UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Exotec Product France SAS,
Exotec North America Inc., and
Exotec Product USA Inc.,
Petitioners

v.

Opex Corporation,
Patent Owner

Case No. IPR2024-00850
U.S. Patent No. 11,472,632 B2

DECLARATION OF DR. STEPHEN DERBY, IN SUPPORT OF PETITION FOR INTER PARTES REVIEW OF UNITED STATES PATENT NO. 11,472,632 B2

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Claim 1, Element [1.pre]: A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of: 52

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Claim 11, Element [11.c4]: a vertical drive operable to drive the vehicle vertically; 139

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Claim 23, Element [23.a2]: wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;.....184

Claim 23, Element [23.b1]: providing a plurality of delivery vehicles 185

Claim 23, Element [23.b2]: wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,.....185

Claim 23, Element [23.b3]: a vertical drive operable to drive the vehicle vertically and 188

Claim 23, Element [23.b4]: a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;.....195

Claim 23, Element [23.c1]: driving a first of the vehicle under one or more of the storage racks along a path that crosses one or more aisle,.....197

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CLAIM LISTING

Claim	Recitation
1.pre	A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of:
1.a1	providing a plurality of storage racks spaced apart from one another forming a plurality of aisles,
1.a2	wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;
1.b1	providing a plurality of delivery vehicles
1.b2	wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,
1.b3	a vertical drive operable to drive the vehicle vertically and
1.b4	a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;
1.c	driving a first one of the vehicles to drive the first vehicle to the storage racks;
1.d1	driving the first vehicle along a first path under a first one of the racks
1.d2	wherein the first rack is adjacent a first one of the aisles and
1.d3	wherein the first path extends in a direction parallel to the first aisle and spaced apart from the first aisle;
1.e	turning the first vehicle while the first vehicle is under the first rack;
1.f	driving the vehicle into the first aisle;
1.g	driving the first vehicle upwardly in the aisle to a first of the storage locations;

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Claim	**Recitation**
1.h	transferring an item between the first vehicle and the first storage location;
1.i	driving the first vehicle downwardly in the aisle until the vehicle is on a horizontal surface;
1.j	driving the first vehicle across the first aisle after the step of driving the first vehicle downwardly; and
1.k	driving the vehicle out from under the storage racks after the step of driving the first vehicle across the first aisle.
3.pre	The method of claim 1,
3.a	wherein a plurality of vertical tracks segments are attached to vertical posts of the first column and
3.b	wherein the step of driving the first vehicle into the first aisle comprises aligning the vertical drive of the first vehicle with the vertical track segments.
4.pre	The method of claim 3,
4.a	wherein the step of driving the first vehicle into the aisle comprises driving a first portion of the vertical drive through the vertical track segment and
4.b	driving a second part of the vertical drive into operative engagement with the vertical track segment.
5.pre	The method of claim 1
5.a	wherein the first storage rack is formed of a plurality of vertical posts and
5.b	the first vehicle has a length and a width and the length is greater than the width and
5.c	wherein the step of driving the first vehicle along the first path comprises driving the vehicle along a path spaced apart from the vertical posts by a distance greater the half the length of the vehicle.

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Claim	**Recitation**
6.pre	The method of claim 1 comprising
6.a	the step of driving the first vehicle to a workstation to present an item to an operator after the step of driving the first vehicle out from under the storage racks.
7.pre	The method of claim 1,
7.a	wherein the step of driving the first vehicle across the aisle comprises driving the first vehicle under a second of the storage racks.
8.pre	The method of claim 1,
8.a	wherein the step of turning comprises rotating the first vehicle about a vertical axis that extends through the first vehicle.
9.pre	The method of claim 8
9.a	wherein the vertical axis extends through the first path.
10.pre	The method of claim 1 comprising
10.a	the step of driving a second of the vehicles under the first rack along a second path parallel to the first path so that the second vehicle passes the first vehicle as the first vehicle travels along the first path.
11.pre	A material handling system for delivering items to storage locations and retrieving items from storage locations, comprising:
11.a1	a first storage rack having a plurality of columns each of which comprises a plurality of storage locations
11.a2	wherein the first storage rack is longitudinally elongated;
11.b1	a second storage rack having a plurality of columns each of which comprises a plurality of storage locations
11.b2	wherein the second storage rack is longitudinally elongated,

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Claim	Recitation
11.b3	wherein the second storage rack is spaced apart from the first storage rack to provide an aisle between the first and second storage racks;
11.c1	a plurality of delivery vehicles
11.c2	wherein each vehicle has a length and a width and
11.c3	each vehicle comprises: a horizontal drive system operable to drive the vehicle along a horizontal surface;
11.c4	a vertical drive operable to drive the vehicle vertically;
11.c5	and a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;
11.d	a track positioned in the aisle wherein the vertical drive is configured to cooperate with the track to drive the vehicle vertically upwardly;
11.e	a first horizontal path that extends under the first rack in a direction parallel to the aisle;
11.f	a second horizontal path that extends under the first rack in a direction parallel to the aisle;
11.g	wherein the horizontal drive is configured to turn the vehicle under the first rack by rotating the vehicle about a vertical axis that extends through the vehicle;
11.h1	wherein the storage rack comprises a plurality of vertical posts and
11.h2	the first and second horizontal paths are each spaced apart from the vertical posts a distance greater the one half the length of the vehicles;
11.i	wherein the first horizontal path under the first rack is spaced apart from the second horizontal path a distance greater than the width of the vehicles.
12.pre	The system of claim 11
12.a	wherein the vertical drive comprises a plurality of rotatable elements that each rotate about a horizontal axis and

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Claim	Recitation
12.b	wherein the horizontal drive comprises a plurality of rotatable elements that each rotate about a horizontal axis transverse the axes of rotation of the vertical drive elements.
14.pre	The system of claim 11
14.a	wherein the track comprises drive elements configured to cooperate with the vertical drive so that rotating the vertical drive about a horizontal axis operates to drive the vehicle upwardly along the track.
23.pre	A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of:
23.a1	providing a plurality of storage racks spaced apart from one another forming a plurality of aisles,
23.a2	wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;
23.b1	providing a plurality of delivery vehicles
23.b2	wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,
23.b3	a vertical drive operable to drive the vehicle vertically and
23.b4	a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;
23.c1	driving a first of the vehicles under one or more of the storage racks along a path that crosses one or more aisle,
23.c2	wherein the step of driving the first vehicle includes driving the first vehicle into a first of the columns in a first of the aisles;
23.d	driving the first vehicle vertically upwardly within the first aisle until the first vehicle is adjacent a first of the storage locations;
23.e	transferring an item from the first storage location to the first vehicle;
23.f	driving the first vehicle downwardly within the first aisle;

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Claim	**Recitation**
23.g	driving the vehicle out of the first aisle via a path that extends under at least one of the storage racks.
24.pre	The method of claim 23
24.a	wherein the path includes a portion passing under one of the racks and extending parallel to one of the aisles.
25.pre	The method of claim 24 comprising
25.a	the step of driving a second of the vehicles past the first vehicle under the one rack as the first vehicle is driven along the portion of the path under the one of the racks.
26.pre	The method of claim 23
26.a	comprising the step of turning the vehicle while the vehicle is under one of the racks,
26.b	wherein the step of turning comprises turning the vehicle to align the vehicle with a path perpendicular to the first aisle.
27.pre	The method of claim 26
27.a	wherein the step of turning the vehicle comprises rotating the vehicle about a vertical axis passing through the vehicle.

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I, Stephen Derby, Ph.D., declare as follows:

I. INTRODUCTION

1. I have been retained by Exotec Product France SAS, Exotec North America Inc., and Exotec Product USA Inc. ("Exotec" or "Petitioners") to serve as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") against Opex Corporation ("Patent Owner") regarding U.S. Patent No. 11,472,632 B2 ("the '632 patent"). (Ex. 1001).[1] I have been asked to submit this Declaration on behalf of Petitioner.

2. I have been asked to consider whether certain references disclose or render obvious claims 1, 3-12, 14 and 23-27 ("the challenged claims") of the '632 patent. My opinions are set forth below. Based on my experience and expertise, it is my opinion that the prior art anticipates and/or renders obvious all limitations of the challenged claims, as I discuss in detail below.

3. I am not, and never have been, an employee of Exotec. I am not receiving compensation for this declaration beyond my normal hourly fees of $250 based on my time actually spent analyzing and documenting my opinions herein on

[1] Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the '632 patent.

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the ’632 patent, the intrinsic record, the asserted prior art references identified in the Petition, and the issues related thereto. My compensation is not related to the outcome of this proceeding, and I will not receive any additional compensation based on the outcome of any IPR or other proceeding involving the ’632 Patent.

4. All of my opinions set forth below are based on my own personal knowledge and professional judgment. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth in this Declaration.

II. BACKGROUND AND QUALIFICATIONS

5. My qualifications can be found in my curriculum vitae (or “CV”), which includes a summary of my professional and educational background, and which is attached to this declaration as Exhibit 1004.

6. I am an expert in the fields of packaging and automation, including the design, development, operation, and optimization of packaging and packaging machinery.

7. I received a Bachelor of Science in Mechanical Engineering from RPI in 1976. I received a Master of Engineering in Mechanical Engineering in 1977 and a Ph.D. in Mechanical Engineering in 1981 from RPI. My Ph.D. thesis was titled “General Robot Arm Simulation Program,” which related to computer graphic simulation of robot arms.

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8. After receiving my Ph.D., I served as an Assistant Professor in Mechanical Engineering at RPI from 1981 to 1986. In 1986, I became an Associate Professor of Mechanical Engineering at RPI. I have taught various packaging-related courses at RPI, including "Modular Automation Concepts" and "Design of Automatic Machinery," which are courses related to the design and development of packaging machinery. I also taught the course "Advanced Manufacturing Lab," in which students design custom packaging for an item and are graded on the aesthetics, functionality, and appropriateness of the packaging. I also have taught various courses related to machine operation, design, and development at RPI. In addition to the courses listed above, I have taught "Mechanisms" and "Kinematic Synthesis," both of which teach students to design machines for a variety of applications, including but not limited to packaging applications.

9. I am currently an Associate Adjunct Professor Emeritus in the Mechanical Engineering, Aeronautical Engineering and Nuclear Engineering Department at Rensselaer Polytechnic Institute ("RPI") in Troy, New York.

10. I was the President of Distributed Robotics LLC, which focuses on novel robotic automation, including for packaging applications. For example, we developed a machine for separating and sorting a bulk collection of packaged products into a uniformly separated, spaced flow (which we refer to as a "product

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singulator"). We developed a machine for stacking cases of packaged products on pallets (which we refer to as a "palletizer").

11. I am the Automation Director for Pack Flow Concepts, LLC, a company that focuses on packaging automation and new product development. For example, we developed a machine for high-speed case packing that is directly connected to a packaging machine. The machine receives packaged products from the packaging machine and automatically places the products in cases at a high speed. I was the Head Automation Consultant for Home Delivery Services, which focuses on e-commerce robotic automation, such as order fulfillment of packaged goods for home-delivery groceries.

12. My research has focused on various areas of automation and design, including designing machines for packaging goods. I have served on consulting teams for many companies on projects related to manufacturing, automation, and robotics, including in the packaging area.

13. Over the years, I have actively served leadership roles on a number of organizations, including on the Conference Planning Board for the American Society of Mechanical Engineers ("ASME"). Since 2005, I have been a Fellow of ASME, which is a distinction given to select ASME members to recognize outstanding achievements in the engineering field. I also received the ASME Best Paper Award in 2005 for the Material Handling Engineering Division.

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14. I have published over 80 peer-reviewed publications, as well as authored several book chapters, books, and trade journal contributions in the field of robotics and packaging. For example, I am the author of the textbook "Design of Automatic Machinery" which, among other things, examines options for practical design of automated processes and provides a desk-reference for designers of automated machines on many automation concepts used in the industry.

15. I am also an inventor of several United States patents and published patent applications in the automated storage and retrieval systems ("AS/RS"). For example, U.S. Patent No. 9,399,529, titled "Automated product engager, transporter and patterned depositor system," relates "to automated systems for engaging products to process the products and then position them on a transporter to transport the products to a patterned depositor for depositing the products in a pattern. An example includes filling bags with food, placing the bags on a conveyor and depositing the bags in a packing pattern within a packing case." Another patent on which I am a named inventor, U.S. Patent No. 9,334,081, titled "Folding side-wall container and automated system of use," relates to "containers utilized in transport of goods typically sold at retail stores, such as pharmacy chain stores, hardware stores, etc., and in particular relates to such a container having a folding side wall." In one "embodiment of the disclosure, the folding side wall container may also include a corrugated, semi-rigid cardboard-type box nested within the container."

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Another patent, U.S. Patent No. 6,688,451, titled "Multi-head robot system and method of use," relates to "a number of robotic devices, each of which is able to operate independently at any of a number of discrete destinations."

16. I am also an inventor of numerous United States patents and published patent applications in the area of machine design and operation. For example, U.S. Patent No. 6,565,308, titled "Bulk mail container unloading system, apparatus and method," relates to a system for material loading and unloading, and more particularly, to an apparatus for moving a bulk mail container from an upright position to an upended position to allow dumping of the container's contents onto an unloading surface. U.S. Patent No. 7,712,598, titled "Robotic tread system having a net-zero motion head for moving objects," relates to a continuous robotic tread system for picking and placing packaged goods, which eliminates repeated stopping and starting of the system.

17. I was a Robot Architect for Jabil in 2023, specializing in custom robotics systems design and integration.

18. Other details concerning my background, experience and testimony as a witness, academic work, and professional history are set forth in my curriculum vitae, which is attached as Exhibit 1004 to this declaration.

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III. MATERIALS REVIEWED

19. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, knowledge, and experience in the relevant art.

20. In forming my opinions, I reviewed and relied upon the following materials and information:

Exhibit	Description
Ex. 1001	U.S. Patent No. 11,472,632 B2 ("the '632 patent")
Ex. 1002	Prosecution History of U.S. Patent No. 11,472,632 B2
Ex. 1005	U.S. Patent Publication No. 2017/0158430A1 ("Raizer")
Ex. 1006	English Translation of CN Patent Publication No. CN 109987366A and Certificate of Translation ("Hangzhou")
Ex. 1007	CN Patent Publication No. CN 109987366A
Ex. 1008	U.S. Patent 10,472,172 B2 ("Goren")

21. I also reviewed any other materials I refer to in this Declaration in support of my opinions.

22. In forming my opinions, I have considered the materials listed above and any other documents cited in this Declaration. My opinions are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the state of the art, the prior art, and the claims and the specification of the '632 patent at the time of the alleged invention.

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IV. LEGAL STANDARDS

23. I am not an attorney, and do not offer opinions on the law in this Declaration.

24. In forming my analyses and conclusions expressed here in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioners.

25. I used my understanding of the following legal principles set forth in this section in reaching my opinions.

26. I understand that, in this proceeding, Exotec has the burden of proving that the challenged claims are invalid by a preponderance of the evidence.

A. Anticipation

27. I have been informed that a claim is invalid as anticipated under 35 U.S.C. § 102 (AIA) if a prior art reference discloses, either expressly or inherently, all limitations of a claim as those limitations are arranged in the claim.

28. I have been informed that a limitation is disclosed inherently in a reference if it is necessarily present in the process or product described in the prior art reference. I understand that probabilities or possibilities are insufficient to show that a prior art reference inherently discloses something beyond what it discloses explicitly.

B. Obviousness

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29. I have been informed that a claim is invalid as obvious under 35 U.S.C. § 103 (AIA) if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person of ordinary skill in the art. I have been informed that the following matters are relevant to determining whether the claimed invention would have been obvious: (1) the scope and content of the prior art, (2) the difference or differences between the patent claim and the prior art, (3) the level of ordinary skill in the art at the time the invention of the patent, and (4) any secondary considerations or objective indicia of non-obviousness.

30. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a claim simply arranges prior art elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, then such a combination is obvious. When a patent claims a structure already known in the prior art altered by the mere substitution of one element for another known in the field, the combination is likely to be obvious unless the combination yields an unpredictable result.

31. I have been informed that when a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill in the art can

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implement a predictable variation, such a variation is likely unpatentable. For the same reason, if a technique has been used to improve one device, and one of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill. One question to consider is whether the improvement is more than predictably using prior art elements according to their established functions.

32. I have been informed that it may often be necessary, in a validity analysis, to consider whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. This can be accomplished by looking to interrelated teachings of multiple patents or other publications or pieces of prior art; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by one of ordinary skill in the art.

33. I have been informed that a validity analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim; it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I have been informed that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton.

34. I have been informed that a claim composed of several elements is not proved obvious merely by demonstrating that each element was, independently,

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known in the prior art. I have been informed that it can be important to identify a reason that would have prompted a person of ordinary skill in the art in the relevant field to combine the elements in the way the claimed new invention does. I am told that one way that subject matter can be proved obvious is by noting there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I have been informed that any need or problem known in the field of endeavor at the time of the claimed invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

35. I have been informed that one should not assume that a person of ordinary skill in the art attempting to solve a problem will be led only to those elements of prior art designed to solve the same problem. Instead, I have been informed that since familiar items may have obvious uses beyond their primary purposes, in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like pieces of a puzzle.

36. I have been informed that, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, persons of ordinary skill in the art have good reason to pursue the known options within their technical grasp. If this leads to the anticipated success, the product was likely not accomplished by innovation but by using ordinary skill and

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common sense. I have been informed that, in such an instance, the fact that the combination was obvious to try may show that the combination was obvious.

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

38. I have been informed that, when determining whether a claimed invention is obvious, any "secondary considerations" of non-obviousness identified by the patentee should also be considered. These secondary considerations can include:

- commercial success of the invention, causally related to the invention itself rather than to companion factors, such as advertising or attractive packaging;
- the invention taught away from the technical direction followed by those skilled in the art;
- a long-felt but unsatisfied need for the invention while the needed implementing arts and elements had long been available;
- the invention achieves results unexpected to those skilled in the

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art;

- copying of the invention by competitors as distinguished from their independent development;
- unsuccessful attempts by those skilled in the art to make the invention;
- acquiescence by the industry to the patent's validity by honoring the patent through taking licenses or not infringing the patent, or both; and
- skepticism, disbelief in or incredulity by those skilled in the art that the patentee's approach worked.

39. I have been informed that, for the above information to impact the obviousness of a patent claim, there must be a nexus between the alleged secondary considerations and the claims. In addition, I have been informed that the burden of introducing evidence of secondary considerations generally is on the Patent Owner. If the Patent Owner or its expert should assert secondary considerations of non-obviousness, I reserve the right to provide a Declaration addressing assertions of non-obviousness due to secondary considerations.

C. Claim Construction

40. I have been informed that claim terms are typically given their plain and ordinary meanings, as would have been understood by a person of ordinary skill in the art at the time of the earliest alleged priority date. I have further been informed

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that when considering the meaning of any terms in the challenged claims of the ’632 patent, I should apply the plain and ordinary meaning of those terms. I have further been informed that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record.

41. I have been informed that, in general, a preamble limits the invention if it recites essential structure or steps, or if it is necessary to give life, meaning, and vitality to the claim. I have further been informed that a preamble is not limiting where a patentee 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 have further been informed that dependence on a particular disputed preamble phrase for antecedent basis may limit claim scope because it indicates a reliance on both the preamble and claim body to define the claimed invention. I have further been informed that clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.

V. PERSON OF ORDINARY SKILL IN THE ART AT THE TIME OF THE ALLEGED INVENTION

42. I have been asked to assume that the ’632 patent is entitled to its earliest alleged priority date of August 14, 2019 (*see* Ex. 1001, 1 (“Related U.S. Application Data” section)). Based on my knowledge and experience, I was a person of ordinary

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skill in the art as of August 14, 2019, and can provide opinions regarding the knowledge of a person of ordinary skill in the art as of that time. My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time.

43. Based on the materials and information I have reviewed and based on my experience in the technical areas relevant to the ’632 patent, a person of ordinary skill in the art at the time of the alleged invention of the ’632 patent would have been a person with a working knowledge of mechanical design and automation. That person would have had a Bachelor of Science degree in an academic discipline emphasizing the design of mechanical, automation, and robotics technologies, in combination with training or at least one to two years of related work experience. Alternatively, that person could have also had a Master of Science degree in a relevant academic discipline with less than a year of related work experience in the same discipline. More education can supplement practical experience and *vice versa*.

44. I exceeded this level of skill in the art as of the earliest filing date of the ’632 patent.

VI. TECHNICAL BACKGROUND

45. Below, I present a brief overview of certain technical concepts and features that would have been known to a person of ordinary skill in the art prior to and at the time of the earliest alleged priority date of the ’632 patent. The technical

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concepts and features that I describe in this Technical Background section reflect the state of the art that a person of ordinary skill in the art would have had knowledge of and would have understood prior to and at the time of the alleged invention of the '632 patent. I rely on, and incorporate as applicable (even if not expressly mentioned below in Section IX), the following disclosures to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '632 patent and how (and why) a person of ordinary skill in the art would have been motivated to consider and combine the disclosures and suggestions from one or more prior art references.

A. Automated Warehouse Solutions Using Autonomous Robots

46. Prior to the '632 patent's earliest alleged priority date, a person of ordinary skill in the art would have been familiar with automated warehouse solutions that used autonomous robots.

47. For example, *Goren* (Ex. 1008) is based on an application published December 15, 2016 (Ex. 1008, Cover). *Goren* explains that, as of at least 2016, "[a] number of systems have been developed for automatically moving inventory items to and from shelves in a warehouse," including "through the use of autonomous vehicles," where "[t]he vehicles perform both transfer and transport functions in moving containers of items within a workspace via a network of roadways." (Ex. 1008, 1:27-36). *Goren* further explains, with respect to the state of the art at the time,

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"[u]nder computer control, the autonomous vehicles transfer and transport case containers of item units between incoming receiving stations, intermediate storage locations, and outgoing order-assembly stations." (Ex. 1008, 1:36-40).

48. *Goren* describes an "inventory handling system" that "comprises multiple shelving units for mounting over a horizontal floor, either mounted on the floor itself or suspended above it." (Ex. 1008, 6:22-27). Each "shelving unit contains a vertical array of shelves on which containers are placed." (Ex. 1008, 6:25-26). "Floor robots travel among the shelving units along paths on the floor." (Ex. 1008, 6:26-27).

49. *Goren* describes "further enhanc[ing]" capabilities of the systems and robots "by elevating the shelving units above the floor, for example on legs high enough so that a floor robot loaded with a container can travel beneath the shelves." (Ex. 1008, 6:40-43). Thus, "the floor robots receive the containers from the lift robots in locations in the aisles alongside the shelving units, and then travel beneath the shelves in order to deliver the containers to their destination." (Ex. 1008, 6:43-47). *Goren* underscored that elevating the shelving units high enough so that floor robots loaded with containers could pass underneath "allows flexible route planning and efficient transport by the floor robots, by eliminating bottlenecks that could otherwise occur in the aisles between the shelving units." (Ex. 1008, 6:41-50).

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50. With reference to FIG. 1 (reproduced below), *Goren* depicts "an automated distribution center 20" that "comprises multiple shelving units 22 which are mounted side-by-side over a horizontal floor 24." (Ex. 1008, 7:48-52).

Ex. 1008, FIG. 1

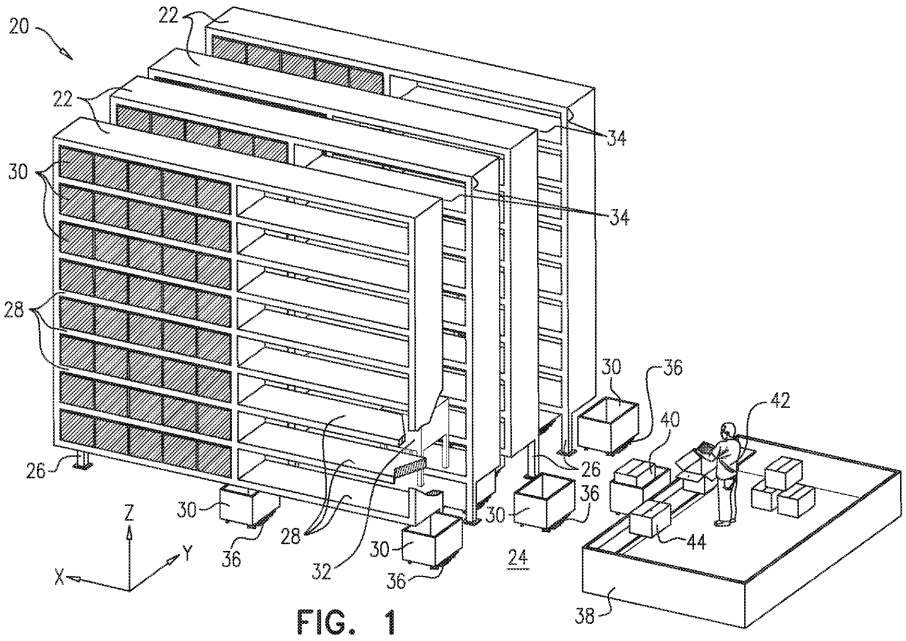


FIG. 1

51. With continued reference to FIG. 1 (above), *Goren* describes that "shelving units 22 are mounted on the floor by legs 26, but alternatively, the shelving units may be suspended from the ceiling or otherwise held above the floors by any suitable means that are known in the art." (Ex. 1008, 7:52-56). The "horizontal plane of floor 24 is taken to be the X-Y plane, with the X-axis running along the length of shelving units 22." (Ex. 1008, 7:57-58).

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52. With continued reference to FIG. 1 (above), *Goren* describes that "[f]loor robots 36 travel among shelving units 22 along horizontal paths on the floor 24, moving independently of but in coordination with lift robots 32." (Ex. 1008, 8:45-47). *Goren* notes that, in the embodiment pictured in FIG. 1 (above), "legs 26 of shelving units 22 are high enough so that floor robots 36 can travel beneath shelves 28 in order to deliver containers 30 to their destinations." (Ex. 1008, 8:50-53). For example, in "distribution center 20," "floor robots convey containers 30 to a packing station 38 where a picker moves items 40 from the containers to cartons 44 for delivery to customers." (Ex. 1008, 8:53-56). Similarly, "floor robots 36 convey containers 30 to lift robots 32 for placement on shelves 28." (Ex. 1008, 8:57-58).

53. *Goren* further explains that "[t]he floor robots travel beneath shelves 28 in order to deliver the containers to their destinations, as well as to reach their rendezvous points with lift robots." (Ex. 1008, 9:3-6). Thus, "gap 34 serves mainly as a loading zone for floor robots 36, while the areas beneath shelves 28 serve as entry and exit lanes." (Ex. 1008, 9:6-9).

VII. SUMMARY OF THE '632 PATENT

A. The '632 Patent's Specification

54. The '632 patent is titled "Material Handling System" and discloses a system and method for automated item storage and/or retrieval. (Ex. 1001, Abstract).

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The ’632 Patent discloses “vehicle[s] for delivering items and a plurality of racks having a plurality of storage locations” and is directed to “delivering items to storage locations and retrieving items from storage locations.” (Ex. 1001, 1:53-55).

55. The ’632 patent purports to identify problems relating to “material handling systems, such as those used in mail-order warehouses, supply chain distribution centers, and custom-order manufacturing facilities,” alleging that they “face significant challenges in responding to requests for inventory articles.” (Ex. 1001, 1:19-22). The ’632 patent alleges that “[a]s the scale of an inventory management system expands to accommodate a greater number and variety of articles,” “so too does the cost and complexity of operating it to simultaneously complete the packing, storing, replenishment, and other inventory management tasks for which it is intended.” (Ex. 1001, 1:24-30). The ’632 patent further alleges that “[g]reater efficiency may often by achieved, for a time, by incrementally expanding the capacity of the facility’s exiting automation infrastructure, particularly when that expansion follows a well-conceived plan for growth.” (Ex. 1001, 1:34-38). The ’632 patent goes on to allege that “[s]ooner or later” “a point of diminishing returns is encountered,” and, at such a point, “a facility operator may be forced to abandon pre-existing material handling infrastructure and to replace that infrastructure with a completely new automation platform.” (Ex. 1001, 1:37-46).

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56. The ’632 patent purports to solve these alleged problems by disclosing “automated material and article handling systems which can be used in warehouse, storage, and/or distribution environments.” (Ex. 1001, 1:12-15). With reference to FIG. 1 (reproduced below), the ’632 patent describes a “material handling system” with “one or more storage racks 800,” where “[e]ach storage rack may include a plurality of storage locations 820.” (Ex. 1001, 7:41-52; FIG. 1).

Ex. 1001, FIG. 1

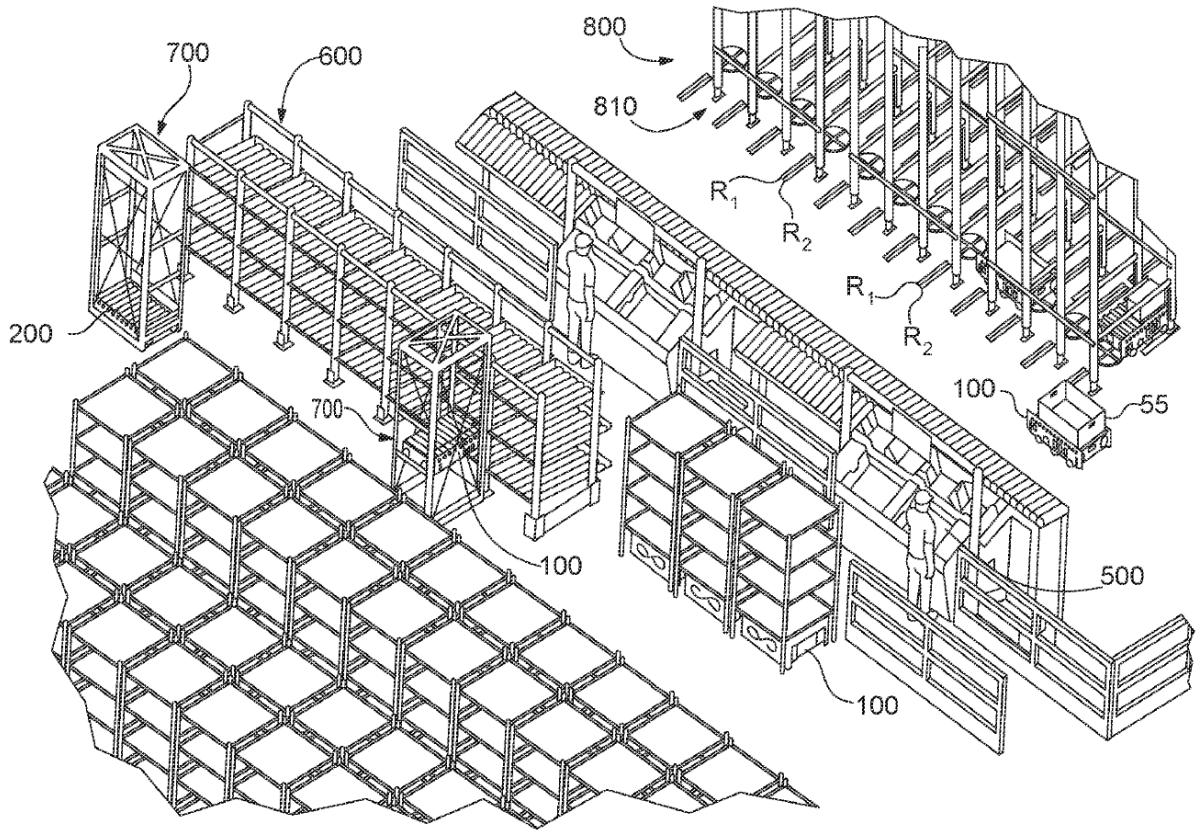


FIG. 1

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57. The “storage locations” of the ’632 patent “may be arranged into one or more vertical columns 810,” and “items that are handled by the system may be stored directly in the storage locations.” (Ex. 1001, 7:41-60).

