

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ARETECH, LLC,
Petitioner,
v.

BIONESS INC.,
Patent Owner.

IPR2023-00492

U.S. Patent No. 9,682,000

DECLARATION OF DAVID REINKENSMEYER, PH.D.

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EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 9,682,000 to Behnke et al. (“the ’000 Patent”)
1002	Prosecution File History for the ’000 Patent (“File History”)
1003	Declaration of Dr. David Reinkensmeyer (“Reinkensmeyer Decl.”)
1004	U.S. Pat. No. 7,883,450 (“Hidler”)
1005	DE3300202 (A1) (“Knevels”)
1006	U.S. Pat. No. 4,781,665 (“Walker”)
1007	U.S. Pat. No. 8,701,226 (“Faucher”)
1008	U.S. Pat. No. 2,991,336 (“Shaw”)
1009	JPS57126732A (“Sugiyama”)
1010	U.S. Pat. No. 6,345,103 (“Braunagel”)
1011	U.S. Pat. Pub. 2012/0000876 (“Bergenstrale”)
1012	Artemiadis, Panagiotis, On the Potential Field-based Control of the MIT-Skywalker, IEEE (June 2011) (“Artemiadis”)
1013	Qi Lu, et. al., A New Active BWS System Capable of Virtually Offloading Partial Body Mass (February 2013) (“Lu”)
1014	1-29-23, Motion to Dismiss Hearing Transcript (Dkt. 60)

1. I, David J. Reinkensmeyer, declare as follows:

2. My name is David J. Reinkensmeyer. I am a Professor of Mechanical and Aerospace Engineering at the University of California, Irvine, with joint appointments as a professor in the department of Anatomy and Neurobiology, the department of Biomedical Engineering, and the department of Physical Medicine and Rehabilitation at the same institution.

3. I have prepared this report as an expert witness retained by Aretech, LLC. In this report I give my opinions as to whether certain claims of U.S. Patent No. 9,682,000 (“the ’000 Patent”) are invalid.

4. This report contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

I. BACKGROUND AND QUALIFICATIONS

A. Summary of Relevant Experience and Qualifications

5. I have summarized in this section my educational background, career history, publications, and other relevant qualifications. My full curriculum vitae is attached as Appendix 1 to this declaration.

6. I am an expert in the fields of biomedical and mechanical engineering, with a focus on movement control, neuro-rehabilitation and robotics. I have studied, taught, practiced, and researched in these fields for over thirty-five years. Currently, I am a Professor of Mechanical and Aerospace Engineering and Anatomy and Neurobiology at the University of California, Irvine in Irvine, California, where I have been on the faculty since 1998.

7. I received my Doctor of Philosophy (Ph.D.) degree in the field of Electrical Engineering from the University of California, Berkely, in 1993. I received my Masters of Science (M.S.) degree in Electrical Engineering from the University of California, Berkely, in 1991, and my Bachelor of Science (B.S.) degree in Electrical Engineering from the Massachusetts Institute of Technology in 1988.

8. After receiving my Ph.D. degree, I worked as a researcher and lecturer at Berkeley and Northwestern, until becoming a research assistant professor at Northwestern University Medical School in 1997.

9. I have been involved in biomedical robotics and mechatronics research since 1986. My research has been funded by a variety of governmental agencies, including the National Institute of Health (NIH) and the National Institute of Disability, Independent Living, and Rehabilitation Research

(NIDILRR). In addition, I have received government Small Business Innovation Research (SBIR) funding, as well as several industrial grants.

10. Throughout my career, I have received numerous awards and honors for my work in these fields, some of which include: (1) a Training Fellowship from 1994-1995 with the National Institute on Disability and Rehabilitation Research, (2) 1998 Sarah Baskin Award for Excellence in Research at the Rehabilitation Institute of Chicago, (3) 2011 Best Paper of the Journal Award for the IEEE Transactions on Neural Systems and Rehabilitation Engineering Journal, (4) 2012 Most Innovative Technology Award in the 2nd IEEE EMBS Unconference on Rehabilitation Robotics, (5) 2016 UC Irvine Distinguished Mid-Career Award for Research, (6) 2016 Henry Samueli School of Engineering Innovator of the Year Award, (7) 2017 Google Scholar Classic Paper Award for having authored one of ten most-cited articles in Rehabilitation Therapy published ten years earlier, (8) 2019 Elected Fellow, American Institute of Medical and Biological Engineers. From 2017-2021, I served on the National Advisory Board for Medical Rehabilitation Research, NIH. I am Editor-in-Chief of the Journal of Neuroengineering and Rehabilitation, one of the top journals in the rehabilitation field. I have held this position for eight years.

11. I regularly teach courses in bioengineering (with emphasis in rehabilitative therapy technologies), robotics, and mechatronics at both the

undergraduate and graduate level. As an expert in these fields, I am also regularly invited to speak at conferences on these topics. By way of example, (1) I was the keynote speaker at the 2013 IEEE International Conference on Rehabilitation Robotics, (2) I was the keynote speaker at the 2022 Rehabweek Conference (which combines eight societies, including International Conference on Rehabilitation Robotics, International Functional Electrical Stimulation Society, International Society for Virtual Rehabilitation), (3) I was the keynote speaker at the 2009 Dynamic Walking Conference in Vancouver, and I have been invited to speak at over eighty other conferences, symposiums, and seminars as may be seen from my curriculum vitae (Appendix 1).

12. I am the author or co-author of over 200 peer-reviewed journal and conference papers, as identified in my curriculum vitae (Appendix 1). My articles have been published in many reputable journals such as, for example, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Neurorehabilitation and Neural Repair, Neurology, Journal of Neurophysiology, Sensors, and the Journal of Neuroengineering and Rehabilitation. My articles have been cited over 18000 times by other academic writings.

13. I also routinely serve as referee for papers submitted to highly reputable journals such as, for example: Nature Medicine; Science Robotics, Science Translational Medicine; IEEE Transactions on Robotics; IEEE

Transactions on Neural Systems and Rehabilitation Engineering; American Journal of Physical Medicine and Rehabilitation; Journal of Rehabilitation Research and Development; Journal of Applied Physiology; Journal of Biomechanical Engineering; ASME Journal of Medical Devices; Topics in Spinal Cord Injury Rehabilitation; Journal of Neuroscience; Journal of Neurophysiology; Experimental Brain Research; Biological Cybernetics; Annual Review of Biomedical Engineering; and Archives of Physical Medicine and Rehabilitation, among others.

14. I am the lead Editor of two books: Neurorehabilitation Technology, 2nd Edition (2016), and Neurorehabilitation Technology, 3rd Edition (2022). I am also a contributor and author of numerous book chapters, including in the following titles: Robotics Research: The Fourth Int. Symposium (1987); Artificial Intelligence Research at MIT (1990); Neural Networks for Control (1990); Biomechanics and Neural Control of Posture and Movement (2000), Standard Handbook of Biomedical Engineering & Design (2003); Emerging and Accessible Telecommunications; Information and Healthcare Technologies: Engineering Challenges in Enabling Universal Access (2002); Springer Handbook of Robotics (2008); Biomedical Engineering Systems and Technology (2008); Emerging Therapies in Neurorehabilitation Series: Biosystems & Biorobotics (2014); Emerging Therapies in Neurorehabilitation II (2015); Springer Handbook of

Robotics, 2nd Edition (2015); Neurorehabilitation Technology, 2nd edition (2016), Neurorehabilitation Technology, 3rd edition (2022), among others. These books and book chapters have been used as references for undergraduate level bioengineering related courses in universities.

15. I have twelve issued U.S. patents that relate to bioengineering, robotics and rehabilitation technologies.

1. Compensation

16. For my efforts in connection with the preparation of this declaration I have been compensated at the rate of \$300 per hour for reading and research, and \$400 per hour for consultation and drafting. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

2. Materials and Other Information Considered

17. I have considered information from various sources in forming my opinions. I have reviewed and considered each of the exhibits listed in the attached Appendix 2 (Appendix of Exhibits) in forming my opinions.

II. UNDERSTANDING OF THE LAW

18. I am not an attorney. In forming my opinions in this Declaration, I applied the relevant legal principles provided to me by counsel, which are summarized in Appendix 4. The contents of Appendix 4 represent my

understanding of the law that I have applied in forming my opinions in this declaration.

III. THE '000 PATENT

19. I understand that the '000 Patent issued on June 20, 2017 from an application filed on June 20, 2013. *See* Ex-1001. I understand that Petitioner is challenging the validity of claims 1-8 and 12-20 of the '000 Patent (the “Challenged Claims”) in the Petition for *Inter Partes* Review to which this declaration will be attached. Those claims are reproduced in Appendix 3. I understand that Petitioner is not challenging claims 9-11. While this declaration is directed to the challenged claims, I have considered all claims (1-20) of the '000 Patent, as well as portions of the '000 Patent prosecution history in forming my opinions.

A. Overview of the '000 Patent

20. The '000 Patent relates to a body weight support (“BWS”) system used for rehabilitation of patients suffering from walking deficiencies (e.g., as a result of a stroke, spinal cord injury, etc.). *See* Ex-1001, Abstract. The '000 Patent describes the invention as generally including “a trolley, a powered conductor operative [sic] coupled to a power supply, and a patient attachment mechanism. The trolley can include a drive system, a control system, and a patient support system.” Ex-1001, Abstract.

21. Figure 1 of the '000 Patent is a block diagram showing components of an exemplary BWS system:

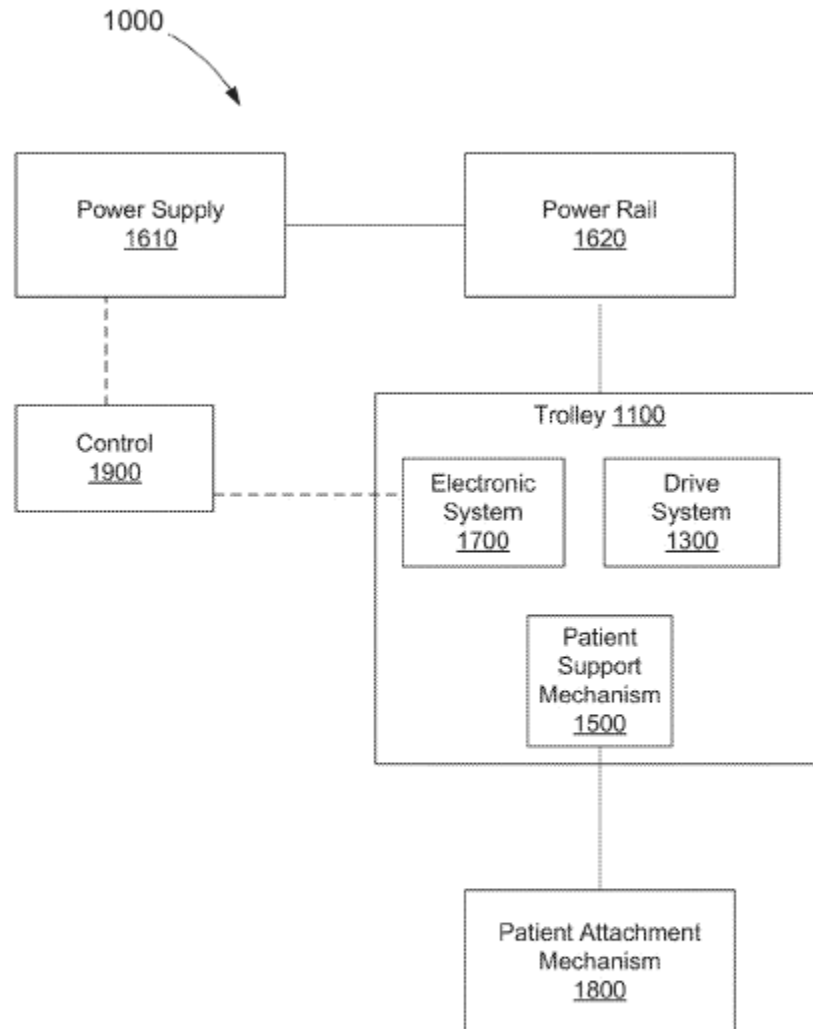


FIG. 1

22. BWS systems were well-known at the time of the application for the '000 Patent. The '000 Patent thus purports to improve on prior art BWS systems. The disclosure and claims focus on three features.

23. Powered Conductor Feature. The Challenged Claims of the '000 Patent require a portion of the trolley being disposed within a powered conductor, and in contact with a conductive inner surface to electrically couple the trolley to the powered conductor (hereafter, the “Powered Conductor Feature”). *Id.*, 35:11-22. An example of a powered conductor is depicted in Figures 2 (element 2620) and 10 (detail view of inside of powered connector):

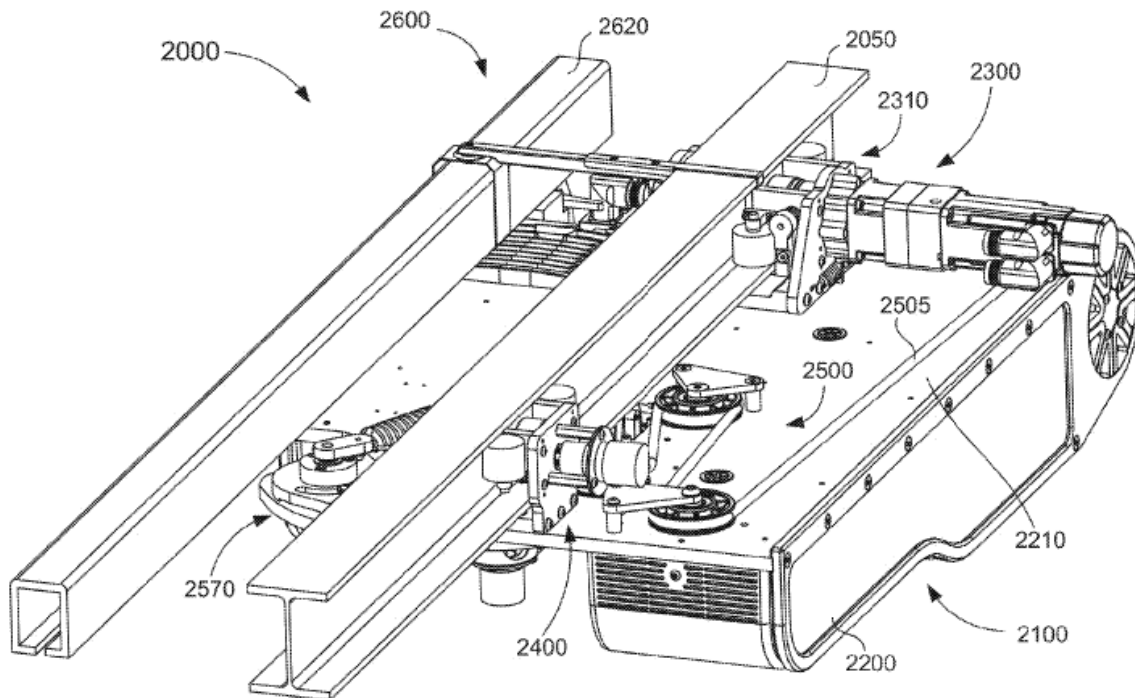


FIG. 2

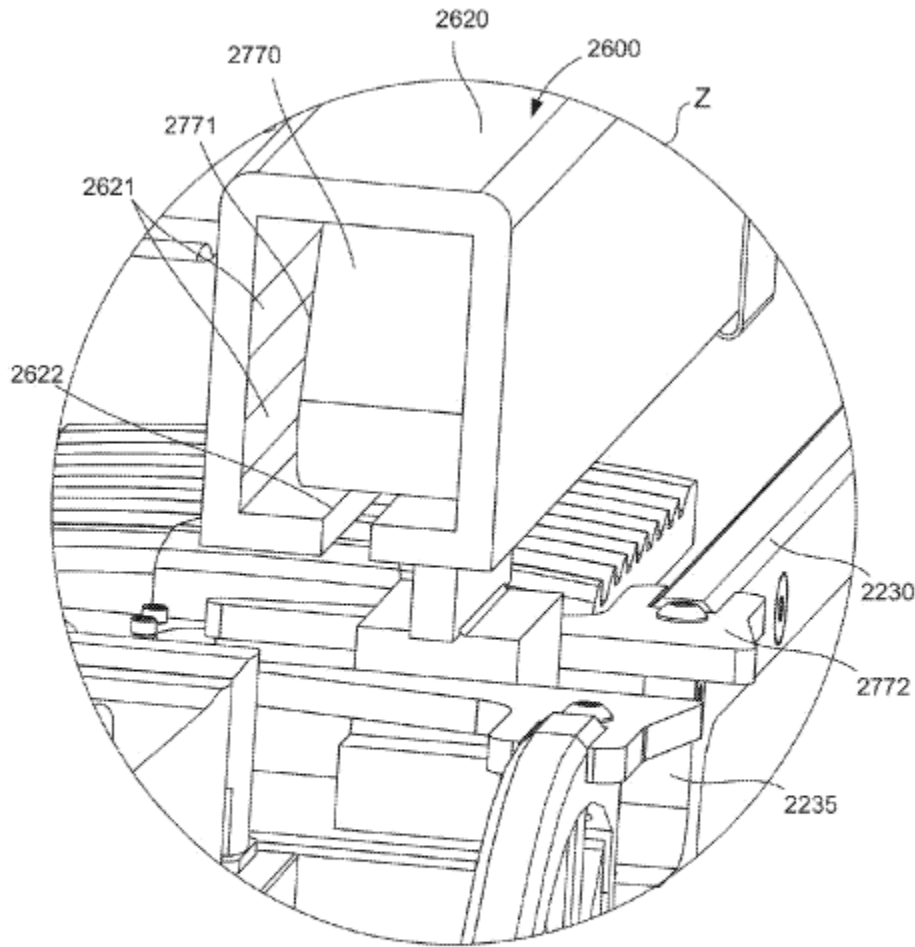
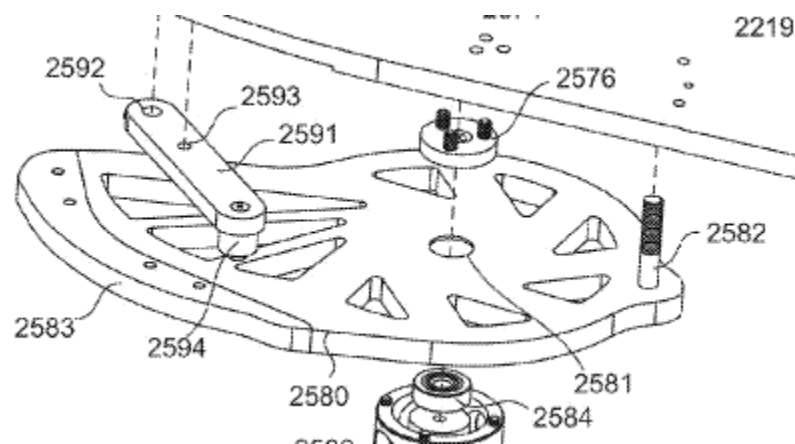


FIG. 10

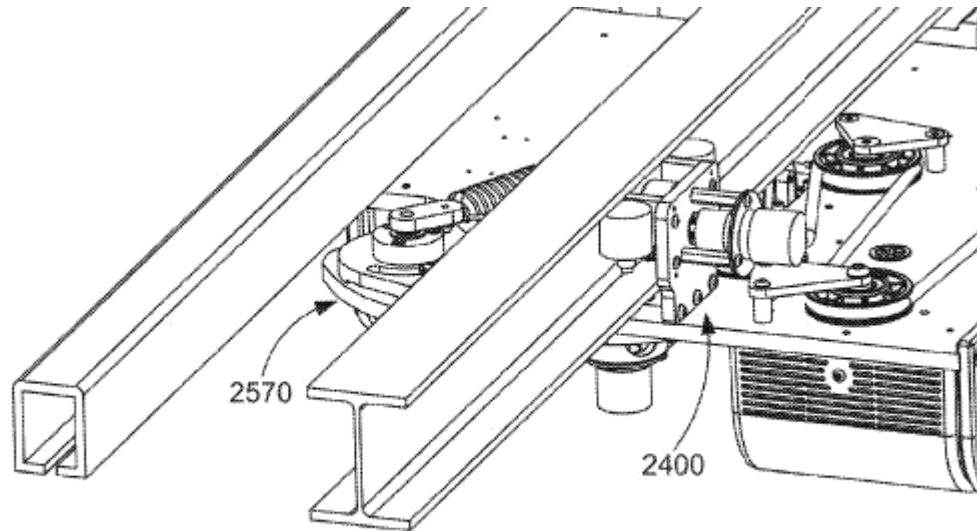
24. Cam Feature. The '000 Patent also states that a “cam” provides a way for the patient support assembly to pivot with the movement of a patient (the “Cam Feature”). A cam is a well-known mechanical component that rotates and, in doing so, is often used to make contact with another component in a way that transforms the rotary motion into a linear motion. The Cam Feature is described in

the '000 Patent in the context of “[a] patient support assembly including a pulley movably coupled to a portion of [a] housing[,] a cam coupled to the pulley, . . . [and] a tether[, wherein] ... the pulley [is] configured to pivot relative to the housing and about a vertical axis in response to a force . . . exerted on the tether, [and] the cam [is] configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley.” Ex-1001, 35:57-36:4. An example of a cam is depicted in Fig. 33 (showing cam 2583):



25. Wheel Feature. The '000 Patent also describes configuring the wheels of the BWS system in a particular manner (the “Wheel Feature”). Specifically, the Wheel Feature is described in the context of a trolley “including a plurality of wheels configured to move along at least one surface of a track [and] a portion of the track [is] disposed between at least one wheel from the plurality of wheels and the powered conductor to isolate the at least one wheel from the powered conductor.” Ex-1001, 36:24-34. The Wheel Feature provides a way for at least one

wheel of the plurality of wheels to be isolated (by the track) from the powered conductor. An example of the Wheel Feature is depicted in Figure 2 (excerpt showing drive assembly 2400 (which contains a wheel assembly that isolates wheels from the powered conductor):



B. Prosecution History

26. I understand that the '000 Patent issued from U.S. Patent Application 13/745,830 (the "'830 Application"), the face of which identifies that it was filed on January 20, 2013. I understand that for purposes of evaluating the validity of the '000 Patent, January 20, 2013 is treated as the applicable priority date of the '000 Patent (hereafter, the "Critical Date"). Thus, for purposes of this declaration, I have assumed a priority date of January 20, 2013, but my opinions as set forth herein would not change if the priority date were up to one year earlier.

27. Based on the file history, I understand that on June 15, 2015, the Examiner issued an Office Action concerning the '830 Application. Ex-1002, 237-44. The Examiner indicated all claims were anticipated by *Hidler* (US PG-Pub 2008/0287268). *Id.* I understand that the Applicant did not argue that the examiner was wrong and, instead, amended the claims and requested reconsideration on September 11, 2015. *Id.*, 253-60.

28. Claim 1 was amended to include a version of the Powered Conductor Feature, while claim 17 (later renumbered as claim 8) was amended to include a version of the Cam Feature. *Id.*

Claim 1:

1. (Currently Amended) An apparatus, comprising:
 - a trolley configured to be movably suspended from a track,
 - a powered conductor operatively coupled to the track, the powered conductor being substantially parallel to the track, the powered conductor including at least one conductive surface, a portion of the trolley being in contact with the at least one conductive surface to configured to be electrically coupled to the trolley to the powered conductor, the portion of the trolley configured to move along the at least one conductive surface when the trolley is moved along the track;
 - at least one patient attachment coupled to the trolley, the at least one patient attachment support assembly configured to support a single patient; and
 - a control system coupled to ~~at least one of the trolley or~~ and at least operably coupled to the powered conductor.

Original Claim 17/Issued claim 8:

17. (Currently amended) An apparatus, comprising:
a housing;
a drive element disposed at least partially within the housing;
a wheel assembly coupled to the drive element and disposed at least partially within the housing; and
a patient support assembly coupled to the housing, the patient support assembly configured to dynamically support a body weight of a patient, the patient support assembly including a cam configured to pivot relative to the housing in response to a force associated with the body weight of the patient, the cam exerting a reaction force when the cam pivots relative to the housing.

29. In response, I understand the Applicant argued that amended claim 1 (and its dependent claims) were patentable because “[n]owhere ... does *Hidler* disclose or suggest a trolley movably in contact with at least one conductive surface of a powered conductor.” *Id.* The Applicant further argued that claim 17 (and its dependent claims) were patentable because “[n]owhere ... does *Hidler* disclose or suggest pivoting of a cam to exert a reaction force in response to a force associated with the body weight of the patient.” *Id.*

30. I further understand the Examiner issued a Final Rejection on December 17, 2015. Ex-1002, 263-68. In that Final Rejection, I understand that the Examiner chose to rely on a new primary reference. *Id.* Specifically, the Examiner rejected application claims 1-3 and 6-8 (later renumbered as patent claims 1-3 and 5-7, respectively) as anticipated by *Bergenstrale* (US PG-Pub 2012/0000876), and application claims 4, 5, 17, 20 and 21 (later renumbered as

patent claims 4, [claim cancelled], 8, 11 and 12, respectively), were rejected as obvious in view of *Bergenstrale* and *Hidler*. *Id.* For the latter combination, the Examiner relied on *Hidler* as teaching: (i) a torque transfer assembly and drive assembly being driven simultaneously; (ii) a housing for protecting certain components; (iii) a clutch or brake element; and (iv) a second drive element couple to a patient support assembly.

31. I understand that in response to the Final Office Action, the Applicant again amended the claims and requested continued examination on March 15, 2016. Ex-1002, 272-81. I understand that Applicant argued that claim 1 (and its dependent claims) were patentable because “[n]owhere ... does *Bergenstrale* disclose or suggest a drive assembly of a trolley and a track from which the trolley is suspended being disposed *outside* of a powered conductor.” *Id.* The Applicant further argued that claim 17 (and its dependent claims) were patentable because “*Bergenstrale* alone or in combination with *Hidler* fails to disclose or suggest a cam pivoting relative to a housing and about a vertical axis in response to a force exerted on a tether.” *Id.* The Applicant also added new claims 22-29 (later renumbered as claims 13-20, respectively), which included a version of the Wheel Feature. *Id.*

32. I understand that the Office issued a Non-Final Rejection on June 2, 2016. Ex-1002, 304-12. I understand that Application claims 1-4 and 6-8 (later

renumbered as patent claims 1-4 and 5-7, respectively) were allowed, with the Examiner stating:

The prior art of record does not teach nor disclose “a portion of the trolley being disposed within the powered conductor” in combination with the other structure contained in claim 1. Bergenstrale’s powered conductor does not contain any portion of the trolley within it. Furthermore, the prior art of record does not suggest a powered conductor with a portion of a trolley within it.

Id.

33. I understand that Application claims 22-24 and 28 (later renumbered as patent claims 13-15 and 19, respectively) were rejected as being anticipated by *Bergenstrale*. *Id.* I understand that Application claims 17, 20, and 21 (later renumbered as patent claims 8, 11 and 12, respectively), were rejected as obvious in view of *Bergenstrale* and Hidler. *Id.*

34. I understand that the Applicant conducted a telephonic interview with the Examiner on September 1, 2016. *See* Ex-1002 at 321. I understand that the Applicant then amended the claims and requested reconsideration on September 2, 2016. *Id.* at 315-23.

35. I understand that the Examiner issued a Notice of Allowance on December 13, 2016. *See* Ex-1002 at 325-27. I understand that the Examiner

reiterated the reasons for allowing claim 1 and its dependent claims. *Id.* I understand that the Examiner allowed claims 1-4, 6-8 and 17-29. *Id.* With respect to application claim 17 (patent claim 8), I understand that the Examiner stated:

Bergenstrale in view of Hidler fails to disclose or suggest “[a] patient support assembly including a pulley movably coupled to a portion of [a] housing[,] a cam coupled to the pulley, . . . [and] a tether[, wherein] . . . the pulley [is] configured to pivot relative to the housing and about a vertical axis in response to a force . . . exerted on the tether, [and] the cam [is] configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley,” as recited in currently-amended independent claim 17.

Id.

36. With respect to application claim 22 (patent claim 13), I understand that the Examiner stated:

Bergenstrale fails to disclose or suggest a trolley “including a plurality of wheels configured to move along at least one surface of a track [and] ... a powered conductor including at least one conductive surface in contact with a portion of the trolley to electrically couple the trolley to the powered conductor, [wherein]... a portion of the track [is] disposed between at least one wheel from the plurality of wheels and the powered conductor to isolate the at least one wheel from the powered

conductor,” as recited in currently-amended independent claim 22. Furthermore, the prior art of record does not suggest at least one wheel isolated from the powered conductor.

Id.

IV. SUMMARY OF THE PRIOR ART APPLIED TO THE CHALLENGED CLAIMS

A. Hidler

37. I have reviewed the Hidler reference (Ex-1004). Based on the face of the Hidler patent itself, I understand that Hidler was filed on May 14, 2008 and later issued to Joseph Hidler on February 8, 2011.

38. I understand that Hidler is prior art to the '000 Patent because it was filed more than two years before the Critical Date of the '000 Patent.

39. Hidler teaches a body-weight support system that allows individuals with severe gait impairments to practice over-ground walking in a safe, controlled manner, where the support system includes rides along a driven trolley and can be controlled in response to the movement of the subject using the system. In my opinion, Hidler is analogous art to the alleged invention of the '000 Patent because it is from the same field of endeavor, i.e., physical rehabilitation systems using an overhead trolley system with pulleys, tracks and conductors. In my opinion Hidler and the '000 Patent are in the same field of endeavor and highly analogous to one another.

B. Knevels

40. I have reviewed the Knevels reference (Ex-1005). I understand the Knevels reference is German patent DE3300202A1 issued to Knevels, et. al., (“Knevels”). Knevels is written in German. I have reviewed a certified translation of Knevels, which is attached to Ex-1005 (including the translators certification).

41. I understand Knevels is prior art to the ’000 Patent because it was filed on May 1, 1984 and published on May 7, 1984, which is more than two decades before the Critical Date of the ’000 Patent.

42. Knevels teaches an overhead trolley system where a conductor is enclosed in a power rail and the trolley can be driven along a track by the conductance of the power rail. In my opinion, *Knevels* is analogous art to the alleged invention of the ’000 Patent because it is it is an overhead trolley system using tracks and conductors.

43. I understand that Knevels was not submitted or cited during examination of the ’000 Patent.

C. Faucher

44. I have reviewed the Faucher reference (Ex-1007). I understand that U.S. Patent No. 8,701,226 (“Faucher”) is prior art because it was filed on February 4, 2009, which is more than three years before the Critical Date of the ’000 Patent.

45. I understand that Faucher itself was not cited or considered before the Office, but the publication of Faucher (Pub. No. 2011/0000015) was cited on the face of the '000 Patent. I understand that the Examiner did not apply or analyze Faucher (or its publication) during examination.

46. Faucher teaches a conductive connection for track-riding patient hoists, where a patient hoist on a trolley rides along a track, with the hoist being powered by a conductor extending along the track. A contact carrier is fit within the trolley and is free to laterally displace with respect to the trolley so that it (and its contact) follows the contour of the track, with the contact remaining in electrical communication with the track conductor.

47. In my opinion, Faucher is analogous art to the alleged invention of the '000 Patent because it relates to body-weight support systems using trolleys, pulleys, tracks, and powered conductors.

D. Walker

48. I have reviewed the Walker reference (Ex-1006). Based on the face of the Walker patent, I understand U.S. Patent No. 4,781,665 ("Walker") is prior art to the '000 Patent because it was filed on August 31, 1987, and on November 1, 1988, more than twenty years before the Critical Date of the '000 Patent.

49. I understand that Walker was not cited or considered during prosecution of the '000 Patent.

50. Walker teaches a power-delivery belt-tensioning system, where a first pulley is coupled by a flexible belt to a second pulley for delivering power from a source to a driven device. The system includes a cam, idler pulley, and spring to maintain a pre-selected degree of tension in the belt upon the occurrence of a surge in power delivered from the source to the driven device.

51. In my opinion, Walker is analogous art to the alleged invention of the '000 Patent because relates to using a pulley system to maintain a selected tension in a tether. Moreover, Walker is analogous to the alleged invention as both require the use of pulley assemblies to convert rotational energy to linear energy as a means for maintaining the selected tension.

V. LEVEL OF ORDINARY SKILL IN THE ART

52. In determining the characteristics of a hypothetical person of ordinary skill in the art of the '000 Patent at the time of the claimed invention ("POSITA"),¹ I considered several things, including various prior art techniques relating to rehabilitative gait therapy systems, the type of problems that such techniques gave rise to, and the rapidity with which innovations were made. I also considered the

¹ I considered the level of ordinary skill in the art on January 20, 2013, the aforementioned Critical Date of the '000 Patent. But, in my opinion, the level of skill for the POSITA would not change if the claims were entitled to a priority date up to at least one year earlier.

sophistication of the technologies involved, and the educational background and experience of those actively working in the field at the time. I also considered the level of education that would be necessary to understand the '000 Patent. Finally, I placed myself back in the relevant period of time and considered the engineers and scientists that I have worked with in the field of bioengineering, robotics, and rehabilitative technologies.

53. Based on the above, I came to the conclusion that a POSITA in the field of art of the '000 Patent would have a bachelor's degree in biomedical engineering, electrical engineering, mechanical engineering, or similar field with at least two years of experience in research in, development of, or practice providing therapy using robotic medical devices/systems. A person with less formal education but more relevant practical experience may also meet this standard. Similarly, a person with less relevant practical experience but more formal education may also meet this standard. Such a person would have been capable of understanding the '000 Patent and the prior art references discussed herein. Based on my education, training, and professional experience in the field of the claimed invention, I am familiar with the level and abilities of a person of ordinary skill in the art at the time of the claimed invention. Additionally, I met at least these minimum qualifications to be a person having ordinary skill in the art as of the time of the claimed invention of the '000 Patent.

VI. CLAIM CONSTRUCTION

54. For purposes of this declaration, I have considered the claim language, specification, and portions of the prosecution history, to determine the meaning of the claim language as it would have been understood by a person of ordinary skill in the art at the time of the invention. I understand that the “plain and ordinary meaning” or *Phillips* standard is applicable in these proceedings. I further understand that, under a plain and ordinary meaning approach, a claim term is given its plain and ordinary meaning in view of the specification from the viewpoint of a person of ordinary skill in the art. My understanding of claim construction principles is set forth in greater detail in Appendix 4.

55. I have applied the *Phillips* standard in my analysis. Unless otherwise stated, I have applied the plain and ordinary meaning to claim terms. I have not formed and do not offer an opinion on the indefiniteness of any claims.

VII. INVALIDITY

56. Based on my review and analysis of the materials cited herein, my opinions regarding the understanding of a POSITA, and my training and experience, it is my opinion that the Challenged Claims are rendered obvious by the Grounds presented in this declaration. The reasons for my conclusions are explained more fully below.

A. Ground 1: Obvious over Hidler in view of Knevels

57. In my opinion, Claims 1-7 and 13-20 of the '000 Patent are invalid because they are obvious over the teachings of Hidler in view of Knevels, including as detailed below.

1. Overview of the Combination of Hidler and Knevels

58. With respect to independent claims 1 and 13, Hidler teaches a body-weight support apparatus, consisting of a trolley, drive assembly, patient attachment, and control system. Hidler, however, does not teach the use of a powered conductor to supply power the trolley. Instead, Hidler powers the trolley through a power cable (326), as depicted in Figure 3:

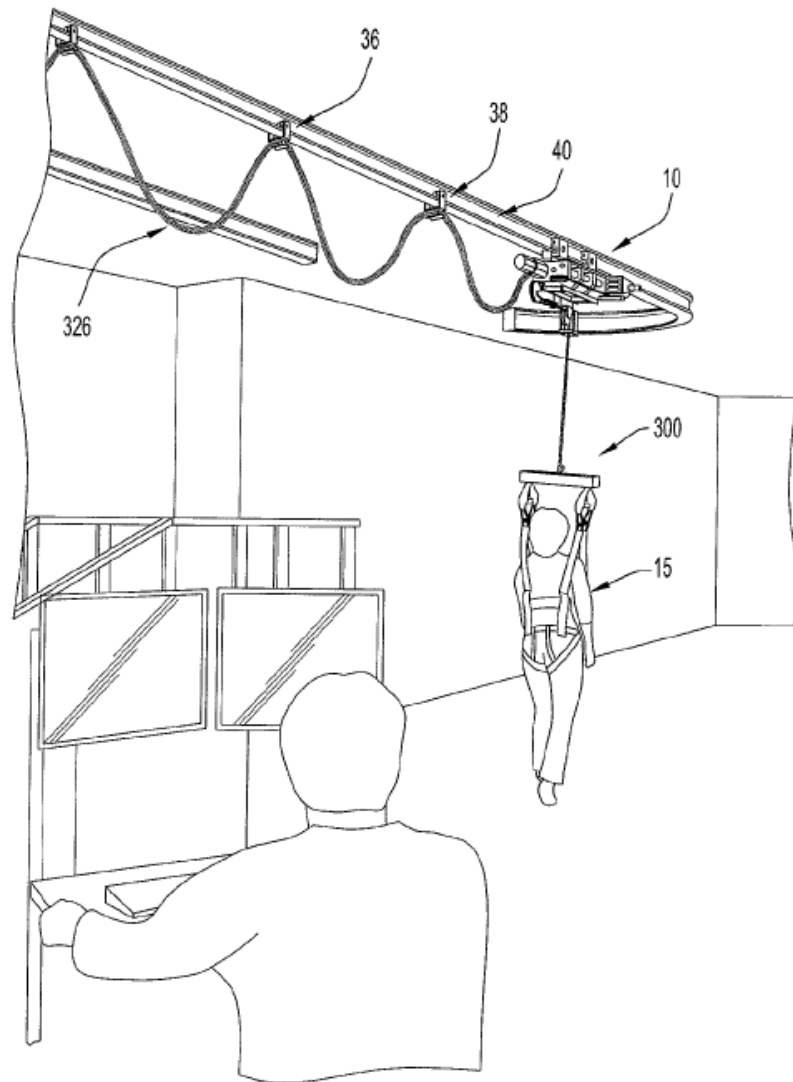
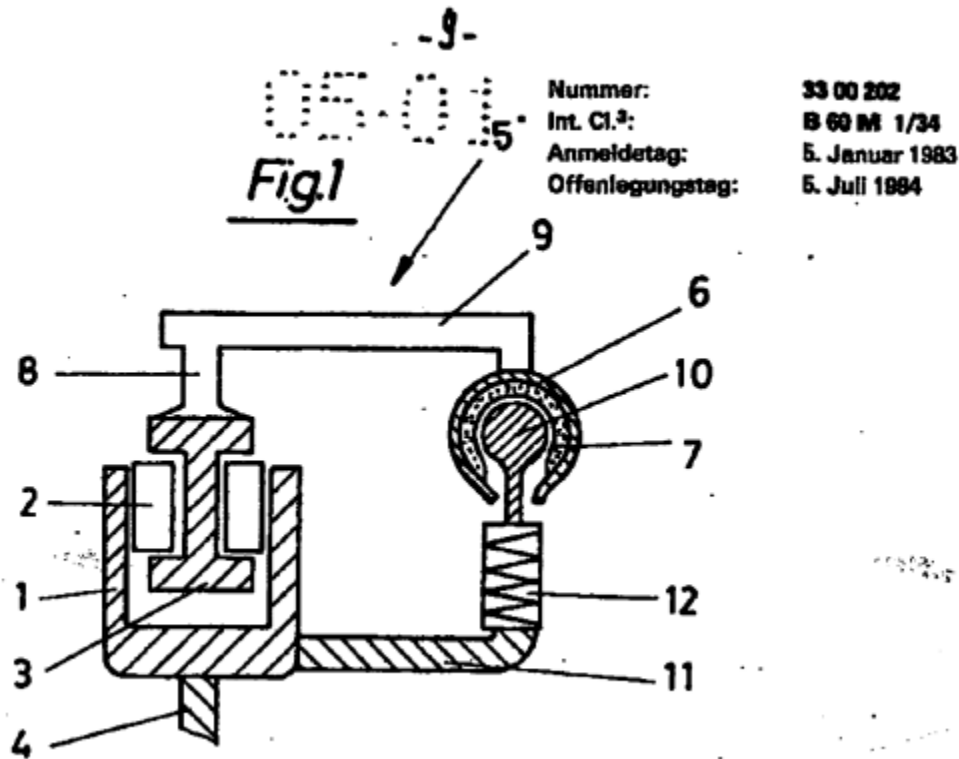


FIG.3

59. Prior to January 20, 2013, POSITAs were well-aware that power rail systems could be used to replace the need for power cables in connection with overhead trolley systems, such as the overhead trolley system of Hidler. Knevels provides an example of this well-known practice, as shown in figure 1, where

trolley 1 powered by a power rail (wire guide tube (6) and contact wires (7)) that is positioned parallel to the trolley's track:



60. As I set forth below, a POSITA would have been motivated to combine Hidler's trolley with an enclosed power rail such as the rail taught in Knevels. For the reasons set forth below, a POSITA also would have expected success in making this well-understood combination.

61. As I explain in more detail below, the combination of Hidler's trolley system with the powered conductor of Knevels teaches each of the limitations of Claims 1-7 and 13-20 of the '000 Patent.

