challenge Under § 103
1	1-7, 11-22	Keirinbou (EX1003/1004) and Gaza (EX1005)
2	8-10	Keirinbou, Gaza and Oler (EX1006)
3	1-3, 5-7, 11-13, 15-20, 22	Tanaka (EX1007/1008) and Potega (EX1009)
4	4, 8, 14, 21	Tanaka, Potega, and Koenck (EX1011)
5	9-10	Tanaka, Potega, and Stephens (EX1010)

52. I am informed by counsel that each of the references cited in the grounds above qualifies as prior art to the challenged claims because each reference was filed or published before the filing of the earliest patent application to which the '397 patent claims priority (February 11, 2004).

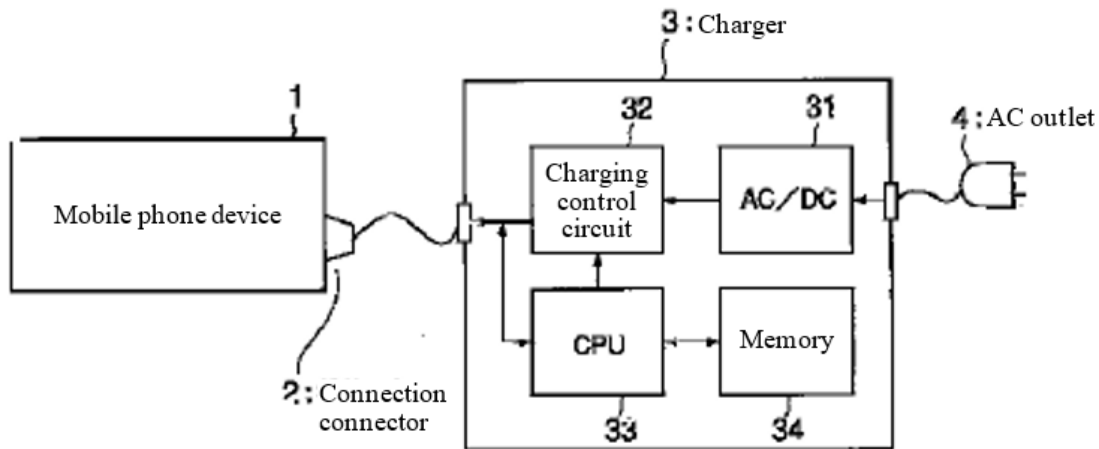
A. Brief Summary and Overview of Prior Art

1. Keirinbou (EX1003/1004)

53. **Keirinbou**, Japanese Patent Application Publication No. JP 2000-323181A to Hisashi Keirinbou (filed on May 13, 1995, published on November 24, 2000), is titled “Charger for Portable Device.” I am informed that Keirinbou qualifies as prior art because it was published on November 24, 2000, more than one year prior to the earliest filing date of the '397 patent (February 11, 2004). I have been provided with Keirinbou (**Exhibit 1003**), which is in Japanese, and a certified translation of Keirinbou (**Exhibit 1004**). For purposes of my analysis, therefore, I will refer and cite to the certified translation.

54. Keirinbou discloses a battery charger for “portable devices that can be used in common with different models of portable devices.” (Keirinbou, Abstract.) More specifically, Keirinbou discloses “a charger for portable devices, such as mobile phone devices, which use built-in secondary batteries as an operating power source.” (*Id.*, [0001].) Keirinbou explains that mobile phones commonly contained built in secondary batteries as power sources but “there are various types (models) of mobile phone devices, and the secondary batteries used differ depending on the model” such as “lithium batteries, nickel-cadmium batteries, nickel-metal hydride batteries, etc.” (*Id.*, [0002]-[0003].) Therefore, “a user must also purchase and switch to a new charger” when “switching to a new mobile phone device.” (*Id.*, [0003].)

55. Keirinbou purports to address this issue by providing a charger that “charges the secondary battery built into the portable device by connecting the portable device thereto, wherein the charger comprises a means for acquiring the type of the connected portable device and a charging control means, and recognizes the characteristics of the secondary battery built into the portable device from the acquired type, and operates the charging control means to perform charging in accordance with the characteristics of the secondary battery.” (Keirinbou, [0006].) Figure 1 is representative of the disclosed battery charging system:

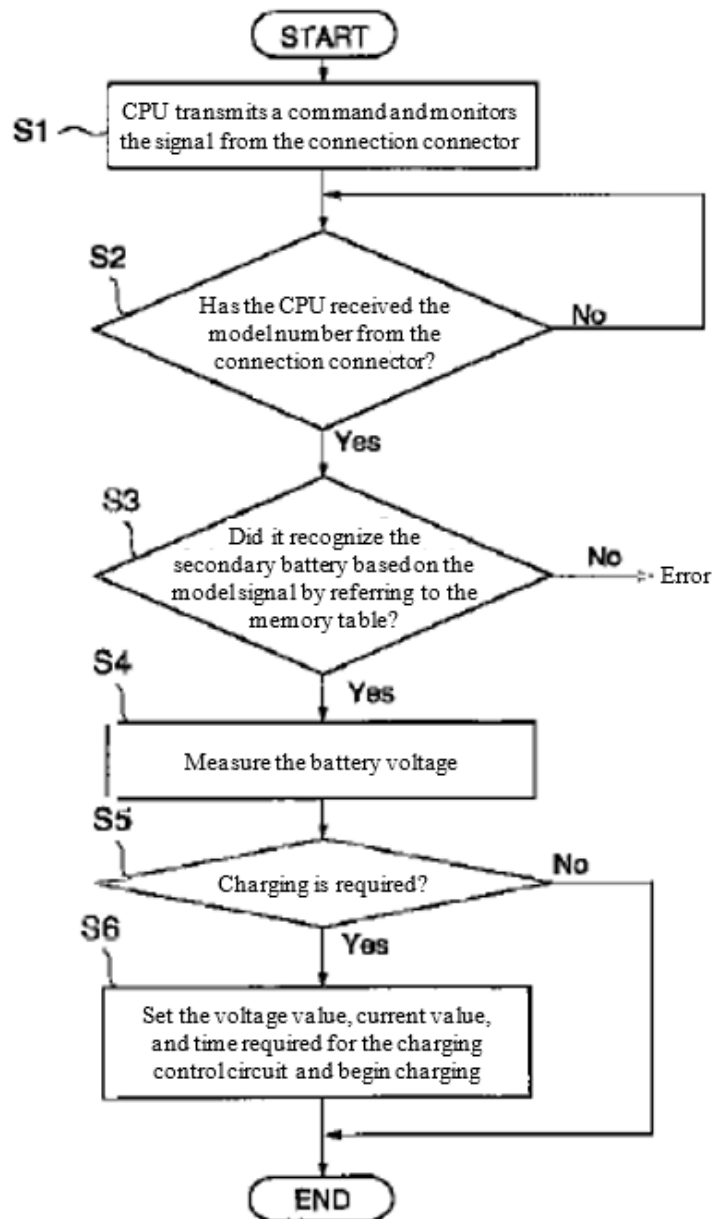


(*Id.*, Fig. 1.)

56. Figure 1 above shows a “mobile phone device [1] with a built-in secondary battery (not shown)” connected via a connector 2 to a battery charger 3 receiving power from an AC outlet 4. (Keirinbou, [0009].) The battery charger 3 comprises an AC/DC converter 31 that “takes in commercial power and converts it to direct current,” a charging control circuit 32 that “controls the charging current to charge the secondary battery built into the mobile phone device according to its characteristics,” a CPU 33 that “controls the entire charger 3,” and a memory 34 that “stores a memory table for recognizing the battery built into the mobile phone device from the model number of the mobile phone device.” (*Id.*)

57. Keirinbou explains that CPU 33 transmits a signal to obtain the model number of the connected portable device which is used, by referring to memory table located in memory 34, to recognize the type of the built-in battery of the device, and then charge the battery based on this information. (Keirinbou, [0012].) This process

is exemplified in Figure 2, reproduced below:



(*Id.*, Fig. 2.) I will provide more information about Keirinbou in my analysis of the claim limitations below.

2. Gaza (EX1005)

58. **Gaza**, U.S. Patent No. 5,998,966, is entitled “Microcontrolled Battery

Charger.” Gaza purports to disclose a battery charger for use with different types of rechargeable batteries. (Gaza, Abstract.) I am informed that Gaza qualifies as prior art because it is a patent that issued on December 7, 1999 from an application filed on March 20, 1998, both dates being before the ’397 patent priority date.

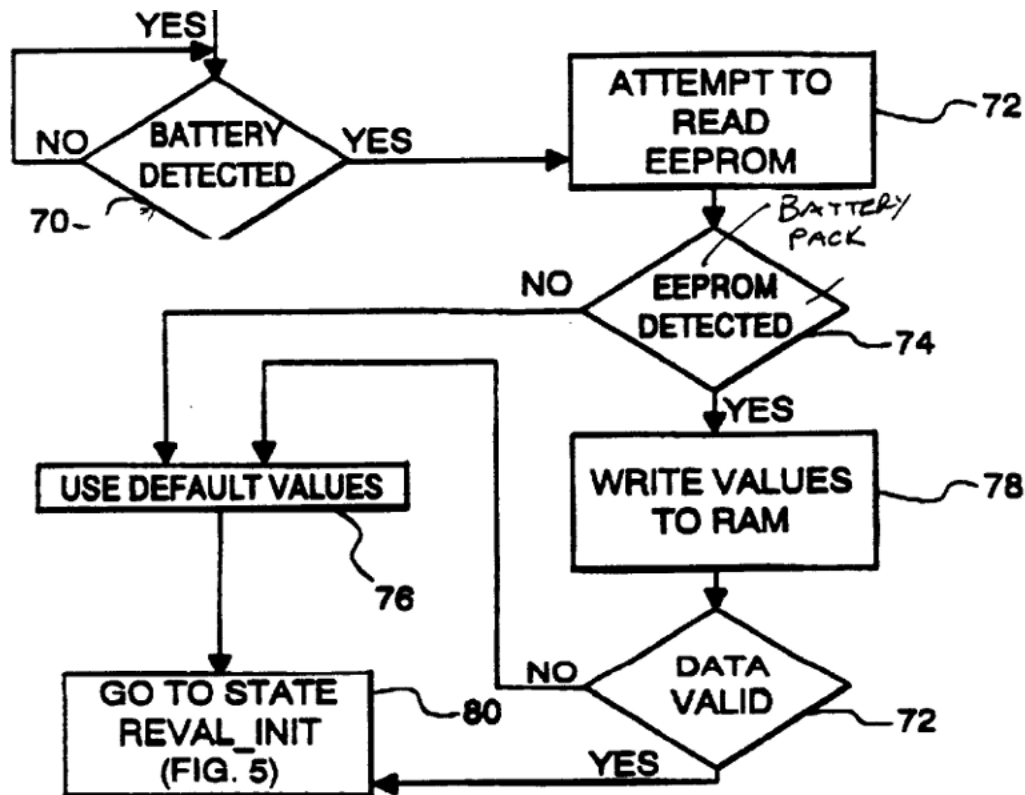
59. My Declaration cites Gaza primarily for its discussion of techniques for allowing a battery charging system to obtain information about the type of batteries being charged. Gaza explains that “[v]arious portable devices and appliances, such as cellular phones, require rechargeable batteries,” which can be of various different types such as nickel cadmium, nickel metal hydride and lithium ion, among others. (Gaza, 1:34-39.) “Because of the different charging characteristics of such batteries, different battery chargers are required. For example, both nickel-cadmium (NiCd), as well as nickel metal hydride (NiMH), require constant current charging. On the other hand, lithium ion batteries require constant current charging up to a certain voltage value and constant voltage charging thereafter. Because of the different charging requirements, different charging circuits are often required.” (*Id.*, 1:39-47.) Gaza further explains that, as was known in the prior art, “smart battery packs” existed that “normally include a memory storage device which contains information regarding the characteristics of the battery as well as the battery type. Some smart battery packs are known to include a microcontroller which allows communication

by way of a bi-directional communication line with the battery charger regarding various battery characteristics.” (*Id.*, 1:51-58.)

60. Gaza purports to disclose an improved battery charging system “that can be used with different types of batteries, such as batteries requiring constant current charging, such as nickel cadmium (NiCd) and nickel metal hydride (NiMH) batteries, as well as batteries which not only require constant current charging, but also require constant voltage charging, such as lithium ion batteries.” (Gaza, 2:44-50.) In one embodiment, Gaza discloses a “dual pocket” charger for charging two separate rechargeable batteries, with one pocket for charging a battery connected to a cellular phone, and another for charging a spare battery. (*Id.*, 2:6-10, 3:11-20.)

61. Gaza explains that certain types of batteries (such as lithium ion batteries) include “an internal memory storage device, such as an electrically erasable programmable read only memory (EEPROM). Such integral EEPROMs are known to be provided with lithium ion modular battery packs which provide various information, including information that the battery is a lithium ion battery.” (Gaza, 3:58-62.) Gaza discloses a technique in which the battery charger can read the EEPROM of the battery pack to obtain information about the battery, and then use that information in charging the rechargeable batteries. For example, Figure 4 shows a power-up routine for the disclosed two-pocket battery charger, and more

specifically, a flowchart of part of the idle-initiate state (IDLE_INIT STATE). (*Id.*, 8:13-52). As relevant to the issues in my Declaration, I have reproduced the bottom part of Figure 4, which describes a technique for attempting to read the battery pack EEPROM (Step 72):



(*Id.*, Fig. 4 (partial figure).)

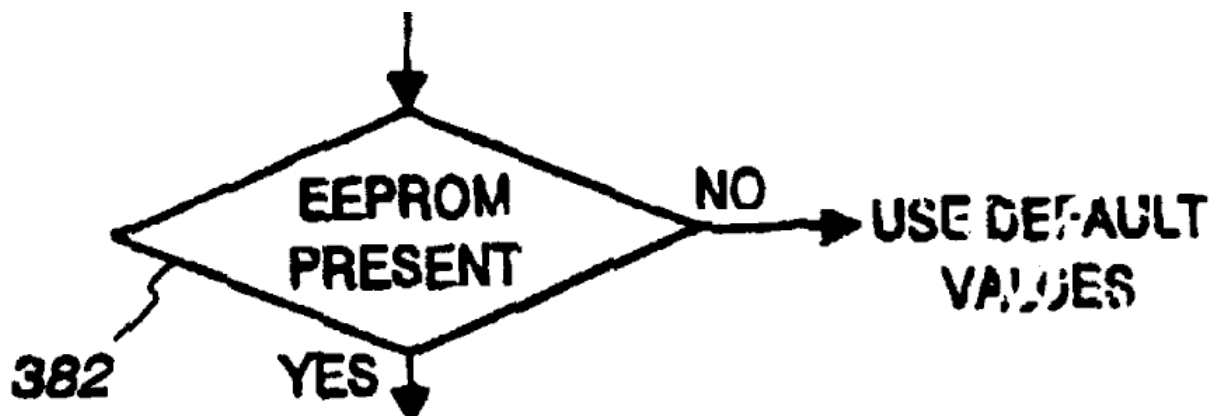
62. Step 70 of Figure 4 above shows that the charger attempts to determine whether a battery has been detected in either the front or rear pockets. (Gaza, 8:31-34.) If a battery is detected, at steps 72 and 74, the system attempts to read the battery pack EEPROM by initially determining whether or not it is present. (*Id.*, 8:40-43.) If an EEPROM is *not* detected, as shown, the system “goes to step 76 and

utilizes default values.” (*Id.*, 8:44-45.) If an EEPROM *is* detected, however, “the constants are written to the on-board RAM on the microcontroller **30** [of the charging system] in step 78.” (*Id.*, 8:45-47.) The process then proceeds to step 79 (erroneously labeled as 72 in Figure 4), in which the data is analyzed “to determine if it is valid, for example, by way of a checksum. If not, the system loops to step 76 and uses default values. If the data is valid, the system goes to the pocket state REVAL_INIT in step 80.” (*Id.*, 8:47-52.)

63. The term “checksum” as used in Gaza refers to a category of well-known mathematical techniques (similar in purpose to a “hash”) for checking the integrity of data, which are commonly used to detect whether data has been corrupted or otherwise altered from the originally-intended values.² As shown above, the charging system in Gaza uses a checksum to determine if the battery information stored in the EEPROM is valid, and if not, uses default values.

² I note that there are different EEPROMs described in Gaza, an EEPROM that is part of the charging system (sometimes labeled as EEPROM 32 in the textual description) and an EEPROM in the battery pack itself. (Gaza, 7:22-30 (EEPROM 32), 3:57-63 (EEPROM is part of battery pack).) My Declaration focuses on the EEPROM in the battery pack, which is referenced in the handwritten note at step 74 of Figure 4 reproduced in the text. (*See also Id.*, 9:25-27 (“As mentioned above, such data from the battery pack EEPROM is stored in state IDLE INIT.”), 16:20-23 (“As indicated above, the battery pack EEPROM contains various information regarding the battery type and size available to the system over the -COMM and -SIZE terminals.”).)

64. A similar process is also shown in connection with Figures 12A through 12C. (Gaza, 14:57-58.) Gaza explains that “the system checks in step 376 [of Figure 12B] whether the system is in the idle state,” and if so, “a reading of the EEPROM of the battery pack is attempted in step 380 [of Figure 12B].” (*Id.*, 16:15-19.) “Thus, in step 382, the system checks whether the battery pack EEPROM is present.” (*Id.*, 16:23-24.) As Figure 12C confirms (reproduced in relevant part below), if the EEPROM is not found at step 382, the system will use default values:



(*Id.*, Fig. 12C (partial figure).) Gaza explains that “the battery pack EEPROM contains various information regarding the battery type and size available to the system over the -COMM and -SIZE terminals... If the battery pack EEPROM is present, the system checks whether the battery is a lithium type battery in step 384.” (*Id.*, 16:20-26.)

65. I will provide more information about Gaza in my discussion of the claim limitations below.

3. Oler (EX1006)

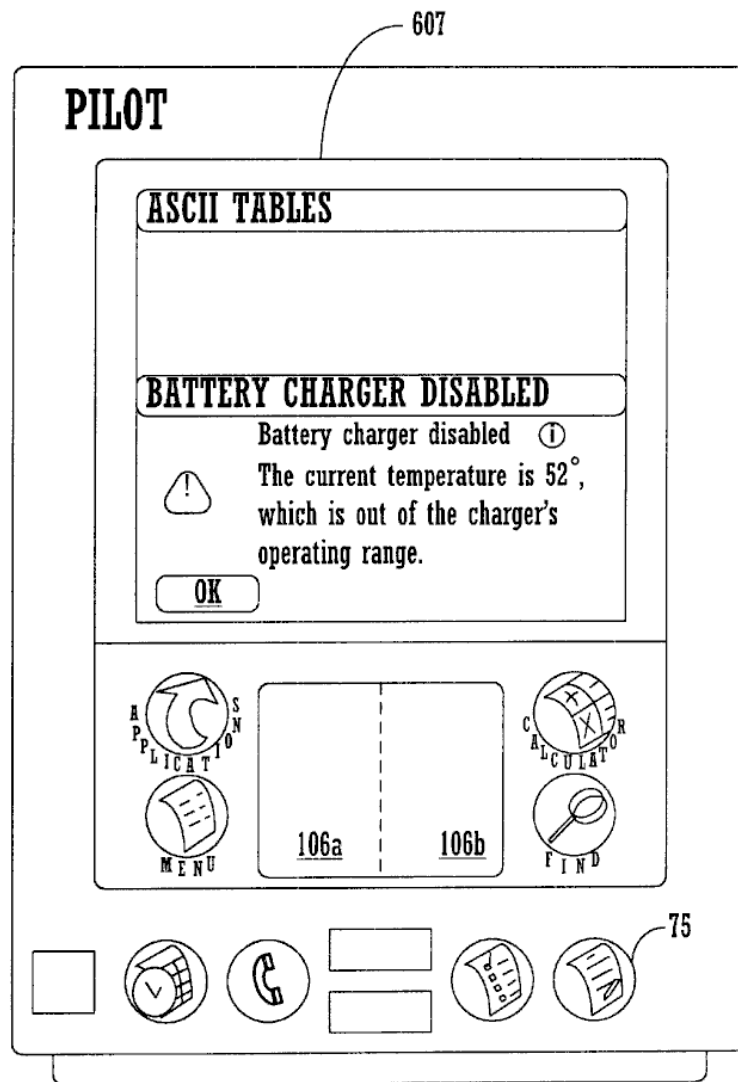
66. **Oler**, U.S. Patent No. 6,437,543 B1, is entitled “Method and System for Extending Battery Life By Monitoring Temperature During Charging.” Oler purports to disclose a system for controlling battery charging that uses a temperature sensor to disable a battery charging circuit in the event battery temperature falls outside the upper and lower limits of the charger. (Oler, Abstract.) I am informed that Oler qualifies as prior art because it is a patent that issued on August 20, 2002 from an application filed on November 20, 2000, both dates being before the '397 patent priority date.

67. My Declaration cites Oler in connection with dependent claims 8-10, which relate to errors that may occur in connection with the charging process. Oler describes a technique for extending the battery life of a rechargeable battery “by preventing charging when the battery’s temperature is out of an acceptable range.” (Oler, 1:7-11.) Oler explains that “significant problems occur if a battery is charged outside of a suitable temperature range,” such as reducing the number of charge/discharge cycles that the battery is capable of, and if the temperature is too high, potentially damaging the battery or risking explosion. (*Id.*, 1:14-23.)

68. Oler purports to address these problems by disclosing a method and system for preventing a battery from charging when its temperature is outside a

predetermined range. (Oler, 3:22-27.) Oler describes an embodiment that monitors the charging of the battery of a personal digital assist (PDA) device, but Oler explains that the disclosed technique “is well-suited to operating with other electronic devices, for example, cell phones, pagers, web browser, etc.” (*Id.*, 4:8-13; *see also id.*, 4:30-32 (“The PDA **100** can be a palm top (‘palm-sized’) portable computer system, an intelligent cellular telephone, or the like.”).)

69. In one embodiment, battery temperature data is collected and checked to see if it falls within an acceptable range. (Oler, Fig. 8 (Steps 805, 808, 810), 7:49-65.) If the temperature falls outside the acceptable range, battery charging is disabled and a message is provided to the display of the device notifying the user of the error. (*Id.*, Fig. 8 (Steps 815, 820), 7:66-8:11.) Figure 6A shows an exemplary message 607 shown on the screen of the device indicating that the temperature falls outside the acceptable range:



(*Id.*, Fig. 6A, 6:22-25.) Oler explains that its invention “is well-suited to displaying the warning in a variety of formats, such as a graphical display (e.g. thermometer), alphabetical characters, etc.” (*Id.*, 6:25-28.)

70. I will provide more information about Oler in my discussion of claims 8-10 below.

4. Tanaka (EX1007/EX1008)

71. **Tanaka**, Japanese Patent Application Publication No. JP 2000-134816A (filed October 27, 1998, published May 12, 2000), is titled “Electronic Device and AC Adapter.” A certified translation of Tanaka is attached as Exhibit **EX1008**. For purposes of my analysis, I will primarily refer to the certified translation of Tanaka. Tanaka describes an AC Adapter that “recognizes the power input specifications of the device itself” and “the power input specifications of the power supply target device based on the notification by impedance variation from the device main body” to generate “operating power source according to the output specifications corresponding to the recognized input specifications.” (Tanaka, Abstract.) I have been informed that Tanaka qualifies as prior art to the ’397 patent because it was published in May 2000, prior to the earliest February 11, 2004 filing date of the ’397 patent.

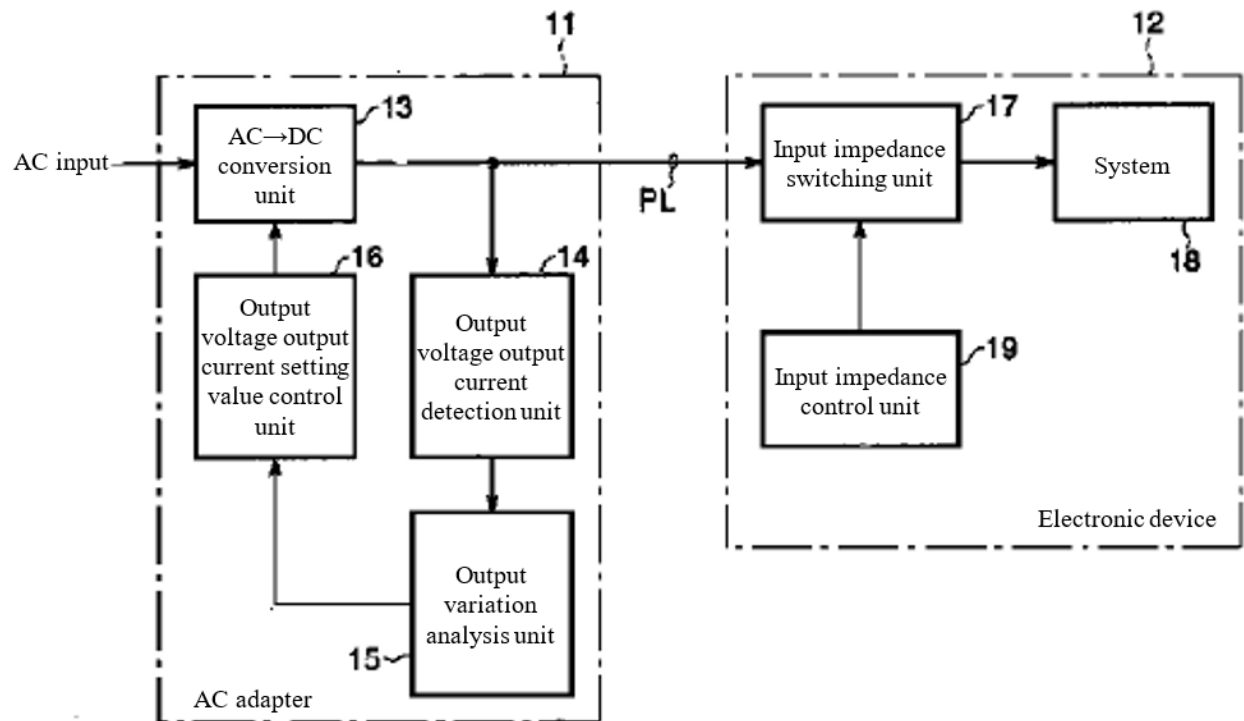
72. Tanaka recognizes that conventionally, “dedicated AC adapters having unique standards were required for each model and furthermore for each type of built-in secondary battery.” (Tanaka, [0002].) Identification technology for AC adapters using dedicated signal lines existed but suffered from physical restrictions “resulting in poor usability and structural complexity.” (*Id.*, [0004].) Further, the signals were susceptible to noise and thus could not be applied to precise electronic

devices such as personal computers. (*Id.*)

73. Tanaka purports to solve this problem by disclosing an “AC adapter capable of supplying and controlling a stable operating power source always according to the device specifications to multiple types of devices having different power input specification.” (Tanaka, [0008].) Further the AC adapter is capable of “realizing an automatic recognition function of device specifications” and “by connecting an AC adapter to the device main body,” the “AC adapter generates and outputs an operating power source according to the specifications of the device main body, without requiring a dedicated control signal line, and without causing noise influence on device operation.” (*Id.*, [0009].) Specifically, “when an AC adapter is connected to the device main body, the impedance of the power line of the AC adapter is varied for a certain period of time to notify the AC adapter of the power input specifications of the device itself.” (*Id.*, [0010].) In other words, the “power input impedance switching means of the electronic device first changes the output voltage or output current of the AC adapter on the device side, and the AC adapter detects ‘1’ (H) or ‘0’ (L) from the change in the voltage or current.” (*Id.*, [0013].) This combination of ‘1’ and ‘0’ provide the AC adapter with input specifications of the device in the form of digital data, periods, or duty data. (*Id.*)

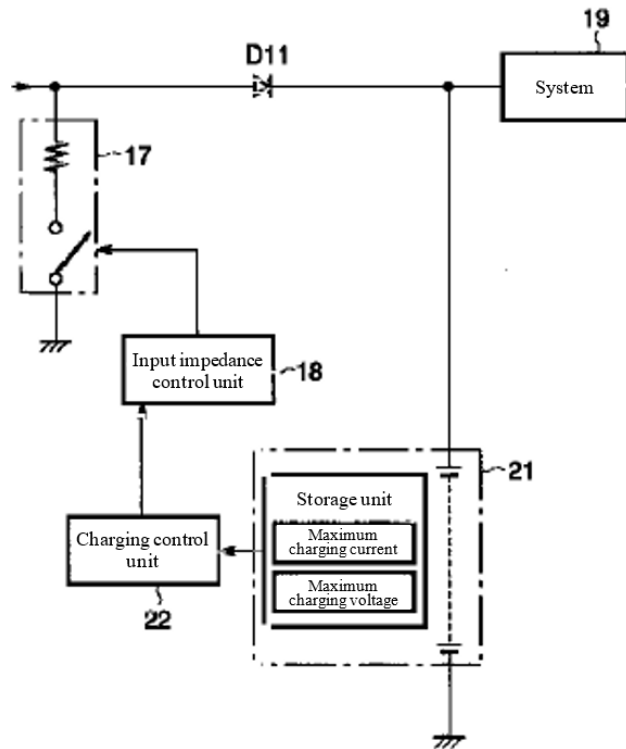
74. Figure 1, reproduced below, is a block diagram representative of the

system:



(Tanaka, Fig. 1.) The figure comprises of an AC adapter **11**, electronic device main body **12**, an AC/DC conversion unit **13** that converts external commercial AC power to DC power, an output voltage/current detection unit **14** that detects impedance variation on the output line (PL) of the AC adapter, an output variation analysis unit **15** that analyzes the type identification information (data/period/duty) and the data content based on the detection output of the output voltage/current detection unit **14**, and an output voltage/current setting value control unit **16** that switches the set values of output voltage and output current limits of the AC adapter. (*Id.*, [0017].)

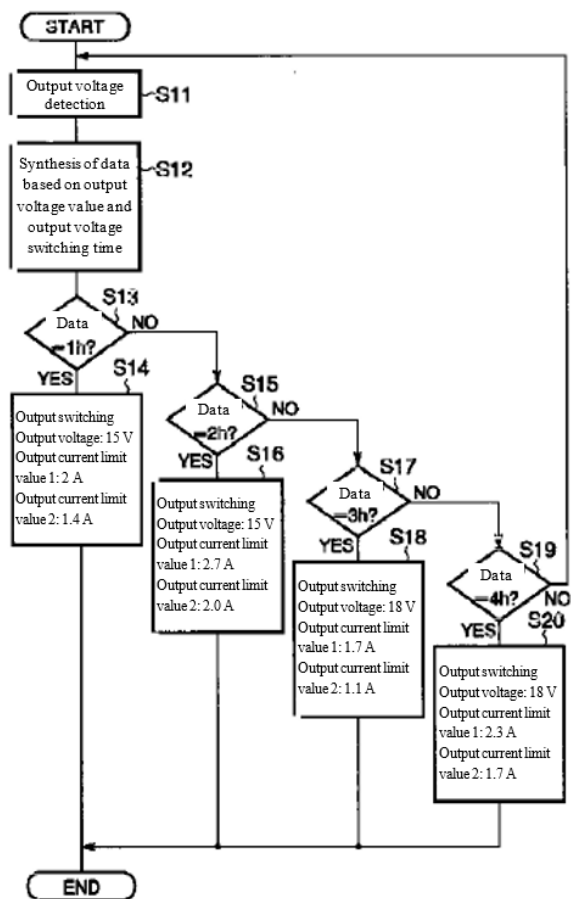
Electronic device **12** is depicted in greater detail by Fig. 5 reproduced below:



(*Id.*, Fig. 5.) The electronic device main body **12** contains an “input impedance switching unit [17] that controls switching of the input impedance of the power output line (PL) of the AC adapter **11**,” a “main circuit unit (system)” (**18** in Fig. 1; **19** in Fig. 5³) “of the electronic device main body **12** operating with the DC output

³ In my opinion, it would have been apparent to a person of ordinary skill in the art that system **18** in Figure 1 and system **19** in Figure 5 refer to the same system, and that input impedance control unit **19** in Figure 1 refers to the same component as input impedance control unit **18** in Figure 5. For example, in discussing Figure 1, Tanaka references system **19** instead of system **18**. (*See Id.*, [0021].) Further, under the “Explanation of Reference Numerals”, Tanaka lists **18** as the “Main circuit unit (system)” and **19** as the “Input impedance control unit” but does not reference any other system or input impedance control unit.

power of the AC adapter **11** as the operating power source,” and “an input impedance control unit” (**19** in Fig. 1; **18** in Fig. 5) “that switches (on/off) the input impedance switching unit **17** for a certain period according to the power input specifications of the device itself.” (*Id.*, [0018].) The charging control unit **22** “reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery **21** and sends this to the input impedance control unit” (**19** in Fig. 1; **18** in Fig. 5). (*Id.*, [0058].) Figure 6, reproduced below, is exemplary:



(*Id.*, Fig. 6.)

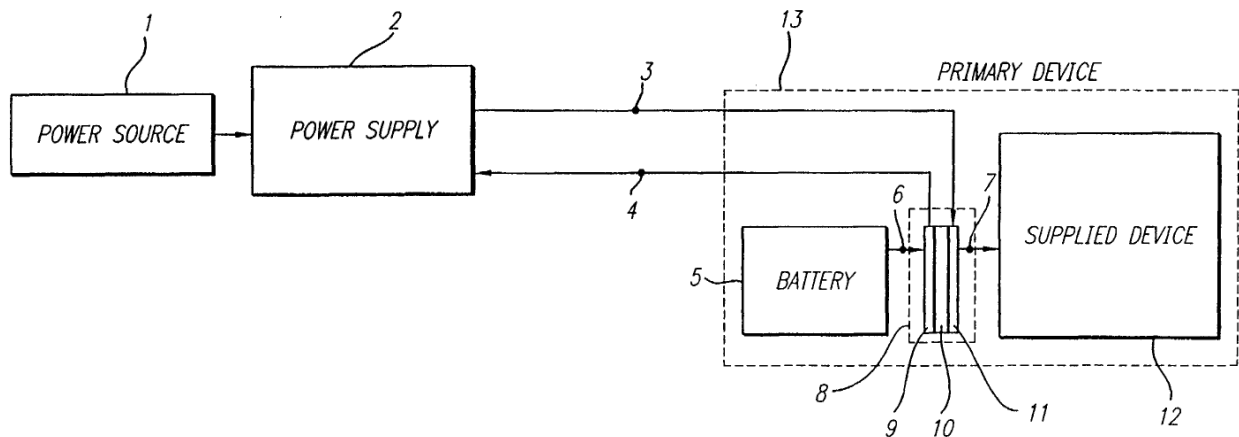
5. Potega (EX1009)

75. **Potega**, US Patent No. 6,459,175 B1 (filed November 17, 1998, published October 1, 2002), is titled “Universal Power Supply.” Potega describes a power supply that “detects power requirements of an electrical device and configures itself to provide the correct power to the device.” (Potega, Abstract.) Specifically, “[b]y using a connector that isolates the device from its battery, the power supply can provide power to the device, recharge the battery, recharge the battery while at the same time providing power to the device, or provide power to the device while preventing the battery from being recharged.” *Id.* I have been informed that Potega qualifies as prior art to the ’397 patent because it was published in October 2002, prior to the earliest February 11, 2004 filing date of the ’397 patent.

76. Potega recognizes that “[p]ower supplies are traditionally device-specific, in that the output voltage of the power converter, whether it be an AC/DC or DC/DC adapter, must be voltage-matched to the host device it was designed to power.” (Potega, 1:15-18.) When these devices contain batteries, the power supply can act as a “battery surrogate” and is “matched to the voltage of the removable batteries” and also “serve[] as the power source for a battery charger in devices that use rechargeable batteries.” (*Id.*, 1:34-35; *Id.* 11:26-27.) But, due to the numerous combinations of cells within a battery pack, along with the plurality of different

battery cell chemistries, “the operating voltage of any electronic device can vary significantly within the same type of electronic device, whether made by the same or a different manufacturer.” (*Id.*, 1:39-42.)

77. Potega purports to solve the aforementioned issues and discloses an “intelligent power supply” that “automatically reconfigures its output voltage, within a broad range, to the powered device’s correct power requirements.” (Potega, 11:54-59.) Figure 1, reproduced below, depicts a generic block diagram of a battery-operated supplied device used in conjunction with an embodiment of the power supply:



(*Id.*, Fig. 1.) Power supply 2, draws power from power source 1 and converts it to the appropriate power level for primary device 13. (*Id.*, 13:14-17.) This voltage is supplied on powerline 3 to primary device 13 containing supplied device 12 (i.e., any electronic or electrical apparatus which in the absence of a power supply, relies

in part or in whole on the battery) and a battery **5**. (*Id.*, 13:18-29.) “Data signals and power signals may be transmitted” between power supply **2** and the supplied device **12**. (*Id.*, 13:31-34.) The battery **5** “may be a removeable battery” and a “rechargeable cell or group of cells of any conventional battery chemistry having any type of output voltage.” (*Id.*, 13:43-49.) Interposed between battery **5** and supplied device **12** is connector **8**. Connector **8** is a universal connector that allows “data and/or power signal[s] defining the power requirements of supplied device **12** or the power characteristics of battery **5** (or both)” to be transmitted to power supply **2**. (*Id.*, 14:24-29.)

78. A more detailed schematic illustration of Fig. 2 is shown in Fig. 10, reproduced below:

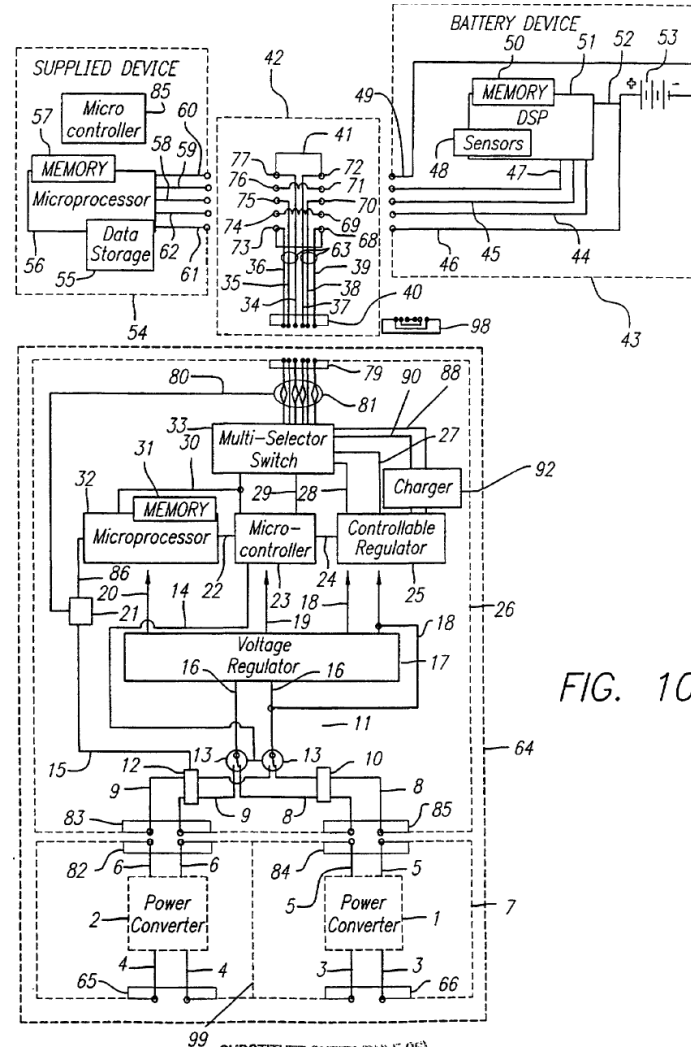


FIG. 10

(Potega, Fig. 10.) FIG. 10 illustrates “a power supply **64** module according to the present invention shown along with a universal connector **42**, a battery device **43**, and a supplied device **54**. While supplied device **54** is shown to include a microprocessor **56**, memory **57**, and data storage **55**, supplied device **54** need not include such components as discussed more fully below. The power supply module **64** is compatible with any readily available AC or DC primary power input. Power converter **1** is an AC/DC converter, and power converter **2** is a variable-input-

voltage DC/DC converter.” (*Id.*, 48:3-14.)