58. FIG. 1 of the ’632 patent also depicts a “delivery mechanism” that “may include one or more vehicles 100 that transport items.” (Ex. 1001, 7:10-17). The “vehicles may retrieve items from storage locations 820 in the racks 800 and deliver the items to a workstation 500 where an operator can retrieve the item from the vehicle.” (Ex. 1001, 7:15-20). The “vehicle may optionally return to a storage area in the rack to store any remaining items that were not retrieved by the operator.” (Ex. 1001, 7:20-22).

59. With reference to FIG. 2 (reproduced below), the ’632 patent illustrates a vehicle with “a horizontal drive assembly 120 for driving the vehicle in a horizontal direction” such that the “horizontal drive 120 may be configured to drive the vehicle along a track or along an open horizontal surface, such as a floor.” (Ex. 1001, 8:9-19).

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Ex. 1001, FIG. 2

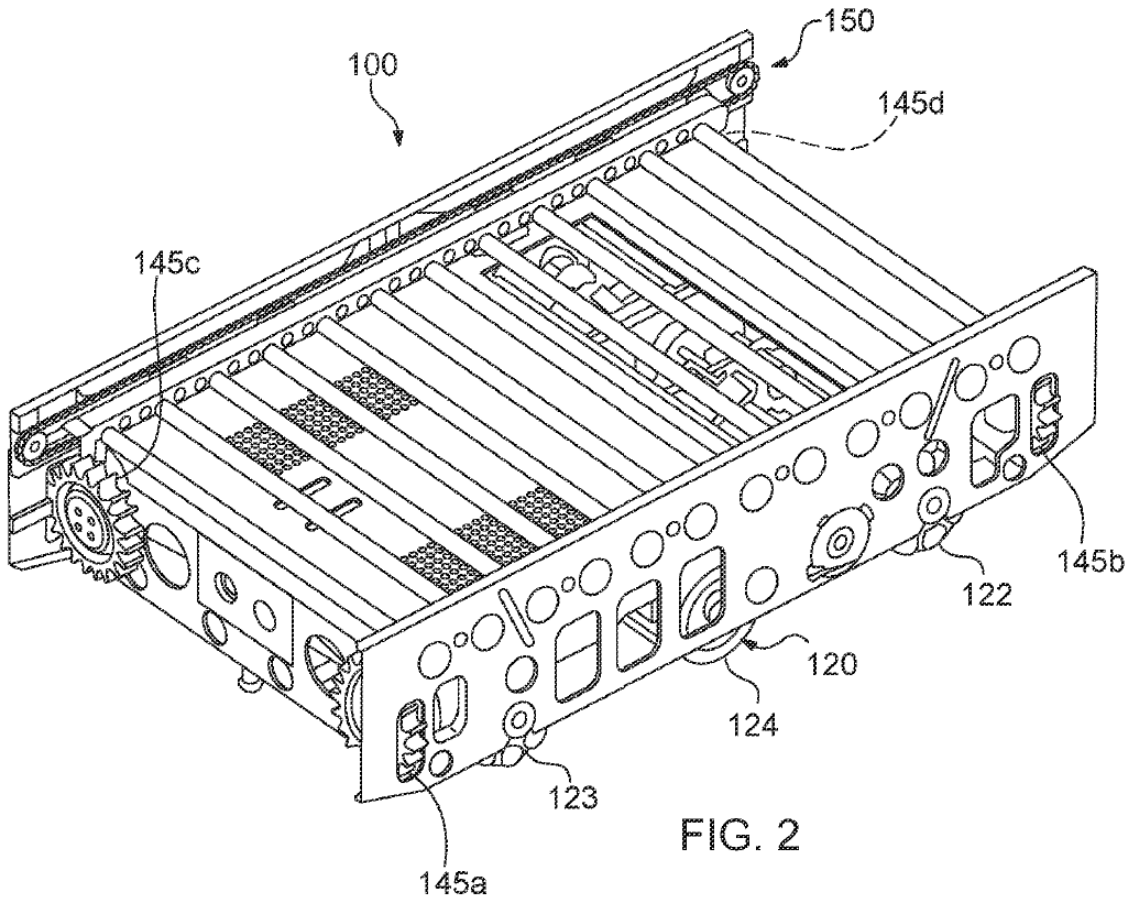


FIG. 2

60. FIG. 2 also depicts a "vertical drive mechanism 140 for driving the vehicle 100 vertically within the rack 20." (Ex. 1001, 9:12-19). The "vertical drive

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mechanism 140[2] may be configured to cooperate with [a] vertical guide mechanism 840 to drive the vehicle vertically." (Ex. 1001, 9:12-19; *see also* FIG. 9 below).

Ex. 1001, FIG. 9

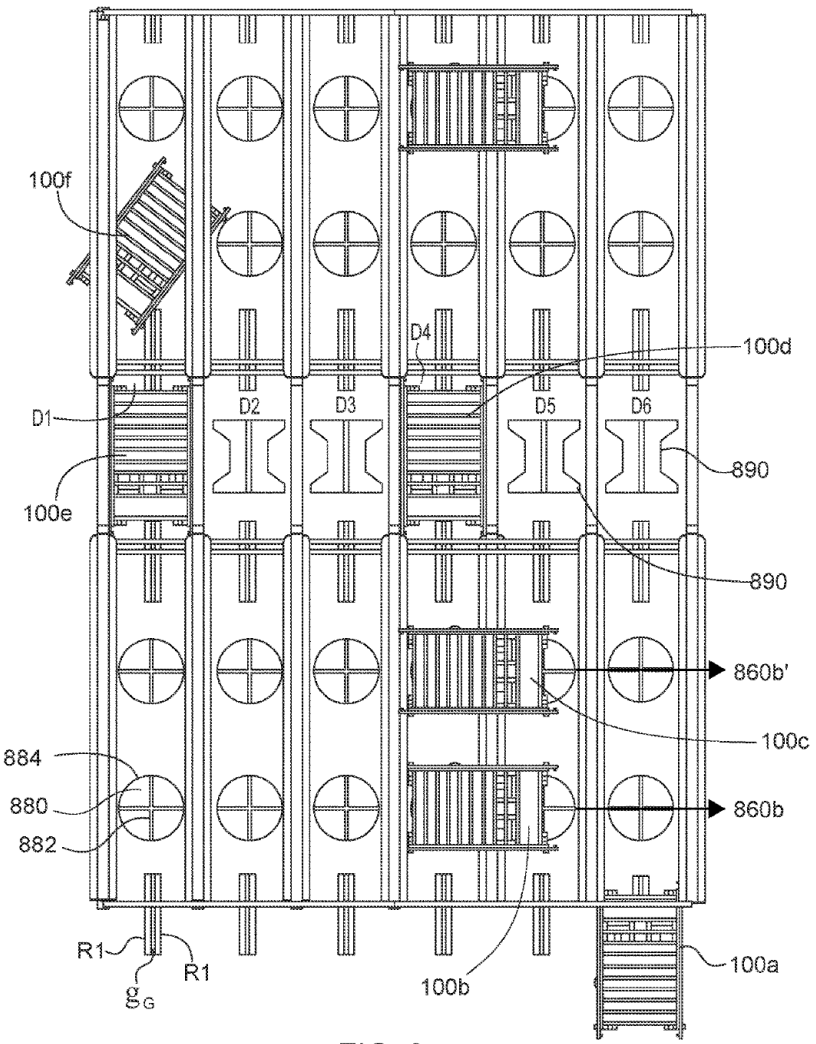


FIG. 9

[2] It is noted that reference number 140 is omitted from FIGS. 2-3 notwithstanding assertions in the Specification of the '632 patent to the contrary.

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61. Further discussed with reference to FIG. 2 above, the ’632 patent indicates the vehicle includes a “transfer mechanism 150” “operative to transfer an item between a platform surface of the vehicle and one of the plurality of destination areas 820.” (Ex. 1001, 10:1-23).

62. With reference to FIG. 7 (reproduced below), the ’632 patent explains that “racks may be configured to allow the vehicles to travel under the racks 800 as well as being able to travel across or along one or more aisles.” (Ex. 1001, 17:7-48).

Ex. 1001, FIG. 7

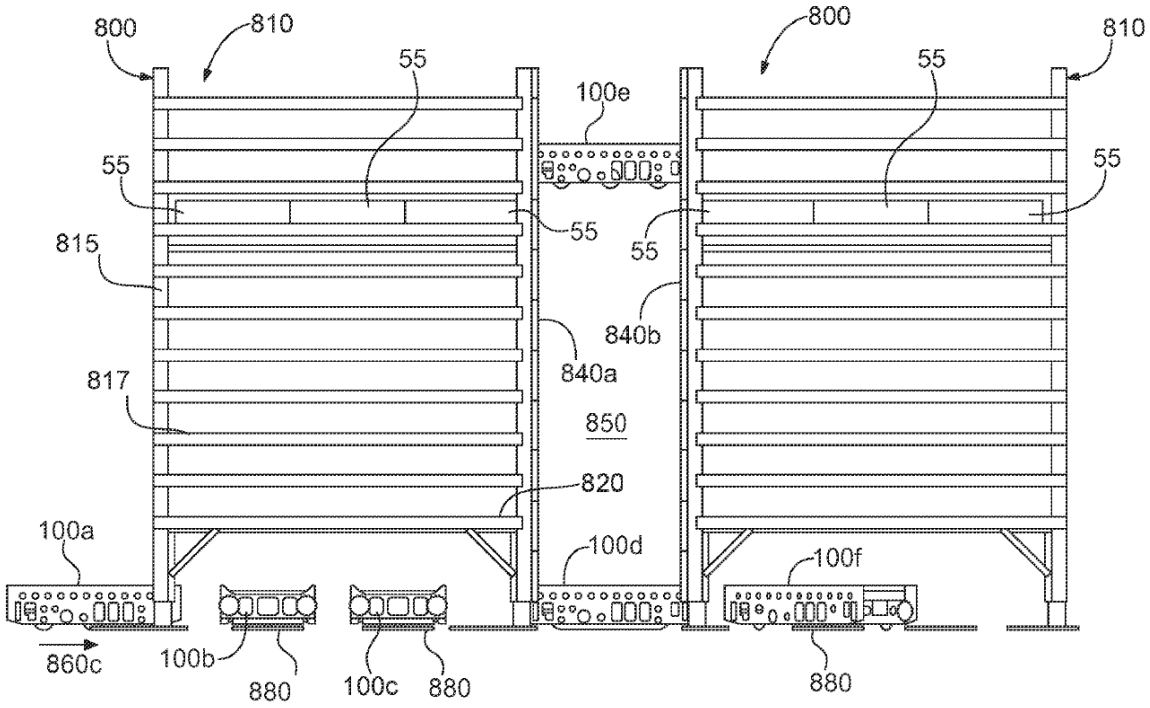


FIG. 7

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B. The ’632 Patent’s Prosecution History

63. Below is a brief summary of the ’632 patent’s prosecution history. This summary is not intended to address or summarize the ’632 patent’s entire prosecution history. Rather, it is intended to summarize the parts that may be relevant to my analysis below.

64. U.S. Patent Application No. 16/994,543 (the “’543 application”) was filed August 14, 2020, and claims priority to U.S. Provisional Application No. 62/886,602, filed August 14, 2019. (Ex. 1001, Cover).

65. On August 14, 2020, the Applicant filed the ’543 application, including original claims 1-27. (Ex. 1002, 152-212). In response to a Notice to File Missing Parts mailed August 24, 2020 (Ex. 1002, 147-148), the Applicant filed a Preliminary Amendment on October 20, 2020, which included amendments to claims 10, 19-22, and 26. (Ex. 1002, 136-143). The amendments appear to have been intended to remove multiple dependencies. (Ex. 1002, 136-143). A Notice of Allowance was mailed June 27, 2022. (Ex. 1002, 76).

66. On June 29, 2022, the Applicant filed Replacement Sheets, indicating it was a submission of Formal Drawings. (Ex. 1002, 60-70). In response to receiving a Notice to File Corrected Application Papers mailed July 12, 2022 (Ex. 1002, 58-59), the Applicant filed an amendment to the specification to replace a reference to “FIG. 13A” to “FIG. 7” on July 14, 2022. (Ex. 1002, 54-56). On August 5, 2022, the

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Applicant filed an amendment to amend "claims 11, 17, and 25 to fix minor typographical errors." (Ex. 1002, 40-49). The August 5, 2022, amendments were entered September 2, 2022. (Ex. 1002, 30-31).

67. On November 1, 2022, the Applicant filed a Request for Certificate of Correction, requesting corrections to claim 11 shown below (Ex. 1002, 22), and another Request for Certificate of Correction on November 8, 2022, requesting to replace Figure 8. (Ex. 1002, 13-21).

Ex. 1002, 22

In Claim 11:

	READS	SHOULD READ
Line 11	"wherein the first storage rack is spaced apart"	--wherein the second storage rack is spaced apart—
Line 36	"wherein the first horizontal path under the path is spaced apart"	--wherein the first horizontal path under the first rack is spaced apart--
Line 37	"from the first horizontal path a distance greater"	-- from the second horizontal path a distance greater--

---

68. The Request filed November 1, 2022, was denied on November 22, 2022, because the corrections did "not match text at corresponding location in printed patent." (Ex. 1002, 11-12). On November 23, 2022, the Applicant filed another Request for Certificate of Correction, requesting corrections to claim 11 shown below. (Ex. 1002, 5).

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Ex. 1002, 5

In Claim 11:

	READS	SHOULD READ
Line 36	"wherein the first horizontal path under the path is spaced apart"	--wherein the first horizontal path under the first rack is spaced apart--
Line 37	"from the first horizontal path a distance greater"	-- from the second horizontal path a distance greater--

69. The November 23, 2022, Request was approved December 5, 2022, and the below Certificate of Correction was issued, making corrections to claim 11. (Ex. 1002, 1-4).

Ex. 1002, 1

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 11,472,632 B2
APPLICATION NO. : 16/994543
DATED : October 18, 2022
INVENTOR(S) : Alexander Stevens and Joseph Valinsky

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Claim 11:

	READS	SHOULD READ
Line 50	"wherein the first horizontal path under the path is spaced apart"	--wherein the first horizontal path under the first rack is spaced apart--
Line 50	"from the first horizontal path a distance greater"	--from the second horizontal path a distance greater--

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C. Claim Construction of the ’632 Patent

70. I have been informed that claim terms are typically given their plain and ordinary meanings, as would have been understood by a person of ordinary skill in the art at the time of the earliest alleged priority date. I have further been informed that when considering the meaning of any terms in the challenged claims of the ‘632 Patent, I should apply the plain and ordinary meaning of those terms. I have further been informed that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record.

71. I have been informed that in general, a preamble limits the invention if it recites essential structure or steps, or if it is necessary to give life, meaning, and vitality to the claim. I have further been informed that a preamble is not limiting where a patentee 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 have further been informed that dependence on a particular disputed preamble phrase for antecedent basis may limit claim scope because it indicates a reliance on both the preamble and claim body to define the claimed invention. I have further been informed that clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.

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VIII. SUMMARY OF THE PRIOR ART

A. *Raizer* (Ex. 1005)

72. United States Patent Publication No. 2017/0158430 A1 ("*Raizer*", Ex. 1005) is titled "Automatic Warehouse System."

73. *Raizer* was filed July 9, 2015, claiming priority to a provisional application filed July 12, 2014, and published June 8, 2017 (Ex. 1005, Cover). Thus, I have been informed that I should assume *Raizer* is prior art under at least 35 U.S.C. § 102(a) (AIA).

74. *Raizer* is directed to "an automatic system for picking and placing boxes on shelves in a warehouse," where the "system comprises a set of autonomous mobile robots," "a network of vertical and horizontal rails that are parallel to the vertical support posts and horizontal shelves," and a "Real Time Traffic Management (RTTM) server" "configured to communicate with the robots." (Ex. 1005, Abstract).

75. *Raizer's* "autonomous mobile robots" include "drivers and controllers" that "execute dedicated algorithms to fully enable the robot's multi-channel degrees of freedom and to use the flexibility of the system's design." (Ex. 1005, ¶[0089]). The "robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse." (Ex. 1005, ¶[0104]). The robots comprise "a command module that houses a processor, software, and other electronics that

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guide the robot and enable it to carry out its assigned tasks." (Ex. 1005, ¶¶[0048-0053]).

76. *Raizer* seeks to overcome challenges associated with "automated systems for warehouse management," including "improving efficiency and reducing cost." (Ex. 1005, ¶¶[0001-0002]). *Raizer* explains that the "largest costs" of such systems "are associated with human labor and storage capacity," and that "small and medium size warehouses" are "burdened with escalating labor cost, increased demand for delivery times, limited working hours, process control difficulties leading to uneven output, employee turnover requiring a costly training process, season to season volatility, and human errors." (Ex. 1005, ¶¶[0002-0003]).

77. *Raizer* explains that an "automatic warehouse solution would provide an answer to many of these issues," however, "there are many constraints" preventing the implementation of such solutions." (Ex. 1005, ¶[0004]). Examples of such constraints include the "requirement of a large capital equipment investment," "[p]oor modularity," "[d]owntime," "[l]imited flexibility," "[n]o gradual implementation capability," and "[r]edundancy capability." (Ex. 1005, ¶¶[0004-0013]).

78. *Raizer* presents a solution to overcome the aforementioned challenges by "provid[ing] an automatic warehouse system that is suitable for small and

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medium sized warehouses," and that "can be relatively inexpensively and easily added to existing warehouses." (Ex. 1005, ¶¶[0015-0017]).

79. *Raizer* discloses an "automatic system for picking and placing boxes on shelves in a warehouse," where the system includes "a set of autonomous mobile robots," "a network of vertical and horizontal rails that are parallel to [] vertical support posts and horizontal shelves of the shelving system in the warehouse," and a "Real Time Traffic Management (RTTM) server" "configured to communicate with the robots and other processors and servers in the warehouse." (Ex. 1005, ¶¶[0018-0021]).

80. *Raizer's* "system is characterized in that the robots comprise a set of on-board sensors, a processor, software, and other electronics configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, ¶[0022]; *see also* Abstract).

81. *Raizer* explains that the "modular architecture of the system allows integrating with an already in-use facility with a high level of implementation flexibility and ongoing scalability." (Ex. 1005, ¶[0023]).

82. With reference to FIG. 1 (reproduced below), *Raizer* illustrates a "floor plan of a typical warehouse," that "is divided into three main sections: a Receiving

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and Dispatch Center (RDC), an Operations Area (OP), and a storage area, which can be divided into zones." (Ex. 1005, ¶[0092]).

Ex. 1005, FIG. 1



Fig. 1

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83. The "storage area comprises a plurality of shelving units consisting of a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves." (Ex. 1005, ¶[0092]). The "vertical supports divide the shelving unit into sections call bays (B1, B2, . . .)," and the "sides of the shelving units that face the aisles between units are called faces (F1, F2, . . .)." (Ex. 1005, ¶[0092]).

84. A "given row of shelves in a bay is designated by a level number and can hold several boxes arranged in one or more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]). To "provide a precise location for a specific box in the storage area, the bays are divided into areas that represent the number of stacks in the bay" such that "the exact location of a box in the warehouse is designated by an address comprising numbers, letters, signs, color, etc. representing the zone, face, bay, level, and specific location," or "using x,y,z coordinates in a coordinate system of the rail system" "or an indoor positioning system." (Ex. 1005, ¶[0092]).

85. With reference to FIGs. 5A and 5B (reproduced below), *Raizer* depicts an example robot of the system. The components of the robot are "mounted on a frame comprised of two long beams 28 that are rigidly connected together at one end by a shorter beam 12." (Ex. 1005, ¶[0103]). An "array of micro-pallet lifters 32" "are used to place boxes on the shelves of the warehouse and to remove them from the shelves." (Ex. 1005, ¶[0103]). On "top of beam 12 is located a battery case 20

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that houses the batteries that power the robot," and the robot has "a command module 14 that houses the processor, software, and other electronics that guide the robot and enable it to carry out its assigned tasks." (Ex. 1005, ¶[0103]).

Ex. 1005, FIGs. 5A and 5B

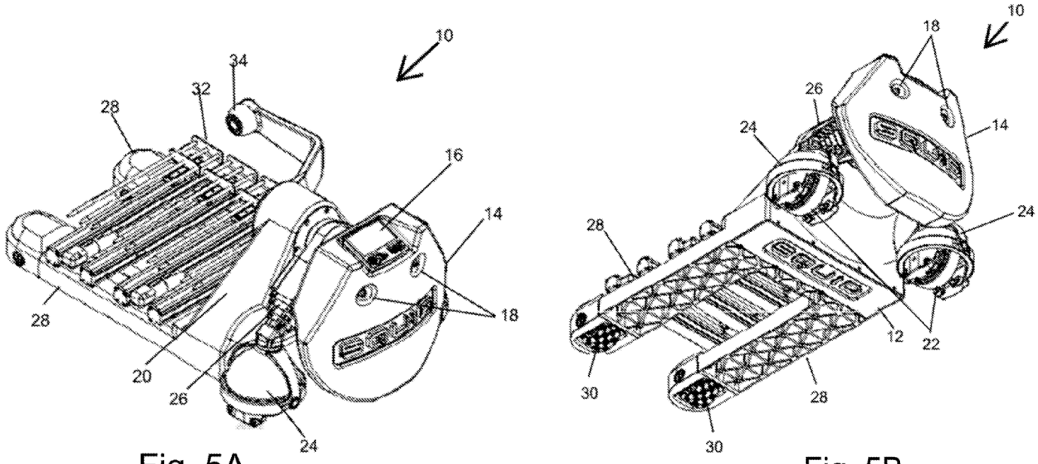


Fig. 5A Fig. 5B

86. The "robot 10" "moves along the ground on four wheels," where "two rear wheels 30 could be fixed and passive so that they can only rotate about their axles which are perpendicular to the axis of the long beams 28 of the frame and are 'dragged along' by the front wheels," or "could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor." (Ex. 1005, ¶[0104]). The "two front wheels 22 can be independently rotated in any direction by drive and steering units 24" such that "the robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse without the use of a track, embedded wire or any other arrangement to guide it." (Ex. 1005, ¶[0104]). The "drive and steering units 24 are attached to the robot by means of arm

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units 26," which "can expand, contract, and have other degrees of freedom that allow the robot to raise itself off the floor and to move up and along the shelves in order to place or pick cartons from the shelves." (Ex. 1005, ¶[0104]).

87. *Raizer's* system is "controlled by a central processing server known herein as the Real Time Traffic Management (RTTM) server," which is "configured to communicate with the robots, picking stations and the warehouse management system (WMS)." (Ex. 1005, ¶[0087]). "Software in the RTTM server uses the information from the WMS as input to generate tasks, prioritization, traffic control, and energy management instructions, which the server sends to the individual robots." (Ex. 1005, ¶[0087]). *Raizer* discloses that "[n]avigation, driving, fine positioning procedure and monitoring the charge of the batteries is done by processors in every robot." (Ex. 1005, ¶[0089]). Each robot includes "drivers and controllers" which "execute dedicated algorithms to fully enable the robot's multi-channel degrees of freedom and to use the flexibility of the system's design." (Ex. 1005, ¶[0089])

88. With reference to FIGs. 8A-8G (reproduced below), *Raizer* depicts "different stages in the process of the robot of the system of the invention leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* explains that, "[i]n order to complete its mission of removing a box from (or delivering a box to) a specific location on a

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shelf the robot travels vertically with both front wheels in the same vertical rail and travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

Ex. 1005, FIGs. 8A, 8B

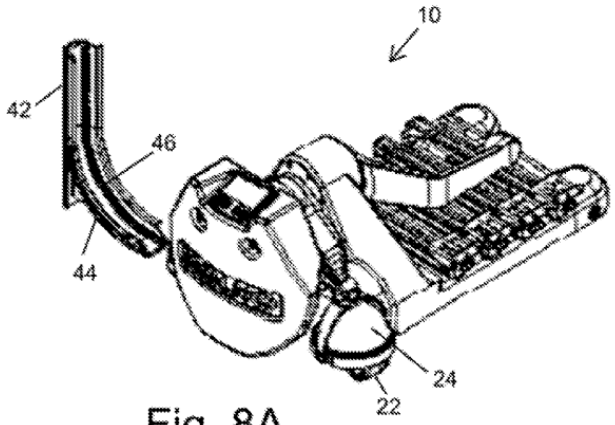


Fig. 8A

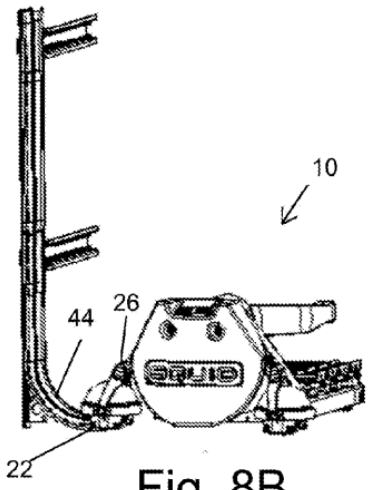


Fig. 8B

Ex. 1005, FIGs. 8C, 8D

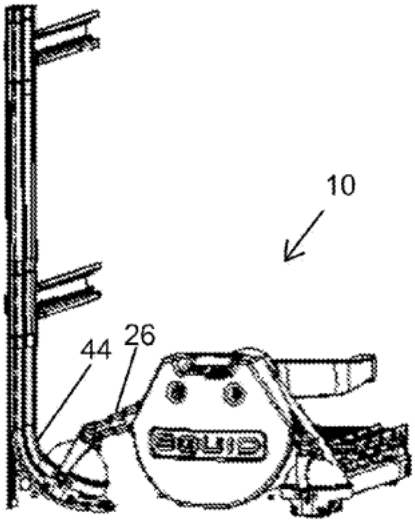


Fig. 8C

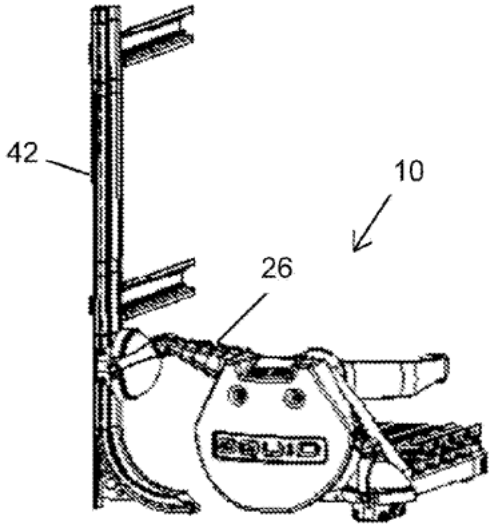


Fig. 8D

Ex. 1005, FIGs. 8E, 8F, 8G

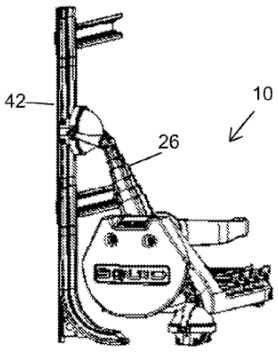


Fig. 8E

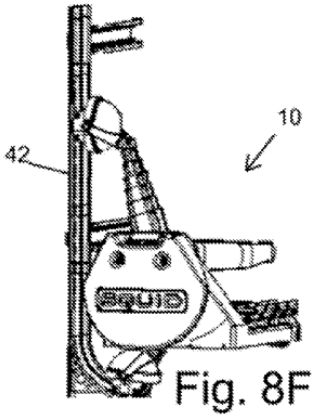


Fig. 8F

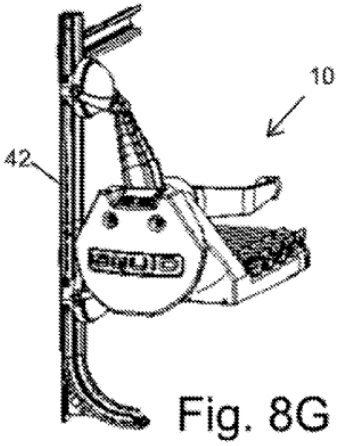


Fig. 8G

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Ex. 1005, FIG. 12A

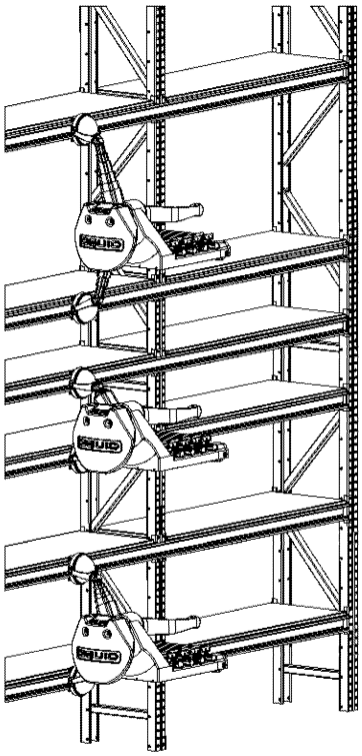


Fig. 12A

B. *Hangzhou* (Ex. 1006)

89. Chinese Patent Publication No. CN 109987366A ("*Hangzhou*," Ex. 1006) is titled "Unmanned Warehousing System and its Inbound and Outbound Methods."

90. *Hangzhou* was filed January 15, 2019, and published July 9, 2019 (Ex. 1006, Cover). Consequently, I have been informed that I should assume *Hangzhou* is prior art under at least 35 U.S.C. § 102(a) (AIA).

91. *Hangzhou* is directed to "an unmanned warehousing system" where "a two-layer channel support frame is provided below a shelf," such that "[the] lower

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layer is used to automatically guide a trolley to pass through," and a "stacking vehicle automatically travels to a designated shelf and aligns with the same, and the standardized container on the shelf is picked up by means of a pickup mechanism." (Ex. 1006, Abstract).

92. *Hangzhou* discloses an "auto-guided trolley" that receives "handling instructions" from a "management terminal." (Ex. 1006, Claim 1). The "auto-guided trolley" is "provided with" "a control portion," "a driving portion" and a "hoisting portion." (Ex. 1006, Claim 1). "The control portion causes the auto-guided trolley to travel by means of the driving portion," and the control portion "causes the hoisting portion to be" "rais[ed] and lower[ed]" "to realize the hoisting or dropping of [a] standardized container." (Ex. 1006, Claim 1).

93. *Hangzhou* seeks to overcome challenges faced by existing systems, including "complex deployment, inconvenient maintenance, and high cost," by providing a solution that is "easy to deploy, convenient to maintain, and cheap." (Ex. 1006, Abstract).