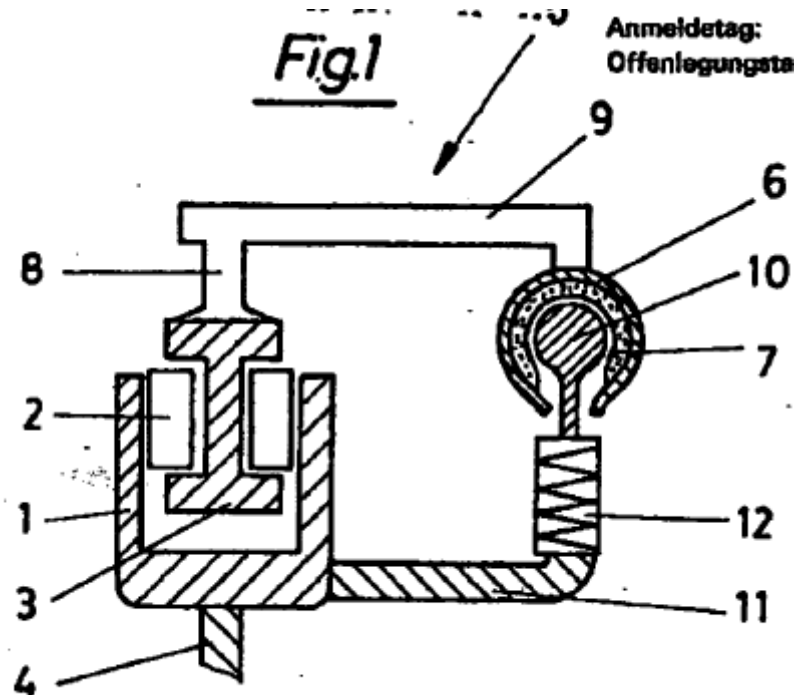
2. Motivation to Combine and Expectation of Success (Hidler in view of Knevels)

62. I understand that Hidler and Knevels are considered to be analogous art since they both relate to overhead trolley systems. In particular, Hidler teaches a body-weight support system that uses a trolley mounted from the ceiling to support the weight of a patient. Knevels teaches a power rail specifically designed to power such an overhead trolley system. In my opinion, a POSITA would have been motivated to combine the teachings of Hidler and Knevels for several reasons.

a. Modifying Hidler to use a power rail based on the teachings of Knevels would have been using well-established prior art elements according to known methods to yield predictable results

63. Prior to January 2013, it was exceedingly well-known and well-understood that power rails could be used to supply power to overhead trolley systems. Power rails, such as the one taught in Knevels, were developed at least as early as in the late 1950s. Knevels, which was published in 1984 (almost 30 years before the Critical Date) teaches a powered conductor capable of powering an overhead trolley system. Ex-1005, 13-17. Specifically, Knevels teaches that its conductor system is used for “in conjunction with a transport means,” such as a suspended track. *Id.*, 13. Like Hidler, Knevels teaches that a trolley travels along

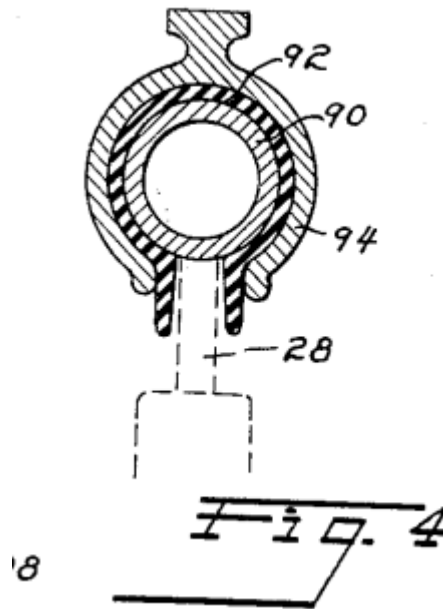
the suspended track. *Id.* For example, figure 1 in Knevels teaches a powered conductor system running next to a suspended track:



Ex-1005 at 19.

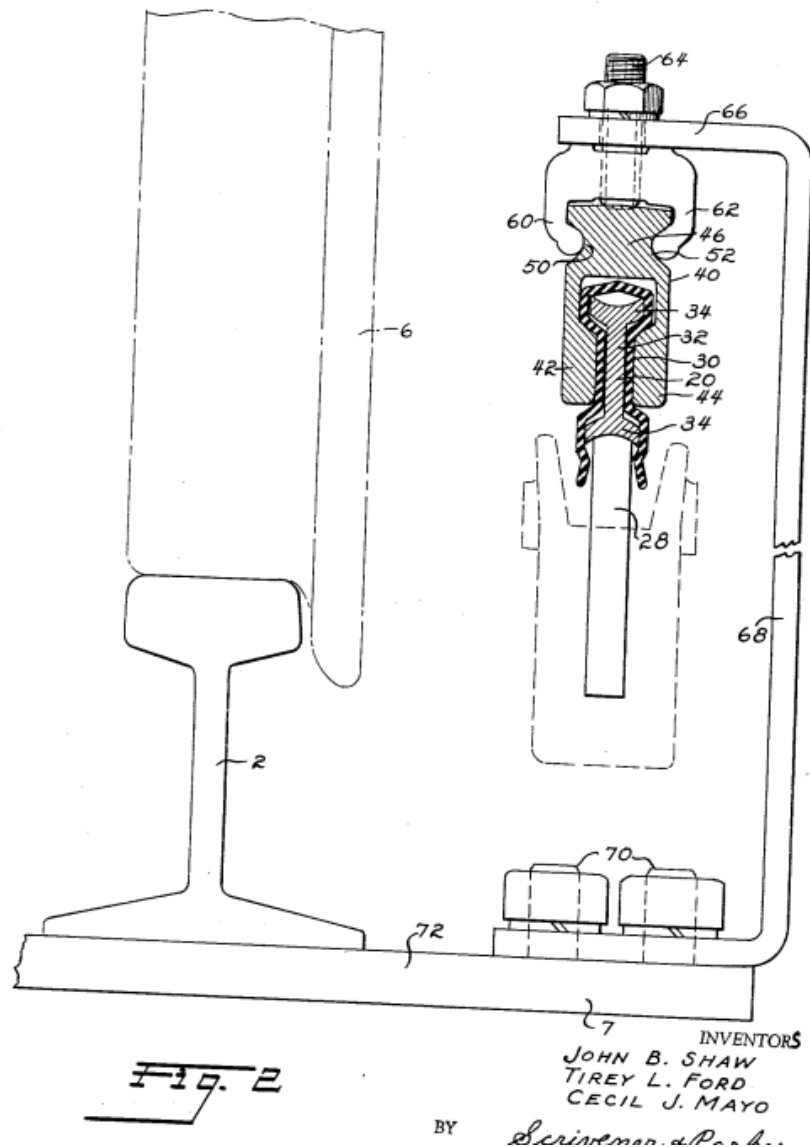
64. Figure 1 of Knevels shows that the power rail is used in conjunction with the trolley (1), which has wheels/castors (2) riding on a suspension I-beam track (3). Ex-1005 at 17, 19. Figure 1 also teaches the power rail (i.e., a powered conductor) comprises a wire guide tube (6) and contact bar (7). *Id.* The power rail works by directly connecting inner conductive surfaces (7 and 7') (as shown in Fig. 2), with the current collector wiper contact (10) extending from the trolley's support arm and casing (11 and 12). *Id.*

65. A POSITA also would have knowledge of many other power rail systems used to power trolleys. For example, U.S. Patent No. 2,991,336A (“Shaw”), filed in 1956, teaches an electrical trolley system with an “elongated conductor bar” that is connected to a power terminal to provide a source of energy to the electric motor. Ex-1008 at 2:16-41. Shaw’s power rail is disclosed in Figure 4:



Ex-1008 at 4:58-75 (showing Shaw’s power rail consisting of “conductor bar 90” that engages the collector device 28 to transfer power).

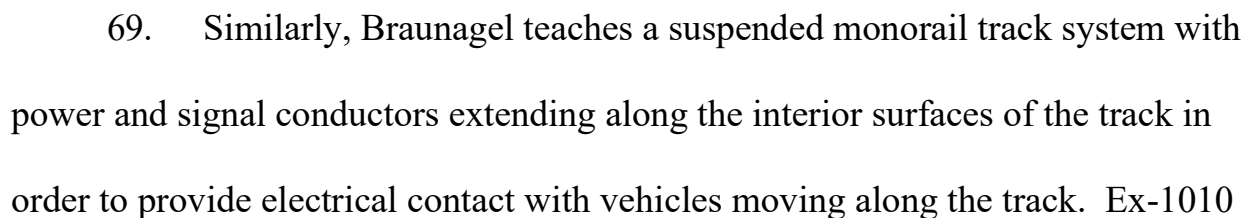
66. In an alternate embodiment, Shaw teaches placing a power rail (item 20) next to a track (item 2):



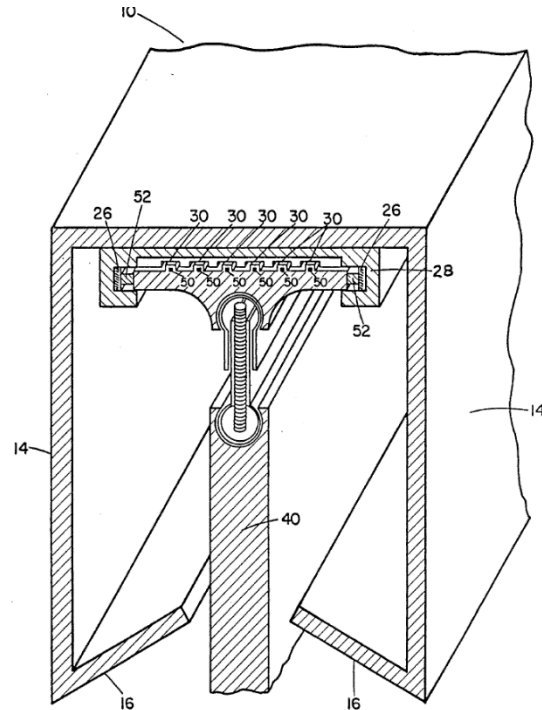
Ex-1008 at Fig. 2 (demonstrating the placement of the power rail (consisting of the conductor bar 20 and collector 28).

67. POSITAs would also have knowledge of other power rails for trolley systems, such in JPS57126732A (“Sugiyama”) and U.S. Patent No. 4,843,971 (“Braunagel”). Exs. 1009-1010.

Ex-1009 at Abstract (teaching a powered conductor (the duct 8 that encloses current collector 10) that is affixed to a track 11).



at Abstract. Specifically, Braunagel teaches two exposed conductors (26) within a main chamber of a track that connect with “slider contacts 50” that remain in contact with the conductors to power a vehicle on a track. An example of the power rail taught in Braunagel is shown in Figure 8:



Ex-1010 at Fig. 8 (showing the conductors and contacts at the top of the figure).

70. The prior art contains other examples of using power rails with trolley lift systems. Bergenstrale, entitled, “Lift Systems with Continuous In-Rail Charging” is another example of power rails being used in connection with body-weight support systems. Ex-1011. Bergenstrale teaches uses a lift system with a rail having at least one conductor positioned on an upper interior surface of the rail, where a carriage is slidably disposed in the rail for relative movement to the rail.

Ex-1011 at Abstract. Bergenstrale's body-weight support system and accompanying power rail are shown in Figures 1 and 6:

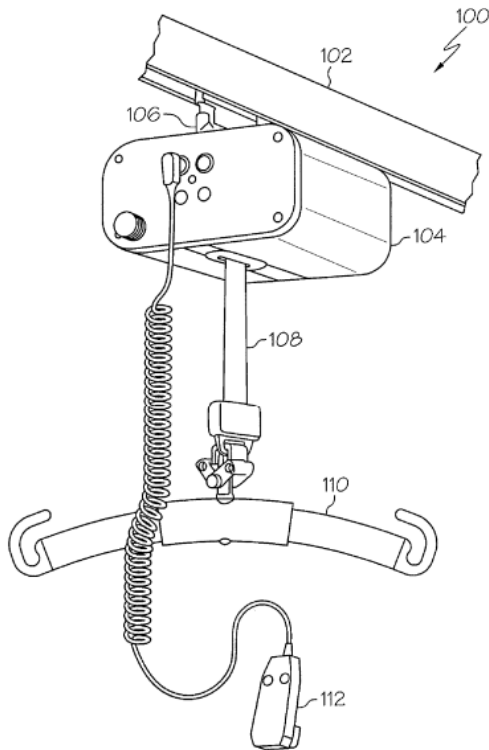


FIG. 1

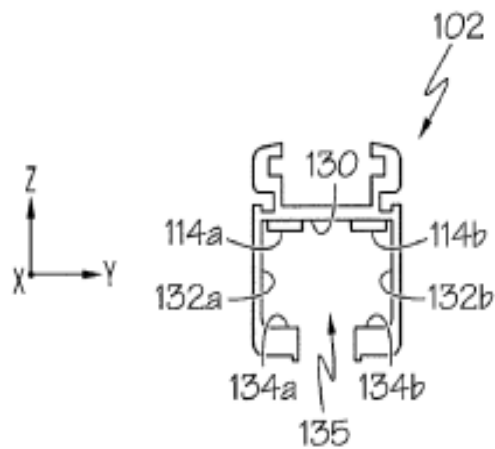


FIG. 6

Ex-1011 at Fig. 1 (teaching a “lift unit 104” (designed to support a patient) coupled to rail 102); id. at Fig. 6, [0034-36] (teaching an embodiment of a conductor 114 for use in the rail 102, in which the lift carriage 106 is “slidably disposed” within).

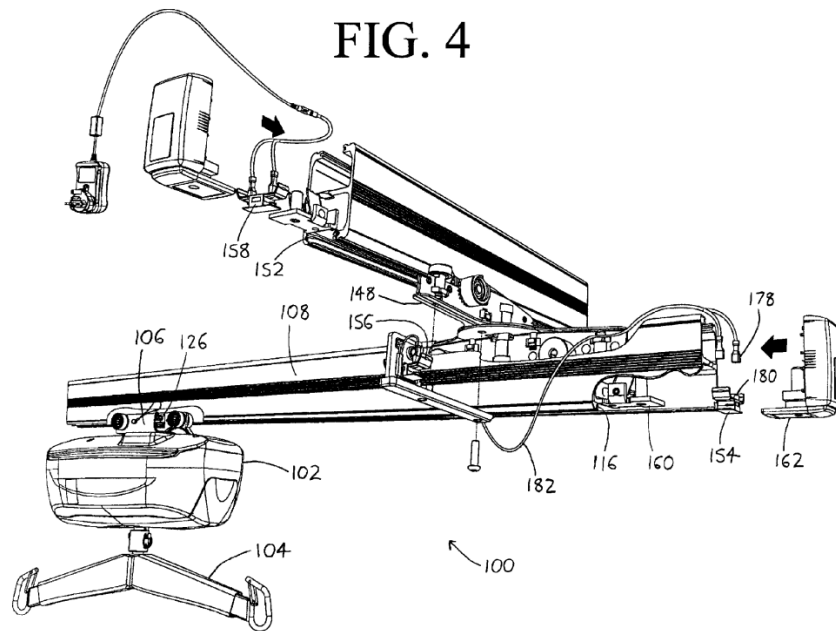
71. For at least these reasons, as of January 20, 2013, POSITAs were well-aware of power rails (including enclosed power rails) and how to use power rails to power vehicles or trolleys on a nearby track prior to the filing of the '000 Patent. As such, modifying Hidler's trolley system to incorporate the power rail of

Knevels would have simply been combining prior art elements according to methods that had been known for decades. Moreover, a POSITA would have understood that this combination would yield the predictable result reflected in the above-cited references—i.e., supplying power to the trolley of Hidler rather than using cables.

b. The prior art expressly suggests replacing a power cable with a power rail to attain predictable benefits

72. A POSITA also would have been aware of the well-recognized benefits of using power rails to replace power cables in a trolley system, such as the system of Hidler.

73. For example, in teaching one such prior art power rail and body-weight support system, Faucher (entitled “Conductive Connection for Track-Riding Patient Hoists”) explains that replacing cables with a power rail improve the functionality of the system: while “[p]ower may be provided to the hoists via 25 elongated flexible cables that follow the hoists along their tracks, . . . these can cause difficulties owing to the length of cable needed where the hoists are to travel long distances, and owing to the desire to avoid cable slack and dangling cable.” Ex-1007, 1:25-29 (teaching a body-weight support system with use of a power rail in a patent application filed in 2008). To avoid the power cable problem, Faucher suggests that a power rail can be used to power a body-weight support system trolley and then expressly teaches how to use such a power rail with a trolley:



Ex-1007 at Fig. 4 (teaching the use of a power rail (items 116 (track conductor), 154 (contact carriers) and leads 182)) to power a patient support hoist trolley 106 via the trolleys mobile contact carrier 126).

74. It is my opinion that the prior art (1) explained the motivation for removing power cables that power trolleys in body-weight support systems (i.e., solving the problem of using elongated power cables necessary to travel long distances, and “the desire to avoid cable slack and dangling cable”); (2) explicitly suggested the use of power rails with body-weight support systems as a means to remove the power cable problem; and (3) taught how power rails can be used in body-weight support systems (see Faucher and Bergenstrale).

75. Accordingly, it is my opinion that a POSITA would have been motivated to combine the body-weight support system of Hidler with the power rail system of Knevels to attain the well-understood benefit of eliminating the power cables of Hidler—i.e., eliminating the “difficulties owing to the length of cable needed where the hoists are to travel long distances, and owing to the desire to avoid cable slack and dangling cable.” Ex-1007, 1:25-29

c. It would have been obvious to try use of Knevels’ power rail with the overhead trolley system of Hidler

76. It is also my opinion that it would have been obvious to try the use of Knevels powered rail to supply power to the overhead trolley system of Hidler.

77. A POSITA would have understood that there are a limited number of predictable options for powering a trolley system—primarily power cables, rechargeable batteries, power rails, and more specifically, enclosed power rails.

78. Given that power rails were well-known in the art as one of a limited number of options to provide power to a trolley, it would have been obvious for a POSITA to try implementing a power rail to replace Hidler’s power cables. This is especially the case here, where there was a recognized design need to solve the problem of elongated power cables in body-weight support systems. In my opinion, this design need would give a POSITA good reason to pursue the known options (i.e., power rails) within their technical grasp.

79. Furthermore, I believe it would have been obvious for a POSITA to try different types of known power rails (such as enclosed vs non-enclosed) in a system like Hidler's. A POSITA would decide which power rail best fit the individual system based on various design parameters, such as space, safety, appearance, and the shape of a trolley's collector).

80. As I explain below, a POSITA also would have had a reasonable expectation of success in trying the power rail solution for Hidler's trolley system.

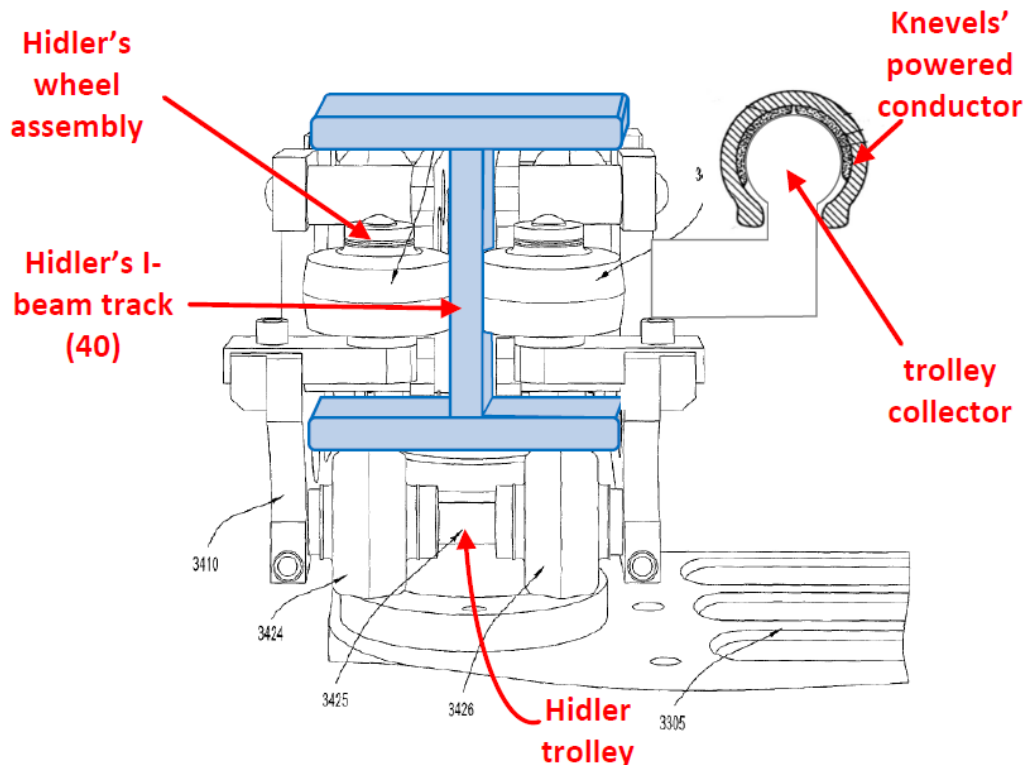
d. Replacing a power cable with a power rail is a simple substitution of known elements in the prior art

81. For the same reasons as discussed above, at least as early as January 2013, a POSITA would have recognized that replacing the power cable of Hidler with a power rail of Knevels amounted to nothing other than a simple substitution of known elements. Both elements have been known for decades, and POSITAs have used both elements in the body-weight support system context for years before the filing of the '000 Patent application.

e. A POSITA would expect to succeed in combining Hidler's body-weight support system with Knevels' power rail

82. It is my opinion that a POSITA would have expected success in modifying Hidler's trolley system to include a power rail as taught in Knevels. Adding Knevel's power rail to Hidler's body weight support system could routinely be accomplished by adding a support arm and current collector to

Hidler's trolley. To show how the systems would be combined, I have included the following annotated drawing based on Hidler's Figure 43, which shows the wheel assembly of the Hidler trolley. To illustrate the combination of Hidler and Knevels, I added the Hidler track (40) (from Figs. 2-4) to Figure 43 to show how Hidler's wheel assembly rides along the track. Finally, I added the Knevels power rail (from Fig. 1 of Knevels) and showed how the Hidler trolley would easily be modified to add a collector capable of receiving power from the added power rail:



Ex-1004 at Fig. 43 (annotated to show modification of the Hidler trolley combined with Knevels' power rail); Ex-1005, 19 (teaching a power rail); Ex-1004 at Figs. 2 (teaching an I-Beam track that the wheel assemblies move on).

83. The annotated image above is a cross-section view of the Hidler track and Knevels' power rail. Both the track and power rail are designed to be parallel to each other and to run the necessary distance for the trolley's operation. With this combination, as Hidler's trolley advances on the track, its current collector moves within the power rail via the support arm, thus giving the trolley power at any position on its track. *Id.* While a POSITA could also implement other possible configurations that apply Knevel's teaching of a powered conductor to Hidler's trolley, there would be an expectation of success for each.

84. For all of these reasons, I conclude that a POSITA would have been motivated to combine Hidler and Knevels, and would have expected success in doing so.

3. Claim 1

85. Based on my review and for the reasons that follow, it is my opinion that claim 1 is obvious based on the teachings of Hidler and Knevels.

f. Limitation 1[pre]

1[pre]	An apparatus, comprising:
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86. I understand that a preamble generally does not state a claim limitation. However, to the extent the preamble limits claim 1, it is my opinion that Hidler teaches an apparatus. The apparatus taught by Hidler is: "a body-weight support system that allows individuals with severe to minor gait impairments to

freely practice over-ground walking in a safe, controlled manner.” Ex-1004 ¶ 4:9-12.

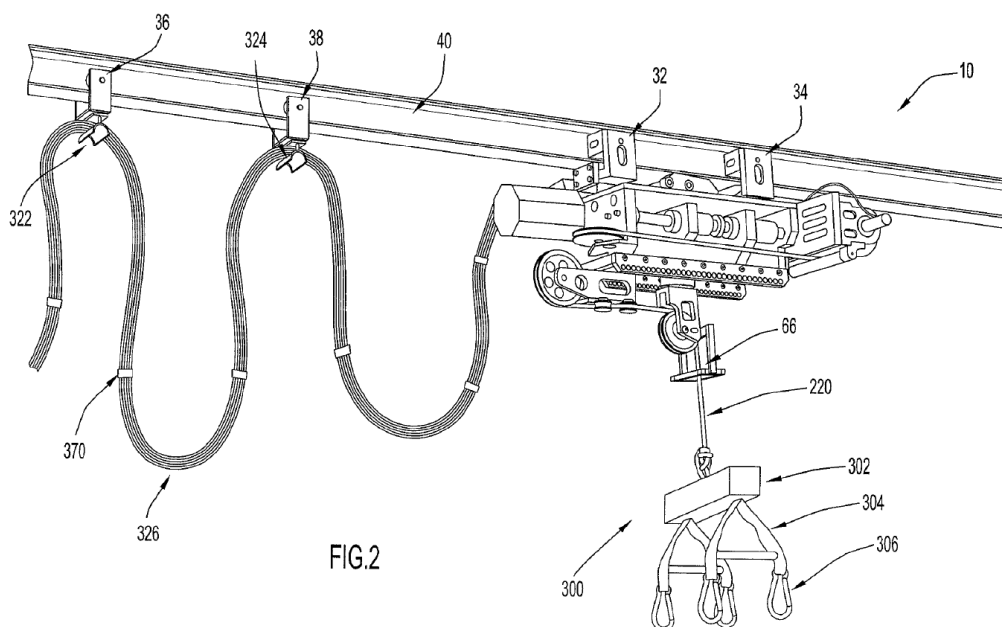
87. Accordingly, in my opinion Hidler teaches Limitation 1[pre].

g. Limitation 1[a]

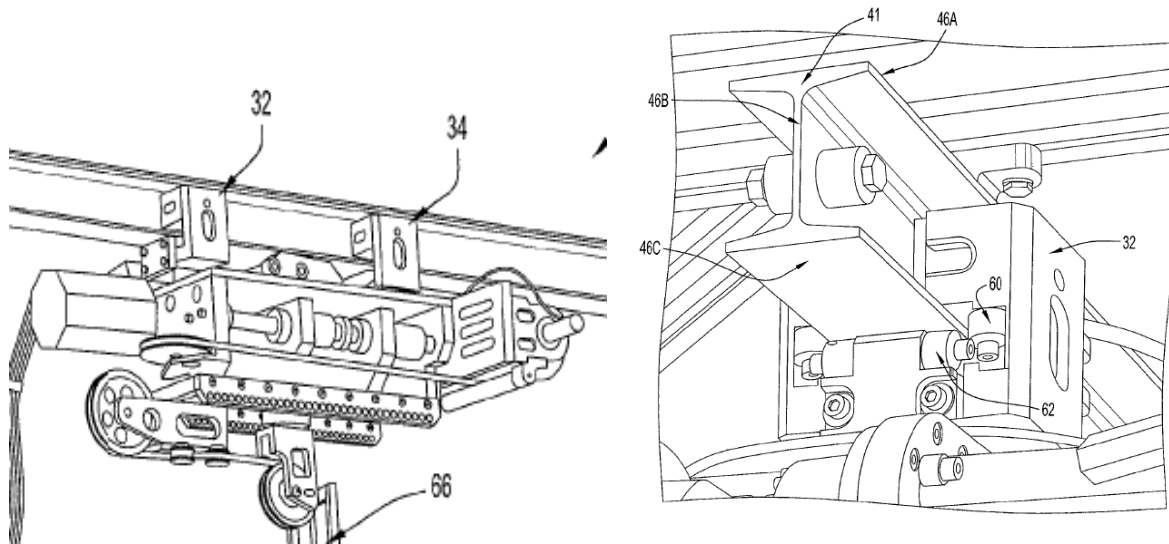
1[a]	a trolley having a drive assembly configured to movably suspend the trolley from a track;
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88. In my opinion, Hidler teaches element 1[a] because Hidler teaches a trolley (30) that has a drive assembly (3300) that moves the trolley (30) suspended from a track (40).

89. As shown in Figures 1-2, Hidler teaches a trolley (30) having a drive assembly (detail shown below) configured to movably suspend the trolley from a track (40):



Ex-1004 at Fig. 2.



Ex-1004 at Figs. 2, 14 (showing placement of wheel assemblies 32 and 34 as they move the trolley along the track).

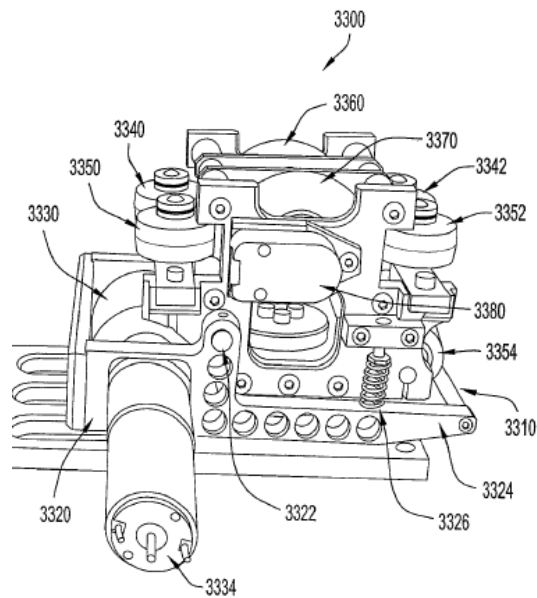
93. The wheel assemblies are mounted to the trolley and mounted to a DC motor (either directly on or between the wheel assemblies). *See* Ex-1004 at Fig. 25 (showing block diagram coupling of motor to the wheels via a controller and encoder):

The trolley 30 rides along the track 40 and allows for forward and backward progression of the subject 15. The wheels on the trolley 30 are pivoting, thereby allowing the system to navigate corners as well as Straight sections. In one embodiment, the trolley 30 includes pivoting wheel assemblies 32 and 34 that are pivotally mounted to a plate or base. In the embodiment illustrated in FIG. 12, a direct current. (DC) motor 50 is mounted between the front and back trolley wheels or wheel assemblies 32 and 34. In another embodiment, a DC motor is mounted to

one of the pivoting wheel assemblies 32 or 34. The motor 50, including a gearhead, is utilized to drive the system via a motor drive wheel 52. The terms “motor,” “drive,” and “drive mechanism’ can be used interchangeably herein. As shown in FIG. 13, a spring 56 pushes the drive wheel 52 against the bottom of the I-beam of the track 40. In particular, the spring 56 pushes a movably mounted bracket 54, to which the motor drive wheel 52 is mounted, toward the track. Thus, the drive wheel 52 contacts the I-beam track 41 beneath the lower flange 46C (as described below).

Ex-1004 at 6:61-7:13.

94. Hidler also teaches a drive assembly because Hidler teaches “assembly 3300 includes a trolley motor 3334 that is coupled to a drive wheel 3330 that engages the track 3150 to move the trolley 3100 along the track 3150. As shown in FIG. 41, the drive wheel 3330 includes an outer surface 3332 and is rotatably mounted on an axle 3334. The drive wheel 3330 is mounted in a drive wheel body 3320 that is pivotally mounted to the housing 3310 by an axle 3322.” *Id.* at 18:53-59. This drive assembly is shown in Figure 40:



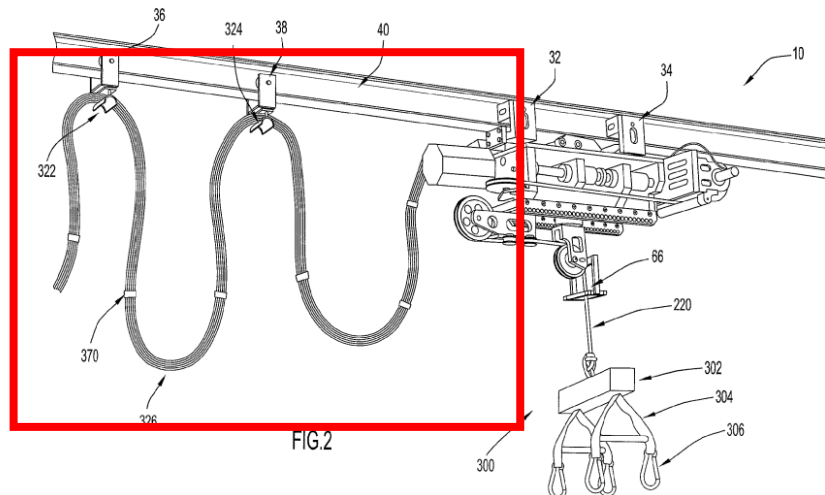
Ex-1004 at Fig. 40 (showing drive wheel 3330 coupled to the support structure and motor axle 3334). A POSITA would recognize that this wheel, motor and support structure also teaches the claimed “drive assembly configured to movably suspend the trolley from a track.”

h. Limitation 1[b]

1[b1]	a powered conductor operatively coupled to the track, the powered conductor being substantially parallel to the track,
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95. In my opinion, the combination of Hidler and Knevels teaches limitation 1[b1] because the combination includes a powered conductor that: (1) runs parallel to Hidler’s track; and (2) provides power to Hidler’s trolley as it moves along the track.

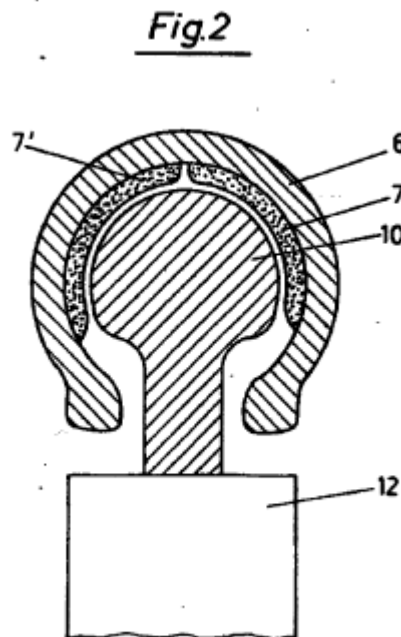
96. As explained with respect to limitation 1[a], Hidler teaches an apparatus with a trolley having a drive assembly configured to movably suspend the trolley from a track. Hidler's drive assembly, however, is powered through powered conductor cables (326) that run substantially parallel to the track (and bunch up as needed, as shown), rather than through an enclosed powered conductor coupled to the track (that runs substantially parallel next to the track).² Ex-1001 at Fig. 2; 5:38-40. Hidler's power cable is shown below in Figure 2:.



² I describe an enclosed powered conductor rail here, rather than powered conductor cables, to meet this limitation because limitation 1[b3] (described below) requires a portion of the trolley to be *disposed within the powered conductor* which is not possible if cables are used as a powered conductor.

Ex-1005 at 19.

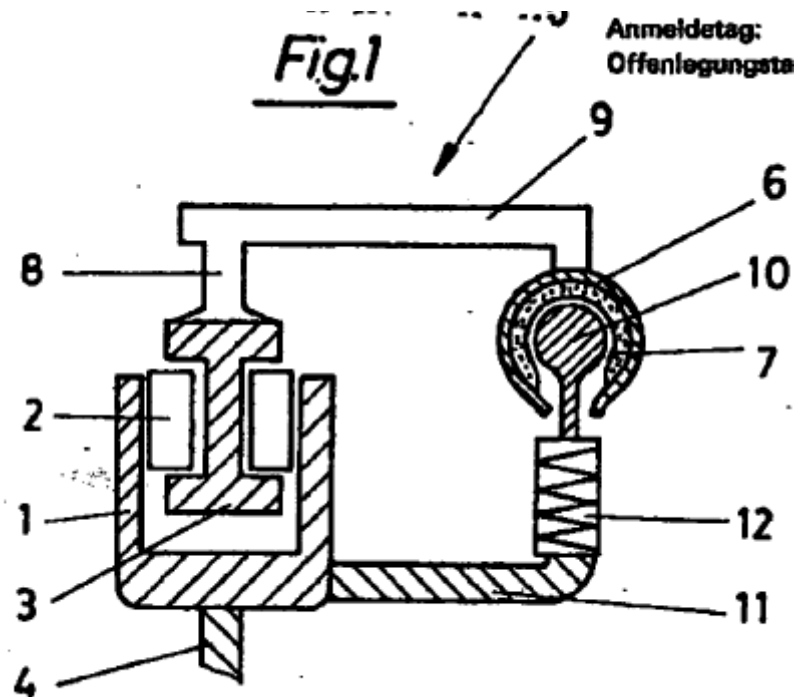
99. Figure 1 of Knevels shows that the taught power rail is used in conjunction with the trolley (1), which has wheels/castors (2) riding on a suspension I-beam track (3). Ex-1005 at 17, 19. Knevels also teaches the power rail (i.e., a powered conductor) comprises a wire guide tube (6) and contact bar (7). *Id.* The power rail works by directly connecting inner conductive surfaces (7 and 7') (as shown in Fig. 2), with the current collector wiper contact (10) extending from the trolley's support arm and casing (11 and 12). *Id.* A more detailed view of the power rail taught by Knevels is shown in Figure 2 below (which shows the inner conductive surfaces of the power rail):



Ex-1005 at Fig. 2. A POSITA would understand Knevel's power rail, as described above and taught in Figures 1 and 2, to be a powered conductor, as that phrase is used in the '000 Patent.

100. A POSITA would understand Knevels' power rail/powering conductor is also operably coupled a track because the trolley traveling along the track directly contacts the power rail using the support arm (11) extending from the trolley. Moreover, there is an electrical connection between the powered conductor and the track, which also makes the two components operatively coupled. The '000 Patent provides a similar exemplary embodiment of operatively coupling the power rail to the track. Ex-1001 at 7:19-24. ("[T]he electronic system 1700 and/or the control 1900 can be operatively coupled (e.g., electrically connected) to the one or more motors such that the electronic system 1700 and/or the control 1900 can send an electronic signal associated with operating the motor(s).").

101. Knevel's power rail is also designed to be substantially parallel to the track, as is shown in Figure 1. Ex-1005 at Fig. 1:



Ex-1005 at Fig. 1; *see also* Ex-1005 at 14 (teaching that “electrical power is fed to the traction means via current collectors and a shockproof contact wire” and is “positioned in parallel to the rail track (3) of such a transport means. . . .” Ex-1005, 14.

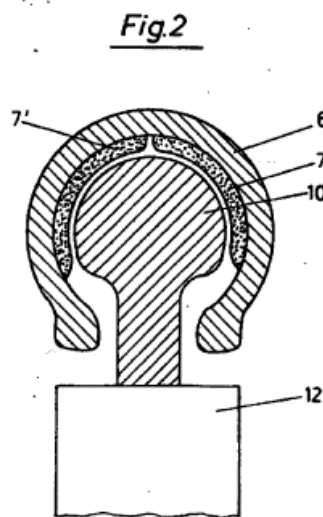
102. As I discussed above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

103. Therefore, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[b1].

1[b2]

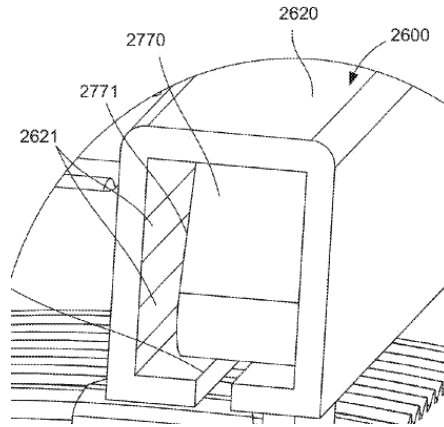
the powered conductor including at least one conductive inner surface,

104. In my opinion, the combination of Hidler and Knevels also teaches 1[b2]. In particular, Knevels teaches “the powered conductor including at least one conductive inner surface” because the inner surface on the Knevels power rail (6) includes multiple conductive inner surfaces (i.e., contact wires 7 and 7’) that transfer power to the trolley’s drive assembly through the current conductor (10):



Ex-1005 at 19; *id.* at 16 (“As is shown by the detailed depiction of the wire guide tube 6 in figure 2, a contact wire 7, 7’ broken into two or more current conductors is suggested within the slotted tube 6.”).

105. Knevels’ teaching of element 1[b2] closely tracks examples provided in the ’000 Patent. In particular, the ’000 Patent provides an example of a powered conductor (2620) including a conductive inner surface (2771) in Figure 10:



Ex-1001 at Fig. 10. The '000 Patent states that the “conductive portion” 2771 can consist of “individual conductors, a conductive, surface, or the like.” Ex-1001 at 13:39-49.

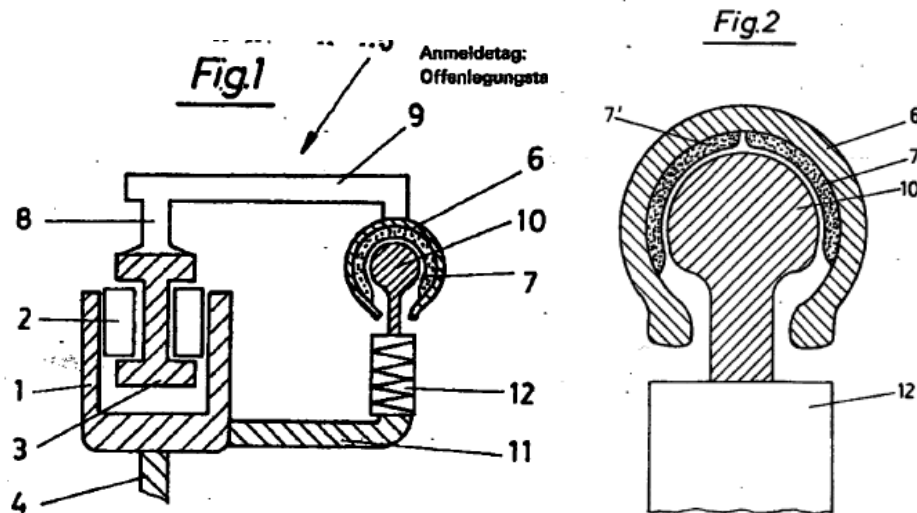
106. As I discussed above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

107. Therefore, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[b2].

1[b3]	a portion of the trolley being disposed within the powered conductor and in contact with the at least one conductive inner surface to electrically couple the trolley to the powered conductor,
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108. In my opinion, the combination of Hidler and Knevels also teaches 1[b3] because the portion of Hidler’s trolley coupled to the Knevels power rail will be disposed within the power rail and in contact with a conductive inner surface of the power rail.