6. Stephens (EX1010)

79. **Stephens**, U.S. Patent No. 5,602,455 (filed November 4, 1994, published February 11, 1997), is titled “Portable Battery Charger with Integrally Attached Output Cable.” Stephens describes “[a] battery charger [] connected to a power source via an input cable. The battery charger has charge switching circuitry for delivering a charge to a battery under the control of a controller.” (Stephens, Abstract.) “The battery charger has the additional capability of detecting and correctly charging different battery types, and responding to error conditions detected during the charging operation.” (*Id.*) I have been informed that Stephens qualifies as prior art to the ’397 patent because it was published in February 1997, prior to the earliest February 11, 2004 filing date of the ’397 patent.

80. My Declaration cites Stephens in connection with dependent claims 9-10, which relate to errors in the battery charging process. Stephens discloses a controller in a battery charger containing several different logic states: state detection logic, charging logic, and indicator logic. (Stephens, 4:25-26.) State detection logic detects the current state of the battery, i.e., if the battery needs to be charged quickly, slowly, is not present, not chargeable, etc. (*Id.*, 4:26-28.) Charging logic is responsive to state detection logic and charges the battery by enabling the

trickle charge switch and the fast charge switch based thereon. (*Id.*, 4:31-34.) Indicator logic is responsive to both state detection logic and charging logic and “indicates to a user via indicator 120 whether battery 110 is charging, is charged, or whether an error was detected during the charging operation.” (*Id.*, 4:35-39.) In one embodiment, indicators may be green and red LEDs that are lit to convey charging or error status. Figures 6-8 are representative. Figure 8, reproduced below, discloses the error subroutine:

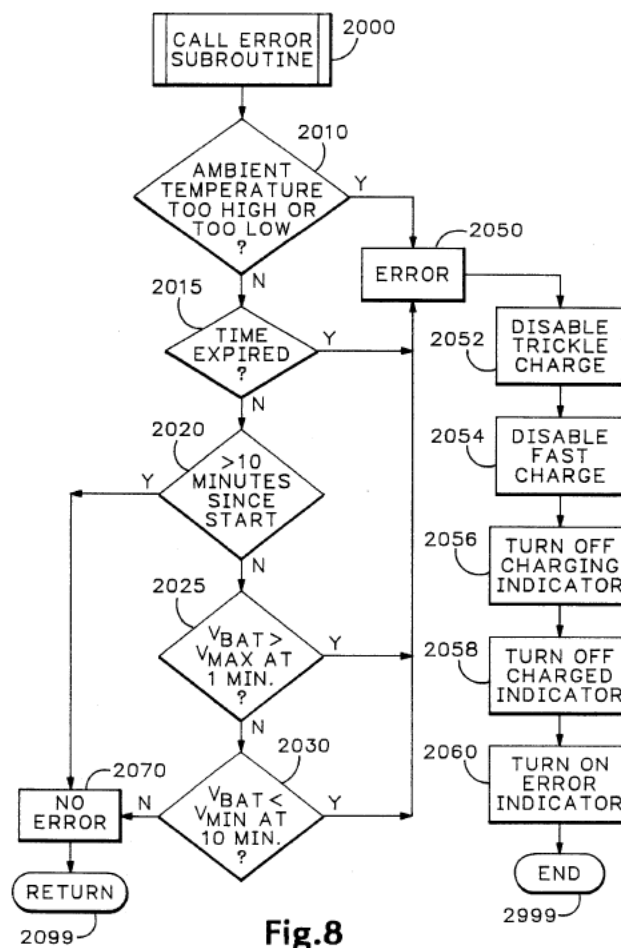


Fig.8

(*Id.*, Fig. 8.)

81. “Error subroutine 2000 checks to see if any error conditions occur during the charging operation” and there are several points during the charging process where the error subroutine depicted in Figure 8 is called. (Stephens, 6:53-54.) For example, if the ambient temperature is either too low or too high to safely and reliably operate the battery charger, if the time out period has expired, if the battery voltage exceeds a predetermined maximum voltage, at the one minute mark after insertion, or if the battery voltage is less than a predetermined low voltage at the 10 minute mark after insertion. (*Id.*, 6:56-7:29.) If an error condition is detected, the “error” indicator is turned on by turning on the red LED. (*Id.*, 6:67-7:2.)

7. Koenck (EX1011)

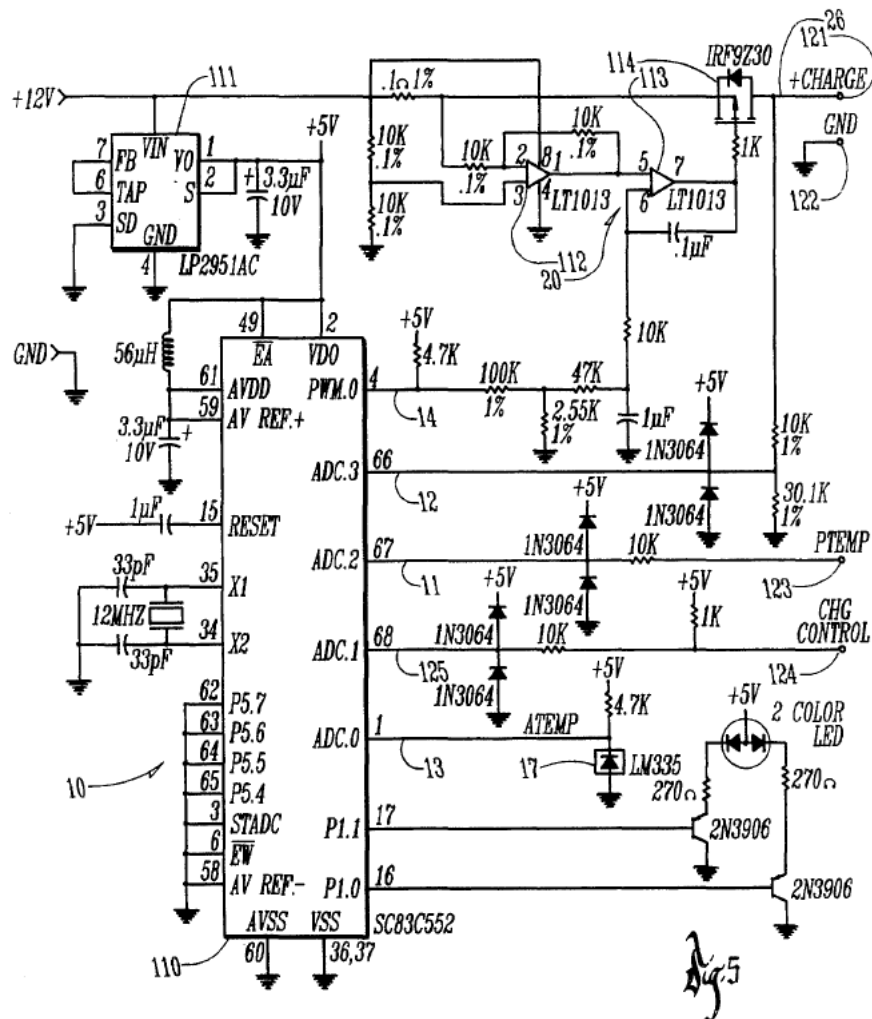
82. **Koenck**, U.S. Patent No. 5,493,199 (filed October 6, 1992, published February 20, 1996), is titled “Fast Battery Charger.” Koenck describes a “fast charging system” that “may automatically identify battery type and automatically adjust to different levels of load current.” (Koenck, Abstract.) By applying a suitable overcharge current value and observing the temperature increase, the charging system is able to determine the level of remaining battery charge. (*Id.*) I have been informed that Koenck qualifies as prior art to the ’397 patent because it was published in February 1996, prior to the earliest February 11, 2004 filing date of the ’397 patent.

83. My Declaration cites Koenck in connection with dependent claims 4 and 8, which relate to the identification of the charge level of the battery and errors of the battery or device type. Koenck explains that NiCad batteries have been successfully utilized in portable electronic devices for years as a power source. Thus, there is a need to quickly and reliably charge NiCad batteries without damaging the cells. Koenck recognizes that the two most important factors in “determining the maximum allowable charge current that may be safely applied to a NiCad battery are temperature and state of charge.” (Koenck, 2:31-33.) For example, “[i]f the battery fully discharged, minimal oxygen generation will occur until the battery nears the fully charged condition. If the battery is nearly fully charged, it will quickly enter the overcharge condition and begin oxygen generation. The difficulty lies in accurate determination of the previous state of charge to avoid damage to the battery.” (*Id.*, 2:42-47.) Further, in certain applications, it is “highly advantageous to maintain the terminal batteries substantially at their fully charged or ‘topped off’ state[.]” (*Id.*, 3:6-8.)

84. To solve this need, Koenck discloses “a monitoring and control system which provides for effective fast charging. In order to avoid damage to the battery, the system automatically tests to determine the initial state of charge and selects the charging rate accordingly.” (Koenck, 3:14-18.) Specifically, the monitoring and

control system will detect the presence of an overcharge condition which causes rapid heating of a battery. By “monitoring [the] cell temperature, it is possible to reliably determine that the overcharge condition has been reached.” (*Id.*, 6:33-41.) Once it has been determined that the battery is not in the overcharge condition, a fast charge parameter table is utilized. However temperature continues to be closely monitored to determine if overcharge has been reached, so that fast charge may be terminated and a controlled temperature overcharge cycle may be initiated to “top-off” the battery for maximum capacity. (*Id.*, 6:65-7:12.) Figure 5 of Koenck is an exemplary embodiment of the fast charging system utilizing a microprocessor system with a programmed control system for fast charging battery packs:

Declaration of Regan Zane, Ph.D. in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 8,610,397 B2



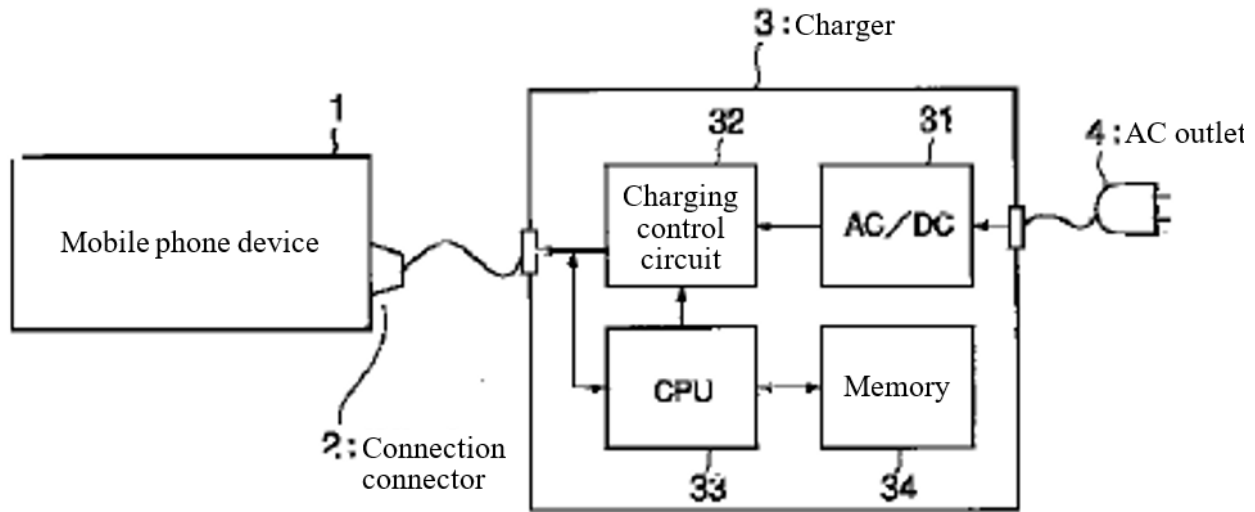
(*Id.*, Fig. 5.)

A. Ground 1: Claims 1-7, 11-22 Are Obvious Over Keirinbou in view of Gaza

- 1. Independent claim 1: “A battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates, the battery charger comprising:” (Claim 1[pre])**

85. To the extent the preamble is limiting, it is my opinion that Keirinbou discloses and renders obvious the preamble.

86. Keirinbou discloses a **“battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto.”** As exemplified by Fig. 1, Keirinbou discloses “a charger for portable devices,” and more specifically, “a charger for portable devices, such as mobile phone devices, which use built-in secondary batteries as an operating power source.” (Keirinbou, [0001] (emphasis added).) Fig. 1 of Keirinbou is reproduced below:



(*Id.*, Fig. 1.) As shown above, the charger 3 of Keirinbou includes among other things charging control circuit 32, CPU 33, and memory 34. Figure 1 also shows mobile phone device 1. Although Keirinbou does not expressly state that the mobile phone device 1 includes “**a wireless communications transceiver coupled thereto,**” a person of ordinary skill in the art would have understood and found it obvious that the mobile phone would have included a wireless communications transceiver to enable communications over a wireless network. The term “**transceiver**” is commonly understood as encompassing an electronic device or component that transmits and receives signals. (*See Newton’s Telecom Dictionary* (17th ed. 2001), p.004 (EX1012) (“**Transceiver**... Any device that transmits and receives.”) (emphasis in original).) It would have been obvious to a person of ordinary skill in the art that mobile phone device in Keirinbou would have included

at least one wireless communications transceiver in order to allow the mobile phone to send and receive signals over a wireless network (such as a cellular network). A wireless transceiver was (and remains today) a basic component of any wireless communications device, including mobile phones. (*See, e.g.*, U.S. Patent No. 6,574,487 B1 to Steven Smith (**EX1017**), 2:28-31 (“the communication device is embodied in a cellular phone having a conventional cellular radio transceiver as is known in the art”); *see also* U.S. Patent No. 6,282,433 B1 to Howard Holshouser (**EX1016**), 3:23-28 (“The telephone unit **60** functions as a conventional cellular phone. The telephone unit **60** includes audio processing circuits **62** and transceiver unit **80**. The transceiver unit **80** is a conventional cellular phone transceiver that communicates over a cellular network according to known standards....”).)

87. It would also have been obvious to a person of ordinary skill in the art that the transceiver in mobile phone device 1 would have been “**coupled**” to the device’s rechargeable battery, as this would have been required in order for the transceiver to receive the power needed to operate the transceiver. This is consistent with Keirinbou’s disclosure that “[a]s is well known, mobile phone devices generally have a built-in secondary battery as a power source.” (Keirinbou, [0002].)

88. Keirinbou also discloses a “**portable wireless communications device and rechargeable battery each respectively having a portable device type and a**

rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types.” The ’397 patent provides that battery types can include “Li or Ni-MH,” and further notes that “device and battery ‘types’ may vary depending upon a given implementation of the present invention. For example, in some applications, device/battery types may be respective models of portable devices/batteries. However, in other applications, the device/battery types may correspond to a particular series of portable devices/batteries.” (’397, 1:57-58; 5:39-47 (emphasis added).)

89. Keirinbou discloses **“a plurality of different portable device types and different rechargeable battery types”** as it discloses information about mobile phones and batteries consistent with the examples in the ’397 patent. For example, Keirinbou discloses that “there are various types (models) of mobile phone devices, and the secondary batteries used differ depending on the model. In other words, the secondary batteries used in mobile phone devices include lithium batteries, nickel-cadmium batteries, nickel-metal hydride batteries, etc., and the capacity thereof varies depending on each mobile phone device.” (Keirinbou, [0002]-[0003] (emphasis added).)

90. Keirinbou further discloses that the **“portable wireless communications device and rechargeable battery each respectively hav[e] a**

portable device type and a rechargeable battery type associated therewith.” As explained below, the “**portable device type**” in Keirinbou includes the model or type of portable device in Keirinbou, and the “**rechargeable battery type**” takes the form of the characteristics of the secondary battery including at least the type of battery and its capacity.

91. For example, Keirinbou discloses that the battery charger will “transmit a predetermined specific command to the portable device” in order to obtain the “model number of the type from the portable device as a response[.]” (Keirinbou, [0007] (emphasis added).) And using this portable device type information, the battery charger also identifies the type of the rechargeable battery. (*Id.*) For example, Keirinbou explains that the charger includes “a memory table that stores the characteristics of a plurality of secondary batteries corresponding to a plurality of types of portable devices,” which is used to control the charging of the secondary battery. (*Id.*; *see also id.*, [0008] (“[T]he present invention is configured to use the means already existing in most portable devices to receive the type signal of the portable device so that the invention recognizes the characteristics of the secondary battery according to this type, and charges the battery according to these characteristics[.]”).)

92. It would have been obvious and apparent to a person of ordinary skill

in the art that the “characteristics” of the rechargeable battery described in Keirinbou define a **“rechargeable battery type,”** as claimed. This is because, as Keirinbou explains, the memory table described above is used to “recognize[] the type of the secondary battery (any of a lithium battery, nickel-cadmium battery, or nickel-metal hydride battery, etc.) and its capacity (steps S2, S3).” (Keirinbou, [0012] (emphasis added).) Keirinbou therefore discloses that the portable device and the secondary battery have, respectively, a **“portable device type”** and **“rechargeable battery type”** that are **“from among a plurality of different portable device types and different rechargeable battery types.”**

93. The claimed **“different rechargeable battery types”** also **“hav[e] respective charging rates,”** as recited at the end of the preamble. As discussed above, Petitioner and Patent Owner dispute the meaning of **“charging rate”**. Petitioner contends **“charging rate”** should be interpreted as “the current expressed in amperes at which the battery is charged.” Patent Owner contends that no construction is necessary. It is my opinion that Keirinbou also discloses **“different rechargeable battery types having respective charging rates”** under either of these views or any other reasonable construction. This is because Keirinbou confirms that the “charging control performed by the charging control means in accordance with the characteristics of the secondary battery is further characterized

by controlling the charging voltage value, charging current value, and charging time.” (Keirinbou, [0007] (emphasis added).) A person of ordinary skill in the art would have understood the term “current” (in “charging current value”) refers to the flow of electric charge through a conductor – a property that is measured in amperes. Accordingly, “charging current value” as described in Keirinbou refers to the current expressed in amperes at which a battery is charged. (*See also id.*, [0010] (“and charges the battery at a voltage value, current value, and time that match the characteristics of the recognized secondary battery.”) (emphasis added), [0011] (“it will be possible to charge the battery with a voltage value, current value, and charge time (any one or two controls are also possible) that match the battery.”) (emphasis added).)

94. I note that the charging current value in Keirinbou would also satisfy Patent Owner’s proposed construction, which is broader than Petitioner’s and does not require that the “**charging rate**” be measured in amperes. Keirinbou discloses other information, such as the “charging voltage value” and “charging time” that might also independently satisfy Patent Owner’s broader interpretation of “**charging rate**,” as these values define an amount of voltage or current provided over a period of time.

95. I note that the claim recites “**different rechargeable battery types**”

that “**hav[e] respective charging rates,**” which is disclosed by Keirinbou. This is because, as noted, Keirinbou discloses recognizing “the built-in secondary battery from the type signal by referring to the memory table, and charges the battery at a voltage value, current value, and time that match the characteristics of the recognized secondary battery[.]” (Keirinbou, [0010] (emphasis added).) It therefore would have been obvious and apparent to a person of ordinary skill in the art that the different secondary battery types in Keirinbou would have had respective charging rates, in accordance with their varying characteristics.

96. I note that the claim language at the end of the preamble recites “**a plurality of different portable device types and different rechargeable battery types having respective charging rates.**” If the phrase “**respective charging rates**” also modifies the claimed “different portable device types,” such a requirement would have been obvious based on Keirinbou. This is because the mobile phone device in Keirinbou receives power from the charger, which is used to provide current to charge its internal secondary battery. (See Keirinbou, [0009] (“a charging control circuit that controls the charging current to charge the secondary battery built into the mobile phone device according to its characteristics.”).) Additionally, the portable device type information provided by the mobile phone device to the charger in Keirinbou as described above, is used to determine the

charging current value used to charge the device. (*Id.*, [0007], [0009].) It therefore would have been obvious that different mobile phone devices would have had respective charging rates associated with their device types, in order to support providing charge to the battery through the device.

(a) “a charging circuit; and” (Claim 1[a])

97. It is my opinion that claim 1[a] is obvious over Keirinbou.

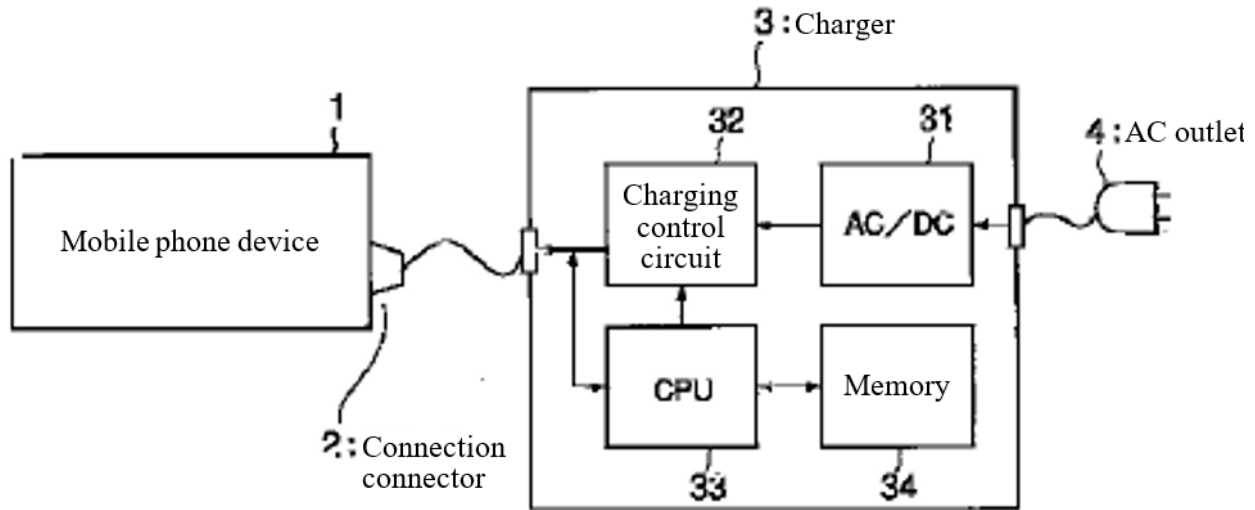
98. Referring to Fig. 1 cited above, Keirinbou discloses that the battery charger **3** includes a **“charging circuit”** in the form of an AC/DC converter 31 and charging control circuit 32. Keirinbou explains that “[i]n the charger 3, 31 is an AC/DC converter that takes in commercial power and converts it to direct current, 32 is a charging control circuit that controls the charging current to charge the secondary battery built into the mobile phone device according to its characteristics.” (Keirinbou, [0009].)

(b) “a controller coupled to said charging circuit and configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 1[b])

99. Limitation 1[b] is obvious over Keirinbou, alone or in view of Gaza.

100. Keirinbou discloses **“a controller coupled to said charging circuit,”**

which corresponds to CPU 33 as shown in Figure 1:



(Keirinbou, Fig. 1.)

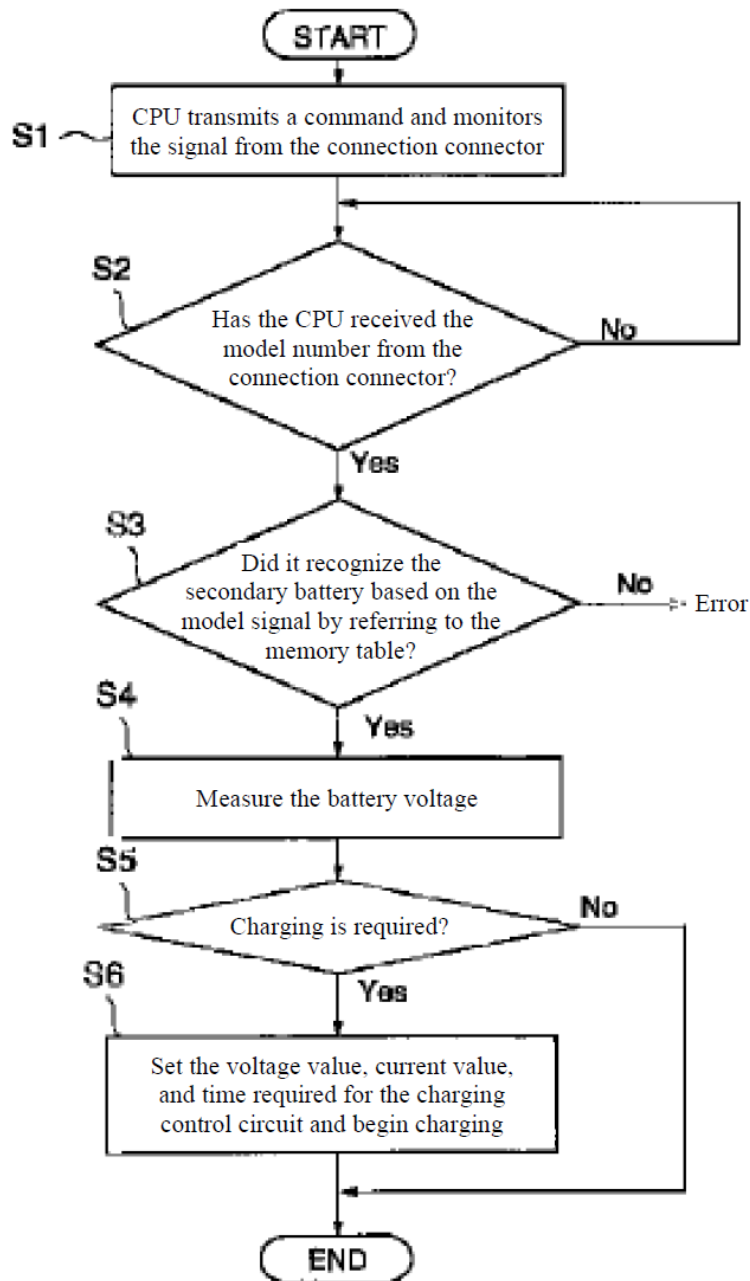
101. Keirinbou explains that CPU 33 “controls the entire charger 3,” and memory 34 “is a memory that stores a memory table for recognizing the battery built into the mobile phone device from the model number of the mobile phone device.” (Keirinbou, [0009].) The controller in Keirinbou is also “**coupled to said charging circuit**” because it is coupled to charging control circuit 32 and AC/DC 31 as shown in Fig. 1. (*Id.*, Fig. 1.) A person of ordinary skill in the art would have understood the depicted lines connecting CPU 33 to charging control circuit 32 in Fig. 1 to indicate that the components are electrically connected.

102. Keirinbou further discloses that the controller will “**cause the portable wireless communications device to identify its corresponding portable device**

type.” More specifically, CPU 33 transmits a “predetermined command” to the portable device to cause it to send back its model information. (Keirinbou, [0011]-[0012]) (“Therefore, in the present invention, the charger 3 equipped with a CPU 33 and a memory 34 is configured to transmit a command from the CPU 33 to obtain the model number of the connected portable device[.]”) (emphasis added), [0012] (“When the AC outlet 4 of the charger 2 is plugged into a commercial power source, the CPU 33 sends out a predetermined command to the connection connector 2 and monitors a signal from the connection connector 2 (step S1). When the connection connector 2 is connected to the mobile phone device 1, the mobile phone device 1 sends back its model number as described above.”) (emphasis added).)

103. Keirinbou further discloses that the controller causes the portable wireless communication device to identify not only its corresponding portable device type, but also **“its corresponding rechargeable battery type,”** as claimed. This is because, after CPU 33 receives model information from the portable wireless device, CPU 33 uses that information to identify the type of secondary battery. More specifically, “when the CPU 33 receives this model number, it recognizes the type of the built-in secondary battery from this model number by referring to the memory table 34, and recognizes the type of the secondary battery (any of a lithium battery, nickel-cadmium battery, or nickel-metal hydride battery, etc.) and its capacity (steps

S2, S3).” (Keirinbou, [0012].) This process is also illustrated in Figure 2:



(*Id.*, Fig. 2.) As shown, at Step S3, the controller attempts to determine the type of secondary battery based on the model information provided by the portable wireless device. (*Id.*, [0010]-[0012].) Keirinbou therefore discloses that the controller causes

the portable wireless communication device to identify its corresponding portable device type “**and its corresponding rechargeable battery type,**” as claimed.

104. Finally, the controller in Keirinbou also “**cause[s] said charging circuit to charge the rechargeable battery based on the respective charging rate thereof,**” as claimed. This is because, if CPU 33 determines that charging is necessary, it causes the charging control circuit 32 (“**said charging unit**”) to charge the secondary battery based on the optimal charging current value for the battery (“**the respective charging rate thereof**”). (Keirinbou, [0013] (“The CPU 33 measures the current voltage on the battery to determine if charging is necessary. If it is necessary, it sets the optimal voltage value and current value for charging the battery in the charging control circuit 32, sets a necessary and sufficient charging time, and executes the charging until the time elapses (steps S4, S5, S6).”) (emphasis added); (*see also id.*, [0006]) (“wherein the charger comprises a means for acquiring the type of the connected portable device and a charging control means, and recognizes the characteristics of the secondary battery built into the portable device from the acquired type, and operates the charging control means to perform charging in accordance with the characteristics of the secondary battery”).) (emphasis added); [0007] (“The charging control performed by the charging control means in accordance with the characteristics of the secondary battery is further characterized

by controlling the charging voltage value, charging current value, and charging time (emphases added).)

105. I note that the claim requires “**the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type,**” which as described above, occurs in Keirinbou when the portable wireless device provides its model number to CPU 33, which is used by CPU 33 to recognize the secondary battery and identify its type. (Keirinbou, [0011]-[0013].) I note that it is unclear if the claim requires that the portable wireless communications device transmit *separate and distinct* pieces of information for the claimed “portable device type” and “corresponding rechargeable battery type.” If there is no such requirement, the model information provided by the portable device in Keirinbou satisfies the claim limitation because the model type provided by portable device is directly used by CPU 33 to identify the corresponding secondary battery type.

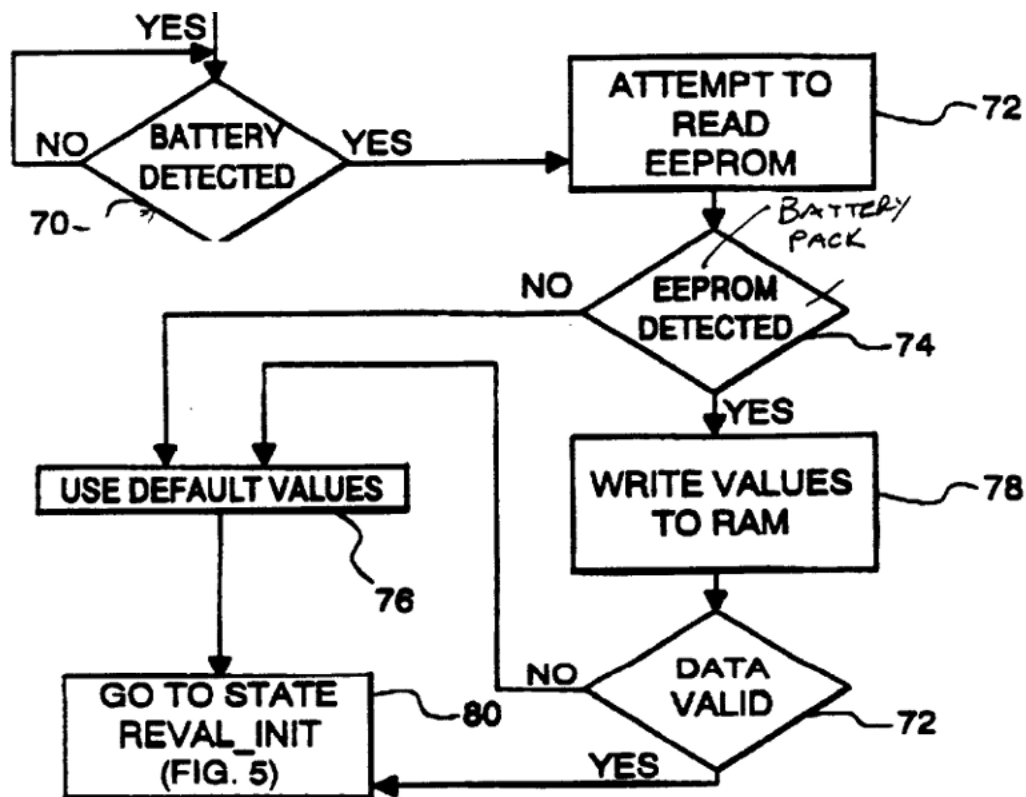
106. But even if this limitation were construed to require that the portable wireless device provide a second or separate piece of information identifying the corresponding rechargeable battery type, such a limitation would have been obvious in further view of Gaza, which discloses a charging system in which battery type information is separately provided by the rechargeable battery itself.

107. Gaza explains that “[v]arious portable devices and appliances, such as cellular phones, require rechargeable batteries,” which can be of various different types such as nickel cadmium, nickel metal hydride and lithium ion, among others. (Gaza, 1:34-39.) Gaza purports to disclose an improved battery charging system that can be used with different types of rechargeable batteries. (*Id.*, 2:44-50.) Gaza further describes so-called “smart battery packs,” a term well-known in the art to refer to rechargeable battery packs that “normally include a memory storage device which contains information regarding the characteristics of the battery as well as the battery type. Some smart battery packs are known to include a microcontroller which allows communication by way of a bi-directional communication line with the battery charger regarding various battery characteristics.” (*Id.*, 1:51-38.) Gaza further refers to the Smart Battery Specifications, which was a standard published by various companies including Intel and Duracell in the 1990s. (*Id.*, 1:58-64.)

108. In one embodiment, Gaza explains that certain types of batteries (such as lithium ion batteries) include “an internal memory storage device, such as an electrically erasable programmable read only memory (EEPROM),” which can “provide various information, including information that the battery is a lithium ion battery.” (Gaza, 3:58-62.) Gaza discloses a technique in which a battery charger can read the EEPROM of the battery pack, if available, and use that information in

charging the rechargeable batteries.

109. For example, Figure 4 of Gaza shows a power-up routine for the disclosed battery charger. As relevant to the issues here, I have reproduced the bottom half of Figure 4 which shows a flowchart of part of the idle-initiate state (IDLE_INIT STATE) (Gaza, 8:13-52), including attempting to read the battery pack EEPROM (Step 72):



(Gaza, Fig. 4 (partial figure).)

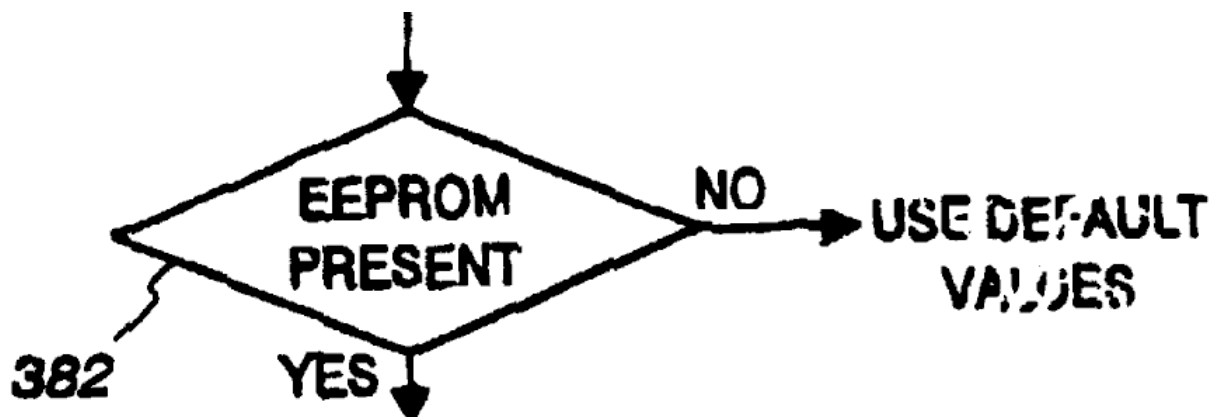
110. As shown in Step 70 above, the charger attempts to determine if a battery has been detected. (Gaza, 8:31-34.) If a battery is detected, at steps 72 and 74, the system attempts to read the battery pack EEPROM by initially determining

whether the EEPROM is present. (*Id.*, 8:40-43.) If an EEPROM is **not** detected, as shown, the system “goes to step 76 and utilizes default values.” (*Id.*, 8:44-45.) If an EEPROM **is** detected, as shown, “the constants are written to the on-board RAM on the microcontroller **30** [of the charging system] in step 78.” (*Id.*, 8:45-47.) The process then proceeds to step 79 (erroneously labeled as 72 in Figure 4), in which the data is analyzed “to determine if it is valid, for example, by way of a checksum. If not, the system loops to step 76 and uses default values. If the data is valid, the system goes to the pocket state REVAL_INIT in step 80.” (*Id.*, 8:47-52.) As noted previously, the term “checksum” refers to a well-known set of mathematical techniques (similar in purpose to a “hash”) for checking the integrity of data, which is well-known to skilled artisans and commonly used to determine whether or not particular data has been corrupted or otherwise altered from the original values.⁴

111. A similar process is also shown in connection with Figures 12A through

⁴ As mentioned before, there are at least two different EEPROMs described in Gaza, an EEPROM that is part of the charging system (sometimes labeled as EEPROM 32 in the textual description) and an EEPROM in the battery pack itself. (*Id.*, 7:22-30 (EEPROM 32), 3:57-63 (EEPROM is part of battery pack).) My Declaration will focus on the EEPROM in the battery pack, which is referenced in the handwritten note at step 74 of Figure 4 reproduced in the text. (*See also Id.*, 9:25-27 (“As mentioned above, such data from the battery pack EEPROM is stored in state IDLE INIT.”), 16:20-23 (“As indicated above, the battery pack EEPROM contains various information regarding the battery type and size available to the system over the -COMM and -SIZE terminals.”).)

12C. (Gaza, 14:57-58.) Gaza explains that “the system checks in step 376 [of Figure 12B] whether the system is in the idle state,” and if so, “a reading of the EEPROM of the battery pack is attempted in step 380 [of Figure 12B].” (*Id.*, 16:15-19.) “Thus, in step 382, the system checks whether the battery pack EEPROM is present.” (*Id.*, 16:23-24.) As the portion of Figure 12C shown above confirms, if the EEPROM is not found at step 382, the system will use default values:



(*Id.*, Fig. 12C (partial figure).) Gaza explains that “the battery pack EEPROM contains various information regarding the battery type and size available to the system over the -COMM and -SIZE terminals... If the battery pack EEPROM is present, the system checks whether the battery is a lithium type battery in step 384.” (*Id.*, 16:20-26 (emphasis added).) If the battery is found to be a lithium ion battery, charger will obtain the maximum voltage and charge rate values for the battery. (*Id.*, 16:65-17:5.) Gaza therefore discloses the ability of a device “**to identify... its corresponding rechargeable battery type,**” as claimed, by allowing the battery of

a wireless mobile device to provide information about the characteristics of its battery, including the type and size of such battery.

112. *Rationale and Motivation to Combine (Keirinbou with Gaza):* It would have been obvious to combine Keirinbou with Gaza, resulting in the battery charger of Keirinbou further adapted to separately receive battery type information based on the teachings of Gaza. Under the proposed combination, therefore, the controller in Keirinbou would be capable of causing the portable wireless device to provide, to the charging circuit, both (1) model information as disclosed in Keirinbou (*see, e.g.*, Keirinbou, [0011]), and (2) battery type information under the further combination with Gaza as described above, which would have been provided by the battery installed in the mobile phone device of Keirinbou. Under this combination, therefore, the portable wireless communications device would have “**identif[ied] its corresponding portable device type and its corresponding rechargeable battery type,**” as recited in the claim, assuming this language requires that two separate and distinct types of information be received.