94. *Hangzhou* discloses multiple embodiments that allow the auto-guided trolley to move along a variety of pathways along a warehouse floor along aisles, underneath shelves, and across aisles and to carry containers along these pathways. With reference to Figure 1 (reproduced below), which illustrates Embodiment 1 of the system, *Hangzhou* teaches "an unmanned warehousing system based on mobile

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robots and caching spaces and an inbound and outbound method, involving a storage sorting system for warehousing. The storage system 10 includes a dispatch control system not presented in the figure, multi-layer shelves 100, several auto-guided trolleys 200, several stacking vehicles 300, and optional sorting workstations 50. Auto-guided trolleys 200 and stacking vehicles 300 are generally powered by built-in batteries." (Ex. 1006, ¶[0035]).

Ex. 1006, Figure 1

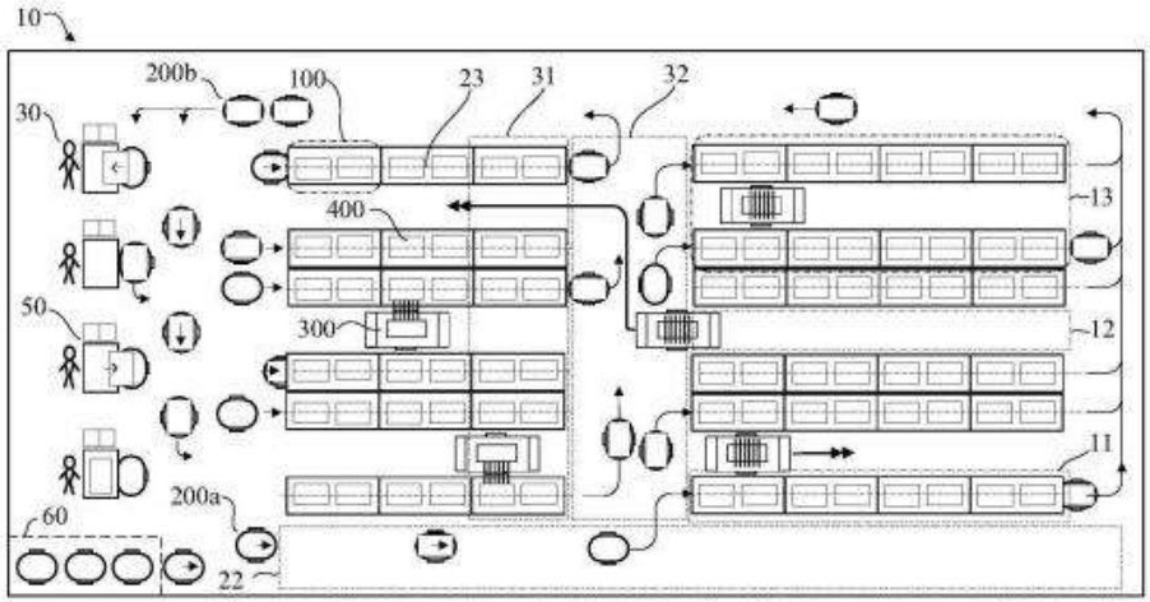


Figure 1

95. With reference to Figure 2 (reproduced below), which illustrates a front-view of the system of Embodiment 1 shown in Figure 1, *Hangzhou* teaches that an "auto-guided trolley travels through the lower layer of the support frame to a position below the container." (Ex. 1006, Abstract). The "auto-guided trolley 200

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preferentially travels in column laneways 32 and auto-guided trolley passage spaces 112." (Ex. 1006, [0048]). Also, "[s]everal modular channel support frames may be mounted below a shelf 100" to raise the shelf to a height greater than the trolley height. (Ex. 1006, [0044]). "Support members 111 divide the space inside channel support frames 110 into an auto-guided trolley passage space 112." (Ex. 1006, [0045]).

Ex. 1006, Figure 2

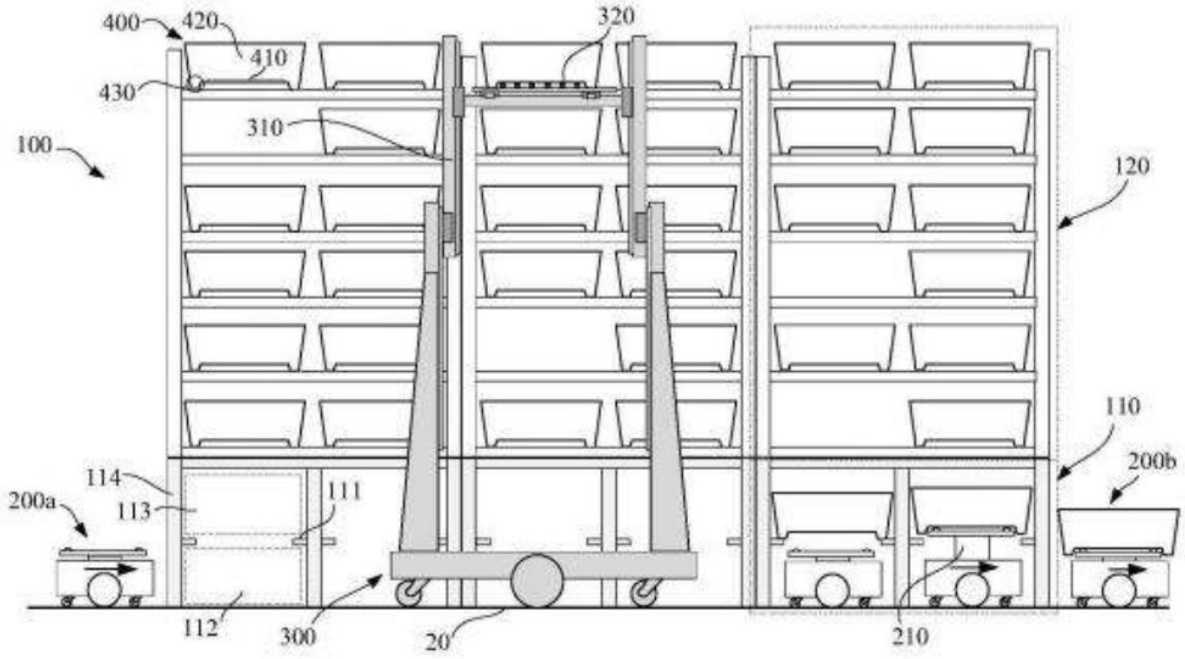


Figure 2

96. With reference to Figure 10 (reproduced below), Hangzhou discloses that "at the position where the dotted lines intersect, an auto-guided trolley 200 may switch between the row direction and the column direction, including the switch between trolley-special row laneways 21 and column channels 33 and between column

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channels 33 and row channels 23. Route switching can usually reduce blockage and shorten the turnover time. Switching the driving direction does not bring a problem to auto-guided trolleys because auto-guided trolleys 200 can be small enough to turn in the auto-guided trolley passage space 112." (Ex. 1006, [0072]).

Ex. 1006, Figure 10

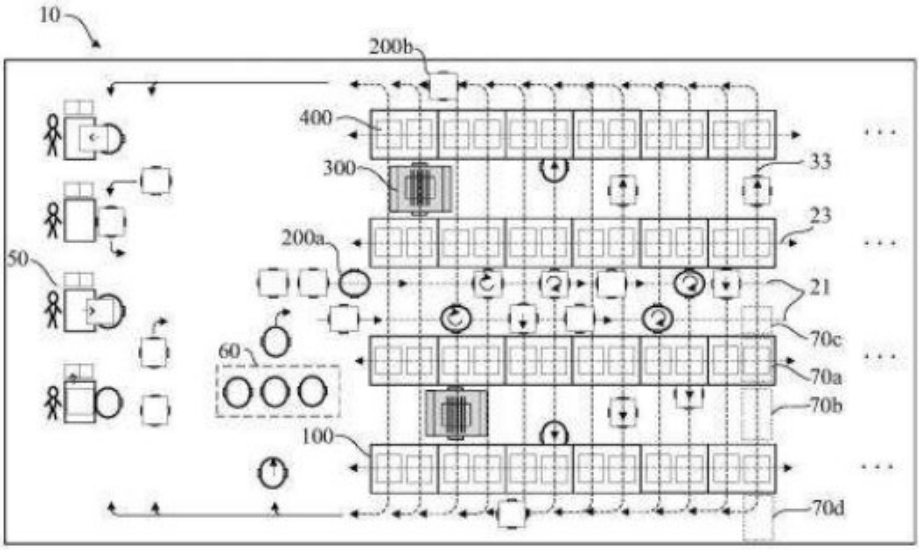


Figure 10

97.*Hangzhou* discloses Embodiment 1, with reference to Figures 1-6, Embodiment 2 with reference to Figures 7-8, Embodiment 3 with reference to Figure 9, and Embodiment 4 with reference to Figure 10. (*See generally* Ex. 1006; Figures 1-10). In *Hangzhou's* Embodiment 1, an "auto-guided trolley 200 preferentially travels in column laneways 32 and auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]). In *Hangzhou's* Embodiment 2, the auto-guided trolleys travel in

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auto-guided passage spaces, and a "column channel 33 where auto-guided trolleys 200 travel" "passes through the stacking row laneway 12 for stacking vehicles 300 to run." (Ex. 1006, ¶[0062]). *Hangzhou's* Embodiment 3 includes the auto-guided trolleys traveling in auto-guided passage spaces and adds to the second embodiment "several trolley-special row laneways 21 between two shelf-laneway combinations 13." (Ex. 1006, ¶¶[0067-0068]).

98. In *Hangzhou's* Embodiment 4, the auto-guided trolleys travel in auto-guided passage spaces, and "an auto-guided trolley 200 may switch between the row direction and the column direction, including the switch between trolley-special row laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006, ¶[0072]). *Hangzhou* refers to Embodiment 4 as "a general form of the previous three embodiments," i.e., Embodiments 1, 2, and 3, and that the Embodiment 4 "allow[s] an auto-guided trolley to choose among all possible paths, which provides the dispatch control system with the maximum search space." (Ex. 1006, ¶[0076]).

IX. THE PRIOR ART RENDERS OBVIOUS CLAIMS 1, 3-12, 14 AND 23-27 OF THE '632 PATENT

A. Ground 1: *Raizer* in view of *Hangzhou* Renders Obvious Claims 1, 3-12, 14 and 23-27 of the '632 patent.

99. *Raizer* in view of *Hangzhou* renders obvious claims 1, 3-12, 14 and 23-27 of the '632 patent.

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Motivation to Combine Raizer* and *Hangzhou

100. There are numerous reasons why a person of ordinary skill in the art would have been specifically motivated to combine *Raizer* and *Hangzhou*.

101. A person of ordinary skill in the art would have had a reasonable expectation of success in the combination of *Raizer* and *Hangzhou* based on the explicit teachings of the references and the knowledge of the person of ordinary skill in the art. Moreover, in view of the disclosures of *Raizer* and *Hangzhou* indicating the robots and trolleys can travel throughout a warehouse, the choice of routing (e.g., turning, under racks, in, across, or parallel to aisles) is an obvious matter of design choice.

102. *Raizer* and *Hangzhou* are both generally directed to the field of automated handling of materials in a warehouse. That is, *Raizer* relates to "the field of automated systems for warehouse management." (Ex. 1005, ¶[0001]). *Hangzhou* relates to "the technical field of warehousing, especially to an unmanned warehousing system." (Ex. 1006, ¶[0001]). These references, like the '632 patent, are directed to automated material and article handling systems which can be used in warehouse, storage, and/or distribution environments to improve the efficient utilization of resources such as space, equipment, and manpower and to improve collision avoidance of automated vehicles (Ex. 1001, 1:12-15; *see also* 1:31-33, 24:20-22 ("…ensure that there are no collisions with other vehicles, with personnel,

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or with fixed structures.")).

103. *Raizer* provides a solution to the problem to be solved by the '632 patent (e.g., improved efficient utilization of resources such as space, equipment, and manpower and collision avoidance), by providing an "automatic system for picking and placing boxes on shelves in a warehouse," where the system includes "a set of autonomous mobile robots," "a network of vertical and horizontal rails that are parallel to [] vertical support posts and horizontal shelves of the shelving system in the warehouse," and a "Real Time Traffic Management (RTTM) server" "configured to communicate with the robots and other processors and servers in the warehouse." (Ex. 1005, ¶¶[0018-0021]). The "Real Time Traffic Management (RTTM) server comprises software that, among other things, generates "traffic control" "instructions" to "send[] to the individual robots." (Ex. 1005, Claim 14). Moreover, *Raizer* explains that its system is a "self-learning system where, for example, algorithm [sic] can track the movement of the robots and organize the routes of traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders." (Ex. 1005, ¶[0098]).

104. *Raizer's* makes clear that "the robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse." (Ex. 1005, ¶[0104]). In view of this, a person of ordinary skill in the art would have understood *Raizer's* system to be directed to addressing congestion issues and

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improving system efficiency. *Raizer* did so by offering a robot with capabilities to move freely and reach any point (e.g., according to x, y, z coordinates) within the warehouse.

105. A person of ordinary skill in the art at the time of the assumed priority date of the '632 patent was well aware of the design need to increase the number of travel ways that are available to autonomous robot vehicles in a warehouse environment such as that disclosed by the *Raizer* in order to decrease congestion and prevent traffic jams. To the extent that *Raizer* were construed as failing to disclose movement of its autonomous robots under its rows of shelves, a person of ordinary skill in the art would have been motivated to consider taking advantage of the mobility of the autonomous robots by considering different travel ways to avoid congestion. *Raizer* also discloses that the autonomous robots and rail system can be implemented in warehouses having a variety of shelving designs as the system is not dependent on the specific shelf structure. (Ex. 1005, ¶[0081]).

106. Considering congestion from a mathematical perspective, given a fixed number of autonomous robot vehicles, increasing the number of travel ways available implies reducing the probability that multiple autonomous robot vehicles use the same travel way, thereby reducing the probability that two autonomous robot vehicles block one another. Thus, increasing the number of travel ways is a logical approach that the skilled person would readily consider.

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107. As evidenced by the Technical Background discussion at Section VI above, a person skilled in the art would consider shelving structures that allow the autonomous robots to travel underneath shelving units to avoid congestion as more robots are used to increase the speed at which items can be retrieved and replaced. It was well known to elevate the shelving units above the floor so that robots loaded with containers can travel underneath thereby allowing for more flexible route planning and the elimination of bottlenecks.

108. *Hangzhou* both identifies and provides a solution to the problem to be solved by the '632 patent (e.g., improved efficient utilization of resources such as space, equipment, and manpower and collision avoidance) by providing "an unmanned warehousing system" based on "mobile robots" and "caching spaces" "involving a storage sorting system," where "a two-layer channel support frame is provided below a shelf," such that "[the] lower layer is used to automatically guide a trolley to pass through." (Ex. 1006, Abstract, ¶[0035]). *Hangzhou* discloses that "an auto-guided trolley 200 preferentially travels in column laneways 32 and in auto-guided trolley passage spaces 112," i.e., under the shelf. (Ex. 1006, ¶[0048]). *Hangzhou* discloses that, to avoid collisions, "auto-guided trolleys carrying standardized containers" "use the cache space below shelf rows," and "run obstacle avoidance algorithms." (Ex. 1006, ¶[0059]).

109. In view of the explicit teaching in *Raizer* of "organiz[ing] the routes of

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traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders" (Ex. 1005, ¶[0098]), a person of ordinary skill in the art would have turned to *Hangzhou* which expressly discloses "preferentially run[ning]" "an auto-guided trolley" "in auto-guided trolley passage spaces 112," i.e., under the shelf. (Ex. 1006, ¶[0048]).

110. A person of ordinary skill in the art would have combined these references to provide the system of *Raizer* with reduced congestion and prevention of traffic jams, while also maximizing efficient use of space, such as by running the robots of *Raizer* in passages under the shelves as disclosed in *Hangzhou* in order to "organize the routes of traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling in orders" as disclosed in *Raizer*. (Ex. 1005, ¶[0098]). Moreover, because the autonomous robots of *Raizer* move both horizontally and vertically, the robots are able to move in the aisles as well as under the shelves to allow maximum flexibility in maneuvering the robots along the warehouse floor and eliminating bottlenecks. Notably, *Raizer* discloses a vertical drive (comprising drive wheels 22, small wheels 36, and drive and steering units 24) operable to move the robot vertically that shares common components with, but is nonetheless distinct from, its horizontal drive system (comprising drive wheels 22, rear wheels 30, and drive and steering units 24).

111. A person of ordinary skill in the art would have understood that

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Raizer's vertical travel flexibility also eliminates the need for *Hangzhou's* stacking vehicles because the *Raizer* robots themselves can pick and place bins or totes on upper shelves, thereby making this combination even more useful. Also, to the extent that *Hangzhou's* disclosure of raising its lowermost shelves to define trolley passages were deemed to possibly reduce available storage space, a person of ordinary skill in the art would have understood that the vertical travel flexibility of *Raizer*'s robots allow for robust increases in available storage space as the shelving units may extend upwardly to take advantage of the full height of a warehouse beyond heights that might be accessible to *Hangzhou's* lifting robots.

112. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* encouragement to use trolleys moving in column and row channels beneath shelves and across aisles to deliver items to picking stations with the three-dimensional travel capabilities of the robots of *Raizer*, because such routing or route switching serves the well-known design need to increase the number of robot travel ways within a warehouse environment thereby reducing congestion and avoiding traffic jams on the warehouse floor. *Hangzhou* also teaches that route switching between column and row channels "can usually reduce blockage and shorten [robot] turnover time." (Ex. 1006, ¶[0072]).

113. Similarly, a person of ordinary skill in the art would have been motivated to combine *Hangzhou's* driving of the trolleys into and across the aisles

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with the "three-dimensional navigation and travel capabilities" of *Raizer,* because such aisle crossing routing also serves the well-known design need to increase the number of robot travel ways within a warehouse environment thereby reducing congestion and avoiding traffic jams.

114. A person of ordinary skill in the art would have also been motivated to combine *Hangzhou's* disclosure of trolleys turning to switch travel directions between perpendicularly arranged column and row channels while under one of the racks with the "three-dimensional navigation and travel capabilities" of the robots of *Raizer*, because such under rack turning reduces congestion and potential for trolley collision. Such turning also allows the *Raizer* robot, which is "completely autonomous and can be steered by its control system to any location on the floor of the warehouse" (Ex. 1005, ¶[0104]), to "choose among all possible paths" thereby further reducing congestion, avoiding tragic jams, and maintaining a more efficient use of space." (Ex. 1006, ¶[0076]).

115. Discussed above are multiple embodiments disclosed by *Hangzhou* that I reference and rely upon in my analysis below. The four embodiments share at least one commonality in that the trolleys travel in passage spaces under the shelves. The latter three embodiments share the commonality that the trolleys can travel into additional laneways. *Hangzhou* further refers to Embodiment 4 as "a general form of the previous three embodiments," i.e., Embodiments 1, 2, and 3. (Ex. 1006,

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¶[0076]). In view of the shared features among *Hangzhou's* multiple embodiments, and *Hangzhou's* explicit disclosure that the embodiment illustrated in FIG. 10 is a general form of the others, a person of ordinary skill in the art would have considered *Hangzhou's* embodiments interchangeable or, at a minimum, as describing features that are readily combinable.

116. For at least the reasons outlined above in this section entitled *Motivation to Combine Raizer* and *Hangzhou*, and those discussed further below, it is my opinion that a person of ordinary skill in the art would have been motivated to combine the teachings of *Raizer* and *Hangzhou*.

Independent Claim 1

Claim 1, Element [1.pre]: A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of:

117. To the extent that element [1.pre] is found to be limiting, *Raizer* discloses claim element [1.pre].

118. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, Abstract). *Raizer* further discloses that the system is comprised of "a set of autonomous mobile robots," "a network of vertical and horizontal rails" that are "parallel to" "vertical support posts and horizontal shelves," and "a Real Time Traffic Management (RTTM) server." (Ex. 1005, Abstract).

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119. *Raizer* discloses that the robots comprise various electronics "configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of [a] network of rails." (Ex. 1005, Abstract).

120. Thus, *Raizer* discloses a method for delivering items to storage locations and retrieving items from storage locations, as recited in claim element [1.pre].

Claim 1, Element [1.a1]: providing a plurality of storage racks spaced apart from one another forming a plurality of aisles,

121. *Raizer* discloses claim element [1.a1].

122. With reference to FIG. 1 (reproduced and annotated below), *Raizer* discloses a "floor plan of a typical warehouse" having a "storage area" with "a plurality of shelving units." (Ex. 1005, ¶[0092]). The shelving units consist of "a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves." (Ex. 1005, ¶[0092]). The "vertical supports divide shelving units into bays (B1, B2, …)." (Ex. 1005, ¶[0092]). The "sides of the shelving units that face the aisles between units are called faces (F1, F2, …)." (Ex. 1005, ¶[0092]).

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Ex. 1005, FIG. 1 (annotated)

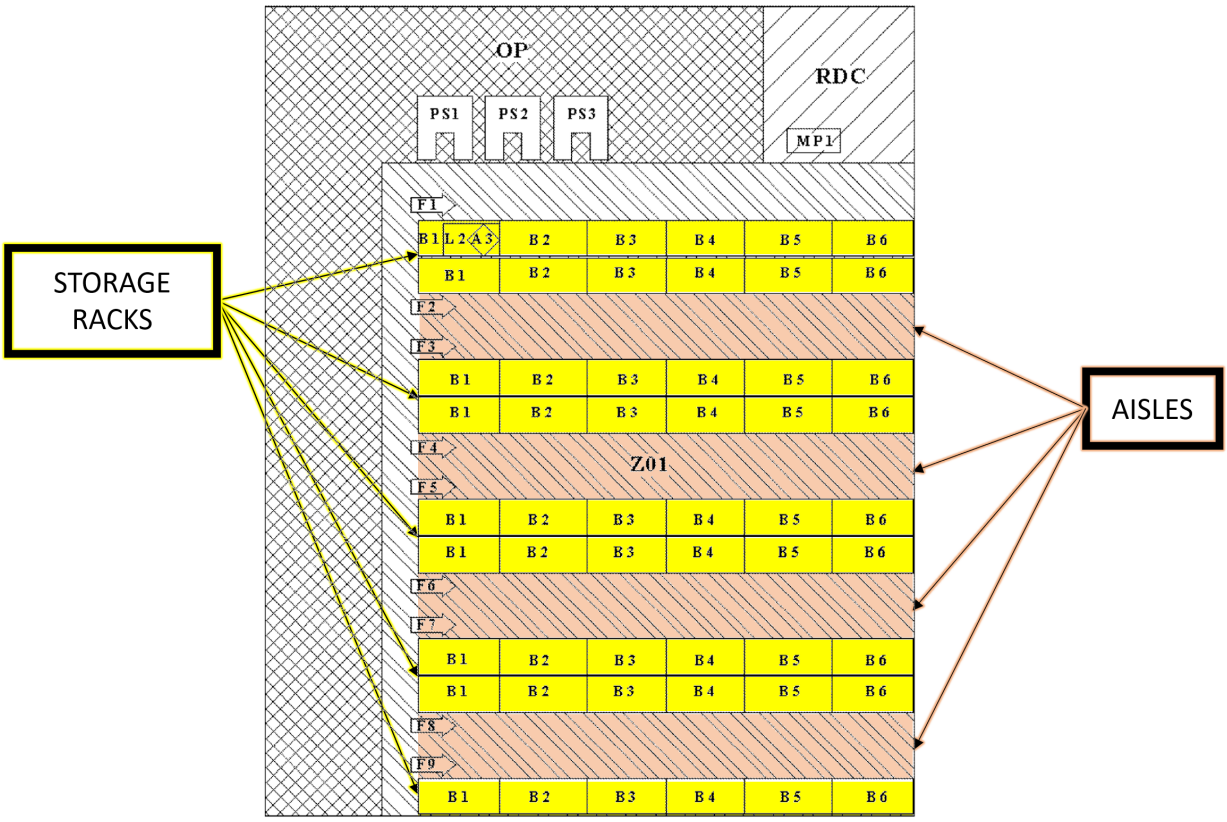


Fig. 1

123. Thus, *Raizer* discloses providing a plurality of storage racks spaced apart from one another forming a plurality of aisles, as recited in claim element [1.a1].

Claim 1, Element [1.a2]: wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;

124. *Raizer* discloses claim element [1.a2].

125. *Raizer*'s "storage area" has "a plurality of shelving units consisting of a framework commonly made up of horizontal and vertical pieces of angle iron that

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support the shelves. The vertical supports divide the shelving unit into sections call [sic] bays" and that "a given row of shelves in a bay . . . can hold several boxes arranged in one or more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]).

126. *Raizer* discloses that the "exact location of a box in the warehouse is designated by an address comprising numbers, letters, signs, color, etc. representing the zone, face, bay, level, and specific location." (Ex. 1005, ¶[0092]). *Raizer* also discloses that the "location of a specific box in the storage area can be designated in other ways, for example using x, y, z coordinates in a coordinate system of the rail system," highlighting the verticality of the system. (Ex. 1005, ¶[0092]).

127. Thus, *Raizer* discloses each storage rack comprises a plurality of columns defined by the vertical supports and each column comprises a plurality of storage locations such as the bays along a given row of shelves, as recited in claim element [1.a2].

Claim 1, Element [1.b1]: providing a plurality of delivery vehicles

128. *Raizer* discloses claim element [1.b1].

129. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, ¶[0018]). The system comprises "a set of autonomous mobile robots." (Ex. 1005, ¶[0019]). The robots "comprise a gripper mechanism" "that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]).

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The robots "complete [a] mission of removing a box from (or delivering a box to) a specific location on a shelf." (Ex. 1005, ¶[0114]).

130. Thus, *Raizer* discloses claim element [1.b1].

Claim 1, Element [1.b2]: wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,

131. *Raizer* discloses claim element [1.b2].

132. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

133. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground," (i.e., along a horizonal surface), "and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

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134. With reference to FIGs. 5A and 5B (reproduced and annotated below), *Raizer* discloses that the "[r]obot 10 moves along the ground on four wheels," where "two rear wheels 30 could be fixed and passive so that they can only rotate about their axles which are perpendicular to the axis of the long beams 28 of the frame and are 'dragged along' by the front wheels," or "the rear wheels could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor." (Ex. 1005, ¶[0104]). "The front driving wheels 22 dictate the steering angle and differential speeds of the rear wheels," and/or "can be independently rotated in any direction by drive and steering units 24." (Ex. 1005, ¶[0104]).

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Ex. 1005, FIG. 5A (annotated)

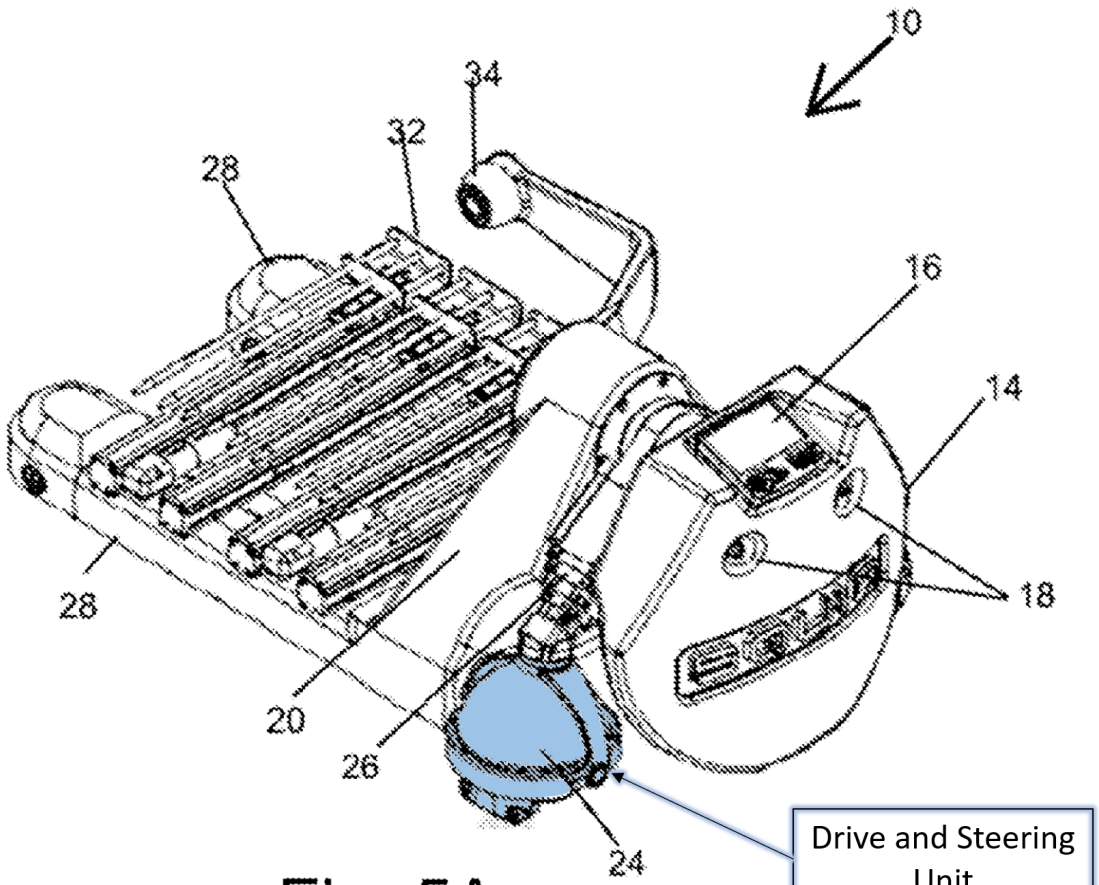


Fig. 5A

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Ex. 1005, FIG. 5B (annotated)

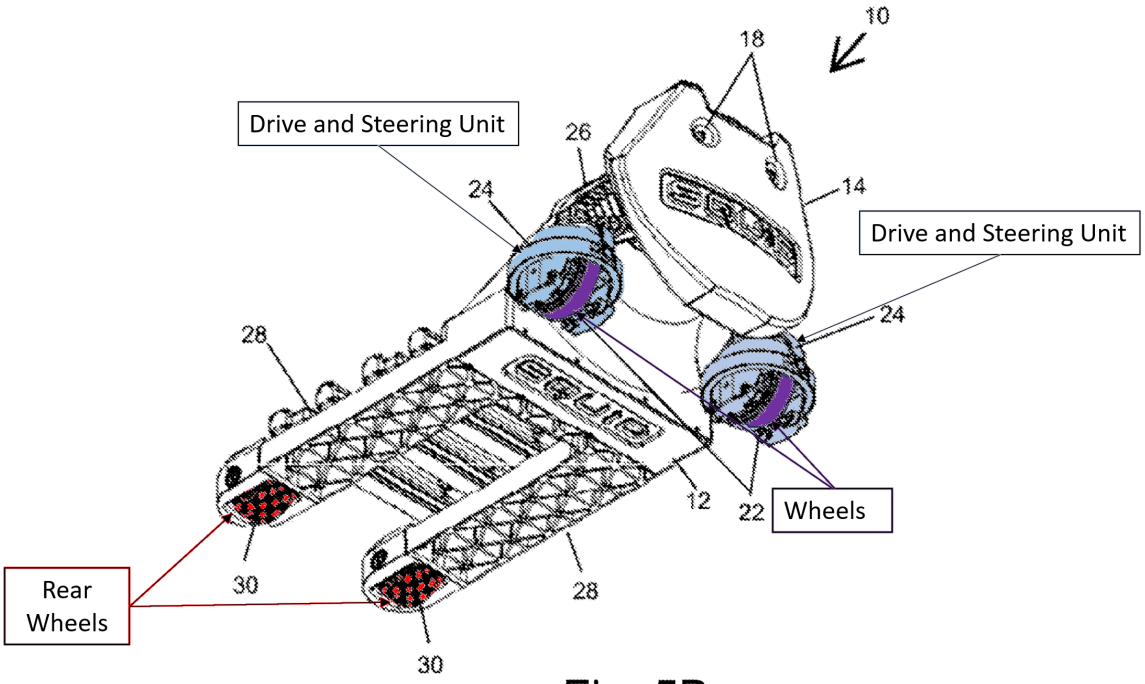


Fig. 5B

135. To be clear, *Raizer* discloses a horizontal drive system comprisingdrive wheels 22 and rear wheels 30, along with drive and steering units 24 that are operable to drive the vehicle along a horizontal surface.