109. In particular, Knevels teaches an enclosed power rail (6) with a conductive inner surface (7, 7') that electrically couples a trolley to the powered conductor:



Ex-1005 at 19.

110. When combined with Hidler's modified trolley (using a collector and support arm in place of Hidler's original power cable), a POSITA would have understood that the collector (i.e., a portion) of the Hidler-Knevels trolley is disposed within the powered conductor and in contact with the at least one conductive inner surface to electrically couple the trolley to the powered conductor, as taught in Knevels. The trolley's current conductor is in contact with at least one conductive inner surfaces (elements 7 and 7' in Knevels), which together operate to electrically couple the trolley to the powered conductor. See Section 1[b2]; Ex-1005 at 14-19.

111. As discussed already above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

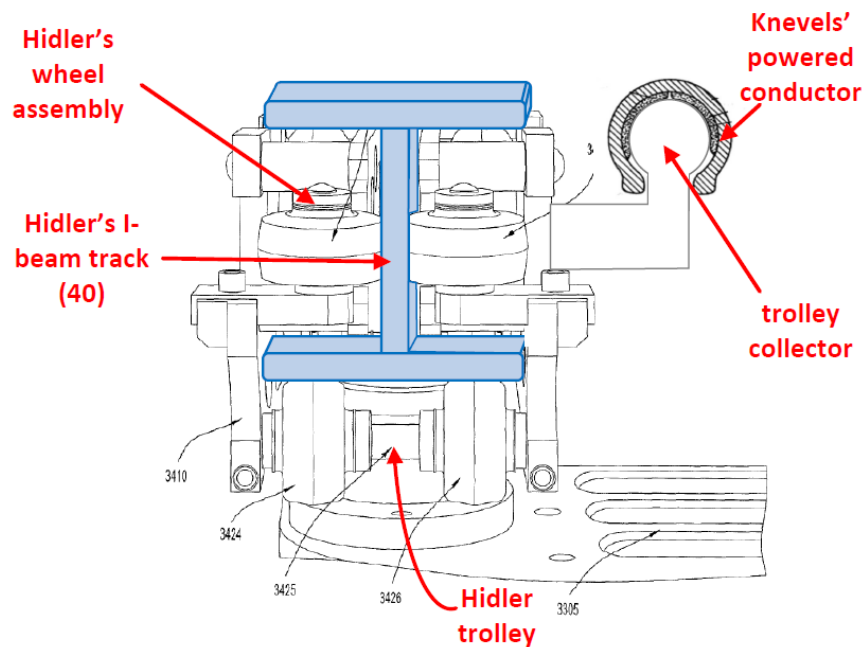
112. Accordingly, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[b3].

1[b4]	the portion of the trolley configured to move within the powered conductor and along the at least one conductive surface when the trolley is moved along the track
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113. In my opinion, the combination of Hidler and Knevels teaches 1[b3] because the current collector from the proposed combination will move along the power rail as the trolley moves along the track. This is because Knevels teaches that its contact wire system runs parallel to the suspended monorail track coupled to it. Ex-1005 at 14-16.

114. Within the Hidler-Knevels system, the trolley's current collector is within the wire guide tube and is "guided with the transport means" that moves down the track. *Id.* Knevels also teaches that the "contact wire guide tube has lengths which correspond to the sections of the suspended monorail . . . provid[ing] the corresponding contact wire guide tubes with couplings so that a smooth sliding surface is provided on the contact wire guide tube ends for the current collector wiper contact. *Id.*

115. Thus, the Hidler-Knevels combination would include the track and trolley from Hidler modified to include a collector and powered conductor that runs parallel to the track, as taught in Knevels. *Id.* More specifically, the current collector that would be incorporated into the trolley of Hidler (as taught in Knevels) would move through the wire guide tube, sliding along the contact wire 7 and 7' (i.e., the inner conductive surface):



Id.; Ex-1005, Fig. 1; Ex-1004 at Figs. 2 and 43.

116. As discussed already above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

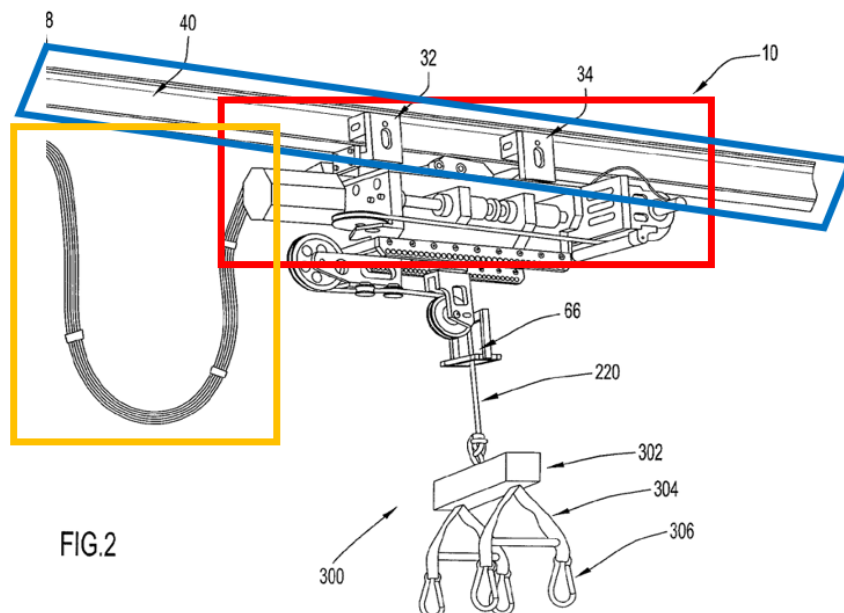
117. Accordingly, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[b4].

1[b5]

the track and the drive assembly each disposed outside of the powered conductor;

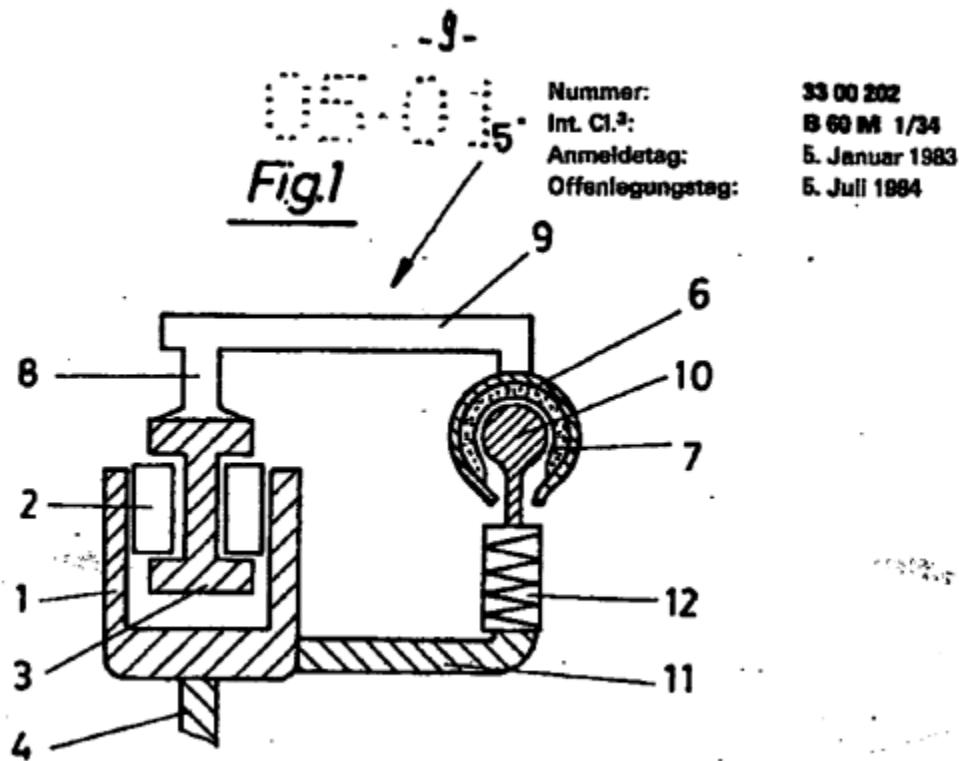
118. In my opinion, the Hidler-Knevels combination teaches “the track and the drive assembly each disposed outside of the powered conductor.”

119. Hidler alone teaches having the track and drive assembly disposed outside of the powered conductor. Figure 2 in Hidler teaches a track (annotated in blue below) and a drive assembly (annotated in red):

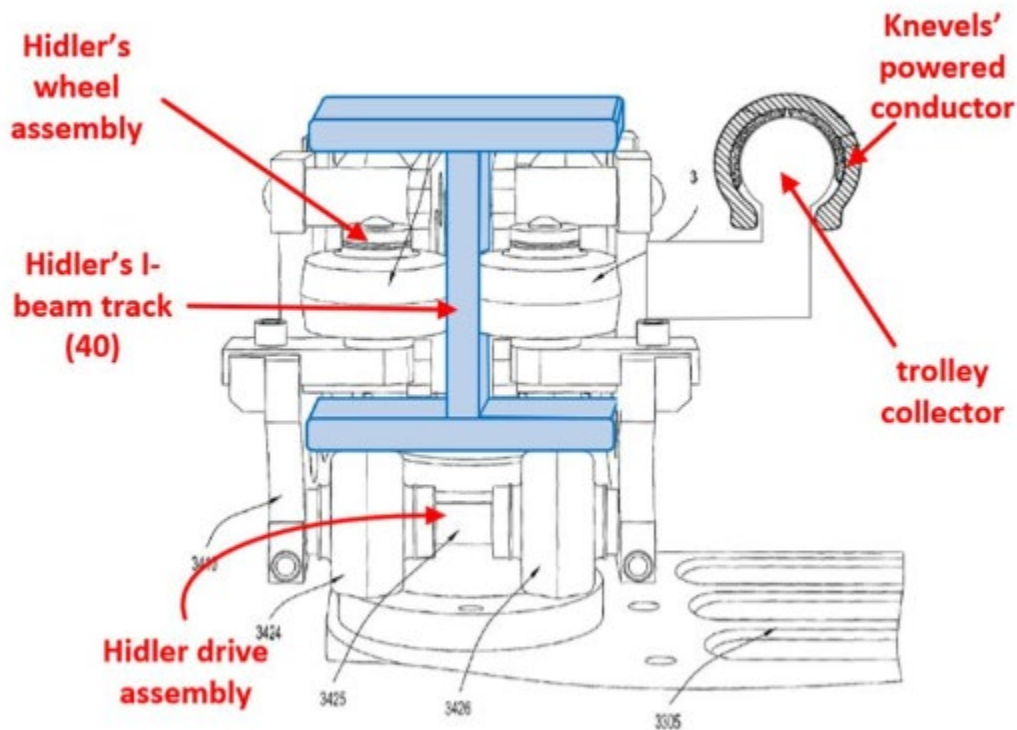


Ex-1004, Fig. 2, 4:12-14 (“The system 10 includes an unloading system 20 (see FIG. 1) that is attached to a driven trolley or movable support 30 that rides along a track 40.”). As shown above, the drive assembly in Hidler is located under the main track, not within the power cables. Ex-1004, Fig. 2, 4:12-14.

120. In the Hidler-Knevels combination, Knevel's power rail (6) replaces the Hidler cable (annotated in orange above) and is separate from the main track (3) (which supports the drive assembly), as taught in Knevels:



121. Applying the teachings of Knevels to modify the trolley system of Hidler would likewise result in the drive assembly being outside of the powered conductor, as reflected in the annotated figure below:



Ex-1004 at Figs. 2 and 43; Ex-1005, Fig. 1.

122. Combining Hidler with Knevels' power rail therefore results in a track and drive assembly still being "disposed outside of the powered conductor," and thus, Hidler in view of Knevels meets limitation 1[b5].

123. As discussed already above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

124. Accordingly, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[b5].

i. Limitation 1[c]

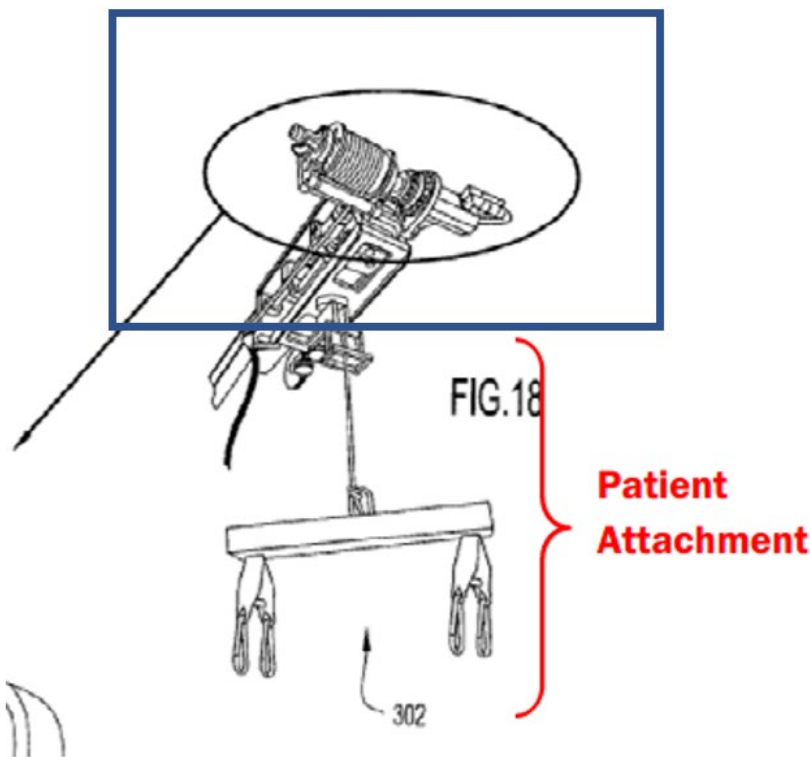
1[c]	at least one patient attachment coupled to the trolley, the at least one patient attachment configured to support a single patient; and
------	---

125. In my opinion, Hidler teaches 1[c] because it describes a trolley with a patient attachment mounted to it that can support one patient (subject).

126. Specifically, Hidler states that “[t]he system according to the present invention is a body-weight support system that allows individuals with severe to minor gait impairments to freely practice over-ground walking in a safe, controlled manner. The system 10 includes an unloading system 20 (see FIG. 1) that is attached to a driven trolley or movable support 30 that rides along a track 40, which in one implementation, can be mounted to a ceiling or other support structure.” Ex-1004, 4:9-21 (emphasis added).

127. Hidler further teaches that “[a]s the subject 15 ambulates, the trolley 30 automatically moves forward or back, staying above the subject 15 so that the subject 15 only feels a vertical unloading force and does not have to drag the mass of the trolley 30.” Ex-1004, 4:21-25.

128. A POSITA would understand that Hidler’s Figures teach the patient attachment being coupled to the trolley:



Ex-1004, Fig. 18.

129. Hidler further teaches coupling the patient attachment to the trolley:

Referring to FIG. 1, the unloading or adjustment system 20 includes a pulley 222 around which a rope 220 passes. Rope 220 can be referred to alternatively as an elongate member. The rope 220 has one end that is coupled to a winch as described below and another end that is coupled to a support assembly, Such as a harness system or assembly, as described below. The Support assembly and the elongate member, in this example the rope 220, form a suspension system that can be used to Support a person or Subject. The rope 220 passes around other pulleys 223A and 223B that guide the rope 220 toward pulley 58. The rope 220

passes around pulley 58 and through a pivotally mounted arm 66 that has an upper end 66A and a lower end 66B. The function and use of arm 66 is described in detail below with respect to FIGS. 15 and 16.

Id. at 5:6-24.

130. Figure 3 of Hidler further depicts the patient attachment coupled to the trolley and supporting one patient:

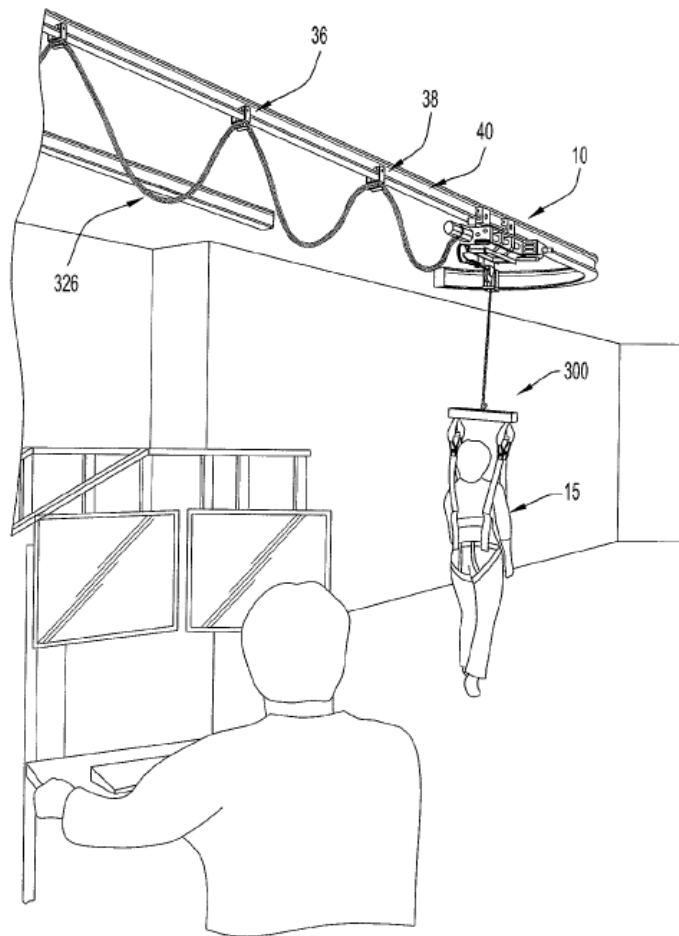


FIG.3

131. Accordingly, in my opinion, Hidler teaches and renders obvious Limitation 1[c].

j. Limitation 1[d]

1[d]	a control system coupled to the trolley and at least operably coupled to the powered conductor.
------	---

132. In my opinion, the combination of Hidler and Knevels teaches 1[d] because Hidler teaches a control system that is coupled to the trolley and to the power source and (as explained above) Knevels teaches using the powered conductor as the power source.

133. Hidler teaches a “user interface 100 allows the therapist to monitor and control all of the features of the system 10.” Ex-1004, 5:57-67. That user interface includes “[l]arge pushbuttons on a touch screen such as that shown in FIG. 5 allow the therapist to raise and lower the patient, to start the constant body-weight support, engage the trolley (e.g. have the trolley track the subjects).” *Id.*

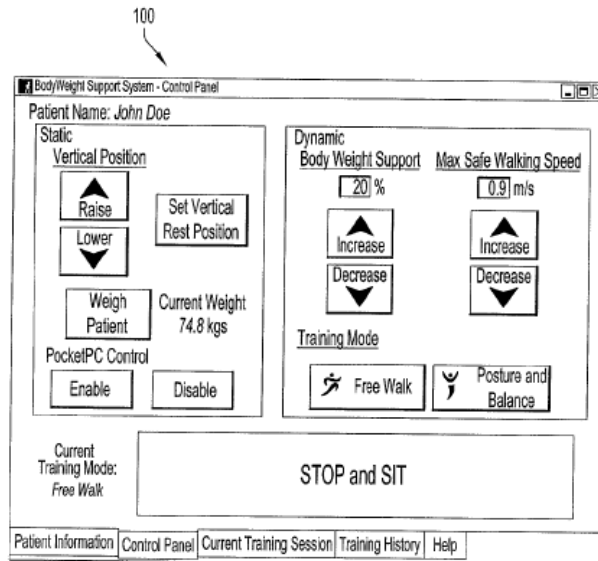


FIG.5

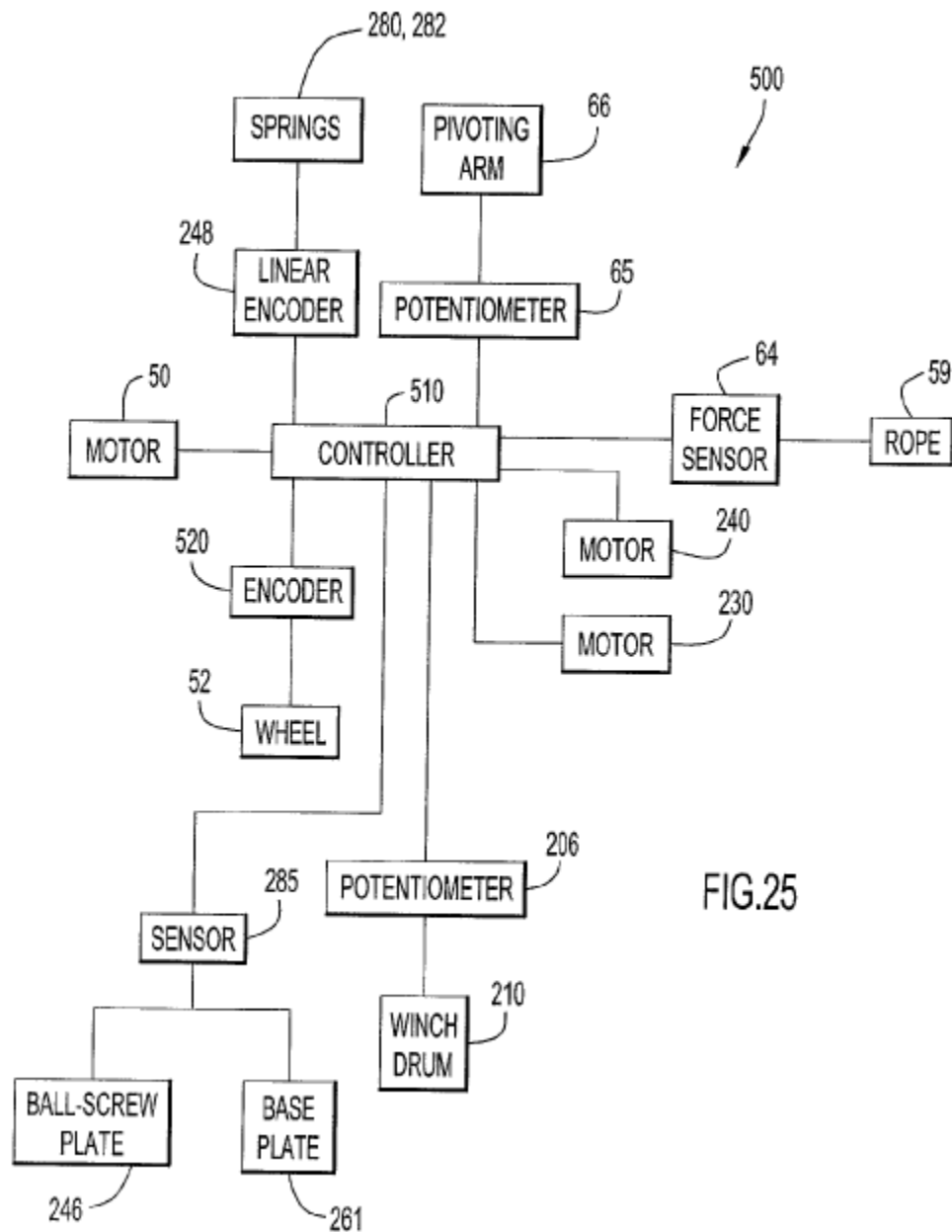
Ex-1004 at Fig. 5.

134. The user interface of Hidler has this capability based on Hidler's taught "control system 500," which is coupled to the trolley so as to receives inputs from sensors and conductors of the body weight support system:

the control system 500 includes a controller 510 that is configured to receive various inputs from the sensors or detectors of the system. . . . The system 500 includes the drive motor 50, the winch motor 230, and the ball-screw motor 240. Each of the motors 50, 230, and 240 is controlled based on the inputs from the corresponding sensors."

Ex-1004, 13:62-14:18.

135. The control system—and its coupling to the trolley—is further depicted in figure 25 of Hidler:



136. Hidler teaches that the control receives power from the cables 326. Ex. 1004, 5:38-42 (“The cables and/or wires 326 are connected to the electrical

system on the trolley 30.”). As explained above, in the combination of Hidler and Knevels, the cables would be replaced by the powered conductor as taught in Knevels. As a result, the combination of Hidler and Knevels also teaches that the control system is operably coupled (e.g., electrically coupled) to the powered conductor. This is because Hidler teaches that the trolley the control system 500 “controls all aspects of the system” (including its motors) and receives inputs from the trolley’s sensors. Ex-1004, 5:57-67; 13:62-14:18. The Hidler-Knevels trolley motors and sensors would be powered by the powered conductor in order to operate. Ex-1004, 5:57-67; 13:62-14:18. Therefore, the control system is electrically coupled to the powered conductor, which is what allows trolley along the track and adjust tension of the support tether in response to patient movement.

137. As discussed already above, a POSITA would have been motivated to combine the power rail of Knevels with the overhead gait system of Hidler. *See* Section Motivation to Combine.

138. Accordingly, in my opinion, Hidler in view of Knevels, teaches and renders obvious Limitation 1[d].

4. Claim 2

2	The apparatus of claim 1, wherein the patient attachment includes one of a passive coupling and an active coupling, the passive coupling configured to be coupled to a tether to couple the patient attachment to the trolley, the active coupling configured to be coupled to a patient harness.
---	---

139. In my opinion, the combination of Hidler and Knevels teaches and renders claim 2 obvious. As explained above, the combination of Hidler and Knevels teaches the apparatus of claim 1. In my opinion, Hidler also teaches the additional limitation in claim 2 because Hidler teaches a patient attachment that includes a passive coupling configured to be coupled to a tether to couple the patient attachment to the trolley.

140. As a threshold matter, I understand claim 2 to require “one of” a passive coupling and an active coupling—i.e., I understand that it is not required to have both a “passive coupling” and an “active coupling” to teach claim 2.

141. The scope of the terms “passive coupling” and “active coupling” in the '000 Patent would not have been clear to a POSITA. However, the '000 Patent states that a “loop” or a “hook” could perform the function of the “passive coupling” of claim 2—i.e., a loop or a hook could be coupled to a tether to couple the patient attachment to the trolley coupling at least one “passive coupling.” This example is shown in Figure 34:

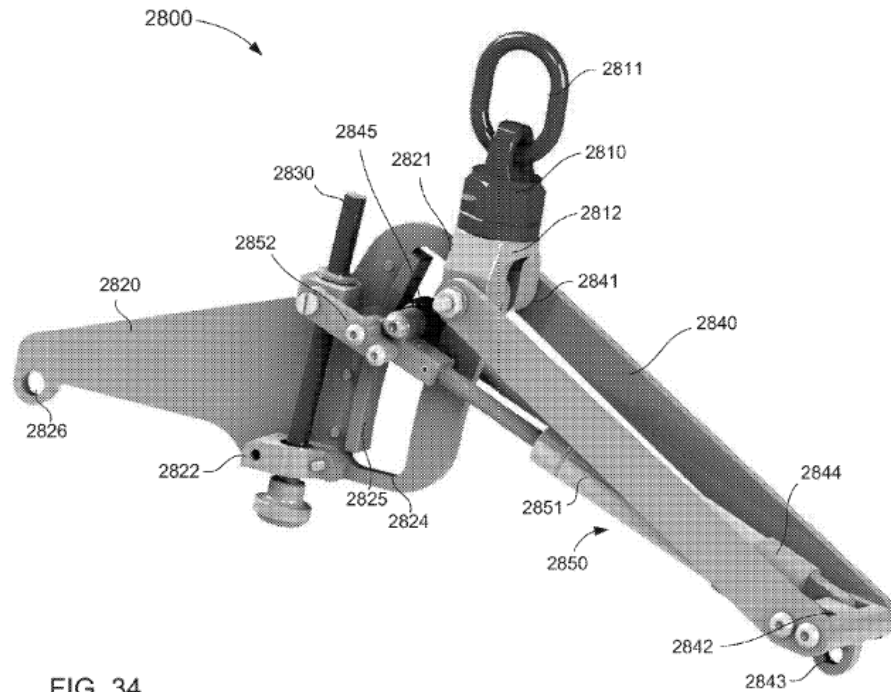
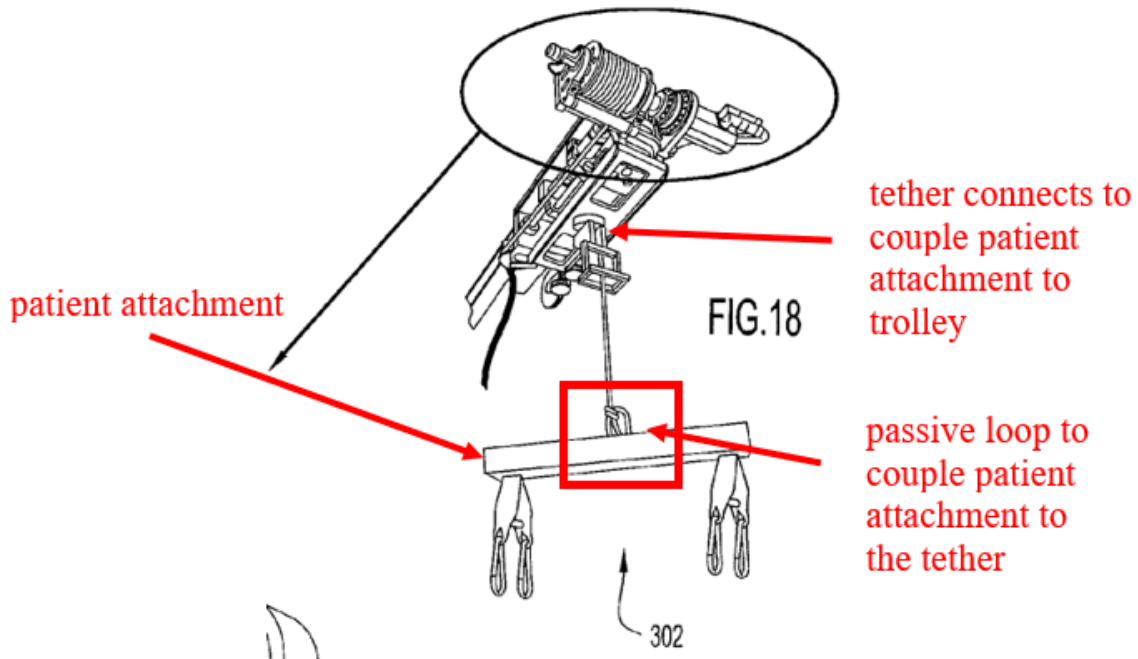


FIG. 34

Ex-1001 at Fig. 34.

142. The '000 Patent describes the coupling 2810 as including “a coupling mechanism 2811 configured to couple to the second end portion 2507 of the tether, as described above. For example, the coupling mechanism 2811 can be a loop or a hook configured to couple to an attachment device of the tether.” *Id.* at 28:6-12. A POSITA would thus understand a “loop” or a “hook” to be a passive coupling even if a POSITA would not otherwise understand the full scope of the term.

143. Hidler teaches using a loop or hook that is configured to be coupled to a tether to couple the patient attachment to the trolley:



Ex-1004 at Fig. 18. Hidler separately teaches that the patient harness is connected to the unloading system by a rope (i.e., a tether) which is connected to the harness. *Id.* at Fig. 1, 5:11-13. The tether is connected to the harness in the same manner as described in the '000 Patent, and therefore, Hidler teaches the claimed “passive coupling configured to be coupled to a tether to couple the patient attachment to the trolley.” I understand that the Examiner expressed the same conclusion concerning Hidler’s teaching the claimed passive coupling.” Ex-1002, 241.

144. For the reasons stated above, in my opinion, Hidler in view of Knevels, teaches and renders obvious Claim 2.

5. Claim 3

3	The apparatus of claim 1, wherein the trolley includes a patient support system, the patient support system configured to actively support a patient.
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145. In my opinion, the combination of Hidler and Knevels teaches and renders claim 3 obvious. For the reasons stated above, the combination of Hidler and Knevels, teaches the apparatus of claim 1. In my opinion, Hidler also teaches the additional limitations in claim 3 because Hidler teaches a patient support system (Figs. 17-25) that actively supports a patient by dynamically adjusting a tether to maintain constant force and support the patient from sudden falls.

146. The control system of Hidler actively controls the tension on the tether (rope 59) based on inputs from a variety of sensors and other components, including motors, potentiometers, encoders, springs, controllers, a winch drum, and a ball screw plate. This is depicted, for example, in figure 25:

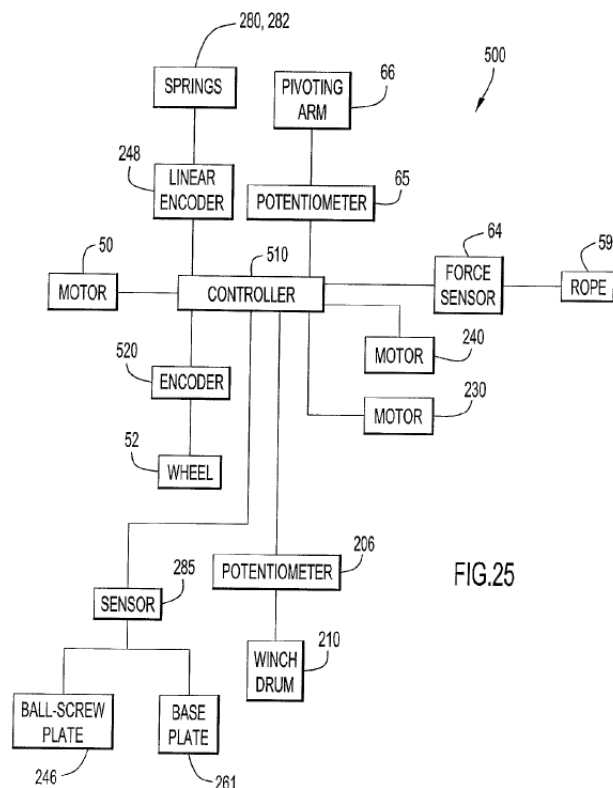


FIG. 25

147. Hidler teaches that this body-weight support system allows for active adjustments, such as providing “constant rope tension (e.g. constant body weight support)” as the patient moves and the length and force on the tether changes. *Id.* at 10:4-22. The system does this by using “two die-springs 280 and 282 pressing against the pulley plate 250 to which the subject is attached.” *Id.* “As the subject walks, a DC motor 230 automatically maintains the spring length constant for springs 280 and 282, which results in constant rope tension.” *Id.* A POSITA would have understood that configuring the system of Hidler to provide such constant rope tension qualifies as configuring the system to actively support a patient. *Compare* Ex-1001, 8:36-48 (“Thus, the support mechanism 1500 can be

configured to exert a reaction force in response to the force exerted by the patient such that the portion of the body weight supported by the support system 1000 remains substantially unchanged. Moreover, by actively supporting the portion of the body weight of the patient, the support system 1000 can limit the likelihood and/or the magnitude of a fall of the patient supported by the support system 1000. Similarly stated, the support mechanism 1500 and the electronic system 1700 can respond to a change in force exerted on the tether in a relatively short amount of time (e.g., much less than a second) to actively limit the magnitude of the fall of the patient.”) *with* Ex-1004, 10:4-23 *and id.*, 4:25-27 (“The system can maintain up to a certain amount of constant rope tension and can provide a certain amount of static unloading.”).

148. For the reasons stated above, in my opinion, Hidler in view of Knevels, teaches and renders obvious Claim 3.

6. Claim 4

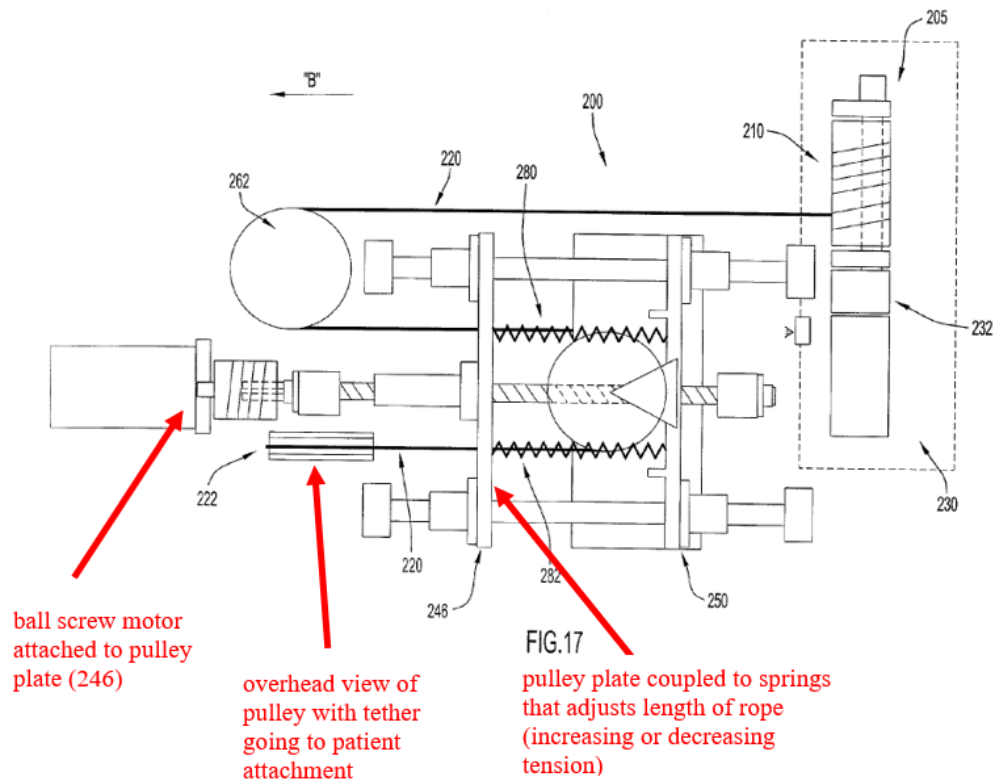
4	The apparatus of claim 1, wherein the trolley includes the drive assembly and a torque transfer assembly, the drive assembly and the torque transfer assembly being driven simultaneously.
---	--

149. As described above, the combination of Hidler and Knevels teaches the apparatus of claim 1. In my opinion, Hidler also teaches the remaining limitation in claim 4 because Hidler teaches that its trolley includes a drive

assembly (*see* limitation [1a]) and a torque transfer assembly that are driven simultaneously.

150. For the same reasons as explained with respect to claim 1 (limitation [1a]), Hidler includes a drive assembly to move a trolley along a track.

151. Hidler also teaches that the trolley includes a torque transfer assembly as part of its system for actively supporting the weight of a patient. In particular, Hidler teaches an unloading system that transfers torque from the ball screw motor to the tether coupling to the patient attachment using pulley plates and springs:



Ex-1004 at Figs. 17, 21-22; 10:59-12:24 (“To apply tension in the rope 220, the ball-screw motor 240 turns the ball-screw 242 which in turn causes the ball-screw

nut 244 to advance the ball-screw plate 246 toward the pulley plate 250. As a result, this movement causes the springs 280 and 282 to compress, causing a force against the pulley plate 250: $F=k \cdot dx$ ”).

152. As a patient walks, “the pulley plate 246 will move back and forth. In order to maintain the force in the rope 220 constant, the spring deflection, dx , must remain constant.” *Id.* at 11:46-48. The pulley plate moving back and forth is result of a linear force. When this happens, the “ball-screw motor 240 turns on and moves the ball-screw plate” to maintain the spring deflection and “the desired level of compression.” *Id.* at 11:49-59. Converting the motor’s rotational force (i.e., torque) to linear force (to counteract the moving pulley plate) requires the ability to transfer torque. In Hidler, this is done with the ball-screw/plate mechanism (i.e., a torque transfer assembly). *See id.*, Fig. 20A. Accordingly, this system is a torque transfer assembly as the rotational energy from the motor is converted to linear energy at the tether.

153. While the patient is moving, Hidler’s torque transfer assembly is being driven to constantly maintain the pre-selected tension in the tether. Ex-1004, 10:59-12:24. Simultaneously (i.e., when the patient is moving), the trolley’s drive assembly is also being driven to track the patient’s movement. *Id.* at 4:22-25 (“As the subject 15 ambulates, the trolley 30 automatically moves forward or back, staying above the subject 15 so that the subject 15 only feels a vertical unloading

of force and does not have to drag the mass of trolley 30.”). As a result, the drive assembly and the torque transfer assembly of Hidler are driven simultaneously as the patient walks—the torque transfer assembly to maintain constant tension on the tether and the drive assembly to move the trolley along the track.

154. I understand that the Examiner expressed the same conclusion concerning Hidler’s teaching “a torque transfer assembly, the drive assembly and the torque transfer assembly being driven simultaneously.” Ex-1002 at 265-66.