113. Keirinbou and Gaza are analogous references to the '397 patent. The '397 patent describes its “Field of the Invention” as relating “to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods.” ('397, 1:20-22.) Keirinbou and Gaza are

thus in the same field of endeavor as the '397 patent, as both describe battery chargers for portable devices such as cellular phones. These references would also have been reasonably pertinent to various problems facing the '397 patent inventors, including how to design and implement a battery charger that obtains device- and battery-related information from the device.

114. A person of ordinary skill in the art would have had ample motivation to combine. As noted, Keirinbou discloses the ability of the battery charger to recognize the type of secondary battery based on the portable device model number, by using a memory table stored in the charger. (Keirinbou, [0011]-[0013].) Although this technique would have been suitable for many applications, it relies on the memory table to match model information with the type of battery – thus requiring that the charger assume that a particular portable device model necessarily has a particular type of battery. But if the rechargeable battery in that portable device or device model were upgraded or replaced with a different type of battery with different characteristics (for example, by upgrading from a nickel-based to a lithium ion battery), the charger may not be aware of the difference in the battery type and thus may rely on less optimal charging parameters. For example, it was well-known (and observed in Gaza) that lithium ion rechargeable batteries have different requirements (such as requiring both constant current and constant charge) when

compared to older battery technologies such as nickel cadmium (NiCd) and nickel metal hydride (NiMH). (Gaza, 3:44-50.) The addition of the techniques in Gaza would have provided a clear benefit to the charging system of Keirinbou by allowing the Keirinbou charger to have the most accurate and up-to-date information about the type and characteristics of the rechargeable battery currently installed in the portable wireless device. This would, in turn, have enhanced Keirinbou's stated goal of "provid[ing] a charger for portable devices that can be used with different models of portable devices by equipping the charger with a means for recognizing the secondary battery being used." (Keirinbou, [0005].)

115. A person of ordinary skill in the art would also have been further motivated, under the proposed combination of Keirinbou and Gaza, to also send the model information as disclosed in Keirinbou, even if the battery provides its own battery type information based on the techniques described in Gaza. This is because, as explained, Gaza acknowledges scenarios in which the charger must revert to default values because the information obtained from the battery is invalid. (Gaza, 8:42-50, Fig. 4 (Steps 74, 78, 79, and 76), 11:9-12, Fig. 12-C (Step 382).) Sending the model information as disclosed in Keirinbou would have beneficially enabled the charger to fall back to a set of baseline default values in the event the information provided by the battery itself was untrustworthy or otherwise unavailable.

116. I also note that an embodiment in Gaza discloses a “dual pocket” battery charger, which is “used for charging a spare battery, as well as the battery connected to the cellular phone.” (Gaza, 2:8-10.) In my opinion, this detail is not material because the proposed combination does not rely on the form factor of the Gaza charging system or its dual-pocket capabilities. Under the proposed combination, the battery information identification techniques of Gaza would have been applied to the charging system of Keirinbou, allowing the controller of Keirinbou to obtain information about the battery installed in the mobile phone device 1, as well as the model information provided by the mobile phone device.

117. An ordinarily skilled artisan would have had a reasonable expectation of success in making the proposed combination, as the proposed combination relies on battery charging and battery detection technologies that were already well-known and in wide use by the late 1990s. An ordinarily skilled artisan would have found the disclosures of Keirinbou and Gaza sufficiently detailed to make the proposed combination, without undue experimentation. For example, adapting the charger of Keirinbou to also receive information about the battery type from the battery pack itself (in addition to the charger receiving device type information) would have entailed nothing more than application of known “smart” battery techniques for transmitting battery information to charging devices using standard data bus

technologies as is already utilized by Keirinbou to communicate between the mobile device and the charger. Additionally, the amount of data that would have been required to send both the model and battery information, under the proposed combination, would have been small and the transmission of this data to the charger would have gone entirely unnoticed by the user.

2. Dependent Claim 2

118. For reference, claim 2 recites:

2. The battery charger of claim 1 wherein different portable device types have at least one different portable device charging parameter; wherein different battery types have at least one different battery charging parameter; and wherein said controller is configured to select at least one actual charging parameter to charge the rechargeable battery based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.

(’397, 12:48-56 (Claim 2).)

119. As I discussed above in my analysis of claim 1 [b], Keirinbou discloses that different portable devices have a portable device type and different rechargeable batteries have a battery type. Keirinbou further discloses a battery charger “**wherein**

different portable device types have at least one different portable device charging parameter,” as claimed. For example, Keirinbou discloses portable device charging parameters that are based on the portable device model number. These device charging parameters include, for example, a voltage value, current value, and a charging time. (See Keirinbou, *e.g.*, [0010] (“The charger for portable devices of the present invention identifies the model of the portable device by the type signal output from the portable device, recognizes the built-in secondary battery from the type signal by referring to the memory table, and charges the battery at a voltage value, current value, and time that match the characteristics of the recognized secondary battery, thereby constituting a charger for portable devices that can be used in common for different models of portable devices.”) (emphasis added).)

120. It would also have been obvious, based on the disclosures of Keirinbou, that **“different battery types have at least one different battery charging parameter,”** as claimed. For example, different types of batteries have different capacities. (Keirinbou, *e.g.*, [0003] (“In other words, the secondary batteries used in mobile phone devices include lithium batteries, nickel-cadmium batteries, nickel-metal hydride batteries, etc., and the capacity thereof varies depending on each mobile phone device.”), [0012] (“Therefore, when the CPU 33 receives this model number, it recognizes the type of the built-in secondary battery from this model

number by referring to the memory table 34, and recognizes the type of the secondary battery (any of a lithium battery, nickel-cadmium battery, or nickel-metal hydride battery, etc.) and its capacity (steps S2, S3).”) (emphasis added).)

121. The fact that “**different battery types have at least one different battery charging parameter,**” is also disclosed by and obvious in view of Gaza. Gaza discloses that different battery types (such as lithium ion vs. nickel-based batteries such as nickel cadmium (NiCd) and nickel metal hydride (NiMH)) have different charging requirements. (Gaza, 2:44-50.) Gaza accordingly discloses different battery charging parameters and charging methodologies for lithium ion (Figure 13) and nickel-based (Figure 9) rechargeable batteries, in order to account for their differences. (*Id.*, Fig. 5 (Step 102, 104, 106), 9:19-32.) For example, for rapid charging of lithium ion batteries, Gaza discloses obtaining “the maximum voltage for the lithium battery” and “the charge rate N_RAPID_INIT,” which are used to set the current for the charging. (*Id.*, 16:62-17:5, Fig. 13A (Steps 416, 418, 420).) For rapid charging of nickel-based batteries, different parameters and steps are required because, as was well-known to ordinarily skilled artisans, nickel-based batteries are more prone to generate unwanted heat during the charging process than lithium ion batteries. Accordingly, Gaza discloses obtaining ΔT timer values that are used to determine when to transition the charger from rapid charging to trickle

mode charging. (*Id.*, e.g., 11:48-52 (“Since both nickel metal hydride (NiMH) and nickel cadmium (NiCd) batteries are subject to a maximum temperature change per unit of time, ΔT timer values are retrieved from the table in step 174 and loaded into the ΔT timer in step 176.”), 12:36-39 (“[T]he system goes to Step 222 [Figure 9C] which checks whether the rate of change of temperature per unit of time is greater than the value from the table. If so, the system goes to step 224 to the NICK_TRICKLE_INIT state.”).) Gaza also discloses obtaining “the maximum allowable voltage VMAX” and “the maximum charging current IMAX” for charging the battery. (*Id.*, 11:61-67.) These are mere examples; Gaza discloses many other examples of different battery charging parameters based on battery type.

122. The proposed combination also discloses and renders obvious that **“said controller is configured to select at least one actual charging parameter to charge the rechargeable battery based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.”** I note that the written description of the ’397 patent does not explain in detail how the claimed **“comparison”** is carried out, but in one embodiment, the patent explains that this step is carried out by selecting an actual charging parameter based on a “limiting” portable device parameter or battery charging parameter. (’397, 8:51-58 (“If the device and battery types are recognized

by the controller 27, it then selects actual charging parameters for charging the rechargeable battery 22 based upon a comparison of the different charging parameters for the portable device 21 and battery 22, at Block 46. More particularly, the controller 27 may select the actual charging parameters based upon a limiting one (or ones) of the different portable device an battery charging parameters, at Block 46.") (emphasis added).) The term "limiting parameter" in this context generally refers to a value defining a constraint or limit within which the charging process should operate for safe and/or effective charging of the battery.

123. The proposed combination discloses numerous examples of the claimed **"at least one actual charging parameter to charge the rechargeable battery."** For example, Keirinbou discloses that the charging system, after recognizing the secondary battery, "charges the battery at a voltage value, current value, and time that match the characteristics of the recognized secondary battery[.]" (Keirinbou, [0010].) In other words, in Keirinbou the controller sets the "optimal voltage and current value for charging the battery in the charging control circuit 32" and "sets a necessary and sufficient charging time, and executes the charging until the time elapses (steps S4, S5, S6)". (Keirinbou, [0013] (emphasis added).) Any of these parameters (*e.g.* voltage, current, time) qualifies as an **"actual charging parameter,"** and in each case, the selection of each of these parameters is performed

because at that time they were determined to be the limiting parameters and were then regulated to ensure optimal charging of the secondary battery.

124. Gaza further discloses examples “**at least one charging parameter to charge the rechargeable battery,**” including the maximum voltage and charge rate (for lithium ion batteries), and the ΔT timer values (for nickel-based batteries), as described above. These actual charging parameters are also selected “**based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter,**” as claimed, because under the proposed combination they were selected as limiting parameters to ensure proper charging of the battery. For example, as explained previously, the ΔT timer values, VMAX, and IMAX values for selected for nickel-based batteries as limiting parameters designed to ensure effective charging for that type of battery. For example, under the proposed combination, the controller in Keirinbou would have selected these limiting parameters from Gaza for use in charging the secondary battery as they are more optimal than the default values provided based on the model information.

125. Under the proposed combination of Keirinbou and Gaza, a further “**comparison**” takes place in order to determine whether to select an actual charging parameter based on battery information derived from the model information as

disclosed in Keirinbou, or from the battery itself under the further combination as disclosed in Gaza. As fully explained for claim 1, the charger under the proposed combination would have checked (for example using a checksum) the data obtained from the battery to make sure it is valid, and if not, would have used default values. This provides another example of selecting an actual charging parameter based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.

3. Dependent Claim 3

126. For reference, claim 3 recites:

3. The battery charger of claim 2 wherein said controller is configured to select the at least one actual charging parameter based upon a limiting one of the at least one different portable device charging parameter and the at least one different battery charging parameter.

('397, 12:57-61 (Claim 3).)

127. As just explained, the selection of an actual charging parameter is based on limiting one of the different portable device and battery charging parameter.

4. Dependent Claim 4

128. For reference, claim 4 recites:

4. The battery charger of claim 2 wherein said controller is

configured to further cause the portable wireless communications device to identify a battery charge level; and wherein said controller is configured to further select the at least one actual charging parameter based upon the battery charge level.

(’397, 12:62-67 (Claim 4).)

129. The controller in Keirinbou’s “**controller**,” which includes CPU **33**, identifies the “**charge level**” and then selects a charging parameter (*e.g.*, voltage, current, time) based on that level. (Keirinbou, [0013] (“The CPU **33** measures the current voltage on the battery to determine if charging is necessary. If it is necessary, it sets the optimal voltage value and current value for charging the battery in the charging control circuit **32**, sets a necessary and sufficient charging time, and executes the charging until the time elapses (steps S4, S5, S6).”) (emphasis added).) It would have also been obvious to have the voltage measured by the portable device and communicated to the controller. The mobile device already has smart circuitry such as a microcontroller to read its memory and communicate with the controller, and the addition of a voltage measurement would be simple and well known in the art, *e.g.*, by the same microcontroller that may be used to communicate with the controller. This would also provide a more reliable measurement with less noise sensitivity by measuring at the battery within the mobile device. Keirinbou therefore

discloses that the portable device “**identif[ies] a battery charge level**” by providing its current battery voltage which is measured by CPU 33.

130. CPU 33 then “**further select[s] the at least one actual charging parameter based upon the battery charge level,**” for example, by setting the voltage value, current value, or charging time in response to determining that charging is necessary based on the charge level. (Keirnbou, [0013].)

5. Dependent Claim 5

131. For reference, claim 5 recites:

5. The battery charger of claim 2 wherein said controller is configured to enter a learning mode for learning the at least one different portable device or battery charging parameter upon receiving a learning mode signal therefrom.

(’397, 13:1-4 (Claim 5).) Keirnbou and Gaza both disclose and render obvious this claim.

132. Turning first to Keirnbou, as fully explained for claim 1, the battery charger enters a “**learning mode**” after it sends a specific command to the portable device to request its model information. (Keirnbou, [0011-0012].) Keirnbou explains, for example, that “[w]hen the AC outlet 4 of the charger 2 is plugged into a commercial power source, the CPU 33 sends out a predetermined command to the

connection connector 2 and monitors a signal from the connection connector 2 (step S1).” (*Id.*, [0012].) That signal, as explained in Keirinbou, identifies the model information of the portable device. Keirinbou explains that “[w]hen the connection connector 2 is connected to the mobile phone device 1, the mobile phone device 1 sends back its model number as described above. Therefore, when the CPU 33 receives this model number, it recognizes the type of the built-in secondary battery from this model number by referring to the memory table 34, and recognizes the type of the secondary battery (any of a lithium battery, nickel-cadmium battery, or nickel-metal hydride battery, etc.) and its capacity (steps S2, S3).” (*Id.*)

133. The “**learning mode**” in Keirinbou therefore corresponds to the mode in which the controller, after receiving model information from the portable device, enters the mode in which it uses the received model information to determine the portable device and/or battery parameters using the memory table 34. And the controller enters this learning mode “**upon receiving a learning mode signal therefrom,**” *i.e.*, upon receiving the signal from CPU 33 indicating the model information of the portable device. (Keirinbou, [0012] (“... CPU 33 sends out a predetermined command to the connection connector 2 and monitors a signal from the connection connector 2 (step S1).”).)

134. Gaza also separately renders obvious this claim limitation under the

proposed Keirinbou-Gaza combination; as explained previously, the charging system in Gaza attempts to read the battery pack EEPROM by initially determining whether the EEPROM is present. (Gaza, 8:40-43.) If an EEPROM is **not** detected, as shown, the system “goes to step 76 and utilizes default values.” (*Id.*, 8:44-45.) If an EEPROM **is** detected, the constants from the EEPROM “are written to the on-board RAM on the microcontroller **30** [of the charging system] in step 78.” (*Id.*, 8:45-47.) The process then proceeds to step 79 (erroneously labeled as 72 in Figure 4), in which the data is analyzed “to determine if it is valid, for example, by way of a checksum. If not, the system loops to step 76 and uses default values. If the data is valid, the system goes to the pocket state REVAL_INIT in step 80.” (*Id.*, 8:47-52.) These values, as explained previously, include information about the battery such as its type.

135. The “**learning mode**” under the proposed Keirinbou-Gaza combination therefore also includes the mode in which the charger, after determining that a battery EEPROM **is** present, reads the values from the EEPROM and validates that data in order to obtain portable device or battery parameters. And the charger under the Keirinbou-Gaza combination enters this learning mode “**upon receiving a learning mode signal therefrom,**” *i.e.*, upon receiving the signal indicating the presence of an EEPROM on the battery pack. It would have been obvious to a person

of ordinary skill in the art that the detection of the battery EEPROM by the charger would have included the controller receiving a signal indicating the presence of the EEPROM. (Gaza, 8:42-43 (“The first step in reading the EEPROM 32 is detecting the EEPROM **32** itself in step 74.”).)

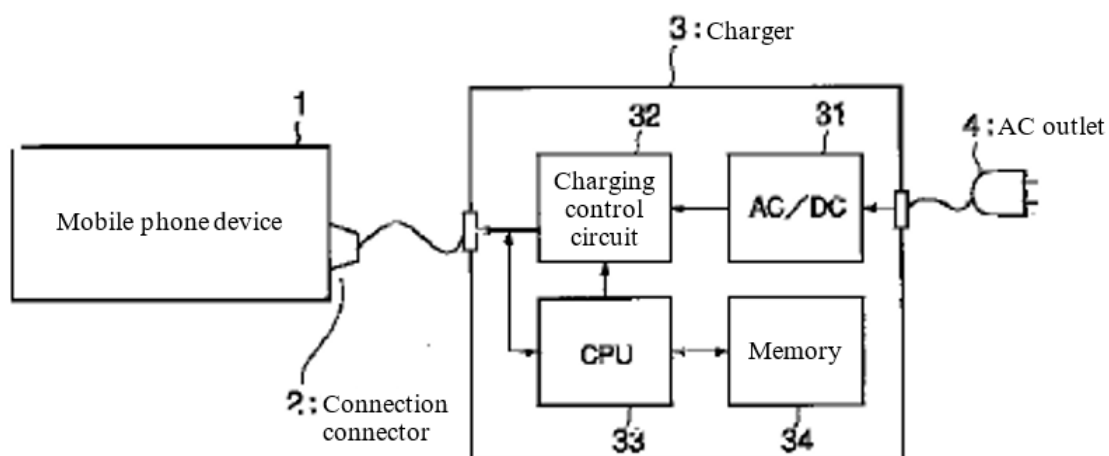
6. Dependent Claim 6

136. For reference, claim 6 recites:

6. The battery charger of claim 2 further comprising at least one memory coupled to said controller and configured to store the at least one different portable device charging parameter and the at least one different battery charging parameter.

(’397, 13:5-9 (Claim 6).)

137. Keirinbou discloses the claimed memory, which is shown as memory 34 shown in Figure 1:



(Keirinbou, Fig. 1.)

138. As shown in the figure above, memory 34 (“**at least one memory**”) is coupled to CPU 33 (“**controller**”). Memory 34 is “an EEPROM (electrically erasable programmable read-only memory)” and “configured so that the memory table can be rewritten or added to by connecting a personal computer to the connection connector 2”. (Keirinbou, [0014].)

139. The memory 34 is also “**configured to store the at least one different portable device charging parameter and the at least one different battery charging parameter,**” as claimed. This is because, as explained fully for claim 2, the memory 34 in Keirinbou is configured to store the voltage value, current value, time, and battery capacity. (See Keirinbou, *e.g.*, [0010], [0012], [0003].)

140. This limitation is also obvious in view of the combination of Keirinbou and Gaza, the latter further disclosing an EEPROM memory on the battery pack that stores battery charging parameters. (Gaza, 3:57-63.) This EEPROM memory is “**coupled to said controller**” because the controller can obtain information by reading the EEPROM. (*Id.*, 8:40-42 (“Once a battery is detected, a battery detection flag is set and the system attempts to read the EEPROM 32 in step 72.”).) The EEPROM on the battery pack, as explained previously, stores information about the battery type and size. (*Id.*, 16:20-21 (“As indicated above, the battery pack EEPROM contains various information regarding the battery type and size[.]”),

3:60-63 (“Such integral EEPROMs are known to be provided with lithium ion modular battery packs which provide various information, including information that the battery is a lithium ion battery.”).)

7. Dependent Claim 7

141. For reference, claim 7 recites:

7. The battery charger of claim 2 wherein the at least one actual charging parameter comprises at least one of a voltage parameter, and a charging time.

(’397, 13:10-12 (Claim 7).)

142. As discussed under the context of claims 1 and 2, Keirinbou discloses the **“at least one actual charging parameter comprises at least one of a voltage parameter, and a charging time.”** For example, as discussed above, Keirinbou discloses selecting “charging parameters” for the device and secondary battery based on an analysis of the device model number. The charging parameters include a voltage parameter and a charging time. (Keirinbou, [0011] (“If the model can be identified, the built-in secondary battery can be recognized, and therefore, if the characteristics of each built-in battery corresponding to each model number are stored in each memory table, the characteristics of the built-in battery can be recognized simply by connecting the portable device, and it will be possible to

charge the battery with a voltage value, current value, and charge time (any one or two controls are also possible) that match the battery.”) (emphasis added); (*see also Id.*, [0007] (“The charging control performed by the charging control means in accordance with the characteristics of the secondary battery is further characterized by controlling the charging voltage value, charging current value, and charging time” (emphasis added), [0010] (“The charger for portable devices of the present invention identifies the model of the portable device by the type signal output from the portable device, recognizes the built-in secondary battery from the type signal by referring to the memory table, and charges the battery at a voltage value, current value, and time that match the characteristics of the recognized secondary battery” (emphasis added), [0013] (“The CPU 33 measures the current voltage on the battery to determine if charging is necessary. If it is necessary, it sets the optimal voltage value and current value for charging the battery in the charging control circuit 32, sets a necessary and sufficient charging time, and executes the charging until the time elapses (steps S4, S5, S6)”) (emphasis added).)

143. This is also obvious in view of Gaza, which further discloses that the **“at least one actual charging parameter comprises at least one of a voltage parameter, and a charging time.”** For example, as explained for claim 2, the charging system in Gaza obtains, for rapid charging of lithium ion batteries, “the

maximum voltage for the lithium battery” and “the charge rate N_RAPID_INIT,” which are used to set the current for the charging. (Gaza, 16:62-17:5, Fig. 13A (Steps 416, 418, 420).) For rapid charging of nickel-based batteries, the charging system obtains “the maximum allowable voltage VMAX” and “the maximum charging current IMAX” for charging the nickel-based battery. (*Id.*, 11:61-67.)

8. Independent Claim 11

144. For reference, claim 11 recites:

11[p] A battery charging system comprising:

11[a] a portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, said portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates; and

11[b] a battery charger comprising

11[c] a charging circuit, and

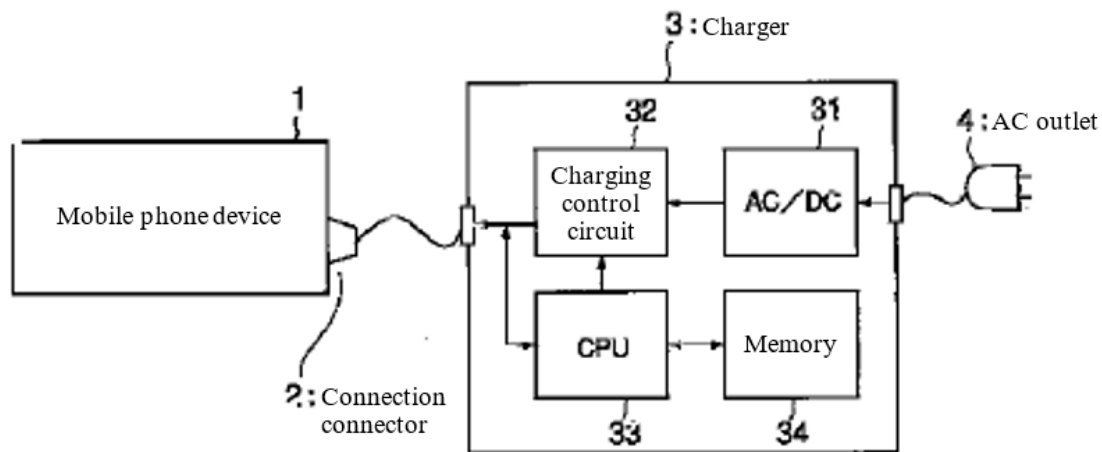
11[d] a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its

corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.

('397, 13:24-42 (Claim 11; bracketed notation (e.g., [a]) added).)

(a) “A battery charging system comprising:” (Claim 11[p])

145. To the extent the preamble is limiting, it is my opinion that Keirinbou discloses the preamble. For example, as fully explained for claim 1 above, Keirinbou discloses a battery charging system that includes a battery charger and mobile device. Figure 1 is representative and depicts “a mobile phone device with a built-in secondary battery (not shown), 2 is a connection connector for connecting the mobile phone device 1 to a charger, 3 is a charger, and 4 is an AC outlet for supplying commercial power to the charger 3.” (Keirinbou, [0009].)



(*Id.*, Fig. 1.)

(b) “a portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, said portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates; and” (Claim 11[a])

146. It is my opinion that claim 11[a] is identical to claim 1[p] above. For the reasons discussed under claim 1[p], claim 11[a] is disclosed or rendered obvious by Keirinbou. The components of claim 11[a] would have been part of the battery charging system, as explained for the preamble.

(c) “a battery charger comprising” (Claim 11[b])

147. Keirinbou discloses “a battery charger.” For example, Keirinbou introduces the claimed invention as “a charger for portable devices, more specifically to a charger for portable devices, such as mobile phone devices, which use built-in secondary batteries as an operating power source.” (Keirinbou, [0001] (emphasis added).) Keirinbou further goes on to clarify that “this invention relates to a charger for portable devices that can be used for portable devices in general, which operate by charging the built-in secondary battery, such as mobile phone devices”. (*Id.*, [0002] (emphasis added).) Keirinbou discloses claim 11[b].

(d) “a charging circuit, and” (Claim 11[c])

148. Claim 11[c] is identical to claim 1[a] above. For the reasons discussed

under claim 1[a], claim 11[c] is disclosed or rendered obvious by Keirinbou.

- (e) “a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 11[d])

149. Claim 11[d] is identical to claim 1[b] above. For the reasons discussed under claim 1[b], claim 11[d] is disclosed or rendered obvious by Keirinbou, alone or in combination with Gaza.

9. Dependent Claims 12-17

150. Dependent claims 12-17 are substantially identical to claims 2-7, respectively, except that they depend directly or indirectly from claim 11 instead of claim 1. For the reasons stated above, these claims are obvious over the prior art.

10. Independent Claim 18

151. For reference, claim 18 recites:

18[p] A battery charging method for a rechargeable battery carried by a portable wireless communications device the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different battery types having respective charging rates, the method

comprising:

18[a] coupling a charging circuit to the portable wireless communications device to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and causing the charging circuit to charge the rechargeable battery based on the respective charging rate thereof.

(’397, 14:20-34 (Claim 18; bracketed notation (e.g., [a]) added).)

(a) “A battery charging method for a rechargeable battery carried by a portable wireless communications device the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different battery types having respective charging rates, the method comprising:” (Claim 18[p])

152. Claim 18[p] is substantially identical to claim 1[p] except in method claim form. For all the reasons explained under claim 1[p] above, claim 18[p] is disclosed or rendered obvious.

- (b) **“coupling a charging circuit to the portable wireless communications device to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and causing the charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 18[a])**

153. It is my opinion that claim 18[a] is substantially similar to claims 1[a] and 1[b] except for the distinction that claim 18[a] is a method claim and further discloses **“coupling a charging circuit to the portable wireless communications device.”** In my opinion, this is a distinction without patentable significance, as Figure 1 of Keirinbou shows the charging control circuit 32 (**“a charging circuit”**) coupled to the mobile phone device 1 (**“the portable wireless communications device”**) through connector 2. (Keirinbou, Fig. 1.) Keirinbou further discloses that if the controller determines that charging is necessary, “it sets the optimal voltage value and current value for charging the battery in the charging control circuit 32, sets a necessary and sufficient charging time, and executes the charging until the time elapses (steps S4, S5, S6).” (*Id.*, [0013].) It therefore would have been obvious and apparent that the charging circuit in Keirinbou was coupled to the portable communications device, as this would have been necessary in order to allow charging of the secondary battery in the mobile phone. For all of the other reasons explained under claims 1[a] and 1[b] above, claim 18[a] is disclosed or rendered

obvious by the prior art.

11. Dependent Claims 19-22

154. Claims 19-22 are substantially identical to claims 2-4 and 7, respectively, except that they depend directly or indirectly from independent claim 18 instead of independent claim 1. For the reasons explained above, these claims are obvious over the prior art.

B. Ground 2: Claims 8-10 Are Obvious Over Keirinbou in view of Gaza and Oler

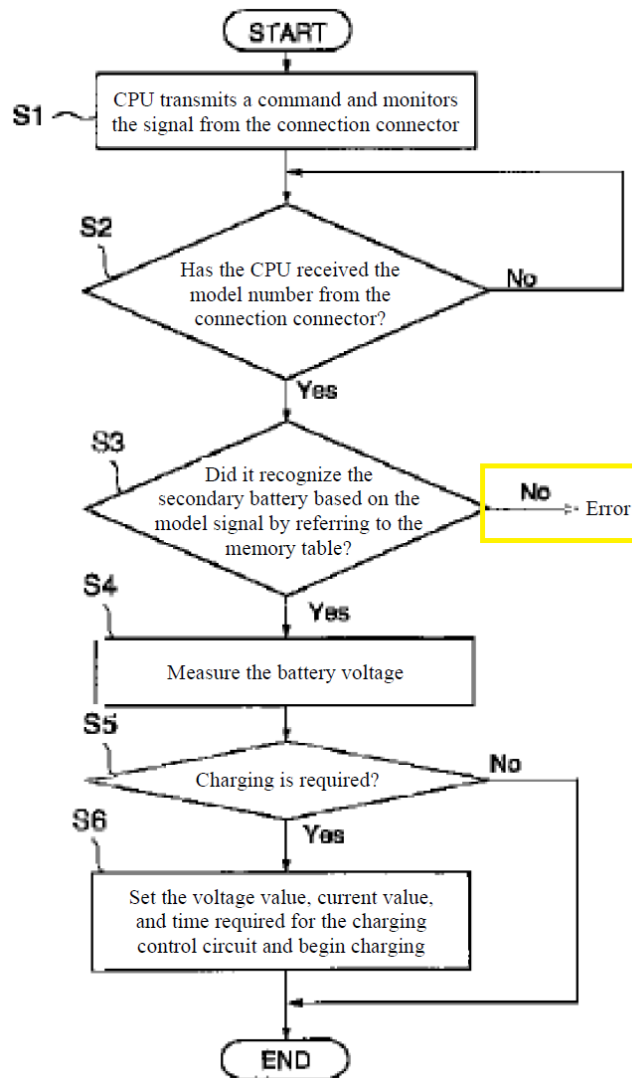
1. Dependent Claim 8

155. For reference, claim 8 recites:

8. The battery charger of claim 1 wherein said controller is configured to further provide an error signal to the portable wireless communications device based upon an unknown portable device type or rechargeable battery type.

(’397, 13:13-16 (Claim 8).) This claim is obvious based on the prior art for Ground 1 (Keirinbou and Gaza), in further view of Oler.

156. Keirinbou discloses that the controller is configured to provide an error signal in the event of an unknown portable device type or rechargeable battery type. This is shown in Step S3 of Figure 2, shown below:



(Keirinbou, Fig. 2 (emphasis added).) As shown at Step S3 above, if the controller (CPU 33) does not recognize the secondary battery based on the model signal provided by the portable wireless device, it signals an error. Keirinbou therefore discloses that “**said controller is configured to further provide an error signal... based upon an unknown portable device type or rechargeable battery type.**”

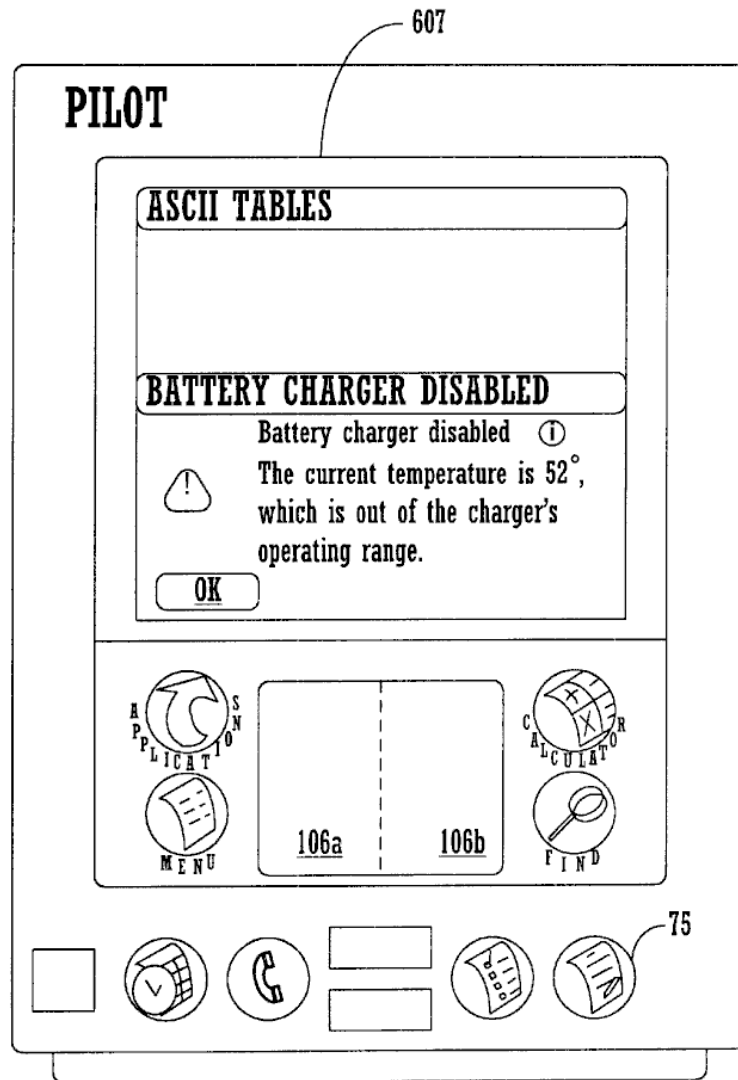
157. Claim 8 further requires that the error signal be provided “**to the**

portable wireless communications device,” but Keirinbou does not expressly state where the error generated in Step S3 is provided. It nevertheless would have been obvious to provide this error signal to the portable wireless communications device, as explained below, in order to allow the portable wireless device to act upon the error such as by displaying an appropriate error message.

158. The requirement that the error signal be provided to the portable wireless communications device would also have been obvious in view of Oler, which describes a technique for extending the battery life of a rechargeable battery “by preventing charging when the battery’s temperature is out of an acceptable range.” (Oler, 1:7-11.) Oler explains that “significant problems occur if a battery is charged outside of a suitable temperature range,” such as reducing the number of charge/discharge cycles and possibly damaging the battery. (*Id.*, 1:14-23.) Oler purports to address these problems by disclosing a method and system for preventing a battery from charging when its temperature is outside a predetermined range. (*Id.*, *e.g.*, 3:22-27.) Oler describes an embodiment that monitors the charging of the battery of a personal digital assist (PDA) device, but Oler explains that the disclosed technique “is well-suited to operating with other electronic devices, for example, cell phones, pagers, web browser, etc.” (*Id.*, 4:8-13; *see also id.*, 4:30-32 (“The PDA 100 can be a palm top (‘palm-sized’) portable computer system, an intelligent

cellular phone, or the like.”).)

159. In one embodiment, battery temperature data is collected and checked to see if it falls within an acceptable range. (Oler, Fig. 8 (Steps 805, 808, 810), 7:49-65.) If the temperature falls outside the acceptable range, battery charging is disabled and a message is provided to the display of the device notifying the user of the error. (*Id.*, Fig. 8 (Steps 815, 820), 7:66-8:11.) Figure 6A shows an exemplary message 607 shown on the screen of the device indicating that the temperature falls outside the acceptable range:



(*Id.*, Fig. 6A, 6:22-25.) Oler explains that its invention “is well-suited to displaying the warning in a variety of formats, such as a graphical display (e.g. thermometer), alphabetical characters, etc.” (*Id.*, 6:25-28.) Oler therefore discloses providing an error signal to a portable wireless communications device, which in this case, is used by the device to display an appropriate error message to the user.

160. ***Rationale and Motivation to Combine (Keirinbou and Gaza, with Oler)***: It would have been obvious to combine with Oler, resulting in the charging system according to the teachings of Keirinbou and Gaza, further adapted to provide an error signal to the portable wireless communications device of Keirinbou, based upon an unknown portable device type or rechargeable battery type. For example, when the controller of Keirinbou determines (during Step S3 in Figure 2) that the secondary battery is unrecognized, the error signal would have been provided to the portable wireless communications device under the teachings of Oler. Although not required by claim 8, it would have been obvious for the portable device to have presented a warning or error messaging advising the user that the battery is not being charged because it is unrecognized.

161. As explained for **Ground 1**, Keirinbou and Gaza are analogous references, and so is Oler. As noted, the '397 patent describes its "Field of the Invention" as relating "to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods." ('397, 1:20-22.) Oler is thus in the same field of endeavor as the '397 patent as it describes battery charging techniques for portable devices such as PDAs and cellular phones. Oler references would also have been reasonably pertinent to various problems facing the '397 patent inventors, including how to design and implement

a battery charging system that provides an error message to the portable wireless device, for example, for display to the user.

162. A person of ordinary skill in the art would have had a clear motivation to combine to provide the error message of Keirinbou to the portable wireless communication device – to allow the portable device to notify the user of the fact that the secondary batter was not charging and the reason (*i.e.*, the secondary battery was not recognized), for example by displaying an appropriate error or warning message on the display of the portable device as disclosed in Oler. (Oler, Fig. 6A.) It was well-known that conventional battery chargers (such as the one described in Gaza) often indicated charging errors by using colored and/or flashing LEDs. (Gaza, 5:21-24.) LEDs may have signaled to a user that *something* was wrong, but they often left the user guessing as to the precise cause of the problem. By configuring the controller of Keirinbou to provide the error signal *to the portable wireless communication device*, that device would have been enabled to use its display to present a clear textual message to the user alerting them to the nature of the problem (such as “Battery Unrecognized – Not Charging”). This, in turn, would have notified the user of the fact that the battery was not charging and the reason why the secondary battery was not being charged. Without this message, the user might erroneously conclude that the battery in their portable wireless device is charging,

only to be surprised later to find that the battery was not charged at all and is now completely discharged.

163. I note that the error message displayed in Oler alerts the user to the fact that the battery is not being charged because of battery *temperature*, whereas in Keirinbou the error arises from the fact that the secondary battery is not recognized. But this distinction presents no obstacle to the proposed combination because, for purposes of claim 8, I am relying on Oler for its more general teaching of providing an error signal to a portable wireless device to enable it to display a battery charging error message to the user, which in turn provides a motivation to adapt the controller of Keirinbou to provide its error signal to the mobile phone device. A person of ordinary skill in the art would have understood that the benefit of sending an error signal to the portable wireless device would have applied to all manner of charging errors. For example, in addition to the combination I described above to notify the user of the error signal from the secondary battery not being recognized in Keirinbou, a person of ordinary skill in the art could have also added an error signal to Keirinbou after step S6 to check for battery temperature and send an additional error signal to the mobile device. Although not required for Claim 8, the skilled person would recognize that adding the additional error signal for temperature would even further improve the reliability and safety of Keirinbou.

164. A person of ordinary skill in the art would also have had a reasonable expectation of success. As explained for **Ground 1**, the ability for portable wireless communication devices to exchange information with charging devices was well-known. For example, smart battery implementations that were well-known by the late 1990s commonly utilized the SMBus, a well-known bus for transferring information between devices. The ability to send an error message to the portable wireless communication device, therefore, would have been a trivial implementation detail well within the capabilities of a skilled artisan.

2. Dependent Claim 9

165. For reference, claim 9 recites:

9. The battery charger of claim 1 wherein said controller is configured to monitor said charging circuit to detect a charging error during charging of the rechargeable battery.

(’397, 13:17-19 (Claim 9).)