136. Thus, *Raizer* discloses claim element [1.b2].

Claim 1, Element [1.b3]: a vertical drive operable to drive the vehicle vertically and

137. *Raizer* discloses claim element [1.b3].

138. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components

configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

139. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

140. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

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141. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

Ex. 1005, FIG. 8B (annotated)

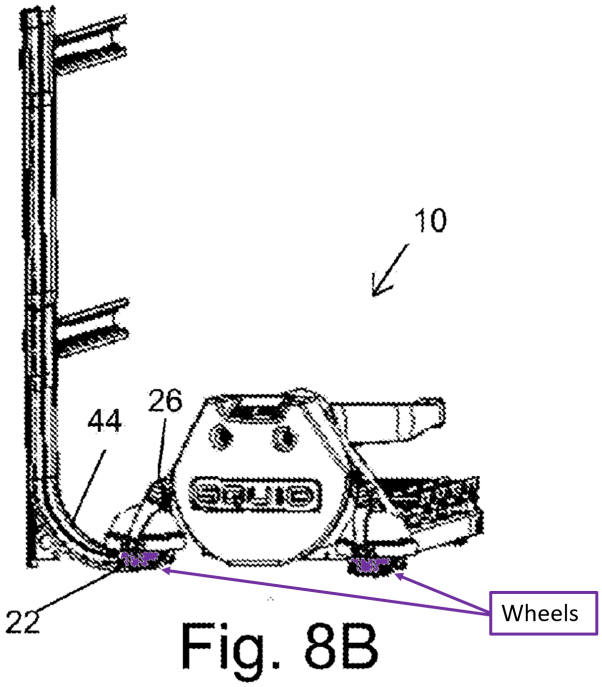


Fig. 8B

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142. In FIG. 8D (reproduced below), *Raizer* depicts, "the right front wheel 22 and right arm unit 26 continu[ing] to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0118]).

Ex. 1005, FIG. 8D

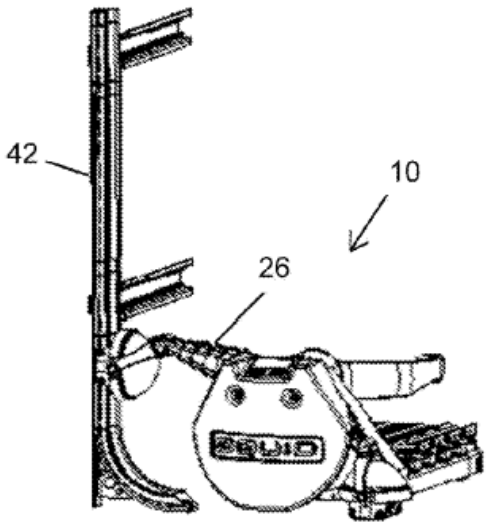


Fig. 8D

143. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

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Ex. 1005, FIG. 8F (annotated)

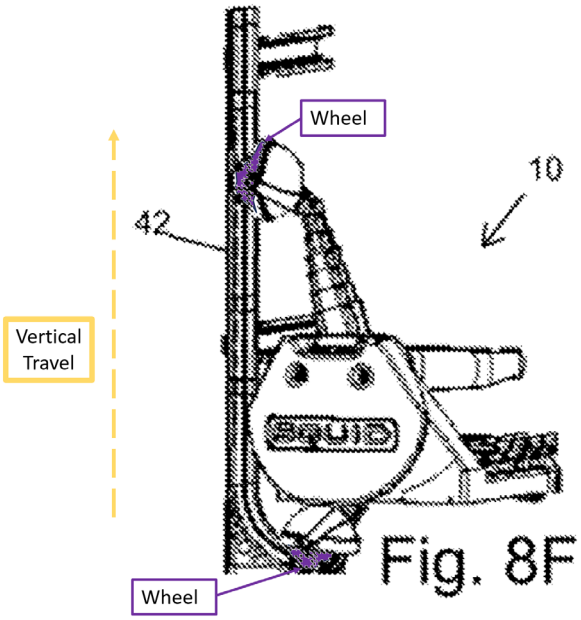


Fig. 8F

144. With reference to FIG. 9A (reproduced and annotated below), *Raizer* shows "a bottom view of the shell 38 of drive and steering unit 24," noting that in the figure "[t]he wheel 22 and all other components of the drive and steering unit have been removed to show the small wheels 36 that lock the robot to the rails." (Ex. 1005, ¶[0122]). As can be seen in FIG. 9A, "on each side of the shell 38 there is a group of five small wheels 36." (Ex. 1005, ¶[0122]). "Each group comprises two wheels mounted with their axles parallel to the sides of the shell and three wheels mounted with the axels [sic] perpendicular to the sides of the shell." (Ex. 1005, ¶[0122]).

Ex. 1005, FIG. 9A (annotated)

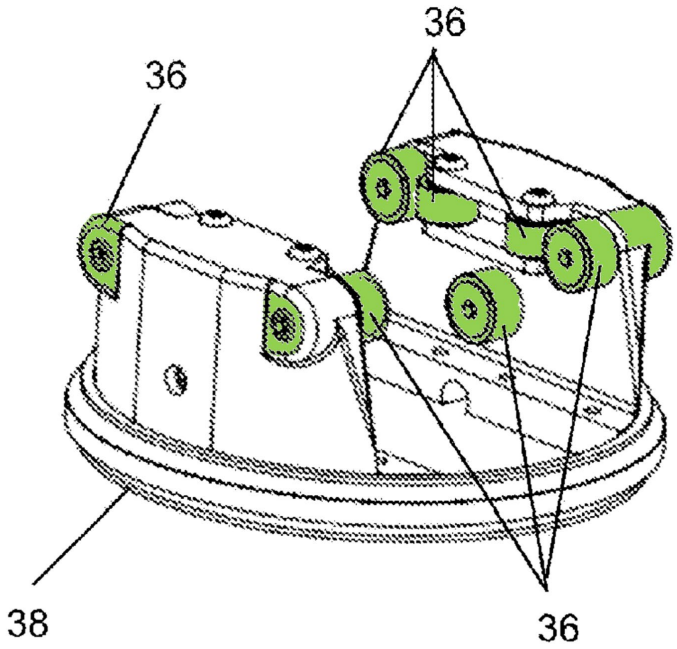


Fig. 9A

145. With reference to FIG. 9B (reproduced and annotated below), *Raizer* discloses "when the drive wheel 22 enters the U shaped channel 46 in rail 42 the small wheels 36 lock the drive wheel on the rail." (Ex. 1005, ¶[0122]).

Ex. 1005, FIG. 9B (annotated)

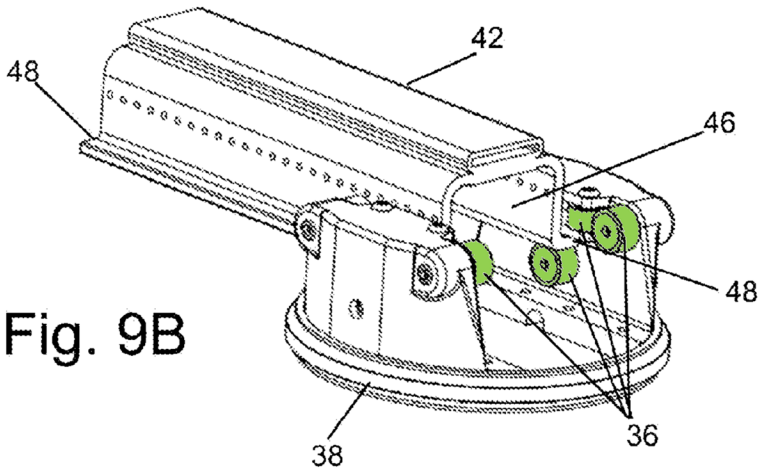


Fig. 9B

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146. To be clear, *Raizer* discloses a vertical drive system comprising drive wheels 22, drive and steering units 24, and small wheels 36 that are operable to drive the vehicle vertically.

147. Thus, *Raizer* discloses a vertical drive operable to drive the vehicle vertically, as recited in claim element [1.b3].

Claim 1, Element [1.b4]: a transfer mechanism operable to transfer an item between the vehicle and one of the storage racks;

148. *Raizer* discloses claim element [1.b4].

149. *Raizer* discloses that the "robots of the system comprise" a "gripper mechanism attached to the top side of the [robot] frame that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The "gripper mechanism comprises an array of micro-pallet lifters" where "each micro-pallet in the array can be independently operated of the others thereby allowing the robot to handle different sized boxes and maximizing the efficient use of shelf space." (Ex. 1005, ¶[0031]). The "robot" can "grab and lift [a] carton" "[i]n order to be able to place the cartons on the shelves or to pick them up." (Ex. 1005, ¶[0101]).

150. *Raizer* discloses that "[t]he combination of the capability of independently changing the lengths and angles of the two arm units 26 and the capability of activating the two drive and steering units 24 independently allows the robot, with the assistance of fine positioning sensor 34, to place a box on a shelf or remove it from any height or any orientation on the shelf." (Ex. 1005, ¶[0133]).

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151. With reference to FIG. 14A (reproduced below), *Raizer* shows a "robot 10 positioning a box 158 on top of a stack of three other boxes on a shelf in the storage area of the warehouse." (Ex. 1005, ¶[0138]).

Ex. 1005, FIG. 14A

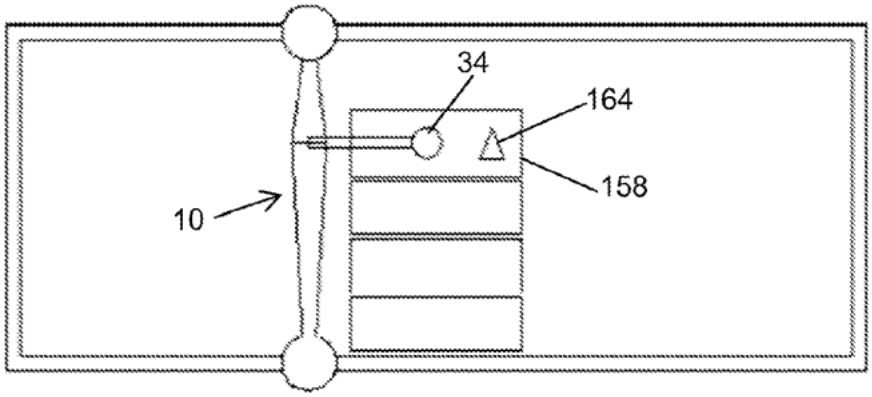


Fig. 14A

152. Thus, *Raizer* discloses a transfer mechanism (the "gripper mechanism") operable to transfer an item between the vehicle and one of the storage racks, as recited in claim element [1.b4].

Claim 1, Element [1.c]: driving a first one of the vehicles to drive the first vehicle to the storage racks;

153. *Raizer* discloses claim element [1.c].

154. *Raizer* discloses driving a first one of the vehicles to drive the first vehicle to the storage rack. *Raizer* discloses "a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots" and that "the robots comprise a set of on-board sensors, a processor,

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software, and other electronics configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Abstract, ¶[0022]).

155. *Raizer* discloses that the robots have "[a] processor, software, and a set of on-board sensors" that are "configured to enable each robot to employ anchor point navigation method to carry out tasks assigned to it by the RTTM." (Ex. 1005, ¶[0034]). By employing "anchor point navigation," the robots "use less accurate sensing and motions when travelling on the floor in order to arrive at the designated destination as rapidly and efficiently as possible." (Ex. 1005, ¶[0080]).

156. *Raizer* further discloses that the robots may "employ dedicated algorithms and more precise sensing only when near anchor points, i.e. fixed specific locations in the warehouse such as terminals (locations at which the robot leaves the floor and climbs a vertical rail of the shelving system)." (Ex. 1005, ¶[0080]).

157. Thus, *Raizer* discloses driving a first one of the vehicles to drive the first vehicle to the storage rack, as recited in claim element [1.c].

Claim 1, Element [1.d1]: driving the first vehicle along a first path under a first one of the racks

158. *Raizer* in view of *Hangzhou* renders obvious claim element [1.d1]. As discussed with respect to claim elements [1.a] and [1.c], *Raizer* discloses a plurality

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of storage racks (shelves) and driving the first vehicle to various locations in the warehouse and different storage locations.

159. *Raizer* further discloses that its system is "plug and play in any warehouse, integrating with an already in-use facility, shelving system and infrastructure resources of a conventional warehouse." (Ex. 1005, ¶[0079]). *Raizer* also discloses that its system deploys "a self-learning system where, for example, algorithm [sic] can track the movement of the robots and organize the routes of traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders." (Ex. 1005, ¶[0098]).

160. To the extent that *Raizer* does not explicitly disclose driving a first vehicle along a first path under a first one of the racks, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

161. *Hangzhou* discloses "an unmanned warehousing system" where "a two-layer channel support frame is provided below a shelf." (Ex. 1006, Abstract). Of the two layers, "[the] lower layer is used to automatically guide a trolley to pass through," (i.e., under the shelf). (Ex. 1006, Abstract). That is, an "auto-guided trolley travels through the lower layer of the support frame to a position below the container." (Ex. 1006, Abstract). The "auto-guided trolley" "is a small mobile robot with auto-navigation ability, usually driven by a differential gear train." (Ex. 1006,

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¶[0048]). The "auto-guided trolley 200 preferentially travels in column laneways 32 and auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]).

162. *Hangzhou*, with reference to Figure 2 (reproduced and annotated below), discloses "several modular support frames" are "mounted beneath a shelf 100" and "support members 111 may be placed at a position on upright columns 114 that are slightly higher than the trolley." (Ex. 1006, ¶[0044]). "Support members 111 divide the space inside channel support frames 110 into an auto-guided trolley passage space 112." (Ex. 1006, ¶[0045]). The "passage space 112" is annotated in Figure 2 below in blue.

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Ex. 1006, Figure 2 (annotated)

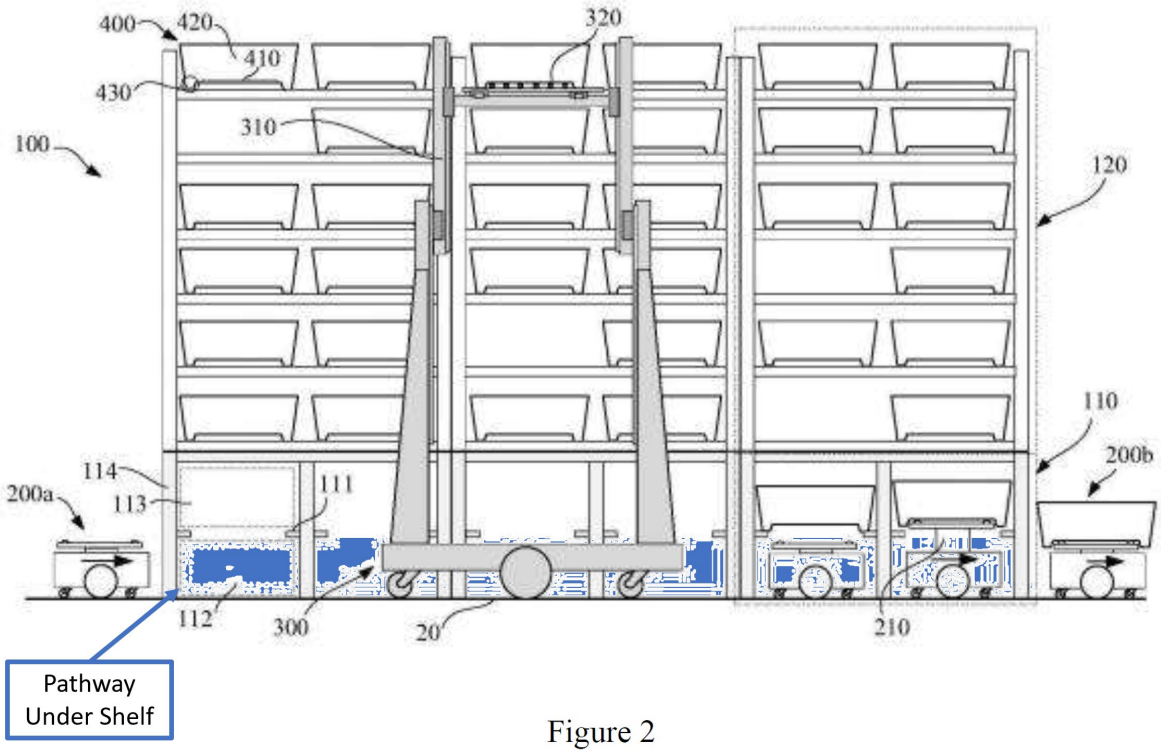


Figure 2

163. That is, Hangzhou discloses a shelf (e.g., a first rack), with a lower layer of a channel support frame that is set up under the shelf, and that the automatically guided trolley (e.g., first vehicle) passes through the lower layer (e.g., is driven along a first path that is under one the first rack).

164. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* driving of the trolleys along a first path under a first rack with the "three-dimensional navigation and travel capabilities" of *Raizer* to provide the system of *Raizer* with increased travel paths for the robots to reduce congestion,

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avoid traffic jams, and maintain a more efficient use of space. A person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

165. Thus, *Raizer* in view of *Hangzhou* renders obvious driving the first vehicle along a first path under a first one of the racks, as recited in claim element [1.d1].

Claim 1, Element [1.d2]: wherein the first rack is adjacent a first one of the aisles and

166. *Raizer* in view of *Hangzhou* renders obvious claim element [1.d2].

167. As discussed with reference to claim element [1.a], *Raizer* discloses a plurality of storage racks (shelves) spaced apart from one another forming a plurality of aisles where the row of racks (shelves) is adjacent the aisle. To the extent *Raizer* does not explicitly discloses a first rack adjacent an aisle, where the vehicle travels under the first rack, the person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

168. *Hangzhou*, with reference to Figure 1 (reproduced and annotated below), also discloses an "unmanned warehousing system, based on mobile robots" and "multi-layer shelves 100." (Ex. 1006, [0035]). The shelves are "placed in rows and columns." (Ex. 1006, ¶[0037]). For example, "multiple modular shelves 100 are horizontally connected into a shelf row 11, and a stacking row laneway 12, which is

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mainly for stacking vehicles 300 to travel and operate and occasionally for auto-guided trolleys 200 and workers to pass through, is provided in front of each shelf row 11." (Ex. 1006, ¶[0037]).

Ex. 1006, Figure 1 (annotated)

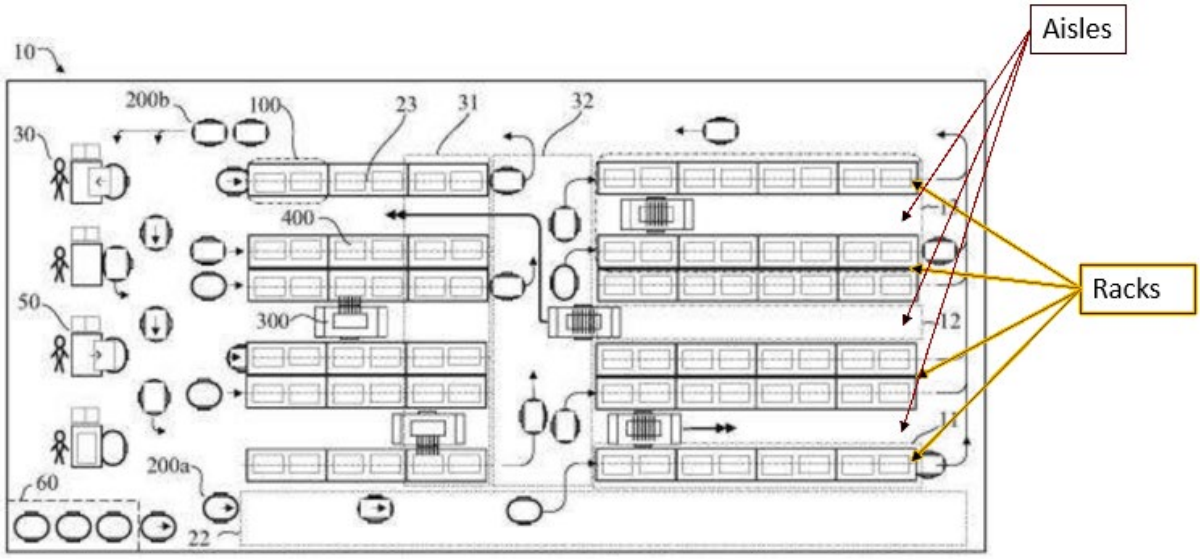


Figure 1

169. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* driving of the trolleys along a first path under a first rack wherein the aisle is adjacent the first rack with the "three-dimensional navigation and travel capabilities" of *Raizer* to provide the system of *Raizer* with reduced congestion, fewer traffic jams, and to maintain a more efficient use of space. A person of ordinary skill in the art would have further been motivated to combine

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Raizer and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

170. Thus, *Raizer* in view of *Hangzhou* renders obvious wherein the first rack is adjacent a first one of the aisles, as recited in claim element [1.d2].

Claim 1, Element [1.d3]: wherein the first path extends in a direction parallel to the first aisle and spaced apart from the first aisle;

171. *Raizer* in view of *Hangzhou* renders obvious claim element [1.d3].

172. As discussed with reference to claim element [1.a], *Raizer* discloses a plurality of storage racks (shelves) spaced apart from one another forming a plurality of aisles adjacent to the row of racks (shelves) under which the robot may travel in a first path spaced apart from and parallel to a first aisle. To the extent *Raizer* does not explicitly disclose the first path extending in a direction parallel to the first aisle and spaced apart from the first aisle, the person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

173. Figure 10 (reproduced below), which represents Embodiment 4 of *Hangzhou* is a "general form of the previous three embodiments," (Ex. 1006, ¶[0076]), including Embodiment 1, as depicted in Figures 1 and 2, and provides the "stacking row aisles 12" and "column channel 33" where auto-guided trolley 200 travel as described with respect to FIGs. 1 and 8 (Ex. 1006 ¶[0062) as well as additional pathways that may be traveled along the warehouse floor. With further

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reference to Figure 10 (reproduced and annotated below)[3], *Hangzhou* discloses that a "dotted line displayed on the center line of each shelf row is used to indicate the row channel 23 for auto-guided trolleys 200 under the shelf, which is a path parallel to the stacking row laneway 12." (Ex. 1006, ¶[0040]).

[3] It is noted that Figure 10 of *Hangzhou* also discloses a first path extending in a direction parallel to the first aisle and spaced apart from the first aisle. (Ex. 1006, ¶[0072]; Figure 10).

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Ex. 1006, Figure 10 (annotated)

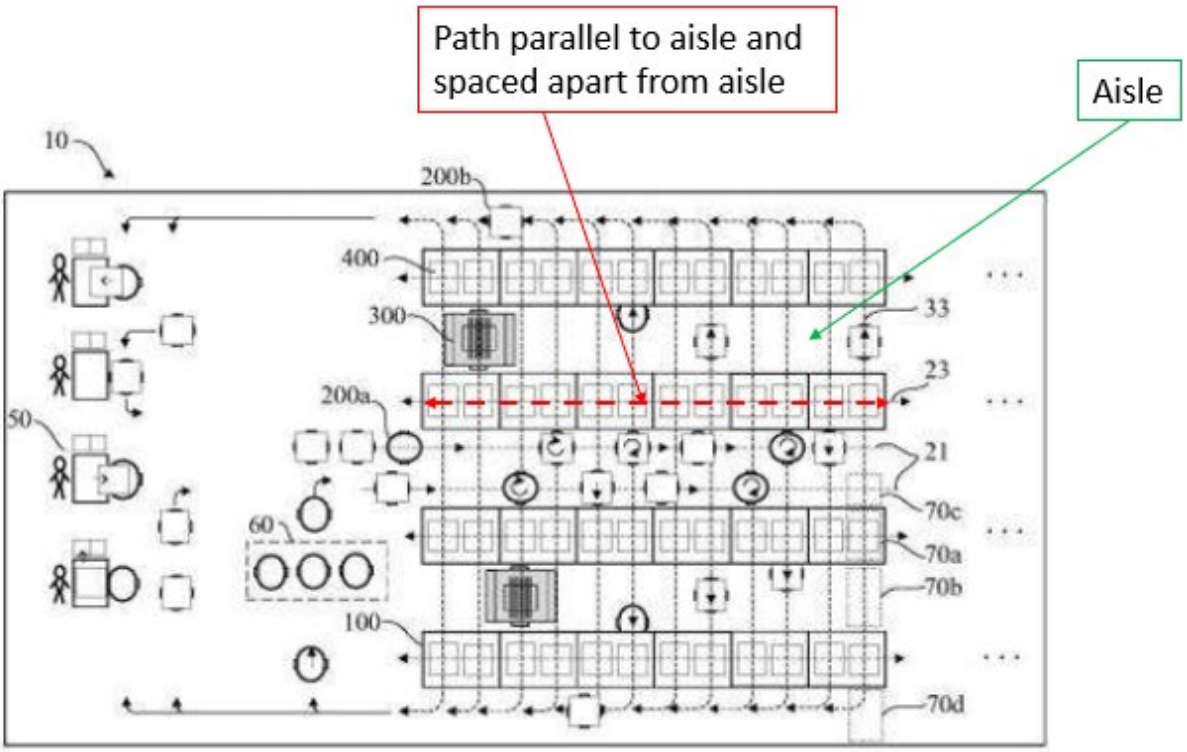


Figure 10

174. That is, the "auto-guided trolleys 200" travel "under the shelf," as indicated by the dotted line in Figure 1, and *Hangzhou* explicitly refers to that path as "a path parallel to the stacking row laneway 12" (i.e., an aisle). (Ex. 1006, ¶[0040]). Further, because the "auto-guided trolleys 200" travel "under the shelf" and not in "the stacking row laneway," the path of the "auto-guided trolleys 200" is spaced apart from the aisle.

175. A person of ordinary skill in the art would have been motivated to combine *Hangzhou*'s driving of the trolleys underneath the storage shelves in a

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direction parallel to the aisle with the "three-dimensional navigation and travel capabilities" of *Raizer* to increase travel paths for the robots to reduce congestion, avoid traffic jams, and maintain a more efficient use of space. Notably, such a combination would have been especially desirable to a person of ordinary skill in the art because the *Raizer's* three-dimensional movement capabilities eliminate the need for *Hangzhou's* stacking robot, thus creating even more reduced congestion and opening up an even a greater number of travel paths (i.e., under storage shelf racks and along aisles). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

176. Thus, *Raizer* in view of *Hangzhou* renders obvious wherein the first path extends in a direction parallel to the first aisle and spaced apart from the first aisle, as recited in claim element [1.d3].

Claim 1, Element [1.e]: turning the first vehicle while the first vehicle is under the first rack;

177. *Raizer* in view of *Hangzhou* renders obvious claim element [1.e]. As discussed with respect to claim elements [1.b1], [1.b2], [1.b3], [1.b4], and [1.c], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

178. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components

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configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). *Raizer* further discloses that "[t]he two front wheels 22 can be independently rotated in any direction by drive and steering units 24. With this arrangement the robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse without the use of a track, embedded wire or any other arrangement to guide it." (Ex. 1005, ¶[0104]). The "motor of the drive assembly is a variable speed motor," making it possible to "steer the robot by activating the drive motors to produce differential rotational speeds of the two front drive wheels." (Ex. 1005, ¶[0109]).

179. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

180. *Raizer* further discloses that its system is "plug and play in any warehouse, integrating with an already in-use facility, shelving system and infrastructure resources of a conventional warehouse." (Ex. 1005, ¶[0079]). *Raizer* also discloses that its system deploys "a self-learning system where, for example, algorithm [sic] can track the movement of the robots and organize the routes of

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traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders." (Ex. 1005, ¶[0098]).

181. To the extent that *Raizer* does not explicitly disclose turning the first vehicle while the first vehicle is under the first rack, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

182. As discussed above with respect to claim element [1.d1], *Hangzhou* discloses driving the vehicle under the rack. *Hangzhou* further discloses that the "trolleys are generally designed in symmetrical to turn in place." (Ex. 1006, ¶[0048]).

183. With reference to Figure 10 (reproduced below), which depicts Embodiment 4 of *Hangzhou* having all of the features of Embodiment 1 disclosed in connection with Figures 1 and 2, *Hangzhou* discloses that "an auto-guided trolley 200 may switch between the row direction and the column direction," noting that "[s]witching the driving direction does not bring a problem to auto-guided trolleys because auto-guided trolleys 200 can be small enough to turn in the auto-guided trolley passage space 112." (Ex. 1006, ¶[0072]).