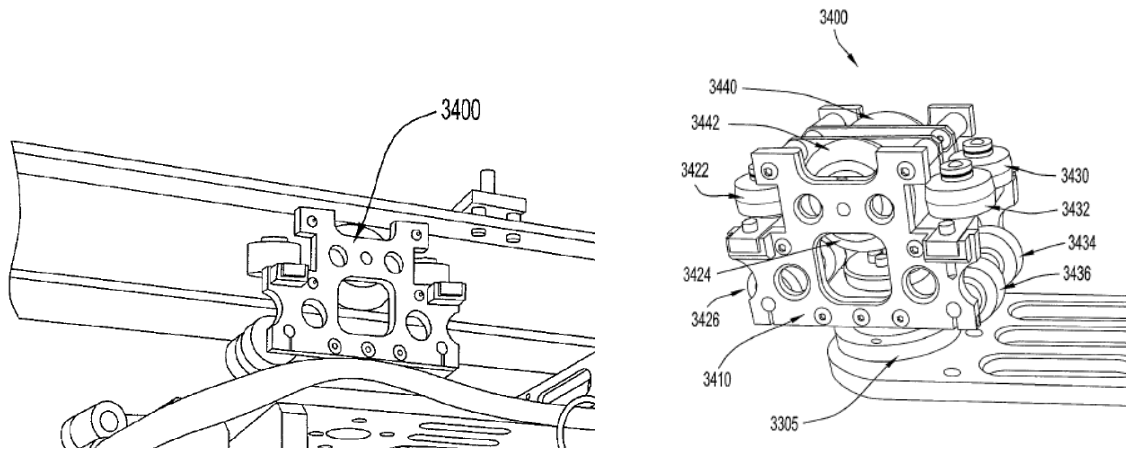
155. For the reasons stated above, in my opinion, Hidler in view of Knevels, teaches and renders obvious Claim 4.

7. Claim 5

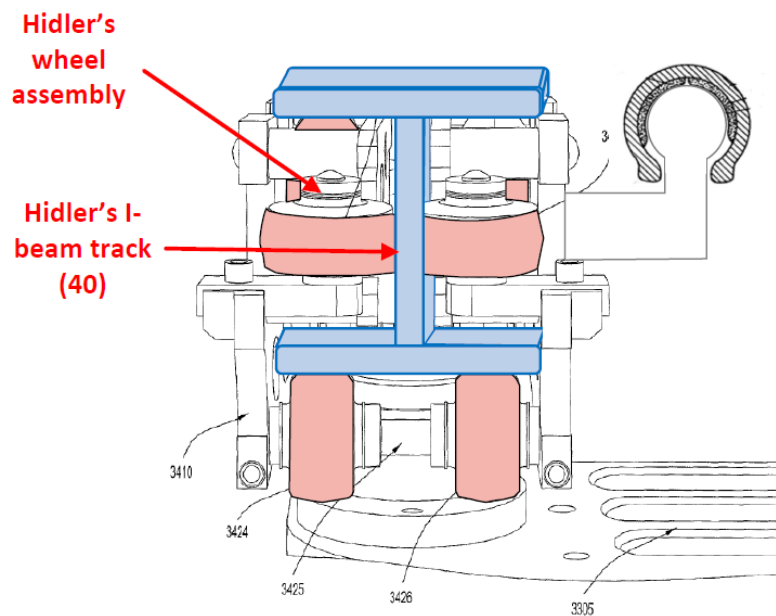
4	The apparatus of claim 1, wherein the drive assembly includes a plurality of wheels, at least a portion of the plurality of wheels disposed above at least a portion of the track
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156. As described above, the combination of Hidler and Knevels teaches the apparatus of claim 1. In my opinion, Hidler also teaches the remaining limitation in claim 5 because Hidler teaches that the drive assembly has a “pivoting wheel assembly 3400” that “includes wheels 3440 and 3442” (i.e., a “plurality of wheels”) and those wheels “rest on the upper inner surface of the lower flange of the track 3150” (i.e., the wheels are “disposed above at least a portion of the track”). Ex-1004, 18:32-43.

157. The wheels 3440 and 3442 of Hidler are *disposed above at least a portion of the track*, as is depicted in Figures 39-40 and the annotated/modified version of Fig. 43:



Ex-1004, Figs. 39 (showing placement of wheel assembly 3400 on the track) and 40 (showing placement of wheels (including wheels 3442 and 3440) within the wheel assembly).



Ex-1004, Fig. 43 (annotated to show cross-section of the Hidler wheel assembly and track, which shows some of Hidler's plurality of wheels are disposed above a portion of Hidler's track).

158. For the reasons stated above, in my opinion, Hidler in view of Knevels, teaches and renders obvious Claim 5.

8. Claim 6

5	The apparatus of claim 1, wherein the trolley is configured to be powered only from the powered conductor.
---	--

159. As described above, the combination of Hidler and Knevels teaches the apparatus of claim 1. In my opinion, Hidler also teaches the remaining limitation in claim 5 because the proposed combination results in the trolley of Hidler being powered only from the power rail, as taught in Knevels.

160. As explained in claim 1, a POSITA would find it desirable to remove the power cable in Hidler and replace it with the Knevels power rail. Once replaced, there is no other power source for the trolley than the Knevels powered conductor and there is no need or valid design consideration to add in additional power sources to power the Hidler trolley.

161. One of the main reasons a POSITA would have been motivated to combine the teachings of Hidler and Knevels would be to eliminate the cables and use the power rail instead. A POSITA would not look for other power sources

other than the power rail after making this modification as it would remove the benefits of using a power rail in the first place *See* Section Motivation to Combine; *see also* Ex-1006, 1:30-60.

162. Accordingly, in my opinion, Hidler, in view of Knevels, teaches and renders obvious the claim 6.

9. Claim 7

7	The apparatus of claim 1, wherein the trolley is configured to be moved from a first position at an end of the track to a second position spaced apart from the end of the track.
---	---

163. As described above, Hidler in view of Knevels, teaches the apparatus of claim 1. In my opinion, Hidler also teaches the remaining limitation in claim 5 because the Hidler's trolley is designed to be moved over a patient along a track.

164. Hidler teaches that its body-weight support trolley "rides along a track" (Ex-1004 at 4:15), "moves along the track" (*id.* at 5:31), "moves in a direction along the track" (*id.* at 19:10) and enables patients "to practice walking around and/or over obstacles" (*id.* at 4:18).

165. A POSITA would have understood the forgoing to teach that the Hidler trolley is "moved from a first position at an end of the track to a second position spaced apart from the end of the track." This is also depicted in figures 3 and 4 of Hidler, depicting the trolley of Hidler being configured to move along a track:

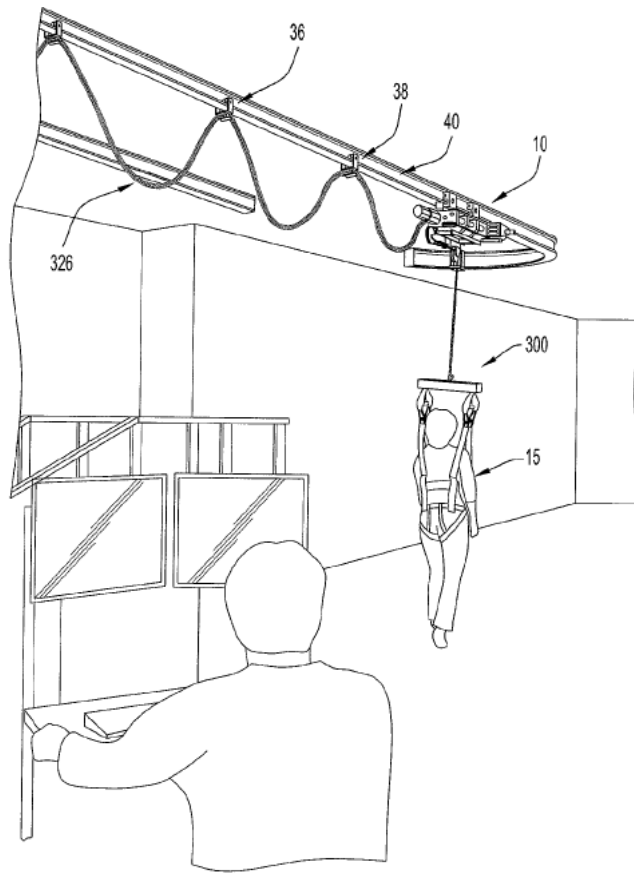


FIG.3

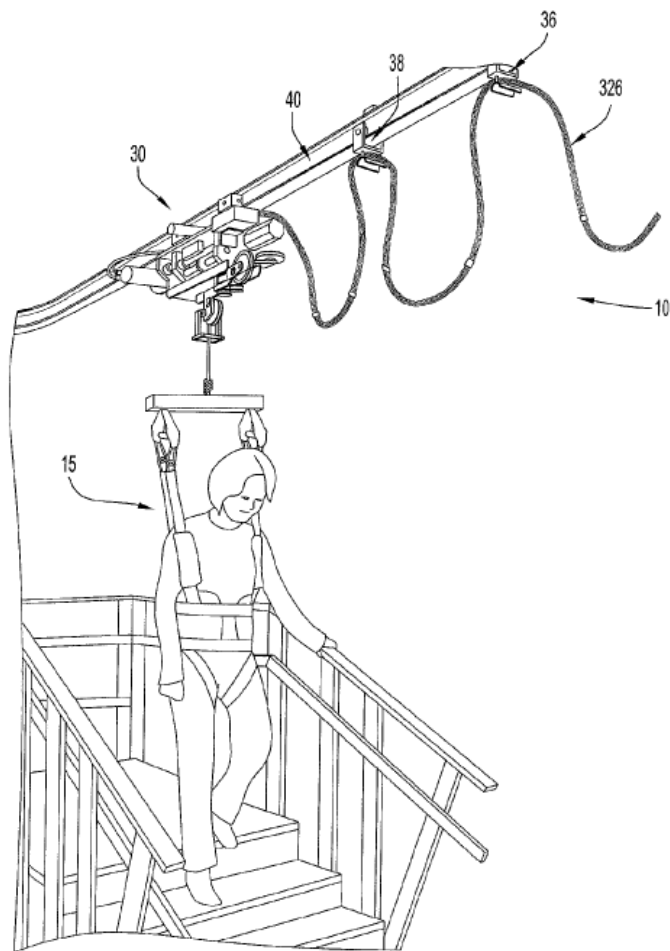


FIG.4

10. Claim 13

a. Limitation 13[pre]

13[pre]	<i>An apparatus, comprising:</i>
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166. To the extent the preamble is a limitation, Hidler teaches 13[pre] for the same reasons stated above for 1[pre]. *Supra*, claim 1[pre].

b. Limitation 13[a]

13[a]	a trolley having a drive assembly, the drive assembly including a plurality of wheels configured to move along at least one surface of a track to move the trolley relative to the track;
-------	---

167. In my opinion, Hidler also teaches Limitation 13[a].

168. For the same reasons as claim 1[a], Hidler teaches a trolley having a drive assembly.

169. As discussed above with respect to claim 5, Hidler also teaches that the drive assembly includes a plurality of wheels. Figure 40 (showing side view of wheel assembly and plurality of wheels in red) and the modified/annotated version of figure 43 (including superimposed I-Beam and Knevels' power rail):

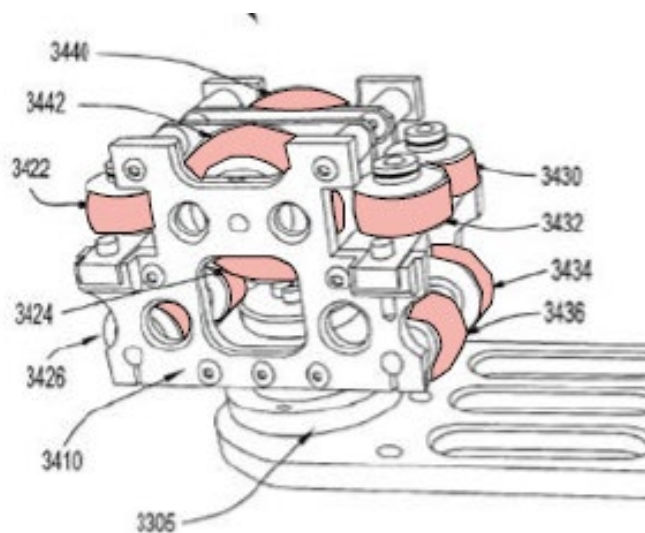


FIG. 40

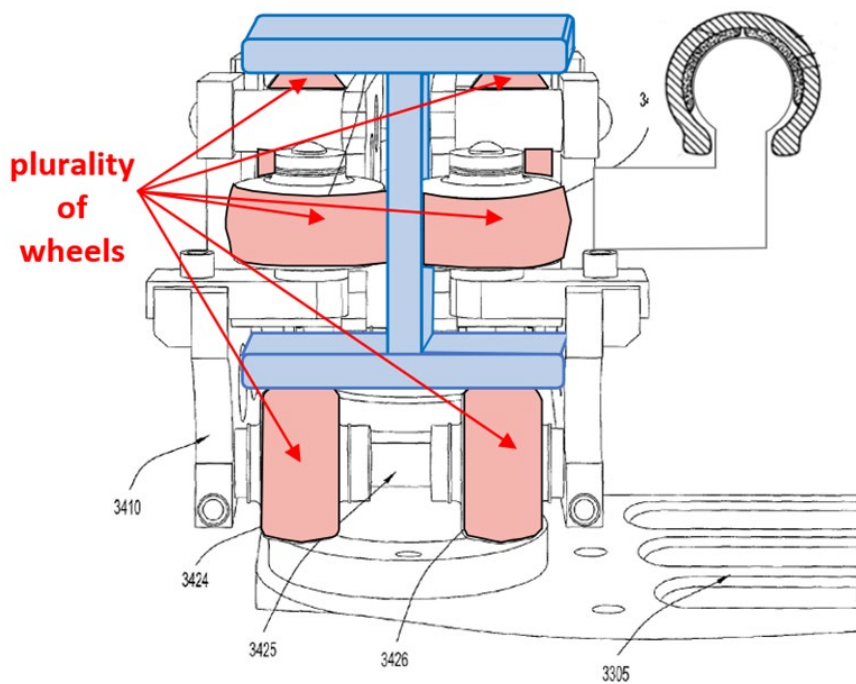


FIG. 43

Ex-1004 at Figs. 40 and 43 (both annotated).

170. As can be seen in the modified/annotated version of Fig. 43, A plurality of wheels in the system of Hidler are configured to move on multiple surfaces of the track. For example, “pivoting wheel assembly 3400 includes wheels 3440 and 3442 that rest on the upper inner surface of the lower flange of the track 3150. . . .” Ex-1004, 18:32-43. Hidler also teaches “wheels 3430 and 3432 and wheels 3420 and 3422 that roll on the web of the I-beam track to provide lateral stability.” *Id.* “[W]heels 3424 and 3426 and wheels 3434 and 3436 [] are configured to roll on the bottom of the lower flange of the I-beam to provide stability in the vertical direction.” *Id.*

171. Accordingly, Hidler’s plurality of wheels allow the trolley to “ride[] along a track” (Ex-1004 at 4:15), “move[] along the track” (*id.* at 5:31), “move[] in a direction along the track” (*id.* at 19:10), or in other words, move the trolley relative to the track.

172. Therefore, in my opinion, Hidler teaches and renders obvious Limitation 13[a].

c. Limitation 13[b]

173. For the reasons discussed below, in my opinion, Hidler, in view of Knevels, teaches and renders obvious each limitation of 13[b].

13[b1]	a powered conductor operatively coupled and substantially parallel to the track
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174. For the same reasons as claim 1[b1], Hidler, in view of Knevels, teaches a powered conductor operatively coupled and substantially parallel to the track.

175. The combination of Hidler and Knevels, teaches a powered conductor physically contacting and electrically connected to the trolley as the trolley moves along the track. *See* Claim 1[b1]. As such, the Hidler-Knevels combination includes a powered conductor operatively coupled to the track. *See* Ex-1001 at 7:19-24 (“[T]he electronic system 1700 and/or the control 1900 can be operatively coupled (e.g., electrically connected) to the one or more motors such that the

electronic system 1700 and/or the control 1900 can send an electronic signal associated with operating the motor(s).”).

176. Knevels also teaches that its powered conductor runs substantially parallel to the track. *See* Claim 1[b1].

177. Accordingly, in my opinion, the combination of Hidler and Knevels teaches and renders obvious Limitation 13[b1].

13[b2]	the powered conductor including at least one conductive surface in contact with a portion of the trolley to electrically couple the trolley to the powered conductor
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178. In my opinion, for the same reasons as claim 1[b2] and 1[b3], the combination of Hidler and Knevels teaches “the powered conductor including at least one conductive surface in contact with a portion of the trolley to electrically couple the trolley to the powered conductor.” *Supra*, claim 1[b2]-1[b3].

179. Accordingly, in my opinion, Hidler teaches and renders obvious Limitation 13[b2].

13[b3]	the portion of the trolley configured to move along the at least one conductive surface when the trolley is moved along the track
--------	---

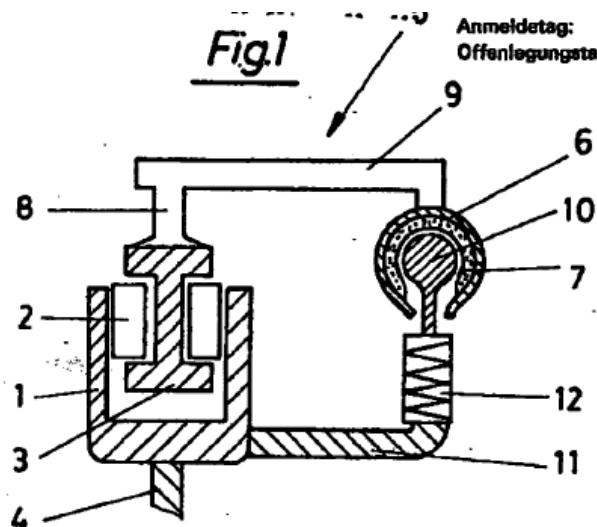
180. In my opinion, for the same reasons as claim 1[b4], the combination of Hidler and Knevels, teaches “the powered conductor including at least one conductive surface in contact with a portion of the trolley to electrically couple the trolley to the powered conductor.” *Supra*, claim 1[b4].

181. Accordingly, in my opinion, Hidler teaches and renders obvious Limitation 13[b3].

13[b4]	a portion of the track disposed between at least one wheel from the plurality of wheels and the powered conductor to isolate the at least one wheel from the powered conductor;
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182. In my opinion, the combination of Hidler and Knevels teaches “a portion of the track disposed between at least one wheel from the plurality of wheels and the powered conductor to isolate the at least one wheel from the powered conductor.”

183. As explained in claim 13[b1], the combination of Hidler and Knevels teaches that the power rail is separate from and runs parallel to the track. As shown below, Knevels’ power rail (i.e., powered conductor (6)) runs next to the track (3) (the I-beam):

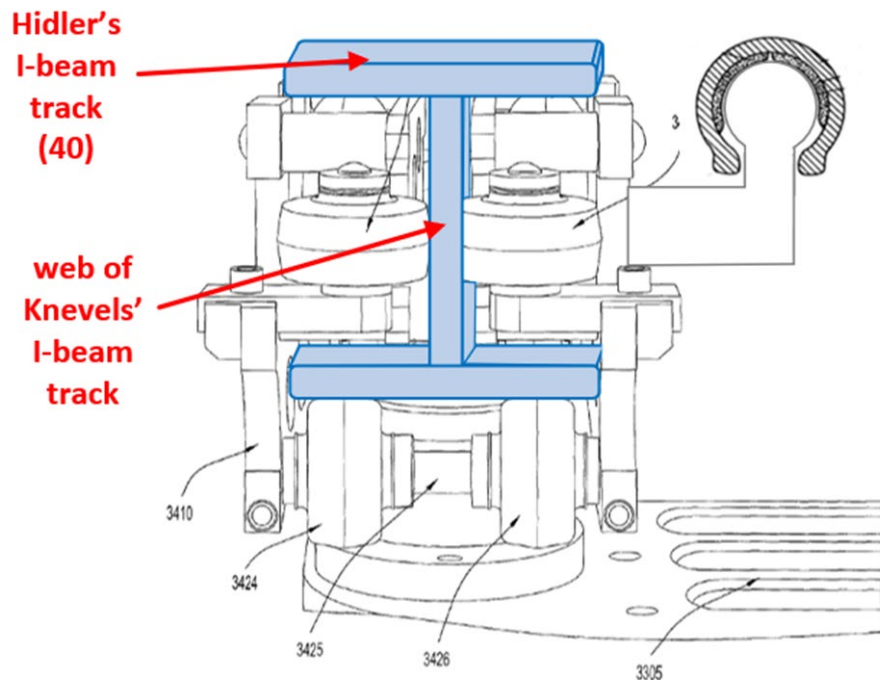


Ex-1005, Fig. 1.

184. As discussed with respect to claim 5, Hidler teaches “wheels 3440 and 3442 that rest on the upper inner surface of the lower flange of the track 3150.”

Ex-1004, 18:32-43. Hidler also teaches “wheels 3430 and 3432 and wheels 3420 and 3422 that roll on the web of the I-beam track to provide lateral stability.” *Id.*

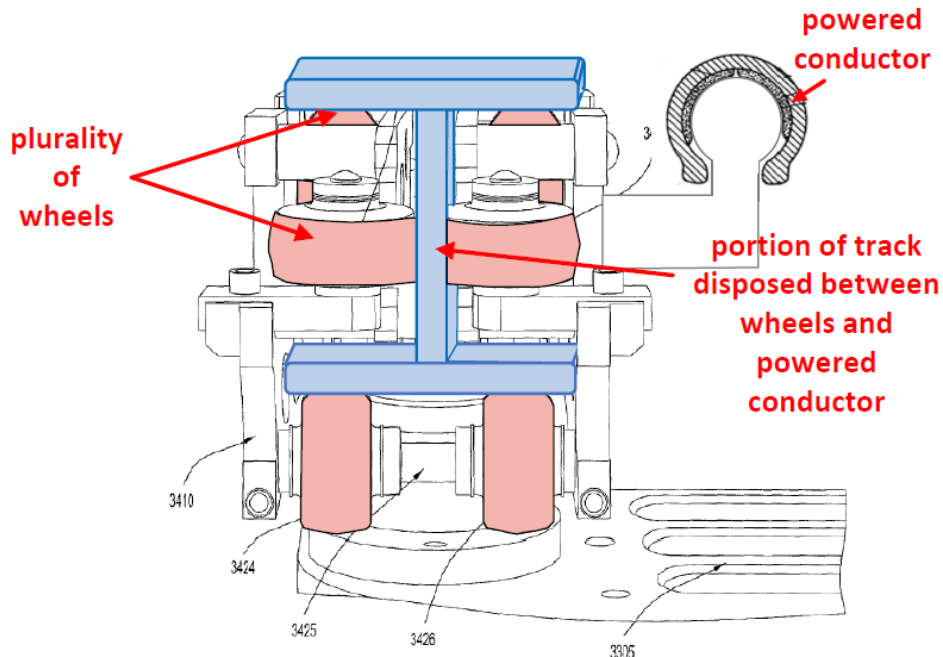
185. A POSITA would have understood that the “web” of an I-beam is the middle, “vertical” part of an I-beam:



Ex-1004 at Fig. 43 (annotated to show modification of the Hidler trolley combined with Knevels' power rail); Ex-1005, Fig. 1 (teaching a power rail); Ex-1004 at Figs. 2 (teaching an I-Beam track that the wheel assemblies move on).

186. Together, Hidler's track, trolley, and wheels combined with the Knevels' power rail teaches that a portion of the track is disposed between several

wheels of the Hidler trolley and the powered conductor, as taught in Knevels, thus isolating at least one wheel from the powered conductor:



Ex-1004 at Fig. 43 (annotated).

187. In the image modified and annotated above, Figure 43 shows how a portion of the track (the web of the I-beam) is disposed between at least one wheel from the plurality of wheels (i.e., the leftmost wheels) and the powered conductor. This Hidler-Knevels combination therefore isolates “at least one wheel from the powered conductor.” Ex-1004, Fig. 43 (annotated image).

188. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Limitation 13[b4].

d. Limitation 13[c]

13[c]	at least one patient attachment coupled to the trolley, the at least one patient attachment configured to support a single patient; and
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189. In my opinion, for the same reasons as claim 1[c], Hidler teaches “at least one patient attachment coupled to the trolley, the at least one patient attachment configured to support a single patient.” *Supra*, claim 1[c].

190. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Limitation 13[c].

e. Limitation 13[d]

13[d]	a control system coupled to the trolley and at least operably coupled to the powered conductor.
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191. In my opinion, for the same reasons as claim 1[d], the combination of Hidler and Knevels teaches “a control system coupled to the trolley and at least operably coupled to the powered conductor. *Supra*, claim 1[d].

192. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Limitation 13[d].

11. Claim 14

14	The apparatus of claim 13, wherein the trolley is configured to be powered only from the powered conductor.
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193. In my opinion, for the same reasons as claim 1[d], the combination of Hidler and Knevels teaches “a control system coupled to the trolley and at least operably coupled to the powered conductor. *Supra*, claim 1[d].

194. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 14.

12. Claim 15

15	The apparatus of claim 13, wherein the trolley includes a patient support system, the patient support system configured to actively support a patient.
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195. As I explained above, the combination of Hidler and Knevels teaches the apparatus of claim 13. In my opinion, for the same reasons as claim 3, Hidler also teaches “wherein the trolley includes a patient support system, the patient support system configured to actively support a patient.” *Supra*, claim 3.

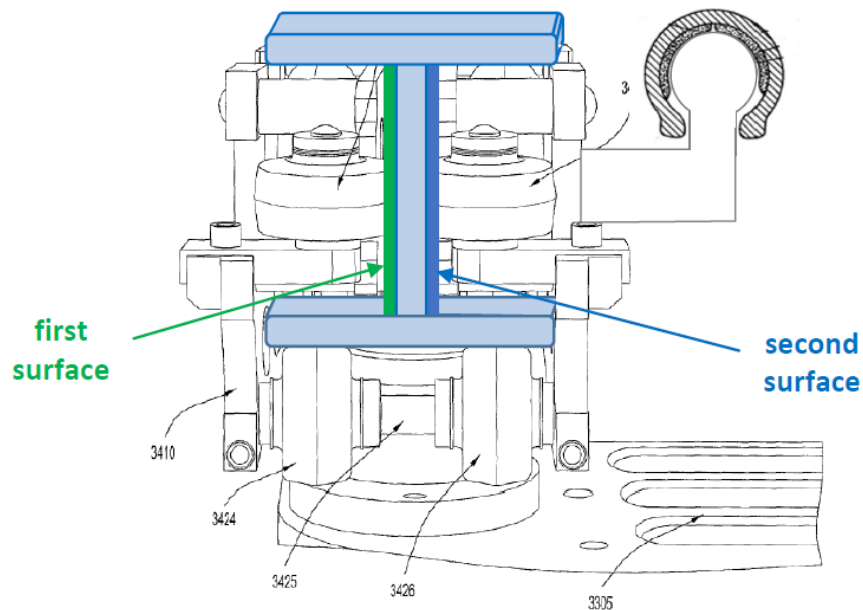
196. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 15.

13. Claim 16

16	The apparatus of claim 13, wherein the drive assembly includes a first wheel from the plurality of wheels and a second wheel from the plurality of wheels, the first wheel from the plurality of wheels being in contact with a first surface of the track and the second wheel from the plurality of wheels being in contact with a second surface of the track such that the portion of the track is disposed between the first wheel from the plurality of wheels and the second wheel from the plurality of wheels.
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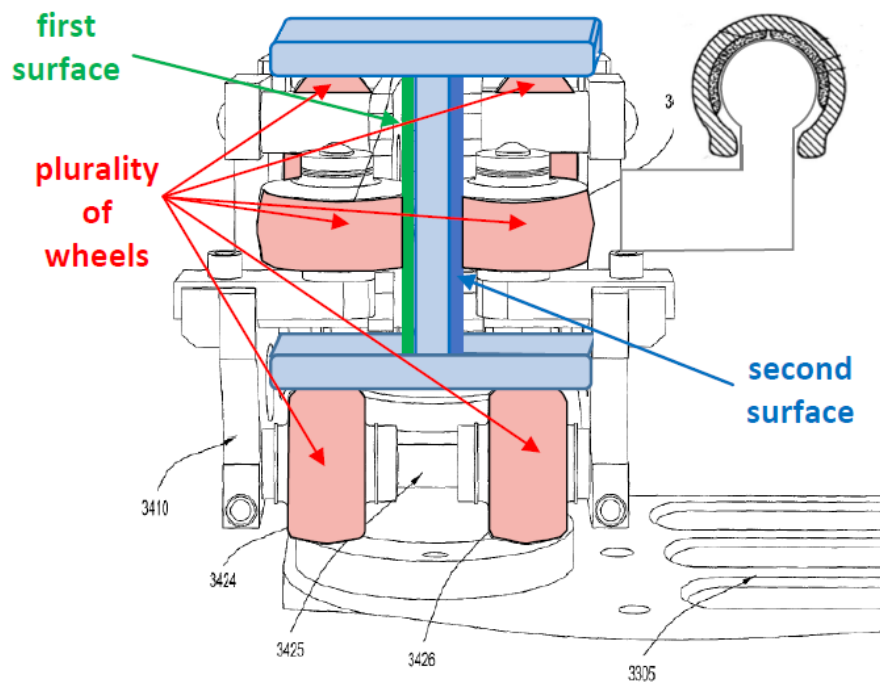
197. As shown above, the combination of Hidler and Knevels teaches the apparatus of claim 13. In my opinion, for similar reasons as claim 13[a] and 13[b4], Hidler, in view of Knevels, also teaches the remaining limitations in claim 16. *Supra*, claim 13[a], 13[b4].

198. As I explained with respect to Limitations 13[a] and 13[b4], Hidler teaches a drive assembly with a plurality of wheels that move on multiple surfaces of the track. *Supra*, claim 13[b4]. These include “wheels 3430 and 3432 and wheels 3420 and 3422 that roll on the web of the I-beam track to provide lateral stability.” The web of the I-beam has at least two surfaces (a surface on the left (annotated in green below) and a surface on the right (annotated in blue below):



Ex-1004, Fig. 43 (annotated).

199. Therefore, the wheels “that roll on the web of the I-beam track,” roll on these two surfaces:



Ex-1004, Fig. 43 (annotated).

200. One of the leftmost wheels is therefore “a first wheel from the plurality of wheels being in contact with a first surface of the track.” Ex-1004, 18:32-43, Fig. 43 (annotated). Similarly, one of the rightmost wheels is “a second wheel from the plurality of wheels being in contact with a second surface of the track.” Ex-1004, 18:32-43; Ex-1004, Fig. 43. Finally, a portion of the track (i.e., the web of the I-beam) is therefore disposed between the first wheel from the plurality of wheels and the second wheel from the plurality of wheels. Ex-1004, 18:32-43; Fig. 43.

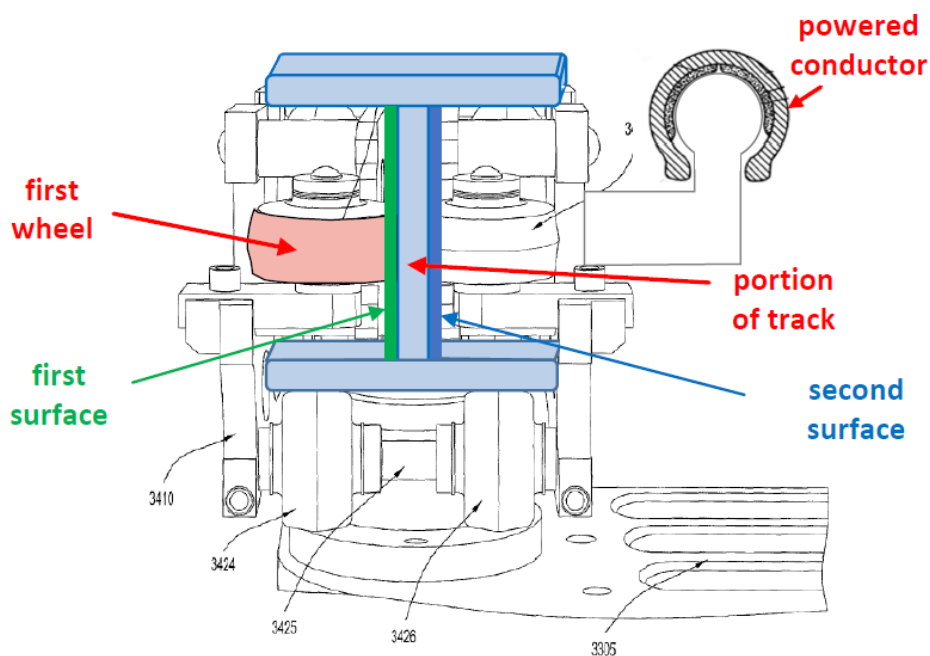
201. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 16.

14. Claim 17

17	The apparatus of claim 16, wherein the portion of the track is disposed between the first wheel from the plurality of wheels and the powered conductor.
----	---

202. As shown above, the combination of Hidler and Knevels teaches the apparatus of claim 16.

203. In my opinion, for the same reasons as claims 13[b4] and 16, the combination of Hidler and Knevels also teaches “wherein the portion of the track is disposed between the first wheel from the plurality of wheels and the powered conductor:”



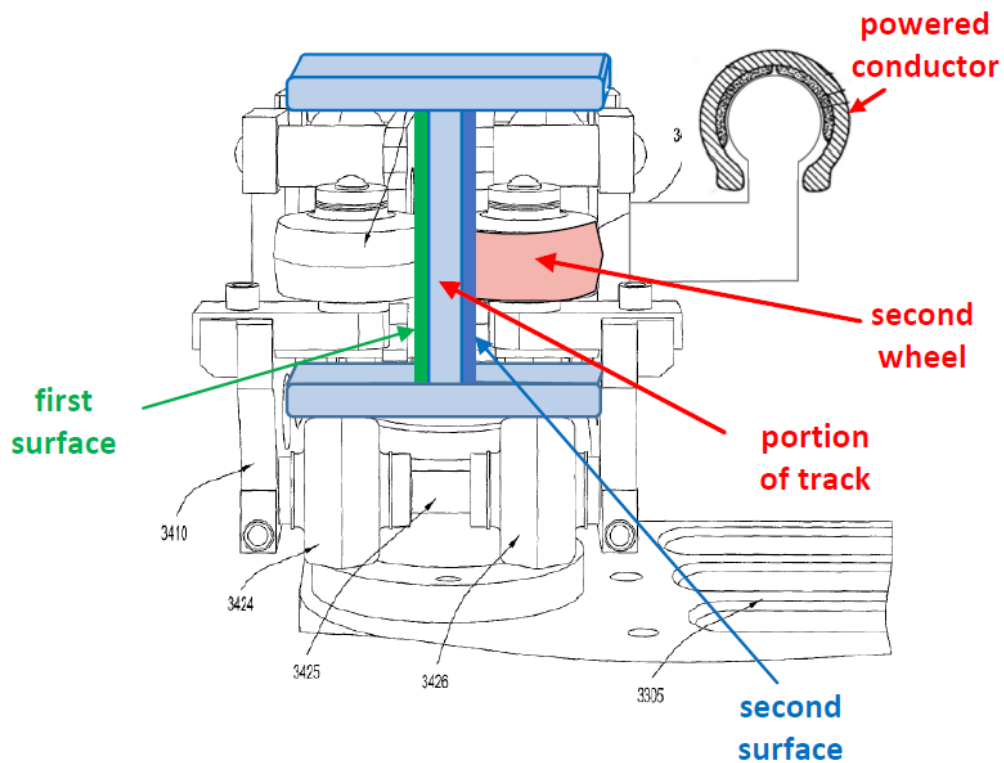
Ex-1004, Fig. 43 (annotated).

204. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 17.

15. Claim 18

18	The apparatus of claim 17, wherein the second wheel from the plurality of wheels is disposed between the portion of the track and the powered conductor.
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205. As I explained above, the combination of Hidler and Knevels teaches the apparatus of claim 17. In my opinion, for the same reasons set forth in connection with claims 13[b4], 16, and 17, the combination of Hidler and Knevels, also teaches “wherein the portion of the track is disposed between the first wheel from the plurality of wheels and the powered conductor.” This can be seen in the following modified and annotated version of figure 43, which illustrates that a wheel on the right side of the I-beam (a second wheel) is disposed between the I-beam (a portion of the track) and the powered conductor:



Ex-1004, Fig. 43 (annotated).

206. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 18.

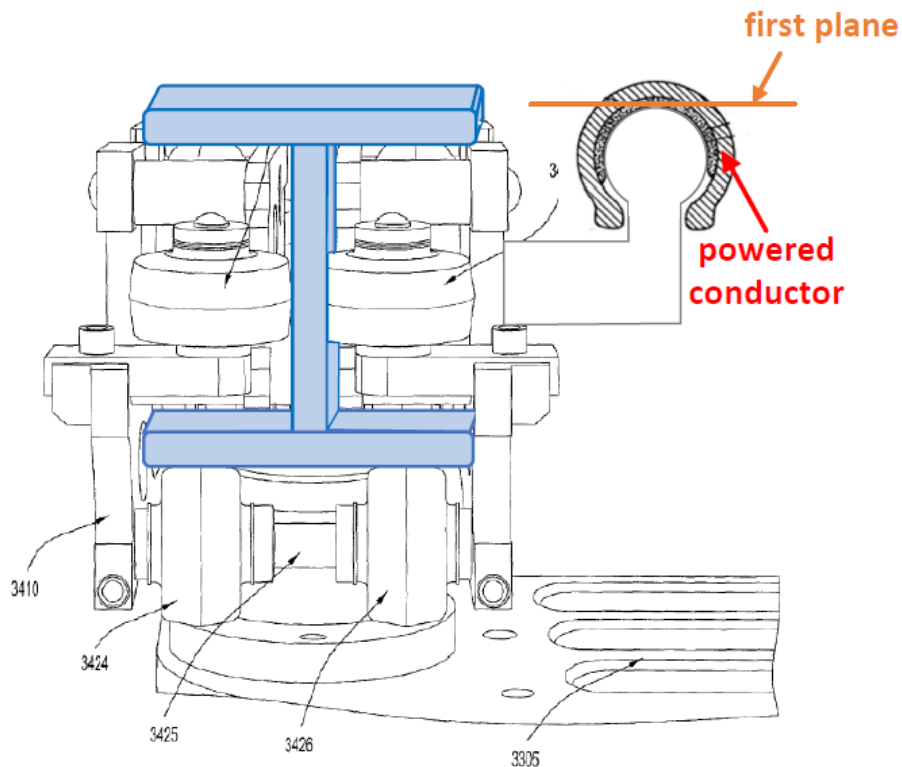
16. Claim 19

19[a]	The apparatus of claim 13, wherein the conductive surface of the powered conductor defines a first plane, and
-------	---

207. As shown above, the combination of Hidler and Knevels, teaches the apparatus of claim 13. In my opinion, the combination of Hidler and Knevels also teaches the remaining limitations in claim 19.

208. The '000 Patent does not explain any special parameters for how the powered conductor “defines” a first plane. In geometry, a plane is a two dimensional surface that extends endlessly. As such, a POSITA would understand that a plane can be defined on any portion of the powered conductor, such as at the top or on one of the sides.

209. In my opinion, Hidler, in view of Knevels, discloses the additional limitations recited in claim 19[a] because Knevels teaches a conductive surface of the powered conductor that can define a first plane (orange) at the top of the conductive surface:



Ex-1004, Fig. 43 (annotated).

210. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 19[a].

19[b]	the drive assembly includes a first wheel from the plurality of wheels and a second wheel from the plurality of wheels, the first wheel from the plurality of wheels and the second wheel from the plurality of wheels being configured to move along at least one surface of the track to movably suspend the trolley from the track, the at least one surface of the track defining a second plane nonparallel to the first plane.
-------	--

211. In my opinion, the combination of Hidler and Knevels also teaches the additional limitations recited in claim 19[b].

212. For the reasons stated for claim 1[a], Hidler teaches a drive assembly.

213. As annotated below in Figure 40, the combination of Hidler and Knevels teaches a plurality of wheels (visible wheels 3440, 3442, 3422, 3430, 3432, 3434, 3436, 3424, and 3426), with a first wheel (wheel 3432) and a second wheel (wheel 3422) moving along a first surface of the track (the inner surfaces of the I-beam) to move the suspended trolley (trolley 30) along the track (track 40).