166. Under the proposed combination of Keirinbou and Gaza, in further view of Oler, it would have been obvious to adapt the controller of Keirinbou to **“monitor said charging circuit to detect a charging error during charging of the rechargeable battery.”** This limitation is independently disclosed by both Gaza and Oler. For example, Gaza discloses a technique of monitoring the temperature of

nickel-based batteries during rapid charging and, if the temperature exceeds a maximum value, the charger falls back to a trickle charge mode. (Gaza, *e.g.*, 12:38-44 (“[T]he temperature cut-off is determined in step 226 [of Figure 9C]. The system next checks in step 228 to determine if the battery temperature BATT TEMP is greater than the maximum temperature TEMP MAX. If so, the system goes to the trickle charge state NICK_TRICKLE_INIT in step 230.”).) The term “trickle charge” in this context refers to a technique of providing a smaller amount of current to slowly recharge the battery, generating less heat. Under the proposed combination of Keirinbou and Gaza, therefore, the controller in Keirinbou would have been **“configured to monitor said charging circuit to detect a charging error during charging of the rechargeable battery,”** *i.e.*, the battery temperature exceeding a maximum value unsuitable for rapid charging of a nickel-based battery. Although claim 9 does not require that the controller take any action based on the charging error, in the case of Gaza, it would have been obvious for the controller to have responded by falling back to a trickle charge mode to reduce the amount of heat being generated during the charging process.

167. Although not required to satisfy claim 9, this claim is also separately rendered obvious under the further combination with Oler which discloses a similar feature for monitoring temperature. As explained, Oler discloses monitoring

charging to determine if the battery temperature falls outside a predetermined range, and if so, treats this event as a charging error and requiring cessation of further battery charging. (Oler, 7:57-8:5 (“In step 810 [Figure 8], a controller **701** determines whether the temperature is within an acceptable range... In one embodiment, the upper limit is 45 degrees Celsius and the lower limit is zero degrees Celsius... If the temperature is outside of an acceptable range, the process **800** disables the battery charging device **704**, in step 815. However, the battery **215** remains electrically connected to the PDA **100** so that it may be powered. The battery charger **704** may be disabled in any suitable fashion, for example, by not sending a signal which enables the battery charging device **704**.”) (emphasis added).) Under the proposed combination of Keirinbou and Gaza with Oler, therefore, it would have been obvious for the controller in Keirinbou to have been **“configured to monitor said charging circuit to detect a charging error during charging of the rechargeable battery,”** *i.e.*, the battery temperature falling outside a predetermined range, to which the controller could have responded by ceasing further battery charging.

168. I note that although Gaza already discloses a similar technique to fallback to trickle charging for nickel-based batteries based on higher temperatures, and although not required by the claim, a person of ordinary skill in the art would

still have been motivated to also include both the Gaza and Oler techniques to beneficially safeguard against *more extreme* temperatures that may have made any continued charging dangerous or ineffective, even when using lower energy trickle charging techniques. For example, in the event the battery reached a temperature that made even trickle charging inappropriate, under the techniques in Oler, all charging could have been stopped until the temperature fell to an acceptable level.

3. Dependent Claim 10

169. For reference, claim 10 recites:

10. The battery charger of claim 9 further comprising an indicator connected to said controller and configured to provide an error indication upon detecting the at least one charging error.

(’397, 13:20-23 (Claim 10).)

170. The proposed combination renders this limitation obvious under two separate and independent theories, one relying on Gaza and the other relying on the further combination with Oler. First, under the combination of Keirinbou and Gaza, as explained for claim 9, in one example the “**charging error**” in Gaza indicates that the battery temperature exceeds a maximum value. Gaza discloses a plurality of light-emitting diodes (LEDs), of red, yellow, and green colors, to “provide the status of the charging system.” (Gaza, 5:21-25.) In one embodiment, “the yellow LEDs

are flashed at a 2 Hz rate to indicate that the measured battery temperature, either for the front **24** or rear pocket **26**, is out of the proper temperature operating range.” (*Id.*, 9:48-54.) Gaza therefore renders obvious an “**indicator**” in the form of one or more LEDs that, under the proposed combination, would have been included as part of the Keirinbou charger. An ordinarily skilled artisan would have been motivated to provide LED indicators on the charger of Keirinbou to provide a visual indicator of the status of the charging system. Under the proposed combination, therefore, it would have been obvious for the battery charger of Keirinbou to comprise LEDs that provide an “**error indication**” that the charging error has occurred, in this case, that the battery temperature fell outside of the acceptable range.

171. As a second and independent basis for rendering obvious this claim, it would have been obvious based on the further combination with Oler to provide an “**error indication**” in the form of a message displayed on the screen of the portable wireless device, as fully explained for claim 8. (Oler, Fig. 6A.) Under this second basis, the “**indicator**” takes the form of the display on the portable wireless device, which is “**connected to said controller**” because the controller under the proposed combination would have been capable of transmitting the error signal to the portable wireless device to enable the device to display the error to the user, as explained in my discussion of claim 8. (*Id.*)

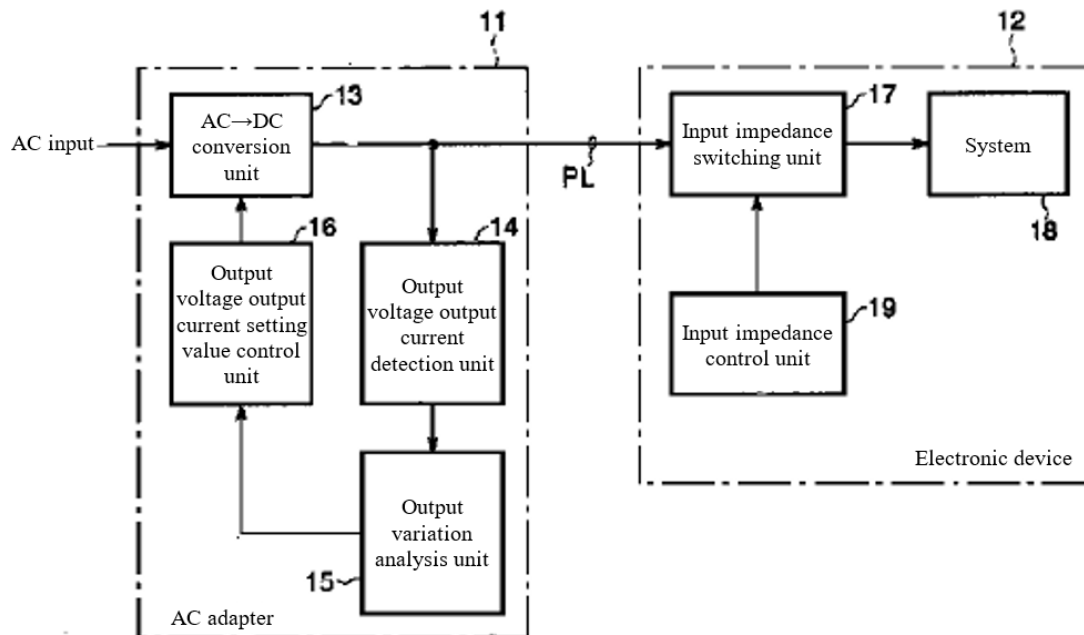
C. Ground 3: Claims 1-3, 5-7, 11-13, 15-20, 22 Are Obvious Over Tanaka in view of Potega

1. Independent claim 1

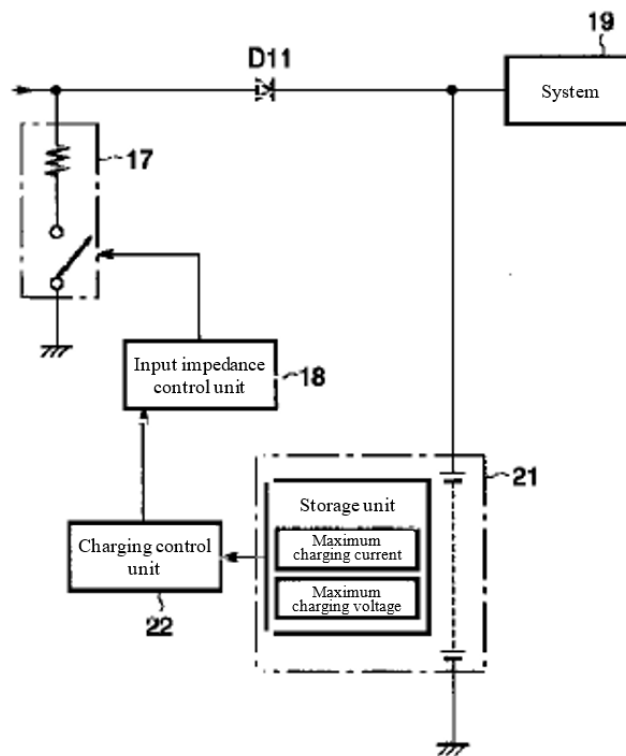
- (a) **“A battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates, the battery charger comprising:”**
(Claim 1[p])

172. To the extent the preamble is limiting, claim 1[p] is disclosed or rendered obvious by Tanaka. Tanaka discloses **“a battery charger for a portable wireless communications device, the portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto”**. For example, Tanaka discloses an AC adapter power source coupled to “the electronic device main body 12 [] provided with a secondary battery[.]” (Tanaka, [0056].) Figures 1 and 5, reproduced below, are representative:

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(*Id.*, Fig. 1.)



(*Id.*, Fig. 5.)

173. Figure 5 represents the “electronic device main body 12” depicted in Figure 1. While Tanaka does not disclose a wireless communications transceiver coupled to the rechargeable battery, a person of ordinary skill in the art would have understood that an “electronic device main body” encompasses a wide variety of devices that contain wireless communications transceivers. For example, Tanaka gives a “portable personal computer” as an example of an electronic device. (Tanaka, [0002], [0006], [0014].) A person of ordinary skill in the art would have been aware that portable personal computers at the time (such as laptop computers) included wireless communications transceivers, for example Wi-Fi (IEEE 802.11) transceivers for connecting to wireless networks. (*See Microsoft Computer Dictionary* (5th ed. 2002) (**EX1013**), p.007 (“**IEEE 802.11** *n.* The Institute for Electrical and Electronics Engineers’ (IEEE) specifications for wireless networking. These specifications... allow computers, printers, and other devices to communicate over a wireless local area network (LAN).”) (bold and italics in original).) Accordingly, a person of ordinary skill in the art would have found it obvious that the portable personal computer in Tanaka would have been a portable wireless communications device that includes a wireless communications transceiver coupled to a rechargeable battery.

174. Tanaka further discloses “**the portable wireless communications**

device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types.”

The '397 patent provides that battery types include “Li or Ni-MH” but also notes that “device and battery ‘types’ may vary depending upon a given implementation of the present invention. For example, in some applications, device/battery types may be respective models of portable devices/batteries. However, in other applications, the device/battery types may correspond to a particular series of portable devices/batteries.” ('397, 1:57-58, 5:39-47.)

175. It would have been obvious based on Tanaka that different devices would have had different device types and different batteries would have had different battery types. For example, in describing the prior art, Tanaka discloses that conventionally, dedicated AC adapter power supplies were required “for each model and furthermore for each type of built-in secondary battery, and therefore there has existed the problem that a dedicated AC adapter had to be made available for each type of device or each type of secondary battery.” (Tanaka, [0006] (emphasis added); *see also id.*, [0002] (“Conventionally, in electronic devices operable by an AC adapter power source such as portable personal computers, dedicated AC adapters having unique standards were required for each model and

furthermore for each type of built-in secondary battery.”) (emphasis added).) In purporting to address this issue, Tanaka discloses “a stable operating power source [] in accordance with the device specifications to multiple types of devices having different power output specifications.” (*Id.*, [0011] (emphasis added).) Tanaka therefore renders obvious that the portable wireless communications device has a **“portable device type”** associated therewith, **“from among a plurality of different portable device types,”** such as different types and models of portable personal computers.

176. Tanaka also renders obvious that the battery in the portable device has a **“rechargeable battery type associated therewith from among a plurality of ... different rechargeable battery types,”** as recited. As explained, Tanaka discloses “different power input specifications” which would have indicated different types of built-in secondary batteries. This is reinforced by Tanaka’s disclosure of various specification numbers corresponding to various current limits one of which is a current limit “for constant current charging of the secondary battery[.]” (*See* Tanaka [0043], Fig. 9.)

177. To the extent this limitation is not disclosed by Tanaka alone, it would have been obvious to one of ordinary skill in the art in view of Potega. Potega discusses the prevalence of numerous battery types (i.e., battery chemistries) and

device types (i.e., phones or laptops and/or their respective models). For example, Potega discloses that there are “many combinations of cells which can be put together to create a battery pack, as well as slightly different voltages from the various types of battery cell chemistries”. (Potega, 1:35-39.) Common battery chemistries include “NiCad and NiMH batteries” which “charge by drawing current” and “L-Ion cells” which “are charged by well-controlled voltage increases.” (*Id.*, 19:1-3 (emphasis added).) Potega additionally discloses the wide variety of device types. Indeed, Potega recognizes that manufacturers continue to build “more and more variants of its electronic products” with as many as “15 new models of [] mobile computers” being released in a year. (*Id.*, 1:54-60 (emphasis added).) Other device types include “tape recorders, video game players, audio CD players” and “home and office phones, toys and entertainment devices, etc., which have been manufactured to operate at specific multiple-battery-cell voltages” such as “20.5 VDC if supplied device 12 were a laptop computer.” (*Id.*, 3:24-25, 3:46-48, 13:17-18.) As I will explain below in my discussion of claim 1[b] below, Tanaka and Potega are analogous references to the ’397 patent.

178. One of ordinary skill in the art would have been motivated to combine the teachings of Potega with Tanaka because both references recognize and purport to solve the same problem and discuss the variety of device and battery types in the

context of that problem. For example, Tanaka recognizes that previously, “dedicated AC adapters having unique standards were required for each model and furthermore for each type of built-in secondary battery.” (Tanaka, [0002].) Similarly, Potega recognizes that a “dedicated power supply model creates a series of problems.” (Potega, 1:53-54.) Accordingly, this limitation would have been rendered obvious over Tanaka in view of Potega.

179. Turning to the remainder of the preamble, Tanaka discloses “**different rechargeable battery types having respective charging rates.**” As discussed above, I understand from counsel that Petitioner and Patent Owner currently dispute the construction of “charging rate” in the co-pending district court litigation. Petitioner contends that the “charging rate” is defined as “the current expressed in amperes at which a battery is charged.” Patent Owner contends that “no construction” is necessary. It is my opinion that Tanaka discloses “**different rechargeable battery types having respective charging rates**” as understood under either construction. For example, as discussed above, one of ordinary skill in the art would have understood that “different power input specifications” suggests that different device types contain different types of built-in secondary batteries because the input specifications include two current limits – a current limit for preventing an overcurrent and a current limit for charging a secondary battery with

a constant current (i.e., the battery charging rate) – and a voltage specification. (Tanaka, [0011], [0043].) Figure 9, reproduced below, depicts four different input specifications, i.e., four different combinations of device and battery types.

Specification No.	Output voltage [V]	Output current limit value 1 [A]	Output current limit value 2 [A]
Specification 1	15	2.0	1.4
Specification 2	15	2.7	2.0
Specification 3	18	1.7	1.1
Specification 4	18	2.3	1.7

[FIGURE 9]

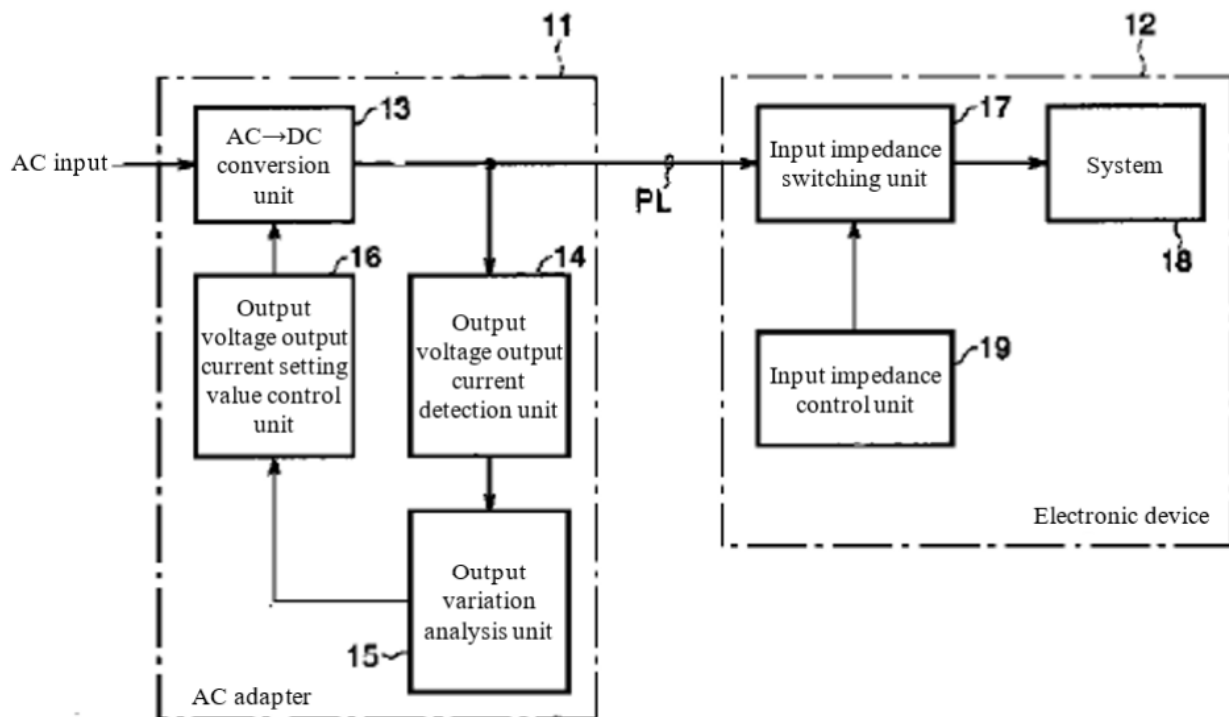
(*Id.*, Fig. 9.) As shown in Figure 9, each specification (i.e., device and battery type) has a corresponding output voltage, output current limit value 1, and output current limit value 2. Thus, it is my opinion that Tanaka discloses “**different rechargeable battery types having respective charging rates.**”

180. To the extent the preamble requires different portable device types to have a respective “**charging rate**”, it is my opinion that Tanaka discloses such. Tanaka discusses that “multiple types of devices hav[e] different power input specifications,” one of which includes current limit value (1) for preventing an overcurrent. (*See* Tanaka, [0011], [0043].) While Tanaka discloses that current limit value (2) corresponds to the “constant current charging of the secondary battery when the electronic device main body 12 is provided with a secondary battery”, it provides no such condition for current limit value (1). (*Id.*, [0043] (emphasis added).) Thus, it is my opinion that current limit (1) may be used irrespective of the

existence of a secondary battery in the device. In other words, current limit value (1) must correspond to the device. Accordingly, it is my opinion that current limit value (1) for preventing an overcurrent is the “**charging rate**” for a portable device type.

(a) “a charging circuit; and” (Claim 1[a])

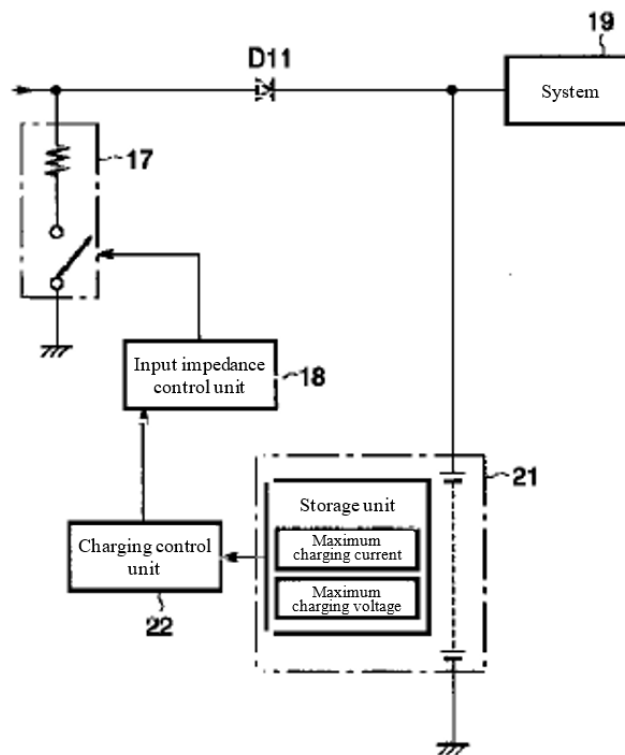
181. Tanaka discloses “a charging circuit.” Specifically, Tanaka discloses an AC adapter containing an “AC→DC conversion unit that converts external commercial AC power to DC power[.]” (Tanaka, [0017].) Figure 1, reproduced below, is representative:



[FIGURE 1]

(*Id.*, Fig. 1.) Reference numeral 11 represents an AC adapter containing the AC-DC

conversion unit 13. Once the AC-DC conversion unit converts the AC power into DC power, the DC power is “supplied to the electronic device main body 12 via the power output line (PL).” (*Id.*, [0021].) Electronic apparatus main body 12 contains secondary battery 21 that is charged by the AC adapter. Figure 5 depicts secondary battery 21 in electronic apparatus main body 12:



(*Id.*, Fig. 5.) Accordingly, it is my opinion that Tanaka discloses a “**charging circuit**”.

(b) **“a controller coupled to said charging circuit and configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 1[b])**

182. Tanaka discloses **“a controller coupled to said charging circuit.”** The output voltage / output current setting value control unit 16, shown in Figure 1 reproduced above, discloses the claimed **“controller”**.

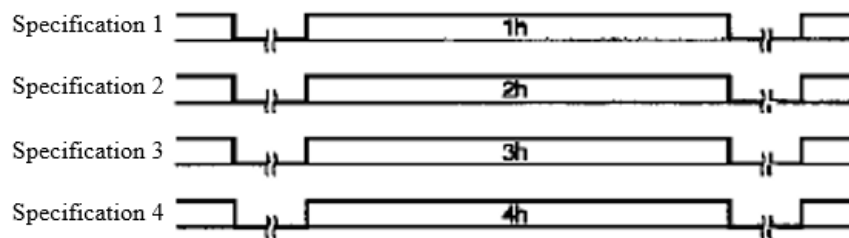
183. As discussed, Figure 1 depicts an AC adapter containing an AC-DC conversion unit 13, output voltage / output current detection unit 14, output variation analysis unit 15, and output voltage / output current setting value control unit 16. (See Tanaka, Fig. 1.) Output voltage / output current detection unit 14 detects the output impedance variation on the power output line (PL) where the variation analysis unit 15 determines the type of identification data (i.e., in the form of digital data, period data, or duty data) and the data content (i.e., the specification number as depicted in Figure 9). Output voltage / output current setting value control unit 16 then sets the values of the output voltage and output current according to the analysis and recognition of the specification number by output variation analysis unit 15. (See *id.*, [0017].) Figure 1 depicts the AC to DC conversion unit 13 tied to the output voltage / output current setting value control unit 16 with a line connecting the two.

It is thus my opinion that Tanaka discloses a “**controller coupled to said charging circuit**”.

184. Tanaka discloses a controller “**configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type.**” The ’397 patent notes that “[v]arious approaches may be used for causing the portable device 21 to identify its battery and device types.” (’397, 5:56-57.) For example, by placing a logic high signal on differential D+ and D- data lines upon first connection, a portable device could recognize that a charger is connected and send back its identification information. (*Id.*, 6:14-22.)

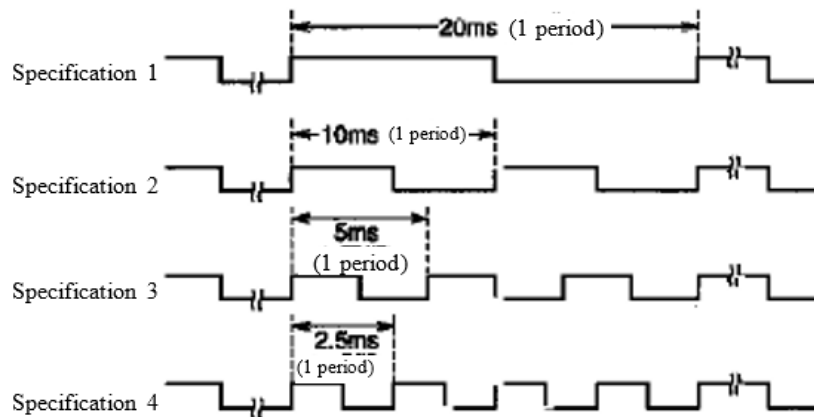
185. A similar method is disclosed in Tanaka. When the AC adapter is connected to the electronic device, it outputs power in a lower range (for example, a constant voltage of 5V or 6V) on the power output line (PL) under a “device specification recognition mode”. (Tanaka, [0020].) When the electronic device, specifically the “input impedance control unit 19 recognizes that power for information exchange at a predetermined low voltage is supplied on the power output line (PL), the input impedance switching unit 17 is switched (on/off) according to the power input specifications of the device itself[.]” (*Id.*, [0023].) In other words, through the opening and closing of the input impedance switch on the

device, the input impedance of the output power line (PL) is varied and information regarding the specifications of the device and battery are conveyed to the AC adapter. Figures 10, 11, and 12, reproduced below, depict the transmission of four different specifications (device/battery type) under three types of identification data (digital data / period data / duty data):



[FIGURE 10]

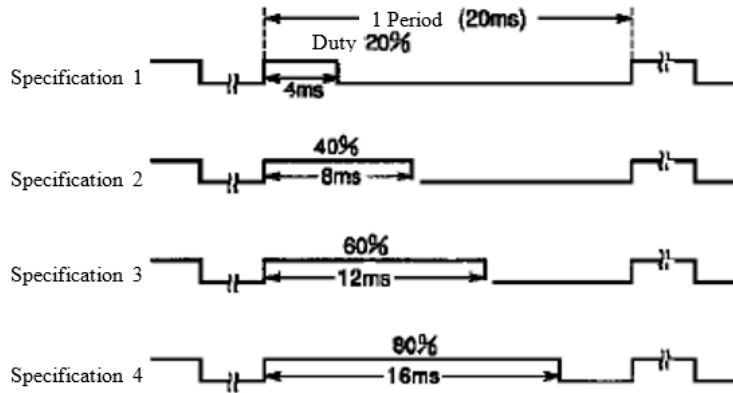
(*Id.*, Fig. 10.)



[FIGURE 11]

(*Id.*, Fig. 11.)

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[FIGURE 12]

(*Id.*, Fig. 12.) These specifications (device/battery type) are summarized in Figure 9, reproduced below:

Specification No.	Output voltage [V]	Output current limit value 1 [A]	Output current limit value 2 [A]
Specification 1	15	2.0	1.4
Specification 2	15	2.7	2.0
Specification 3	18	1.7	1.1
Specification 4	18	2.3	1.7

[FIGURE 9]

(*Id.*, Fig. 9.) It is my opinion that while Tanaka discloses only four separate specifications (device/battery type pairings), one of ordinary skill in the art would have understood that this could be applied to any number of device types and battery types under any possible combination of devices and batteries. While Tanaka does not explicitly disclose which component causes the AC adapter to enter this “device specification recognition mode,” a person of ordinary skill in the art would have found it obvious that the output voltage / output current setting value control unit 16 (i.e., the “controller”) would have been responsible for setting the output power in

the 5V range as it is the main component that sets the output on the power output line (PL). Accordingly, Tanaka discloses a controller “**configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type.**” This is because, as shown above, the portable wireless communications device identifies output voltage and current values that correspond to “multiple types of devices having different power input specifications” (*id.*, [0008], [0011], [0079]), thus providing an identification for both the portable device and rechargeable battery.

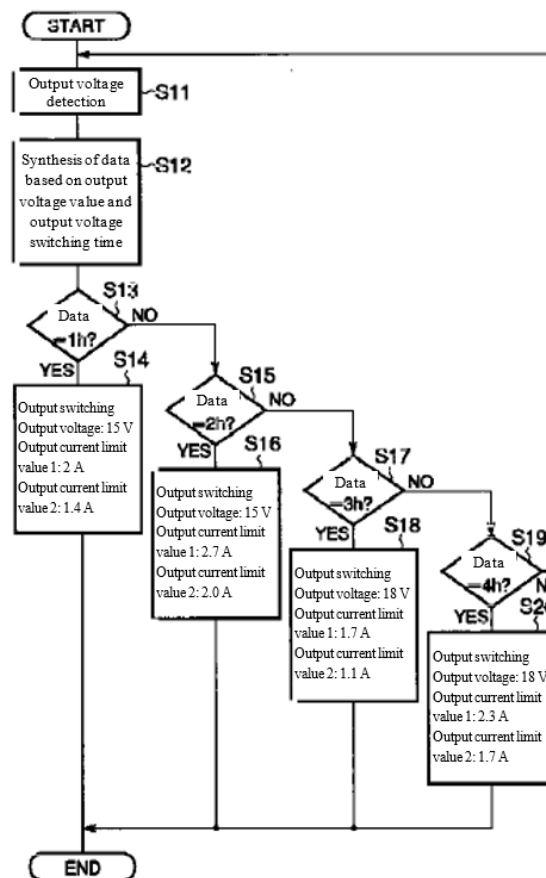
186. To the extent the claim requires the separate transmission of device type and battery type information, it is my opinion that it would have been obvious to a person of ordinary skill in the art in view of Potega. For example, Potega recognizes that smart batteries allow a battery device to be able to provide “factory-loaded data about the battery, such as the manufacturer’s ‘design voltage,’ real-time actual output voltage, type of battery chemistry, date of manufacture, etc.” to a power supply. (Potega, 58:20-25 (emphasis added).) And that a device may have other tools, such as a BIOS, which can provide information about the device such as “details about the hardware configuration inside the device.” (*See id.*, 66:52-61). A person of ordinary skill in the art would have found it obvious that the hardware configuration in Potega may correspond to the make or model of the device or in

other words, a “device type.” Accordingly, a person of ordinary skill in the art would have found it obvious for a device to provide separate battery and device type identification information.

187. A person of ordinary skill in the art would have been motivated to combine the teachings of Tanaka with Potega to improve the effectiveness of an “AC adapter capable of realizing an automatic recognition function of device specifications and a matching function of output power source[.]” (Tanaka, [0009].) A person of ordinary skill in the art would have recognized under certain circumstances, the device and battery may not be tied together, especially when a user may substitute other batteries into that device. (*See* Potega, 29:47-50 (“This verification may not be valid for decision-making, since a significant number of gray-market battery packs are in the marketplace, according to Sanyo (San Diego, Calif.)”); *see also* U.S. Patent No. 6,242,893 to Freedman (**EX1015**), 3:60-65 (“Thus, many new batteries are replacements in device applications such as radios which have used a wide range of primary and secondary cell types over the years, with all such batteries being physically very similar, e.g., with the same case and the same connector.”).) By independently transmitting and identifying the battery type apart from the device type, it would have furthered Tanaka’s goal of disclosing an AC adapter capable of providing power to multiple types of devices and batteries in

a safe and effective manner.

188. A person of ordinary skill in the art would have had a reasonable expectation of success, and implementation of the proposed combination would have been straightforward as it would have involved the same methods disclosed in Tanaka. For example, Tanaka already discloses transmitting information from the device and battery to the charger as data through the input impedance control method, as shown in Fig. 6, reproduced below, for data comparisons at steps S13, S15, S17, and S19:



(Tanaka, Fig. 6.) It would have been obvious to a person of ordinary skill in the art to transmit the battery and device type data as taught by Potega using the input impedance control method already disclosed in Tanaka, especially given that Tanaka already shows that the data is stored in the electronic device. (*See id.*, Fig 5 (secondary battery 21 with “Storage unit” including “Maximum charging current” and “Maximum charging voltage”); *see also* Tanaka, [0058] (“the secondary battery 21 ... charging control unit 22 reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery 21 and sends this to the input impedance control unit 18.”).) A skilled artisan would have found the disclosures of Tanaka and Potega sufficiently detailed to implement the combination described above, without undue experimentation.

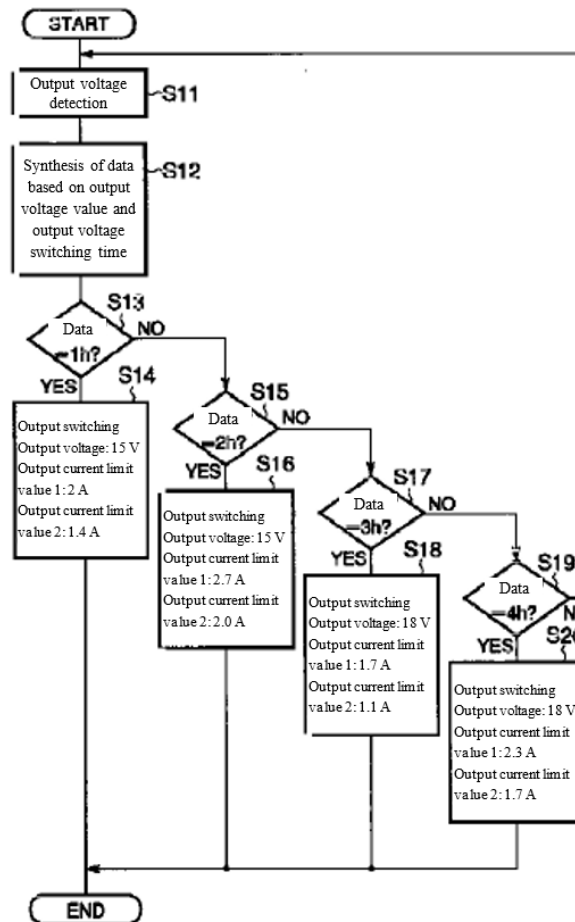
189. Further, Tanaka and Potega are analogous references to the '397 patent. The '397 patent explains that “[t]he present invention relates to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods.” ('397, 1:20-22.) Both Tanaka and Potega are directed to a power supply that can be used to power multiple types of devices and additionally charge rechargeable batteries contained within. (*See* Tanaka, Abstract (“The present invention provides an electronic device and an AC adapter capable of realizing an automatic device specification recognition function and an

output power source matching function, with which a stable operating power source can be continuously supplied in accordance with device specifications to multiple types of devices having different power input specifications”); *id.*, [0006] (“there has existed the problem that a dedicated AC adapter had to be made available for each type of device or each type of secondary battery.”); *see also* Potega, 1:8-13 (“This invention relates to a universal, ‘plug and play’ power supply. More particularly, the invention relates to a universal power supply that is able to deliver automatically the varied power requirements of multiple diverse devices attached to it and simultaneously and independently adjust the voltage or current or both supplied to each device.”); *id.*, 11:26-27 (“The power supply also serves as the power source for a battery charger in devices that use rechargeable batteries.”).) Tanaka and Potega would have been reasonably pertinent to problems facing the ’397 inventors in implementing various aspects of their invention such as allowing device and battery information to be sent independently.

190. Accordingly, Tanaka alone or in combination with Potega discloses and renders obvious a controller **“configured to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type.”**

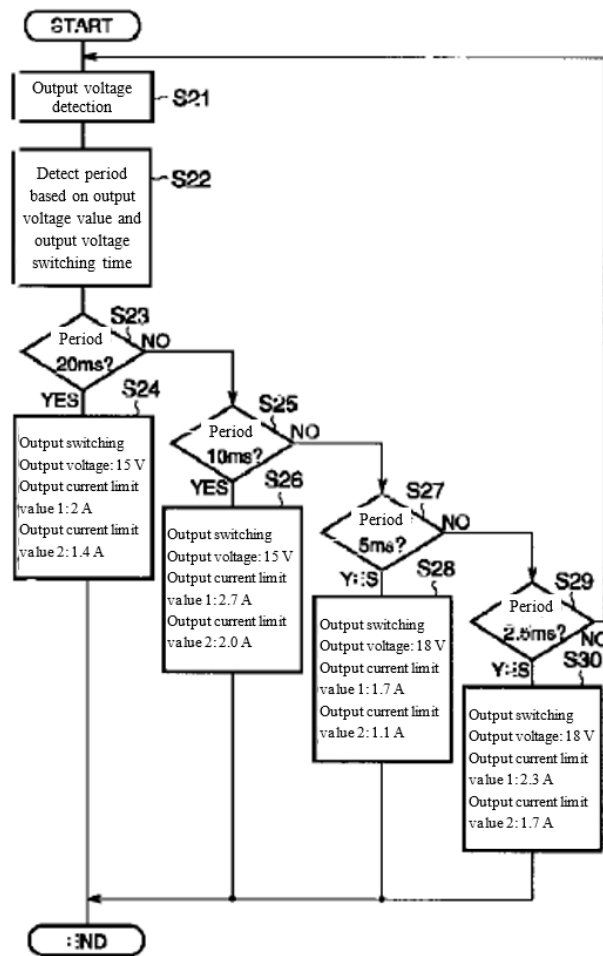
191. Once the device type and battery type have been identified, the

controller “**cause[s] said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.**” As outlined above, the input impedance control unit 19 in the electronic device sends the information regarding the specifications of the device over the power output line (PL) by varying the output impedance. The output voltage / output current detection unit 14 detects the output impedance variation on the power output line (PL) where the variation analysis unit 15 determines the specification number (the device/battery identification information) which contains the current limit of the device and battery. It is my opinion that these current limits correspond to the device and battery “**charging rates**” as understood under both Petitioner’s and Patent Owner’s proposed constructions in the co-pending district court litigation. The output voltage / output current setting value control unit 16 (i.e., the “**controller**”) then sets the values of the output voltage and output current according to the analysis and recognition of the specification number by variation analysis unit 15. In other words, the “**controller**” sets the output based on the device charging rates (output current limit 1 – for preventing an overcurrent) and battery charging rates (output current limit 2 – constant current charging of the battery) associated with the recognized specification (device/battery type). This process is exemplified under Figures 6, 7, and 8, reproduced below, which correspond to Figures 10, 11, and 12 shown above:



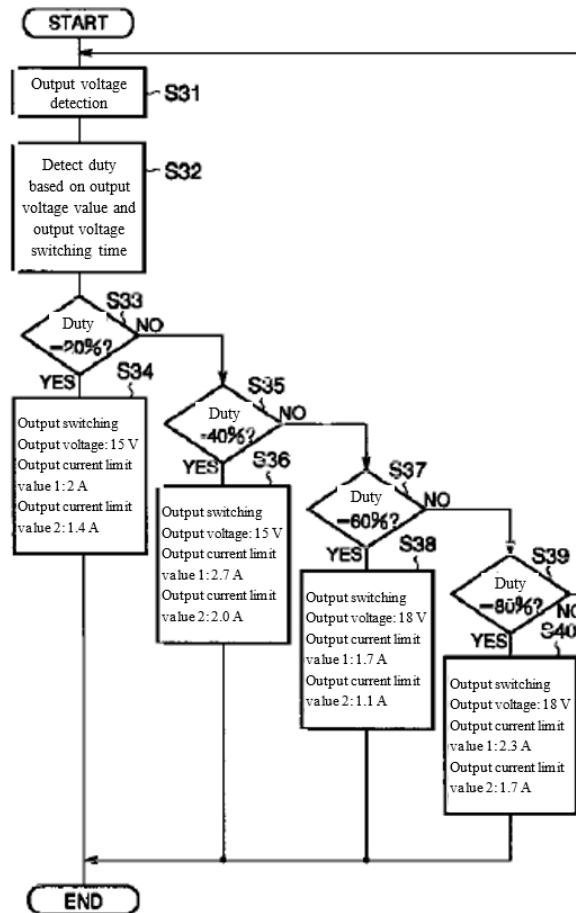
[FIGURE 6]

(Tanaka, Fig. 6.)



[FIGURE 7]

(*Id.*, Fig. 7.)