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Ex. 1006, Figure 10

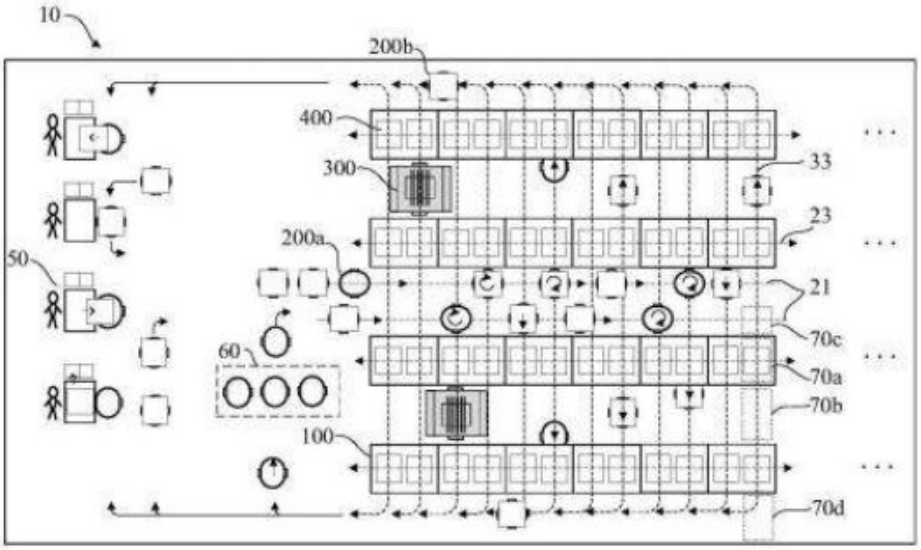


Figure 10

184. *Hangzhou* further discloses that an "auto-guided trolley 200 carrying standardized containers 400 switches between the row and column directions along the traveling direction by performing a series of actions, including dropping and docking the standardized containers on the support members, the *trolley turning 90° in place*, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

185. The "trolley passage space 112" can be seen in Figure 2 (reproduced and annotated below) as being under the rack. *Hangzhou* discloses that "a row channel, a column channel, or both the row and column channels are provided for the auto-guided trolley carrying the standardized container or the moveable bracket to travel under the shelf." (Ex. 1006, ¶[0008]). "[C]ache spaces 113" are disclosed

for "docking standardized containers," and "[a] horizontal gap is spared between members 111, making auto-guided trolley passage connect the cache spaces 113." (Ex. 1006, ¶[0045]). This "allow[s] auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

Ex. 1006, Figure 2 (annotated)

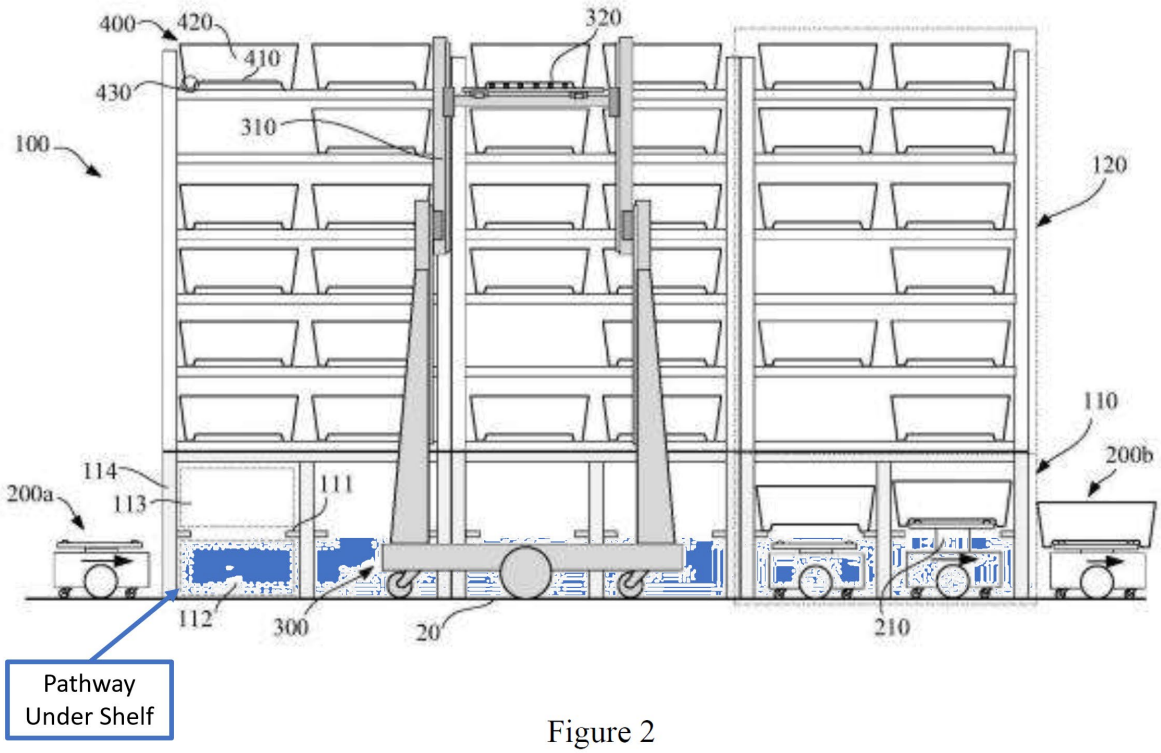


Figure 2

186. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf. However, were *Raizer's* disclosure

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deemed insufficient to disclose this feature, a person of ordinary skill in the art would have been motivated to combine *Hangzhou's* trolley being configured to rotate in place 90° under shelves to switch traveling direction with the three dimensional travel capabilities of *Raizer* because, as taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). Route switching based on such turning also "usually reduce[s] blockage and shorten[s] [trolley] turnover time." (Ex. 1006, ¶[0072]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

187. Thus, *Raizer* in view of *Hangzhou* renders obvious turning the first vehicle while the first vehicle is under the first rack, as recited in claim element [1.e].

Claim 1, Element [1.f]: driving the vehicle into the first aisle;

188. *Raizer* in view of *Hangzhou* renders obvious claim element [1.f]. As discussed with reference to claim element [1.b1], [1.b2], [1.b3], [1.b4], [1.c], and [1.e], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

189. *Raizer* discloses "a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots" and

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that "the robots comprise a set of on-board sensors, a processor, software, and other electronics configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Abstract, ¶[0022]).

190. *Raizer* discloses that the robots have "[a] processor, software, and a set of on-board sensors" that are "configured to enable each robot to employ anchor point navigation method to carry out tasks assigned to it by the RTTM." (Ex. 1005, ¶[0034]). By employing "anchor point navigation," the robots "use less accurate sensing and motions when travelling on the floor in order to arrive at the designated destination as rapidly and efficiently as possible." (Ex. 1005, ¶[0080]).

191. *Raizer* further discloses that the robots may "employ dedicated algorithms and more precise sensing only when near anchor points, i.e. fixed specific locations in the warehouse such as terminals (locations at which the robot leaves the floor and climbs a vertical rail of the shelving system)." (Ex. 1005, ¶[0080]). To the extent *Raizer* does not explicitly disclose driving the vehicle into the aisle, the person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

192. *Hangzhou* also discloses driving the vehicle into the first aisle from the pathways underneath the shelving units. As discussed with reference to claim

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element [1.e], *Hangzhou* discloses "auto-guided trolley[s] 200 preferentially travels in column laneways 32 and auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]). With reference to Figure 10 (reproduced and annotated below), *Hangzhou* discloses that the "auto-guided trolleys" can "switch between trolley-special row laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006, ¶[0072]). As illustrated in Figure 10, the trolley can move underneath the shelving units in a path parallel to the aisles (such as row channels 23), and then turn to travel from underneath the shelving unit and across aisles (such as row laneways 21 along the column channels 33).

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Ex. 1006, Figure 10 (annotated)

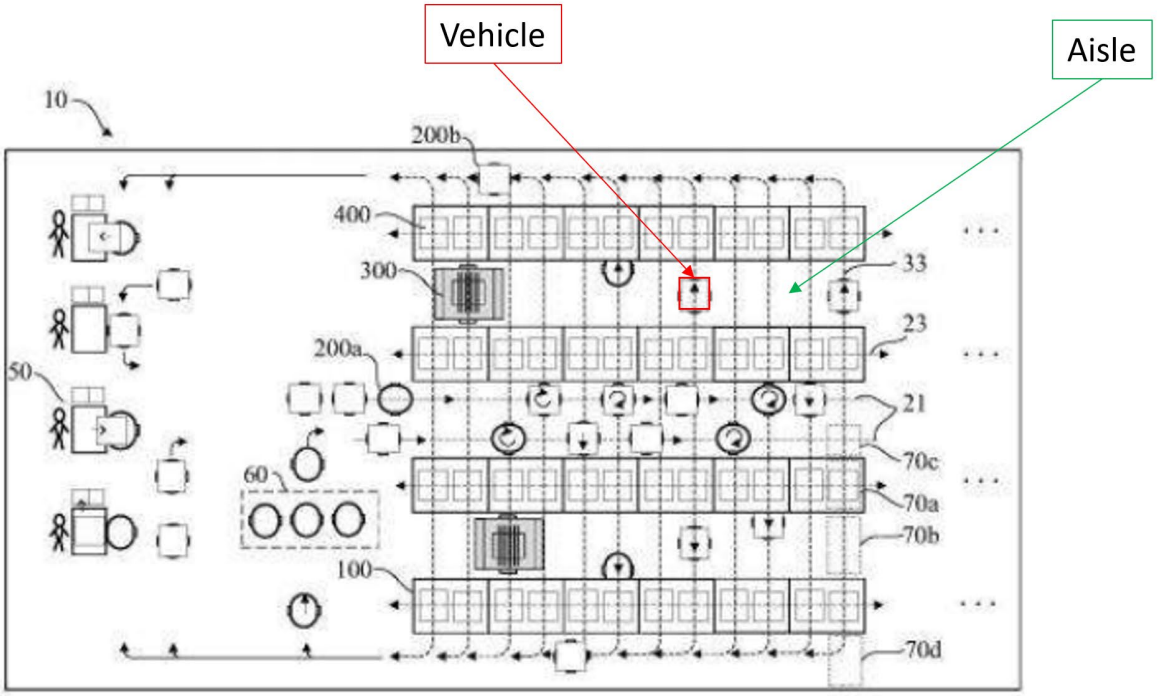


Figure 10

193. The embodiment illustrated in Figure 10 is "a general form of the previous three embodiments," (Ex. 1006, ¶[0076]) including Embodiment 1, as illustrated in Figures 1-6, and provides additional pathways that may be traveled along the warehouse floor. A person of ordinary skill in the art would have understood that the additional pathways shown in Figure 10 allow for travel underneath the shelves and across aisles.

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194. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf and then travel across an aisle as disclosed in *Hangzhou*. As taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

195. Thus, *Raizer* in view of *Hangzhou* renders obvious driving the vehicle into the first aisle, as recited in claim element [1.f].

Claim 1, Element [1.g]: driving the first vehicle upwardly in the aisle to a first of the storage locations;

196. *Raizer* discloses claim element [1.g].

197. *Raizer* discloses that, "[i]n order to complete its mission of removing a box from (or delivering a box to) a specific location on a shelf the robot travels vertically with both front wheels in the same vertical rail and travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

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198. *Raizer* discloses a "network of vertical and horizontal rails that are parallel to the vertical support posts and horizontal shelves of the shelving system in the warehouse." (Ex. 1005, ¶[0020]). A "curved piece of rail called a terminal 44 is attached to the bottom of the vertical rails where they reach the ground." (Ex. 1005, ¶[0111]). "This is the only place where robots 10 can connect or disconnect from the rails 42 in order to climb or descend from the shelves." (Ex. 1005, ¶[0111])

199. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]). These vertical rails are engaged by the robots in the aisles between the shelves.

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Ex. 1005, FIG. 8B (annotated)

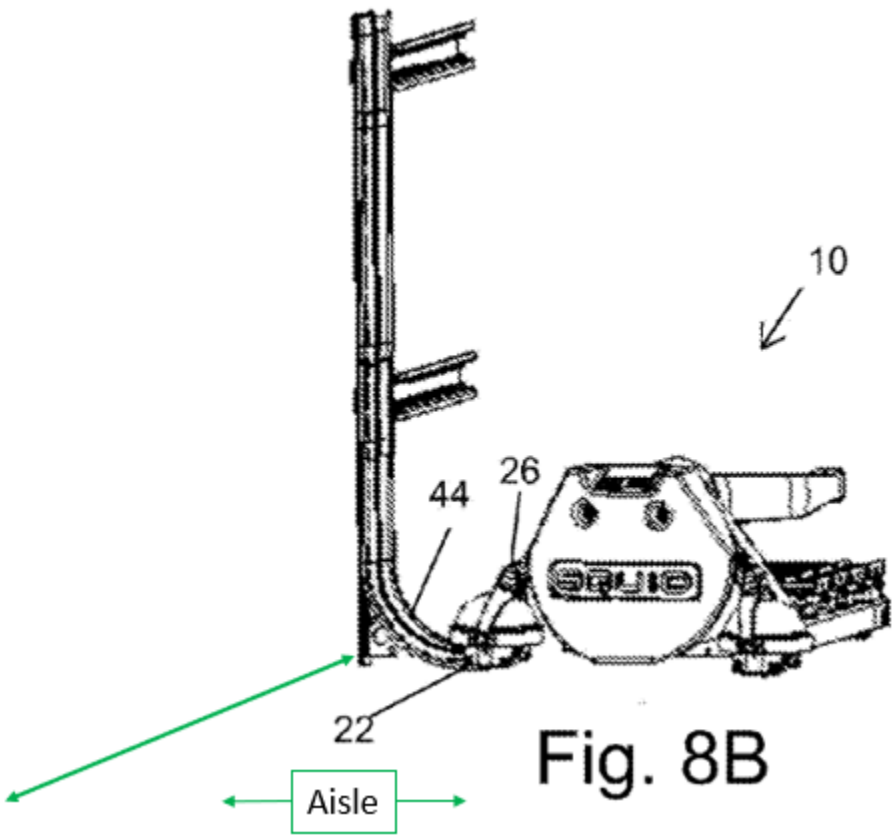


Fig. 8B

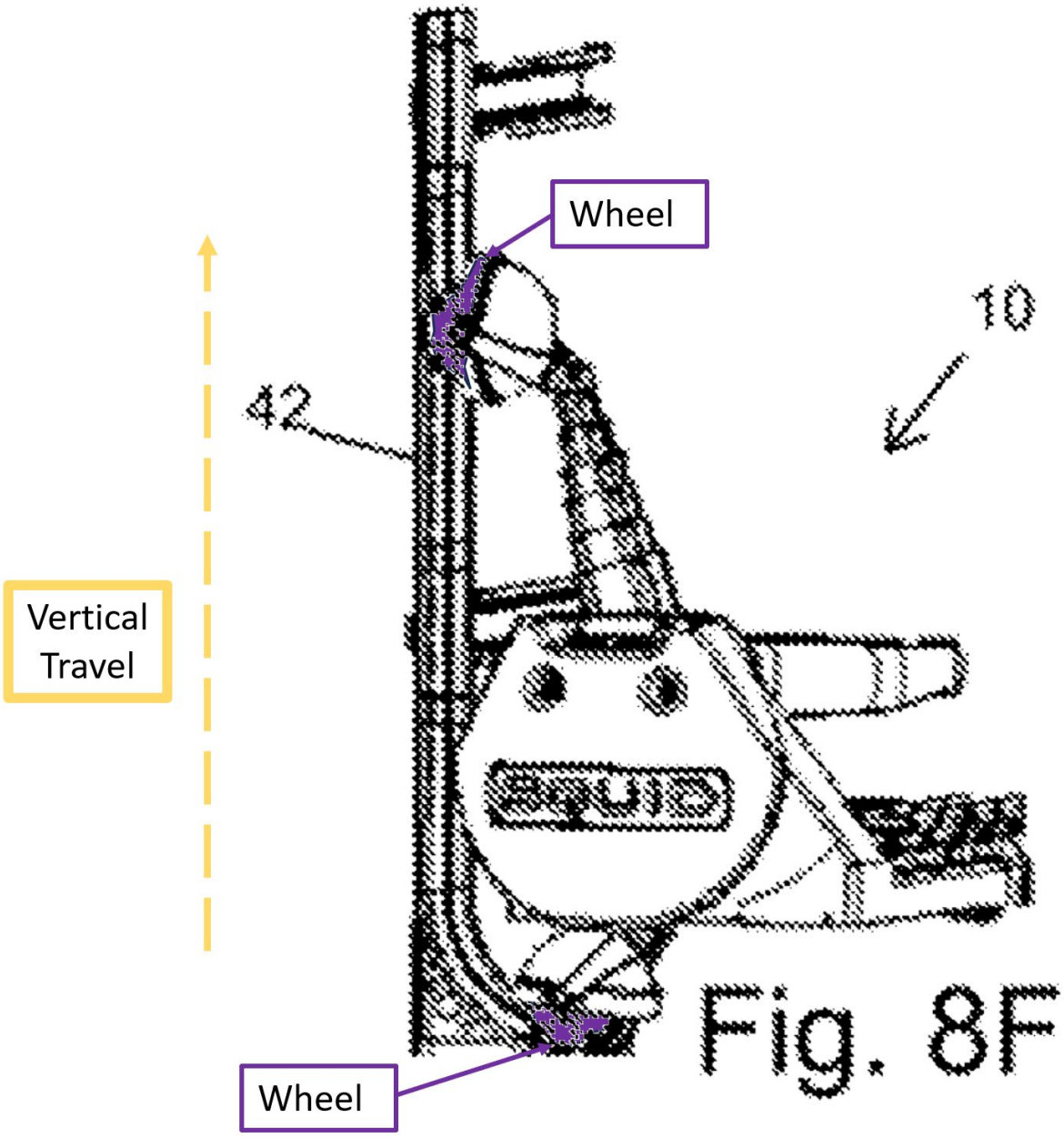
200. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

201. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10

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slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

Ex. 1005, FIG. 8F (annotated)



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202. Thus, *Raizer* discloses driving the first vehicle upwardly in the aisle to a first of the storage locations, as recited in claim element [1.g].

Claim 1, Element [1.h]: transferring an item between the first vehicle and the first storage location;

203. *Raizer* discloses transferring an item between the first vehicle and the first storage location, as recited in claim element [1.h].

204. *Raizer* discloses that the "robots of the system comprise" a "gripper mechanism attached to the top side of the [robot] frame that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The "gripper mechanism comprises an array of micro-pallet lifters" where "each micro-pallet in the array can be independently operated of the others thereby allowing the robot to handle different sized boxes and maximizing the efficient use of shelf space." (Ex. 1005, ¶[0031]). The "robot" can "grab and lift [a] carton" "[i]n order to be able to place the cartons on the shelves or to pick them up." (Ex. 1005, ¶[0101]).

205. *Raizer* discloses that "[t]he combination of the capability of independently changing the lengths and angles of the two arm units 26 and the capability of activating the two drive and steering units 24 independently allows the robot, with the assistance of fine positioning sensor 34, to place a box on a shelf or remove it from any height or any orientation on the shelf." (Ex. 1005, ¶[0133]).

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206. With reference to FIG. 14A (reproduced below), *Raizer* shows a "robot 10 positioning a box 158 on top of a stack of three other boxes on a shelf in the storage area of the warehouse." (Ex. 1005, ¶[0138]).

Ex. 1005, FIG. 14A

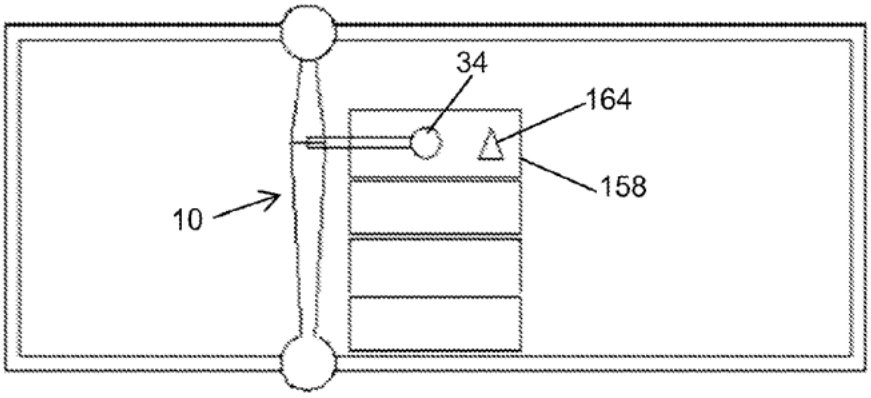


Fig. 14A

207. Thus, *Raizer* discloses transferring an item between the first vehicle and the first storage location, as recited in claim element [1.h].

Claim 1, Element [1.i]: driving the first vehicle downwardly in the aisle until the vehicle is on a horizontal surface;

208. *Raizer* discloses driving the first vehicle downwardly in the aisle until the vehicle is on the horizontal surface, as recited in claim element [1.i].

209. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3

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dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

210. *Raizer* further discloses that the "three-dimensional navigation and travel capabilities" enable a robot "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Claim 1; emphasis added; see also Claims 4, 18).

211. Thus, *Raizer* discloses driving the first vehicle downwardly in the aisle until the vehicle is on the horizontal surface, as recited in claim element [1.i].

Claim 1, Element [1.j]: driving the first vehicle across the first aisle after the step of driving the first vehicle downwardly; and

212. *Raizer* in view of *Hangzhou* renders obvious claim element [1.j].

213. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

214. *Raizer* further discloses that the "three-dimensional navigation and travel capabilities" enable a robot "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the

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network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Claim 1; see also Claims 4, 18).

215. To the extent that *Raizer* does not explicitly disclose driving the vehicle across the first aisle after the step of driving the first vehicle downwardly, a person of ordinary skill in the art would have understood that, in view of *Raizer*'s disclosure of the robot's ability "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse," a robot could be driven across an aisle after having been driven downwardly to a horizontal surface.

216. Given *Hangzhou's* disclosure of trolleys "carrying standardized containers" "in row and column directions" (Ex. 1006, ¶[0050]) underneath the shelving units and across multiple aisles along the column channels as discussed with respect to claim elements [1.d1], [1.d2], [1.d3], and [1.f], it would have been obvious to a person of ordinary skill in the art to combine *Hangzhou's* movement capabilities underneath the shelves and across multiple aisles to *Raizer's* system because to do so allows *Raizer's* robots to move more directly to and from picking stations while also reducing congestion and more efficiently using warehouse space. A person of ordinary skill in the art would have further been motivated to combine

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Raizer and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

217. Thus, *Raizer* in view of *Hangzhou* renders obvious driving the first vehicle across the first aisle after the step of driving the first vehicle downwardly, as recited in claim element [1.j].

Claim 1, Element [1.k]: driving the vehicle out from under the storage racks after the step of driving the first vehicle across the first aisle.

218. *Raizer* in view of *Hangzhou* renders obvious claim element [1.k].

219. As discussed with reference to claim elements [1.f] and [1.j], *Raizer* and *Hangzhou* disclose driving the vehicle into or across an aisle.

220. Further, as discussed with reference to claim element [1.d1], *Raizer* and *Hangzhou* discussed with reference to claim elements [1.d1], [1.f], and [1.j], a person of ordinary skill in the art would have understood that a vehicle could be driven out from under the storage racks after having been driven across an aisle.

221. Figure 10 (reproduced below) of *Hangzhou* is “a general form of the previous three embodiments,” (Ex. 1006, ¶[0076]), including Embodiment 2 as illustrated in Figure 8, and provides the "stacking row aisles 12” and “column channel 33 where auto-guided trolleys 200 travel” as described with respect to Figure 8 (Ex. 1006, ¶[0062]). As illustrated by Figure 10, the trolley can move underneath the shelving units in a path parallel to the aisles (such as row channels

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23), and then turn to travel from underneath the shelving unit and across aisles (such as row laneways 21 along the column channels 33).

Ex. 1006, Figure 10

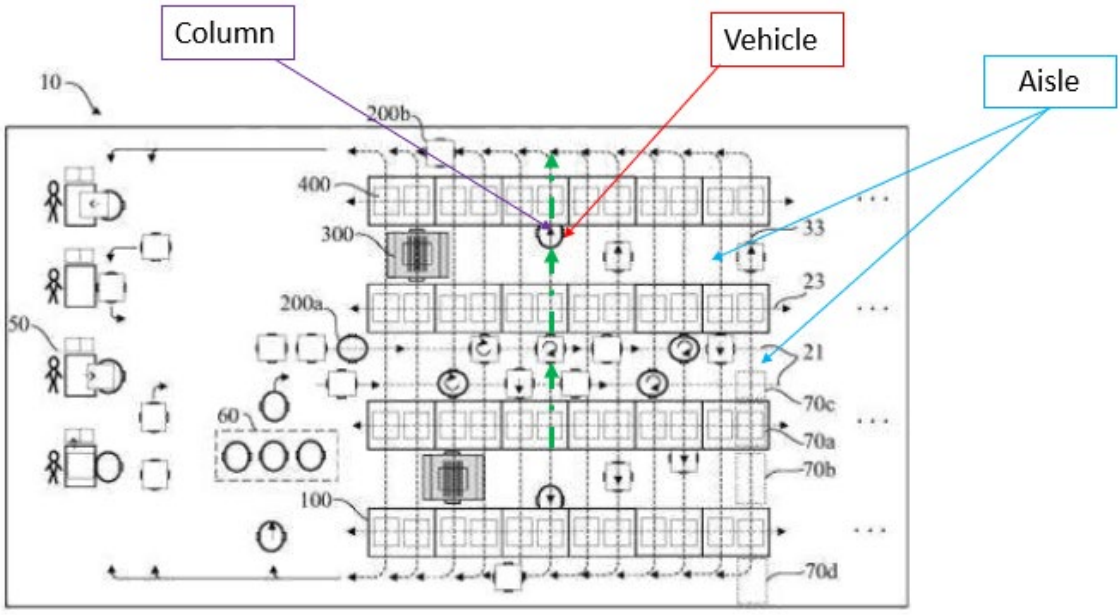


Figure 10

222. Given *Hangzhou's* disclosure of trolleys "carrying standardized containers" "in row and column directions" (Ex. 1006, ¶[0050]) underneath the shelving units and across multiple aisles as illustrated above with respect to Figure 10, it would have been obvious to a person of ordinary skill in the art to combine *Hangzhou's* movement capabilities underneath the shelves and across multiple aisles

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to *Raizer's* system because to do so allows *Raizer's* robots to move more directly to and from picking stations while also reducing congestion and more efficiently using warehouse space. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

223. Thus, *Raizer* in view of *Hangzhou* renders obvious driving the vehicle out from under the storage racks after the step of driving the first vehicle across the first aisle, as recited in claim element [1.k].

Dependent Claim 3

Claim 3, Element [3.pre]: The method of claim 1

224. *Raizer* in view of *Hangzhou* renders obvious claim element [3.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the elements of claim 1. Thus, *Raizer* in view of *Hangzhou* renders obvious [3.pre].

Claim 3, Element [3.a]: wherein a plurality of vertical tracks segments are attached to vertical posts of the first column and

225. *Raizer* discloses or renders obvious claim element [3.a].

226. *Raizer* discloses a "storage area with a "plurality of shelving units." (Ex. 1005, Abstract). *Raizer's* "plurality of shelving units consist[] of a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves. The vertical supports divide the shelving unit into sections call [sic] bays" and "a given row of shelves in a bay. . . can hold several boxes arranged in one or

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more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]). *Raizer* further discloses "a network of vertical and horizontal rails that are parallel to the vertical support posts and horizontal shelves of [a] shelving system in [a] warehouse." (Ex. 1005, ¶[0018]). *Raizer* further discloses that "the system's rails, which allow for the vertical and horizontal movement capabilities of the robot along the shelving, are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

227. *Raizer* discloses "a junction between vertical and horizontal rails," that is "comprised of an open circular area centered at the intersection between vertical and horizontal rails." (Ex. 1005, ¶[0123]). *Raizer* further discloses "[a] section of rail, known herein as a bridge, [that] pivots about the center of [a] circular area to alternately connect the two sections of vertical rails or the two sections of the horizontal rail. (Ex. 1005, ¶[0123]).

228. With reference to FIG. 8E (reproduced and annotated below), *Raizer* explicitly depicts a plurality of vertical track segments attached to vertical posts of the first column (defined by the vertical supports of the shelves).

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Ex. 1005, Figure 8E (annotated)

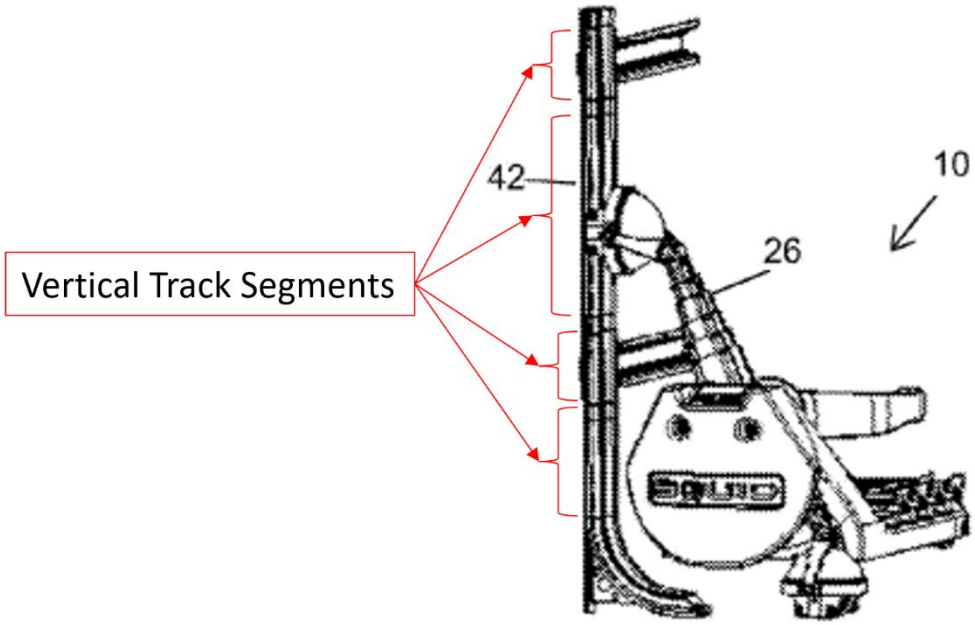


Fig. 8E

229. To the extent *Raizer* does not explicitly disclose vertical track segments attached to multiple vertical posts of the first column, such a feature would have been obvious to a person of ordinary skill in the art in view of *Raizer's* explicit disclosure of attaching vertical rails to the vertical supports of the shelving in *Raizer* (Ex. 1005, ¶[0078]). In addition, a person of ordinary skill in the art would have been motivated to have vertical rails on multiple vertical supports of a column in order to reduce collisions and congestion along the vertical rails of *Raizer*.

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230. Thus, *Raizer* discloses or renders obvious wherein a plurality of vertical track segments are attached to vertical posts of the first column, as recited in claim element [3.a].

Claim 3, Element [3.b]: wherein the step of driving the first vehicle into the first aisle comprises aligning the vertical drive of the first vehicle with the vertical track segments.

231. *Raizer* discloses claim element [3.b]. As discussed with reference to claim elements [1.b1], [1.b2], [1.b3], [1.b4], [1.c], [1.e], and [1.f], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations including into the aisles.

232. *Raizer* discloses "a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots" and that "the robots comprise a set of on-board sensors, a processor, software, and other electronics configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Abstract, ¶[0022]).

233. *Raizer* discloses the robots configured to utilize "anchor point navigation," which "use[s] less accurate sensing and motions when traveling on the floor in order to arrive at the designated destination as rapidly and efficiently as

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possible and employ dedicated algorithms and more precise sensing only when near anchor points, i.e. fixed specific locations in the warehouse such as terminals (locations at which the robot leaves the floor and climbs a vertical rail of the shelving system)." (Ex. 1005, ¶[0080]).

234. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

235. With reference to FIG. 8A (reproduced and annotated below), *Raizer* discloses the robot uses a "set of on-board sensors to travel using anchor point navigation to the designated vertical rail that it has been instructed to ascend to reach one of the shelves in the warehouse." (Ex. 1005, ¶[0115]). As the robot approaches the terminal, a sensor "stops the robot at an exact position relative to the terminal." (Ex. 1005, ¶[0115]). After stopping, "[t]he electric steering motors in the drive and steering units 24 are activated to turn both front wheels 22 by ninety degrees so that they are exactly facing the 'U'-shaped channel in the terminal 44." (Ex 1005, ¶[0115]). Thus, the drive and steering units 24 are activated to turn both front wheels 22 of the vertical drive of *Raizer's* robot 10 to align with the terminal 44 and the vertical track segments embodied by vertical rail 42.