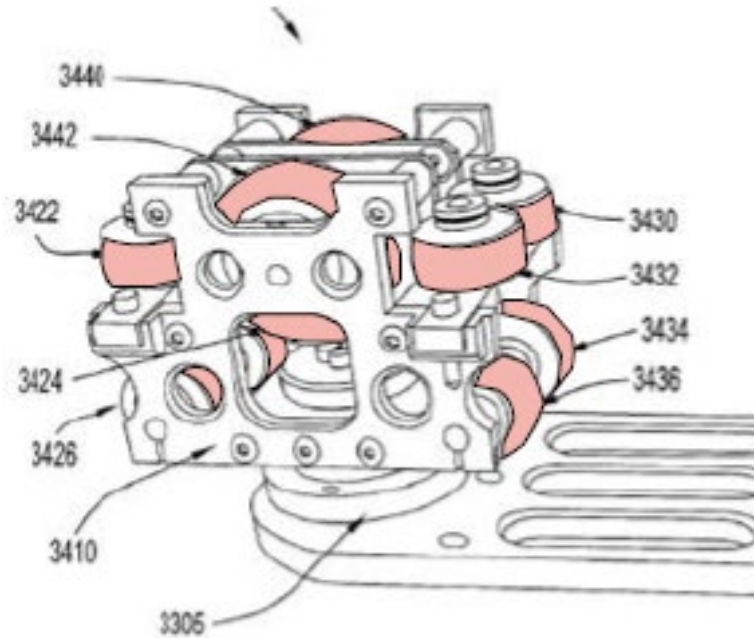
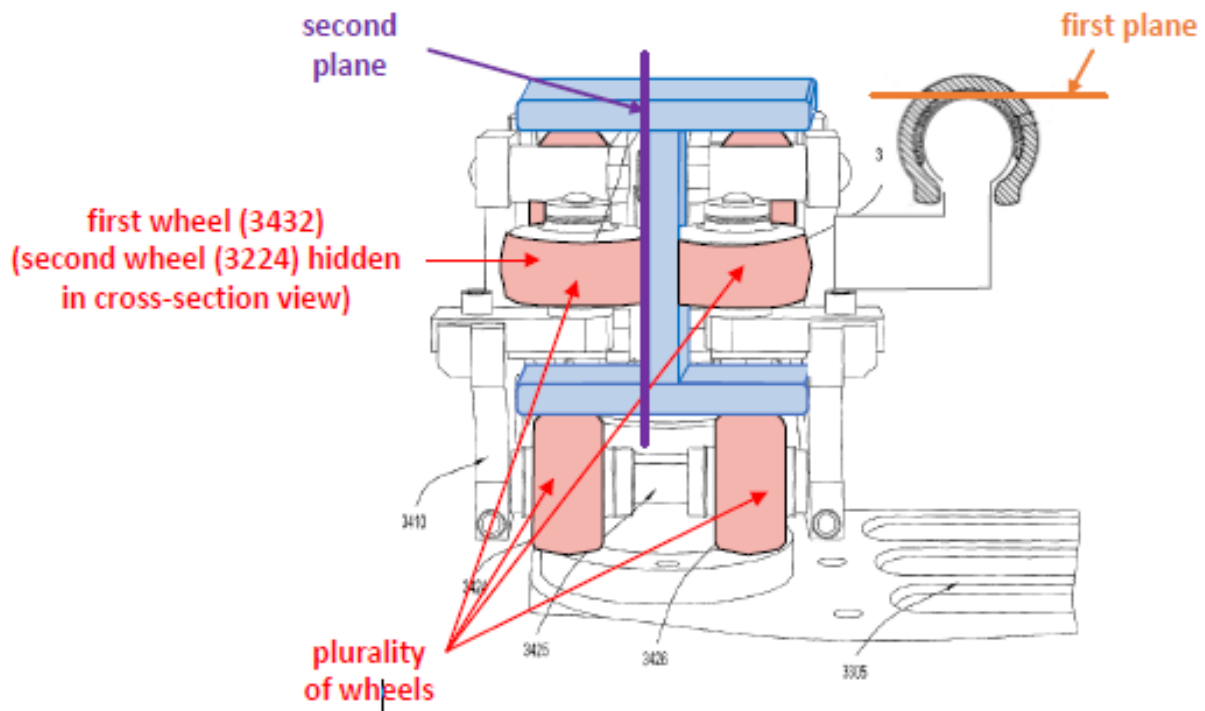


FIG. 40

Ex-1004, Fig. 43 (annotated).

214. The Hidler and Knevels combination teaches that the surface of the track along which the wheels move defines a second plane (purple below) that is perpendicular (so, not parallel) to the plane defined by powered conductor (orange below):



Ex-1004, Fig. 43 (annotated).

215. That second plane is on the inner surface of the Hidler track's I-beam. The claimed second wheel (3422) (from Fig. 40) cannot be seen from the two-dimensional, cross-section shown here as it is hidden behind the first wheel (3432) and wheel (3442)):

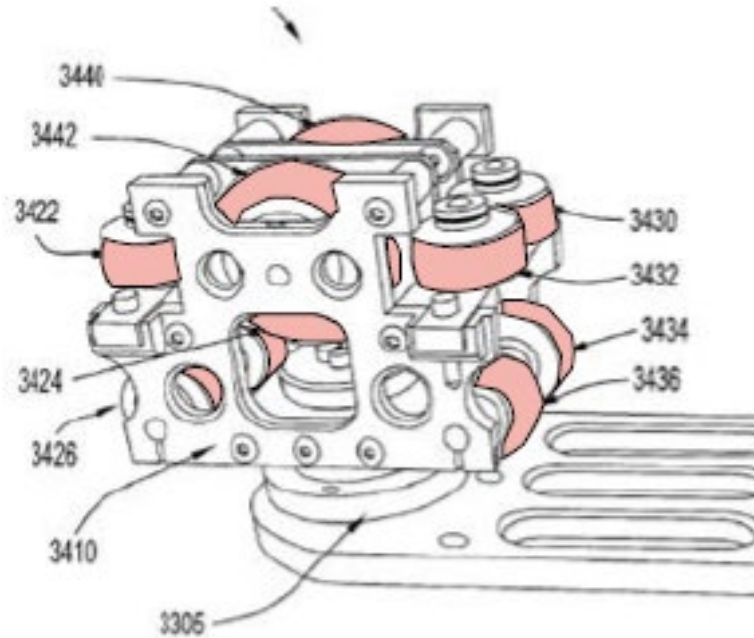


FIG. 40

Ex-1004, Fig. 40 (annotated) (showing that two wheels 3432 and 3422 are aligned and roll on the same surface of the I-beam).

216. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 19[b].

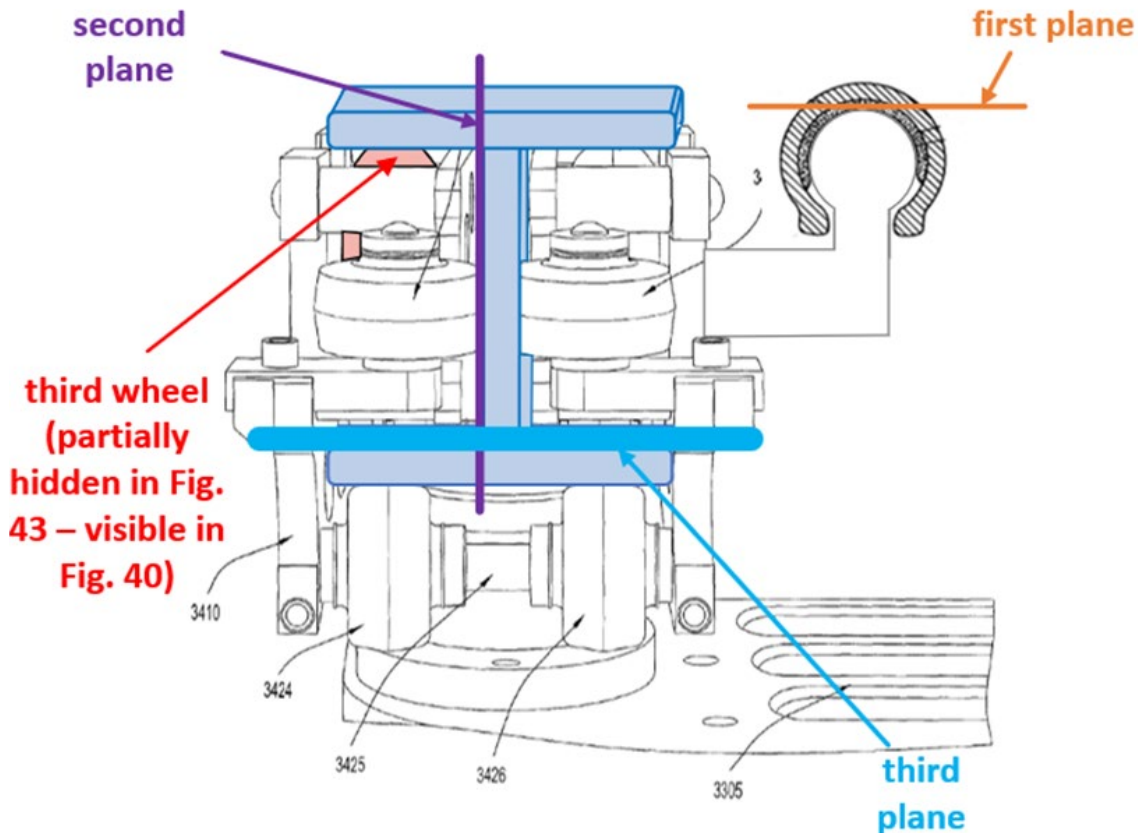
217. Therefore, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 19.

17. Claim 20

20	The apparatus of claim 19, wherein the drive assembly includes a third wheel from the plurality of wheels, the third wheel from the plurality of wheels being configured to move along a surface of the portion of the track, the surface of the portion of the track defines a third plane parallel to the first plane.
----	--

218. As I explained above, the combination of Hidler and Knevels, teaches the apparatus of claim 19. In my opinion, for similar reasons as claim 19, the combination of Hidler and Knevels also teaches “wherein the drive assembly includes a third wheel from the plurality of wheels, the third wheel from the plurality of wheels being configured to move along a surface of the portion of the track, the surface of the portion of the track defines a third plane parallel to the first plane.” *Supra*, claim 19.

219. The Hidler-Knevels combination teaches all of the limitations of claim 20, including the third wheel and the third, parallel plane defined by another surface of the track (which is located on the upper surface of the lower flange of the I-beam track):



Ex-1004, Fig. 43 (annotated). Here, the third plane is the upper surface of the lower flange of the Hidler I-Beam.

220. Accordingly, in my opinion, Hidler in view of Knevels teaches and renders obvious Claim 20.

B. Ground 2: Obviousness over Hidler in view of Faucher and Walker

221. In my opinion, Claims 8 and 12 of the '000 Patent are invalid because they are obvious over the teachings of Hidler, Faucher, and Walker. Exs. 1004, 1006-07.

1. Overview of the Proposed Combination

222. With respect to independent claim 8, Hidler teaches a body-weight support apparatus, trolley, drive element, wheel assembly, patient support assembly, pulley system, tether, and sensor system. Hidler, however, does not teach providing a housing surrounding a portion of the drive element. Instead, Hidler teaches a housing for certain elements, such as housing 3500 covering various cables, wires or other communication links.

223. Hidler also does not teach the use of a cam as part of its system for dynamically supporting the body-weight of a patient.

224. As set forth below, a POSITA would have found it obvious to modify the system of Hidler to include a housing based on the teachings of Faucher.

225. As is also set forth below, a POSITA would have found it further obvious to modify the system of Hidler to use a cam based on the teachings of Walker.

2. Motivation to Combine and Expectation of Success (Hidler-Faucher- Walker)

226. In my opinion, Hidler and Faucher are analogous art because they are both from the same field of endeavor, *i.e.*, body-weight support trolleys. A POSITA would also consider Hidler and Walker to be analogous art because they both relate to pulley tension systems, wherein the goal for the system is maintaining pre-selected tension.

a. Motivation to modify Hidler to include a larger housing in view of Faucher

227. A POSITA would have been motivated to modify Hidler to include a larger housing, based on a POSITA's general knowledge or, at a minimum, as taught in Faucher. *See* Ex-1002, 266-267. Modifying Hidler to include a housing, as taught in Faucher, amounts to nothing more than applying a known technique (housing a body-weight support trolley) to achieve predictable benefits—namely protecting the equipment, improving safety, and creating better aesthetics.

228. The use of housing with overhead trolley systems was a known technique prior to January 2013. Indeed, Hidler itself teaches and suggests the use of housings as a means for protecting assemblies, providing support, and decoration. Specifically, Hidler teaches the housing 3500 (to house wires) and a housing 3410 (surrounding the wheel assembly). Ex-1004 at 18:12-23, 44-48, Figs. 1 (showing housing surrounding cables) and 40 (showing housing 3410):

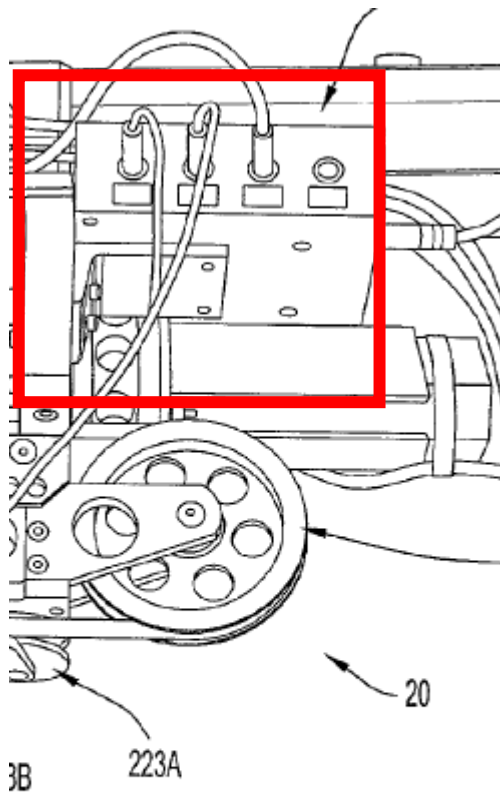


FIG. 1

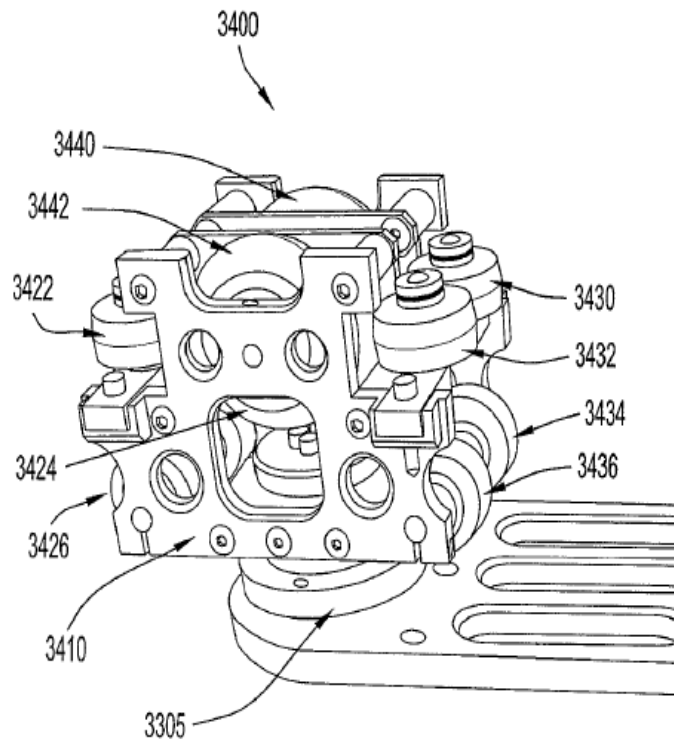
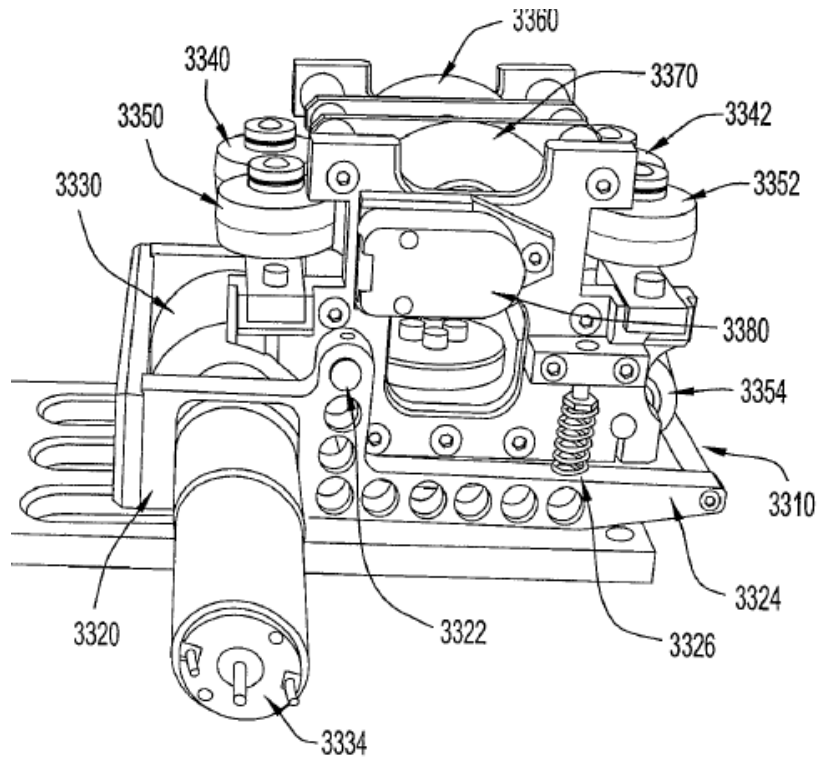
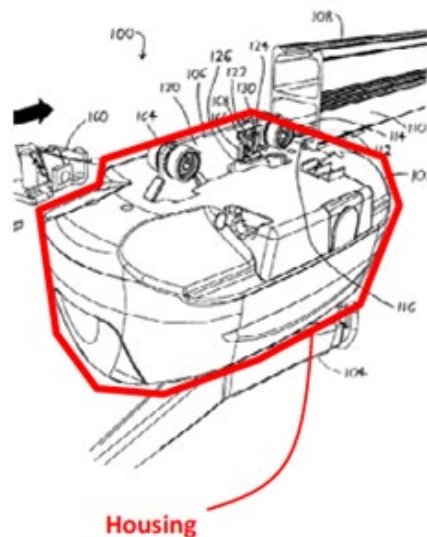


FIG. 40

229. Hidler also already teaches a “drive wheel body” surrounds portions of its wheel assembly (which is part of Hidler’s drive element), which a POSITA would have considered a housing. Ex-1004 at 18:57-64 (“The drive wheel 3330 is mounted in a drive wheel body 3320 that is pivotally mounted to the housing.”); Fig. 40 (showing the drive wheel body 3320 and housing 3310):

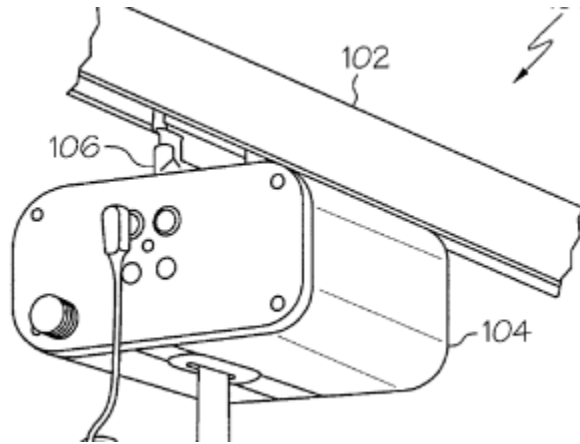


230. Other references also illustrate the wide-spread nature of using housings with overhead trolley systems. As noted above, Faucher expressly teaches a surrounding housing for an overhead trolley system:



Ex-1007, Fig. 1.

231. Bergenstrale also teaches a housing surrounding the trolley:



Ex-1011 at Fig. 1 (showing a housing surrounding lift unit 104).

232. The benefits of using housings with overhead trolleys were also well-known prior to January 2013. In particular, a POSITA would have understood that housings were desirable to protect equipment, protect persons near equipment from accidental injury, and aesthetics.

233. Given the express teachings and suggestions in Hidler, the routine use of housings with overhead trolleys, and the well-known and predictable benefits of such use, in my opinion, a POSITA would be motivated to combine Hidler's trolley with Faucher's teaching of a housing surrounding the entire trolley and would expect success in trying the combination.

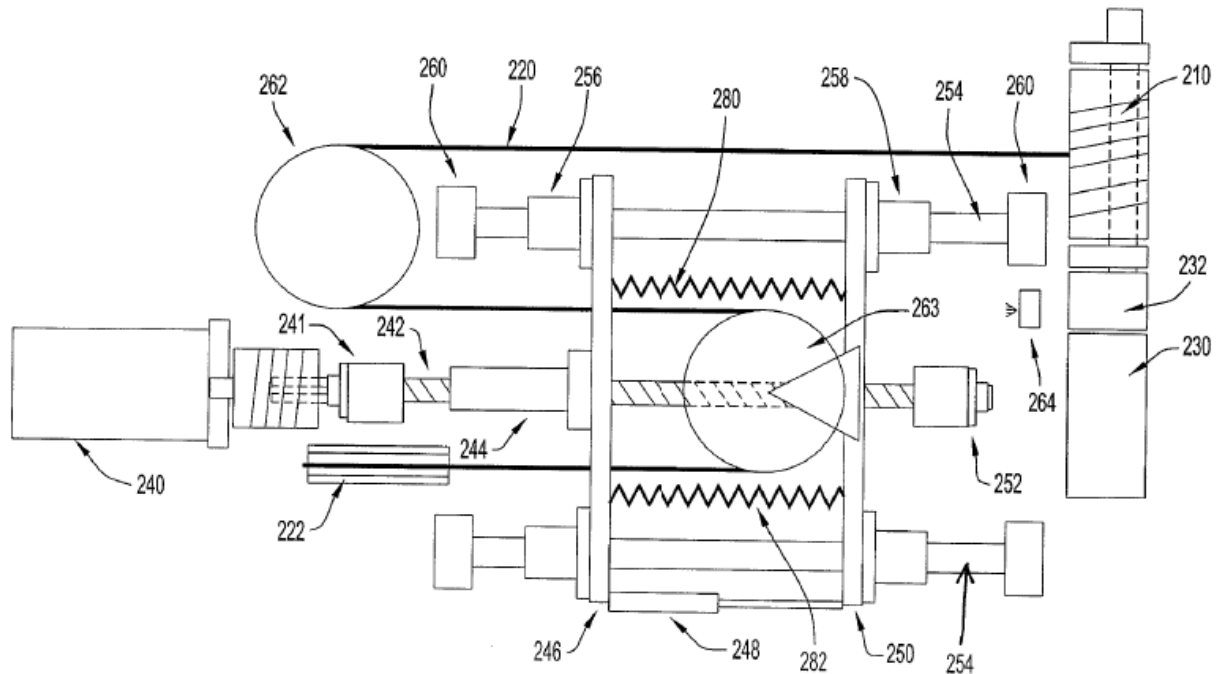
234. Combining Faucher's housing with Hidler's housing amounts to nothing more than applying a known technique (housing a body-weight support

trolley) of a similar device. A POSITA would expect to improve Hidler's support structure with such a housing, including adding the predictable result of protection of equipment, safety of persons near equipment, and aesthetics.

b. Replacing Hidler's Ball Screw Mechanism With Walker's Cam Amounts To Nothing More Than a Simple Substitution of One Known Element for Another

235. Independent Claim 8 of the '000 Patent requires use of a "cam." A POSITA would have understood that a cam is one common way of transforming the rotational force (torque) generated by a motor into a linear force. In the context of the body-weight support system of the '000 Patent, the cam is specifically used to transform the rotational force of the motor into a linear force that controls the tension on the tether attached to the patient.

236. The trolley system of Hidler transforms the rotational force of a motor into linear force on a tether, but Hidler does not teach using a cam to achieve this function. Instead, Hidler teaches converting the rotational motion from a motor to linear motion on the tether by using a ball screw (242) and pulley plate (246). Ball screw assemblies are well-known mechanisms for transforming rotary motion to linear motion. *Id.* In such an assembly, a motor turns a ball screw, which then moves an attached plate. This system is shown in Fig. 20A of Hidler:

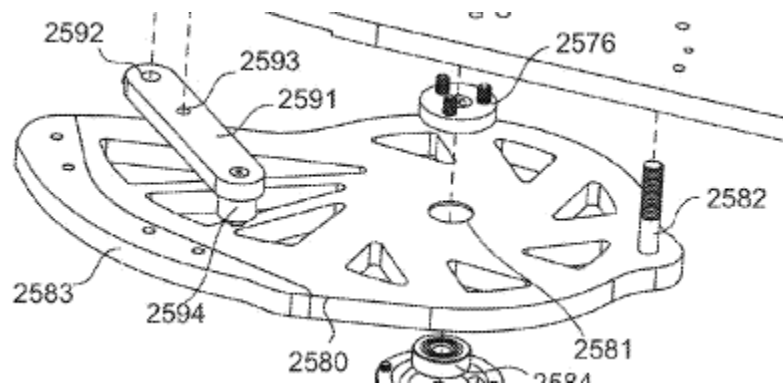


Ex-1004, Fig. 20A; 11:5-36 (“To apply tension in the rope 220, the ball-screw motor 240 turns the ball-screw 242 which in turn causes the ball-screw nut 244 to advance the ball-screw plate 246 toward the pulley plate 250. As a result, this movement causes the springs 280 and 282 to compress, causing a force against the pulley plate 250 $F=k \cdot dx$ (see FIG.22)”). In short, in Hidler, as the pulley plate moves pulley 263, the tension in the tether is increased or decreased as the length of the tether moving around the pulley change.

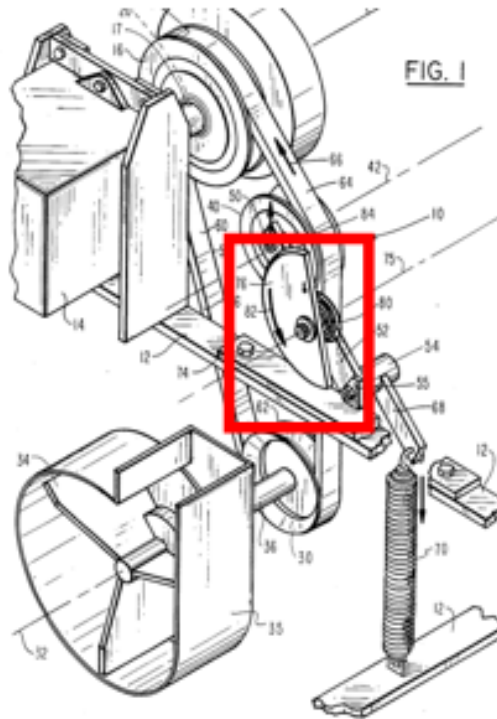
237. As reflected above, Hidler does not teach the elements of claim 8 requiring use of a cam, including “a cam operably coupled to the pulley” and configuring the cam “to pivot relative to the housing about the vertical axis in

response to the pivoting of the pulley, the cam exerting a reaction force when the cam pivots relative to the housing.”

238. A POSITA, however, would have found it obvious to modify Hidler to use a cam, such as the cam taught in Walker, instead of the ball screw/pulley plate mechanism. A cam is a well-known mechanical component that rotates and, in doing so, is often used to make contact with another component in a way that transforms the rotary motion into a linear motion. It is often a part of a rotating member (such as a semi-circle or an irregular shape) that moves a member at a point around its irregular rotating path. Ex-1001 at Fig. 33 (showing irregularly shaped cam member):



239. Walker teaches one such use of a cam in a pulley tensioning system, as a means for maintaining a belt’s tension:



Ex-1006 at Fig. 1; 4:1-11 (teaching that cam 76 has a shape that causes a variation in space between the guide 74 and pulley axis 42). Walker further teaches that the cam is used to “move idler pulley 40” to “maintain pre-selected tension.” *Id.* at 4:28-34.

240. A POSITA would have understood that the ball screw system of Hidler and the cam system of Walker maintain tension both transform rotational energy to linear energy for the purpose of moving a pulley. Moving the pulley changes the length of a tether/belt, which adjusts the tension of the tether. Moving a pulley further away, such that it naturally increases the length of the tether/belt

increases tension; moving a pulling closer, such that it naturally shortens the length of the tether/belt (and generates slack) reduces tension.

241. A POSITA would have understood that modifying Hidler to use a cam, either based on a POSITA's own knowledge of cams or based on the pulley/cam system as taught in Walker, would have been an obvious substitution of one known element for another (replacing a ball screw assembly with a cam) to obtain predictable results (converting rotary motion into linear motion).

242. Cams have been well-known in the art for hundreds of years and were used in body-weight support systems prior to the Critical Date. *Id.* For example, Artemiadis uses a cam to raise and lower a treadmill to provide swing clearance for an impaired leg:

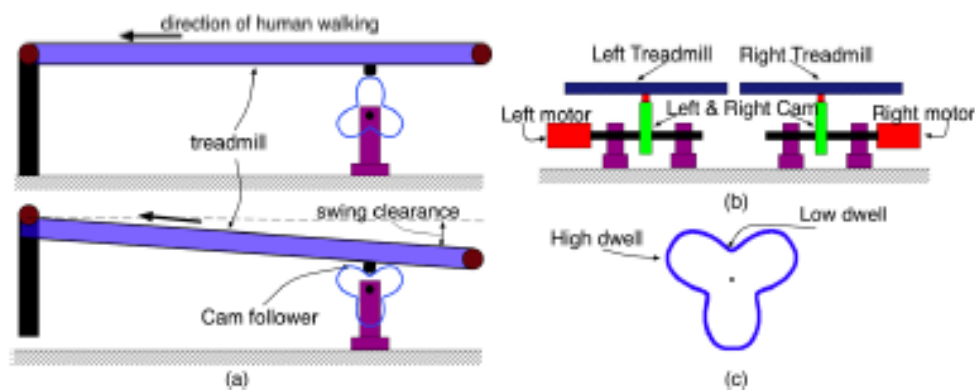
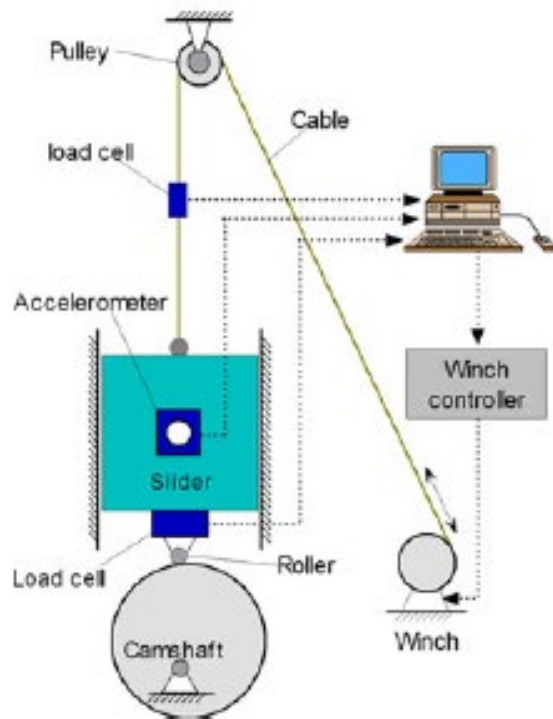


Fig. 2. (a) Side view of the cam-based vertical actuation system of the treadmill. A 60° rotation of the cam lowers the one end of the treadmill to provide the necessary swing clearance. (b) Front view of the motor-cam systems for each of the two belts of the split treadmill. (c) The cam profile. The high-low dwell sequence was replicated three times for allowing the use of the cam at future applications with continuous rotation of the cam.

Ex-1012 at Fig. 2 (using a cam to transform rotational energy into linear energy to move a treadmill up and down).

243. Similarly, in Lu, a cam is used with a pulley system to mimic the force of a walking patient:



Ex-1013 at Fig. 7 (using a cam to manipulate the position of a load cell in a pulley system).

244. A POSITA would have predicted that using a cam to successfully transform rotational force into linear force in a body-weight support system was predictable. Moreover, given a POSITA's knowledge of cams, a POSITA would also understand that using a cam to control a tether's tension is a mechanical

substitution of Hidler's ball-screw mechanical system. Thus, using Walker's cam in place of Hidler's ball screw amounts to a simple substitution of known elements.

3. Using a cam with Hidler's pulley system would have been obvious to try

245. Even if cams had not previously been used in the art for this precise purpose, use of a cam with the system of Hidler also would have been obvious to try to any POSITA. There are a discrete number of fundamental, rudimentary ways of transforming rotary motion into linear motion. Using a cam has been a conventional method of doing so for decades (or, more likely, centuries), and was certainly conventional prior to January 2013. *Id.* A POSITA would expect predictable results and success with each well-known technique for transforming rotational force into linear force.

246. Given the routine problem of needing to transform rotational energy into linear energy, and the well-known and predictable benefits of using a cam to accomplish this task, a POSITA would be motivated to combine Hidler's trolley with Walker's teaching of a cam and would expect success in trying the combination.

4. Claim 8

a. Limitation 8 ``` [pre] ```

8[a]	An apparatus, comprising:
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247. To the extent the preamble is a limitation, in my opinion, Hidler discloses an apparatus for the same reasons as set forth above in connection with claim 1

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[pre]
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b. Limitation 8[a]

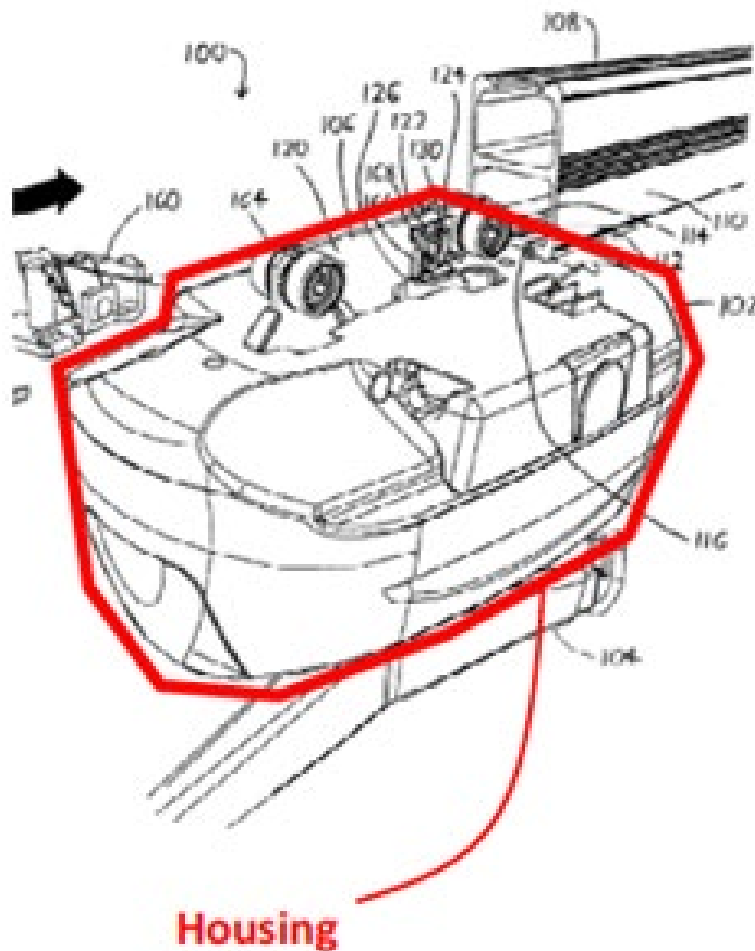
8[a]	a housing
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248. As I noted above, Hidler does not teach the type of housing required by later limitations of claim 8. But a POSITA would have found it obvious to modify Hidler to include a housing based on either a POSITA's own general knowledge of the use of housings, or at least based on the teachings of Faucher. *See* Section Motivation to Combine.

249. It would have been generally obvious to a POSITA to modify Hidler to include a housing as required in claim 8 because the use of housings was a routine and conventional practice prior to January 2013. A POSITA would have been aware of this practice both generally with respect to mechanical devices and specifically with respect to body weight support systems. *See* Section Motivation to Combine. As such, it would have been generally obvious to a POSITA to

modify Hidler to include the claimed housing. *See* Ex-1002, 266-267 (examiner concluding the same).

250. To the extent it would not have been generally obvious to use a housing with Hidler, it would also have been obvious to modify Hidler based on the teachings of Faucher. In particular, Faucher teaches a “housing” that surrounds the trolley of a body-weight system, as shown in Figure 1:



Ex-1007, Fig. 1.

251. As noted above, a POSITA would have been motivated to modify Hidler to incorporate the type of housing shown in Faucher. *See* Section Motivation to Combine.

252. Accordingly, in my opinion, Hidler in view of Faucher teaches and renders obvious Claim 8[a].

8[b]	a drive element disposed at least partially within the housing;
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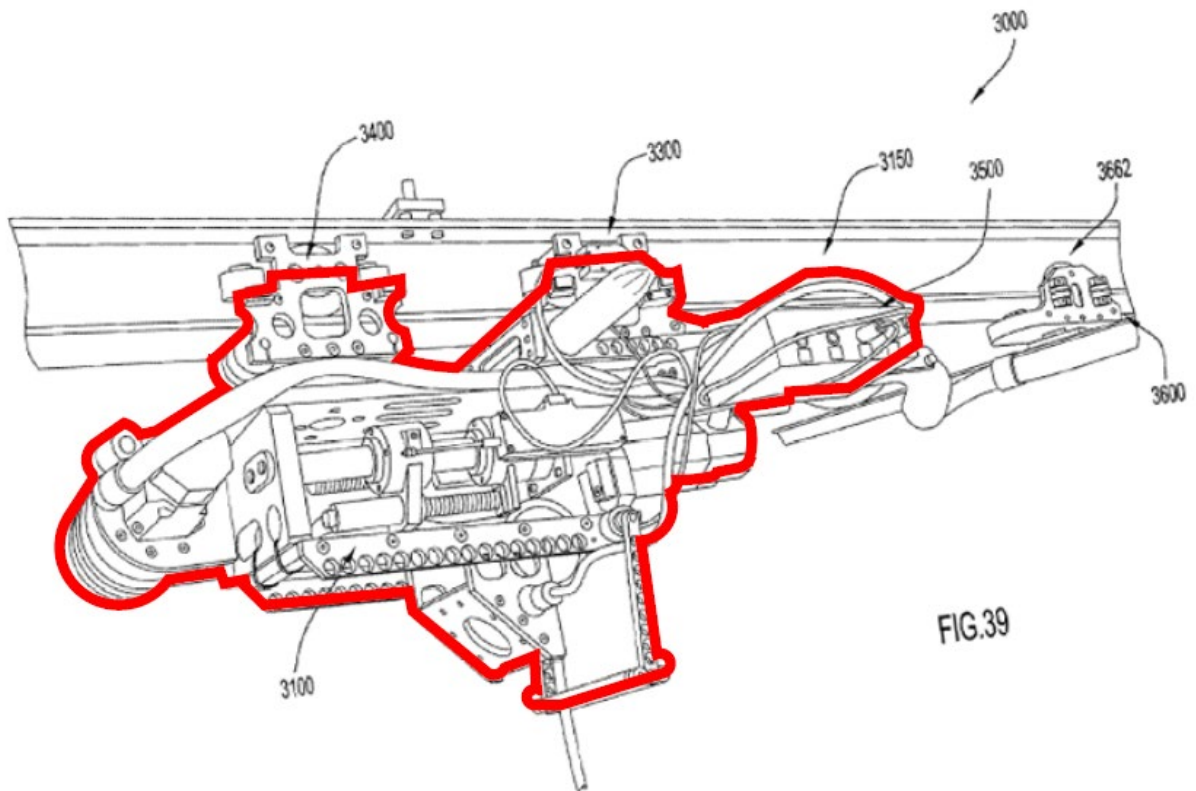
253. As explained with respect to claim 8[a], the combination of Hidler and Faucher teaches the claimed housing. In my opinion, the combination of Hidler and Faucher also teaches and renders obvious limitation 8[b] because Faucher teaches a housing that encloses a trolley (other than its wheels on the track), including the drive element of the trolley.

254. As explained in claim 1[a], Hidler discloses a drive assembly (or element), which consists of a motor mounted to wheel assemblies, that allows the trolley to “ride[] along the track.” Ex-1004, 6:61-7:13. Modifying Hidler to incorporate a housing, as taught in Faucher, would result in enclosing the drive element (and other components) of Hidler within the housing.

255. This configuration can be seen, for example, in Figure 1 of Faucher:

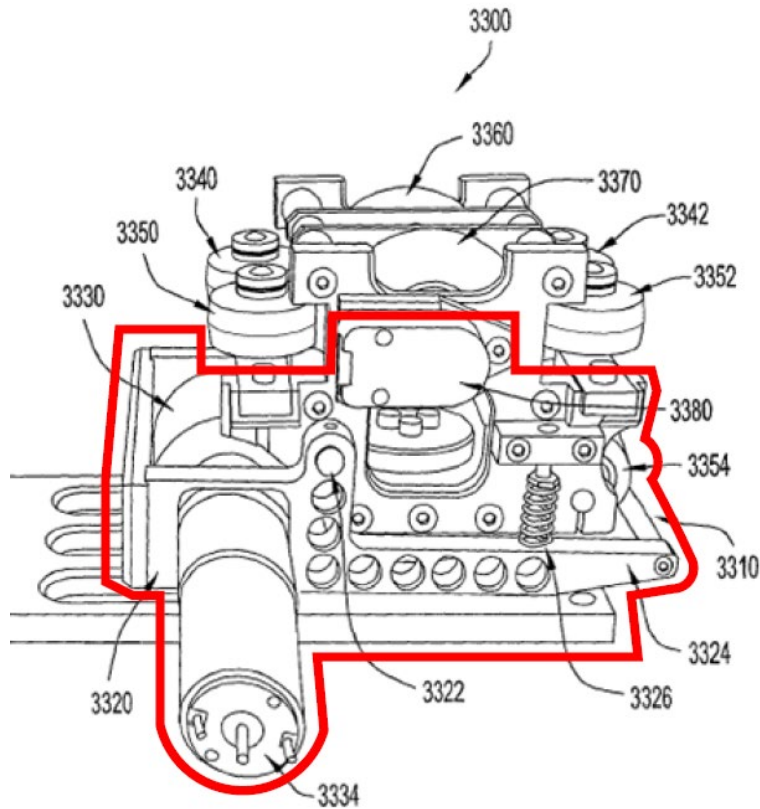
[illegible]

256. Using Faucher's housing with Hidler would result in Hidler's trolley being nearly completely surrounded by a housing. Therefore, at least a portion of Hidler's drive element, as identified above, would be enclosed within the housing:



Ex-1004 at Fig. 39 (annotated to show location of Faucher's housing on Hidler's trolley).