[FIGURE 8]

(*Id.*, Fig. 8.) In the output specification setting process shown in Figure 8, “the output voltage/output current setting value control unit 16 receives device input specification data” as outlined above in steps S31 and S32. (*Id.*, [0070].) The data content is then processed by the output variation analysis unit 15 in steps S33, S35, S37, and S39. If the duty cycle is 20%, output variation analysis unit 15 recognizes that device type and battery type of specification 1 was transmitted and accordingly recognizes that the output voltage is 15V, the output current limit value (1) is 2A,

and the output current limit value (2) is 1.4A as depicted in step S34. If the duty cycle was not 20% but rather 40%, output variation analysis unit 15 recognizes the output voltage is 15V, output current limit value (1) is 2.7A, and output current limit value (2) is 2.0A as depicted in step S36. As described above, these limits are then used by output voltage / output current setting value control unit 16 to control the AC-DC conversion unit 13 and charge the battery based on the limit values. (*See* Tanaka, [0038] (“the output voltage becomes the output voltage setting value”), [0042] (“As a result, the output voltage decreases by the amount of the current comparison data (ic). Specifically, when the output current value exceeds the current setting value, current limiting is applied and the output voltage changes.”).)

192. Accordingly, Tanaka discloses a controller that causes “**said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.**”

2. Dependent Claim 2

193. For reference, claim 2 recites:

2. The battery charger of claim 1 wherein different portable device types have at least one different portable device charging parameter; wherein different battery types have at least one different battery charging parameter; and wherein said controller is configured to select

at least one actual charging parameter to charge the rechargeable battery based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.

(’397, 12:48-56 (Claim 2).)

194. Tanaka discloses “**different portable device types have at least one different portable device charging parameter; wherein different battery types have at least one different battery charging parameter**”. As discussed above, Tanaka alone or in view of Potega, discloses different portable device types and different battery types and each have charging parameters. (See Tanaka, Fig. 9.) For example, “[w]hen the secondary battery 21 is charged with a constant current during power-off or sleep state of the system 19, the charging control unit 22 reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery 21 and sends this to the input impedance control unit 18. The input impedance control unit 18 determines the power input specifications of the electronic device main body 12 based on the maximum charging current and maximum charging voltage data, and according to the power input specifications, switches the switch of the impedance switching unit 17 by a predetermined variation means to vary the impedance on the power output line (PL)

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of the AC adapter 11. (*Id.*, [0058]-[0059] (emphasis added).) The maximum charging current is comprised of a “current limit value (1) for preventing [an] overcurrent”, and a “current limit value (2) for constant current charging of the secondary battery” with a constant current. (*Id.*, [0043].) It is my opinion the current limits correspond to the device charging parameter and the battery charging parameter respectively.

195. It is my opinion that the “maximum charging voltage” further identifies both a device charging parameter and a battery charging parameter. For example, the “maximum charging voltage” corresponds to the overvoltage limit (V) listed as one of multiple device charging parameters in Table 1 (reproduced below) of the ’397 patent:

TABLE 1		
Exemplary Device Charging Parameters		
Device Charging Parameter	Device Type #1	Device Type #2
Overvoltage limit (V)	6.0	5.25
Undervoltage limit (V)	4.0	4.8
Overcurrent limit (mA)	800	400
Constant current (mA)	750	350
Battery full (mA)	40	20
Battery full (V)	4.15	4.22

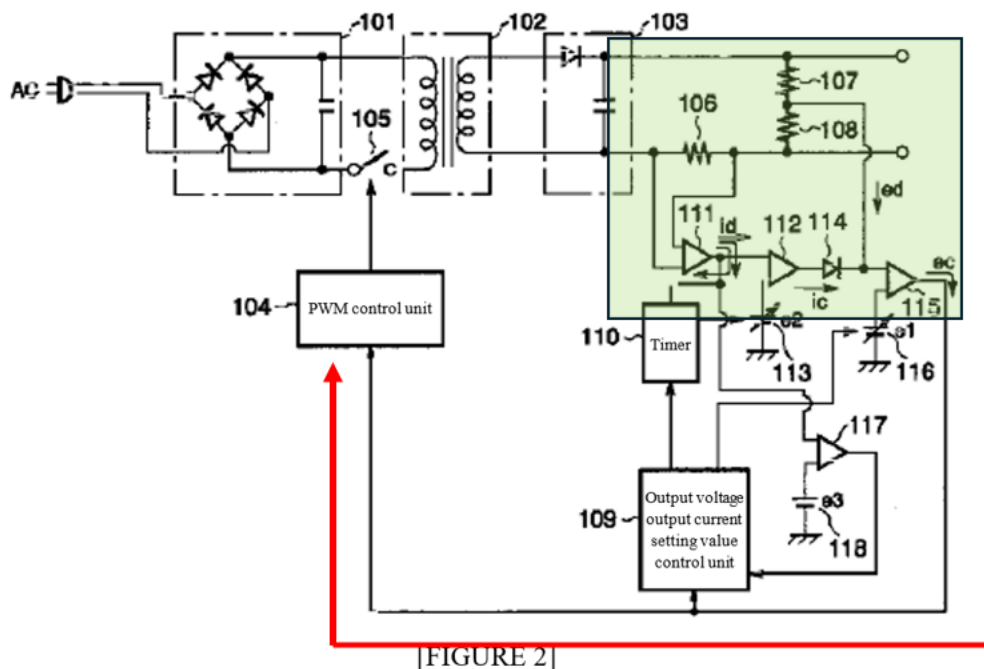
(’397, 7:9-20.) These values, such as overvoltage limit (V), are analogous to the “maximum charging voltage” in Tanaka, thus confirming that the maximum charging voltage in Tanaka qualifies as a portable device charging parameter. The

“maximum charging voltage” may also be a *battery* charging voltage for similar reasons, i.e., the “maximum charging voltage” relates to the maximum voltage allowable during the battery charging process. Indeed, Tanaka discloses that the “maximum charging voltage” may be read from the storage unit of the secondary battery, confirming that it qualifies as a battery charging parameter. (Tanaka, [0061].) Therefore, it is my opinion that the “maximum charging voltage” qualifies as a device charging parameter and/or a battery charging parameter.

196. Tanaka discloses or renders obvious **“and wherein said controller is configured to select at least one actual charging parameter to charge the rechargeable battery based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.”** As described above, Tanaka discloses both device and battery charging parameters, such as a maximum charging voltage, an overcurrent limit (as output current limit value 1), and a constant current parameter for charging the battery (as output current limit value 2), as shown in Fig. 6. These parameters are then communicated to the charger and its controller circuitry. I will now detail how the AC adapter handles the charging parameters in greater detail.

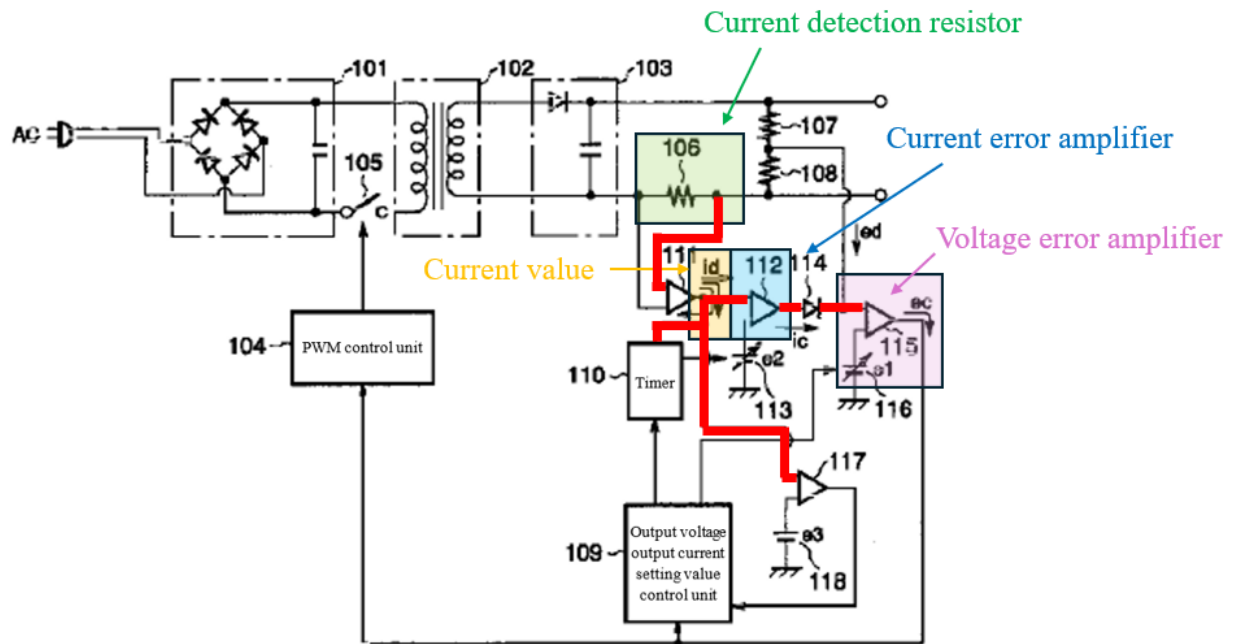
197. As the AC adapter begins to output power on the power output line (PL), “the output voltage and output current are detected by voltage dividing

resistors 107 and 108, a current detection resistor 106, a voltage error amplifier 115, a current error amplifier 112, etc., included in the output voltage/output current detection unit 14 shown in Figure 1, and the detected values are sent (fed back) to the PWM control unit 104." (Tanaka, [0030] (emphasis added).)



(*Id.*, Fig. 2 (colored annotations and highlighting added).)

198. Specifically, the output current is detected by “amplifying the voltage across the current detection resistor 106 by an amplifier 111, and inputting the current value (i_d) to the current error amplifier 112, comparator 117, and timer 110.” (Tanaka, [0033].) This current value (i_d) is then compared to a reference voltage (e_2) (113) to obtain a current comparison data (i_c) which is fed into a voltage amplifier 115. (*Id.*, [0034].)



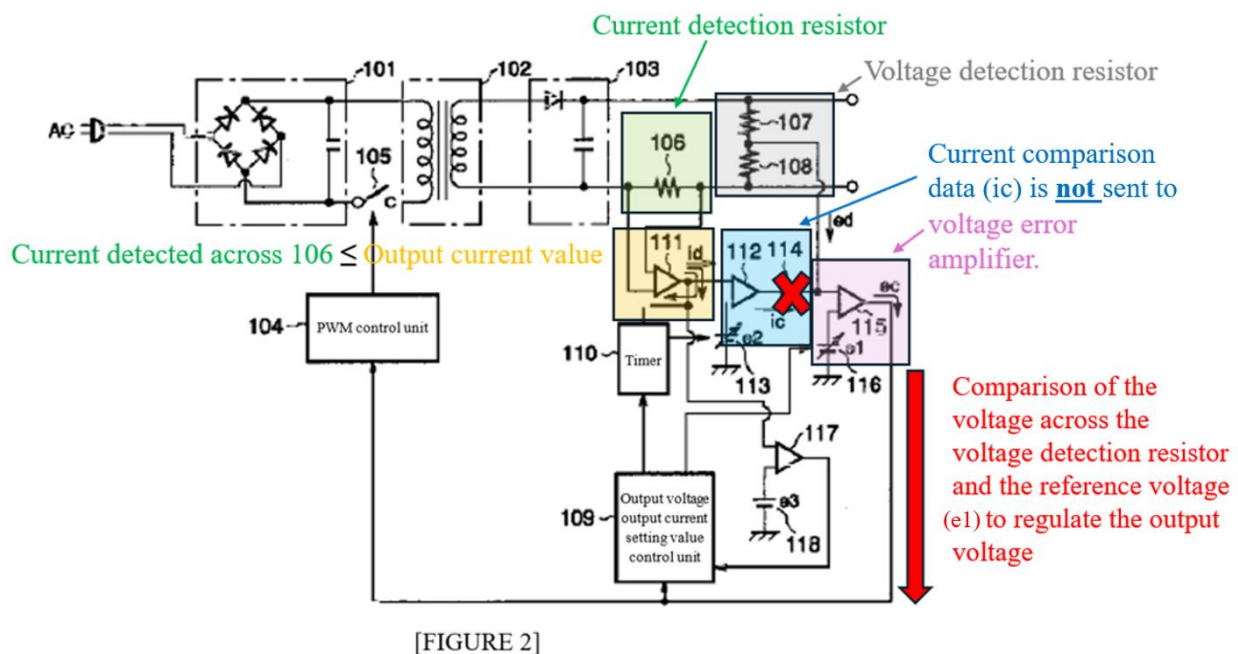
[FIGURE 2]

(*Id.*, Fig. 2 (colored annotations and highlighting added).)

199. The output voltage is detected by “inputting voltage data (ed) obtained by dividing the output voltage by the voltage dividing resistors 107 and 108 into the voltage error amplifier 115.” (Tanaka, [0032].) “The voltage error amplifier 115 performs the following operations (a) and (b) based on the magnitude relationship between the current comparison data (ic) and the voltage data (ed).” (*Id.*, [0035].)

200. **Operation (a):** If the output current (output current value (id)) detected across the current detection resistor 106 is less than or equal to the current limit (output current setting value set by the reference voltage (e2)), the current comparison data (ic) is not sent to the voltage error amplifier 115. (Tanaka, [0035].)

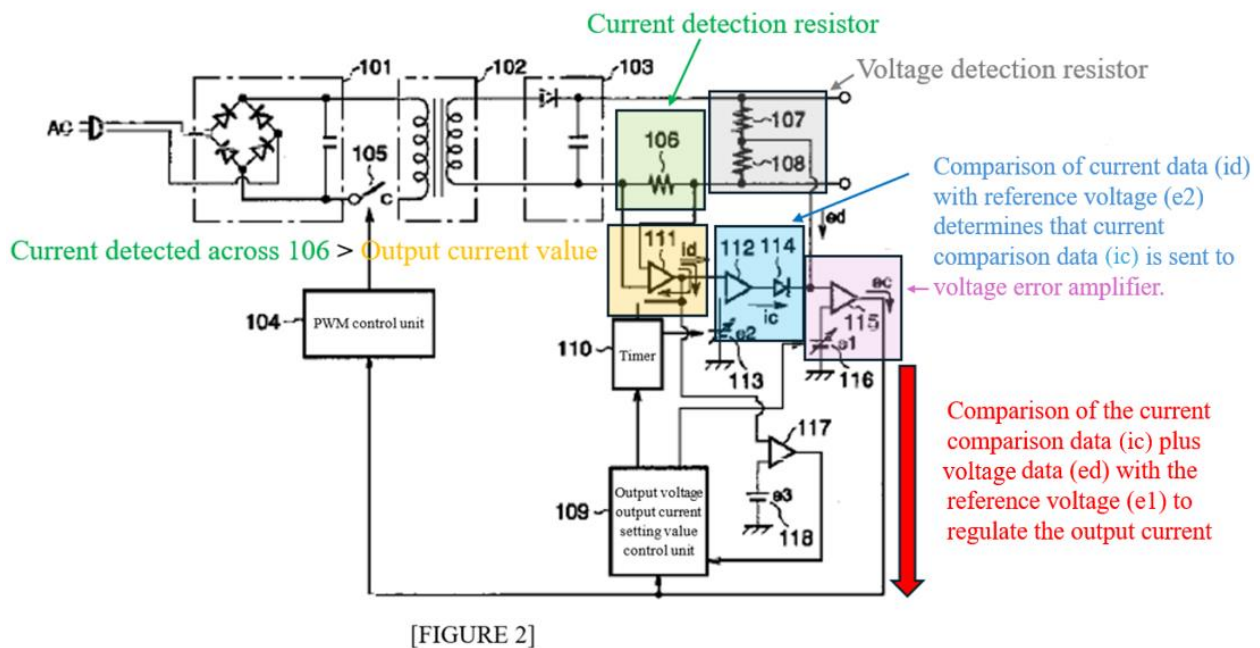
Here, the voltage amplifier 115 compares the voltage measured at voltage detection resistor 107 and 108 with the reference voltage (e1) set by reference voltage setting unit 116. (*Id.*, [0036].) The voltage comparison data (ec) output from the voltage amplifier 115 is then sent to “the output voltage/output current setting value control unit 109 constituting the output voltage/output current setting value control unit 16 shown in Figure 1 and the PWM control unit 104.” (*Id.*, [0037].) Thus, “the output voltage becomes the output voltage setting value.” (*Id.*, [0038].)



(*Id.*, Fig. 2 (colored annotations and highlighting added).)

201. **Operation (b):** When the “output current value exceeds the output current setting value set by the reference voltage (e2) of the reference voltage setting unit 113, the current comparison data (ic) is output to the voltage error amplifier 115.

In this case, the voltage error amplifier 115 compares [voltage data (ed) + current comparison data (ic)] with the reference voltage (e1) of the reference voltage setting unit 116” and outputs that comparison data as (ec). (Tanaka, [0039]-[0040].) The voltage comparison data (ec) is then sent to the output voltage/output current setting value control unit 109 and the PWM control unit 104. (*Id.*, [0041].) Therefore, “when the output current value exceeds the current setting value, current limiting is applied and the output voltage changes.” (*Id.*, [0042].)



(*Id.*, Fig. 2 (colored annotations and highlighting added).)

202. Here, the two amplifiers, 112 and 115, are disclosed to continuously compare the device charging parameters (i.e., “Output Voltage [V]” and current limit value (1)) and battery charging parameters (i.e., current limit value (2)) to the charger

output, and the results of the comparisons are used to determine the charger output. It is important to recognize in the above disclosures describing Fig. 2 of Tanaka that a skilled person would recognize that an “error amplifier” as used for 112 and 115 is a very common circuit component used in control circuits that compares the two signals at its input, subtracts the signal values to determine the difference or error between them, and amplifies the error as needed for the circuit design. As described above, the embodiment in Fig. 2 of Tanaka compares the device and battery charging parameters to the charger output using the error amplifiers and selects one of the parameters as the actual charging parameter by having one amplifier override the other and cause the “output voltage” to “become the output voltage setting value” or a “current limiting is applied” based on the error amplifier condition.

203. Further, a person of ordinary skill in the art would have found it obvious that the AC adapter must compare current limit value (1) (or the device charging parameter) and current limit value (2) (or the battery charging parameter) and determine which of the two current limit values are greater. For example, Figure 9, reproduced below, discloses that “Specification 1” contains a current limit value (1) of 2A and a current limit value (2) of 1.4A:

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Specification No.	Output voltage [V]	Output current limit value 1 [A]	Output current limit value 2 [A]
Specification 1	15	2.0	1.4
Specification 2	15	2.7	2.0
Specification 3	18	1.7	1.1
Specification 4	18	2.3	1.7

[FIGURE 9]

(Tanaka, Fig. 9.) The AC adapter switches between these two current limits by first determining if the output current is equal to or less than the current limit value (2). If this is true, then “the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (1).” (*Id.*, [0044].) “When the output current exceeds the current limit value (2) ... the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (2).” (*Id.*, [0045].) However, if the magnitude relationship between current limit value (1) and current limit value (2) were reversed, it would be illogical for the AC adapter to first evaluate the output current against current limit value (2) instead of current limit value (1) because exceeding current limit value (2) would also exceed current limit value (1). Accordingly, the AC adapter would have to recognize that current limit value (2) is greater than current limit value (1), and adjust the switching process described above. And because the current limit value is set as the reference voltage (e2) which determines the charger output, Tanaka discloses or renders obvious a comparison of the battery charging parameter

to the device charging parameter to determine which current limit to use in the current error amplifier to compare against the charger output.

204. Thus, for each of the reasons described above, Tanaka discloses **“different portable device types have at least one different portable device charging parameter; wherein different battery types have at least one different battery charging parameter; and wherein said controller is configured to select at least one actual charging parameter to charge the rechargeable battery based upon a comparison of the at least one different portable device charging parameter and at least one different battery charging parameter.”**

3. Dependent Claim 3

205. For reference, claim 3 recites:

3. The battery charger of claim 2 wherein said controller is configured to select the at least one actual charging parameter based upon a limiting one of the at least one different portable device charging parameter and the at least one different battery charging parameter.

(’397, 12:57-61 (Claim 3).)

206. Tanaka discloses **“select[ing] the at least one actual charging parameter based upon a limiting one of the at least one different portable device charging parameter and the at least one different battery charging parameter”**.

As discussed under the context of claims 1 and 2 above, amplifiers 112 and 115 continuously compare the device and battery charging parameters to the output and the corresponding results are used to determine the output as the actual charging parameter. (*See* Tanaka, [0035]-[0042].) However, when “the output current value exceeds the current setting value, current limiting is applied and the output voltage changes.” (*Id.*, [0042] (emphasis added).) This current limit can be either current limit value (1) for preventing an overcurrent (i.e., the device charging parameter) or current limit value (2) for constant current charging of the secondary battery (i.e., the battery charging parameter). (*Id.*, [0043].)

207. The AC adapter determines whether the reference voltage (e2) of the reference voltage setting unit 113 should be set to current limit value (1) or needs to be switched to current limit value (2) by periodically comparing the output current with one of the two current limit values. For example, “[w]hen the output current is equal to or less than the current limit value (2), the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (1).” (Tanaka, [0044].) However, “[w]hen the output current exceeds the current limit value (2), after a predetermined time elapses, e.g., 6 seconds after exceeding the current limit value (2), the reference voltage (e2) of the reference voltage setting unit

113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (2).” (*Id.*, [0045].) In other words, the two error amplifiers 112 and 115 determine if current limit value (1) or current limit value (2) is more limiting and the more limiting value will become the “**actual charging parameter**”.

208. Accordingly, Tanaka discloses “**said controller is configured to select the at least one actual charging parameter based upon a limiting one of the at least one different portable device charging parameter and the at least one different battery charging parameter.**”

4. Dependent Claim 5

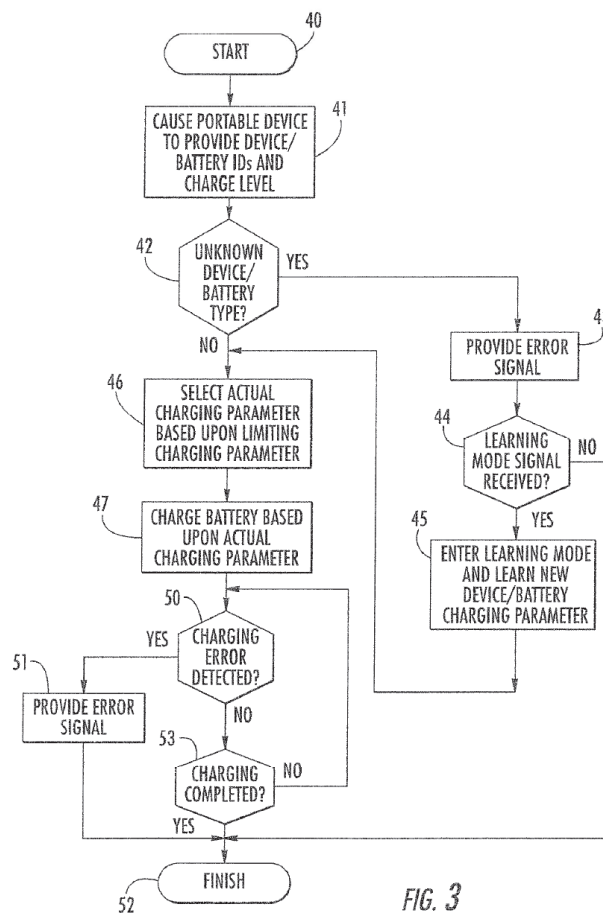
209. For reference, claim 5 recites:

5. The battery charger of claim 2 wherein said controller is configured to enter a learning mode for learning the at least one different portable device or battery charging parameter upon receiving a learning mode signal therefrom.

(’397, 13:1-4 (Claim 5).)

210. The ’397 patent describes a sequence of four exemplary events associated with the learning mode: (1) the charger checks to see if the attached device and/or battery are known or unknown, (2) if unknown, the charger controller

provides an error signal to the device letting the device know it does not recognize the attached device and/or battery, (3) the device sends back a learning mode signal letting the charger know the device will send its parameters soon, and (4) the charger enters a learning mode for learning the new parameters. Figure 3 in the '397 patent is representative (reproduced below):



('397, Fig. 3.)

211. Tanaka discloses a “**learning mode signal**”. As discussed above, an AC adapter can signal to the electronic device that it is open to learning new

parameters through the output of “a low power and low voltage level (for example, a constant voltage of about 5V to 6V) on the power output line (PL)[.]” (Tanaka, [0020].) It is my opinion that the “low power and low voltage” transmitted corresponds to the learning mode signal. While Tanaka discloses that the AC adapter sends the learning mode signal, it would have been obvious to one of ordinary skill in the art for the electronic device to send the signal. For example, it would be advantageous for the device to send the learning mode signal because the device would be in the best position to determine when it is prepared to send its information.

212. Tanaka further discloses entering a learning mode for learning new parameters. “When the secondary battery 21 is charged with a constant current during power-off mode or sleep state of the system 19, the charging control unit 22 reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery 21 and sends this to the input impedance control unit 18.” (Tanaka, [0058]); *See also* Tanaka, Fig. 5.) Then, when “AC adapter 11 outputs power for information exchange at a low power and low voltage level (for example, a constant voltage of about 5V to 6V) on the power output line (PL) as a device specification recognition mode,” device specifications may be sent to the power supply through the variation of impedance until “AC

adaptor 11 recognizes and sets the device specifications by the impedance conversion, and outputs power (for example, a constant voltage of 15V to 18V) according to the set device specifications to the power line (PL).” (Tanaka, [0020] (emphasis added).) It is my opinion that the “device specifications recognition mode” is the “**learning mode**”.

213. To the extent a learning mode requires an error signal, it would have been obvious to one of ordinary skill in the art, in view of Potega, to check the validity of the device and/or battery prior to sending a learning mode signal. For example, Potega discloses that in certain situations, the device and/or battery connected may be unknown to the battery charger. Indeed, Potega recognizes that users may purchase and use “knock-offs” or “gray market batteries” that comprise of nonstandard chemistries. (Potega, 29:47-52.) Similarly, electronics manufacturers may release dozens of new products each year, many of which may be unrecognizable to a power supply. (*Id.*, 1:34-67.) Therefore, it would have been obvious to one of ordinary skill in the art to validate the identity of the connected device and/or battery prior to sending/receiving a learning mode signal. It would have been obvious to combine the teachings of Potega with Tanaka due to safety concerns. One of ordinary skill in the art would have recognized that manufacturers of consumer goods are mindful of potential faults and errors that may harm

consumers. By incorporating safety features such as device/battery validation, a manufacturer would provide additional desired protection.

214. Accordingly, it is my opinion that Tanaka, in view of Potega, discloses **“a learning mode for learning the at least one different portable device or battery charging parameter upon receiving a learning mode signal therefrom.”**

5. Dependent Claim 6

215. For reference, claim 6 recites:

6. The battery charger of claim 2 further comprising at least one memory coupled to said controller and configured to store the at least one different portable device charging parameter and the at least one different battery charging parameter.

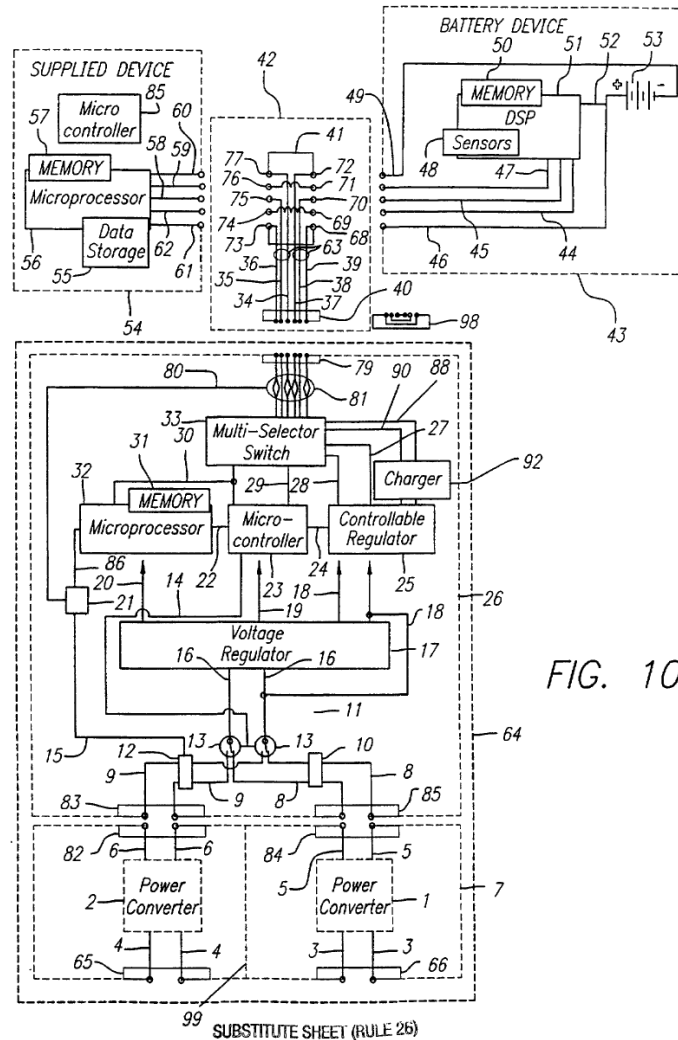
(’397, 13:5-9 (Claim 6).)

216. Tanaka discloses **“at least one memory coupled to said controller and configured to store the at least one different portable device charging parameter and the at least one different battery charging parameter”**. As discussed above, “when the output voltage/output current setting value control unit 16 receives data indicating the device input specifications”, the output process as indicated in Figures 6, 7, and 8 are executed. (Tanaka [0067]; *see id.*, Figs. 6-8; *see also id.*, [0068].) One of ordinary skill in the art would have recognized and found

it obvious that, for output voltage/output current setting value control unit to determine which output process to execute, it would have been coupled to a memory mapping the stored device input specifications to the correct stored output values. The device input specifications represent the device charging parameter and battery charging parameter as disclosed in the claims above. Accordingly, it would have been obvious to one of ordinary skill in the art to have included a memory coupled to the controller to store the at least one different portable device charging parameter and the at least one different battery charging parameter.

217. To the extent this limitation is not disclosed by Tanaka, it would have been obvious in view of Potega. Tanaka discloses a memory coupled to a controller. (See Tanaka, [0061] (“[W]hen the secondary battery 21 is charged with a constant current during power-off of the system 19, the charging control unit 22 first reads the current battery capacity, maximum charging current, and maximum charging voltage from the battery capacity data stored in the storage unit of the secondary battery 21, and sends these values to the input impedance control unit 18.” (emphasis added)).) However, it would have been obvious to one of ordinary skill in the art to instead incorporate and couple a memory to the controller in the AC adapter in view of Potega. For example, Potega discloses a power supply configured with microprocessor 32, memory 31, and microcontroller 23 coupled together. Figure 10,

reproduced below, is representative:



(Potega, Fig. 10.) A person of ordinary skill in the art would have recognized this disclosure and been motivated to incorporate a memory on the AC adapter because incorporating a memory device on the AC adapter can increase efficiency and allow the AC adapter to quickly verify certain device and/or battery types.

6. Dependent Claim 7

218. For reference, claim 7 recites:

7. The battery charger of claim 2 wherein the at least one actual charging parameter comprises at least one of a voltage parameter, and a charging time.

('397, 13:10-12 (Claim 7).)

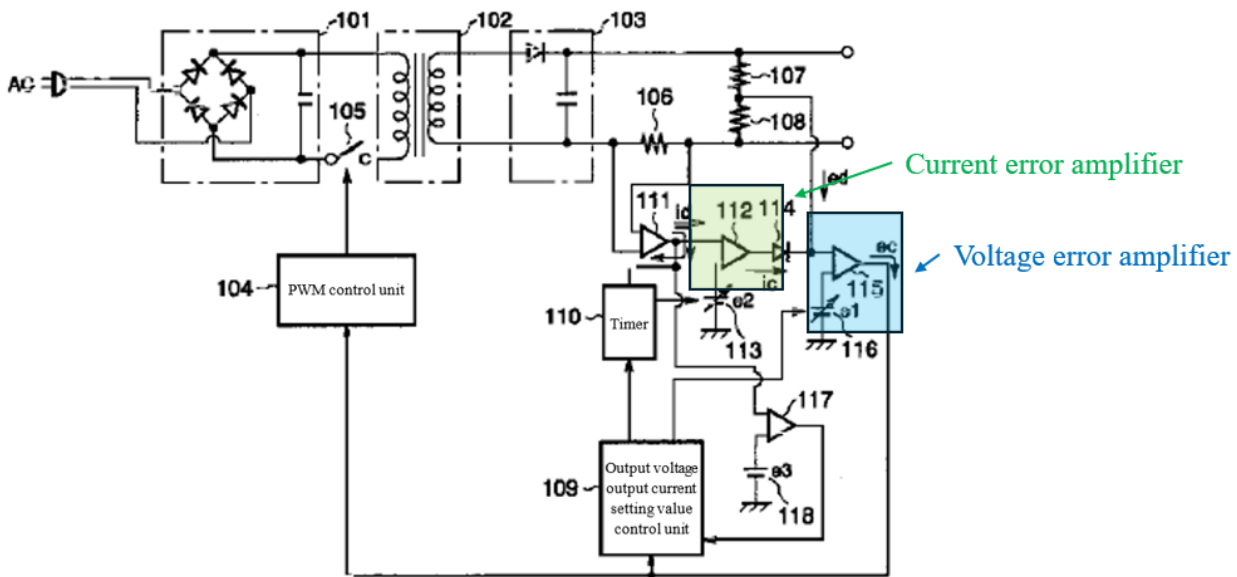
219. Tanaka discloses “**the at least one actual charging parameter comprises at least one of a voltage parameter**”. As discussed above, in response to the device specification mode, the electronic device varies the input impedance of the power output line (PL) to identify various specifications. The output voltage/output current setting value control unit 16 of the AC adapter 11 then recognizes the power input specifications of the electronic device received from the output variation analysis unit 15, sets the output specifications, and outputs power according to the specifications on the power output line (PL). These specifications include its respective output current limit (1) for preventing an overcurrent, output current limit (2) for charging a secondary battery, and an output voltage. (*See* Tanaka, Fig. 9.)

Specification No.	Output voltage [V]	Output current limit value 1 [A]	Output current limit value 2 [A]
Specification 1	15	2.0	1.4
Specification 2	15	2.7	2.0
Specification 3	18	1.7	1.1
Specification 4	18	2.3	1.7

[FIGURE 9]

(*Id.*) Once the device specifications are transmitted, the embodiment in Figure 2 of

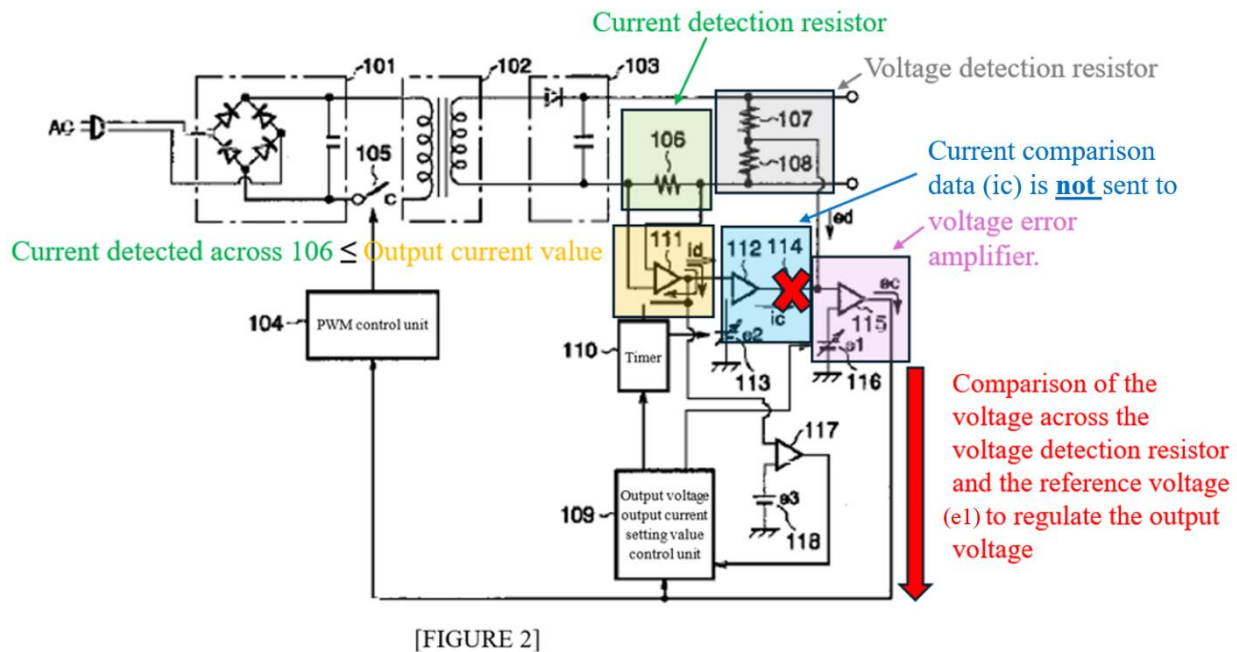
Tanaka, reproduced below, uses two amplifiers, 112 and 115, to compare the device and battery charging parameters to the output in order to determine how the output should be changed:



[FIGURE 2]

(*Id.*, Fig. 2 (colored annotations and highlighting added).) When the output current (output current value (id)) detected across the current detection resistor 106 is less than or equal to the current limit (output current setting value set by the reference voltage (e2)), the current comparison data (ic) is not sent to the voltage error amplifier 115. (*Id.*, [0035].) The voltage amplifier 115 compares the voltage measured at voltage detection resistor 107 and 108 with the reference voltage (e1) set by reference voltage setting unit 116. (*Id.*, [0036].) The voltage comparison data (ec) output from the voltage amplifier 115 is then sent to “the output voltage/output

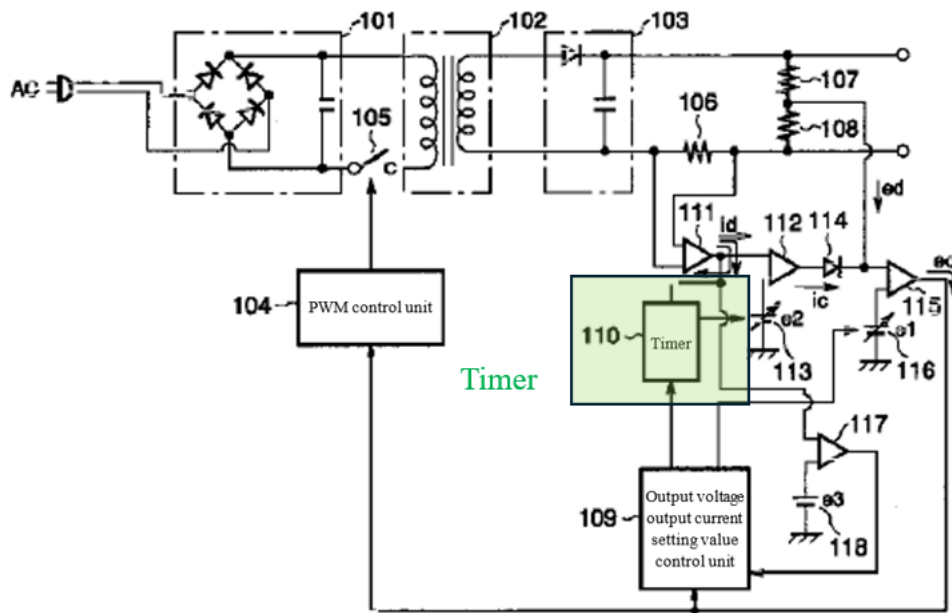
current setting value control unit 109 constituting the output voltage/output current setting value control unit 16 shown in Figure 1 and the PWM control unit 104.” (*Id.*, [0037].)



(*Id.*, Fig. 2 (colored annotations and highlighting added).) Thus, “the output voltage becomes the output voltage setting value.” (*Id.*, [0038].) Accordingly, it is my opinion that Tanaka discloses that the actual charging parameter (i.e., the output voltage) comprises at least one of a voltage parameter (i.e., the output voltage setting value).