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Ex. 1005, FIG. 8A (annotated)

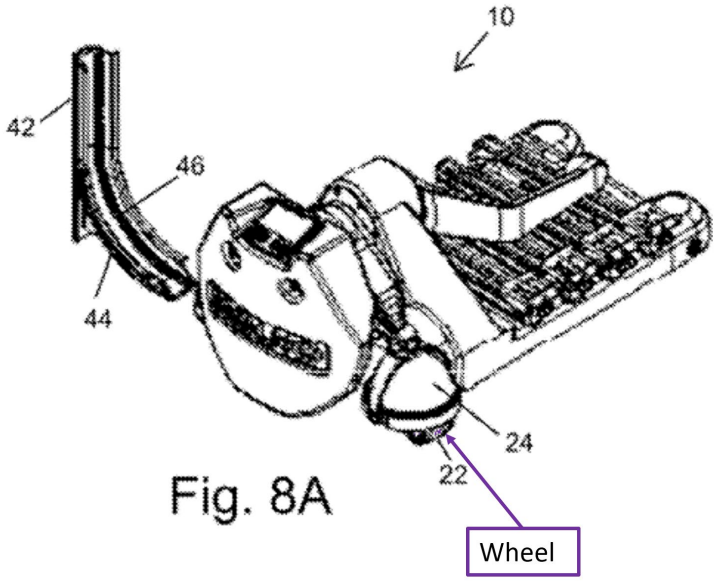


Fig. 8A

236. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

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Ex. 1005, FIG. 8B (annotated)

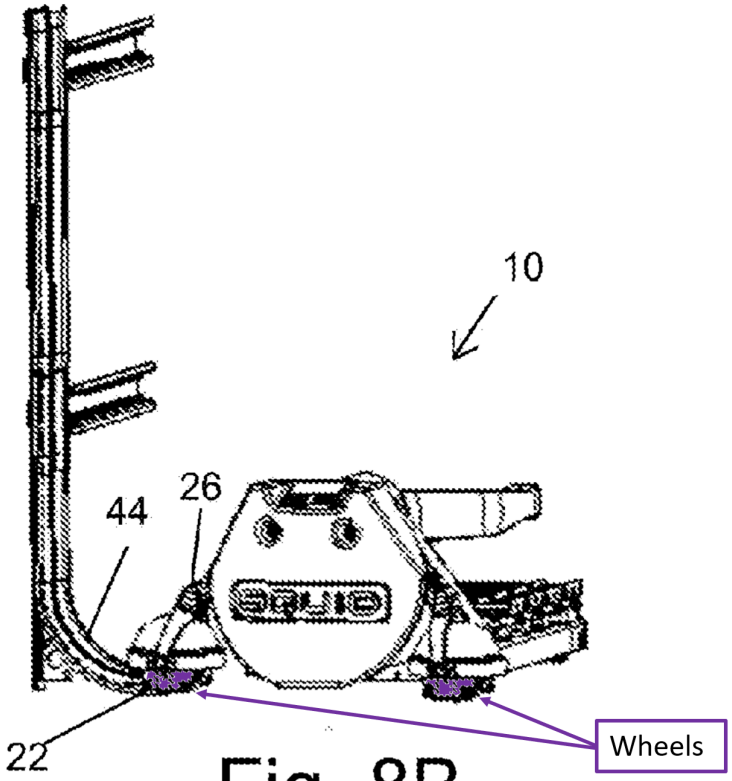


Fig. 8B

237. Thus, *Raizer* discloses wherein the step of driving the first vehicle into the first aisle comprises aligning the vertical drive of the first vehicle with the vertical track segments, as recited in claim element [3.b].

Dependent Claim 4

Claim 4, Element [4.pre]: The method of claim 3

238. *Raizer* in view of *Hangzhou* renders obvious claim element [4.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 3. Thus, *Raizer* in view of *Hangzhou* renders obvious [4.pre].

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Claim 4, Element [4.a]: wherein the step of driving the first vehicle into the aisle comprises driving a first portion of the vertical drive through the vertical track segment and

239. *Raizer* discloses claim element [4.a].

240. As discussed with respect to claim elements [1.b1], [1.b2], [1.b3], [1.b4], [1.c], [1.e], and [1.f], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse including the aisles. Further, as discussed with respect to claim elements [1.b3] and [1.g], *Raizer* discloses the robot having two driving and steering units attached to the front of the robot's body by means of two arm units that are configured to engage with the vertical rails and move the robot vertically.

241. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

242. With reference to FIG. 8A (reproduced and annotated below), *Raizer* discloses the robot uses a "set of on-board sensors to travel using anchor point navigation to the designated vertical rail that it has been instructed to ascend to reach one of the shelves in the warehouse." (Ex. 1005, ¶[0115]). As the robot approaches the terminal, a sensor "stops the robot at an exact position relative to the terminal."

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(Ex. 1005, ¶[0115]). After stopping, "[t]he electric steering motors in the drive and steering units 24 are activated to turn both front wheels 22 by ninety degrees so that they are exactly facing the 'U'-shaped channel in the terminal 44." (Ex 1005, ¶[0115]).

Ex. 1005, FIG. 8A (annotated)

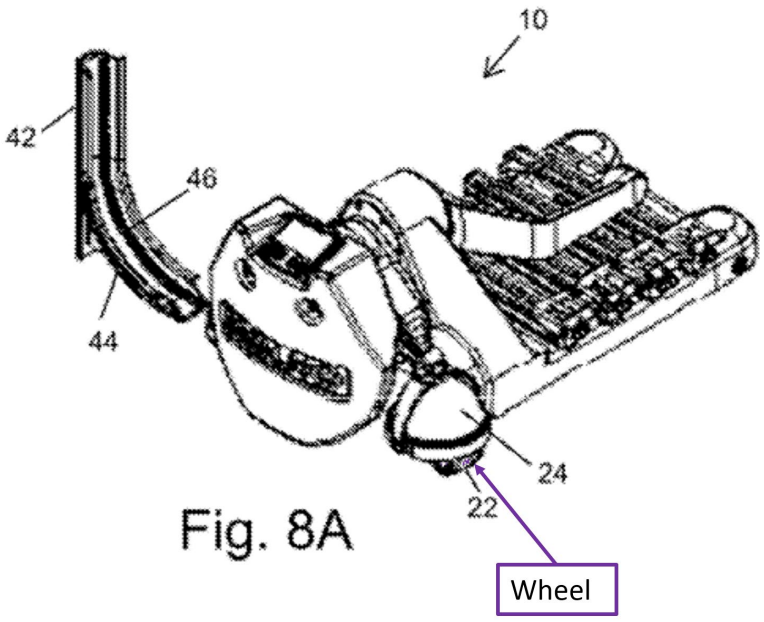


Fig. 8A

243. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized

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movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

Ex. 1005, FIG. 8B (annotated)

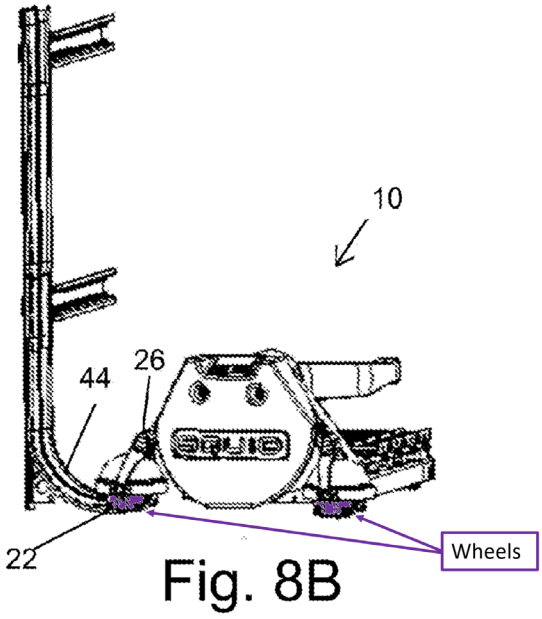


Fig. 8B

244. In FIG. 8E (reproduced and annotated below), *Raizer* shows "the right wheel has advanced further up vertical rail 42 and starts to pull the robot 10 slightly off the ground." (Ex. 1005, ¶[0119]; FIG. 8E).

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Ex. 1005, FIG. 8E (annotated)

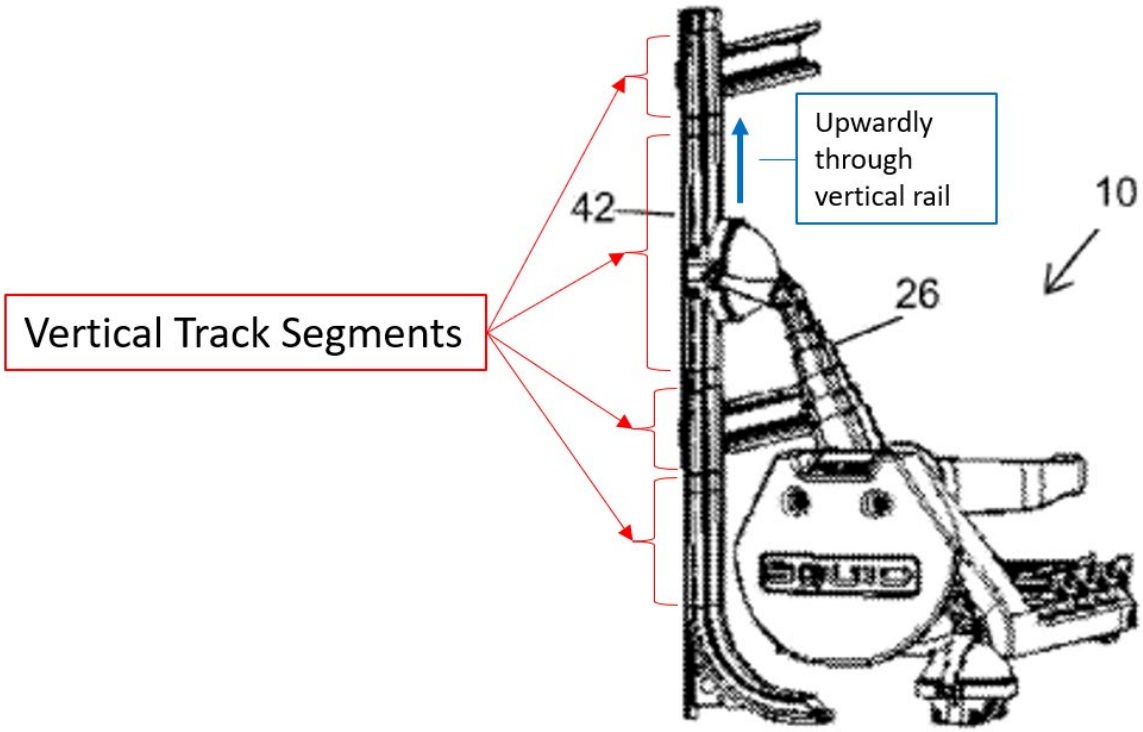


Fig. 8E

245. *Raizer* plainly illustrates movement of a first portion of its vertical drive (i.e., the right front wheel 22 of the right arm unit 26) upwardly and through the vertical rail 42 track segments as illustrated in the annotated Fig. 8E above.

246. That is, *Raizer* discloses the "right front wheel 22" driven through the terminal 44 in order to move upwardly and through the vertical rail 42 track segment.

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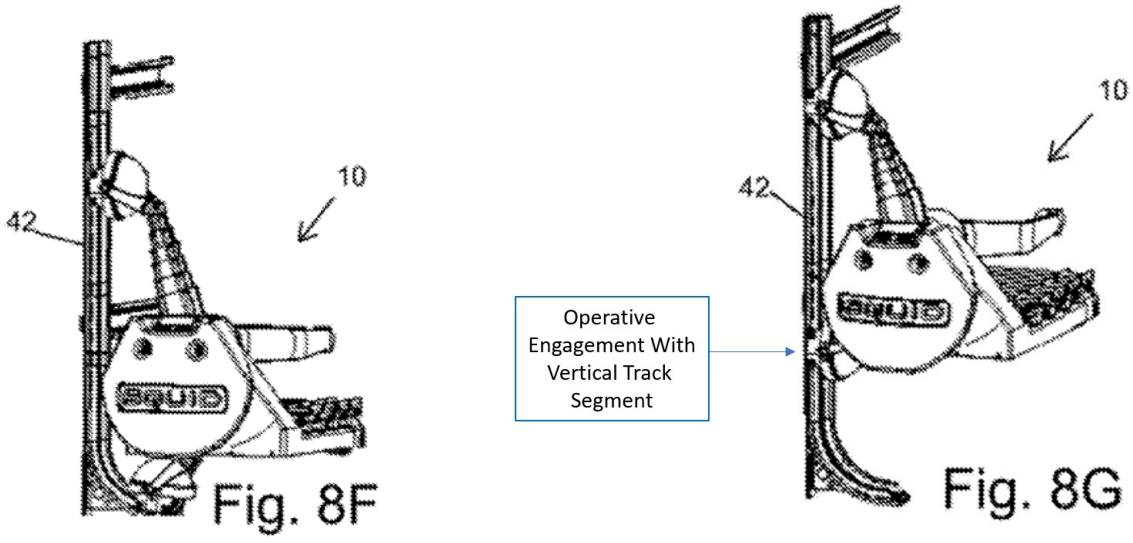
247. Thus, *Raizer* discloses wherein the step of driving the first vehicle into the aisle comprises driving a first portion of the vertical drive through the vertical track segment, as recited in claim element [4.a].

Claim 4, Element [4.b]: driving a second part of the vertical drive into operative engagement with the vertical track segment.

248. *Raizer* discloses claim element [4.b].

249. In reference to FIGs. 8F and 8G (reproduced below), *Raizer* discloses a second part of its vertical drive, namely, its left front wheel 22 moves into the "U"-shaped channel 46 in terminal 44 and is locked into the vertical rail 42," so that both parts of the vertical drive are configured to move upwardly as shown in FIG. 8G. and the second part of the vertical drive becomes operatively engaged with the lower-most vertical track segment. (Ex. 1005, ¶[0120]-[0121]; FIGS. 8F-8G).

Ex. 1005, FIGs. 8F, 8G (annotated)



250. *Raizer* plainly illustrates movement of a second part of its vertical drive (i.e., the left front wheel 22 of the left arm unit 26) into and through terminal 44 to operatively engage the lower-most vertical track segment of the vertical rail 42.

251. Thus, Raizer discloses driving a second part of the vertical drive into operative engagement with the vertical track segment, as recited in claim element [4.b].

Dependent Claim 5

Claim 5, Element [5.pre]: The method of claim 1

252. *Raizer* in view of *Hangzhou* renders obvious claim element [5.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the elements of claim [1]. Thus, *Raizer* in view of *Hangzhou* renders obvious [5.pre].

Claim 5, Element [5.a]: wherein the first storage rack is formed of a plurality of vertical posts and

253. *Raizer* discloses claim element [5.a]. As discussed with respect to claim elements [1.pre], [1.a1], [1.a2], and [3.a] *Raizer* discloses a "plurality of shelving units" with "a network of vertical and horizontal rails" that are "parallel to" "vertical support posts and horizontal shelves," that form a storage rack. Thus, *Raizer* discloses wherein the first storage rack is formed of a plurality of vertical posts, as recited in claim element [5.a].

Claim 5, Element [5.b]: the first vehicle has a length and a width and the length is greater than the width and

254. *Raizer* discloses claim element [5.b].

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255. Figure 5D (reproduced below) is a "top view" "of robot 10 of the system of the invention." (Ex. 1005, ¶[0103]). With reference to FIG. 5D, *Raizer* discloses the robot's main components are "mounted on a frame comprised of two long beams that are rigidly connected together at one end by a shorter beam." (Ex. 1005, ¶[0103]). That is, *Raizer* depicts the robot (vehicle) has a length and a width, and the length is greater than the width.

Ex. 1005, FIG. 5B (annotated)

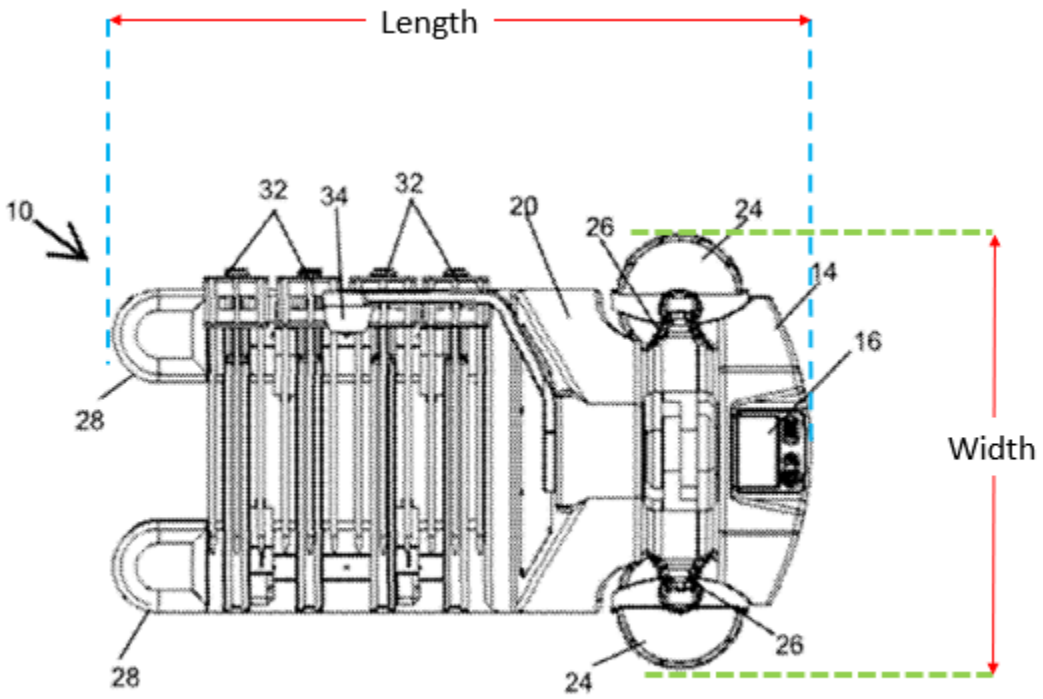


Fig. 5D

256. Thus, *Raizer* discloses a first vehicle that has a length and width and the length is greater than the width, as recited in claim element [5.b].

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Claim 5, Element [5.c]: wherein the step of driving the first vehicle along the first path comprises driving the vehicle along a path spaced apart from the vertical posts by a distance greater the[4] half the length of the vehicle.

257. *Raizer* in view of *Hangzhou* renders obvious claim element [5.c]. As discussed with respect to claim elements [1.a], [1.c], and [1.d1], *Raizer* and *Hangzhou* disclose driving the first vehicle to various locations in the warehouse and different storage locations including along a first path under the storage racks.

258. To the extent that *Raizer* does not explicitly disclose driving the vehicle along a path spaced apart from the vertical posts by a distance greater than half the length of the vehicle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

259. *Hangzhou* discloses "support members 111 divid[ing] the space inside channel support frames 110 into an auto-guided trolley passage space 112 and a cache space 113 for docking standardized containers." (Ex. 1006, ¶[0045]). There

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[4] It is noted that the claim language in the '632 patent recites "by a distance greater the half the length of the vehicle." (Ex. 1001, 25:62-63). While it is not clear as to what is intended by "a distance greater the half," such a claim is rendered obvious by *Raizer* and *Hangzhou* nonetheless to the extent "the half' is interpreted to mean "than half."

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exists a "horizontal gap . . . between support members 111 making auto-guided trolley passages space 112 connect the cache spaces 113 in the row direction of the shelf to form a row channel 23 in that direction to allow auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

260. *Hangzhou* discloses that the trolleys traveling under the shelves may "switch between trolley-special row laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006), ¶[0072]). The trolleys perform route switching by "dropping and docking the standardized containers on the support members, the trolley turning 90° in place, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

261. *Hangzhou* discloses that the "diameter of the trolley 200 is less than the short side of the channel support frame 110," and that "[w]hen the trolley 200 travels to the center of the channel support frame 110, the trolley 200 may turn in place without movement interference." (Ex. 1006, ¶[0073]).

262. Given *Hangzhou's* disclosure of trolleys moving in column and row channels beneath shelves and being small enough to rotate in place 90° to switch traveling directions, a person of ordinary skill in the art would have understood that the trolleys path would be spaced apart from the vertical posts by a distance greater than half the length of the vehicle in order to allow the trolleys to turn without

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colliding with the support members and to allow the robots of *Raizer* to engage with the vertical rails once in the aisle between the shelves.

263. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* spacing of the trolley away from the shelves in order to allow free movement in column and row channels beneath shelves thereby reducing congestion, avoiding collisions, and making efficient use of space. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

264. Thus, *Raizer* in view of *Hangzhou* renders obvious wherein the step of driving the first vehicle along the first path comprises driving the vehicle along a path spaced apart from the vertical posts by a distance greater than half the length of the vehicle, as recited in claim element [5.c].

Dependent Claim 6

Claim 6 Element [6.pre]: The method of claim 1 comprising

265. *Raizer* in view of *Hangzhou* renders obvious claim element [6.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the elements of claim [1]. Thus, *Raizer* in view of *Hangzhou* renders obvious [6.pre].

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Claim 6, Element [6.a]: the step of driving the first vehicle to a workstation to present an item to an operator after the step of driving the first vehicle out from under the storage racks.

266. *Raizer* in view of *Hangzhou* renders obvious claim element [6.a]. As discussed with reference to claim elements [1.h], [1.i], [1.j], and [1.k], *Raizer* in view of *Hangzhou* renders obvious driving the vehicle out from under the storage racks after retrieving an item.

267. *Raizer* discloses a warehouse floor plan that "is divided into three main sections; a Receiving and Dispatch Center (RDC), and Operations Area (OP), and a storage area." (Ex. 1005, ¶[0092]). *Raizer* discloses that "[h]uman workers man the picking stations" "to receive boxes containing items required to fill customer's orders that the robots have retrieved from the storage area." (Ex. 1005, ¶[0092]).

268. *Raizer* further discloses a Real Time Traffic Manager server which sends a task message "via communication link to the robot." (Ex. 1005, ¶[0096]). *Raizer* discloses that "software in the robot calculates its path to [the] address and [the] robot self-navigates to [the] address." (Ex. 1005, ¶[0096]). Once the robot retrieves the item it "navigates to [a] picking station 108 and unloads [the item]." (Ex. 1005, ¶[0096]). Raizer discloses that "[h]uman workers man the picking stations… to receive boxes containing items required to fill customer's orders that the robots have retrieved from the storage area." (Ex. 1005, ¶[0092]).

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269. To the extent *Raizer* does not explicitly disclose driving the first vehicle to a workstation to present an item to an operator after the step of driving the vehicle out from under the storage racks, a person of ordinary skill would have looked to *Hangzhou* for such a teaching.

270. As discussed with reference to claim element [1.k], *Raizer* and *Hangzhou* disclose driving a vehicle out from under storage racks after retrieving an item.

271. *Hangzhou* discloses that "the invention provides an unmanned warehousing system and its inbound and outbound methods, realizing efficient transportation of 'goods to people.'" (Ex. 1006, ¶[0009]).

272. *Hangzhou* discloses that "[s]everal auto-guided trolleys 200 cooperate with several stacking vehicles 300 to remove and transport standardized containers 400 on the shelves 100 to sorting workstations 50, which is called the outbound process or container delivery process." (Ex. 1006, ¶[0036]). The trolleys "drive along stacking row laneways 12 and column laneways 32 and in auto-guided trolley passage space 112, performing actions like positioning, lifting, dropping, and carrying to transfer standardized containers 400 between cache spaces 113 and sorting workstations 50." (Ex. 1006, ¶[0047]). *Hangzhou* discloses that "at sorting workstations 50, workers 30, or sorting arms absen[t] from the figure remove the items for outbound from standardized containers 400." (Ex. 1006, ¶[0036]). A

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person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

273. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of driving the first vehicle to a workstation to present an item to an operator after the step of driving the first vehicle out from under the storage racks, as recited in claim element [6.a].

Dependent Claim 7

Claim 7, Element [7.pre]: The method of claim 1

274. *Raizer* in view of *Hangzhou* renders obvious claim element [7.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the elements of claim [1]. Thus, *Raizer* in view of *Hangzhou* renders obvious [7.pre].

Claim 7, Element [7.a]: wherein the step of driving the first vehicle across the aisle comprises driving the first vehicle under a second of the storage racks.

275. *Raizer* in view of *Hangzhou* renders obvious claim element [7.a]. As discussed with respect to claim elements [1.b1], [1.b2], [1.b3], [1.b4], [1.c], [1.e], [1.f], and [1.j], *Raizer* discloses vehicles traveling in any direction, to various locations in the warehouse, and into and out of the aisles.

276. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

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277. *Raizer* further discloses that the "three-dimensional navigation and travel capabilities" enable a robot "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Claim 1; *see also* Claims 4, 18).

278. To the extent that *Raizer* does not explicitly disclose driving the vehicle across the first aisle and under a storage rack, a person of ordinary skill in the art would have understood that, in view of *Raizer's* disclosure of the robot's ability "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse," a robot could be driven across an aisle and underneath storage racks to minimize congestion and optimize the number of pathways traveled by the robots to allow more robots to maneuver along the warehouse floor.

279. To the extent that *Raizer* does not explicitly disclose driving the first vehicle under a second of the storage racks, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

280. Figure 10 (reproduced below) of *Hangzhou* is a "general form of the previous three embodiments," (Ex. 1006, ¶[0076]), including Embodiment 2 as illustrated in Figure 8, and provides the "stacking row aisles 12" and "column

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channel 33 where auto-guided trolleys 200 travel" as described with respect to Figure 8 (Ex. 1006, ¶[0062]) as well as additional pathways that may be traveled along the warehouse floor. With reference to Figure 10, *Hangzhou* discloses that the "auto-guided trolleys" can "switch between trolley-special laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006, ¶[0072]). As illustrated by Figure 10, the trolley can move underneath the shelving units in a path parallel to the aisles (such as row channels 23), and then turn to travel from underneath the shelving unit and across aisles (such as row laneways 21 along the column channels 33).

Ex. 1006, Figure 10

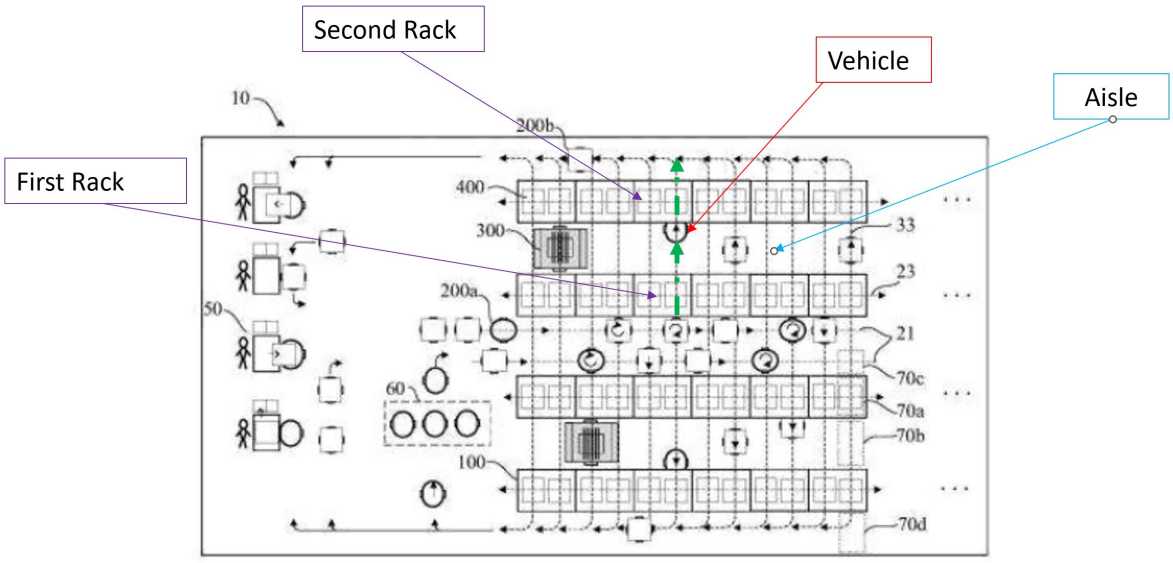


Figure 10

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281. *Hangzhou* discloses "one trolley-special row laneway 21" and "auto-guided trolleys 200 enter the laneway form one end in turn and turn in place after reaching the designated shelf column." (Ex. 1006, ¶[0068]). The "trolleys enter the corresponding column channel 33" and pass "through the stacking row laneway 12." (Ex. 1006, ¶¶[0062, 0068]).

282. *Hangzhou* discloses that because the trolley moves into the "stacking row laneway for stacking vehicles," a "path planning algorithm is needed to avoid the collision between [the] auto-guided trolleys 200 and [the] stacking vehicles 300." (Ex. 1006, ¶[0062]). *Hangzhou* discloses that the trolley will "get the information on the stacking vehicles and space occupancy on the route ahead form the dispatch control system when [the] auto-guided trolley 200 has reached the edge of a stacking row laneway 12 the trolley is about to enter," and "conduct an analysis" to "determine whether the time for passing through the stacking row laneway 12 is crossed over with the time for stacking vehicles to running through this section of the row laneway 21 [sic]." (Ex. 1006, ¶[0063]). The trolley has "opportunities to cross the row laneway" and will "[m]ove forward if there is no intersection" (Ex. 1006, ¶[0063]). "After the auto-guided trolley 200 enters the opposite auto-guided trolley passage space 112, the next step is based on the carrying of standardized containers and the occupancy of the cache space ahead." (Ex. 1006, ¶[0064]).

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283. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* driving of the trolleys along a first path under a first rack with the "three-dimensional navigation and travel capabilities" of *Raizer* to provide the system of *Raizer* with increased travel paths for the robots to reduce congestion, avoid traffic jams, and maintain a more efficient use of space. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*) and in the sections above discussing claim elements [1.j].

284. Thus, *Raizer* in view of *Hangzhou* renders obvious wherein the step of driving the first vehicle across the aisle comprises driving the first vehicle under a second of the storage racks, as recited in claim element [7.a].

Dependent Claim 8

Claim 8, Element [8.pre]: The method of claim 1

285. *Raizer* in view of *Hangzhou* renders obvious claim element [8.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements claim 1. Thus, *Raizer* in view of *Hangzhou* renders obvious [8.pre].

Claim 8, Element [8.a]: wherein the step of turning comprises rotating the first vehicle about a vertical axis that extends through the first vehicle.

286. *Raizer* in view of *Hangzhou* render obvious claim element [8.a].

287. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units, " where "each unit compris[es] one front wheel and components

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configured to rotated [sic] the front wheel at least 360 degrees *about a vertical axis* to the floor in order to steer the robot" and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). *Raizer* discloses that "[t]he front wheels 22 of robot 10 can be independently rotate 360 degrees about an axis vertical to the floor by their respective drive and steering units 24." (Ex. 1005, ¶[0107]). The "motor of the drive assembly is a variable speed motor," making it possible to "steer the robot by activating the drive motors to produce differential rotational speeds of the two front drive wheels." (Ex. 1005, ¶[0109]).