257. As shown in Hidler Figure 40, such a combination would put portions of the drive element, including at least the motor 3340 and portions of the drive wheel 3330, within the housing:



Ex-1004 at Fig. 40 (annotated to show that a housing surrounding all of Hidler except for the wheels on the track, as in Faucher, would place a portion of Hidler's motor, drive wheel, and wheel assembly in the housing).

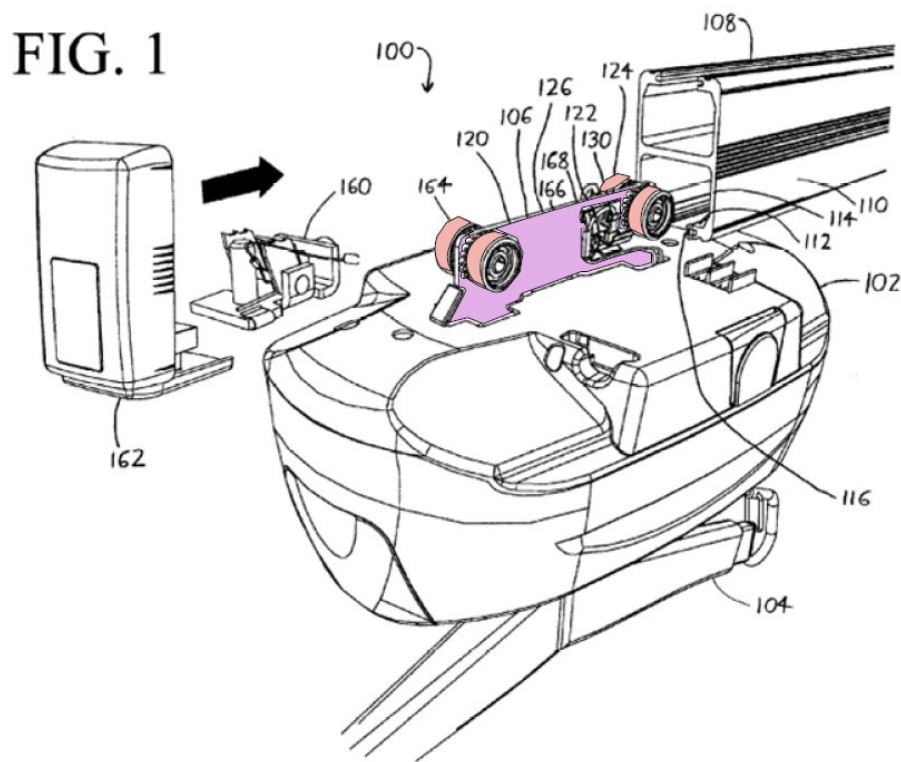
258. As noted above, a POSITA would have been motivated to modify Hidler to incorporate the type of housing shown in Faucher. *See* Section Motivation to Combine.

259. Accordingly, in my opinion, Hidler in view of Faucher teaches and renders obvious Claim 8[b].

c. Limitation 8[c]

8[c]	a wheel assembly coupled to the drive element and disposed at least partially within the housing; and
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260. For the same reasons as claim 8[b], the combination of Hidler and Faucher teaches limitation 8[c] because Faucher teaches that the housing at least partially covers the wheel assembly, as shown in Figure 1, where the housing covers the portion of the wheel assembly connecting the wheels to the drive element:



Ex-1007, Fig. 1 (annotated figure) (showing only the wheels of the entire wheel assembly outside of the housing).

261. Hidler also teaches that the wheel assembly is coupled to the drive element. Ex-1004 at 18:53-19:7 (“[A]ssembly 3300 includes a trolley motor 3334 that is coupled to a drive wheel 3330 that engages the track 3150 to move the trolley 3100 along the track 3150. As shown in FIG. 41, the drive wheel 3330 includes an outer surface 3332 and is rotatably mounted on an axle 3334. The drive wheel 3330 is mounted in a drive wheel body 3320 that is pivotally mounted to the housing 3310 by an axle 3322. On each side of the drive wheel body 3320 there is a spring 3326 that engages an upper end or limit 3328 (see FIG. 41) and exerts a downward force on end or portion 3324 of the drive wheel body 3320 so that the drive wheel 3330 is forced into contact with the track 3150.”).

262. As noted above, a POSITA would have been motivated to modify Hidler to incorporate the type of housing shown in Faucher. *See* Section Motivation to Combine. As taught in Faucher, applying the housing to Hidler would cover the portion of the wheel assembly connecting the wheels to the drive element.

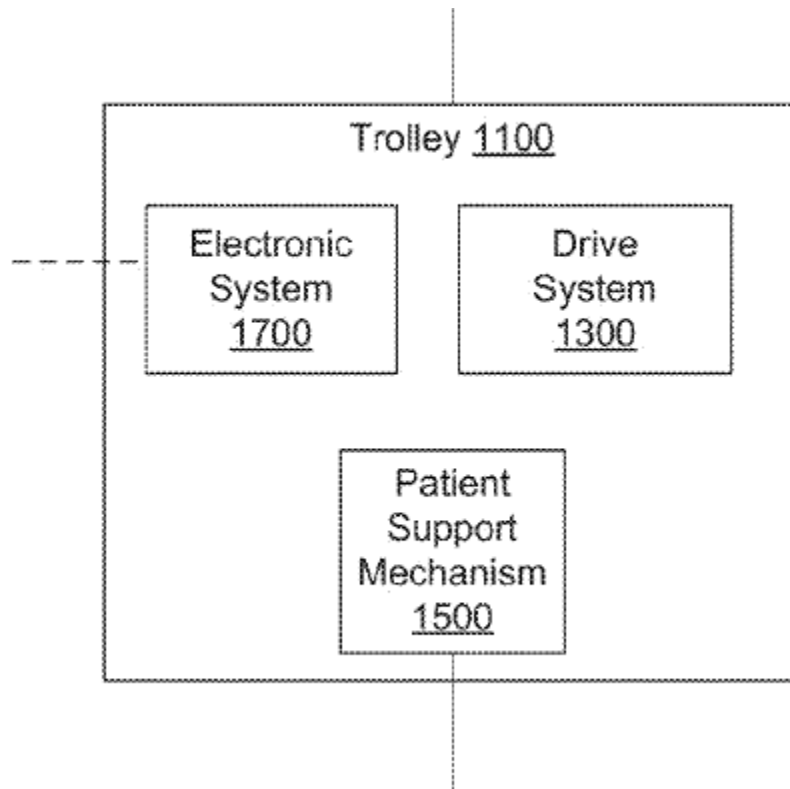
263. Accordingly, in my opinion, Hidler in view of Faucher teaches and renders obvious Claim 8[c].

d. Limitation 8[d]

8[d1]	a patient support assembly coupled to the housing
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264. In my opinion, Hidler, in combination with Faucher, teaches claim 8[d1] because Faucher teaches that the housing surrounds and is connected to “a patient support assembly”—i.e., the assembly that dynamically supports a patient’s weight (e.g., controls the tension in the tether that is attached to the patient).

265. The ’000 Patent does not define “patient support assembly,” but states that the patient support assembly is what is “configured to dynamically support [the] body weight of a patient.” Ex-1001, 4:14-16. The specification further identifies a “patient support mechanism 1500,” which a POSITA would understand to be the patient support assembly. The “patient support mechanism” is identified as being a component of the trolley 1100:



Ex. 1001 at Fig. 1.

266. The '000 Patent states that the patient support mechanism “can include a tether that can be temporarily coupled to a coupling portion of the patient attachment mechanism.” *Id.*, 7:33-46. Moreover, the specification describes that the “support mechanism 1500 can be configured to exert a reaction force in response to the force exerted by the patient.” *Id.*, 8:36-48.

267. In my opinion, Hidler teaches the claimed “patient support assembly” for the same reasons that Hidler teaches claim 3. Hidler’s patient support assembly is configured to dynamically support a patient by providing “constant rope tension (e.g. constant body weight support)” as the patient moves and the length and force

on the tether changes. *Id.* at 10:4-22. By using a “DC motor 230 [to] automatically maintain[] the spring length constant for springs 280 and 282, which results in constant rope tension,” in conjunction with Hidler’s pulley system, as described in more detail below with respect to limitation 8[d2]. *Id.*

268. Modifying Hidler to add a housing surrounding the trolley, as taught in Faucher, would result in the housing being coupled to the trolley and, as such, the patient support assembly that is a component of the trolley.

269. Accordingly, in my opinion, Hidler in view of Faucher teaches and renders obvious Limitation 8[d1].

8[d2]	the patient support assembly including a pulley movably coupled to a portion of the housing and a cam operably coupled to the pulley,
-------	---

270. In my opinion, the combination of Hidler and Faucher teaches “the patient support assembly including a pulley movably coupled to a portion of the housing because Hidler specifically teaches that its pulley moves within the system as a patient walks. The Hidler support system is shown below:

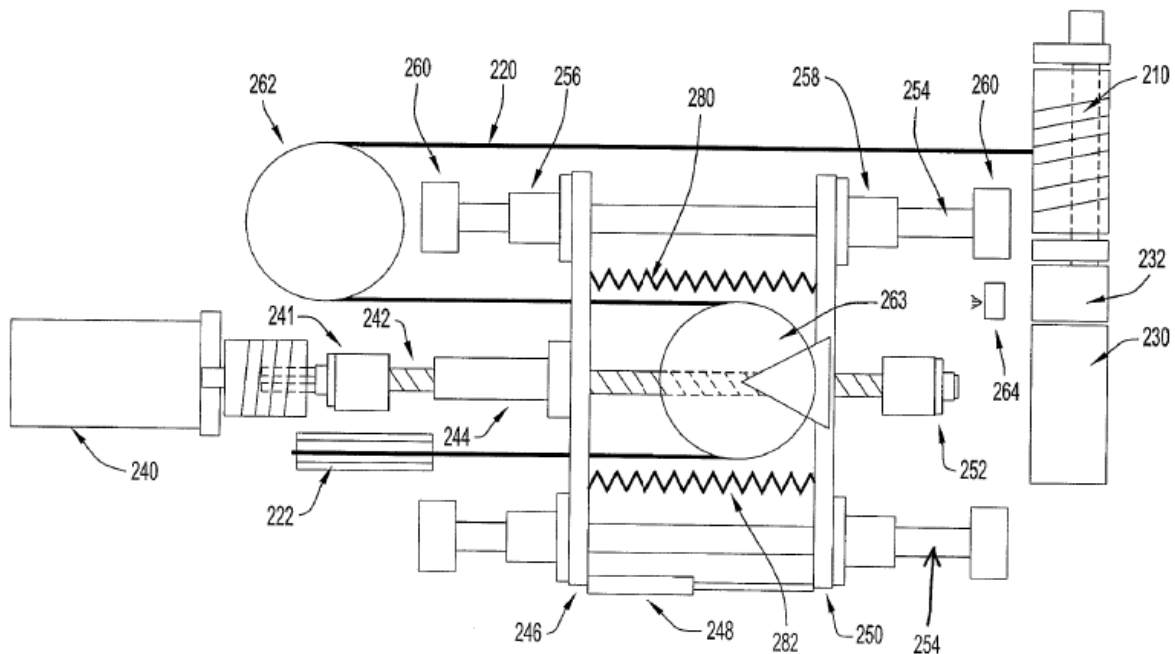


FIG. 20A

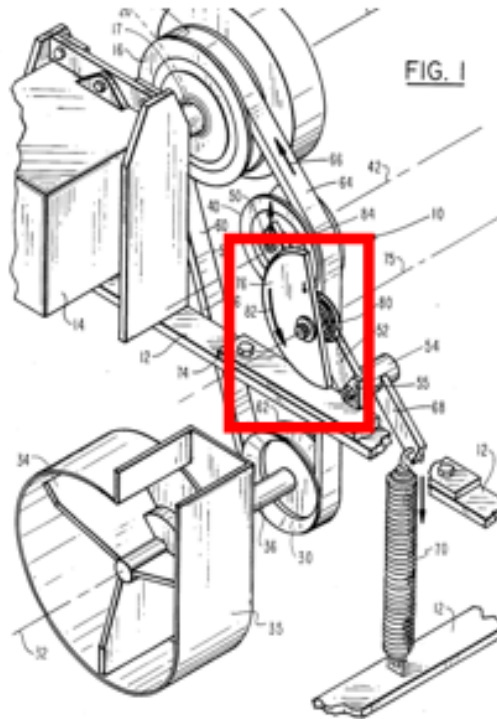
Ex-1004, Fig. 20A. Hidler teaches that pulley plate 263 is “mounted” to pulley plate 250. Ex-1004, 11:5-13. Pulley plate 250 is designed to “slide freely” along rods 250. *Id.*

271. Pulley 263 needs to be movably coupled to the trolley (which includes the housing from Faucher) in order to work in the Hidler system. Ex-1001, 11:5-65. As noted in the specification, the pulley plate 250 (which is pulley 263 is attached to) “moves back and forth” as a subject walks. *Id.* As the pulley plates are moving, the springs distance is constantly measured, and if the dimensions

vary, the ball-screw motor 240 turns on and moves the ball-screw plate 246 to the left or to the right in order to maintain the spring deflection (dx) at the desired level of compression (see FIGS. 23 and 24). *Id.* This allows for the tension in the spring to be maintained. *Id.*

272. Accordingly, in my opinion, Hidler in view of Faucher, teaches and renders obvious this portion of Limitation 8[d2].

273. In my opinion, a POSITA would have been further motivated to modify Hidler to incorporate a cam that is “operably coupled to the pulley” in view of the teachings of Walker. *See* Section Motivation to Combine. Specifically, Walker teaches a pulley tensioning system that uses a cam to manipulate the position of a pulley, as a means for controlling a the belt’s tension:



Ex-1006 at Fig. 1; 4:1-11 (teaching that cam 76 has a shape that causes a variation in space between the guide 74 and pulley axis 42).

274. Walker further teaches that the cam is used to “move idler pulley 40” to “maintain pre-selected tension.” *Id.* at 4:28-34. Thus, the ball screw system of Hidler and the cam system of Walker maintain tension in the same way, by moving a pulley to change the length of a tether/belt, which adjusts the tension of the tether.

275. Walker explains that a cam works in a way that when “relaxation in the tension within belt 44” occurs, it “will enable spring 80 to nudge cam 76 in the direction of arrow 82 thereby to move idler pulley 40 in this case upwardly and

maintain the desired pre-selected tension.” Ex-1006, 4:1-11. In other words, as a tether changes tension, the position of the cam will rotate, and when rotated, the cam will cause a change in the pulley’s position, which allows for a constant, pre-selected tension to be maintain. As such, a POSITA would have understood that the cam is “operatively coupled” to the pulley.

276. In my opinion, substituting Walker’s cam (or any well-known cam) into Hidler’s trolley (in place of the ball screw mechanism) would still allow for constant tension to be maintained. For the reasons set forth above, a POSITA would have expected success in making this modification.

277. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Limitation 8[d2].

8[d3]	the patient support assembly including a tether engaged with the pulley and configured to dynamically support a body weight of a patient
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278. For the same reasons as claims 1c, 2, and 8[d1-d2], Hidler teaches and renders obvious the limitations of 8[d3].

279. Specifically, Hidler teaches the “patient support assembly” includes a tether (i.e., rope) that is engaged with the pulley and configured to dynamically (i.e., actively) support a body weight of a patient. For example, Hidler states that the “the unloading or adjustment system 20 includes a pulley 222 around which a

rope 220 [i.e. tether] passes.” Ex-1004, 5:11-24, 11:46-59. Hidler’s rope is “coupled to . . . a support assembly, such as a harness system or assembly.” *Id.*

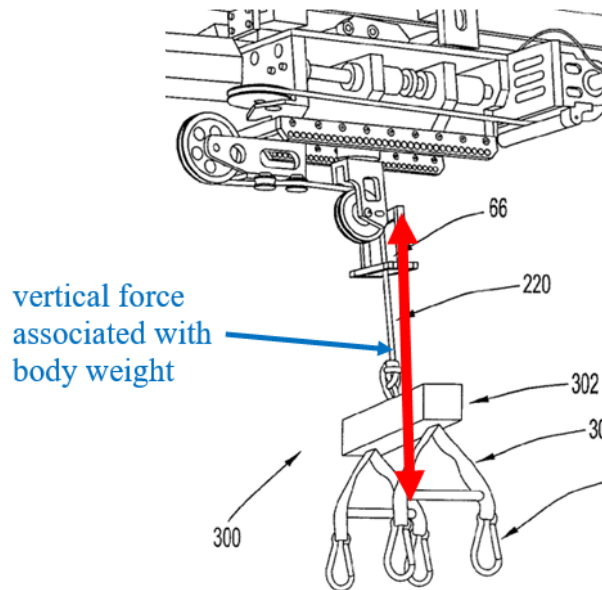
280. Hidler’s patient support system also is configured to dynamically support the body weight of a patient, as set forth in connection with claim 3, above. In short, Hidler teaches that as a patient walks when attached to the system, “the pulley plate 246 will move back and forth[, and keeps] force in the rope 220 constant through its ball screw motor system (which can be substituted with Walker’s cam system). Ex-1004, 5:11-24, 11:46-59; Ex-1006, 4:1-11.

281. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Limitation 8[d3].

8[d4]	the pulley configured to pivot relative to the housing and about a vertical axis in response to a force associated with the body weight of the patient exerted on the tether,
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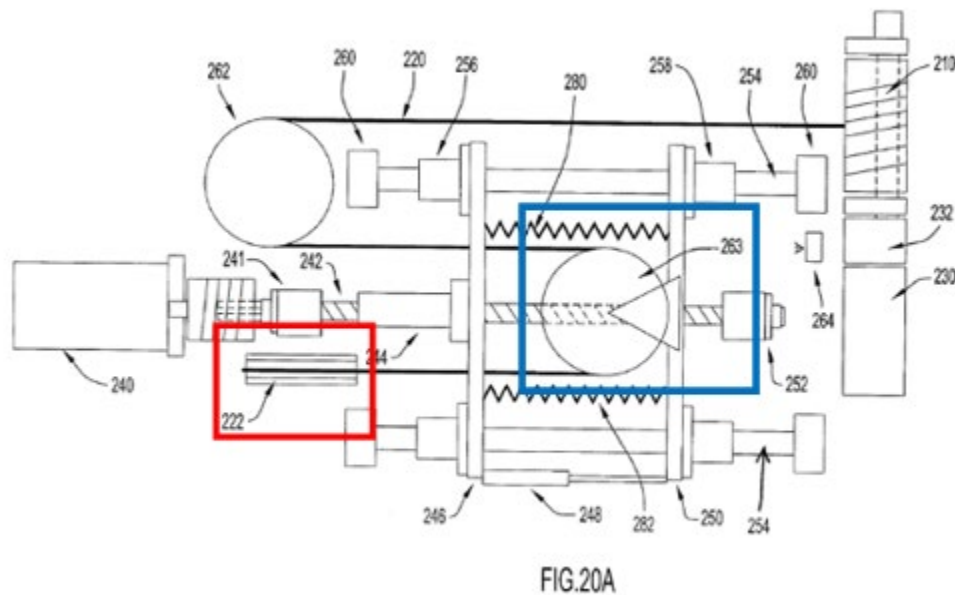
282. In my opinion, the combination of Hidler, Faucher, and Walker teaches the limitations of 8[d4] because Hidler’s pulley is already configured to pivot relative to the housing and about a vertical axis in response to a force associated with the body weight of the patient exerted on the tether.

283. The trolley’s tether experiences a force from the body weight of a patient:



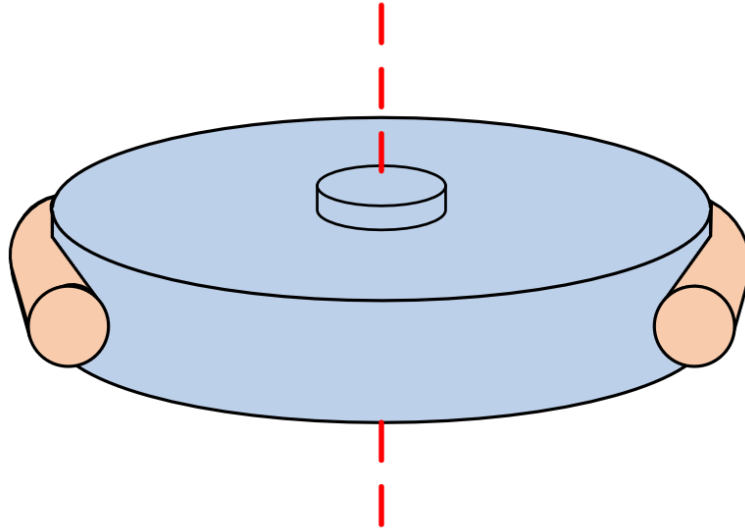
Ex-1004 at Fig. 2 (annotated).

284. The tether (220) attached to the Hidler trolley wraps around a first pulley 222 (in red) before wrapping around pulley 263 (in blue):



Ex-1004 at Fig. 20A (showing an overhead view of the trolley).

285. As shown in my exemplary drawing below, Hidler's pulley 263 meets claim limitation 8[d4] as it lies in a horizontal plane, and as such, pivots around a vertical axis:



(showing exemplary side view of a tether (orange), going around a pulley (blue), in the same horizontal orientation as pulley 263, pivoting around a vertical axis (red)).

286. POSITA would understand that the Hidler's pulley 263 can be configured to pivot "relative to [Faucher's] housing" as the pulley will move, pivot, and turn within Faucher's housing surrounding Hidler's trolley. *Id.* In other words, the pulley will pivot and move in response to a force on the tether, independent from, and relative to, the housing. For the reasons set forth above, a POSITA would have expected success in making this substitution.

287. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Limitation 8[d4].

8[d5]	the cam configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley, the cam exerting a reaction force when the cam pivots relative to the housing,
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288. The combination of Hidler, Faucher, and Walker also teaches the limitations of 8[d5] by replacing the Hidler ball-screw assembly with Walker's teaching of a cam.

289. Hidler's active trolley support system works by moving a pulley 263 in a horizontal plane. *See* Fig. 20A:

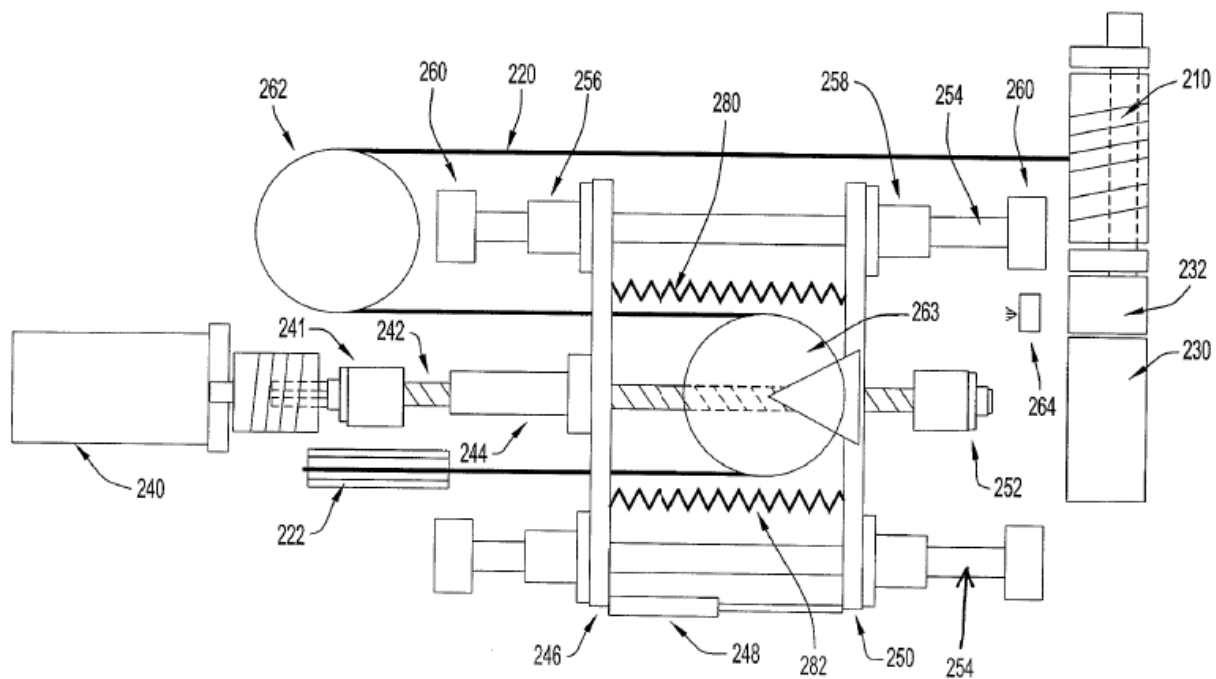


FIG.20A

Ex-1004 at Fig. 20A.

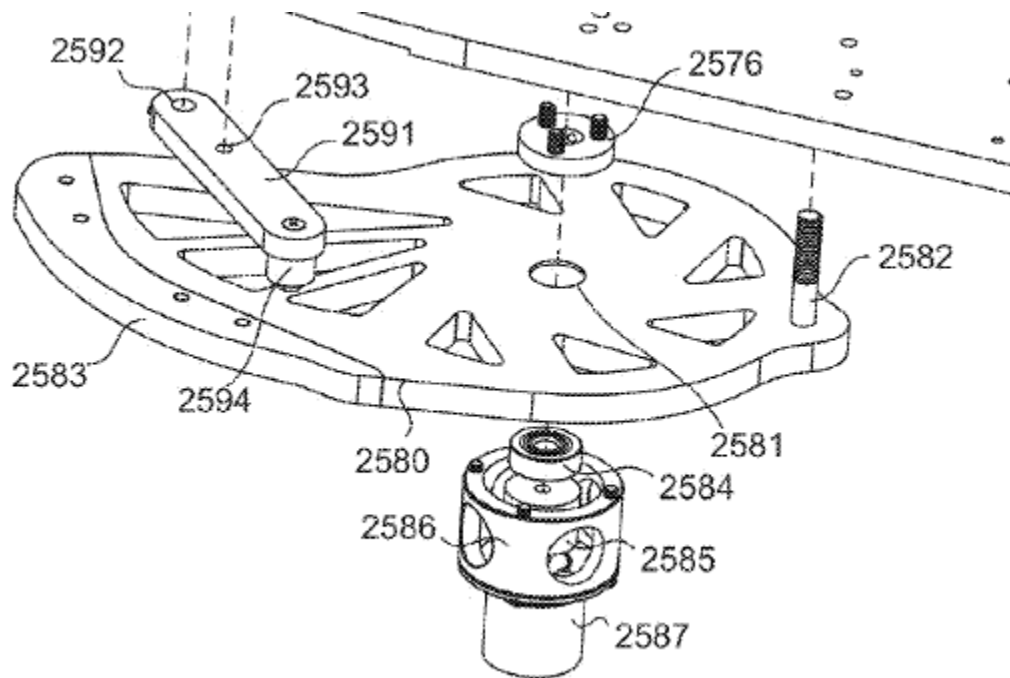
290. As the pulley moves, the tension in the tether adjusts. If pulley 263 moves closer to pulley 222, tension is relieved as the distance the tether must travel is shortened; if pulley 263 moves further from pulley 222, tension is increased as the distance the tether must travel is elongated. *Id.* The pulley must be moved by a power source (i.e., a motor).

291. Hidler teaches converting the rotational force from a motor to linear force moving the tether by using a ball screw (242) and pulley plate (246). Ex-1004 at 20A. As an encoder (248) indicates that an increase or decrease in tether tension is needed, Hidler's control system moves pulley 262 in a linear manner by converting the motors rotational energy via the ball screw assembly (ball screw 242 and ball screw plate 246). *See* Ex-1004 at Fig. 20A, 11:5-59 ("As the subject walks, the pulley plate 246 will move back and forth. In order to maintain the force in the rope 220 constant, the spring deflection, dx , must remain constant. The linear encoder 248 measures the instantaneous length of the springs 280 and 282 and if the dimension " dx ' varies, the ball-screw motor 240 turns on and moves the ball-screw plate 246 to the left or to the right in order to maintain the spring deflection (dx) at the desired level of compression (see FIGS. 23 and 24). The pulley plate 250 moves back and forth along the direction of arrow "A" in FIG.24 as the subject walks. The force sensor is also monitored continuously so that if the

average rope force is too low, the springs 280 and 282 are compressed, or if the force is too high, the springs 280 and 282 are uncompressed.”).

292. While Hidler teaches moving pulley 263 linearly with a ball screw, a POSITA would have found it obvious to modify Hidler to use a cam instead, such as the cam taught in Walker. Cams were well-known in the art as a means for converting rotational energy to linear energy, which is what is required to use Hidler’s motor to move pulley 263 in a horizontal plane. Walker expressly teaches its cam is used to “move idler pulley 40” to “maintain pre-selected tension.” *Id.* at 4:28-34.

293. As pulley 263 is designed to be moved linearly in a horizontal plane, using Walker’s cam in Hidler requires placing the cam in the same plane, such that it rotates around a vertical axis. *See* Ex-1001 at Fig 33, showing how the orientation of a horizontal cam 2583 with engagement surface 2583 pivots around a vertical axis (opening 2581 and axle 2575 (not shown)):



Ex-1001, Fig. 33.

294. Thus, when the Hidler-Walker combination pulley moves linearly in response to the motion of a patient, it will engage the cam and force the cam to rotate around a vertical axis. Accordingly, the cam added to Hidler (in replace of the ball screw system) will be a cam “configured to pivot about the vertical axis in response to the pivoting of the pulley.” As the cam’s movement will be independent from (and relative to) any housing, “the cam configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley.”

295. In my opinion, the cam also “exerts a reaction force when the cam pivots relative to the housing.” This is because as a patient moves or falls, the

tether changes direction and/or force which causes pulley 263 to pivot/try to move with pulley plate 250. In response to the movement of the pulley pushing against the irregularly shaped cam, the cam will pivot and exert a reaction force in order to counteract the pivoting pulley in order to maintain a constant tension.

296. For the reasons set forth above, a POSITA would have expected success in modifying Hidler with Walker and Faucher to include a cam configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley, the cam exerting a reaction force when the cam pivots relative to the housing. Additionally, like Hidler's original ball-screw system, the cam will be coupled to a motor in order to rotate and re-position the pulley to maintain the proper pre-selected tension. For the reasons set forth above, a POSITA would have expected success in making this substitution.

297. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Limitation 8[d5].

8[d6]	the cam operably coupled to a sensor configured to detect pivoting of the cam.
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298. It is also my opinion that the combination of Hidler, Faucher, and Walker also teaches the limitations of 8[d6] because Hidler already teaches using sensors configured to detect movement with its ball-screw mechanism, which can be used in conjunction with Walker's cam for the same purpose.

299. Hidler teaches coupling sensors and pulleys relating to the force of a patient based on its disclosure of “sensors monitor[ing] the amount of unloading force and the subject's vertical position.” Ex-1004, 10:21-23. Hidler further teaches that “ultrasonic sensor measures the location of the pulley plate 250” so that if “the ball-screw plate 246 or the pulley plate 250 moves too close to the rod support blocks 260, the winch motor 230 will turn on and either let rope 220 out . . . or spool the rope 220 up. . . .” Ex-1004, at 11:55-12:7. Using the Hidler-Walker cam, instead of the ball screw and pulley plate, allows for the sensors to monitor pivoting of the cam (rather than the pulley plate) in reaction to pulley 263/pulley plate 250 moving from a subject moving or falling. *Id.* For the reasons set forth above, a POSITA would have expected success in making this substitution.

300. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Limitation 8[d6].

301. Therefore, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Claim 8.

5. Claim 12

12	The apparatus of claim 8, further comprising a second drive element coupled to the patient support assembly, the second drive element configured to dynamically support the patient.
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302. For the reasons I explained above, the combination of Hidler, Faucher, and Walker teaches the apparatus of claim 8. In my opinion, Hidler also

teaches the additional limitations of claim 12 by teaching a second drive assembly configured to dynamically support the patient, in addition to the drive assembly that moves the trolley along a track.

303. I explained the first drive element taught by Hidler in claims 1[a], 13[a], and 8[b]. That drive element allows for the trolley to move along the rail (in keeping up with/above the patient in the horizontal direction).

304. Hidler also teaches the “a second drive element coupled to the patient support assembly, the second drive element configured to dynamically support the patient.” That second drive element, includes a motor 230 that automatically maintains the spring length constant for springs 280 and 282, which results in constant rope tension via a winch drum, ball screw assembly (or Walker’s cam assembly after the substitution), and sensors monitor the amount of unloading force and the subject's vertical position. Ex-1004, 10:4-23 (emphasis added).

305. In other words, the second drive element, the DC motor, allows for the body-weight support system to dynamically adjust the tension of the rope (or tether) in order to support the patient (i.e., from falling down in the vertical direction). *Id.*

306. I understand that the Examiner expressed the same conclusion—i.e., that Hidler teaches “a second drive element coupled to the patient support

assembly, the second drive element configured to dynamically support the patient.”

Ex-1002 at 242.

307. Accordingly, in my opinion, Hidler in view of Faucher and Walker, teaches and renders obvious Claim 12.

VIII. RESERVATION OF RIGHTS

308. My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the '000 Patent that would render any of the challenged claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the owner of the '000 Patent and to take into account new information that becomes available to me.

309. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on February 13, 2023.

By: 
David J. Reinkensmeyer, Ph.D.

**APPENDIX 1: CURRICULUM VITAE OF DAVID J. REINKENSMeyer,
PH.D.**

CURRICULUM VITAE

David J. Reinkensmeyer, Ph.D.

Office Address and Phone Number: 3225 Engineering Gateway, Zot: 3975, (949)824-5218

Current Position: Professor, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, Department of Biomedical Engineering, Department of Physical Medicine and Rehabilitation

Home Address and Phone Number: 46 Urey Ct., Irvine, CA 92617

Date of Birth: 9/22/66

Place of Birth: Moline, Illinois

Current Citizenship: U.S.

Education:

Ph.D. in Electrical Engineering, 1993, University of California, Berkeley

M.S. in Electrical Engineering, 1991, University of California, Berkeley

B.S. in Electrical Engineering, 1988, Massachusetts Institute of Technology

Professional Interests: biological motor control, neurorehabilitation, robotics, mechatronics

Academic Appointments:

Professor, Step VIII, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, University of California, Irvine, July 2022 – current

Professor, Step VII, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, University of California, Irvine, 2019 – 2022

Professor, Step V, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, University of California, Irvine, 2016 – 2019

Professor, Step IV, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, University of California, Irvine, 2013 – 2106

Professor, Step III, Department of Mechanical and Aerospace Engineering, Department of Anatomy and Neurobiology, University of California, Irvine, 2010 – 2013

Professor, Step II, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 2007 – 2010

Associate Professor, Step III, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 2005 – 2007

Associate Professor, Step II, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 2003 – 2005

Assistant Professor, Step V, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 2002 – 2003

Assistant Professor, Step IV, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 2000 – 2002

Assistant Professor, Step III, Department of Mechanical and Aerospace Engineering, University of California, Irvine, 1998 – 2000

Adjunct Assistant Professor, Department of Physical Medicine and Rehabilitation, Northwestern University Medical School, 1998 – present

Research Assistant Professor, Department of Physical Medicine and Rehabilitation, Northwestern University Medical School, 1997 – 1998

Post-Doctoral Fellow, Sensory-Motor Performance Program, Rehabilitation Institute of Chicago and Department of Physical Medicine and Rehabilitation, Northwestern University Medical School, 1994 – 1997, Mentor: Prof. Zev Rymer

Lecturer, Department of Human Biodynamics, University of California, Berkeley, 1994

Research Assistant, Motor Control Laboratory, Department of Human Biodynamics, Graduate Group in Bioengineering, University of California, Berkeley, 1990 – 1994; Mentor: Prof. Steve Lehman

Research Assistant, Neurology Unit, Department of Electrical Engineering, University of California, Berkeley, 1989 – 1990; Mentor: Prof. Larry Stark

Research Assistant, Artificial Intelligence Laboratory and Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, 1986 – 1988; Mentor: Prof. Chris Atkeson

Academic Affiliations:

Reeve-Irvine Research Center

UCI Center for the Health Effects of Exercise in Children

Center for the Neurobiology of Learning and Memory

Sue and Bill Gross Stem Cell Center

Northwestern University Department of Physical Medicine and Rehabilitation

Consulting Activities:

Founding Member, Robomedica Inc., Technical Advisory Board

Paid Consultant: Hocoma A.G.

Founder, Paid Consultant: Flint Rehabilitation Technologies

Awards and Honors:

2022	Plenary Speaker, 2022, SOMFER, Societe Francaise de Medicine Physique et de Readaptation on December 1 in Rennes, France
2022	Keynote Speaker, 2022 Rehabweek Conference, which combines 8 societies, including International Conference on Rehabilitation Robotics, International Functional Electrical Stimulation Society, International Society for Virtual Rehabilitation.
2020	UCI's Greek life Faculty Favorite May 2020
2019	Fellow, American Institute of Medical and Biological Engineers
2017 - 2021	Member, National Advisory Board for Medical Rehabilitation Research, NIH
2017	Elected Fellow, UC Irvine Center for the Neurobiology of Learning and Memory
2017	Google Scholar Classic Paper author –One of ten most-cited articles in Rehabilitation Therapy that were published ten years earlier.
2017	HSSOE Dean's Honoree for Teaching Excellence

2017	Mechanical and Aerospace Engineering Student Council Professor of the Year
2016	Brenes Keynote Lecturer, University of Pittsburgh Rehabilitation Research Day
2016	UC Irvine Distinguished Mid-Career Award for Research
2016	Henry Samueli School of Engineering Innovator of the Year Award
2014	Mechanical and Aerospace Engineering Student Council Professor of the Year
2013	Keynote Speaker, 2013 IEEE International Conference on Rehabilitation Robotics
2012	2012 Most Innovative Technology Award 2 nd IEEE EMBS Unconference on Rehabilitation Robotics (for work with Dan Zondervan on the Smart Wheelchair Trainer).
2011	2011 Most Innovative Technology Award 1 st IEEE EMBS Unconference on Wearable and Ubiquitous Technology for Health and Wellness (for work with Nizan Friedman and Prof. Mark Bachman on the MusicGlove).
2011	NIH National Institute of Biomedical Imaging and Bioengineering Lecture, Biomedical Engineering Society Annual Meeting
2011	IEEE Transactions on Neural Systems and Rehabilitation Engineering Best Paper of the Journal Award for 2011
2009-2012	Chair, NSF/WTEC European Study on Technology for Mobility
2004	Fariborz Maseeh Best Faculty Research Award, Henry Samueli School of Engineering
2000	Chancellor's Award for Excellence in Fostering Undergraduate Research, Henry Samueli School of Engineering
2000	Special Computer Award for Undergraduate Research, Division of Undergraduate Education and the Office of Academic Computing
1999	UCI Faculty Career Development Award
1998	Whitaker Foundation Biomedical Engineering Research Grant
1998	Sarah Baskin Award for Excellence in Research at the Rehabilitation Institute of Chicago
1996 – 1997	NIH National Research Service Award Fellow
1994 – 1995	National Institute for Disability and Rehabilitation Training Fellow
1993	Franklyn M. Henry Grant
1988 – 1991	National Science Foundation Graduate Fellowship
1988	Ernst M. Guillemin Prize for Best Undergraduate Thesis in Electrical Engineering at MIT
1987	Tau Beta Pi
1985	NCR Scholastic Achievement Award

Citation Statistics

Citations 17988, h-index 72 (Google Scholar, 9/20/22)

Professional Association Memberships:

IEEE Robotics and Automation Society
IEEE Engineering in Medicine and Biology Society
Society for Neuroscience

Professional Service and Activities:

Editor-in-Chief, Journal of Neuroengineering and Rehabilitation, 2014 – current
Associate Editor, Archives of Physical Medicine and Rehabilitation, 2013 – 2014
Associate Editor, IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2002-2010
Chair, NSF/WTEC International Study on Technology for Mobility, 2009-2012
Member, National Advisory Board for Medical Rehabilitation Research, NIH, 2017 - 2021

Track Chair/Associate Editor, 2007 IEEE EMBS Conference, Rehabilitation engineering and biorobotics themes, co-chair EMBC07 sessions Robotic Devices for Rehabilitation I and II; Scientific Program Committee and Session Chair: 2005 IEEE International Conference on Rehabilitation Robotics, Chicago, Illinois, June 28-July 1, 2005, 6th International Conference on Rehabilitation Robotics, Stanford University, Stanford, California, U.S.A., July 1-2, 1999; "Ergonomics of Assistive Technology II," 1st Joint Meeting of BMES and EMBS, Atlanta, Georgia, Oct 13-16, 1999; Reviewer American Society of Biomechanics Conference 2007; Co-referee, Doctoral thesis of Tobias Nef, student of Prof. Dr.-Ing. Robert Riener, Professor for Rehabilitation Engineering, ETH and University Zurich, Switzerland; Referee for Doctoral thesis of Jan Veneman, student of Prof. Frans van der Loos, University of Twente, Netherlands; Referee for Doctoral thesis of Ludovic Dovat, student of Etienne Burdet, National University of Singapore. Best Paper Selection Committee, 2009 IEEE International Conference on Rehabilitation Robotics, Invited Participant, NSF Workshop on Neuromechanical Engineering, Arlington, VA September 14-15, 2009; Invited Participant, NICHD Scientific Vision Workshop on Diagnostics and Therapeutics, Bethesda, MD March 1-2, 2011, Site Review Panel, Swiss National Science Foundation National Centre of Excellence (NCCRs) in Intelligent Robots for Improving the Quality of Life, 2011-2021, Invited Participant, 2nd Roadmapping Workshop on US Medical and Healthcare Robotics, sponsored by NSF and USC 2012; Conference Committee 2012 IEEE EMBS Unconference on Rehabilitation Robotics; Advisory Board, Stanford University Restore Center, 2020-2021, Invited Participant Liberate 2021 NSF Workshop on Living Better through Rehabilitative and Assistive Technologies. Senior Program Committee; American Psychological Association's Technology, Mind & Society conference to be held virtually on November 3-5, 2021

Reviewer: Stroke, IEEE Transactions on Biomedical Engineering, Neurorehabilitation and Neural Repair, IEEE Transactions on Neural Systems and Rehabilitation Engineering; Advanced Robotics; Journal of Rehabilitation Research and Development; Journal of Neurophysiology, Experimental Brain Research, IEEE Sensors Journal, Journal of Applied Biomechanics, Journal of Neuroscience, Journal of Neuroengineering and Rehabilitation, IEEE Transactions on Robotics, International Journal of Robotic Research, Paralyzed Veterans of America Spinal Cord Research Foundation; Annual Meeting of the Rehabilitation Engineering Society of North America, 2000; 6th International Conference on Rehabilitation Robotics, Stanford University, 1999; Proposal Pre-reviewer, VA Medical Center, Palo Alto, California; Rehabilitation Institute of Chicago, Illinois; 7th International Conference on Rehabilitation Robotics, Evry, France, 2001; American Institute of Biological Sciences/Army Medical Research and Materiel Command; Engineering and Physical Sciences Research Council (United Kingdom); Reviewer, Scientific Review and Evaluation Board, Department of Veterans Affairs, Rehabilitation Research and Development Service, 1999, 2000, 2002, 2003; NIH MRS Study Section 2009, 2011; IROS 2009; Review Panel member, NSF Collaborative Research in Computational Neuroscience Program 2010; Craig Neilsen Foundation 2011, IEEE ICORR 2011, PLOS Computational Biology 2012, 2013, Nature Medicine, Israeli Ministry of Science and Technology 2013, 2013 IEEE International Conference on Rehabilitation Robotics, 2013 Frontiers in Computational Neuroscience, 2013 IEEE Transactions on Haptics, 2013 Journal of Motor Behavior, 2014 Data Safety and Monitor Board, Spaulding Rehabilitation Hospital, "Lower Extremity Allotransplantation: An Experimental Rehabilitation Protocol in an Inpatient Setting.", 2014 Science, 2014 Neuron, Experimental Brain Research, Journal of Neurophysiology, Neurorehabilitation and Neural Repair, Journal of Motor Behavior, Journal of Neural Engineering, IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2016 NIDILRR Grant Review Panelist, 2016 Science Translational Medicine, 2017 NIDILRR Grant Review Panelist 2017 NIH Quantum (Major Technology Advances in Medicine) Grant Review Panelist, 2017 Science Robotics, 2017 PNAS, 2018 Science Robotics, NSF 2020, Stanford Restore Center 2020, Current Biology 2021

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5. Sergio Gago, Ph.D.