220. To the extent this claim additionally requires a charging time, Tanaka discloses the “**at least one actual charging parameter comprises...a charging time.**” Tanaka discloses an AC adapter that utilizes a timer. (See Tanaka, [0033]

(“[T]he detection of the output current is performed by amplifying the voltage across the current detection resistor 106 by an amplifier 111, and inputting the current value (id) to the current error amplifier 112, comparator 117, and timer 110.” (emphasis added); *see also id.*, [0043] (“In this embodiment, as shown in Figure 9, there are two current limits. One is a current limit value (1) for preventing overcurrent, and the other is a current limit value (2) for constant current charging of the secondary battery when the electronic device main body 12 is provided with a secondary battery. Switching between the current limit value (1) and the current limit value (2) is realized by the timer 110 switching the set value of the reference voltage setting unit 113, that is, the reference voltage (e2).” (emphasis added)).) Figure 2, reproduced below, is representative:



[FIGURE 2]

(*Id.*, Fig. 2.) AC adapter utilizes this timer when determining when to adjust the output charging profile and respective charging limit:

“The switching between the current limit value (1) and the current limit value (2) is carried out: (a) When the output current is equal to or less than the current limit value (2), the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (1). (b) When the output current exceeds the current limit value (2), after a predetermined time elapses, e.g., 6 seconds after exceeding the current limit value (2), the reference voltage (e2) of the reference voltage setting unit 113 is switched to the reference voltage value corresponding to the output current setting value of the current limit value (2).”

(*Id.*, [0044]-[0045] (emphasis added).) In other words, the AC adapter will compare the output current to the predetermined time (e.g., 6 seconds) to determine if the output profile needs to be changed. Accordingly, Tanaka discloses the “**at least one actual charging parameter comprises...a charging time.**”

221. To the extent this limitation is not disclosed, it would have been obvious to one of ordinary skill in the art to utilize a charging time in the “**actual charging parameter.**” As discussed above, Tanaka discloses that battery capacity data, i.e.,

current battery capacity, maximum charging current, and maximum charging voltage, is stored in the storage unit of the secondary battery. (Tanaka, [0061].) It would have been obvious to one of ordinary skill in the art to communicate these parameters to the battery charger and for the charger to utilize such data in determining an “actual charging parameter.” For example, a charger would recognize that if the current battery capacity is at 90%, and the maximum charging current is 2A, it would reach maximum capacity in certain amount of time and accordingly set that charge time. Setting the charging time in this manner would result in benefits such as efficiency and safety.

222. For all the reasons stated above, Tanaka discloses the **“one actual charging parameter comprises at least one of a voltage parameter, and a charging time.”**

7. Independent Claim 11

223. For reference, claim 11 recites:

11[p] A battery charging system comprising:

11[a] a portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, said portable wireless communications device and rechargeable battery each respectively having a portable device type

and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates; and

11[b] a battery charger comprising

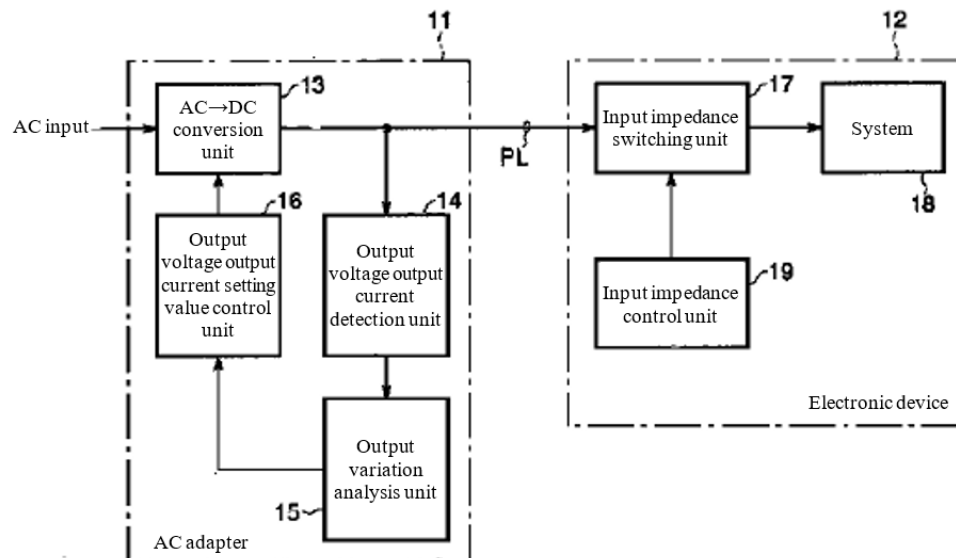
11[c] a charging circuit, and

11[d] a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.

('397, 13:24-42 (Claim 11; bracketed notation (e.g., [a]) added).)

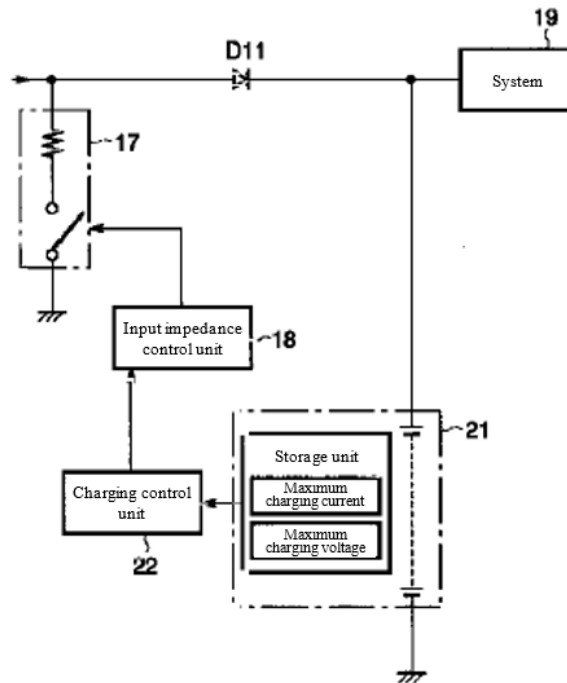
(c) “A battery charging system comprising:” (Claim 11[p])

224. To the extent the preamble is limiting, it is my opinion that Tanaka discloses “**a battery charging system**”. For example, Tanaka discusses “an AC adapter provided with an output specification switching function” coupled to “an electronic device having an external power input function receiving an operating power source from the AC adapter”. (Tanaka, [0012].) Electronic device contains secondary battery that may be charged by AC adapter. Figures 1 and 5, reproduced below, are representative:



[FIGURE 1]

(*Id.*, Fig. 1.) Figure 1 depicts the AC adapter 11 coupled to the electronic device 12. It is my opinion that while the secondary battery is not depicted here, one of ordinary skill in the art would recognize electronic device 12 would contain a rechargeable battery.



[FIGURE 5]

(*Id.*, Fig. 5.) Figure 5 depicts the electronic device 12 in greater detail. It is my opinion that the electronic device in Figure 5 is identical to the electronic device in Figure 1.

225. Accordingly, Tanaka discloses “a battery charging system”.

- (d) **“a portable wireless communications device including a rechargeable battery and a wireless communications transceiver coupled thereto, said portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different rechargeable battery types having respective charging rates; and” (Claim 11[a])**

226. It is my opinion that claim 11[a] is identical to claim 1[p] above. For the reasons discussed under claim 1[p], claim 11[a] is disclosed or rendered obvious by Tanaka.

- (e) **“a battery charger comprising” (Claim 11[b])**

227. Tanaka discloses **“a battery charger.”** For example, as discussed above, Figures 1 and 5 depict a battery charging system containing an AC adapter, electronic device, and a rechargeable battery contained within the electronic device. The AC adapter is capable of charging the rechargeable battery contained within the electronic device. (*See* Tanaka, [0062] (“During charging of the above secondary battery 21...”); *see also id.*, [0043] (“...for constant current charging of the secondary battery...”); [0058] (“When the secondary battery 21 is charged with a constant current during power-off or sleep state of the system 19, the charging control unit 22 reads the maximum charging current and maximum charging voltage data from the storage unit provided in the secondary battery 21 and sends this to the

input impedance control unit 18.”); [0059] (“The input impedance control unit 18 determines the power input specifications of the electronic device main body 12 based on the maximum charging current and maximum charging voltage data, and according to the power input specifications, switches the switch of the impedance switching unit 17 by a predetermined variation means to vary the impedance on the power output line (PL) of the AC adapter 11.”); [0061] (“As a modification example of the charging control of the above secondary battery, when the secondary battery 21 is charged with a constant current during power-off of the system 19, the charging control unit 22 first reads the current battery capacity, maximum charging current, and maximum charging voltage from the battery capacity data stored in the storage unit of the secondary battery 21, and sends these values to the input impedance control unit 18. When charging starts, the charging capacity is recognized by the charging current, and the battery capacity data stored in the storage unit of the secondary battery 21 is rewritten according to the recognized value.”).)

228. Accordingly, Tanaka discloses “**a battery charger**”.

(f) “a charging circuit, and” (Claim 11[c])

229. It is my opinion that claim 11[c] is identical to claim 1[a] above. For the reasons discussed under claim 1[a], claim 11[c] is disclosed or rendered obvious by Tanaka.

- (g) “a controller coupled to said charging circuit and configured to cause said portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and to cause said charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 11[d])

230. It is my opinion that claim 11[d] is identical to claim 1[b] above. For the reasons discussed under claim 1[b], claim 11[d] is disclosed or rendered obvious by Tanaka.

8. Dependent Claims 12, 13, and 15-17

231. Dependent claims 12, 13, and 15-17 are substantially identical to claims 2, 3, and 5-7, respectively, except that they depend directly or indirectly from claim 11 instead of claim 1. For the reasons stated above, these claims are obvious over the prior art.

9. Independent Claim 18

232. For reference, claim 18 recites:

18[p] A battery charging method for a rechargeable battery carried by a portable wireless communications device the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different battery types having respective charging rates, the method

comprising:

18[a] coupling a charging circuit to the portable wireless communications device to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and causing the charging circuit to charge the rechargeable battery based on the respective charging rate thereof.

(’397, 14:20-34 (Claim 18; bracketed notation (e.g., [a]) added).)

(h) “A battery charging method for a rechargeable battery carried by a portable wireless communications device the portable wireless communications device and rechargeable battery each respectively having a portable device type and a rechargeable battery type associated therewith from among a plurality of different portable device types and different battery types having respective charging rates, the method comprising:” (Claim 18[p])

233. It is my opinion that claim 18[p] is identical to claim 1[p] except in method claim form. It is my opinion that for all the reasons explained under claim 1[p] above, claim 18[p] is disclosed or rendered obvious.

- (i) **“coupling a charging circuit to the portable wireless communications device to cause the portable wireless communications device to identify its corresponding portable device type and its corresponding rechargeable battery type, and causing the charging circuit to charge the rechargeable battery based on the respective charging rate thereof.” (Claim 18[a])**

234. It is my opinion that claim 18[a] is substantially similar to claims 1[a] and 1[b] except for the distinction that claim 18[a] is a method claim and further claims **“coupling a charging circuit to the portable wireless communications device”**. In my opinion, this is a distinction without patentable significance, as Figure 1 of Tanaka shows the AC→DC conversion unit 13 (**“a charging circuit”**) coupled to the electronic device 12 (**“the portable wireless communications device”**) through the power line (PL). (Tanaka, Fig. 1.) Tanaka further discloses that once the AC→DC conversion unit converts the AC power into DC power, the DC power is “supplied to the electronic device main body 12 via the power output line (PL).” (*Id.*, [0021].) It therefore would have been obvious and apparent that the charging circuit in Tanaka was coupled to the electronic device, as this would have been necessary in order to allow charging of the secondary battery in the electronic device. For all of the other reasons explained under claims 1[a] and 1[b] above, claim 18[a] is disclosed or rendered obvious by the prior art.

10. Dependent Claims 19, 20, and 22

235. Claims 19, 20, and 22 are substantially identical to claims 2, 3 and 7, respectively, except that they depend directly or indirectly from independent claim 18 instead of independent claim 1. For the reasons explained above, these claims are obvious over the prior art.

D. Ground 4: Claims 4, 8, 14, 21 are Obvious Over Tanaka in view of Potega and Koenck

11. Dependent Claim 4

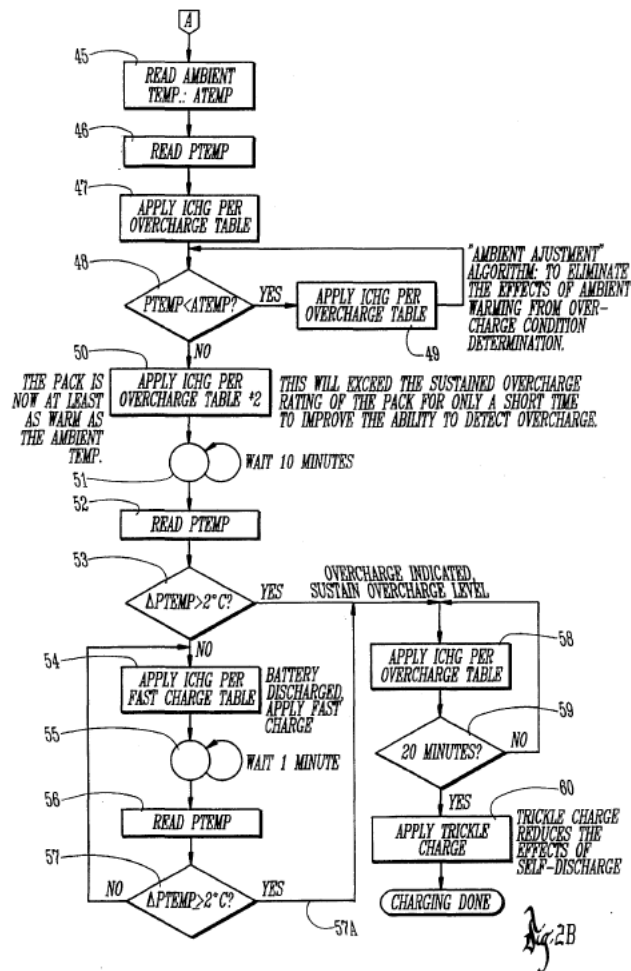
236. For reference, claim 4 recites:

4. The battery charger of claim 2 wherein said controller is configured to further cause the portable wireless communications device to identify a battery charge level; and wherein said controller is configured to further select the at least one actual charging parameter based upon the battery charge level.

(’397, 12:62-67 (Claim 4).)

237. Tanaka and Potega (as discussed in connection with claims 1 and 2), in view of Koenck, disclose a controller that “**is configured to further cause the portable wireless communications device to identify a battery charge level**”. When a “hand-held computerized terminal with rechargeable batteries” is “bodily inserted into a charger receptacle”, the battery charging system of Koenck

determines the “state of the charge of the battery” by determining the presence of an overcharge condition by applying twice the permissible sustained overcharge rate and monitoring cell temperature. (Koenck, Abstract; 6:30-39.) Steps 50 to 53 in Fig. 2B are representative:



(*Id.*, Fig. 2B.)

238. To the extent Koenck does not disclose a “**controller**” that “**cause[s]** the portable wireless communications device to identify a battery charge level”,

it would have been obvious to one of ordinary skill in the art because a portable device would be in a better position to measure internal parameters such as the temperature of the battery as required by Koenck. Tanaka already discloses that the controller causes the electronic device to measure other related parameters such as its battery capacity. (See Tanaka [0061], (“when the secondary battery 21 is charged with a constant current during power-off of the system 19, the charging control unit 22 first reads the current battery capacity, maximum charging current, and maximum charging voltage from the battery capacity data stored in the storage unit of the secondary battery 21, and sends these values to the input impedance control unit 18.” (emphasis added).) Therefore, one of ordinary skill in the art would have found it obvious for the system in Tanaka to additionally identify the battery charge level as it would have provided a clear benefit such as increasing the safety of the battery charging system as explained by Koenck.

239. If it is determined that the battery is not in an overcharge condition, the controller then “**select[s] the at least one actual charging parameter based upon the battery charge level**” by utilizing a “fast charge parameter table” to apply the appropriate charge value. (Koenck, 6:56-7:2.) Tables 1 and 2, a portion of which is reproduced below, disclose values of overcharge and fast charge for successive temperatures:

TABLE I

Charge Table: Overcharge and Fast Charge				
Battery type: 800 ma-hr fast charge				
Temp, °C.	Overcharge value		Fast Charge value	
	C. units	ma.	C. units	ma.
-30	0.040	32	0.160	128
-28	0.044	35	0.176	141
-26	0.048	38	0.192	154
-24	0.052	42	0.208	166
-22	0.056	45	0.224	179
-20	0.060	48	0.240	192
-18	0.068	54	0.264	211
-16	0.076	61	0.288	230
-14	0.084	67	0.312	250
-12	0.092	74	0.336	269
-10	0.100	80	0.360	288
-8	0.120	96	0.408	326
-6	0.140	112	0.456	365
-4	0.160	128	0.504	403
-2	0.180	144	0.552	442
0	0.200	160	0.600	480

(*Id.*, 8:35-55.) During fast charging, the temperature continues to be closely monitored to determine when overcharge has been reached so that fast charging may be terminated and “a controlled temperature overcharge cycle may be initiated as represented by step 58” in Fig. 2B above to “top-off” the battery for maximum capacity.” (*Id.*, 7:5-12.) Accordingly, Tanaka and Potega, in view of Koenck discloses a “controller [] configured to further cause the portable wireless communications device to identify a battery charge level; and wherein said controller is configured to further select the at least one actual charging parameter based upon the battery charge level.”

240. *Rationale and Motivation to Combine (Tanaka and Potega with Koenck)*: As explained in **Ground 3**, Tanaka and Potega are analogous references

and so is Koenck. The '397 patent describes its "Field of the Invention" as relating "to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods." ('397, 1:20-22.) Koenck is thus in the same field of endeavor as the '397 patent as it describes a system for effective fast battery charging for "a hand-held computerized terminal with rechargeable batteries". (Koenck, Abstract). Koenck would also have been reasonably pertinent to various problems facing the '397 patent inventors, including how to design and implement a battery charging system that causes the portable device to measure the current charge of its battery.

241. A person of ordinary skill in the art would have had a clear motivation to combine Koenck with Tanaka and Potega because Koenck recognizes that it is important to identify the battery charge level for multiple reasons. For example, certain battery chemistries such as NiCad batteries will exhibit harmful characteristics when overcharged. (See Koenck, 2:37-47 ("At high temperatures the heat released by the oxygen recombination reaction may cause excessive cell temperature to be experienced leading to premature failure of the plate separator material and subsequent short-circuiting. If the battery is fully discharged, minimal oxygen generation will occur until the battery nears the fully charged condition. If the battery is nearly fully charged, it will quickly enter the overcharge condition and

begin oxygen generation.”); *See also id.*, 3:16-18 (“In order to avoid damage to the battery, the system automatically tests to determine the initial state of charge and selects the charging rate accordingly.”).)

242. A person of ordinary skill in the art would also have had a reasonable expectation of success. As explained above, Tanaka already discloses the ability for a portable wireless communication device to exchange information with the charging device. The ability to send the battery charge level to the portable wireless communication device, therefore, would have been a trivial implementation detail well within the capabilities of a skilled artisan.

12. Dependent Claim 8

243. For reference, claim 8 recites:

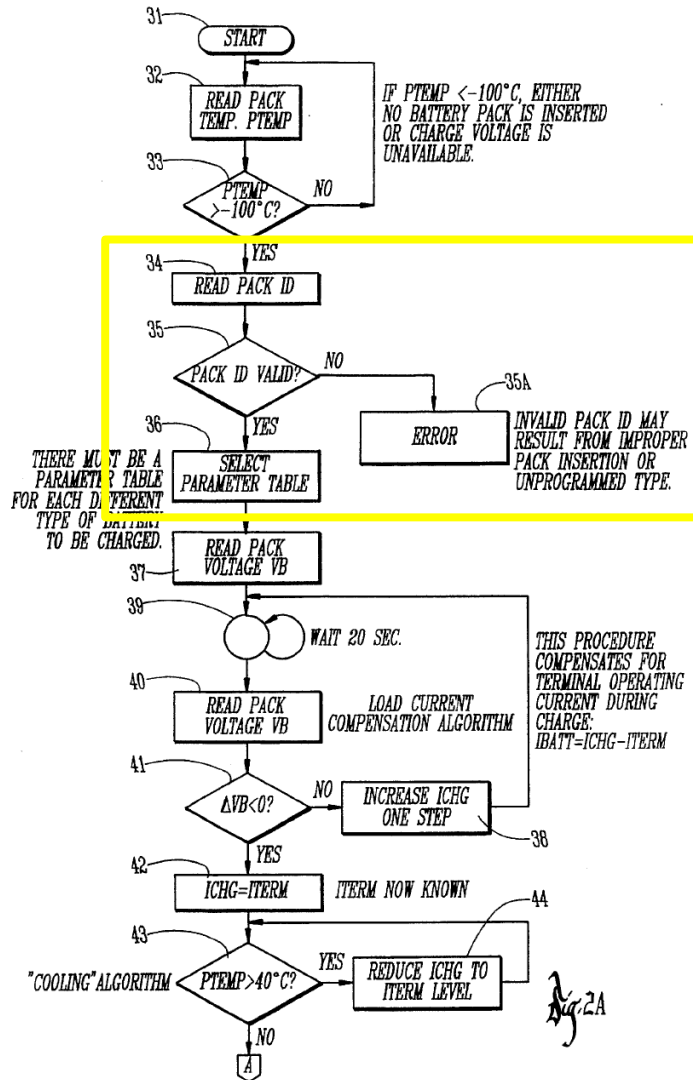
8. The battery charger of claim 1 wherein said controller is configured to further provide an error signal to the portable wireless communications device based upon an unknown portable device type or rechargeable battery type.

(’397, 13:13-16 (Claim 8).)

244. It would have been obvious to one of ordinary skill in the art that Tanaka and Potega, in view of Koenck, discloses “**an error signal ... based upon an unknown portable device type or rechargeable battery type**”. Koenck

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discloses that a system may “automatically identify battery type”. (Koenck, Abstract; *see also id.*, 11:14-17 (“The battery identification means such as 110, Fig. 30, would distinguish the presence of absence of an internal current regulator as well as identifying the various battery types requiring different charging and overcharge treatment.”).) And that “[f]ollowing determination of the presence of a battery pack 25 in the charger, the pack type must be identified as represented at 34 and 35 to allow for cells with different charge characteristics.” (*Id.*, 5:30-33.) However, “[i]n the case of an invalid reading of battery pack identity, the program may branch to an error sub routine as indicated at 35A.” (*Id.*, 5:33-35 (emphasis added).) Figure 2A of Koenck, reproduced below, is representative:



(*Id.*, Fig. 2A (colored annotations added).)

245. While Koenck does not disclose that this error signal is transmitted to the portable wireless communications device, it would have been obvious to one of ordinary skill in the art in view of Potega “to further provide an error signal to the portable wireless communications device.” Potega discloses that “[t]he power supply’s internal logic can be modified to react to detected battery charging in

numerous ways, but the most notable ones would be to alert the passenger (via a screen message on the laptop, perhaps an audible alarm, etc.), of the official rules regarding charging computer batteries on that flight.” (Potega, 29:9-14 (emphasis added).) And “[i]f the passenger still insists on charging the supplied device's battery, the embedded power supply's logic circuit issues a final screen-based warning to the miscreant passenger, announcing that all power to the computer will be turned off after a pre-determined time, perhaps 2 minutes.” (*Id.*, 29:23-27 (emphasis added).)

246. Accordingly, Tanaka and Potega, in combination with Koenck, discloses a controller “**configured to further provide an error signal to the portable wireless communications device based upon an unknown portable device type or rechargeable battery type**”.

247. *Rationale and Motivation to Combine (Tanaka, Potega, and Koenck):*
As explained in **Grounds 3** and above, Tanaka, Potega, and Koenck are analogous references to the '397 patent.

248. A person of ordinary skill in the art would have had a clear motivation to combine Tanaka, Potega, and Koenck. Tanaka already recognizes that there may be situations where abnormal conditions exist. (See Tanaka, [0072] (“When the output specifications of the AC adapter 11 do not match the input specifications of

the electronic device main body 12, the AC adapter 11 maintains a certain low power low voltage output state or stops power supply at the time of connection, thereby avoiding inconvenience caused by supplying an abnormal operating power source to the electronic device main body 12.” (emphasis added)).) And both Koenck and Potega recognize that abnormal conditions may arise due to the battery chemistry. (See Koenck, 5:38-45 (“[f]uture technology developments may offer new cell types with unusual charging parameters that may be accommodated by applying an appropriate charging algorithm.”); see also Potega, 29:47-52 (“This verification may not be valid for decision making, since a significant number of gray-market battery packs are in the marketplace, according to Sanyo (San Diego, Calif.). Sanyo estimates that some 20% of all batteries sold are "knock-offs" of UL-approved batteries which don't meet UL standards. (emphases added))).) Thus, a person of ordinary skill in the art would have been motivated to additionally check for abnormal conditions, such as an unrecognizable battery type, prior to charging in order to increase both the reliability and safety of battery charging.

249. A person of ordinary skill in the art would have been motivated to send the error signal to the portable device because devices, such as the portable personal computer identified in Tanaka, are better equipped to display information to a user. For example, common portable devices such as laptops have much larger screens for

displaying information compared to battery chargers which typically do not contain any screen whatsoever. Furthermore, by providing the error signal to the device, it presents the opportunity to utilize additional protective circuits in the device itself as an additional layer of defense, rather than solely relying on protective circuits in the charger.

250. A person of ordinary skill in the art would have had a reasonable expectation of success. Potega discloses smart battery implementations that were well-known by the late 1990s and commonly utilized the SMBus, a well-known bus for transferring information between devices. The ability to send an error message to the portable wireless communication device, therefore, would have been a trivial implementation detail well within the capabilities of a skilled artisan.

13. Dependent Claim 14

251. For reference, claim 14 recites:

21. The battery charging system of claim 12 wherein said controller is configured to further cause the portable wireless communications device to identify a battery charge level; and wherein said controller is configured to further select the at least one actual charging parameter based upon the battery charge level.

('397, 14:1-6 (Claim 14).)

252. It is my opinion that claim 14 is identical to claim 4 except in system claim form. It is my opinion that for all the reasons explained under claim 4 above, claim 14 is disclosed or rendered obvious.

14. Dependent Claim 21

253. For reference, claim 21 recites:

21. The method of claim 19 further comprising causing the portable wireless communications device to identify a battery charge level of the rechargeable battery; and wherein selecting comprises selecting the at least one actual charging parameter further based upon the battery charge level.

('397, 14:48-52 (Claim 21).)

254. It is my opinion that claim 21 is identical to claim 4 except in method claim form. It is my opinion that for all the reasons explained under claim 4 above, claim 21 is disclosed or rendered obvious.

E. Ground 5: Claim 9-10 is Obvious Over Tanaka in view of Potega and Stephens

15. Dependent Claim 9

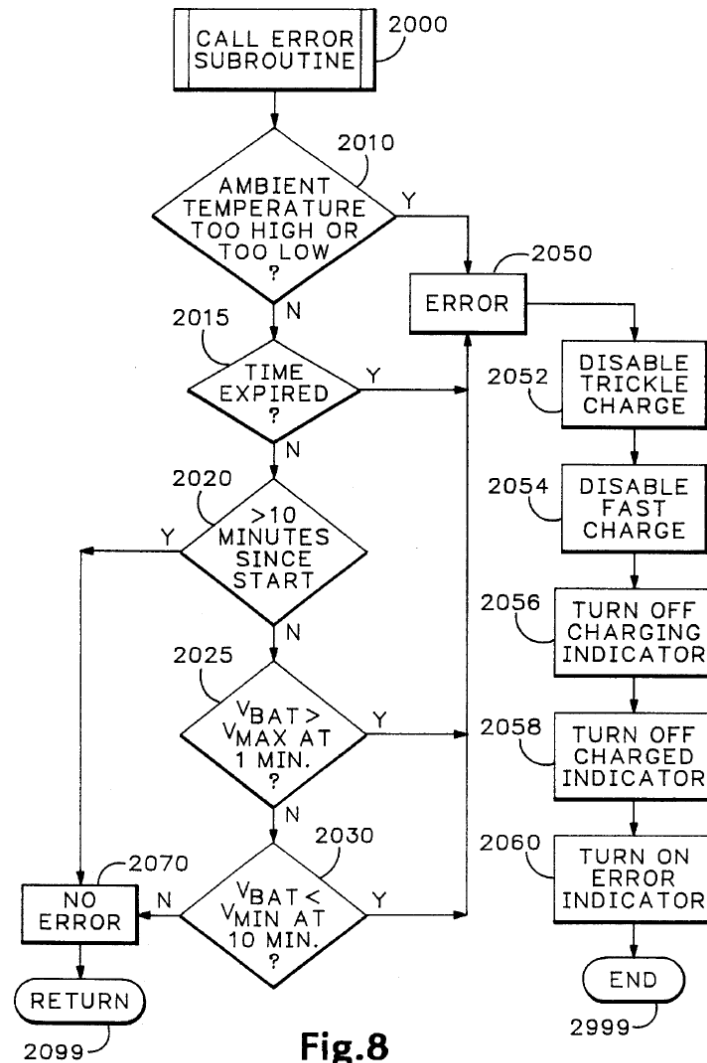
255. For reference, claim 9 recites:

9. The battery charger of claim 1 wherein said controller is configured to monitor said charging circuit to detect a charging error

during charging of the rechargeable battery.

(’397, 13:17-19 (Claim 9).)

256. It would have been obvious to one of ordinary skill in the art that Tanaka and Potega, in view of Stephens discloses a controller “**configured to monitor said charging circuit to detect a charging error during charging of the rechargeable battery**”. Stephens discloses a battery charger controlled by a “controller” with the ability to detect and correctly charge different battery types, and respond to error conditions detected during the charging operation. (Stephens, 1:65-2:16.) Specifically, “[c]ontroller 170 contains state detection logic 172, charging logic 175, and indicator logic 177.” (*Id.*, 4:25-26.) “Indicator logic 177 is responsive to state detection logic 172 and charging logic 175 and indicates to a user via indicator 120 whether battery 110 is charging, is charged, or whether an error was detected during the charging operation.” (*Id.*, 4:34-38 (emphasis added).) Error subroutine 2000 in Figure 8 is representative:



(*Id.*, Fig. 8.) As indicated in Figure 8, error subroutine 2000 will return an error condition under several conditions including (1) whether the “ambient temperature is either too high or too low to safely and reliably operate battery charger 100”, (2) “if the time out period has expired”, i.e., “if the battery has failed to become fully charge even though ample time has elapsed for it to become fully charged under normal conditions”, (3) “if the battery voltage exceeds a predetermined maximum

voltage” indicating the battery contains an open cell or another problem, or (4) “if the battery voltage is less than the predetermine low voltage” indicating the battery has a short circuit or another problem that is preventing it from taking a charge. (*Id.*, 6:56-59; 7:4-7; 7:11-14; 7:21-27.)

257. Accordingly, a person of ordinary skill in the art would have found it obvious that Tanaka and Potega, in view of Stephens, discloses a “**controller**” that “**is configured to monitor said charging circuit to detect a charging error during charging of the rechargeable battery**”.

258. *Rationale and Motivation to Combine (Tanaka and Potega with Stephens)*: As explained in **Grounds 3** and **4**, Tanaka and Potega, are analogous references to the '397 patent, and so is Stephens. As noted above, the '397 patent describes its “Field of the Invention” as relating “to the field of battery-powered portable devices, and, more particularly, to battery chargers for such portable devices and related methods.” ('397, 1:20-22.) Stephens is thus in the same field of endeavor as the '397 patent as it describes battery charging techniques for portable devices such as a “portable computer, or another electronic device, such as a tape player, CD player, radio, tape recorder, television, etc.” (Stephens, 3:9-12.) Stephens would also have been reasonably pertinent to various problems facing the '397 patent inventors, including how to design and implement a battery charging system

that encounters errors in battery charging.

259. A person of ordinary skill in the art would have had a clear motivation to combine Stephens with Tanaka and Potega because improving safety in battery charging was a common need in the industry. For example, US Patent No. 6,242,893 B1 to Robert P. Freedman (**Ex.1015**) discusses with “[t]he development of new battery chemistries, and particularly the commercial development of high capacity and high rate lithium cells,” comes the need to closely monitor and control the operating requirements of such cells. (Freedman, 1:12-21.) And that “[f]ailure to observe safety precautions” may cause the battery to “overheat vent, or leak electrolyte” and potentially result in explosions or extremely serious fires. (*Id.*, 1:22-30.) Therefore, “charging conditions must be closely controlled to maintain both safety and optimal operation conditions.” (*Id.*, 1:32-34.) Similarly, Tanaka recognizes that “device protection measures” may be necessary. (Tanaka, [0076] (“Also, when the output specifications of the AC adapter do not match the power input specifications of the electronic device or when there is no impedance variation on the electronic device side for identifying the AC adapter (or notifying the device specifications to the AC adapter), device protection measures such as stopping output, lowering voltage, or preventing large current flow can be easily taken.” (emphasis added).))

260. A person of ordinary skill in the art would have had a reasonable expectation of success. Potega discloses smart battery implementations that were well-known by the late 1990s and commonly utilized the SMBus, a well-known bus for transferring information between devices. The ability to send an error message to the portable wireless communication device, therefore, would have been a trivial implementation detail well within the capabilities of a skilled artisan.

16. Dependent Claim 10

261. For reference, claim 10 recites:

10. The battery charger of claim 9 further comprising an indicator connected to said controller and configured to provide an error indication upon detecting the at least one charging error.

(’397, 13:20-23 (Claim 10).)

262. It would have been obvious to one of ordinary skill in the art that Tanaka and Potega, in view of Stephens, discloses an “**error indication upon detecting the at least one charging error**”. As discussed under the context of claim 9 above, Stephens discloses that charging logic 175 indicates to a user via indicator 120 whether an error was detected during the charging operation. (Stephens, 4:34-38.) “[I]ndicator 120 is a three state indicator made up of red LED 121 and green LED 122. When red LED 121 is lit, an ‘error’ condition is indicated.” (Stephens,

4:40-42 (emphasis added).) For example, if one of the error conditions described above under claim 9 are satisfied, block 2060 turns on the "error" indicator by turning on red LED 121. (*See Id.*, Fig. 8.)

263. As discussed in connection with claim 9, a person of ordinary skill in the art would have been motivated to combine the teachings of Tanaka, Potega, and Stephens. A person of ordinary skill in the art would have been motivated to apply charging error indicators to the system of Tanaka to alert a user of a problem and potentially mitigate damage to the device, battery, and/or the surroundings. As discussed above, Freedman discloses that "[f]ailure to observe safety precautions" may cause the battery to "overheat vent, or leak electrolyte" and potentially result in explosions or extremely serious fires. (Freedman, 1:22-30.) Accordingly, one of ordinary skill in the art would have understood and appreciated that an indicator alerting a user of a problem would be highly beneficial to modify and enhance the "device protection measures" disclosed in Tanaka. Accordingly, claim 10 is obvious under Tanaka and Potega in view of Stephens.

VI. NO SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

264. As explained in **Part III.B**, I understand that "secondary considerations" may be used as indicia of nonobviousness, provided that there is a nexus to the invention claimed. I understand from counsel, that Patent Owner in the

district court litigation has not yet identified any secondary considerations evidence with a nexus to the claimed invention. Nor am I aware of information, such as commercial success, unexplained results, long felt but unsolved need, industry acclaim, simultaneous invention, copying, skepticism by experts, and failure of others, suggesting that the claims in this Declaration are not obvious. To the extent Patent Owner provides information it claims relates to secondary considerations, I reserve the right to supplement my analysis and opinions to comment on it.

VII. CONCLUSION

265. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in this proceeding. If required, I will appear for cross-examination at the appropriate time. I reserve the right to offer opinions relevant to the invalidity of the challenged claims at issue and/or offer testimony in support of this Declaration.

Declaration of Regan Zane, Ph.D. in Support of
Petition for *Inter Partes* Review of
U.S. Patent No. 8,610,397 B2

266. I hereby declare that all statements made herein of my own knowledge are true and that all statements are made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: October 7, 2025

Respectfully submitted,

A handwritten signature in cursive script, reading "Regan Zane", is written over a horizontal line.

Regan Zane, Ph.D.

Appendix A



Dr. Regan A. Zane

Director ASPIRE NSF Engineering Research Center

David G. and Diann L. Sant Endowed Professor
Department of Electrical and Computer Engineering

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SHORT BIO

Dr. Regan Zane is the founding Director of the Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE), an NSF sponsored engineering research center involving 10 universities, 4 national labs, more than 85 faculty and staff, more than 300 students, and more than 60 industry and innovation partners. He holds the David G. and Diann L. Sant Endowed Professor position at Utah State University in the Department of Electrical and Computer Engineering, where he founded the USU Power Electronics Lab (UPEL), the Electric Vehicle and Roadway (EVR) research facility and test track, and the Battery Limits and Survivability Test (BLAST) lab.

Dr. Zane is an IEEE Fellow and has published more than 250 peer-reviewed articles, served as co-inventor on more than 40 issued patents, received international and institutional recognition in research, teaching and innovation, and raised more than \$190 million in research, development and demonstration funding. His programs maintain a strong emphasis on collaboration with academic, government and industry partners to develop and transition innovative technologies into the marketplace.

Dr. Zane has made significant contributions to the design, modeling, and application of resonant converters and to the development of advanced control techniques for modular power converters in a wide range of applications. His current programs cover key aspects of electrified transportation, from battery, vehicle, and charging systems to grid integration, smart charge management, demand response and distributed energy resources. Additional topics include wireless power transfer, medium voltage grid-tied power converters, control of modular scalable series and parallel input and output converters, high efficiency, high frequency, high power density, and high performance dc-dc, ac-dc, dc-ac power converters, ac and dc microgrids, battery management systems, drivers for LEDs and discharge lamps in energy efficient lighting systems, active stability control and adaptive tuning in multi-input, multi-output converter systems, active converter and system health monitoring, power integrated circuit design, and low-power energy harvesting.

EMPLOYMENT

- 2020 – present **Director**, NSF Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE) Engineering Research Center, College of Engineering, Utah State University.
- 2012 – present **Full Professor**, *Department of Electrical and Computer Engineering*, Utah State University. **David G. and Diann L. Sant Endowed Professor** (since 2018) and **USTAR Professor** (2012 – 2018). Founding Director of the Center for Sustainable Electrified Transportation (SELECT), Electric Vehicle & Roadway (EVR) Research Facility and Test Track and USU Power Electronics Lab (UPEL).
- 2008 – 2016 **Associate Professor**, *Department of Electrical, Computer, and Energy Engineering*, University of Colorado at Boulder.
- 2001 – 2008 **Assistant Professor**, *Department of Electrical and Computer Engineering*, University of Colorado at Boulder.
- 1999 – 2001 **Senior Research Scientist**, *Electronic Power Conversion*, Corporate Research & Development Center, General Electric, Niskayuna, NY. Principle researcher in area of custom integrated circuits for power management applications within GE businesses with an emphasis on miniature controllers for energy efficient lighting systems.