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Date: 9/98 – 12/03

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3. Robert Sanchez (co-advisor was Prof. Bobrow)

Date: 6/03 – 8/05

Dissertation title: Passive and active orthoses for upper extremity movement training after stroke

Postdoctoral employment: Alcon, Irvine CA

4. Jeff Nessler

Date: 5/02 – 8/05

Dissertation title: Robotic assessment of locomotor ability following spinal cord injury in rats
Postdoctoral employment: Postdoctoral fellow, Rehabilitation Institute of Chicago/Northwestern University; Currently, Assistant Professor, Department of Kinesiology, Cal State San Marcos

5. Lennie Kahn (a Ph.D. Student in Biomedical Engineering at Northwestern University. Primary advisor was Dr. W. Zev Rymer, Northwestern University)

Date: 1/98 – 8/05

Dissertation title: Kinetically altered reaching in chronic hemiparetic stroke: understanding strength and coordination impairment and implications for recovery.

Postdoctoral employment: GE Healthcare, Chicago IL

6. Jiayin Liu

Date: 9/03 – 3/06

Dissertation title: Robotic Environments for Training and Assessing the Human Motor System

Postdoctoral employment: Research Engineer, Aubrey Group (Biomedical device consulting)

7. Jeremy Emken

Date: 7/02 – 4/06

Dissertation title: Human Locomotor Control, Adaptation, and Rehabilitation

Postdoctoral employment: Postdoctoral fellow, California Institute of Technology; Currently – Engineer, Verily Life Sciences, formerly Google [X].

8. Daisuke Aoyagi (primary Ph.D. advisor was Prof. J.E. Bobrow)

Date: 1/03 – 6/06

Dissertation title: A robotic device for human gait rehabilitation: Achieving naturalistic assistance for the pelvis and legs through compliant pneumatic actuation and temporal synchronization

Postdoctoral employment: Research engineer, Rancho Los Amigos National Rehabilitation Hospital;

Currently – Assistant Professor, Dept of Mechanical Engineering, Cal State Chico

9. Eric Wolbrecht (primary advisor was Prof. J.E. Bobrow)

7/04 – 6/07

Dissertation title: A pneumatic robot for retraining arm movement after stroke

Postdoctoral employment: Assistant Professor, Dept. of Mech. Eng., University of Idaho

10. Julius Klein

9/05 – 5/09

Dissertation title: Performance enhancing mechanisms for human manipulation

Postdoctoral employment: Postdoctoral fellow, Department of Bioengineering, Imperial College, London;

Currently – Research Engineer, Technalia, Spain

11. Laura Marchal

7/05 – 5/09

Dissertation title: Haptic guidance for enhancing human motor learning: application to a robot-assisted powered wheelchair trainer

Postdoctoral employment: Postdoctoral fellow, Swiss Federal Institute of Technology (ETH-Zurich)

Currently – Assistant Professor, University of Bern, Switzerland

12. Steve Spencer

4/08 – 11/11

Dissertation title: Movement Training and Post-Stroke Rehabilitation Using a Six Degree of Freedom Upper-Extremity Robotic Orthosis and Virtual Environment

Postdoctoral employment: Research Engineer, Los Alamos National Laboratory

13. Sergi Perez
9/07 – 12/2012
Dissertation title: Estimating Maximal Effort Movement during Rehabilitative Training of Humans and Rodents
Postdoctoral employment: Software engineering – Amazon.com; currently, software engineer Google
14. Nizan Friedman – Rehabilitation Devices for Training, Assessing, and Monitoring Hand Function
6/10 – 5/13 (co-advised with Prof. Mark Bachman)
Postdoctoral employment: CEO of start-up, Flint Rehabilitation Devices
15. Danny Zondervan – Leveraging Mechanical Resonance into Mobility and Recovery for Stroke Survivors: a Novel Rehabilitation Technique 6/10 – 5/14
Postdoctoral employment: CTO of start-up, Flint Rehabilitation Devices
16. Jaime Duarte – Effects of Robotic Challenge Level on Motor Learning, Rehabilitation, and Motivation: The Real-World Challenge Point Framework, 6/09 – 8/14
Postdoctoral employment – Postdoctoral fellow, ETH Zurich , CEO of MyoSwiss
17. Justin Rowe – Evaluating Robotic Assistance and Developing Wearable Activity Monitors to Correct Learned Nonuse after Stroke 6/10 – 8/15; Postdoctoral employment – Research Engineer, Flint Rehabilitation Devices
18. Brendan Smith – Unexpected Elements of Human Force Control and Instances of Preservation after Severe Stroke: Implications for Optimality, Variability and Rehabilitation Technology
9/11 – 3/17; Postdoctoral employment – Assistant Professor, Department of Mechanical Engineering, Loyola Marymount University
19. Morgan Ingemanson – Proprioception and motor learning after stroke – insights from neuroimaging studies (Dept. of Anatomy and Neurobiology)
9/13 – 6/2017; Postdoctoral employment: Medical Affairs Manager, Evoke Neuroscience
20. Sumner Norman – Brain computer interface design for robot assisted neurorehabilitation
9/12 – 9/17; Postdoctoral employment: Postdoctoral fellow, Cal Tech, Andersen Lab
21. Yasemin Sarigul-Klijn – Design and Evaluation of a New Class of Device for Therapy and Mobility: ExoChairs, Dept. of Biomedical Engineering, 9/14 – 11/17
22. Diogo Schwerz de Lucena – New Technologies for On-Demand Hand Rehabilitation in the Living Environment after Neurologic Injury 9/14 – 7/19; Postdoctoral employment: Postdoctoral fellow, Harvard, Walsh Lab
23. Quentin Sanders – Hand Rehabilitation after Stroke: Understanding and Optimizing the Usage of Wearable Robotic Technologies 9/15 – 9-20; Postdoctoral employment: Biomedical Engineer at x – the moonshot factory (formerly GoogleX)/Postdoctoral Fellow North Carolina State University
24. Merav Senesh – Breaking the Routine: Understanding the Interplay of Control Synergies and Reinforcement Learning to Improve Motor Training and Recovery in Neurologic Conditions after stroke 9/17 – 6-21; Postdoctoral employment, Rafael Advanced Defence Systems, Israel
25. Dylan Reinsdorf – Engineering for Arm Use After Stroke: A Precision Rehabilitation Model, Minimalistic Robot Design Pattern, and Proprioception-Targeting Gaming Paradigm
9/19 – 8/22; Postdoctoral employment, research engineer, iRhythm, San Francisco

26. Shusuke Okita – Wearable sensing for neurorehabilitation
9/18 – current

27. Veronica Swanson – Determinants of uptake of robotic rehabilitation technologies
9/20 – current

28. Chris Johnson – Robotic assessment of ankle sensory motor ability
9/20 – current

29. Caitlin Callaghan – Clinical assessment of hand function
9/21 – current

M.S. Advisees:

1. Chris Painter
Date: 6/99 – 7/00
Master's Project: Web-based motion control for physical rehabilitation

2. Clifton Pang
Date: 9/99 – 3/01
Master's Project: Java Therapy, a web-based system for stroke rehabilitation

3. John Wynne
Master's Project: A backdriveable robotic device for manipulating and measuring stepping
Date: 9/00 – 3/02

4. Jeff Nessler
Master's Project: Affordable actuator backdriveability for human robot interaction: the series elastic servomotor
Date: 1/01 – 5/02

5. Shawn McGuan
Master's Thesis: A biomechanical model for studying spinal control of stepping in the rat
Date: 1/99 – 12/02

6. Karen Ngai
Master's Thesis: The Mechanical Design of a Backdriveable Robot for Measuring and Manipulating Pelvic Motion
Date: 9/02 – 12/03 (co-advisor with J. Bobrow)

7. Jason Lin
Master's Thesis: Pelvic Assist Manipulator Version 2.0: Design of Control hardware and Algorithm
Date: 9/02 – 6/04 (co-advisor with J. Bobrow)

8. Gigi Au
Master's Project: TIM, A Three-dimensional Interactive Manipulandum, As an Input Device for Java Therapy
Date: 9/03 – 8/04

9. Wade Ichinose – Pelvic Assist Manipulator Version 3.0: Design of Mechanical Hardware, Safety Features, and a New Leg Robot
Date: 9/02 – 12/04 (co-advisor with J. Bobrow)

10. Megan Thomas – SARA: Stand Assist Rehabilitation Apparatus
Date: 9/02 – 6/05
11. Laura Marchal – A Simulator and Control Algorithm for Teaching Children to Drive a Powered Wheelchair
Date: 7/05 – 4/06
12. Kareem Adnan – Baby wrist simulator
9/05 – 12/07
13. Steve Spencer – Hand movement training device
9/05 – 8/07
14. Cole Young – Master's Thesis Project: Quantifying movement quality in competitive diving
9/2009 – 8/2011
15. Justin Spring – Master's Thesis Project: Robotic perturbations for measuring strategies for control of the pelvis during walking
9/11-9/12
16. Miquel Batalle Lopez – Master's Thesis Project: Stiffness and grip force measurement using an eccentric mass motor: a dynamic model and experimental verification 9/11-8/12
17. Adan Amarallis – Master's Thesis: Comparing Haptic Guidance to Error Amplification in Robot-Assisted Training of a Golf-Putting Task Performed by Initially Skilled Trainees 9/12—12/13
18. Aurelia Darling – Master's Thesis: Feedback Control for a Smart Wheelchair Trainer Based on the Kinect Sensor 1/14 – 9/14
19. Derek Bissell – Master's Thesis: Mechanism for tone-cancellation for the severely impaired wrist after stroke 1/14 – 7/15
20. Hugo Dominguez-Marzo – Master's Project: Tone-cancelling exoskeleton 9/15 – 7/15
21. Wyatt Moscoso – Master's Thesis: Effect of Ball Inflation Pressure and Padded Headgear on Ball-Head Impacts in Water Polo and Soccer 9/15 – 3/13/17
22. Gerard Moreso – MovIt: A powered wheelchair interface for integrated, moderate exercise 9/16 – 12/17
23. Yinchu Dong: Development and evaluation of two control methods for MOVit: An exercise-enabling driving interface for powered wheelchair users 9-17 - 6/18
24. Yasmeen AbuZeid: Arm movement pattern recognition for infants with perinatal brachial plexus injury for contingent reinforcement 9/18 – 6/19
25. Pol Sin Arumi: Data science for regenerative robotic rehabilitation 9/19 – 12/20/21
26. Kyle Seward: A robot for rehabilitation of the mouse forelimb; 9/19 – 6/21
27. Claire Chaisson: Neural correlate of proprioception; 9/20-6/21

28. Caitlin Callaghan: Role of memory in proprioceptive recall; 9/19 – 6/21

Student Awards

Wojciech Timoszyk, Student Paper Award, IEEE EMBS Conference, 2003

Liu, Graduate Student Travel Award based on Best Paper Award, 9th IEEE International Conference on Rehabilitation Robotics, 2005

Aoyagi, Graduate Student Travel Award based on Best Paper Award, 9th IEEE International Conference on Rehabilitation Robotics, 2005

Sanchez, Graduate Student Travel Award based on Best Paper Award, 9th IEEE International Conference on Rehabilitation Robotics, 2005

Nessler, Graduate Student Travel Award based on Best Paper Award, 9th IEEE International Conference on Rehabilitation Robotics, 2005

Laura Marchal best poster, 2006 Maseeh Graduate Student Poster Award, Henry Samueli Engineering Symposium

Eric Wolbrecht, student travel award, 2007 IEEE Conference on Neural Engineering

Laura Marchal, 2009, Dean's Dissertation Fellowship

2013 IEEE International Conference on Rehabilitation Robotics (1st and 3rd prize awarded to Ph.D. students Dan Zondervan, Brendan Smith and Jaime Duarte for work on Resonating Arm Exercise/Propulsion and Real-World Challenge Point in Rehabilitation)

Student M.S. and Ph.D. Committees

2012-2013 Mark Plecnik MAE MS Thesis Committee, Arthur Valadares, Qualifying Exam, Anatomy and Neurobiology Advancement and Dissertation Committee: Virginia Liu 2013

Anatomy and Neurobiology, Advisement Committee, Inez Falcon, Jennifer Wu

Anatomy and Neurobiology Advancement Exam Committee, Calvin Schneider, 2013

2013 Joan Aguilar MAE Ph.D. Qualifying Committee

2013 Inez Falcon, Anatomy and Neurobiology, Advancement Committee

2014 Aggie Szymanska BME Ph.D. Qualifying Committee

2014 Brian Parrish MAE Qualifying and Dissertation Committee

2014 Kaustubh Sonawale, Qualifying Committee

2014 Mark Plecnik, Qualifying Committee

2014 Christine King, BME Qualifying and Dissertation Committee

2014 Jennifer Wu, Anatomy and Neurobiology, Advancement Exam Committee

2014 Katie Jo Turk, Department of Dance MFA Committee

2014 Beatrice Hui, Department of Dance MFA Committee

2014 Brandon Tsuge, MAE, Ph.D. Qualifying Committee

2015 Shramana Ghosh, MAE, Ph.D. Qualifying Committee

2015 Marco Minniti, MAE, Ph.D. Qualifying Committee

2016 Crystal M. Reyna, Dept. of Ecology and Evolutionary Biology, Ph.D. Qualifying Committee

2017 External reviewer of Ph.D. dissertation, Diana Rui, Departamento de Informatica e Ingenieria de Sistemas, Universidad de Zaragoza

2017 External reviewer of Ph.D. dissertation, Federica Aprigliano, Biorobotics Ph.D. Program, Scuola Superiore Sant'Anna

2017 Maria Bauer, MAE, Ph.D. Qualifying Committee

2017 Peter Wong, MAE, Ph.D. Qualifying Committee

2018 Vatche Donikian, MAE, Ph.D. Qualifying Committee

2018 Joseph Bell, MAE, Ph.D. Qualifying Committee

2021 Raffaele Ranzani, ETH Zurich, Ph.D. Thesis Defense Committee

2021 Maria Masquini, Scuola Superiore Sant'Anna, PhD. Thesis External Reviewer

2022 Eshan Shamloo, ChemE, Ph.D. Defense

2022 Jessica Vidmark, BME, Ph.D. Qualifying Committee

2022 Jeanette Plantin, Karolinska Institute, Ph.D. Thesis Opponent

2022 Maral Kasiri, BME, Ph.D. Qualifying Committee
2022 Dina Abulon, MAE, Ph.D. Qualifying Committee

Extramural Funding:

Previous:

G1: Principal Investigator, "Mechanical Imaging of the Hemiplegic Workspace", National Research Service Award, National Institutes of Health, F32HD08067-01, 1/1/95-12/31/96, \$60,000

G2: Principal Investigator, "Mechatronic Rehabilitation for Arm Movement after Stroke", Whitaker Foundation Biomedical Engineering Research Grant, 9/1/98-2/28/01, \$210,000

G3: Principal Investigator, "Development of a Rehabilitator for Arm Therapy after Brain Injury" National Institute on Disability and Rehabilitation Research, H133G80052, 5/1/98 – 4/30/03, \$371,238, 8%

G4: Principal Investigator, "Exploring PC Accessibility: A Dynamic Force Feedback System for Rehabilitation", Microsoft Corporation New Discoveries Grant, 5/01/99 – 4 /30/01, \$50,000

G5: Co-Investigator, "Mechanically Assisted Upper Limb Movement for Assessment and Therapy", National Institutes of Health Small Business Innovation Research Grant (Phase II) to Rehabilitation Technologies Division of Applied Resources Corporation, 8/1/01 – 7/30/03, Total: \$720,000; UCI Subcontract: \$108,589, 8%

G6: Principal Investigator, "Robotic outcome assessment in spinal cord injury and regeneration", Roman Reed Grant Program, \$61,293, 1/1/02 – 12/31/02, 1%

G7: Co-Investigator, "Operating System for Internet Facilitated Stroke Rehabilitation", National Institutes of Health Small Business Innovation Research Grant (Phase I) to Rehabilitation Technologies Division of Applied Resources Corporation, 1/1/02 – 1/1/03, Total: \$100,000; UCI Subcontract: \$30,603, 8%

G8: Co-Investigator, "Use Dependent Plasticity of Spinal Inhibition", National Institutes of Health, R01 NS40917 PI: Allan Tobin, Brain Research Institute, UCLA, 4/01/02 – 3/31/07, Total: \$2,563,743; UCI Subcontract \$78,283, 8%

G9: Principal Investigator, "Development of a Robotic Step Training Device", Robomedica, Inc. Santa Monica, CA, 4/1/02 – 9/30/02, Total: \$30,000, 1%

G10: Co-Investigator, "Robotically Generated Locomotion in Rodents", National Institutes of Health, R01 NS42951, Bioengineering Research Partnership, PI: V. Reggie Edgerton, Brain Research Institute, UCLA, 7/01/02 – 6/31/07, Total: \$1,500,326; UCI Subcontract \$351,518, 16%

G11: Co-Investigator, "Development of a Robotic Step Training Device for Teaching Individuals with Neurologic Impairments to Walk", PI: Kevin Vallence, Robomedica, Inc., NIST Advanced Technology Program, ATP 00-00-4906, 7/1/02 – 10/31/05 Total: \$2,000,000, UCI Subcontract \$521,884, 8%

G12: Principal Investigator, "Gait training robotic assist device", NIDRR Rehabilitation Engineering Research Center on Spinal Cord Injury, H133E020732, Project V, Lead Institution: Rancho Los Amigos Rehabilitation Hospital, 11/1/02 – 10/30/07. Grant Total: \$4,500,000, Project V Total: \$726,123, UCI Subcontract: \$118,942

G13: Principal Investigator: "Home-based, telerehabilitation system for improving functional hand and arm movement recovery", NIDRR Rehabilitation Engineering Research Center on Rehabilitation

Robotics and Telemanipulation, H133E020724, Project V, Lead Institution: Rehabilitation Institute of Chicago, 11/1/02 – 10/30/07. Grant Total: \$4,352,960, Project V Total: \$433,120, UCI Subcontract: \$272,397.

G14: Co-Investigator: “Facilities of research in spinal cord injury: Developing new relevant methods for evaluating recovery from spinal cord dysfunction,” DJR subproject title: “Robotic methods for evaluating recovery from spinal cord injury”, NIH Contract awarded to Reeve-Irvine Center, NO1 NS3235, Principal Investigator: Oswald Steward. DJR’s subproject is one of three subprojects on this contract that will share experimental and staff resources at the Reeve-Irvine Center. Grant total: \$2,640,463, DJR subproject total (approximate): \$871,000, 1/01/03-12/31/08

G15: Principal Investigator, NIH Contract N01-HD-3-3352, “Robotic device for rehabilitation therapy” 10/03 -- 9/06, \$862,000; co-investigators are Prof. James Bobrow (UCI MAE) and Prof. Steve Cramer (UCI Neurology)

G16: Co-Investigator: Using Robotics to Assess the Adaptive Capacity of the Human Lumbosacral Spinal Cord, PI: Susan Harkema, UCLA, Project V of NIH PPG Grant, P01 NS16333-22, PI V. Reggie Edgerton 6/01/03 – 12/30/04, UCI Subcontract: \$32,000

G17: Co-Principal Investigator, Gesture Therapy: Low-Cost Computer Vision for Arm Movement Training at Home after Stroke, Co-Principal Investigator L. Enrique Sucar, UC Mexus/Conacyt CN-15-179, 6/01/05 – 12/31/06, \$25,000, DJR total: \$12,500

G18: Principal Investigator, “Home Based System for Exercise: Smart Sensors and Adaptive Signal Processing”, California-Catalonia Research Grant, 9-1-08 – 8/30/09, \$35,000.

G19: Principal Investigator, NIH Contract Extension for N01-HD-3-3352, “Robotic device for rehabilitation therapy” 10/06 -- 9/09, \$1,362,819; co-investigators are Prof. James Bobrow (UCI MAE) and Prof. Steve Cramer (UCI Neurology)

G20: Principal Investigator, NIH Contract Extension for N01-HD-3-3352, “Robotic device for rehabilitation therapy” 9/09 --3/11, \$275,000, co-investigators are Prof. James Bobrow (UCI MAE) and Prof. Steve Cramer (UCI Neurology)

G21: Principal Investigator: “A robotic powered wheelchair trainer with haptic guidance as needed”, NIDRR, H133G090111, 10/01/09 – 9/30/12, \$200,000

G22: Principal Investigator: “Targeting T-WREX to improve functional outcomes of upper extremity therapy”, NIDRR Rehabilitation Engineering Research Center on Rehabilitation Robotics and Telemanipulation, H133E070013, Lead Institution: Rehabilitation Institute of Chicago, 10/1/07 – 9/30/12. Grant Total: \$4,352,960, Project V Total: \$322,170, UCI Subcontract: \$252,787. The goal is to develop technology for improving functional recovery of arm movement.

G23: Principal Investigator: “Determinants of the effectiveness of robot-assisted hand movement training”, NIH-R01HD062744-01, \$1,471,924, 3/12/10 – 3/28/16. The goal is to study the role of range of motion, effort, previous history of practice, and corticospinal tract integrity of hand motor rehabilitation after stroke.

G24: Principal Investigator: “Enhancing use-dependent hand motor recovery during spinal cord injury regeneration with a grasp training robot and an implanted hand grasp sensor”, Roman Reed Foundation, \$100,000, 1/1/12 – 12/31/12. The goal is to develop devices for improving hand rehabilitation in primate model of spinal cord injury.

G25: Co- Investigator: “A music-based rehabilitation device for training and assessing hand function, \$150,000 (UCI Subcontract: \$48,000) NIH SBIR Grant 10/1/12 – 3/30/13, PI is Nizan Friedman at Flint Rehabilitation Devices. UCI PI is Steve Cramer. The goal of this project is to develop and test a commercial prototype of a sensorized glove for retraining and measuring hand function of chronic stroke patients. The research prototype of the glove was developed at the iMove collaboratory in the Sue and Bill Gross Stem Cell Research Center.

G26: Co-Principal Investigator, “Engineering career development center in movement and rehabilitation sciences”, NIH K12 1K12HD073945-01, lead institution is Northwestern University, \$2,500,000, UCI Subcontract \$69,705 9/1/12 – 5/31/17. The goal of this center is to develop scholars with engineering and other quantitative backgrounds to become successful rehabilitation scientists in basic, translational, and/or clinical research, by providing salary support for the scholars to be trained through a network of mentors provided through Northwestern University, University of California at Irvine, the Rehabilitation Institute of Chicago, University of North Carolina, Case Western Reserve University, Marquette University, Stanford University, and University of Delaware.

G27: Co-Principal Investigator, “Machines Assisting Recovery from Stroke and Spinal Cord Injury for Reintegration into Society (MARS3)”, National Institute of Disability and Rehabilitation Research Rehabilitation Engineering Research Center on Rehabilitation Robotics , H133E120010, other Co-Principal Investigator Jim Patton, University of Illinois at Chicago, Lead Institution: Rehabilitation Institute of Chicago, 10/1/12 – 9/30/17. Grant Total: \$4,748,665, UCI Subcontract \$653,666. The goal of this center is to progress the intelligent use of robotic devices for rehabilitation therapy and assistance for people with a physical impairment after stroke, spinal cord injury, and cerebral palsy. Also PI for the Project D3: “Wheelchair-based, robotic, upper extremity exercise and power-assisted propulsion”, the goal of which is to develop a robotic, power-assist lever drive for a manual wheelchair that people with severe upper extremity impairment can use to both exercise and ambulate.

G28: Co- Investigator: “A music-based rehabilitation device for training and assessing hand function”, \$75,000 (UCI Subcontract: \$25,000) NIDRR SBIR Grant 11/1/12 –43/30/13, PI is Nizan Friedman at Flint Rehabilitation Devices. UCI PI is Steve Cramer. The goal of this project is to develop and test a commercial prototype of a sensorized glove for retraining and measuring hand function of sub-acute stroke patients.

G29: Co- Investigator: “Resonating Arm Exerciser: Affordable Active Assistance for Arm Rehabilitation” \$75,000 (UCI Subcontract: \$25,000) NIDRR SBIR Grant 11/1/12 –43/30/13, PI is Dan Zondervan at Flint Rehabilitation Devices. UCI PI is Steve Cramer. The goal of this project is to develop and test a commercial prototype of a resonant-assistance lever drive wheelchair for arm therapy after stroke.

G30: Co-Investigator: “A music-based rehabilitation device for training and assessing hand function”, \$1,500,000 (UCI Subcontract: \$455,340) 2R44HD074331-02 01/15/14-01/14/16 SBIR Phase 2 PI is Nizan Friedman at Flint Rehabilitation Devices. UCI PI is Steve Cramer. The goal of this project is to further develop and test a commercial prototype of a sensorized glove for retraining and measuring hand function of sub-acute stroke and spinal cord injury patients.

G31: Co-Investigator, “Enabling forelimb function with agonist drug and epidural stimulation in SCI”, UCI Subcontract: \$150,000. 1U01EB015521-01A1 07/01/13 – 06/30/18. UCLA PI is Daniel Lu. The goal of this project is to restore upper extremity function following spinal cord injury.

G32: Co-Investigator, “Lever actuated rehabilitation of the arm using wheelchair propulsion and computer gaming”. UCI Subcontract: Grant Total: \$1,500,000, UCI Subcontract \$129,848 R44HD082882 (SBIR Phase 2). PI is Danny Zondervan at Flint Rehabilitation Devices. UCI Subcontract PI is Steve Cramer. 09/03/15-08/31/17 The major goals of this project are to further develop and test a commercial prototype

of an assistive, lever-drive wheelchair specifically designed to provide arm rehabilitation through repetitive elbow/shoulder flexion/extension exercise.

G33: Co-Investigator, “An interactive, wearable device for measuring and motivating hand use after stroke”, UCI Subcontract: Grant Total: \$1,500,000, UCI Subcontract \$396,354, R44 HD 086953 (SBIR Phase 2) PI is Nizan Friedman at Flint Rehabilitation Devices 05/18/16-04/30/19 The goal of this project is to develop and test a functional prototype of a wearable device designed to track upper extremity movement and to motivate use of the hand and arm following a stroke.

G34: Co-Investigator, VA primate consortium to test novel regenerative therapies after spinal cord injury, 11/1/2014-10/31/2018, UCI IPA is \$160,000.

Current:

G35: Principal Investigator, Determinants of the effectiveness of robot-assisted hand movement training NIH-2R01HD062744-06, \$1,519,857, 08/01/2018 – 05/31/2023, The goal is to study the role of somatosensory input in robot-assisted hand motor rehabilitation after stroke.

G36: Co-Principal Investigator, “Collaborative Machines Enhancing Therapies (COMET)” National Institute of Disability and Rehabilitation Research Rehabilitation Engineering Research Center on Rehabilitation Robotics, 90REGE0005-01, other Co-Principal Investigator Jim Patton, University of Illinois at Chicago, Lead Institution: Shirley Ryan Ability Lab, 9/30/18 – 9/29/23. Grant Total: \$4,624,741 UCI Subcontract \$669,915. Positive outcomes require a long and fragile chain of events – development, testing, validation, clinician uptake, and patient acceptance. This center advances collaborative technologies that focus on outcomes in a real-life rehabilitation setting. Device development and pilot testing will be followed by an observational uptake study at the Shirley Ryan AbilityLab, to identify patient, therapist, and machine variables related to clinical uptake of rehabilitation therapy technologies. This involves partnerships with University of California at Irvine, University of Illinois at Chicago, Northwestern University, University of Alabama at Birmingham, North Carolina State University, Delft University of Technology, Harvard; as well as commercial, clinical, and consumer stakeholders.. Also PI for the Project D4: “Wearable sensing for movement practice”, the goal here is to develop and use a custom wearable sensing platform as a research platform to develop and test a new set of algorithms that provides accurate feedback about hand, gait, arm, and custom limb movement, for both people with stroke and spinal cord injury.

G37: Co-Principal Investigator, “Engineering career development center in movement and rehabilitation sciences”, NIH K12 2K12HD073945-06, lead institution is Northwestern University, \$2,500,000, UCI Subcontract \$49,562 9/1/17 – 8/31/22. The goal of this center is to develop scholars with engineering and other quantitative backgrounds to become successful rehabilitation scientists in basic, translational, and/or clinical research, by providing salary support for the scholars to be trained through a network of mentors provided through Northwestern University, University of California at Irvine, the Shirley Ryan Ability Lab, University of North Carolina, Case Western Reserve University, Marquette University, Stanford University, and University of Delaware.

G38: Co-Investigator, “Enhancing motor retraining using stem cell therapy”, the NIH Alliance for Regenerative Rehabilitation Research and Training, PI is Sunil Gandhi, \$100,000, 7/1/2018-6/30/2020. This pilot project takes a novel, live imaging approach to exploring the role of somatosensory feedback in regenerative rehabilitation after spinal cord injury (SCI). The proposed project includes both the use of human neural stem cells as well as motor retraining in a mouse model system.

G39: Co-Investigator, “FitMi Plus: smart functional modules for practicing activities of daily living after stroke”, NIH 1R44HD097803-01 PI is Daniel Zondervan, \$1,671,785, UCI Subcontract [[\$59,207,]] 03/01/2019 – 08/31/2022. This Fastrack SBIR seeks to develop functional modules for the FitMi home

rehabilitation system. The modules will consist of real-world objects that can be attached to the FitMi Pucks to allow users to practice specific functional tasks while engaging with FitMi's motivating software platform.

G40: Co-Principal-Investigator, "Brain-computer interface-functional electrical stimulation for stroke recovery", NIH 1R01HD095457-01A1. Lead PI is An Do, \$3,860,000, 04/01/2019 – 03/21/24. This project seeks to determine if BCI-FES therapy can provide lasting gains in gait function in chronic stroke patients with foot drop; determine what factors influence BCI-FES therapy; and explicitly elucidate the underlying neural repair mechanisms. DJR project budget: \$231,429

G41: Principal Investigator, "Sensing Hand Recovery", a development project that is part of the Sensor Technologies Applied to Rehabilitation in Stroke Research Rehabilitation Engineering Research Center, National Institute of Independent Living, Disability, and Rehabilitation Research, 90REGE0010, Center Principal Investigator Zev Rymer, Shirley Ryan Ability Lab, 9/30/19 – 9/29/24. UCI Subcontract \$575,000.

G42: Principal Investigator, "Sensor-Enhanced Activity Management (SEAM)", a development project that is part of the ICTS Access for Mobile Rehabilitation (mRehab) Rehabilitation Engineering Research Center, National Institute of Independent Living, Disability, and Rehabilitation Research, 90REGE0011, Center Principal Investigator Mike, Shepherd Center, 9/30/19 – 9/29/24. UCI Subcontract \$925,000.

G43: Principal Investigator, "Robotics Technologies in Rehabilitation: A Translational Incubator", Optional Function part of the UCI Institute for Clinical and Translational Science, Institute PI: Dan Cooper, 4/1/19 – 3/30/25, \$765,561

G44: Co-Investigator, "Boost: A pragmatic inpatient rehabilitation strategy for improving musculoskeletal arm recovery after stroke", 1R44HD106850-01, PI: Daniel Zondervan, Flint Rehabilitation Devices, The goal of this project is to develop a active arm rest for a manual wheelchair that helps implement a pragmatic rehabilitation for enabling individuals with even severe arm impairment to increase UE motor drive early after stroke. 9/21/21 – 8/31/23, \$868,802

Intramural Funding:

IG1: Co-Principal Investigator, "Novel Mechanisms of Motor Control During Growth and Development in Children", CORCLR Multi-Investigator Faculty Research Grant, Co-Principal Investigator: Dan Cooper, M.D., Dept. of Pediatrics, College of Medicine, 7/1/01 – 6/30/02, \$12,500

IG2: Co-Principal Investigator, "Mechanisms of motor rehabilitation using robot-like movement training and brain imaging", CORCLR Multi-Investigator Faculty Research Grant, Co-Principal Investigator: Steve Cramer, M.D., Dept. of Pediatrics, College of Medicine, 7/1/05 – 6/30/06, \$12,500

IG3: Principal Investigator, iMove Center – Innovate, Regenerate, UCI Ignition Grant, Large-Scale Interdisciplinary Research Ignition Initiative, 4/2010 – current, \$40,000. The mission of the iMove Center is to transform human mobility through information technology, robotics, and neuroregenerative therapies, using dance, sport, and computer gaming as the motivating context.

Publications:

U.S. Patents

P1: Reinkensmeyer DJ (1998) "Movement guiding system for quantifying, diagnosing, and treating impaired movement performance", Patent No. 5830160

P2: Reinkensmeyer DJ, Painter CC, Pang CE (2003) "Method and apparatus for mass-delivered movement rehabilitation ", Patent No. 6,613,000 (licensed by Applied Resources Corporation)

P3: Reinkensmeyer DJ, Timoszyk W, London N, de Leon RD, Edgerton VR (2005) "Robotic device for locomotor training," Patent No. 6,880,487 (licensed by Robomedica, Inc., resulting in over \$600K in sales for company)

P4: Reinkensmeyer DJ, Wynne JH (2004) "Mechanism for manipulating and measuring legs during stepping", Patent No. 6,796,926

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C67: Rowe JB, Friedman N, Bachman M, Reinkensmeyer DJ (2013) The Manometer: A non-obtrusive wearable device for monitoring spontaneous use of the wrist and fingers, IEEE International Conference on Rehabilitation Robotics, June:1-6

- C68: Duarte JE, Gebrekristos B, Perez S, Rowe JB, Sharp K, Reinkensmeyer DJ (2013) Effort, performance, and motivation: Insights from robot-assisted training of human golf putting and rat grip strength, IEEE International Conference on Rehabilitation Robotics, June:1-6
- C69: Smith BW, Zondervan D, Lord TJ, Chan V, Reinkensmeyer DJ (2014) Feasibility of a Bimanual, Lever-Driven Wheelchair for People with Severe Arm Impairment after Stroke 36th Annual International IEEE EMBS Conference, 2014:5292-5
- C70: Sans-Muntadas A, Duarte JE, Reinkensmeyer DJ (2014) Robot-Assisted Motor Training: Assistance Decreases Exploration During Reinforcement Learning. 36th Annual International IEEE EMBS Conference, August 26-30.
- C71: Rowe J, Friedman F, Chan V, Cramer S, Bachman M, Reinkensmeyer DJ (2014) The Variable Relationship between Arm and Hand Use: A Rationale for Using Finger Magnetometry to Complement Wrist Accelerometry When Measuring Daily Use of the Upper Extremity, 36th Annual International IEEE EMBS Conference, August 26-30.
- C72: Norman S, Dennison M, Cramer SC, Srinivasan R, Reinkensmeyer DJ (2015) Movement Anticipation and EEG: Implications for BCI-Contingent Robot Therapy, 7th International IEEE EMBS Conference on Neural Engineering
- C73: Wolbrecht E, Morse K, Perry JC, Reinkensmeyer DJ (2016) Design of a Thumb Module for the FINGER Rehabilitation Robot, 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society
- C74: Taheri H, Reinkensmeyer DJ, Wolbrecht E (2016) Model-Based Assistance-As-Needed for Robotic Movement Therapy after Stroke, 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society
- C75: Schwerz de Lucena D, Stoller O, Rowe JB, Chan V, Reinkensmeyer DJ (2017) Wearable sensing for rehabilitation after stroke: Bimanual jerk asymmetry encodes unique information about the variability of upper extremity recovery. IEEE International Conference on Rehabilitation Robotics; 1603-1608
- C76: Norman SL, Lobo-Prat J, Reinkensmeyer DJ (2017) How do strength and coordination recovery interact after stroke? A computational model for informing robotic training. IEEE International Conference on Rehabilitation Robotics
- C77: Sarigul-Klijn Y, Lobo-Prat J, Smith BW, Thayer S, Zondervan D, Chan V, Stoller O, Reinkensmeyer DJ (2017) There is plenty of room for motor learning at the bottom of the Fugl-Meyer: Acquisition of a novel bimanual wheelchair skill after chronic stroke using an unmasking technology. IEEE International Conference on Rehabilitation Robotics, 2017:50-55
- C78: Smith BW, Rowe JB, Reinkensmeyer DJ (2018) Directly Measuring the Rate of Slacking as Stroke Survivors produced Isometric Forces during a Tracking Task, Proc. 40th International Engineering in Medicine and Biology Conference (EMBC)
- C78: Lobo-Prat J, Moreso G, Dong Y, Lew C, Sharifrazi N, Radom-Aizik S, Reinkensmeyer DJ (2018) Design and Preliminary Testing of MOVit: a Novel Exercise-Enabling Control Interface for Powered Wheelchair Users, Proceedings 7th IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)
- C79: Sanders Q, Okita S, Lobo-Prat J, Schwerz de Lucena D, Smith BW, and Reinkensmeyer DJ (2018) Design and Control of a Novel Grip Amplifier to Support Pinch Grip with a Minimal Soft Hand

Exoskeleton, Proceedings 7th IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)

C80: Ailsworth JW, Blaylock JA, Norman SL, Reinkensmeyer DJ, Kamper DG (2020) An Actuated Glove Targeting Brain and Muscle Activation for Hand Rehabilitation Following Stroke, Proceedings 9th IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob)

C81: Reinsdorf DS, Mahan EE, Reinkensmeyer DJ (2021) Proprioceptive Gaming: Making Finger Sensation Training Intense and Engaging with the P-Pong Game and PINKIE Robot, Proc. 43rd International Engineering in Medicine and Biology Conference (EMBC), 11/1-11/5/21 PubMedID: 34892649

C82: Okita S, Schwerz de Lucena D, Chan V, Reinkensmeyer DJ (2021) Measuring Movement Quality of the Stroke-Impaired Upper Extremity with a Wearable Sensor: Toward a Smoothness Metric for Home Rehabilitation Exercise Programs, Proc. 43rd International Engineering in Medicine and Biology Conference (EMBC) PubMed ID: 34892649

Other conference papers:

A1: Atkeson CG, Reinkensmeyer DJ (1988) Using Associative Content-Addressable Memories to Control Movement. Taniguchi Found. 12th Int. Symposium: Neural Programming, Nov 21-24, 203-221

A2: Lum PS, Reinkensmeyer DJ, Lehman SL (1993) Force feedback suffices for one hand in a bimanual transport task. Abstract. Symposium on deafferentation and the role of the sensory afferent in human motor control. May 14-15. University of Laval, Quebec

A3: Reinkensmeyer DJ, Lum PS, Lehman SL (1995) Rehabilitators: Robotic devices and simple machines for physical therapy. *Transactions on Robotics Research*. Society of Manufacturing Engineers, vol. 3

A4: Reinkensmeyer DJ, Rymer WZ (1996) "Mechanical imaging of the hemiplegic workspace" Proceedings of the 1st Trainee Conference, National Center for Medical Rehabilitation Research, NIH, April 19-20, Bethesda, MD.

A5: Reinkensmeyer DJ, Lorber DM, Rymer WZ (1996) A device for quantifying workspace deficits and abnormal synergies after stroke. Ninth International Conference on Biomechanics and Neural Control of Movement, sponsored by the Engineering Foundation, June 1-6, Mt. Sterling, Ohio

A6: Reinkensmeyer DJ, Dewald JPA, Rymer WZ (1996) Workspace deficits and abnormal synergies during guided reaching after stroke, Society for Neuroscience Abstracts

A7: Scheidt RA, Conditt MA, Reinkensmeyer D, Mussa-Ivaldi F (1997) Motor adaptation persists in the absence of kinematic errors, Society for Neuroscience Abstracts

A8: Reinkensmeyer DJ, Schmit BD, Rymer (1998) Contribution of restraint forces to workspace deficits in spastic hemiparesis, Advances in Motor Rehabilitation, Hilton Hotel, Lisle, Illinois June 19

A9: Reinkensmeyer DJ, Schmit BD, Rymer (1998) Arm stiffness at the active workspace boundary in spastic hemiparesis, Society for Neuroscience Abstracts

A10: Yasukawa A, Gaebler-Spira D, Reinkensmeyer DJ, Schmit BD (1999) Mechanical and clinical measures of elbow pronation spasticity to assess the treatment effect of Botulinum A toxin and casting,

Proceedings of the Annual Meeting of the American Academy for Cerebral Palsy and Developmental Medicine, Washington DC, September 15-18

A11: Reinkensmeyer DJ, Painter C, Yang S, Abbey E, Kaino B (2000) An Internet-based, force-feedback rehabilitation system for arm movement after brain injury, Proceedings of CSUN's 15th Annual International Conference: Technology and Persons with Disabilities, March 20-25, Los Angeles, CA, <http://www.csun.edu/cod/conf2000/proceedings/0080Reinkensmeyer.html>

A12: Kahn LE, Averbuch M, W. Z. Rymer, Reinkensmeyer D.J. (2000) Improvements in arm movement in chronic stroke patients after robotic active assist therapy, Proceedings of the World Congress on Medical Physics and Biomedical Engineering

A13: Timoszyk WK, de Leon R.D., London N., Joynes R., Edgerton V.R., Reinkensmeyer D.J. (2000) Robotic system to examine biomechanics of spinal-injured rat stepping, Southern California Conference on Biomechanics, April 7-8, Los Angeles, <http://chp.hsc.usc.edu/mbrl/SCCB/ABSTRACTS.htm>

A14: Takahashi CD, Reinkensmeyer DJ (2000) Noise inhibits motor adaptation to robot-generated force fields during reaching, Southern California Conference on Biomechanics, April 7-8, Los Angeles, <http://chp.hsc.usc.edu/mbrl/SCCB/ABSTRACTS.htm>

A15: Reinkensmeyer DJ, Timoszyk WK, de Leon RD, London N, Joynes R, Roy RR, Edgerton VR (2000) Robotic quantification of stepping by spinally-transected rats: comparison of virtual and physical treadmill approaches, Society for Neuroscience Abstracts, 260.12

A16: de Leon RD, Timoszyk WK, London N, Joynes R, Roy RR, Reinkensmeyer DJ, Edgerton VR (2000) Locomotor adaptations to robot-applied force fields in spinally-transected rats, Society for Neuroscience Abstracts, 260.13

A17: London NJS, de Leon RD, Timoszyk WK, Joynes R, Roy RR, Reinkensmeyer DJ, Edgerton VR (2000) Development of a robotic system for training hindlimb stepping in spinally transected rats, Society for Neuroscience Abstracts, 260.14

A18: Timoszyk WK, de Leon RD, London N, Joynes R, Roy RR, Edgerton VR, Reinkensmeyer DJ (2001) The lumbosacral spinal cord adapts to robotic loading during stance, Society for Neuroscience Abstracts

A19: Takahashi CD, Reinkensmeyer DJ (2001) Impaired motor adaptation and directional weakness during reaching following hemiparetic stroke, Society for Neuroscience Abstracts, 832.14

A20: Kahn LE, Zygmans M, Mah C, Rymer WZ, Reinkensmeyer DJ (2001) Mechanical assistance and repetitive effort as stimuli for movement recovery after stroke, Society for Neuroscience Abstracts

A21: de Leon RD, Timoszyk WK, Zhao L, London NSJ, Roy RR, Edgerton VR, Dobkin BH, Gomez-Pinilla F, Reinkensmeyer DJ (2001), Use of robots to assess the recovery of hindlimb movements and weight bearing during stepping in spinal cord-injured adult rats, Society for Neuroscience Abstracts, 297.20

A22: Reinkensmeyer DJ (2002) Robotic outcome assessment in spinal cord injury and regeneration, Third Annual California Spinal Cord Injury/ Neural Regeneration Consortium Meeting, Reeve-Irvine Research Center 3-21-02

A23: Reinkensmeyer DJ (2001) Java Therapy: A web-based system for mass-delivered movement rehabilitation after stroke", Proceedings of the State of the Science Conference on Telerehabilitation and

Applications of Virtual, M.J. Rosen and D.E. Lauderdale (ed), National Rehabilitation Press, Washington, D.C, October 12-13, 2001,70-73

A24: Milot MH, Marchal-Crespo L, Reinkensmeyer D, Cramer (2011) Brain circuits underlying motor learning with haptic guidance and error amplification, Organization for Human Brain Mapping, Quebec

A25: M. Brown, J. J. Rowe, K. Sharp, D. J. Reinkensmeyer, and N. Friedman (2014) "The Manometer: An Innovative Tool for Hand and Wrist Measurement in Occupational Health," Am. J. Phys. Med. Rehabil., vol. 93, no. 3, 2014 a30

A26: Ingemanson M, Cramer SC, Reinkensmeyer DJ, Rowe JB, Chan V, Wolbrecht E (2015) Brain Activity In Sensorimotor Areas Predicts Treatment Gains From Robotic Finger Rehabilitation (2015) Organization of Human Brain Mapping conference (<http://ohbm.loni.usc.edu/>) in Honolulu, Hawaii from June 14-18, 2015.

A27: Beling J, Zondervan D, Snyder B, Jiggs G, Reinkensmeyer D (2015) Use of a mechanically passive rehabilitation device as a training tool in Vietnam: impact on upper extremity rehabilitation after stroke. Physiotherapy, Volume 101, Supplement 1, pages e138-139. World Confederation for Physical Therapy Congress, Singapore, May 1-4, 2015

A28: Norman S, McFarland D, Sarnacki W, Wolpaw J, Wolbrecht E, Reinkensmeyer D (2016) Sensorimotor Rhythms During Preparation for Robot-Assisted Movement, International BCI Meeting, Asilomar, CA.

A29: Ingemanson M, Rowe J, Chan V, Cramer SC, Reinkensmeyer DJ (2016) Robotic Retraining of Finger Movements after Stroke, International Stroke Conference, Los Angeles, CA, Abstract TP155

A30: J. Russell Huie, Abel Torres-Espin, Carlos Almeida, Diego Schwerz De Lucena, David Reinkensmeyer, John Bixby, Vance Lemmon, David Magnuson, Jessica Nielson, Jan Schwab, Carol Taylor-Burds, Wolfram Tetzlaff, Ephron Rosenzweig, Mark Tuszynski, Karim Fouad, Michael Beattie, Jacqueline C. Bresnahan, Maryann E. Martone, Jeffery S. Grethe, and Adam R. Ferguson (2020) Data Sharing Infrastructures for SCI:ODC-SCI.org and beyond, National Neurotrauma Neurotrauma Society

A31: Reinkensmeyer DJ, Reinsdorf DS, Johnson CA (2021) Training Somatosensation with Proprioceptive Robots and Propriopixels, International Conference on Rehabilitation Robotics, 9/23-9/25/21.

A32: S. Parra, J. Perry, E. Wolbrecht, D. Reinkensmeyer, D. Gupta, Pre-training neural correlates for predicting gains from robot-assisted finger training after stroke, American Society of Neurorehabilitation 2022.

Other publications:

R1: Atkeson CG, Reinkensmeyer DJ (1989) Using Associative Content-Addressable Memories to Control Robots. MIT Artificial Intelligence Memorandum 1124

R2: Abouf E, Atkeson CG, Reinkensmeyer DJ (1987) Task-Level Robot Learning: Ball Throwing. MIT Artificial Intelligence Memorandum 1006

Public Lectures and Presentations:

Prior to 1999, ~ 37 conference presentations.

Presentation, "The Real World of Robots", Beall Center Family Day, March 19, 2005

Keynote Speaker, Robotics track, International Conference on Aging and Disability, February 2006, Tampa Bay
 State of the Science Meeting, NIDRR RERC on Robotics and Telerehabilitation, San Diego, CA, March, 2006
 Balgrist Hospital Seminar, Zurich, Switzerland, March 2006
 Robotics Group Seminar, Ecole Polytechnique Federale de Lausanne, March 2006
 U.C.I. Henry Samueli School of Engineering 5th Annual Research Symposium May, 2006
 11th Annual Congress of the European College of Sport Science, Lausanne, Switzerland 2006
 USC Dept. of Biokinesiology and Physical Therapy, 2007
 Sister Kinney Rehabilitation Institute, Minneapolis, Minnesota, 2007
 Robotics Institute, Carnegie Mellon University, 2007
 ETH Zurich, 2007
 Innovations in Rehabilitation Technology Conference, Hebrew University of Jerusalem 2007
 U. Twente, Netherlands 2008
 Academic Hospital Munich 2008
 Cambridge University 2008
 U. Rene Descartes, Paris 2008
 UCLA Neural Repair Program 2009
 USC Biomedical Engineering Seminar Series 2009
 Keynote Speaker Dynamic Walking Conference, Vancouver 2009
 Rehabilitation Institute of Chicago Seminar 2009
 Invited speaker, IEEE EMBS Conference 2009, 2 sessions
 Invited speaker, NSF/WTEC Final Workshop on European Research and Development in Mobility Technology for People with Disabilities, 11/12/2010
 Invited speaker, University of North Carolina, North Carolina State Biomedical Engineering Lecture Series, 2011
 Keynote Speaker, North American Neurorehabilitation Symposium 2010, Shepherd Rehabilitation Center, Atlanta, GA
 Invited Speaker for 2 talks, American Association of Academic Physiatrists Annual Meeting, Chandler Arizona, 2011
 Invited Speaker, State of the Science meeting for Machines Assisting Recovery in Stroke, Chicago, IL, 2011
 Invited speaker, Wounded Warrior Symposium, U.C. Irvine 2011
 Invited speaker, Calit2 EHealth Symposium, U.C. Irvine 2011
 Plenary speaker, NIH National Institute of Biomedical Imaging and Bioengineering Lecture, 2011 Biomedical Engineering Society Annual Meeting, Hartford, CT
 Invited speaker, 3rd International Symposium on lifechips, February 19, 2012, Calit2, U.C. Irvine
 Invited speaker, Translational Technologies in Rehabilitation, 2/25/2012, Rancho Los Amigos National Rehabilitation Center, Downey, CA
 Invited speaker, 2012 IEEE International Conference on Robotics and Automation, Wearable Robotics Workshop
 Invited speaker, 2012 California Children's Services Annual Therapist Inservice, Irvine Medical Treatment Unit, CA
 Plenary Speaker, 2012 Summer School of Neurorehabilitation, Emerging Therapies, Zaragoza, Spain, Sept 16-21
 UCI Department of Rehabilitation In-service, June, 2012
 UCI Computer Gaming and Virtual Worlds Seminar, October, 2012
 UCI Sue and Bill Gross Stem Cell Research Seminar, November, 2012
 Surf-IT 8-20-2012
 Applications of New Technologies in Rehabilitation, RIC CE course, 10-5-2012
 UCI Seminar in Computer Gaming and Virtual Worlds, 10-17-2012
 Dept Anatomy and Neurobiology PIN 11-16-2012
 UCI Stem Cell Center 11-29-2012

Wadsworth Center, Division of Translational Medicine, 2-9-2013
 Deans Quarterly Lecture, 5-21-2013
 Invited Speaker, July 2013 RESNA
 Keynote Speaker, July 2013 IEEE Conference on Rehabilitation Robotics
 Borchard Colloquium on Computational Neurorehabilitation, July 2013
 MARS Advisory Board Meeting, July 2013
 TLC Conference, Calit2, 7-29-2013
 NIDRR RERC Director's Meeting, August 2013
 Keynote Speaker, August 2013 Movement and Rehabilitation Science Day, Northwestern University Medical School
 UCI Dept of Physical Medicine and Rehabilitation Residency Training Program, September 2013
 UCLA Dept of Physiological Sciences, October 2013
 University of Texas Department of Mechanical Engineering Chevron Centennial Distinguished Lecture, October 25, 2013.
 University of Illinois, Department of Mechanical Science and Engineering Bio-Interest Group Seminar Series, February, 2014
 21st Joint Symposium on Neural Computation, U.C. Irvine, May, 2014
 Osher Lifelong Learning Institute, U.C. Irvine, May, 2014
 MARS Advisory Board Meeting July 2013, Northwestern University
 UCI COSMOS Distinguished Lecture, July, 2014
 Inside UCI Lecture, September 2014
 UCI Department of Physical Medicine and Rehabilitation Guest Lecture, September 2014
 Summer School of Neurorehabilitation, Baiona, Spain, Plenary Speaker, September 2014
 Wearable Robotics Conference, Baiona, Spain, Invited Lecture, September 2014
 Neurorestorative Care, Scripps Hospital, Invited Lecture, November 2014
 UCI Center for Digital Transformation, Keynote Lecture, November 2014
 University of Michigan, Rehabilitation Robotics Center, Invited Lecture, November 2014
 St. Jude Rehabilitation Center, Invited Lecture, January 29, 2015
 UCI Department of Evolutionary Biology and Ecology, February 5, 2015
 Arizona State University Piper Robotic Rehabilitation Conference, Plenary Speaker, February 14, 2015
 Invited speaker, Bioinspired Robotics: Softer, Smarter, Safer Symposium, Wyss Institute, Harvard University, June 6, 2015
 UCI Cosmos, Distinguished All-Cosmos Lecture, July 8, 2015
 Inside UCI Lecture, July 20, 2015
 UCI Department of Physical Medicine and Rehabilitation Guest Lecture, July 21, 2015
 UCI Neurotrauma Symposium, August 12, 2015
 Presentation to Skuba University visiting faculty and students, August 31, 2015
 Healthsouth Hospital Inservice, September 4, 2015
 University of Toronto, Institute of Biomaterials and Biomedical Engineering Distinguished Seminar, September 14, 2015
 Neural Prosthesis Seminar Series at Case Western Reserve University, September 17, 2015
 ETH Zurich Distinguished Lecture in Robotics, September 22, 2015
 Chapman/UCI Stroke Symposium, November 20, 2015
 PH194 Lecture on Entrepreneurship, November 11, 2015
 Concordia University Irvine, Department of Biology Seminar, March 3, 2016
 Brenes Keynote Lecturer, University of Pittsburgh Rehabilitation Research Day, May 18, 2016
 USC Department of Biokinesiology Seminar Speaker, May 20, 2016
 Webster Elementary, 90 3rd graders, field trip for robotics at UCI, May 25, 2016
 Biomechanics and Neural Control of Movement Conference, June 15, 2016, invited speaker
 UCI Department of Physical Medicine and Rehabilitation Guest Lecture, August 8, 2016
 Invited Speaker, Inside UCI, August 15, 2016
 Invited Speaker, Seminar Series of the Department of Biomechanics and the Center for Research in Human Movement Variability of the University of Nebraska Omaha, September 9, 2016

Invited Speaker, Interacting with Robots through Touch Workshop, UC Irvine, September 13, 2016
 Davis Magnet School, 6th grade classes presentation on robotics, 12/14/2016
 Invited Speaker, Southern California Robotics Symposium, USC, 4/13/2017
 Invited Speaker, Wearacon, Phoenix, AZ, 4/21/2017
 Invited Speaker, ICORR workshop, Human-robot synchronization for assistive technologies, London, England, 7/17/2017
 Invited Speaker, International Neurorehabilitation Symposium, London, England, 7/20/2017
 University of Tskuba Student Welcome Lecture, 8/15/2017
 UCI PM&R Resident Research Training, 8/31/2017
 Invited Speaker, Inside UCI, 8/23/2017
 Invited Speaker, Barrow Neurological Institute, 2017 Stroke Rehab Symposium, Current Trends in Stroke Rehabilitation: A Lecture and Lab Based Learning Experience, 10/7/2017
 Invited Speaker, UCI Center for the Neurobiology of Learning and Memory, 10/17/2017
 Keynote Speaker, Annual Meeting of the American Society of Neurorehabilitation, Baltimore, MD 11/11/2017
 Invited Speaker, Department of Health and Exercise Science, Colorado State University, 3/25/2017
 Keynote Speaker, Neural Computation and Engineering Connection Meeting, University of Washington 1/18/2018
 Invited Speaker, UCI/Univ Twente Arm Support Workshop 1/22/2018
 Invited Speaker, UCLA Spinal Cord Injury Course, 2/22/18
 Invited Speaker, NSF Mind-Motor-Machine Nexus Meeting, Marconi Conference Center, CA 7/19/2018
 Invited Speaker, Progress in Clinical Motor Control, Penn State University, 7/27/2018
 UCI Department of Physical Medicine and Rehabilitation Guest Lecture, 8/30/2018
 Invited Speaker, Dept of Mechanical Engineering, Rice University, 9/17/2018
 South Middle School, 8th grade classes presentations on robotics, 9/25/2018
 Invited Speaker and "Power Presenter", American College of Rehabilitation Medicine, 9/30/2018
 Invited Speaker, Depts of Biomedical Engineering and Brain and Behavioral Sciences, UT Dallas, 10/1/2018
 Invited Speaker, Department of Mechanical Engineering, UCSB, 11/8/2018
 Keynote Speaker, 7th Annual International Symposium on Regenerative Rehabilitation Seattle, WA | 11/11/2018
 Invited Speaker, American Society for Neurorehabilitation, 11/20/2018
 Invited Speaker, Institute for Robotics and Intelligent Machines, Georgia Tech, 11/28/2018
 Invited Speaker, Shepherd Center, Atlanta, Georgia 11/29/2018
 Invited Speaker, Pacifica Christian High School, 11/26/2018
 Invited Speaker, Sue and Bill Gross Public Stem Cell Talk Series, 1/28/2019
 Invited Speaker, St. Joseph Hospital Occupational Therapist Inservice, 2/4/2019
 Invited Speaker, UC Davis, Neuroengineering Seminar Series, 2/11/2019
 Keynote Speaker UC Irvine Brain Bee, 2/15/2019
 Invited Speaker, National Advisory Board for Medical Rehabilitation Research, at NIH, 5/7/2019
 Keynote Speaker, University of North Carolina/NC State Biomedical Engineering Department Retreat, 9/28/2019
 Invited Speaker, Biola University Science Honors Program, 11/17/2019
 Invited Speaker, National Rehabilitation Hospital, 12/3/2019
 Invited Speaker, World Congress on Neurorehabilitation, 10/7/2020
 Invited Speaker, Universitat Politècnica de Catalunya, Master's Degree in Neuroengineering and Rehabilitation Program, 10/9/20
 Invited Speaker, North Carolina State Biomedical Engineering Seminar, 11/12/2020
 Invited Speaker, Burke Neurological Institute | Weill Cornell Medicine, 1/26/2021
 Invited Speaker, Frontiers of Regenerative Rehabilitation, AR3T Center, University of Pittsburgh, Stanford, University of Texas, Mayo Clinic, 2/25/2021
 Invited Speaker, University of Pennsylvania, Adaptive Devices and Prosthetic Technologies Club, 4/22/2021

Invited Speaker, Department of Biomedical Engineering, University of Delaware, 4/22/2021

Invited Speaker, National Center for Adaptive Neurotechnologies, 4/26/21

Invited Speaker, Notre Dame High School Robotics Club, San Jose, CA 5/5/2021

Invited Speaker, NSF Liberate Workshop, 5/6/2021

Invited Speaker, STEM High School, Highlands Ranch, CO, 5/18/2021

Invited Speaker, NeuroReHack, International Summer/Winter School and Hackathon on Neurorehabilitation Engineering, EdX, 7/10/2021

Invited Speaker, UC-HBCU Stem Program, Irvine, 7/16/2021

Invited Speaker, 2021 IEEE-EMBS International Conference on Biomedical and Health Informatics Jointly organized with the 17th IEEE-EMBS International Conference on Wearable and Implantable Body Sensor Networks 7/28/2021

Invited Speaker, 2021 American Society of Biomechanics Meeting 8/12/21, Symposium on Personalized Neurorehab: How Patient-specific Motor Learning Can Inform Treatment

Invited Speaker, Rehabilitation Technology Commercialization, Rehabilitation Engineering Bootcamp, Northwestern University, 8/23/2021

Plenary Speaker, Summer School: Towards a Continuum of Robot-assisted Therapy, Organized by EPFL, ETHZ, Clinica Hildebrand, Centro di Riabilitazione in Brissago, Ticino, Switzerland, 9/9/21

Speaker, Session on Computational Neurorehabilitation, International Conference on Rehabilitation Robotics, 9/24/2021

Invited Speaker, Universitat Politècnica de Catalunya, Master's Degree in Neuroengineering and Rehabilitation Program, 9/28/2021

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Invited Speaker, Wearable Sensors in Rehabilitation: Tracking for the Future, sponsored by Northwestern University and Shirley Ryan Ability Lab, 10/20/2021

Invited Speaker, University of Minnesota Neurorobotics Consortium Seminar, 12/9/2021

Plenary Speaker, 16th Annual Conference of Korean Society for NeuroRehabilitation, 3/25/2022

Invited Speaker, Robotics and Technology in Rehabilitation Symposium, MossRehab/Einstein Healthcare Network, 4/30/2022

Invited Speaker, GATI-BEAM Program, UC Irvine, 7/15/2022

Invited Speaker, Rehabweek Workshop on Digital Biomarkers and Prediction Models, 7/25/2022

Keynote Speaker, Rehabweek, Rotterdam, Netherlands, 7/27/2022. This is a meeting that combines meetings for 8 societies: International Consortium on Rehabilitation Robotics (ICORR), International Functional Electrical Stimulation Society (IFESS), International Industry Society in Advanced Rehabilitation Technology (IISART), International Society for Virtual Rehabilitation (ISVR), Netherlands Society of Rehabilitation Medicine (NSRM), Dutch Chapter of the International Society for Prosthetics and Orthotics (ISPO-NL), Masterclass in Neurotechnology (MiNT), American Society of Rehabilitation Medicine (ACRM). I spoke at a plenary session attended by all societies.

Invited Speaker, A Robotarium for Latin America, Tec de Monterrey, 9/1/2022

Invited Speaker, Utilizing Technology to Improve Outcomes in Rehabilitation, Cedars-Sinai Medical Center, 9/20/2022

Plenary Speaker for the Societe Francaise de Medicine Physique et de Readaptation, 12/1/2022, Rennes, France. This is the National Meeting of the French Society for Physical Medicine and Rehabilitation attended by about 1500 people.

Courses Taught:

HB110 Biological Motor Control, University of California, Berkeley

MAE106 Mechanical Systems Laboratory

MAE250 Biorobotics

BME120/220 Quantitative Physiology: Sensory Motor Systems

Anatomy 503A Histology

Freshman Seminar: Technology, Children, and Poverty

University Service:

MAE Academic Planning Committee, 10/98 – 6/99
MAE Undergraduate Design Committee, 4/99 – 6/01
MAE High Tech Program Committee, 8/00 – 6/01
MAE Physical Infrastructure Committee, 7/02
Biomedical Engineering Advisory Committee, 10/99 – 1/01
Biomedical Engineering Corporate Internship Committee, 8/99 – 1/01
Biomedical Engineering Undergraduate Committee, 5/99 – 7/01
Biomedical Engineering Graduate Committee, 7/00 – 6/02
Biomedical Engineering Neuroengineering Proposal Committee, 12/02 – 6/03
Biomedical Engineering Seed Grant Review Committee, 2003
Henry Samueli School of Engineering Research and Travel Committee, 2003-2006
Henry Samueli School of Engineering Representative, Divisional Senate Assembly, 2003-2004
Biomedical Engineering Faculty Search Committee, 2004
Biomedical Engineering Preliminary Exam Committee, 2003-2007, 2009
MAE Graduate Studies Committee, 2005-2008
Council on Educational Policy 2009 - 2010
2010, 2011, 2012, 2014, 2015, 2018, 2019 ICTS Cosmos Laboratory – Robotic Rehabilitation
2010 UCI Med School High-School Outreach Program – Robotic Rehabilitation Demos
MAE Undergraduate Studies Committee, 2008-2014
ME ABET Coordinator, 2008-2013
Department of Anatomy and Neurobiology, Faculty Representative, SoM fundraising seminars, 2013
Department of Anatomy and Neurobiology, SoM representative 2012-2013
MAE Undergraduate Advisor 2009 – 2013
Interdepartmental Neuroscience Program – Executive/admissions committee 2014 – 2017
Associate Chair, Department of Mechanical and Aerospace Engineering, 2016 – 2017
HSSOE Strategic Planning Committee 2016 – 2017
DOE/NSF Title IX Compliance Review Interviewee – 5-2017
MAE SED Section Preliminary Exam Coordinator – 2014-2017
Balsells Recognition Luncheon Speaker, 11-30-2017
UCI's Engineering Student Council Shadow Day Lab Tour 2-15-2018
Campus-wide committee on Ph.D. in Neuroscience 2018-2020
Committee on UCI Dual BS/MD degree 2019-2020
Host and provide daily laboratory/research experience for 8-12 U. Tskuba Aerospace Students, 2015-2019 (summer and winter visit 2018)
MAE Undergraduate Studies Committee, 2018-current
Calit2 Division Council 2012 – current
Mentor for Newport Harbor High School Mentoring Program 2014-current
Mentor for HSSOE St. Margaret's Episcopal High School Summer Internship Program 2012-current
HSSOE Strategic Planning Committee 2022

APPENDIX 2: MATERIALS CONSIDERED IN THE PREPARATION OF THIS DECLARATION

Exhibit No.	Description
1001	U.S. Patent No. 9,682,000 to Behnke et al. (“the ’000 Patent”)
1002	Prosecution File History for the ’000 Patent (“File History”)
1004	U.S. Pat. No. 7,883,450 (“Hidler”)
1005	DE3300202 (A1) (“Knevels”)
1006	U.S. Pat. No. 4,781,665 (“Walker”)
1007	U.S. Pat. No. 8,701,226 (“Faucher”)
1008	U.S. Pat. No. 2,991,336 (“Shaw”)
1009	JPS57126732A (“Sugiyama”)
1010	U.S. Pat. No. 6,345,103 (“Braunagel”)
1011	U.S. Pat. Pub. 2012/0000876 (“Bergenstrale”)
1012	Artemiadis, Panagiotis, On the Potential Field-based Control of the MIT-Skywalker, IEEE (June 2011) (“Artemiadis”)
1013	Qi Lu, et. al., A New Active BWS System Capable of Virtually Offloading Partial Body Mass (February 2013) (“Lu”)

APPENDIX 3: CHALLENGED CLAIMS

1. An apparatus, comprising:

a trolley having a drive assembly configured to movably suspend the trolley from a track;

a powered conductor operatively coupled to the track, the powered conductor being substantially parallel to the track, the powered conductor including at least one conductive inner surface, a portion of the trolley being disposed within the powered conductor and in contact with the at least one conductive inner surface to electrically couple the trolley to the powered conductor, the portion of the trolley configured to move within the powered conductor and along the at least one conductive surface when the trolley is moved along the track, the track and the drive assembly each disposed outside of the powered conductor;

at least one patient attachment coupled to the trolley, the at least one patient attachment configured to support a single patient; and

a control system coupled to the trolley and at least operably coupled to the powered conductor.

2. The apparatus of claim 1, wherein the patient attachment includes one of a passive coupling and an active coupling, the passive coupling configured to be coupled to a tether to couple the patient attachment to the trolley, the active coupling configured to be coupled to a patient harness.

3. The apparatus of claim 1, wherein the trolley includes a patient support system, the patient support system configured to actively support a patient.

4. The apparatus of claim 1, wherein the trolley includes the drive assembly and a torque transfer assembly, the drive assembly and the torque transfer assembly being driven simultaneously.

5. The apparatus of claim 1, wherein the drive assembly includes a plurality of wheels, at least a portion of the plurality of wheels disposed above at least a portion of the track.

6. The apparatus of claim 1, wherein the trolley is configured to be powered only from the powered conductor.

7. The apparatus of claim 1, wherein the trolley is configured to be moved from a first position at an end of the track to a second position spaced apart from the end of the track.

8. An apparatus, comprising:

a housing;

a drive element disposed at least partially within the housing;

a wheel assembly coupled to the drive element and disposed at least partially within the housing; and

a patient support assembly coupled to the housing, the patient support assembly including a pulley movably coupled to a portion of the housing and a cam operably coupled to the pulley, the patient support assembly including a tether engaged

with the pulley and configured to dynamically support a body weight of a patient, the pulley configured to pivot relative to the housing and about a vertical axis in response to a force associated with the body weight of the patient exerted on the tether, the cam configured to pivot relative to the housing about the vertical axis in response to the pivoting of the pulley, the cam exerting a reaction force when the cam pivots relative to the housing, the cam operably coupled to a sensor configured to detect pivoting of the cam.

* * *

12. The apparatus of claim 8, further comprising a second drive element coupled to the patient support assembly, the second drive element configured to dynamically support the patient.

13. An apparatus, comprising:

a trolley having a drive assembly, the drive assembly including a plurality of wheels configured to move along at least one surface of a track to move the trolley relative to the track;

a powered conductor operatively coupled and substantially parallel to the track, the powered conductor including at least one conductive surface in contact with a portion of the trolley to electrically couple the trolley to the powered conductor, the portion of the trolley configured to move along the at least one conductive surface when the trolley is moved along the track, a portion of the track disposed between at least one

wheel from the plurality of wheels and the powered conductor to isolate the at least one wheel from the powered conductor;

at least one patient attachment coupled to the trolley, the at least one patient attachment configured to support a single patient; and

a control system coupled to the trolley and at least operably coupled to the powered conductor.

14. The apparatus of claim 13, wherein the trolley is configured to be powered only from the powered conductor.

15. The apparatus of claim 13, wherein the trolley includes a patient support system, the patient support system configured to actively support a patient.

16. The apparatus of claim 13, wherein the drive assembly includes a first wheel from the plurality of wheels and a second wheel from the plurality of wheels, the first wheel from the plurality of wheels being in contact with a first surface of the track and the second wheel from the plurality of wheels being in contact with a second surface of the track such that the portion of the track is disposed between the first wheel from the plurality of wheels and the second wheel from the plurality of wheels.

17. The apparatus of claim 16, wherein the portion of the track is disposed between the first wheel from the plurality of wheels and the powered conductor.

18. The apparatus of claim 17, wherein the second wheel from the plurality of wheels is disposed between the portion of the track and the powered conductor.

19. The apparatus of claim 13, wherein the conductive surface of the powered conductor defines a first plane, and

the drive assembly includes a first wheel from the plurality of wheels and a second wheel from the plurality of wheels, the first wheel from the plurality of wheels and the second wheel from the plurality of wheels being configured to move along at least one surface of the track to movably suspend the trolley from the track, the at least one surface of the track defining a second plane nonparallel to the first plane.

20. The apparatus of claim 19, wherein the drive assembly includes a third wheel from the plurality of wheels, the third wheel from the plurality of wheels being configured to move along a surface of the portion of the track, the surface of the portion of the track defines a third plane parallel to the first plane.

APPENDIX 4: UNDERSTANDING OF THE LAW

I have applied the following legal principles provided to me by counsel in arriving at the opinions set forth in this declaration.

Legal Standard for Prior Art

I am not an attorney. I have been informed by attorneys of the relevant legal principles and have applied them to arrive at the opinions set forth in this declaration.

I understand that the petitioner for *inter partes* review may request the cancelation of one or more claims of a patent based on grounds available under 35 U.S.C. § 102 and 35 U.S.C. § 103 using prior art that consists of patents and printed publications.

Anticipation and Prior Art

I understand that § 102 specifies when a challenged claim is invalid for lacking novelty over the prior art, and that this concept is also known as “anticipation.” I understand that a prior art reference anticipates a challenged claim, and thus renders it invalid by anticipation, if all elements of the challenged claim are disclosed in the prior art reference. I understand the disclosure in the prior art reference can be either explicit or inherent, meaning it is necessarily present or implied. I understand that the prior art reference does not have to use the same words as the challenged claim, but all of the requirements of the claim must be disclosed so that a person of ordinary skill in the art could make and use the claimed subject-matter.

In addition, I understand that § 102 also defines what is available for use as a prior art reference to a challenged claim.

Under § 102(a)(1), a challenged claim is anticipated if it was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the challenged claim(s).

Under § 102(a)(2), a challenged claim is anticipated if it was described in a patent or published application for patent naming another inventor and effectively filed before the effective filing date of the challenged claim(s).

I understand that the effective filing date of a patent or prior art reference is generally the filing date of that application. However, I understand that a patent or prior art reference may be granted an earlier effective filing date if it properly claims priority to an earlier patent application.

I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

I understand that when a challenged claim requires selection of an element from a list of alternatives, the prior art teaches the element if one of the alternatives is taught by the prior art.

Legal Standard for Obviousness

I understand that even if a challenged claim is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the claimed subject matter would have been obvious to a person of ordinary skill in the pertinent art at the time the alleged invention.

I understand that obviousness must be determined with respect to the challenged claim as a whole.

I understand that one cannot rely on hindsight in deciding whether a claim is obvious.

I also understand that an obviousness analysis includes the consideration of factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claim, (3) the level of ordinary skill in the pertinent art, and (4) “secondary” or “objective” evidence of non-obviousness.

Secondary or objective evidence of non-obviousness includes evidence of: (1) a long felt but unmet need in the prior art that was satisfied by the claimed invention; (2) commercial success or the lack of commercial success of the claimed invention; (3) unexpected results achieved by the claimed invention; (4) praise of the claimed invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the claimed invention; and (7) contemporaneous and independent invention by others. However, I understand that there must be a relationship between any secondary evidence of non-obviousness and the claimed invention.

I understand that a challenged claim can be invalid for obviousness over a combination of prior art references if a reason existed (at the time of the alleged invention) that would have prompted a person of ordinary skill in the art to combine elements of the prior art in the manner required by the challenged claim. I understand that this

requirement is also referred to as a “motivation to combine,” “suggestion to combine,” or “reason to combine,” and that there are several rationales that meet this requirement.

I understand that the prior art references themselves may provide a motivation to combine, but other times simple common sense can link two or more prior art references. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may come from market forces.

I understand obviousness to include, for instance, scenarios where known techniques are simply applied to other devices, systems, or processes to improve them in an expected or known way. I also understand that practical and common-sense considerations should be applied in a proper obviousness analysis. For instance, familiar items may have obvious uses beyond their primary purposes.

I understand that the combination of familiar elements according to known methods is obvious when it yields predictable results. For instance, obviousness bars patentability of a predictable variation of a technique even if the technique originated in another field of endeavor. This is because design incentives and other market forces can prompt variations of it, and predictable variations are not the product of innovation, but rather ordinary skill and common sense.

I understand that a particular combination may be obvious if it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of

ordinary skill has good reason to pursue the known options within his or her technical grasp. This would result in something obvious because the result is the product not of innovation but of ordinary skill and common sense. However, I understand that it may not be obvious to try a combination when it involves unpredictable technologies.

It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

It is my understanding that the Manual of Patent Examining Procedure §2143 sets forth the following as exemplary rationales that support a conclusion of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

A person of ordinary skill in the art looking to overcome a problem will often use the teachings of multiple publications together like pieces of a puzzle, even though the prior art does not necessarily fit perfectly together. Therefore, I understand that references for obviousness need not fit perfectly together like puzzle pieces. Instead, I understand that obviousness analysis takes into account inferences, creative steps, common sense, and practical logic and applications that a person of ordinary skill in the art would employ under the circumstances.

I understand that a claim can be obvious in light of a single reference, if the elements of the challenged claim that are not explicitly or inherently disclosed in the reference can be supplied by the common sense of one of skill in the art.

I understand that obviousness also bars the patentability of applying known or obvious design choices to the prior art. One cannot patent merely substituting one prior art element for another if the substitution can be made with predictable results. Likewise, combining prior art techniques that are interoperable with respect to one another is generally obvious and not patentable.

In order for a claim to be found invalid based upon a modification or combination of the prior art, there must be reasonable expectation that a person of ordinary skill would have successfully modified or combined the prior art to arrive at the claimed arrangement. This does not mean that it must be certain that a person of ordinary skill would have been successful – the law only requires that the person of ordinary skill in the art would have

perceived a reasonable expectation of success in modifying or combining the prior art to arrive at the claimed invention.

In sum, my understanding is that obviousness invalidates claims that merely recite combinations of, or obvious variations of, prior art teachings using understanding and knowledge of one of ordinary skill in the art at the time and motivated by the general problem facing the inventor at the time. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of or attempting obvious variations on prior art references in the claimed manner.

Legal Standard for Claim Construction

I understand that before any invalidity analysis can be properly performed, the scope and meaning of the challenged claims must be determined by claim construction.

I understand that a patent may include two types of claims, independent claims and dependent claims. I understand that an independent claim stands alone and includes only the limitations it recites. I understand that a dependent claim depends from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to the limitations recited in the claim (or claims) from which it depends.

In comparing the challenged claims to the prior art, I have carefully considered the patent and its file history in light of the understanding of a person of ordinary skill at the time of the alleged invention.

I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to sources available at the time of the alleged invention that show what a person of ordinary skill in the art would have understood the disputed claim language to mean. It is my understanding that this may include what is called “intrinsic” evidence as well as “extrinsic” evidence.

I understand that, in construing a claim term, one should primarily rely on intrinsic patent evidence, which includes the words of the claims themselves, the remainder of the patent specification, and the prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. I understand that extrinsic evidence may include principles, concepts, terms, and other resources available to those of ordinary skill in the art at the time of the invention.

I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else or something more specific. I understand that to determine whether a term has special meaning, the claims, the patent specification, and the prosecution history are particularly important, and may show that the inventor gave a term a particular definition or intentionally disclaimed, disavowed, or surrendered claim scope.

I understand that the claims of a patent define the scope of the rights conferred by the patent. I understand that because the claims point out and distinctly claim the subject matter which the inventors regard as their invention, claim construction analysis must

begin with and is focused on the claim language itself. I understand that the context of the term within the claim as well as other claims of the patent can inform the meaning of a claim term. For example, because claim terms are normally used consistently throughout the patent, how a term is used in one claim can often inform the meaning of the same term in other claims. Differences among claims or claim terms can also be a useful guide in understanding the meaning of particular claim terms.

I understand that a claim term should be construed not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the entire specification. I understand that because the specification is a primary basis for construing the claims, a correct construction must align with the specification.

I understand that the prosecution history of the patent as well as art incorporated by reference or otherwise cited during the prosecution history are also highly relevant in construing claim terms. For instance, art cited by or incorporated by reference may indicate how the inventor and others of skill in the art at the time of the invention understood certain terms and concepts. Additionally, the prosecution history may show that the inventors disclaimed or disavowed claim scope, or further explained the meaning of a claim term.

With regard to extrinsic evidence, I understand that all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may indicate how one of skill in the art used or understood the claim terms. However, I understand that

extrinsic evidence is considered to be less reliable than intrinsic evidence, and for that reason is generally given less weight than intrinsic evidence.

I understand that in general, a term or phrase found in the introductory words or preamble of the claim, should be construed as a limitation if it recites essential structure or steps, or is necessary to give meaning to the claim. For instance, I understand preamble language may limit claim scope: (i) if dependence on a preamble phrase for antecedent basis indicates a reliance on both the preamble and claim body to define the claimed invention; (ii) if reference to the preamble is necessary to understand limitations or terms in the claim body; or (iii) if the preamble recites additional structure or steps that the specification identifies as important.

On the other hand, I understand that a preamble term or phrase is not limiting where a challenged claim defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I understand that to make this determination, one should review the entire patent to gain an understanding of what the inventors claim they invented and intended to encompass in the claims.

I understand that 35 U.S.C. § 112 ¶ 6 created an exception to the general rule of claim construction called a “means plus function” limitation. These types of terms and limitations should be interpreted to cover only the corresponding structure described in the specification, and equivalents thereof. I also understand that a limitation is presumed to be a means plus function limitation if (a) the claim limitation uses the phrase “means for”; (b)

the “means for” is modified by functional language; and (c) the phrase “means for” is not modified by sufficient structure for achieving the specified function.

I understand that a structure is considered structurally equivalent to the corresponding structure identified in the specification only if the differences between them are insubstantial. For instance, if the structure performs the same function in substantially the same way to achieve substantially the same result. I further understand that a structural equivalent must have been available at the time of the issuance of the claim.