EDUCATION

Institution	Degree	Year	Field of Study
University of Colorado at Boulder	Ph.D. (GPA: 4.0)	1999	Electrical Engineering
Dissertation title , “ <i>Development, analysis, and implementation of an ASIC controller for single-phase power factor correction.</i> ”			
University of Colorado Boulder	M.S. (GPA: 4.0)	1998	Electrical Engineering
University of Colorado Boulder	B.S. (GPA: 4.0)	1996	Electrical Engineering

HONORS AND AWARDS

2025	IEEE Fellow
2021	Campus Researcher of the Year Award, Utah State University
2020	Utah Clean Cities Sustainability Partner of the Year (for SELECT & ASPIRE Centers)
2019	Utah Innovation Award in Clean Technology and Energy for “Robust and Efficient Battery Management System,” sponsored by Utah Governor’s Office of Economic Development
2018	David G. and Diann L. Sant Endowed Professor, Utah State University
2017	Department Researcher of the Year Award, ECE Department, Utah State University
2015	Inaugural Director of the USU Electric Vehicle and Roadway (EVR) Research Facility and Test Track
2011	Selected member of the 2012-2013 Defense Sciences Study Group (DSSG), Institute for Defense Analyses (IDA), US Defense Advanced Research Projects Agency (DARPA)
2011	Holland Teaching Award, University of Colorado
2009	IEEE Power Electronics Society Transaction Prize Letter Award
2008	IEEE Power Electronics Society Richard M. Bass Outstanding Young Power Electronics Engineer Award
2008	Coleman Institute Faculty Sabbatical Fellowship
2008	John and Mercedes Peebles Innovation in Teaching Award, University of Colorado
2007	IEEE Power Electronics Society Transaction Prize Letter Award
2007	Senior Member, IEEE
2006	Provost Faculty Achievement Award, University of Colorado
2006	Inventor of the Year Award, Technology Transfer Office, University of Colorado
2006	IEEE MTT Microwave Prize for best journal paper
2004	NSF Faculty Early Career Development (CAREER) Program Award Recipient
2001	Six-Sigma Green Belt Certificate, GE Corporate Research and Development
2001	Manager’s Award, General Electric Corporate Research and Development

PUBLICATION RECORD**Books** (published or in press)

- [1] L. Corradini, D. Maksimovic, P. Mattavelli, R. Zane, *Digital control of high-frequency switched-mode power converters*, Hoboken, NJ: Wiley, 2015.

Journals (published or in press)

- [1] S. Gurudiwan, A. Zade, H. Wang and R. Zane, "Optimized Timing Control for Leading-Edge Aligned Modulation of a T-Type Bridge in Unfolding-Based AC–DC Converters," in *IEEE Transactions on Power Electronics*, vol. 40, no. 4, pp. 4716-4721, April 2025, doi: 10.1109/TPEL.2024.3514819.
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- [16] M. Kamel, V. Sankaranarayanan, R. Zane, D. Maksimovic, “State-of-Charge Balancing with Parallel and Series Output Connected Battery Power Modules,” *IEEE Transactions on Power Electronics*, vol. 37, no. 6, pp. 6669 – 6677, Jan. 2022, doi: 10.1109/TPEL.2022.3143835.
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- [4] R. Hassan, H. Wang, R. Zane, “A Power Electronic Instrument for Continuously Monitoring Stability and stabilizing a dc microgrid,” Disclosure submitted Dec. 2019, US patent application pending, US20210293893A1.
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Invited Presentations and Seminars

- [1] R. Zane, keynote speaker, “The Future of Electrified Transportation — Power Electronics to the Rescue!,” IEEE COMPEL 2025, Knoxville, TN, Jun 2025.
- [2] R. Zane, invited speaker, “Advanced EV charging infrastructure: supporting the grid of the future,” GE Electrification Forum, Niskayuna, NY, Oct. 2023.
- [3] R. Zane, invited speaker, “ASPIRE Overview and the Future of Electrified Transportation in Utah,” Utah AFL-CIO Annual Convention, West Valley City, UT, Jun. 2023.

- [4] R. Zane, invited speaker, “ASPIRE pilots and State of Utah Transportation Electrification Initiative,” Salt Lake City Infrastructure Committee meeting, Salt Lake City, UT, Apr. 2023.
- [5] R. Zane, invited speaker and panelist, “Cross-agency, Coordinated Multi-modal Electrification Plan,” UTA Electrification Forum, Salt Lake City, UT, Sep. 2022.
- [6] R. Zane, invited speaker and panelist, “Status and Future of Wireless Charging,” IEEE International Transportation Electrification Conference, ITEC 2022, Anaheim, CA, Jun. 16, 2022.
- [7] R. Zane, invited plenary dinner presentation, “A Perspective on the Future of Electrified Transportation and its Demand for Copper,” Rio Tinto Customer Day, Salt Lake City, UT, Jun. 1, 2022.
- [8] R. Zane, invited public talk, “Electric Avenues – The Future of Electrified Transportation,” USU Science Unwrapped series, Logan, UT, Apr. 1, 2022. <https://www.youtube.com/watch?v=Kb7yXprPNhM>.
- [9] R. Zane, invited talk, “Launching your Engineering Career – Electrified Transportation,” USU Launch your Engineering Career series for engineering students, Logan, UT, Mar. 30, 2022.
- [10] R. Zane, invited webinar, “Impact of wireless charging on battery requirements for EVs,” Stanford StorageX International Symposium, August 27, 2021. <https://energy.stanford.edu/storagex-initiative/events/past-events>.
- [11] R. Zane, invited webinar, “An Electric Future for Transportation,” Center for Transportation, Environment, and Community Health (CTECH), Impacts of Transportation and Urban Systems on Health and the Environment Webinar Series, Apr. 6, 2021. https://vod.video.cornell.edu/media/CTECH+Webinar+Series+-+An+Electric+Future+for+Transportation.CC1/I_rgf9l39m
- [12] R. Zane, invited speaker and panelist, “ASPIRE NSF Engineering Research Center and UTA Intermodal Hub Project,” Utah Institute of Transportation Engineers (ITE), UPA UT, WTS Panel Workshop, Feb. 16, 2021.
- [13] R. Zane, invited roundtable moderator, “An EV Future webinar: Designing the Infrastructure,” US DOE Office of Electricity An EV Future Initiative webinar, Dec. 9, 2020.
- [14] R. Zane, “Electric Road Studies: Utility Power Requirements and Upgrade Costs,” invited presentation, US Department of Energy (DOE) and International Energy Agency (IEA) Hybrid Electric Vehicle (HEV) Task 45 Electrified Roadways committee webinar, Nov. 18, 2020.
- [15] R. Zane, invited roundtable moderator, “An EV Future webinar: Managing Load,” US DOE Office of Electricity An EV Future Initiative webinar, Nov. 5, 2020.
- [16] R. Zane, C. Fawson, invited breakout speaker, Energy Technology and Innovation Outlook panel, Utah Economic & Energy Summit, Oct. 26, 2020.
- [17] R. Zane, “Advancing Sustainability through Powered Infrastructure for Roadway Electrification,” invited presentation, NSF POETS ERC Annual Meeting, Oct. 2020.
- [18] R. Zane, “Utah’s future in electrified transportation,” invited interview, Live Electric series podcast, hosted by Rocky Mountain Power, Oct. 2, 2020.
- [19] J. Campbell, R. Zane, A. Graul, Z. Song, T. Molloy, B. Grunkemeyer, “Western Smart Plug-in Electric Vehicle Community Partnership Lessons Learned,” invited panelists, webinar hosted by Rocky Mountain Power, Sep. 10, 2020.
- [20] R. Zane, “Electrified roadways,” invited radio interview, USU INSTEAD podcast series, Episode 36, Aug. 2020.
- [21] R. Zane, “Microgrid demonstration project, smart charge management, and electrified transportation,” invited presentation, UK delegation on electric utilities, hosted by Rocky Mountain Power, Salt Lake City, UT, Dec. 2019.
- [22] R. Zane, “Electric roadways – technology overview,” invited keynote presentation, Charging Ahead – SELECT Thought Leadership Series, West Lafayette, IN, Oct. 2018.
- [23] R. Zane, A. Kamineni, “Practical challenges in designing a dynamic wireless charging system,” invited presentation, IEA HEV-TCP Task 26 Workshop 9 on Wireless Charging, Detroit, MI, Nov. 6-7, 2018.
- [24] R. Zane, invited Future of Transportation Keynote Speaker, Utah Clean Cities 25th Anniversary celebration, Salt Lake City, UT, Nov. 2, 2018.

- [25] R. Zane, two-week invitation as a visiting professor at the University of Cantabria, Spain. Provided guest seminars on “Electric roads – a vision for the future of transportation,” “Electric bike design,” “Vehicle controller design,” and a tutorial on “Basics of inductive charging systems.” Santander, Spain, May 2018.
- [26] R. Zane, one-week invitation as a visiting professor at India Institute of Technology, Kharagpur. Provided an IEEE society Talk on “Challenges and opportunities in transportation electrification,” a seminar on “Electric vehicle charging infrastructure,” and guest lectures on “Vehicle controller design,” “Electric bike design,” and “Life balancing active battery management systems.” Kharagpur, India, March 2018.
- [27] R. Zane, Live Electric Week, invited guest panelist on RadioActive, KRCL 90.9fm Salt Lake City radio, Sep. 2017.
- [28] R. Zane, invited speaker and panelist, “Transportation Solutions for Improved Air Quality,” The Governor’s Utah Energy Development Summit, Salt Lake City, UT, May 2017.
- [29] R. Zane, “A sustainable (electrified) future for roadway transportation,” Clean Energy Institute invited seminar, University of Washington, Seattle, WA, Apr. 2017.
- [30] R. Zane, “Autonomy and electrification,” invited guest lunch speaker, Federal Highway Administration (FHWA) Western Administrators Annual Meeting, Salt Lake City, UT, Mar. 2017.
- [31] R. Zane, “Charging infrastructure for electric vehicles,” Rocky Mountain Power Electric Vehicle Technology Workshop, Salt Lake City, UT, Jan. 2017.
- [32] R. Zane, “Electric roadways,” invited guest interview, Cool Science Radio hosted by Lynn Ware Peek and Chris Cherniak, KPCW NPR radio, Dec. 2016.
- [33] R. Zane, “Modular battery systems,” IEEE ESARS / International Transportation Electrification Conference, Toulouse, France, Nov 2-4, 2016.
- [34] R. Zane, “Technologies to accelerate electric vehicle adoption,” SAGE Westin Roundtable Series, University of Wisconsin-Madison, WI, Nov. 2016.
- [35] R. Zane, “Wireless EV charging systems for electrified roadways,” Electric Vehicle Technology Conference (EVTC), Cocoa, FL, Oct. 2016.
- [36] R. Zane, “Center for Sustainable Electrified Transportation (SELECT),” invited presentation, Federal Highway Administration (FHWA), Salt Lake City, UT, Aug. 2016.
- [37] R. Zane, “Electrification: Sustainability for transportation systems,” invited presentation, Ben-Gurion University of the Negev, Ben-Gurion, Israel, Jul 2016.
- [38] R. Zane, “Electrification: Towards a sustainable future for our transportation system,” USU Sunrise Session, Salt Lake City, UT, Jan. 2016
- [39] R. Zane, “Sustainable electrified transportation,” Institute of Transportation Engineers (ITE) Annual Conference, Salt Lake City, UT, Jan. 2016.
- [40] R. Zane, “Center for Sustainable Electrified transportation Systems (SELECT),” USTAR confluence annual conference, Salt Lake City, UT, Sept. 2015.
- [41] R. Zane, “Rush Hour. Transportation solutions for a sustainable urban Salt Lake,” invited panelist, public event at The Leonardo, Salt Lake City, Aug. 2015.
- [42] R. Zane, “USTAR advanced transportation institute,” USTAR confluence annual conference, Salt Lake City, UT, Nov. 3-4, 2014.
- [43] R. Zane, “Vehicle power management: research advances for cost and weight reduction,” Battery Show and Electric & Hybrid Vehicle Technology Conference, Novi, MI, Sep. 15 – 17, 2014.
- [44] R. Zane, “Research directions at the USU Power Electronics Lab (UPEL),” invited presentation, University of Cantabria, Santander, Spain, Jun. 26, 2014.
- [45] R. Zane, “Advances in electrified transportation and power electronics at the USU Power Electronics Lab (UPEL),” USU Foundation Board Meeting, Park City, May 7, 2014.

- [46] R. Zane, “High efficiency energy conversion for next generation energy systems and electronic loads,” National Academy of Engineering (NAE), EU-US Frontiers of Engineering (FOE) Symposium, Beckman Center, Irvine, CA, Nov. 3 – 5, 2011.
- [47] R. Zane, Z. Popovic, “Low power RF energy harvesting,” invited presentation, MIT MTL/MITEI Workshop on Next Generation u-Energy Systems, Cambridge, MA, Dec. 2010.
- [48] Z. Popovic, R. Zane, “Integrated design of power management and RF powering,” invited presentation, *Energy challenges in RFIDs and wireless sensors, European microwave conference*, Paris, France, Sep. 2010.
- [49] R. Zane, D. Maksimovic, “Digital control of SMPS,” invited industry short course, Analog Devices, Inc., Shanghai, China and San Jose, CA, Aug. 2010.
- [50] R. Zane, “Energy harvesting & power electronics,” invited presentation and panel session on energy harvesting, *IEEE Appl. Power Electron. Conf. Expo.*, Palm Springs, CA, Feb. 2010.
- [51] R. Zane, Z. Popovic, “RF energy harvesting: what, where, why and how,” invited presentation, *IDTechEx Energy Harvesting & Storage USA*, Denver, CO, Nov. 2009.
*Hosted an invited laboratory tour for the conference at UCB.
- [52] R. Zane, “Efficient low power energy harvesting for miniature wireless devices,” invited presentation, *CMOS Emerging Technologies Workshop*, Vancouver, BC, Sep. 2009.
- [53] R. Zane, “Efficient power management for low power energy harvesting,” invited presentation, *Darnell nanoPower Forum*, San Jose, CA, May 2009.
- [54] R. Zane, D. Maksimovic, J. Morroni, “Digital control of SMPS,” invited industry short course, Lockheed Martin, Grand Prairie, TX, Mar. 2009.
- [55] R. Zane, “Low Power Energy Harvesting -- Making the Difference with Efficient Power Management,” invited presentation, Future of DC-DC Conversion, IEEE Applied Power Electronics Specialists Conference (APEC), Washington D.C., Feb. 2009.
- [56] R. Zane, “Towards externally powered telemetric chronic neural implants,” invited seminar as part of the NSF international collaboration travel grant, Towards a Dynamic Brain Clamp, Federal University of Ceara, Sobral, Brazil, Jan 2009.
- [57] R. Zane, “Low power energy harvesting for wireless sensors,” Grainger invited seminar series, University of Illinois, Champaign-Urbana, Dec. 2008.
- [58] R. Zane, “Digital control in SMPS,” invited industry short course, On-semiconductor, Toulouse, France, May 2008.
- [59] Z. Popovic, R. Zane, “RF energy harvesting,” invited presentation, *Darnell nanoPower Forum*, San Jose, CA, Jun. 2008.
- [60] R. Zane, “Digital auto-tuning and adaptive techniques for SMPS,” invited seminar, IEEE PELS-IES joint technical session, Santander, Spain, Apr. 2008.
- [61] J. Shin, R. Zane, Z. Popovic, “Batteryless microPower sensors for context aware technologies,” invited presentation, RESNA 2007, sponsored by NSF Emerging Technology – Tools for the Future, Phoenix, AZ, Jun. 2007.
- [62] R. Zane, Z. Popovic, “Efficient low power RF energy harvesting and power management,” invited presentation, *Darnell nanoPower Forum*, San Jose, CA, Jun. 2007.
- [63] R. Zane, “CAREER: Modeling, control and design of energy-efficient lighting systems,” invited presentation, NSF 2004 Grantees workshop, Reno, NV, Apr. 2007.
- [64] R. Zane, D. Maksimović, “Digital control of switch-mode power supplies,” on-site invited industry short course, Analog Devices Inc., San Jose, CA, Jul. 2006.
- [65] R. Zane, D. Maksimović, “Digital control of switched-mode power supplies,” professional educational seminar, *IEEE Applied Power Electronics Conference and Exposition*, Dallas, TX, Mar. 2006.

- [66] R. Zane, Z. Popovic, “Harvesting ambient energy for low power sensors,” invited presentation, *IEEE Presents Innovation and Technology in Colorado*, Colorado Technology Week, Denver, CO, Oct. 2005.
- [67] R. Zane, Z. Popovic, “Batteryless MicroPower Sensors for Context Aware Technologies,” invited presentation, *Annual Coleman Institute Meeting*, Oct. 2005.
- [68] R. Zane, D. Maksimović, B. Miao, “Active identification and automated digital controller design in DC-DC power converters,” invited presentation, *Annual AFRL Space Power Workshop*, Apr. 2005.
- [69] T. Zhao, J. Israel, R. Zane, Z. Popovic, “Electronics for wireless neural sensors,” poster presentation, *Coleman Institute Annual Conference*, Oct. 2004.
- [70] R. Zane, “Digital control in switch mode power supplies,” on-site invited industry tutorial, Artesyn Technologies, Framingham, MA, May 2004.
- [71] D. Maksimović, A. Prodic, R. Zane, “Digital control of high-frequency switching power converters,” professional educational seminar, *IEEE Applied Power Electronics Conference and Exposition*, Anaheim, CA, Feb. 2004.
- [72] D. Restrepo, D. Finch, R. Zane, A. Sharp, “CEMS-based chronic brain implants,” poster presentation, *Coleman Institute Annual Conference*, Oct. 2003.
- [73] R. Zane, D. Maksimović, “Custom IC blocks for enabling digital control in switching power converters,” invited lecture series, *IEEE Solid-State Circuits Society*, Denver chapter, Jul. 2003.
- [74] R. Zane, D. Maksimović, “Digital control in switching converters,” *Annual AFRL Space Power Workshop*, Apr. 2003.
- [75] D. Restrepo, D. Finch, R. Zane, M. Stowell, A. Sharp, “CEMS-based chronic brain implants,” poster presentation, *Coleman Institute Annual Conference*, October 2002.
- [76] D. Maksimović, R. Zane, “Scalable digital control for switching power converters,” invited presentation, *Intel Technology Symposium*, Seattle, Aug. 2002.
- [77] R. Zane, D. Maksimović “Intelligent control in power converters and systems” *DARPA workshop on integrated smart power*, Arlington, VA, Nov. 2002.

RESEARCH GRANTS & CONTRACTS

Research Grants and Contracts Awarded

Department of Energy, “SuperCharge: Sustainable Utilization of Power Infrastructure Enabling Rapid and Replicable MHDVs Charging through Hybrid AC/DC Distribution Networks and Renewable Grid Energy Integration,” USU Total: \$22M. Role: PI. Oct. 2025 – Sep. 2028.

Department of Energy, “Wasatch Front Multi-Modal Corridor Electrification Plan,” USU total: \$1.12M. Role: PI. Oct. 2023 – Mar 2025.

State of Utah, “Statewide Strategic Planning for Transportation Electrification Infrastructure,” \$2.1M per year ongoing state appropriation, USU total over first 5 years: \$10.5M. Role: PI. Jul 2023 – June 2028.

State of Utah, “Freight Logistics Electrification Demonstration Project,” One-time State appropriation, USU total: \$15M. Role: PI. Jul 2022 – June 2025.

State of Utah, “Battery Electric Trainset Development,” One-time State appropriation, Total: \$24M. Role: PI. Partnered with Stadler Rail. Jul 2022 – June 2026.

Department of Energy, “Utility Managed Distributed Energy Resources Intelligent Community, UDERMS iCommunity,” total prime DOE share to Rocky Mountain Power: \$6.42M; USU subaward DOE share total: \$2.4M. Role: USU PI, program Co-PI. Jan 2021 – Dec 2024.

National Science Foundation, “High School Creative Design Course Supplement: Engineering Research Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE),” USU total: \$378k. Role: PI & Director. Sep 2021 – Aug 2023. Investigators: R. Zane (PI, USU), K. Gkritza (Purdue), Q. Lv (CU-Boulder), S. Nazarian (UTEP), G. Covic (Univ. of Auckland).

National Science Foundation, “2021 NSF Internship Supplements: Engineering Research Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE),” USU total: \$231k. Role: PI & Director. Sep 2021 – Aug 2023. Investigators: R. Zane (PI, USU), K. Gkritza (Purdue), Q. Lv (CU-Boulder), S. Nazarian (UTEP), G. Covic (Univ. of Auckland).

State of Utah, “Freight Logistics Electrification Demonstration Pre-pilot,” One-time State appropriation, USU total: \$5M. Role: PI. June 2021.

National Science Foundation, “Engineering Research Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE),” USU total: \$26M. Role: PI & Director. Sep 2020 – Aug 2025 (renewable for 10 years, \$50.6M total). Investigators: R. Zane (PI, USU), K. Gkritza (Purdue), Q. Lv (CU-Boulder), S. Nazarian (UTEP), G. Covic (Univ. of Auckland).

Department of Energy, “Western Smart Regional EV Adoption and Infrastructure at Scale (WSEV@Scale),” total prime DOE share to Rocky Mountain Power: \$6.6M; USU subcontract DOE share: \$3.3M. Role Co-PI, USU lead. Oct. 2020 – Sep. 2023.

Department of Energy, “eMosaic: Electrification Mosaic Platform for Grid-Informed Smart Charging Management,” total prime DOE share to ABB, Inc.: \$4.9M; USU subcontract DOE share: \$1.5M. Role Co-PI, USU lead. Oct. 2020 – Dec. 2024.

Department of Energy, “Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification,” total prime DOE share to USU: \$1.75M. Role: Co-PI. Oct 2020 – Dec. 2023. USU Investigators: Z. Song (PI), R. Zane (Co-PI), A. Graul (Co-PI).

Department of Energy, “Resilient-Interoperable-Smart Charge Management Control Systems Architecture for EVs at scale,” total prime DOE share to Dream Team Co LLC: \$4.76M, USU subcontract DOE share \$1.1M. Role: Co-PI. Oct. 2020 – Dec. 2024. USU Investigators: A. Kamineni (PI, USU), R. Zane (USU).

State of Utah, “Electrified Transportation, Support for SELECT Center and ASPIRE ERC Growth,” One-time State appropriation, USU total: \$3M. Role: PI. June 2020.

Pacificorp, “Power Balance and Demand Response for a Charging Intermodal Hub,” USU total: \$1.9M. Role: PI. Dec 2019 – Dec 2021. Investigators: R. Zane (PI, USU), J. Gunther (USU).

CBMM North America, Inc., “Nanocrystalline cores in wireless chargers,” USU total: \$100k. Role: Co-PI. Dec 2019 – Dec 2010. Investigators: A. Kamineni (PI, USU), R. Zane (USU).

Tokef LLC, “Hybrid Energy Storage for UTVs – Milestone 2,” USU total: \$111k. Role: PI. Sep 2019 – Sep 2020. Investigators: R. Zane (USU, PI).

Toyota Motor North America, “Augmentation to Phase 2 and Phase 3: Design, Development and Testing of a Dynamic Wireless Power Transfer System for Electric Vehicles,” USU total: \$133k. Jan 2019 – Dec 2019. Investigators: R. Zane (USU, PI), A. Kamineni (USU).

Toyota Motor North America, Visiting Scientist PhD program agreement for Shuntaro Inoue, USU total: \$267k. Aug 2019 – Jul 2023. Investigators/co-advisors: R. Zane (USU, PI), A. Kamineni (USU).

Department of Energy, “Long-range battery electric vehicle with megawatt wireless charging,” total prime DOE share: \$5M; USU subcontract DOE share: \$960,000. Role: Project Co-PI, USU lead. Oct 2019 – Sep 2022. Investigators: B. Lindgren (Kenworth), R. Zane (USU), M. Masquelier (WAVE), M. Casteel (UPS), S. Kiliccote (eIQ), E. Smalley (Seattle City Light), L. Whittemore (PGE).

DOE ARPA-E, “Low-cost, easy-to-integrate, and reliable grid energy storage system with 2nd life lithium batteries,” total prime DOE ARPA-E share: \$2M; USU subcontract total DOE share: \$631,645. Role: Project Co-PI, USU lead. May 2019 – June 2021. Investigators: A. Tong (UCSD), R. Zane (USU), J. Quinn (CSU).

Idaho National Laboratory / Battelle, “WPT technical support for cyber security research,” USU total: \$31k. Role: PI. Feb 2019 – Jan 2020. Investigators: R. Zane (USU, PI), A. Kamineni (USU).

Toyota Motor North America, Inc., “Characterization of the Evatran PLUGLESS 7.2 kW System,” USU total: \$62k. Role: PI. Jan 2019 – Apr 2020. Investigators: R. Zane (USU, PI), A. Kamineni (USU).

AECOM Technical Services, Inc., “Illinois tollway pre-pilot feasibility study,” USU total: \$280k. Role: PI. Jan 2019 – Dec 2019. Investigators: R. Zane (PI, USU), A. Kamineni (USU), M. Halling (USU), N. Roberts (USU).

US DOT Federal Transit Administration (FTA), “Electric Bus Corridor Model,” USU total: \$50k. Role: Co-PI. Jan 2019 – Mar 2020. Investigators: Z. Song (PI, USU), R. Zane (USU).

USTAR Industry Partnership Program, “Development of an integrated thermal management and optimized concrete enclosure for stationary wireless charging systems,” USU total: \$363k, Jan. 2019 – Apr 2020. Investigators: N. Roberts (PI, USU), R. Zane (USU), M. Halling (USU).

Department of Energy, “Enabling secure and resilient XFC: A software/hardware security co-design approach,” Virginia Tech prime contractor, total DOE share \$2.5M; USU subcontract total DOE share: \$577,213. Role: Project Co-PI, USU lead. Oct. 2018 – Dec 2020. Investigators: R. Gerdes (VT), S. Rahman (VT), K. Heaslip (VT), R. Zane (USU), A. Paaso (ComEd), C. Rodine (ChargePoint), P. Jonathan (OnBoard Security), K. Vamvoudakis (Georgia Tech), M. Pipattanasomporn (VT), S. Bogosyan (Istanbul Tech).

Department of Energy, “High power wireless extreme fast charging development and deployment for electric trucks,” WAVE prime contractor, total DOE share: \$4.3M, USU total: \$636,364. Role: Project Co-PI, USU lead. Aug. 2018 – Jul. 2021. Investigators: M. Masquelier (WAVE), R. Zane (USU), K. Aron (Schneider Electric), J. Kreese (Cummins), T. Williamson (TTSI).

Raytheon Integrated Defense Systems, “Analysis and design of the series resonant converter and parallel resonant converter and wireless power transfer,” USU total: \$74,799. Role: PI. May 2018 – Dec 2018. Investigators: R. Zane (PI, USU).

TransChill, LLC, “Battery energy storage system for transport chillers,” USU total: \$99,949. Role: PI. Jan. 2018 – Aug. 2018. Investigators: R. Zane (PI, USU).

Tokef LLC, “Hybrid energy storage for electric trucks,” USU total: \$19,916. Role: PI. Apr. 2018 – Jul. 2018. Investigators: R. Zane (PI, USU).

Tokef LLC, “Feasibility study for electric roadway paint,” USU total: \$23,455. Role: Co-PI. Apr. 2018 – Sep. 2018. Investigators: R. Christensen (PI, USU), R. Zane (Co-PI, USU).

PacifiCorp, “Advancing smart inverter integration in Utah,” USU, total \$99,997. Role: PI. Jan. 2018 – Dec. 2018. Investigators: R. Zane (PI, USU).

PacifiCorp, “Development and demonstration of a microgrid system at the USU EVR,” USU, total \$189,999. Role: PI. Jan 2018 – Jun. 2020. Investigators: R. Zane (PI, USU).

DOE ARPA-E, “Feasibility analysis of electric roadways through localized traffic, cost, adoption, and environmental impact modeling,” USU, total \$498,170. Role: PI. Oct. 2017 – Sep. 2018. Investigators: R. Zane (PI, USU), Z. Song (Co-PI, USU), J. Quinn (Co-PI CSU), N. Gkritza (Co-PI Purdue).

USTAR, “Thermal management test lab for high reliability energy storage systems,” USU total: \$694,514. Role: PI. May 2017 – Feb 2017. Investigators: R. Zane, (PI, USU).

NASA, “Active battery management system with physics based life modeling,” EP Systems prime contractor, subcontract to USU. USU total: \$29,252. Role: PI. Jun 2017 – Nov 2017. Investigators: R. Zane (PI, USU).

Raytheon Integrated Defense Systems, “Power system control,” USU total: \$25,522. Role: PI. May 2017 – Sep 2017. Investigators: R. Zane (PI, USU).

Electric Power Systems LLC, “Development of a passive battery management system for a silicon nanowire battery,” USU total: \$15,078. Role: PI. Mar 2017 – Aug 2017. Investigators: R. Zane (PI, USU).

Department of Energy, “WestSmartEV: Western Smart Plug-in Electric Vehicle Community Partnership,” Rocky Mountain Power (RMP) prime contractor, total prime DOE share: \$4M; total DOE share subcontract to USU: \$1.2M. Role: Co-PI. Jan 2017 - Dec 2019. Investigators: Z. Song (PI, USU), R. Zane (Co-PI, USU).

Raytheon Integrated Defense Systems, “Analysis and design of series resonant converter (SRC) prototype with digital control,” USU total \$149,998. Role: PI, Jan 2017 – Dec 2017. Investigators: R. Zane (PI, USU).

Colorado DOT, “Phase 1: Planning study for electric roadway pilot project,” AECOM prime contractor, subcontract to USU. Role: PI. Jan 2017 – May 2017. USU Total: \$90k. R. Zane (PI, USU).

USTAR Engineering Research Triangle, “Automated monitoring and control of electric vehicle charging infrastructure,” USU total: \$40k. Role: Co-PI. Jan 2017 – Dec 2017. Investigators: M. Parvania (UofU), R. Zane (USU), J. Salmon (BYU).

NIDILRR, “Energy management system for battery powered mobility devices based on wireless power transfer concept to promote community living and participation,” USU total: \$599,077. Role: Co-PI. Sep 2016 – Sep 2019. Investigators: Z. Pantic (PI, USU), R. Zane (Co-PI, USU), C. Bodine (Co-PI, UC-Denver), C. Coopmans (Co-PI, USU).

Raytheon Integrated Defense Systems, “CHIPS: research, magnetics design, and breadboard,” USU total \$73,080. Role: PI, Oct 2016 – Mar 2017. Investigators: R. Zane (PI, USU).

ONR, “Robust plug-and-play expeditionary battery system,” Utah State University (USU). Total: \$737,217. Role: PI, Sep 2016 – Dec 2018. Investigators: R. Zane (PI, USU), K. Smith (Co-PI, NREL), S. Trimboli (Co-PI, UCCS), D. Maksimovic (Co-PI, CU-Boulder), J. Pinon (Co-PI, HDS).

FTA Lo-No, “Utah’s Public/Public/Private Partnership for the Deployment of Electric Bus Technology: Downtown to the University Connection,” Utah Transit Authority prime contract, subcontract to USU. USU total: \$78k. Investigators: R. Zane (PI, USU), Z. Song (Co-PI, USU), J. Quinn (Co-PI, CSU).

Raytheon Integrated Defense Systems, “Analysis and design of series resonant converter (SRC) prototype with digital control,” USU total \$149,044. Role: PI, Jun 2016 – Dec 2016. Investigators: R. Zane (PI, USU).

Department of Energy (DOE), ARPA-E AMPED, “Hybrid energy storage demonstration plus-up, advanced control of large battery packs,” Utah State University (USU). Total: \$500k. Role: PI, Jan. 2016 – Mar. 2017. Investigators: R. Zane (PI, USU), S. Trimboli (UCCS), D. Maksimovic (UCB), K. Smith (NREL).

USTAR, “Center for Sustainable Electrified Transportation Systems (SELECT),” Utah State University (USU). Total: \$750k. Role: PI, Jul. 2015 – Jun. 2016. Investigators: R. Zane (PI, USU), Z. Pantic (USU), J. Quinn (USU), R. Gerdes (USU), R. Sharma (USU), P. Barr, (USU).

Department of transportation, “Advance Radar based low ground clearance vehicle detection and warning system,” Intelligent Automation Inc (IAI) prime contractor, subcontract to USU. Role: PI, Sep. 2015 to Mar 2016. USU Total: \$10,350.

Peery Foundation, “Bidirectional three phase power inverter for dual purpose grid tied and grid forming applications,” USU total: \$150,000. Role: PI, Jan 2015 – Dec 2017. Investigators: R. Zane (PI, USU).

Utah State University, “Electric Vehicle and Roadway (EVR) Research Facility and Test Track,” R. Zane received \$2.4M award for EVR facility construction and selected as inaugural EVR Director. Construction Aug 2014 – Mar 2015.

Raytheon Integrated Defense Systems, “Analysis and design of series resonant converter (SRC) prototype with digital control,” USU total \$91,927. Role: PI, Jan 2015 – Dec 2015. Investigators: R. Zane (PI, USU).

Department of Energy (DOE), ARPA-E AMPED, “Tech-to-market plus-up, advanced control of large battery packs,” Utah State University (USU). Total: \$170k. Role: PI, Jan. 2015 – Dec. 2015.

Investigators: R. Zane (PI, USU), S. Trimboli (UCCS), D. Maksimovic (UCB), K. Smith (NREL), D. Anderson (Ford).

Office of Naval Research, “Phase I: Hybrid Energy Storage Modules (HESM), Advanced Bi-Directional Power Conversion (BDPC) System,” subcontract to Raytheon, USU Total: \$110K.

Role: PI, Aug 2014 – Jul 2015.

Investigators: R. Zane (PI, USU).

Department of Transportation, “A Novel Multi-Sensor Wireless Network for Bridge Structural Health Monitoring,” subcontract to Intelligent Automation, Inc. (IAI), USU total: \$25K. Jan 2014 – May 2015.

Investigators: R. Zane (PI, USU).

National Institute on Disability Rehabilitation Research, RERC-ACT, “Wireless power system for socially interactive robots,” subcontract to University of Colorado, USU total: \$106K. Nov. 2013 – Dec. 2014.

Investigators: R. Zane (PI, USU), Z. Pantic (USU), R. Baktur (USU).

Raytheon Integrated Defense Systems, “High Power Series Resonant Converter (SRC) 32 kW prototype,” USU total \$99K. May 2013 – Dec. 2013.

Investigators: R. Zane (PI, USU).

Raytheon Integrated Defense Systems, “High Power Series Resonant Converter (SRC) Proof of Concept,” USU total \$30K. May 2013 – Dec. 2013.

Investigators: R. Zane (PI, USU).

DARPA, “Hydraulic actuation for micro-scale robots (HAMR),” subcontract to MIT, USU total: \$252K. Role: Co-PI, Mar 2013 – Aug 2015.

Investigators: A. Hosoi (PI, MIT), K. Iagnemma (MIT), R. Zane (USU).

Department of Energy (DOE), ARPA-E AMPED, “Robust cell-level modeling and control of large battery packs,” Utah State University (USU) lead, team members: National Renewable Energy Labs (NREL), University of Colorado Boulder and Colorado Springs, Ford. Total: \$3.4M.

Role: PI, Jan. 2013 – Dec. 2015.

Investigators: R. Zane (PI, USU), S. Trimboli (UCCS), D. Maksimovic (UCB), K. Smith (NREL), D. Anderson (Ford).

Office of Naval Research, “Support integration and test of power management controller (PMC) for Phase II compact power conversion technology (CPCT) program,” subcontract to Raytheon, USU Total: \$167K.

Role: PI, Aug 2012 – Apr 2013.

Investigators: R. Zane (PI, USU).

Department of Energy (DOE), ARPA-E Solar ADEPT, “Wafer-Level Sub-Module Integrated DC/DC Converter,” CU-Boulder (lead), team members Nuvotronics LLC, National Renewable Energy Labs (NREL), Total: \$1.3M.

Role: Co-PI, Nov. 2011 – Oct. 2014.

Investigators: D. Maksimovic (Program PI, UCB), Z. Popovic (Co-PI, UCB), R. Zane (Co-PI, UCB), Jean Marc Rollin (Co-PI, Nuvotronics), F. Patrick McCluskey (Co-PI, NREL).

Office of Naval Research, “Compact Power Conversion Technologies (CPCT) ONR Phase II: Bidirectional Power Converter,” subcontract to Raytheon, Total: \$542K. Program split between UCB and USU in 2012.

Role: PI, May 2011 – Dec 2012.

Investigators: R. Zane (PI, USU), D. Maksimovic (UCB).

Office of Naval Research, “Support on power converter controls: Compact Power Conversion Technologies (CPCT) ONR Phase I PROGRAM,” subcontract to Raytheon, Total: \$54K.

Role: PI, Jan 2010 – Jun 2010.

Investigators: R. Zane (PI, ECE, UCB), R. Erickson (ECE, UCB), D. Maksimovic (ECE, UCB).

Texas Instruments, “Power control and management for ultra high efficiency data servers,” \$264K:

Role: Co-PI, Colorado Power Electronics Center (CoPEC), Jun 2010 – May 2013.

Investigators: D. Maksimovic (PI, ECE, UCB), R. Zane (Co-PI, ECE, UCB).

Analog Devices, Inc., “Specifications-driven design space boundaries for point-of-load converters,” Total award: \$44K:
Role: PI, Colorado Power Electronics Center (CoPEC), Jan 2010 – Dec. 2010.
Investigators: R. Zane (PI, ECE, UCB), D. Maksimovic (ECE, UCB).

Raytheon Integrated Defense Systems, “Cascade operation of bi-directional power converter (BDPC) using digital control and power factor corrected (PFC) rectifier,” Total: \$18k.
Role: PI, Colorado Power Electronics Center (CoPEC), Jun 2010 – Dec 2010.
Investigators: R. Zane (PI, ECE, UCB), D. Maksimovic (ECE, UCB)

Raytheon Integrated Defense Systems, “Power converter controls for 3-phase DC-AC inverter,” Total: \$50k.
Role: PI, Colorado Power Electronics Center (CoPEC), Jan 2010 – Dec 2010.
Investigators: R. Zane (PI, ECE, UCB), R. Erickson (ECE, UCB), D. Maksimovic (ECE, UCB)

Department of Education, National Institute on Disability Rehabilitation Research, RERC-ACT, “Non-linear context-aware prompting system for adults with cognitive disabilities in the workplace,” Total: \$1.1M.
Role: co-PI, subcontract to UCD, RERC-ACT “Rehabilitation Engineering Research Center on the Advancement of Cognitive Technologies,” program period: Jan 2010 – Dec 2015.
Investigators: M. Melonis (PI, UCB), R. Zane (co-PI, ECE, UCB), Z. Popovic (co-PI, ECE, UCB), A. Mihailidis (co-PI, UCD), S. Van Vuuren (Co-PI, UCB). Prime contract: C. Bodine (PI, Assistive Technology Partners Director, Physical Medicine and Rehabilitation, UCHSC), M. Lightner (ECE, UCB).

Department of Transportation, “A novel multi-sensor wireless network for bridge structural health monitoring,” Total: \$35K, subcontract to Intelligent Automation, Inc.
Role, PI, Jun. 2010 – Jul. 2011.
Investigators: R. Zane (ECE, UCB).

Northrop Grumman, “RF energy harvesting system miniaturization,” Total: \$22k.
Role: PI, Colorado Power Electronics Center (CoPEC), Jan 2009 – Dec 2009.
Investigators: R. Zane (PI, ECE, UCB), Z. Popovic (ECE, UCB).

On-Semiconductor, “Digitally controlled Class-D audio amplifiers for portable applications,” Total: \$44k
Role: PI, Colorado Power Electronics Center (CoPEC), Jan 2009 – Dec 2009.
Investigators: R. Zane (PI, ECE, UCB), L. Corradini (ECE, UCB), R. Erickson (ECE, UCB).

NSF, “Towards a Dynamic Brain Clamp,” International collaboration travel grant, Total: \$30K.
Role: Co-PI; travel grant lead by PI D. Restrepo, UCHSC, UC-Denver; Travel to Federal University of Ceara, Sobral, Brazil, Jan 2009.

Coleman Institute, “Low-power energy harvesting in cognitive disability applications,” Total: \$77K
Sabbatical Faculty Fellowship, Fall 2008 – Spring 2009.
Investigators: R. Zane (Co-PI, ECE, UCB), Z. Popovic (Co-PI, ECE, UCB).

MSI/DARPA, “PPeC: Parasitically Powered embedded Communication,” Total: \$88K
Role: Co-PI, subcontract to MicroSat Systems (MSI), Jan 2008 – Dec. 2008.
Investigators: R. Zane (Co-PI, ECE, UCB), Z. Popovic (Co-PI, ECE, UCB).

NASA, “Wireless Ultrasonic Transducer Network for Airframe Structure Health Management,” Total: \$100K, subcontract to Intelligent Automation, Inc.
Role, PI, Jan. 2008 – Dec. 2010.
Investigators: R. Zane (ECE, UCB).

NSF, “IREE: Modeling, control and design of energy efficient lighting systems,” Total: \$44.5K
Role: PI, International Research and Education in Engineering (IREE) supplement on NSF CAREER grant. Sep. 2007 – Jun. 2008.
Investigators: R. Zane (PI, ECE, UCB).

NSF CNS, “NOSS: An integrated power aware sensor-simulation network system for long-term performance assessment of concrete infrastructures,” Total: \$600K:
Role, Co-PI, Sep. 2007 – Aug. 2010.

- Investigators: X.C. Cai (PI, CS, UCB), R. Zane (ECE, UCB), Y. Xi (Civil, UCB).
- DOE, “Miasolé Solar America Initiative, SAI,” Total: \$1,049,874 (Awarded by DOE, but later withdrawn by Miasole)
Role: Co-PI, DOE SAI, subcontract to Miasolé, Aug. 2007 – Jul. 2010.
Investigators: M. Brandemuehl (PI, CEAE, UCB), R.W. Erickson (ECE, UCB), R. Zane (ECE, UCB).
- On-Semiconductor, “LED drives for general lighting applications,” Total award: \$88K:
Role: PI, Colorado Power Electronics Center (CoPEC), Jan. 2007 – Dec. 2008.
Investigators: R. Zane (PI, ECE, UCB).
- National Semiconductor, “System IC controls for backlighting in LCD HDTV,” Total: \$326K:
Role: PI, Colorado Power Electronics Center (CoPEC), Aug. 2003 – July. 2009.
Investigators: R. Zane (PI, ECE, UCB).
- Powercast Corp., “Integrated design of rectenna and power management circuit,” Total: \$44K:
Role: PI, Colorado Power Electronics Center (CoPEC), Aug. 2007 – July. 2008.
Investigators: R. Zane (PI, ECE, UCB), Z. Popovic (ECE, UCB).
- Analog Devices, Inc., “Digital control loops in SMPS,” Total award: \$176K:
Role: PI, Colorado Power Electronics Center (CoPEC), Oct. 2006 – Dec. 2009.
Investigators: R. Zane (PI, ECE, UCB).
- NASA Glenn, “Spacecraft Power Converter Health Monitoring and Prognostics,” Total: \$137K:
Role: PI, program period: Apr. 2006 – Mar. 2009.
Investigators: R. Zane (PI, ECE, UCB), D. Maksimović (ECE, UCB).
- Astec / Artesyn Technologies, “Auto-tuning controller for POL converters” Total: \$88K
Role: PI, Colorado Power Electronics Center (CoPEC), Jan. 2006 – Dec. 2007.
Investigators: R. Zane (PI, ECE, UCB), D. Maksimović (ECE, UCB).
- Luna Innovations, “Phase II SBIR: RF Power Scavenging for Wireless Sensors,” Total: \$100K
Role: Co-PI, subcontract to Luna Innovations on US Navy/Air Force SBIR Contract No. N00164-05-C-6088, program period: Nov. 2005 – Mar. 2007.
Investigators: Z. Popovic (PI, ECE, UCB), R. Zane (ECE, UCB).
- CU TTO, “Energy harvesting for maintenance free operation of wireless devices,” Total: \$100K:
Role: PI, Proof-of-Concept (POC) competition, program period: July 2006 – May 2007.
Investigators: R. Zane (PI, ECE, UCB), Z. Popovic (ECE, UCB).
- DARPA, “Planer Integrated Power Processor (PIPP),” Total: \$320K:
Role: PI, Phase I: Robust Integrated Power Electronics (RIPE), subcontract to General Electric, program period: Sep. 2005 – Aug. 2009.
Investigators: R. Zane (PI, ECE, UCB), D. Maksimović (ECE, UCB).
- Intel, “High-frequency digital multi-phase controller and modulator,” Total: \$186K
Role: Co-PI, Colorado Power Electronics Center, program period: Jan 2005 – Dec 2006.
Investigators: D. Maksimović (PI, ECE, UCB), R. Zane (ECE, UCB).
- Department of Education, “Batteryless power supplies for sensor technologies,” Total: \$150K:
Role: PI, subcontract to UCHSC, RERC-ACT “Rehabilitation Engineering Research Center on the Advancement of Cognitive Technologies,” program period: Jan 2005 – May 2007.
Investigators: Subcontract: R. Zane (PI, ECE, UCB). Prime contract: C. Bodine (PI, Assistive Technology Partners Director, Physical Medicine and Rehabilitation, UCHSC), M. Lightner (ECE, UCB).
- NSF Faculty Early Career Development (CAREER) Program, “CAREER: Modeling, Control, and Design of Energy-Efficient Lighting Systems,” Total: \$400K + \$6K REU:
Role: PI, program period: Feb. 2004 – Jan. 2010.
Investigators: R. Zane (PI, ECE, UCB).
- NSF, “SENSORS: Collaborative Research: Self-Configuring In Situ Wireless Sensor Networks for Prescribed Fire Management,” Total: \$300K:

Role: Co-PI, program period: Sept 2003 – May 2007.

Investigators: R. Han (PI, CS, UCB), R. Zane (ECE, UCB), L. Queen (School of Forestry, University of Montana), C. Seielstad (School of Forestry, University of Montana).

NASA Glenn Research Center, “Stability Control in PMAD Systems through Power Converter Modules with Direct Digital Control,” Total: \$74K,

Role: PI, program period: Aug 2003 – Nov. 2005.

Investigators: R. Zane (PI, ECE, UCB), D. Maksimović (ECE, UCB).

Artesyn Technologies, “Digital control in multiphase converters” Total: \$74K

Role: PI, Colorado Power Electronics Center (CoPEC), Jan. 2003 – Dec. 2005.

Investigators: R. Zane (PI, ECE, UCB), D. Maksimović (ECE, UCB)

Coleman Institute, “Feasibility study for CEMS-based chronic brain implants,” Total: \$370K:

Role: Co-PI, program period: Jan 2001 – Dec 2004.

Investigators: D. Restrepo (PI, Cell and Developmental Biology, Director Neuroscience, UCHSC), R. Zane (ECE, UCB), A. Sharp (Integrative Physiology, UCB), D. Finch (Mechanical Engineering, UCB).

DOE, “Modeling and IC-Control of High Frequency Electronic Ballasts,” Total: \$154K:

Role: PI, subcontract to General Electric, program period: Aug 2001 – Jul 2004.

Investigators: R. Zane (PI, ECE, UCB).

CoPEC associate memberships, various companies, Total: \$133K:

Role: Co-PI, Zilker Labs, 2003 – 2007, Intersil, 2003 – 2004, Northrop Grumman, 2005 – 2007.

Investigators: R. Erickson, D. Maksimović, R. Zane (all Co-PIs, ECE, UCB).

Philips Research, “Development of Solid-State LED Power Supply,” Total: \$30K:

Role: Co-PI, Colorado Power Electronics Center, Aug 2001 – Jul 2002.

Investigators: R. Erickson (PI, ECE, UCB), R. Zane (ECE, UCB).

TEACHING ACCOMPLISHMENTS

Educational development and research grants

Department of Energy (DOE), “GATE Center of Excellence, in Innovative Drivetrains in Electric Automotive Technology Education (IDEATE),” joint program with University of Colorado Colorado Springs, Total: \$954K.

Role: PI (for CU-Boulder campus), Oct. 2011 – Sep. 2016.

Investigators: G. Plett (Program PI, UCCS), **R. Zane** (sub-contract PI, UCB/USU), D. Maksimovic (UCB).

Teaching – Courses Taught at Utah State University

- Electrified Transportation Systems (aka ASPIRE 101), ECE-MAE-CEE 5930
 - Spring 2022, 2023, and 2024: created new multi-campus, cross-disciplinary course on electrified transportation systems.
- Fundamentals of Electric Power Systems, ECE 5110, 3 credits.
 - Spring 2020: introduced new course materials on electric utility modeling and simulation
- Power Electronics for Electric Drive Vehicles, 3 credits.
 - Fall 2018: introduced as regular course, ECE 5150/6150.
 - Fall 2017, 2016, 2014, 2013, 2012: new course co-developed with CU-Boulder as part of the DOE IDEATE GATE Center. Course was offered via distance learning with lectures, assignments and materials shared between USU and CU-Boulder campuses. Offered as special topics, ECE 5930/6930.
- Electric Vehicles Design Lab, ECE 5930/6930, 3 credits (pre-requisite is Power Electronics for Electric Drive Vehicles theory course).
 - Spring 2018, 2017 and 2013: new laboratory course co-developed with visiting instructor, Daniel Costinett. Redesigning course in Spring 2017 for new lab designs in Spring 2018.
- Modeling and control of power electronics systems, ECE 7170
 - Spring 2020, 2021, 2022, 2023
 - Fall 2018, ECE 7170, introduced as regular course.
 - Summer 2017, Spring 2017, Spring 2015, independent study, ECE 7930

- Digital control of high frequency switched mode power supplies
 - Spring 2022, 2023, Summer 2021, Fall 2019, Fall 2016, taught as independent study, ECE 7930
- Resonant and soft switching techniques in power electronics, ECE 7180
 - Spring 2019, Summer 2017, Spring 2016; introduced as new regular course.
- Power electronics for grid-connected systems
 - Fall 2014, Independent study, ECE 7930
- Undergraduate introduction to engineering, ENGR 1500
 - Spring 2019

Teaching – Courses Taught at CU-Boulder

- Electronics Design Laboratory, ECEN 2830, 3 credits.
 - Spring 2011: co-developed and co-taught this new sophomore level laboratory as part of a new undergraduate curriculum development at CU-Boulder. 70 students.
 - Fall 2011: continued course development and taught course. 31 students.
- Renewable Sources and Efficient Electrical Energy Systems, ECEN 2060.
 - Spring 2008: co-developed and co-taught this new sophomore level course as a first step in developing a new curriculum in energy and energy efficiency.
- Circuits / Electronics III, Introduction to Microelectronic Circuits, ECEN 3250, 5 credits, combined lecture and laboratory required core undergraduate course.
 - Fall 2006: 20 undergraduate.
 - Fall 2007: 33 undergraduate enrolled.
 - Received the 2008 John and Mercedes Peebles Innovation in Teaching Award, University of Colorado
 - Fall 2011: 51 students. Developed and taught course as the first version within new undergraduate curriculum as a 3 credit theory course.
- Introduction to Power Electronics, dual-listed ECEN 4797/5797 + online CAETE remote delivery
 - Fall 2001: 19 undergraduate, 20 graduate
 - Fall 2009: 21 undergraduate, 54 graduate
- Power Electronics Laboratory, dual-listed ECEN 4517/5517
 - Spring 2004: 54 undergraduate (lecture included 10 graduate)
 - Spring 2005: 10 graduate
 - Spring 2006: 46 undergraduate (lecture included 16 graduate)
 - Spring 2007: 42 undergraduate and 10 graduate
 - Spring 2008: Co-developed and co-taught a major modification to the laboratory, with the new name: Power Electronics and Photovoltaic Power Systems Laboratory
 - Developed a mobile solar power system cart and re-designed the laboratory experiments to focus on power electronic components in the solar power system.
- Analog IC Design, dual-listed ECEN 4228/5228 – now ECEN 4827/5827 + online CAETE
 - Spring 2002: 12 undergraduate, 22 graduate
 - Spring 2003: 26 undergraduate, 37 graduate
 - Spring 2004: 22 undergraduate, 27 graduate
 - Developed detailed course notes, additional assignments, and adjusted course content to create a two-semester sequence, with Analog IC as a prerequisite for Mixed-Signal IC.
 - Fall 2004: 14 undergraduate, 9 graduate
 - Detailed course notes posted online in place of a formal textbook. Additional changes made to syllabus to coordinate with mixed-signal IC design. Submitted formal course proposals for the two-semester IC design sequence.
 - Fall 2010: 3 undergraduate, 27 graduates
- Mixed-Signal IC Design (new course developed in 2002), ECEN 5018 – Now ECEN 5837

- Fall 2002: 15 graduate
 - Developed new course in Fall 2002, including detailed course notes (see website, ece.colorado.edu/~ecen5007), assignments, on-line tutorials for Cadence tools, and final project designs. Course notes are used in place of a formal text book.
- Fall 2003: 22 graduate
- Spring 2005: 21 graduate
 - Developed new on-line tutorials and two-week design assignments integrating theory and extensive use of CAD tools for complete custom IC design.
- Spring 2006: 16 graduate
- Spring 2008: 16 graduate
- Spring 2010: 5 graduate
- Digital Control in SMPS, Industry Short Course, University of Colorado, Boulder, CO, July 2005, August 2006, August 2007. Enrolled 28 industry participants in two sessions three days each. Instructors: R. Zane, D. Maksimović, B. Miao.
 - Materials on digital control of SMPS from this course have now been integrated into ECEN 5807: Modeling and control of power electronic systems, with detailed notes, tutorials and simulation models posted online: <http://ece-www.colorado.edu/~ecen5807>
- Student evaluations on Faculty Course Questionnaire (FCQ) results for Instructor to date
 - a. *Fall 2006 and on:* 6.0, 5.7, 5.5, 5.4, 5.2, 4.9, 4.3, 4.2 (out of 6)
 - b. *Spring 2006 and before:* 1 A+, 2 A, 1 A-, 4 B+, 3 B

Graduate Final Thesis Examinations – Serving as Primary Advisor

1. Marium Rasheed, Ph.D., “Architectural Design of Hybrid Battery Energy Storage Systems with Integrated Active Balancing and Reconditioning Control,” May 2023. Currently at Ford Motor Company, Dearborn, MI.
2. Shuntaro Inoue, Ph.D., “Architectural Design of Hybrid Battery Energy Storage Systems with Integrated Active Balancing and Reconditioning Control,” Dec 2022. Currently at Toyota Central R&D Labs, Inc., Japan.
3. Chakridhar Reddy, Ph.D., “AC-AC Converter Topologies for Wireless Charging Applications,” May 2022. Currently at Lucid Motors, Newark, CA.
4. Mahmoud Mansour, M.S., “Power factor correction and multi-cell control for a medium-voltage three-phase unfolding input-series output-parallel AC-DC converter,” Dec 2021. Currently a Research Engineer III at USU-ASPIRE, Logan, UT.
5. Rees Hatch, M.S., “Analysis and design of 3-phase unfolding based AC-DC battery chargers,” June 2021. Currently a Research Engineer III at USU-ASPIRE, Logan, UT.
6. Joshua Wooten, M.S., “Control of series connected battery powered modules,” June 2021. Currently an engineer at Northrup Grumman, Ogden, UT.
7. Benny Varghese, Ph.D., “Roadway-embedded transmitters and multi-pad receivers for high power dynamic wireless power transfer,” May 2021. Currently Research Scientist at Idaho National Laboratory, Idaho Falls, ID.
8. Rohail Hassan, Ph.D., “Active stability monitoring and stability control of DC microgrids using incremental continuous injection,” April 2021. Currently Research Scientist at General Electric Global Research Center, Niskayuna, NY.
9. Mohamed Ahmed Kamel, Ph.D., “Analysis and control of parallel and series connected modular battery systems,” Nov 2020. Currently at General Motors.
10. Dorai Yelaverthi, Ph.D., “Three-phase unfolding based soft DC-link converter topologies for AC to DC applications,” Aug 2020. Currently Research Scientist at ABB US Corporate Research Center, Raleigh, NC.
11. Anindya Bagchi, Ph.D., Emerging works on wireless inductive power transfer: AUV charging from constant current distribution and analysis of controls in EV dynamic charging, Aug 2020. Currently at Advanced Energy.
12. Tarak Saha, Ph.D., “Soft-switched resonant DC-DC converter in underwater DC power distribution network,” Jul. 2020. Currently Research Scientist at General Electric Global Research Center, Niskayuna, NY.
13. Hongjie Wang, Ph.D., “Design and control of series resonant converters for DC current power distribution applications,” May 2018. Currently Assistant Professor at Utah State University in Logan, UT.

14. Muhammed Muneeb Ur Rehman, Ph.D., “Modular, scalable battery systems with integrated cell balancing and dc bus power processing,” March 2018. Currently at Amazon, Seattle, WA.
15. Weilun (Warren) Chen, Ph.D., “Bidirectional three-phase ac-dc power conversion using dc-dc converters and a three-phase unfold,” Nov 2017. Currently at United Technologies Research Center in Hartford, CT.
16. Hien Ngyuen, Ph.D., “Design and Control of a Modular Resonant DC-DC Converter for Point-of-Load Applications,” July 2014. Currently at a start-up solar company in CA.
17. Daniel Seltzer, Ph.D., “Modeling and Control of the Dual Active Bridge Series Resonant Converter,” May 2014. Currently employed at Space-X in Los Angeles, CA.
18. Daniel Costinett, Ph.D., “Analysis and Design of High Efficiency, High Conversion Ratio, DC-DC Power Converters,” June 2013. Currently an Assistant Professor of ECE at University of Tennessee, Knoxville.
19. Qingcong Hu, Ph.D., “Techniques to improve LED drivers by reducing voltage stress and required energy storage,” Sep. 2011. Current employed at CREE Semiconductor, Durham, NC.
20. Thurein Paing, Ph.D., “Power management techniques for micropower energy scavenging,” May, 2011. Currently employed at Maxim Integrated, Fremont, CA.
21. Ryan Schnell, Ph.D., “Digital control of LFSW HID lamp drivers with soft saturation magnetic materials and integrated resonant lamp ignition,” August, 2010. Currently employed at Analog Devices, Longmont, CO.
22. Jeffery Morroni, Ph.D., “Adaptive tuning and monitoring of digitally controlled switched mode power supplies,” October, 2009. Currently employed at Texas Instruments, Santa Clara, CA and Longmont, CO.
23. Mariko Shirazi, Ph.D., “Embedded frequency response measurement capability for monitoring and tuning of system dynamics in digitally-controlled DC-DC converters,” September, 2009. Currently employed at the National Renewable Energy Lab (NREL), Golden, CO.
24. Montu Doshi, Ph.D., “Power control architectures for CCFL and HBLED based light sources,” August, 2009. Currently employed at Texas Instruments, Longmont, CO.
25. Arseny Dolgov, M.S. Thesis, “Power management system for online low power RF energy harvesting optimization,” May 2009. Currently employed at Ball Aerospace, Boulder, CO.
26. Yang Zhang, Ph.D., “Digital control in modular masterless multiphase microprocessor power supplies,” August, 2006. Currently employed at Texas Instruments in Santa Clara, CA.
27. Yan Yin, Ph.D., “Modeling and IC control of electronic ballasts,” June 2004. Currently employed at Texas Instruments in Longmont, CO.
28. Preeti Bhandarkar, M.S. Thesis, “Design of a low-power sigma-delta A/D converter for chronic brain implants,” April 2004.

Current Graduate Students – Serving as Primary Advisor (paid as RA or Fellowship)

1. Abdullah Baig, Ph.D. candidate, entered Aug. 2023.
2. Azmeer Zahid, Ph.D. candidate, entered Aug. 2023.
3. Haris Ahmed, Ph.D. candidate, entered Aug. 2023.
4. Mayank Chawla, Ph.D. candidate, entered Aug. 2021.
5. Sanat Poddar, Ph.D. candidate, entered Aug. 2021.
6. Aditya Zade, Ph.D. candidate, entered Aug. 2021.
7. Shubhangi Gurudiwan, Ph.D. candidate, entered Aug. 2021.
8. Jackson Morgan, Ph.D. candidate, entered Jan 2021 (BS to PhD).

Past Graduate Students, Non-Thesis MS – Serving as Primary Advisor

1. Aaron Mattmiller, M.S. graduate, Aug. 2010.
2. Jieyeon Choi, M.S. graduate, May 2010.
3. Jim Patterson, M.S. graduate, May 2008.

4. Jeffrey Israel, M.S. graduate, May 2007.
5. Michael Weimer, M.S. graduate, May 2006.
6. Tony Carosa, M.S. graduate, Spring 2006.
7. Kevin Lybarger, M.S., expected graduation: May 2007.
8. Steve Scroggs, M.S. graduate, Fall 2005.
9. Sandra Johnson, M.S. graduate, Spring 2004.
10. Jonathan Gray, M.S. graduate, Fall 2002.

Undergraduate Students Advised and Independent Study

1. Brian Hobbs, BS student, EURP research student.
2. Forrest Nichols, BS student, EURP research student. Entering BS/MS program 2024.
3. Jennifer Hinton, BS student, research on AC/DC power converters, Aug 2020 – Dec 2021.
4. Brooks Maughan, BS student, research on EV charging systems, May 2020 – May 2021.
5. Jackson Morgan, BS student, research on impacts of EV charging and renewable energy on electric grids, Aug. 2019 – Dec 2020.
6. Joshua Zaugg, BS student, research on DC-DC converter modeling and hardware design, Jan 2019 – May 2020.
7. Ian Colbert, BS student, research on battery systems and grid modeling for electric vehicle charging, Mar. 2018 – May 2019.
8. Mahmoud Mansour, BS student, research on microgrid and energy management systems and high power electric vehicle charging, Mar. 2018 – May 2019.
9. Rees Hatch, BS student, research on battery systems, transport chillers, and wireless power transfer systems, Mar. 2018 – May 2019.
10. Daniel Bosco, BS student, research on solar inverters, microgrid, and grid modeling. Jan. 2018 – May 2020.
11. Shaun Bartschi, BS student, research on electric transportation and RFID tags for autonomous vehicle alignment, Sep 2017 – Jan 2019.
12. Matthew Hansen, BS student, research on electric vehicle dynamic modeling, charging infrastructure, and electric roadways, Jan 2017 – Aug 2020.
13. Jacob Alder, BS student, research on solar power installation and support of SELECT research center, Oct 2016 – May 2019.
14. Justin Jones, BS student, research on bidirectional power supplies, Jan 2014 – 2015.
15. William Balling, BS student, research on high voltage, low power, pulse generation circuit for piezoelectric structural health monitoring systems, Jan 2014 – 2015.
16. Justin Cox, BS student, research on high voltage, low power pulse power supply design for solid-state pumps and valves, May 2013 – present.
17. Kelly Hathaway, MS/BS student, research on bidirectional DC-DC converter modules for battery management systems in electric vehicles. May 2013 – 2015.
18. Kevin Kennedy, BS student, research on digital control of bidirectional resonant power converters, Aug 2012 – 2105.
19. Douglas Bloomquist, BS student, research on low power wireless sensor networks and energy harvesting, DLC apprentice, Aug. 2009 – Aug. 2010. Continued on as a graduate research assistant.
20. Daniel Costinett, BS student, research on low power energy harvesting for wireless sensors, DLC apprentice, Aug. 2008 – 2009. Continued as a Ph.D. student.
21. Daniel Seltzer, MS/BS student, research on low power piezo-electric element drive circuit for aircraft wing integrity monitoring, Mar. 2008 – 2009. Continued as a Ph.D. student.

22. Adam Bierman, MS/BS student, research on energy efficient lighting systems, Sep 2007 – present. Sponsored by NSF REU and IREE supplements, including international exchange in Spain.
23. Ryan Dolan, MS/BS student, research on lighting electronics, Jun 2007 – Dec. 2007.
24. Carey Davis, BS student, research on energy efficient lighting systems, DLC apprentice, Jan 2007 – May 2008.
25. Michael Weimer, MS/BS student, independent study in 2005 on harvesting power and electronics design for NSF Sensors project: Fire sensors.
26. Arseny Dolgov, B.S. candidate, research work on an NSF REU project in lighting electronics and on a Coleman Foundation project on wireless sensors, graduation: May 2007.
 - a. Received the **Dean's Outstanding Graduate for Research** award, May 2007.
27. Eric Hicks, independent study project, "A/D converter design and Cadence software tutorial development," Fall 2002.
28. Deirdre Lynch, independent study project, "Electronics 4 laboratory," Fall 2002.
29. Andrew Kowles, independent study project, "Analysis of resonant LCC circuits," Spring 2002.

Postdoctoral Researchers Advised

1. Dr. Yingying Zhang, Mar 2020 – Aug 2020.
2. Dr. Hongjie Wang, Jun 2018 – Jul 2019.
3. Dr. Abhilash Kamineni, Aug 2017 – Jul 2019.
4. Dr. Prasanth Thummala, Nov 2016 – Jun 2017.
5. Dr. Baljit Riar, Sep 2016 – Dec 2019.
6. Dr. Shijie Zhou, Jun 2015 – May 2016.
7. Dr. Mehmed Celebi, Sep 2015 – Aug 2016.
8. Dr. Michael Evzelman, Sep 2013 – Sep 2016.
9. Dr. Tuba Yilmaz, Nov 2013 – Dec 2014.
10. Dr. Sara Dadras, Nov 2012 – Jun 2013.
11. Dr. Victor Manuel Lopez Martin, Jun 2012 – Dec 2012.
12. Dr. Luca Corradini, Jun 2009 – Dec 2011.
13. Dr. Botao Miao, Jun 2004 – Dec 2006.

SERVICE ACTIVITIES

Service – Editorial staff, conference, society and standards committees

1. Conference General Chair, IEEE Wireless Power Technologies Conference and Exhibit, WPTCE 2023, San Diego, CA, Jun. 2023.
2. Society for Automotive Engineers (SAE) standards committee member, SAE J2954/2, Wireless power transfer of heavy duty plug-in electric vehicles and positioning communication, Dynamic Wireless Power Transfer sub-team chair, Jun. 2017 – present.
3. IEEE PELS Cyber-Physical Security Initiative Steering Committee member, Jan. 2018 – Dec. 2021.
4. IEEE Workshop on Cybersecurity of Power Electronic Systems (CyberPELS), organizing committee member, Treasurer, 2019.
5. Guest Editor, IEEE Journal of Emerging and Selected Topics in Power Electronics, Special Section on Cybersecurity of Power Electronics through Hardware Hardening, 2018 – 2019.
6. Associate Editor, IEEE Transactions on Power Electronics, Jan. 2006 – present.
7. Associate Editor, IEEE Journal of Emerging and Selected Topics in Power Electronics, 2013 – present.

8. General Co-Chair, Conference on Electric Roads and Vehicles, 2015, 2016, 2018, 2020, 2023, 2025.
9. IEEE Power Electronics Society (PELS), Administrative Committee (AdCom), 2008 – 2014.
10. IEEE Applied Power Electronics Conference and Exposition (APEC) conference committee member (2001 – 2012) and Topic Chair (2005-2006)
11. IEEE Power Electronics Specialists Conference (PESC) committee member (2001 – 2010)
12. IEEE Power Electronics Society (PELS) Simulation, Modeling, and Control Committee vice-chair 2006
13. IEEE Workshop on Control and Modeling for Power Electronics (COMPEL), Program Chair & Treasure, COMPEL 2014, University of Oviedo, Spain; Program Chair, COMPEL 2010, hosted at the University of Colorado, Boulder, CO
14. IEEE Energy Conversion Congress & Exposition (ECCE), Topic Chair, 2016 – present.
15. IEEE Standards Committee, PAR 1789, “Recommending practices for modulating current in High Brightness LEDs for mitigating health risks to viewers,” Dec. 2008 – 2012.

Service – Major Internal, Utah State University

- Engineering Dean search committee, 2023 – present
- Faculty search committee chair, power / power electronics, 2018 – 2019.
- College of Engineering undergraduate research committee, 2013 – 2016.
- ECE department graduate studies committee, 2013 – present.
- Faculty search committee member, computer engineering, 2016-2017.
- Workshop organizer, Engineering State, Summer 2017, 2018, 2019.
- Director, USU Power Electronics Lab (2012-2020), Electric Vehicle and Roadway (EVR) Test Track and Research Facility (2015 – present), and Battery Limits and Survivability (BLAST) Lab, 2018 – present.
- Director, Center for Sustainable Electrified transportation (SELECT), 2015 – 2020.
- Faculty search committee chair, power / power electronics, 2012 – 2013.

Service – Major Internal, University of Colorado Boulder

- Faculty search committee chair, 2011 – 2012
 - a. Led faculty search for energy engineering area faculty in the ECEE department.
- Undergraduate curriculum committee, 2010 – 2012
 - a. Participate in weekly department committee meetings and provide materials and updates on curriculum for circuits, electronics and power courses.
- Curriculum development
 - a. Participated in new curriculum development teams for analog courses (3 core circuits courses, new sophomore Electronics Design Lab, and sophomore elective on renewable energy)
- Course assessment teams, 2004 – 2008
 - a. Team member, ECEN 3250, Circuits III
 - b. Team member, ECEN 3100 Digital Logic
- Internal review committee, 2003
 - a. Participated in department review meetings, reviewed final committee report, participated in discussions with external review board
- Graduate studies committee, 2001-2010
 - a. Participate annually in graduate student admissions, departmental teaching assistant (TA) offers and fellowships; periodic meetings on graduate studies and curriculum
- Chairman, power area Ph.D. preliminary examination committee
 - a. Committee chairman in 2002, 2005, 2007; committee member in 2003, 2004, 2006.
- Colorado power electronics center (CoPEC) faculty member
 - a. Assist in hosting annual CoPEC industry sponsor meeting and laboratory exposition and coordinate weekly group meetings with student presentations
 - b. Participate in student recruiting, curriculum development, and lab management

Service – Journal and Conference Paper Reviews

- IEEE Journal of Emerging and Selected Topics in Power Electronics (~2 papers per year)
- IEEE Transactions on Power Electronics (full papers and letters) (~ 6 papers per year)
- IEEE Journal of Solid-State Circuits (~ 2 papers per year)
- IEEE Transactions on Circuits and Systems, Parts I & II (~ 2 papers per year)
- IEEE Industrial Applications Society Transactions (~ 1 paper per year)
- IEEE Transactions on Industrial Electronics (~1 paper per year)
- IEEE Transactions on Microwave Theory and Techniques (~1 paper per year)
- IEEE Energy Conversion Congress & Exposition (ECCE) (~ 10 papers per year)
- IEEE Applied Power Electronics Conference (APEC) (~ 10 papers per year)
- IEEE Transportation Electrification Conference & Expo, ITEC (~10 papers per year)
- IEEE Workshop on Control and Modeling for Power Electronics (COMPEL) (~10 papers per year)
- IEEE International Symposium on Circuit and Systems (ISCAS) (~ 10 papers per year)
- IEEE International Symposium on Industrial Electronics (ISIE) (~ 2 papers per year)

Service – Consulting Positions

- Jul 2025 – present. Cooley LLP. Patent consultant and expert witness.
- Apr 2025 – present. DLA Piper LLP (US). Patent consultant and expert witness.
- Sep 2023 – present. Faegre Drinker Biddle & Reath, LLP. Patent consultant and expert witness.
- Jul 2023 – Nov 2024. Knobbe, Martens, Olson & Bear, LLP. Patent consultant and expert witness.
- Feb 2022 – present. Bond Shoeneck & King. Patent consultant and expert witness.
- May 2021 – Apr 2022. Holland & Knight LLP. Patent consultant and expert witness.
- Apr 2021 – Aug 2024. Paul Hastings LLP. Patent consultant and expert witness.
- Sep 2020 – Dec 2020. Akin Gump Strauss Hauer & Feld LLP. Patent consultant and expert witness.
- Nov 2019 – Feb 2025. Alston & Bird LLP. Patent consultant and expert witness.
- July 2019 – May 2021. Radulescu LLP. Patent consultant and expert witness.
- Sep 2018 – Oct 2019, Dec 2021 – present. Baker Botts LLP. Patent consultant and expert witness.
- May 2018 – Aug 2018. Bookoff McAndrews, PLLC. Patent consultant and expert witness.
- Aug 2016 – Dec 2017. Bristows LLP. Patent consultant and expert witness.
- Jul 2016 – present. Friedman, Suder & Cooke. Patent consultant and expert witness.
- Feb 2016 – Nov 16. Jenner & Block, LLP. Patent consultant and expert witness.
- Jan 2015 – present. Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P. Patent consultant and expert witness.
- Jan 2012 – Dec 2013. Institute for Defense Analysis (IDA). Selected as member of the 2012-2013 Defense Sciences Study Group (DSSG), US Defense Advanced Research Projects Agency (DARPA).
- Feb 2010 – Aug. 2011. Friedman, Suder & Cooke, patent consultant. Served as an expert witness on electronic ballast case, including expert report, deposition, and testimony at trial.
- May 2008 – Dec 2014: Intelligent Automation Inc., low power piezo-electric driver design consultant.
- Nov 2008 – Nov 2009: Cymbet Corporation, low power energy harvesting design consultant.
- Jun. 2006 – Nov 2009: Telegen / Vu1, electronic ballast design consultant.
- Oct. 2005 – Mar. 2007: Luna Innovations, low power management design consultant.
- Aug. 2005 – Dec. 2005: Intertainment, low power management design consultant.
- June 2005 – Dec. 2006: Intelligent Automation Inc., power converter design consultant.
- Dec. 2004 – May 2005: Cooley Godward LLP, patent consultant.
- Nov. 2004 – Jan 2005: ITU Ventures, technology consultant.

- Nov. 2004 – Dec. 2006: Winstead Sechrest & Minick P.C., patent consultant.
- May 2004: Zilker Labs, consultant on digital control and custom IC design in power converters.
- May 2004: Artesyn Technologies, 3-day short course on digital control in switching power converters.
- 2002 – 2005: Jet Propulsion Labs, University of Washington, Neptune Project Power Group Review Committee
- 2001 – 2005: General Electric Global Research, consulting on application of digital and custom mixed-signal IC controls in lighting electronics and related applications

Expert testimony – Summary list of cases with expert testimony at deposition or trial (past 6 years)

- ITC Investigation No. 337-TA-1414, Complainants: Infineon Technologies Austria AG and Infineon Technologies Americas Corp. Respondents*: Innoscience (Suzhou) Technology Holding Co., Ltd., Innoscience (Suzhou) Semiconductor Co., Ltd., Innoscience (Zhuhai) Technology Company Ltd., and Innoscience America, Inc. U.S. Patent Nos 8,264,003, 9,899,481.
- District Case No 4:23-cv-937 (Eastern District of Texas, Sherman Division). Ilumi Solutions, Inc* v. Gemstone Lights Canada Ltd. U.S. Patent Nos 8,890,435, 8,922,126, 8,896,232.
- District Case No 2:23-cv-00160-JRG (Eastern District of Texas, Marshall Division). Cognipower LLC v. Samsung Electronics*. U.S. Patent Nos RE47,031, RE47,713, RE47,714, RE49,157, RE49,425.
- District Case No. 2:22-CV-00398-JRG-RSP. Mojo Mobility Inc. v. Samsung Electronics*. U.S. Patent Nos. 7,948,208, 9,577,440, 11,201,500, 11,292,349, 11,316,371, 11,462,942.
- ITC Investigation No. 337-TA-1374. Complainants: Wangs Alliance Corporation d/b/a WAC Lighting* Respondents: Tech Lighting, LLC, VC Brands, LLC, Minka Lighting. Patent 10,488,897 B2.
- IPR Petition Case No. IPR2024-00073. Vizio Inc.* v. Polaris Powered Technologies, LLC. Patent No. 7,843,148.
- ITC Investigation No. 337-TA-1371. Complainants: Signify North America Corporation and Signify Holding B.V.* Respondent: Current Lighting Solutions, LLC, In the Matter of Certain LED Lighting Devices, LED Power Supplies, Components Thereof, and Products Containing Same. Patents 9,119,268 and 8,063,577.
- IPR Case No. IPR2022-001559. Volkswagen Group of America, Inc.* v. Scramoge Technology Ltd., US Patent No 7,825,537.
- IPR Case No. IPR2022-01543. Volkswagen Group of America, Inc.* v. Scramoge Technology Ltd., US Patent No 10,243,400.
- District Case No: 2:22-cv-02095-JAD-DJA (District of Nevada). Signify North America Corporation et al.* v. Lepro Innovation Inc. et al. US Patent No 8,063,577.
- IPR Case No. IPR2022-00147. Volkswagen Group of America, Inc.* v. Arigna Technology Ltd. US Patent No 7,049,850.
- District Case No: 2:20-CV-00269-JRG (Eastern District of Texas). Garrity Power Services LLC v. Samsung Electronics*. US Patent 9,906,067.
- District Case No. 1:19-cv-02240-UNA (D. Del, Dec. 2019). Volterra Semiconductor, LLC., v. Monolithic Power Systems, Inc. (MPS)*. US Patent Nos. 7,772,955, 7,525,408, and 6,362,986.
- IPR Case No. 2020-00836. Satco Products, Inc. v. Seoul Semiconductor Co., Ltd*. US Patent No 7,081,722.
- District Case No. 6:20-cv-00018 (Western District of Texas, WACO Division). Jiaxing Super Lighting Electric Appliance Co., Ltd., and Obert, Inc. v. CH Lighting Technology Co., Ltd.*, Elliott Electric Supply Inc. and Shaoxing Ruising Lighting Co., Ltd.
- District Case No. 2:19-cv-04047 (Central District of California). Jiaxing Super Lighting Electric Appliance Co., Ltd., and Obert, Inc. v. MaxLite, Inc*.
- District Case No. 1:19-cv-5516-DLC (Southern District of New York). Signify North America Corporation et al.* v Axis Lighting Inc.
- District Case No. 2:19-cv-06125-JMA-SIL (Eastern District of New York). Signify North America Corporation and Signify Holding B.V.* v. Satco Products, Inc. Oct 2019.

- IPR Case No (unassigned). Maxlite, Inc.* v. Jiaying Super Lighting Electric Appliance Co., Ltd. US Patent No 9,879,265.
- IPR Case No (unassigned). Maxlite, Inc.* v. Jiaying Super Lighting Electric Appliance Co., Ltd. US Patent No 9,723,662.
- IPR Case No (unassigned). Maxlite, Inc.* v. Jiaying Super Lighting Electric Appliance Co., Ltd. US Patent No 9,807,826.
- Ex Parte Reexam, Control No. 90/014,297, Patent 6,958,623, Mail date May 2019.
- District Case No. 1:17-cv-00247-LPS-CJB (D. Del, Oct 2018). ON Semiconductor* v. Power Integrations, Inc.
- IPR Case No. IPR2018-00921. Feit Electric Company, Inc., v. Philips Lighting Holding*. US Patent No 6,586,890.
- ITC Investigation No. 337-TA-1081. Complainant: Philips Lighting*. Respondents: Feit Electric, Satco, and Lowe's. In the Matter of: Regarding Certain LED Lighting Devices. Patents: 7,038,399 and 7,256,554.
- District Case No. 17-cv-03597-WHO (Northern District of California). Opticurrent, LLC* v. Power Integrations, Inc. US Patent No. 6,958,623.
- IPR Case IPR2018-01524. MPOWERD INC. v. LUMINAID LAB, LLC. US Patent No. 9,347,629.
- UK Court Case Claim No HP-2016-00046. Philips Lighting* v. Megaman Limited, Neonlite International Limited, and Neonlite Electronic & Lighting Limited. Intellectual property list patents court London UK. EP 1 502 483 and EP 1 887 836 B1 patents.
- IPR Case No. IPR2016-01133. Acuity Brands Lighting, Inc. v. Lynk Labs, Inc. US Patent No. 8,841,855.
- IPR Case No. IPR2016-01116. Acuity Brands Lighting, Inc. v. Lynk Labs, Inc. US Patent No. 8,531,118.
- IPR Case No. IPR2015-01293. WAC Lighting Co. v. Philips Lighting*. 7,352,138 patent.
- IPR Case No. IPR2015-01294. WAC Lighting Co. v. Philips Lighting*. 7,038,399 patent.
- IPR Case No. IPR2015-01287. WAC Lighting Co. v. Philips Lighting*.
- IPR Case No. IPR2015-01292. WAC Lighting Co. v. Philips Lighting*.