288. To the extent that *Raizer* does not disclose rotating the first vehicle about a vertical axis that extends through the first vehicle while underneath a rack, a person of ordinary skill in the art would turn to the teaching of Hangzhou as set forth above with respect to Claim [1.e].

289. A person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

290. Thus, *Raizer* and *Hangzhou* render obvious wherein the step of turning comprises rotating the first vehicle about a vertical axis that extends through the first vehicle, as recited in claim element [8.a].

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Dependent Claim 9

Claim 9, Element [9.pre]: The method of claim 8

291. *Raizer* in view of *Hangzhou* renders obvious claim element [9.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements claim 8. Thus, *Raizer* in view of *Hangzhou* renders obvious [9.pre].

Claim 9, Element [9.a]: wherein the vertical axis extends through the first path.

292. *Raizer* in view of *Hangzhou* renders obvious claim element [9.a]. As discussed with respect to claim element [1.e] and [8], *Raizer* in view of *Hangzhou* renders obvious a vehicle capable of rotating 360 degrees about a vertical axis that extends through the vehicle's body while under storage shelves.

293. To the extent *Raizer* does not explicitly disclose a method of turning where the vertical axis extends through the first path, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

294. With further reference to Figure 1 (reproduced and annotated below), *Hangzhou* discloses that a "dotted line displayed on the center line of each shelf row is used to indicate the row channel 23 for auto-guided trolleys 200 under the shelf, which is a path parallel to the stacking row laneway 12." (Ex. 1006, ¶[0040]).

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Ex. 1006, Figure 1 (annotated)

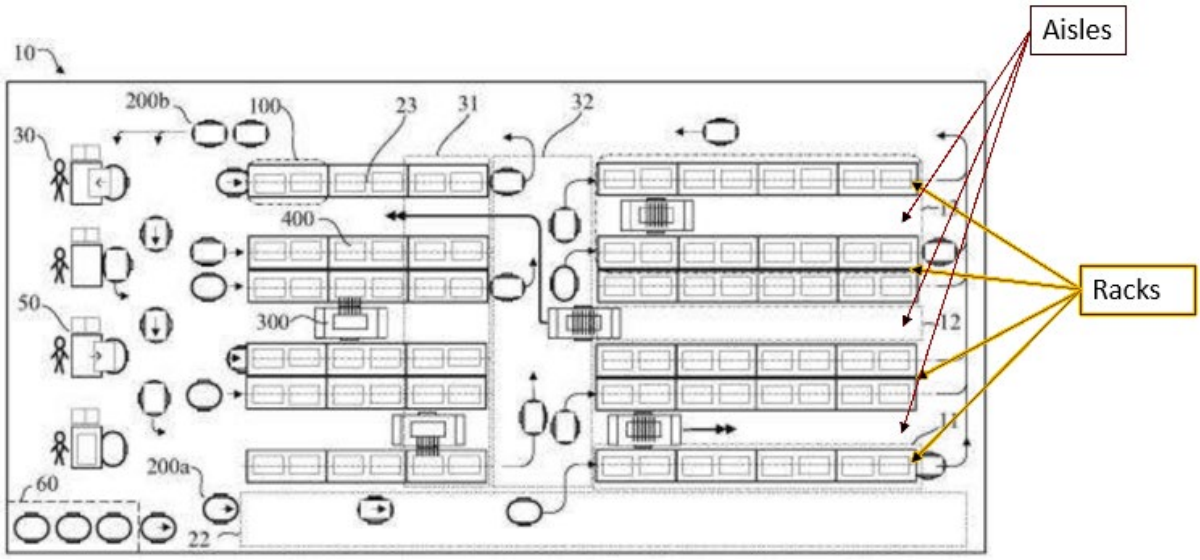


Figure 1

295. With reference to Figure 10 (reproduced below), *Hangzhou* discloses driving the vehicle under the rack in a "row direction and column direction" and "switching the driving direction" "at the position where the dotted lines intersect" by "turn[ing] in the auto-guided trolley passage space 112." The route switching occurs "when the trolley moves to the center of the channel support frame." (Ex. 1006, ¶[0072]). That is, the trolley rotates about an axis extending through the first path when it "switch[es] between the row direction and column direction" by "turning 90° in place." (Ex. 1006, ¶[0073]).

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Ex. 1006, Figure 10

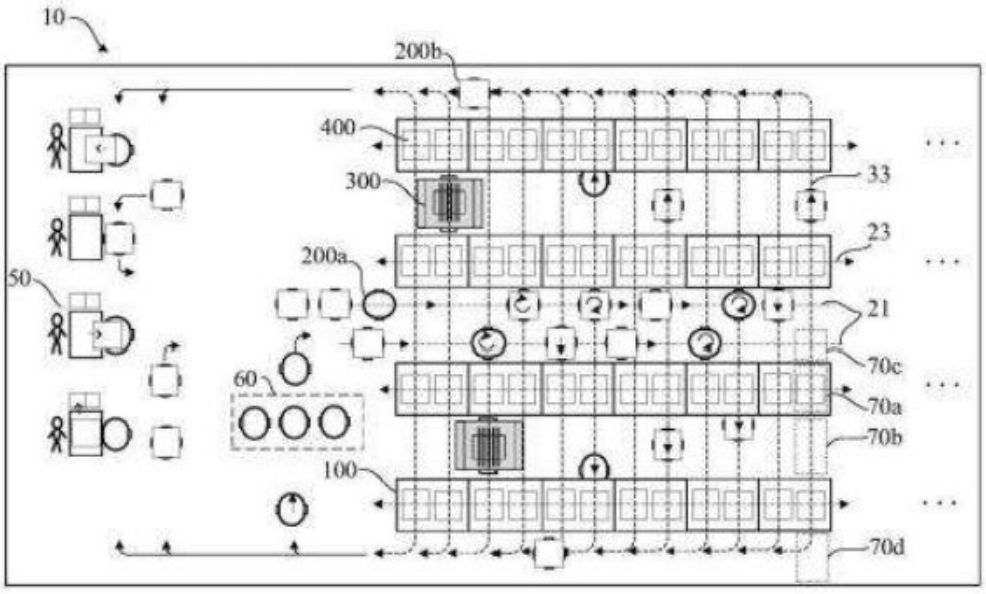


Figure 10

296. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf about an axis that extends through the first path the vehicle was traveling. However, were *Raizer's* disclosure deemed insufficient to disclose this feature, a person of ordinary skill in the art would have been motivated to combine *Hangzhou's* teaching that a trolley can rotate in place 90° under shelves to switch traveling direction with the three dimensional travel capabilities of *Raizer* because, as taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing

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congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). Route switching based on such turning also "usually reduce[s] blockage and shorten[s] [trolley] turnover time." (Ex. 1006, ¶[0072])A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*) and in the sections above discussing claim elements [1.e] and [8].

297. Thus, *Raizer* in view of *Hangzhou renders* obvious wherein the vertical axis that extends through the first path as recited in claim [9.a].

Dependent Claim 10

Claim 10, Element [10.pre] The method of claim 1 comprising

298. *Raizer* in view of *Hangzhou* renders obvious claim element [10.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 1. Thus, *Raizer* in view of *Hangzhou* renders obvious [10.pre].

Claim 10, Element [10.a]: the step of driving a second of the vehicles under the first rack along a second path parallel to the first path so that the second vehicle passes the first vehicle as the first vehicle travels along the first path.

299. *Raizer* in view of *Hangzhou* renders obvious claim element [10.a].

300. As discussed with respect to claim element [1.b1], [1.b2], and [1.d1], *Raizer* in view of *Hangzhou* renders obvious a set of autonomous robots capable of traveling in any direction, including under the storage shelves.

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301. To the extent that *Raizer* does not explicitly disclose driving a second vehicle under the first rack along a second path parallel to the first path so that the second vehicle passes the first vehicle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

302. The '632 patent describes that a "rack" "includes a plurality of columns" "populated within [sic] a number of containers or totes." (Ex. 1001, 18:22-26).

303. *Hangzhou* discloses the modular shelves "placed in rows and columns to improve the plot ratio." (Ex. 1006, ¶[0037]). "Two shelf rows are usually placed face to face to share a stacking row laneway 12 in the middle," such that the "combination of the stacking row laneway 12 and all the shelf rows 11 facing the row laneway is defined as a shelf-laneway combination 13. (Ex. 1006, ¶[0037]). *Hangzhou* further discloses "two adjacent shelf-laneway combinations 13 preferentially adopt a back-to-back layout to improve the plot ratio." (Ex. 1006, ¶[0038]). That is, *Hangzhou* describes a rack including a plurality of columns.

304. Embodiment 4 of *Hangzhou* is a "general form of the previous three embodiments," (Ex. 1006, ¶[0076]), including embodiment 1 as illustrated in Figure 1. *Hangzhou* discloses, with reference to Figure 1 (reproduced and annotated below), that a first vehicle and a second vehicle travel under a rack and parallel to one another such that one of the vehicles could pass the other. (Ex. 1006, Figure 1).

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Ex. 1006, Figure 1 (annotated)

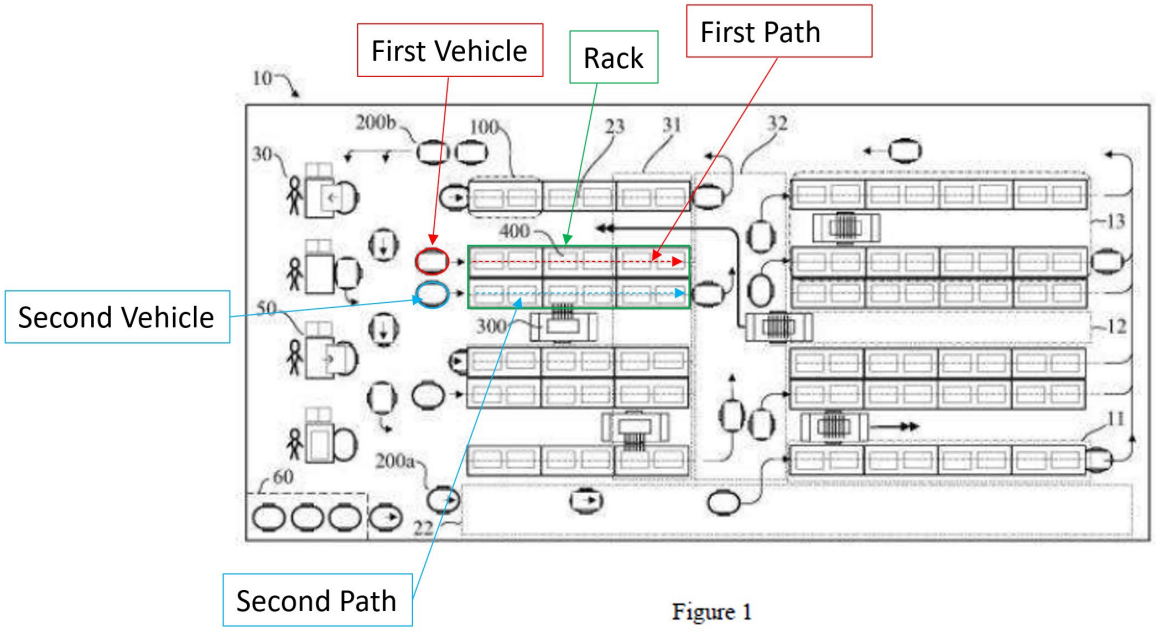


Figure 1

305. *Hangzhou* discloses "a plurality of auto-guided trolleys 200 travel in stacking row laneways 12 and column laneways 32 and in auto guided trolley passage space 122" "to reduce blockage." (Ex. 1006, ¶[0047]). A person of ordinary skill in the art would understand that allowing the second vehicle traveling in parallel to pass the first vehicle would result in less congestion and increased efficiency.

306. To the extent that *Hangzhou* does not explicitly disclose driving a second of the vehicles under the first rack along a second path parallel to the first path, a person of ordinary skill in the art would have understood that, in view of *Hangzhou's* disclosure of combining two shelf rows to have a single wider shelf to allow for multiple rows of boxes. Additionally, it would have been obvious to a

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person of ordinary skill in the art given *Hangzhou's* disclosure of allowing multiple auto-guided trolleys to drive underneath the shelves along the column laneways, to have two trolleys entering traveling along parallel paths underneath a singular, wider shelf.

307. A person of ordinary skill in the art would have been motivated to combine the driving of two trolleys under a rack, in parallel, as disclosed in *Hangzhou* with the three-dimensional travel capabilities of *Raizer's* robots because allowing two robots to maneuver under the racks and pass each other would further "reduce blockage and shorten the turnover time," and increase the system's output rate. (Ex. 1006, ¶[0072]). A person of ordinary skill in the art would have further understood that allowing two robot laneways underneath a shelf (rack) would allow for more efficient use of shelving space by increasing the amount of shelving space relative to unused space in the aisles between the shelves. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*) and in the sections above discussing claim elements [1.e].

308. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of driving a second of the vehicles under the first rack along a second path parallel to the first path so that the second vehicle passes the first vehicle as the first vehicle travels along the first path as recited claim element [10.a].

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Independent Claim 11

Claim 11, Element [11.pre]: A material handling system for delivering items to storage locations and retrieving items from storage locations, comprising:

309. To the extent that element [11.pre] is found to be limiting, *Raizer* discloses claim element [11.pre].

310. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, Abstract). *Raizer* further discloses that the system is comprised of "a set of autonomous mobile robots," "a network of vertical and horizontal rails" that are "parallel to" "vertical support posts and horizontal shelves," and "a Real Time Traffic Management (RTTM) server." (Ex. 1005, Abstract).

311. *Raizer* discloses that the robots comprise various electronics "configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of [a] network of rails." (Ex. 1005, Abstract).

312. Thus, *Raizer* discloses claim element [11.pre].

Claim 11, Element [11.a1]: a first storage rack having a plurality of columns each of which comprises a plurality of storage locations

313. *Raizer* discloses claim element [11.a1].

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314. *Raizer*'s "storage area" has "a plurality of shelving units consisting of a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves. The vertical supports divide the shelving unit into sections call [sic] bays" and that "a given row of shelves in a bay . . . can hold several boxes arranged in one or more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]).

315. *Raizer* discloses that the "exact location of a box in the warehouse is designated by an address comprising numbers, letters, signs, color, etc. representing the zone, face, bay, level, and specific location." (Ex. 1005, ¶[0092]). *Raizer* also discloses that the "location of a specific box in the storage area can be designated in other ways, for example using x, y, z coordinates in a coordinate system of the rail system," highlighting the verticality of the system. (Ex. 1005, ¶[0092]).

316. Thus, *Raizer* discloses a first storage rack comprised of a plurality of columns defined by the vertical supports and each column comprises a plurality of storage locations such as the bays along a given row of shelves, as recited in claim element [11.a1].

Claim 11, Element [11.a2]: wherein the first storage rack is longitudinally elongated;

317. *Raizer* discloses claim element [11.a2].

318. With reference to FIG. 1 (reproduced and annotated below), *Raizer* discloses a "floor plan of a typical warehouse" having a "storage area" with "a

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plurality of shelving units." (Ex. 1005, ¶[0092]). The shelving units consist of "a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves." (Ex. 1005, ¶[0092]). The "vertical supports divide shelving units into bays (B1, B2, …)."

Ex. 1005, FIG. 1 (annotated)

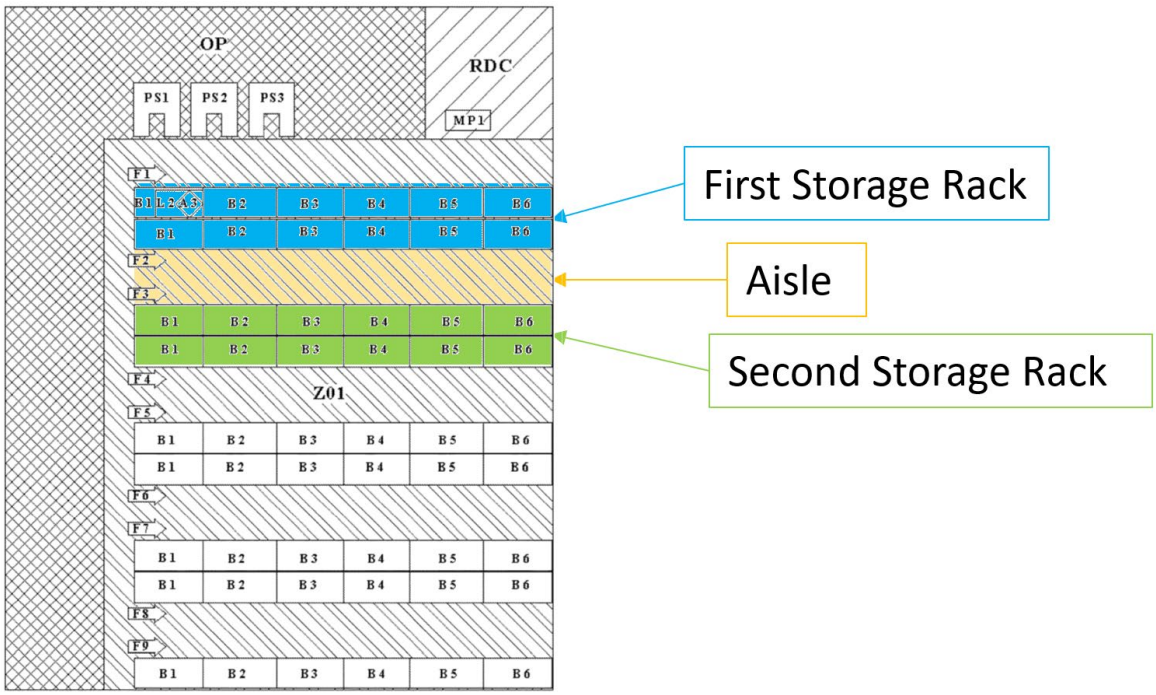


Fig. 1

319. Thus, *Raizer* discloses wherein the first storage rack is longitudinally elongated, as recited in claim element [11.a2].

Claim 11, Element [11.b1]: a second storage rack having a plurality of columns each of which comprises a plurality of storage locations

320. *Raizer* discloses claim element [11.b1].

321. *Raizer*'s "storage area" has "a plurality of shelving units consisting of a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves. The vertical supports divide the shelving unit into sections call [sic] bays" and that "a given row of shelves in a bay . . . can hold several boxes arranged in one or more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]).

322. *Raizer* discloses that the "exact location of a box in the warehouse is designated by an address comprising numbers, letters, signs, color, etc. representing the zone, face, bay, level, and specific location." (Ex. 1005, ¶[0092]). *Raizer* also discloses that the "location of a specific box in the storage area can be designated in other ways, for example using x, y, z coordinates in a coordinate system of the rail system," highlighting the verticality of the system. (Ex. 1005, ¶[0092]).

323. Thus, *Raizer* discloses a second storage rack comprised of a plurality of columns defined by the vertical supports and each column comprises a plurality of storage locations such as the bays along a given row of shelves, as recited in claim element [11.b1].

Claim 11, Element [11.b2]: wherein the second storage rack is longitudinally elongated,

324. *Raizer* discloses claim element [11.b2].

325. With reference to FIG. 1 (reproduced and annotated below), *Raizer* discloses a "floor plan of a typical warehouse" having a "storage area" with "a

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plurality of shelving units." (Ex. 1005, ¶[0092]). The "vertical supports divide shelving units into sections call [sic] bays (B1, B2, …)," and "[t]he sides of the shelving units that face the aisles between units are called faces (F1, F2, …)" (Ex. 1005, ¶[0092]).

Ex. 1005, FIG. 1 (annotated)

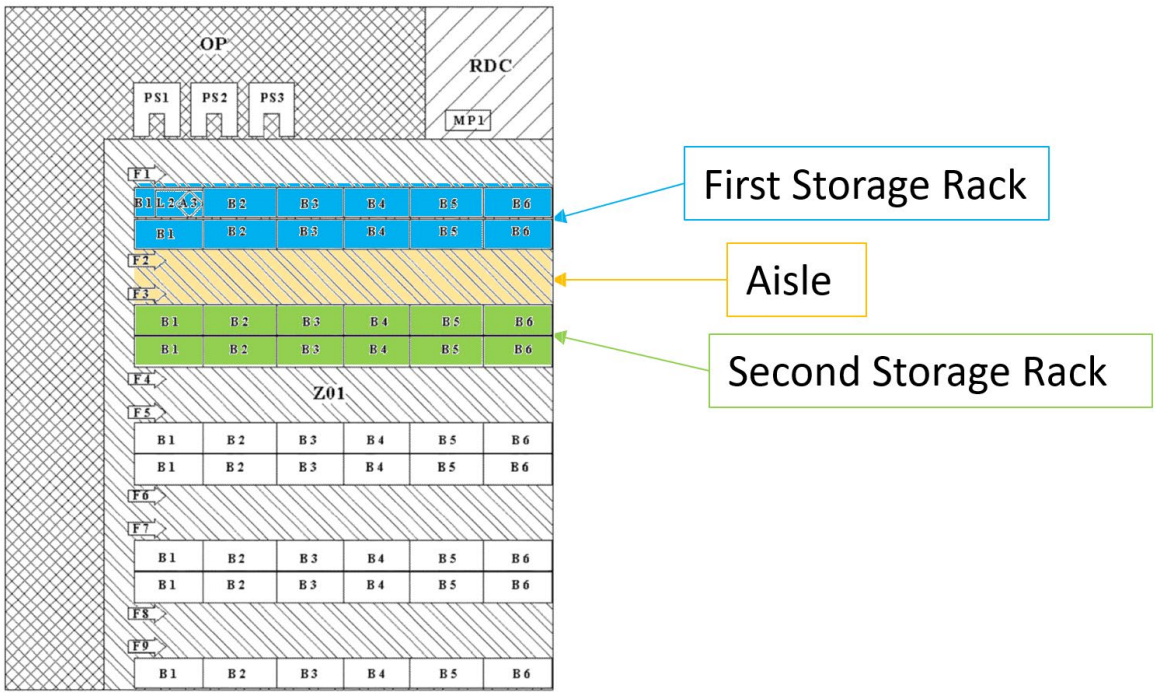


Fig. 1

326. Thus, *Raizer* discloses second storage rack is longitudinally elongated element [11.b2].

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Claim 11, Element [11.b3]: wherein the second storage rack is spaced apart from the first storage rack to provide an aisle between the first and second storage racks;

327. *Raizer* discloses claim element [11.b3].

328. With reference to FIG. 1 (reproduced and annotated below), *Raizer* discloses a "floor plan of a typical warehouse" having a "storage area" with "a plurality of shelving units." (Ex. 1005, ¶[0092]). The shelving units consist of "a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves." (Ex. 1005, ¶[0092]). The "vertical supports divide shelving units into bays (B1, B2, …)." (Ex. 1005, ¶[0092]). The "sides of the shelving units that face the aisles between units are called faces (F1, F2, …)." (Ex. 1005, ¶[0092]).

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Ex. 1005, FIG. 1 (annotated)

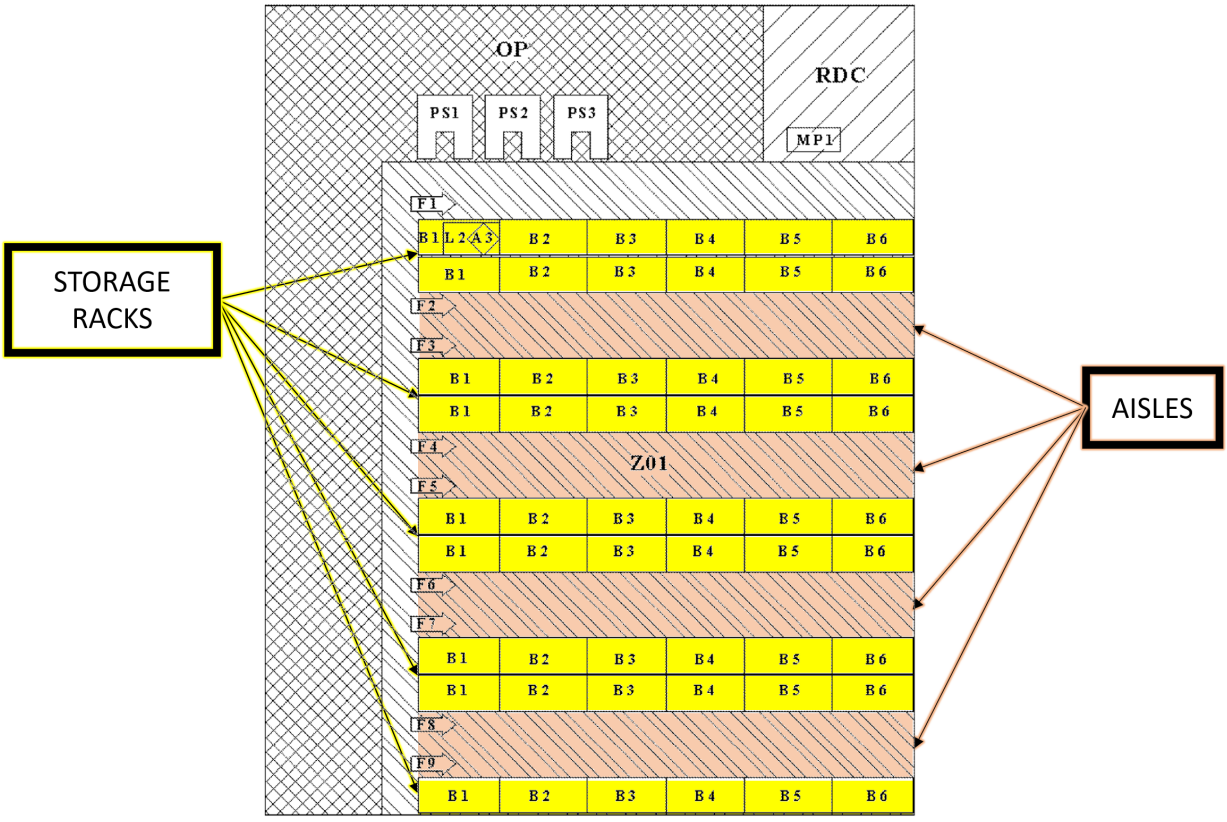


Fig. 1

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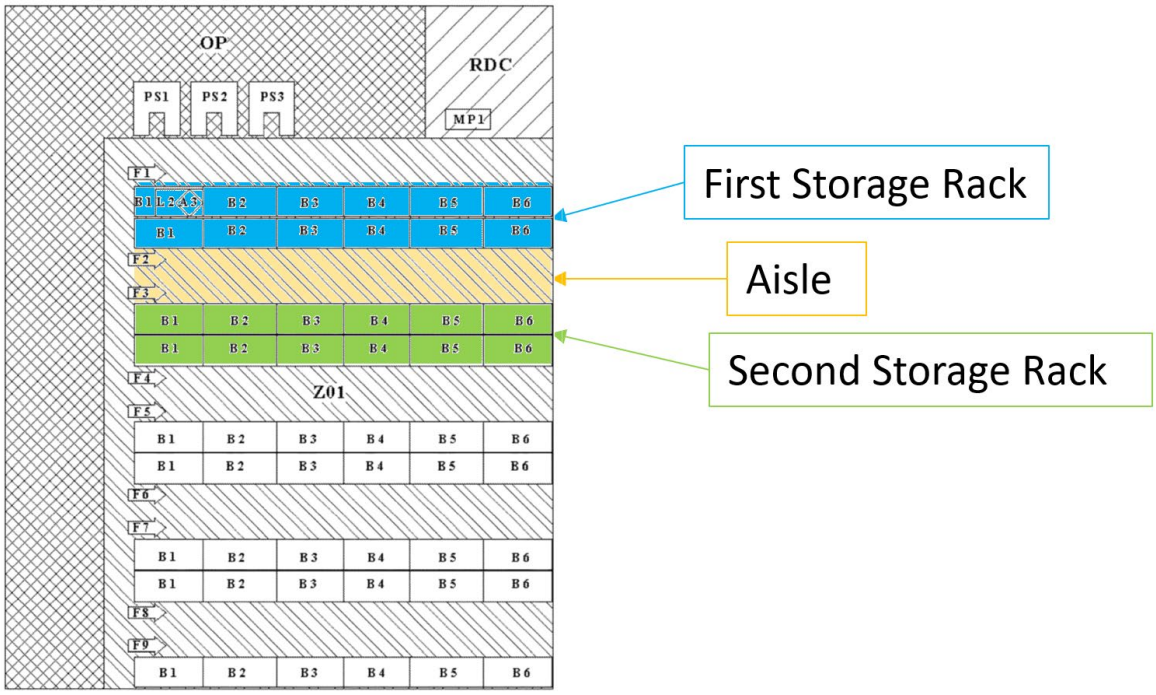


Fig. 1

329. Thus, *Raizer* discloses the second storage rack is spaced apart from the first storage rack to provide an aisle between the first and second storage racks, as recited in claim element [11.b3].

Claim 11, Element [11.c1]: a plurality of delivery vehicles

330. *Raizer* discloses claim element [11.c1].

331. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, ¶[0018]). The system comprises "a set of autonomous mobile robots." (Ex. 1005, ¶[0019]). The robots "comprise a gripper mechanism" "that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]).

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The robots "complete [a] mission of removing a box from (or delivering a box to) a specific location on a shelf." (Ex. 1005, ¶[0114]).

332. Thus, *Raizer* discloses a plurality of delivery vehicles, as recited in claim element [1.c1].

Claim 11, Element [11.c2]: wherein each vehicle has a length and a width and

333. *Raizer* discloses claim element [11.c2].

334. *Raizer*, with reference to FIG. 5B (reproduced and annotated below), discloses the robot's main components are "mounted on a frame comprised of two long beams that are rigidly connected together at one end by a shorter beam." (Ex. 1005, ¶[0103]).

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Ex. 1005, FIG. 5B (annotated)

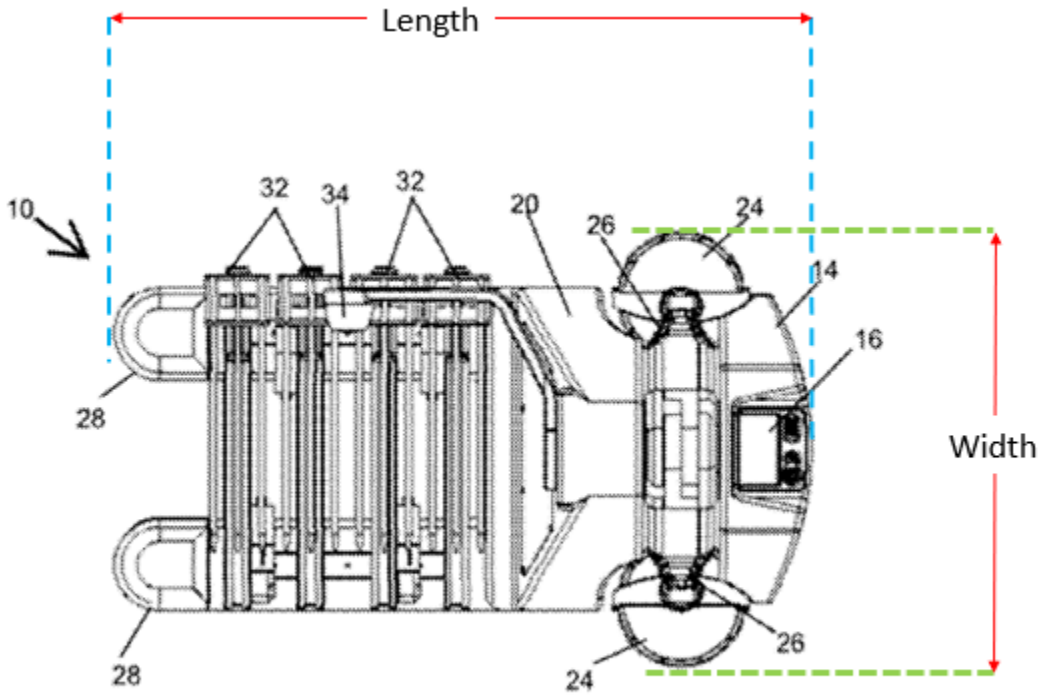


Fig. 5D

335. Thus, *Raizer* discloses wherein each vehicle has a length and a width, as recited in claim element [11.c2].

Claim 11, Element [11.c3]: each vehicle comprises: a horizontal drive system operable to drive the vehicle along a horizontal surface;

336. *Raizer* discloses claim element [11.c3].

337. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a

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horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

338. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground," (i.e., along a horizonal surface), "and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving, [and] are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

339. *Raizer* discloses that a robot "travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

340. With reference to FIGs. 5A and 5B (reproduced and annotated below), *Raizer* discloses that the "[r]obot 10 moves along the ground on four wheels," where "two rear wheels 30 could be fixed and passive so that they can only rotate about

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their axles which are perpendicular to the axis of the long beams 28 of the frame and are 'dragged along' by the front wheels," or "the rear wheels could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor." (Ex. 1005, ¶[0104]). "The front driving wheels 22 dictate the steering angle and differential speeds of the rear wheels," and/or "can be independently rotated in any direction by drive and steering units 24." (Ex. 1005, ¶[0104]).

Ex. 1005, FIG. 5A (annotated)

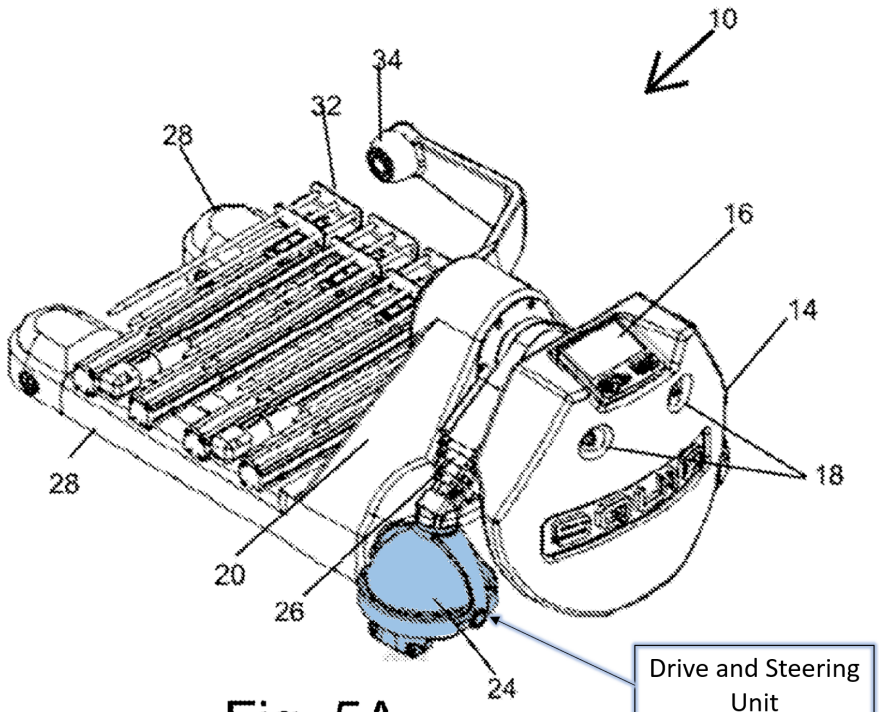


Fig. 5A

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Ex. 1005, FIG. 5B (annotated)

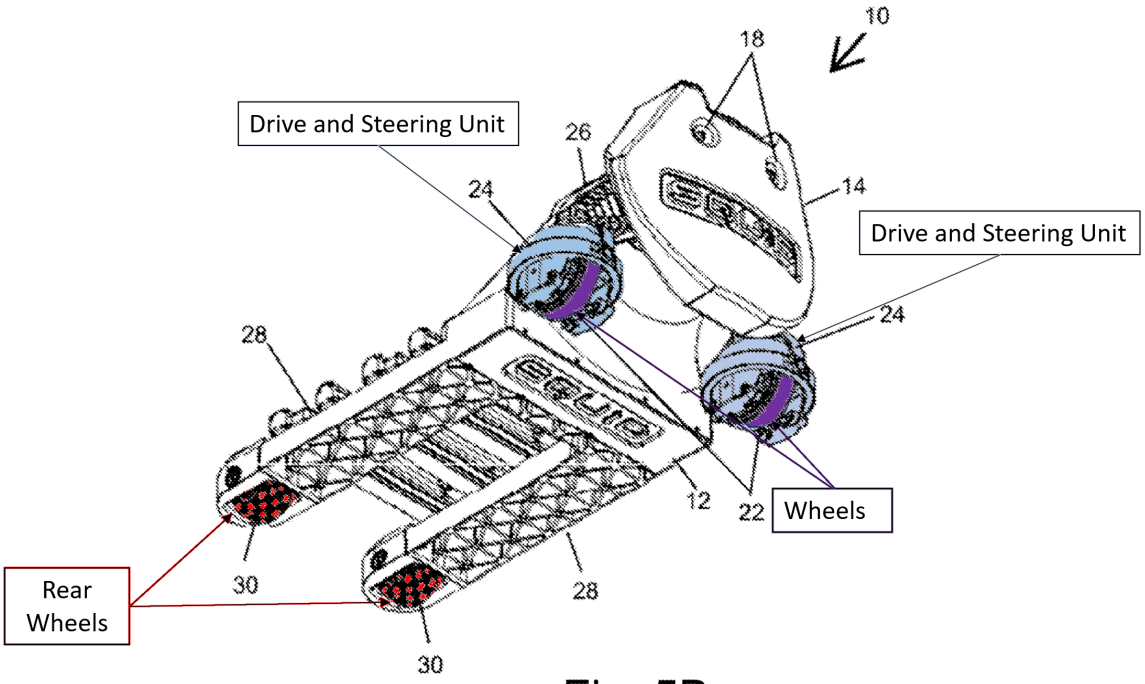


Fig. 5B

341. Thus, *Raizer* discloses each vehicle comprises: a horizontal drive system comprising drive wheels 22 and rear wheels 30, along with drive and steering units 24 that are operable to drive the vehicle along a horizontal surface, as recited in claim element [11.c3].

Claim 11, Element [11.c4]: a vertical drive operable to drive the vehicle vertically;

342. *Raizer* discloses claim element [11.c4].

343. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components

configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

344. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

345. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

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346. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

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Ex. 1005, FIG. 8B (annotated)

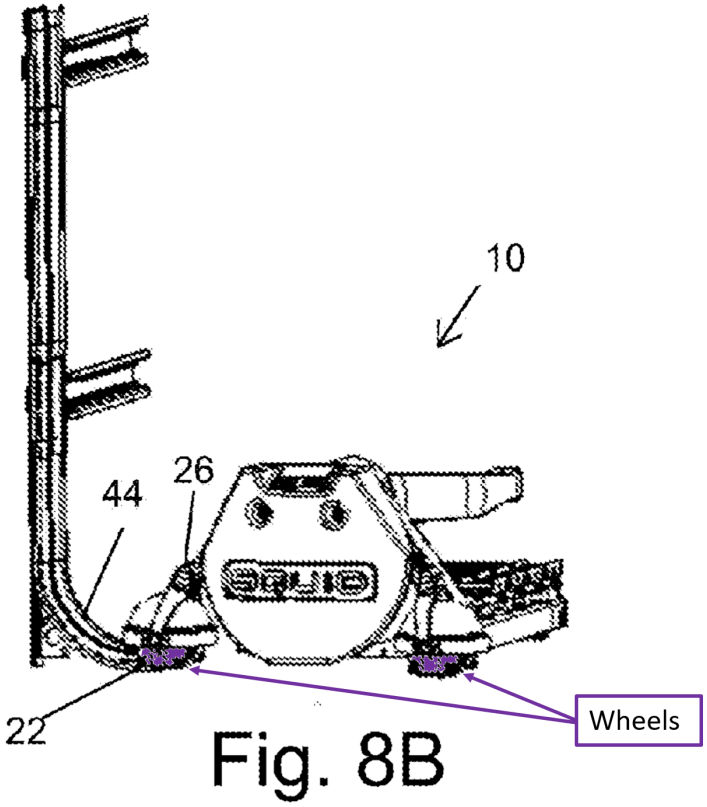


Fig. 8B

347. In FIG. 8D (reproduced below), *Raizer* depicts, "the right front wheel 22 and right arm unit 26 continu[ing] to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0118]).

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Ex. 1005, FIG. 8D

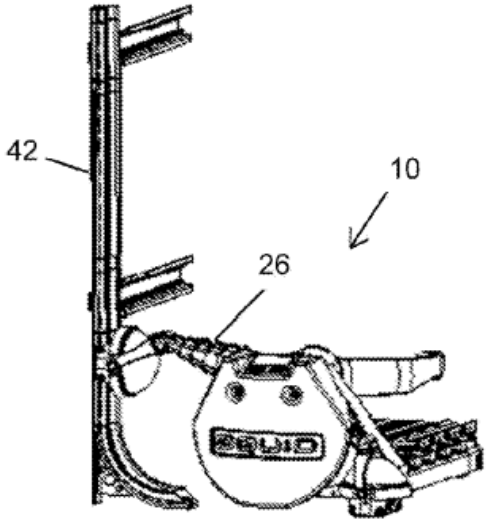


Fig. 8D

348. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

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Ex. 1005, FIG. 8F (annotated)

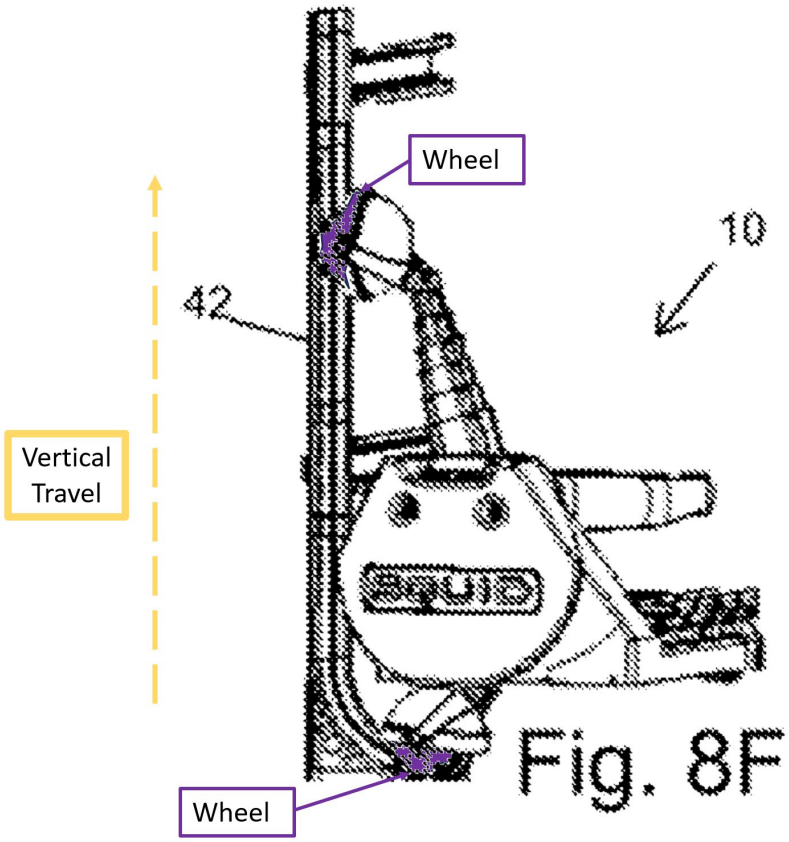


Fig. 8F

349. With reference to FIG. 9A (reproduced and annotated below), *Raizer* shows "a bottom view of the shell 38 of drive and steering unit 24," noting that in the figure "[t]he wheel 22 and all other components of the drive and steering unit have been removed to show the small wheels 36 that lock the robot to the rails." (Ex. 1005, ¶[0122]). As can be seen in FIG. 9A, "on each side of the shell 38 there is a group of five small wheels 36." (Ex. 1005, ¶[0122]). "Each group comprises two wheels mounted with their axles parallel to the sides of the shell and three wheels mounted with the axels [sic] perpendicular to the sides of the shell." (Ex. 1005, ¶[0122]).

Ex. 1005, FIG. 9A (annotated)

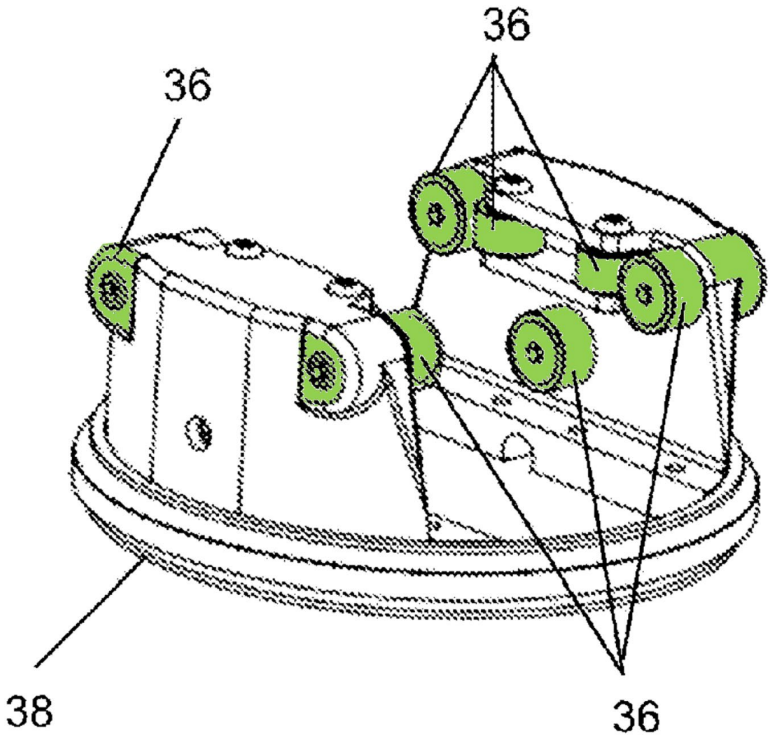
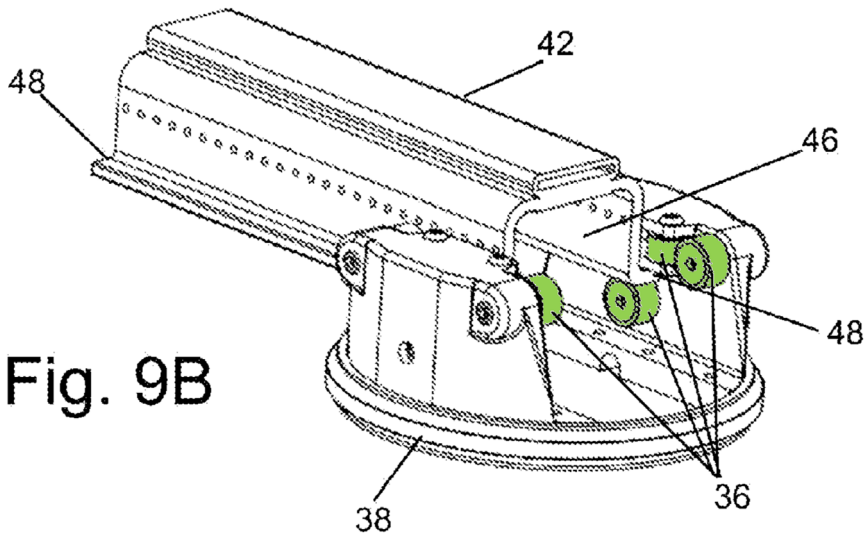


Fig. 9A

350. With reference to FIG. 9B (reproduced and annotated below), *Raizer* discloses "when the drive wheel 22 enters the U shaped channel 46 in rail 42 the small wheels 36 lock the drive wheel on the rail." (Ex. 1005, ¶[0122]).

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Ex. 1005, FIG. 9B (annotated)



351. To be clear, *Raizer* discloses a vertical drive comprising drive wheels 22, drive and steering units 24, and small wheels 36 that are operable to drive the vehicle vertically.

352. Thus, *Raizer* discloses a vertical drive operable to drive the vehicle vertically, as recited in claim element [11.c4].

Claim 11, Element [11.c5]: and a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;

353. *Raizer* discloses claim element [11.c5].

354. *Raizer* discloses that the "robots of the system comprise" a "gripper mechanism attached to the top side of the [robot] frame that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The "gripper mechanism comprises an array of micro-pallet lifters" where "each micro-pallet in the array can be independently operated of the others thereby allowing the robot to handle different sized boxes and

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maximizing the efficient use of shelf space." (Ex. 1005, ¶[0031]). The "robot" can "grab and lift [a] carton" "[i]n order to be able to place the cartons on the shelves or to pick them up." (Ex. 1005, ¶[0101]).

355. *Raizer* discloses that "[t]he combination of the capability of independently changing the lengths and angles of the two arm units 26 and the capability of activating the two drive and steering units 24 independently allows the robot, with the assistance of fine positioning sensor 34, to place a box on a shelf or remove it from any height or any orientation on the shelf." (Ex. 1005, ¶[0133]).

356. With reference to FIG. 14A (reproduced below), *Raizer* shows a "robot 10 positioning a box 158 on top of a stack of three other boxes on a shelf in the storage area of the warehouse." (Ex. 1005, ¶[0138]).

Ex. 1005, FIG. 14A

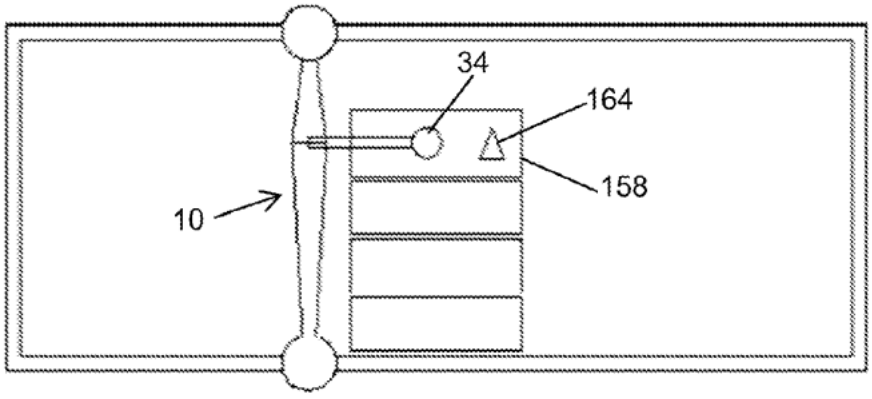


Fig. 14A

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357. Thus, *Raizer* discloses a transfer mechanism (the "gripper mechanism") operable to transfer an item between the vehicle and one of the storage locations, as recited in claim element [11.c5].

Claim 11, Element [11.d]: a track positioned in the aisle wherein the vertical drive is configured to cooperate with the track to drive the vehicle vertically upwardly;

358. *Raizer* discloses claim element [11.d]. As discussed with respect to claim elements [11.a1], [11.a2], [11.b1], and [11.b2], *Raizer* discloses a plurality of storage shelves arranged to include aisles between the shelves.

359. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

360. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and

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along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

361. *Raizer* discloses a "network of vertical and horizontal rails that are parallel to the vertical support posts and horizontal shelves of the shelving system in the warehouse." (Ex. 1005, ¶[0020]). *Raizer* discloses "[a] curved piece of rail called a terminal 44 is attached to the bottoms of the vertical rails where they reach the ground." (Ex. 1005 ¶[0111]). "This is the only place where robots 10 can connect or disconnect from the rails 42 in order to climb to or descend from the shelves." (Ex. 1005, ¶[0111]). From the above description and in the context the warehouse depicted in FIG. 1, a person of ordinary skill in the art would have understood that terminal 44 and vertical rails 42 represent a track positioned in an aisle extending upward and attaching to vertical support posts of the shelving units.

362. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

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363. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

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Ex. 1005, FIG. 8B (annotated)

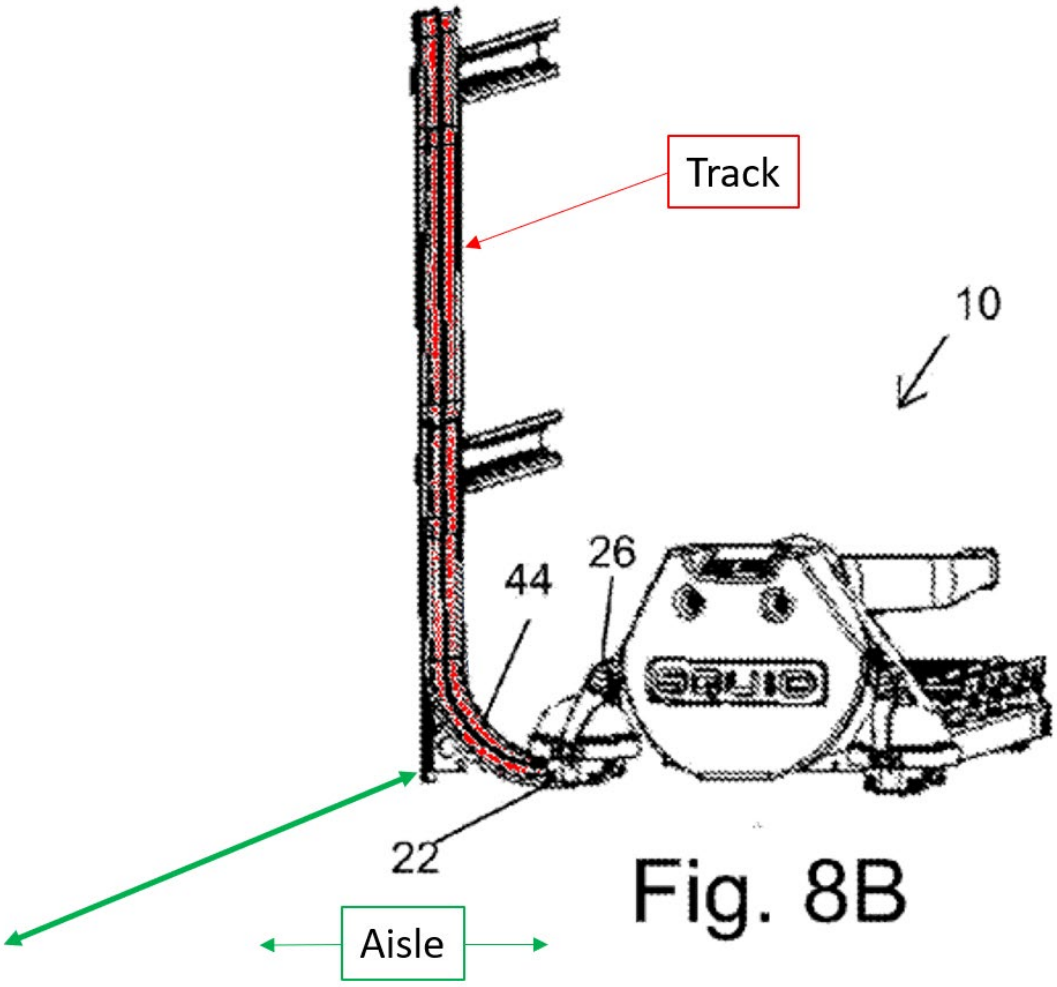


Fig. 8B

364. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

Ex. 1005, FIG. 8F (annotated)

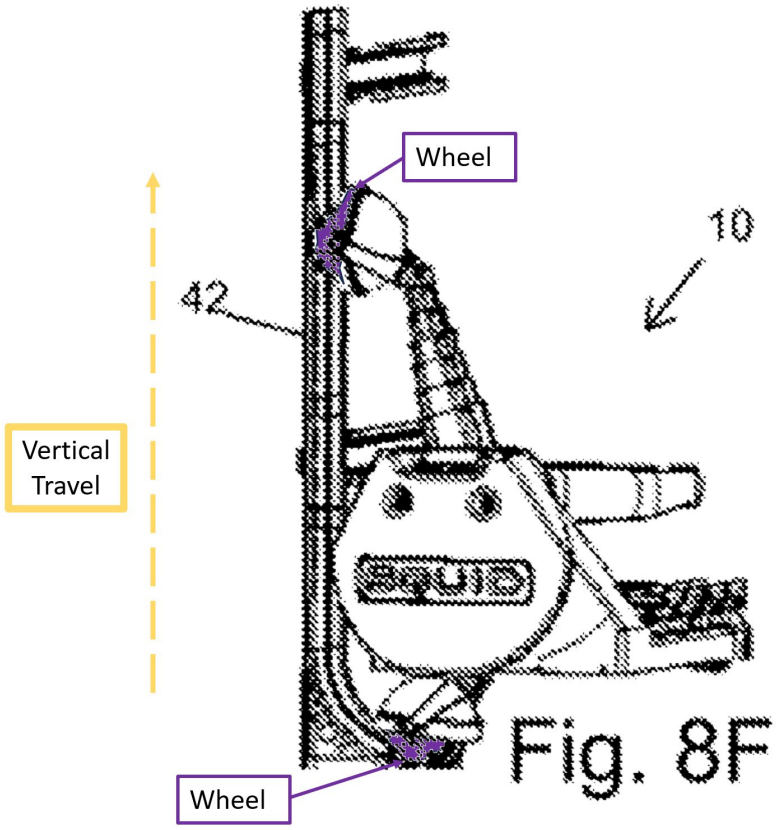


Fig. 8F

365. Thus, *Raizer* discloses a track (the disclosed termianl 44 and/or vertical rails 42) positioned in the aisle wherein the vertical drive is configured to cooperate with the track to drive the vehicle vertically upwardly, as recited in claim element [11.d].

Claim 11, Element [11.e]: a first horizontal path that extends under the first rack in a direction parallel to the aisle;

366. *Raizer* in view of *Hangzhou* renders obvious claim element [11.e]. As discussed with reference to claim element [11.b3], *Raizer* discloses a plurality of

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storage racks (shelves) spaced apart from one another forming a plurality of aisles where the row of racks is adjacent the aisle.

367. To the extent that *Raizer* does not explicitly disclose a first horizontal path that extends under the first rack in a direction parallel to the aisle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

368. *Hangzhou* discloses "an unmanned warehousing system" where "a two-layer channel support frame is provided below a shelf." (Ex. 1006, Abstract). Of the two layers, "[the] lower layer is used to automatically guide a trolley to pass through," (i.e., under the shelf). (Ex. 1006, Abstract). That is, an "auto-guided trolley travels through the lower layer of the support frame to a position below the container." (Ex. 1006, Abstract). The "auto-guided trolley" "is a small mobile robot with auto-navigation ability" "driven by a differential gear train." (Ex. 1006, ¶[0048]). The "auto-guided trolley preferentially travels in column laneways" and "in auto-guided trolley passage spaces." (Ex. 1006, ¶[0048]).

369. *Hangzhou*, with reference to Figure 2 (reproduced and annotated below), discloses "[s]everal modular channel support frames may be mounted below a shelf 100" to raise the shelf to a height greater than the trolley height. (Ex. 1006, ¶[0044]). "Support members 111 divide the space inside channel support frames 110 into an auto-guided trolley passage space 112." (Ex. 1006, ¶[0045]).

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Ex. 1006, Figure 2 (annotated)

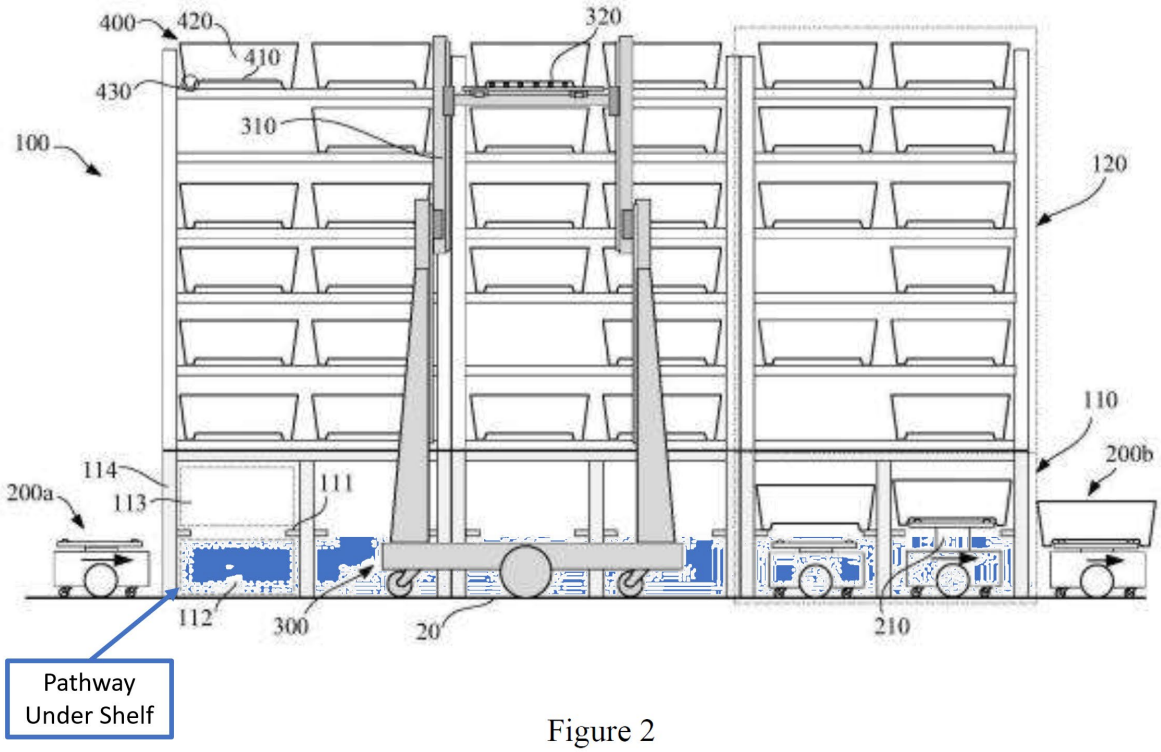


Figure 2

370. That is, Hangzhou discloses a shelf (e.g., a first rack), with a lower layer of a channel support frame that is set up under the shelf, and that the automatically guided trolley (e.g., first vehicle) passes through the lower layer (e.g., is driven along a first path that is under one the first rack).

371. With respect to Figure 1 (reproduced below), *Hangzhou* discloses "auto-guided trolleys 100" travel "under the shelf," as indicated by the dotted line, and *Hangzhou* explicitly refers to that path as "a path parallel to the stacking row laneway 12" (i.e., an aisle). (Ex. 1006, ¶[0040]).

Ex. 1006, Figure 1

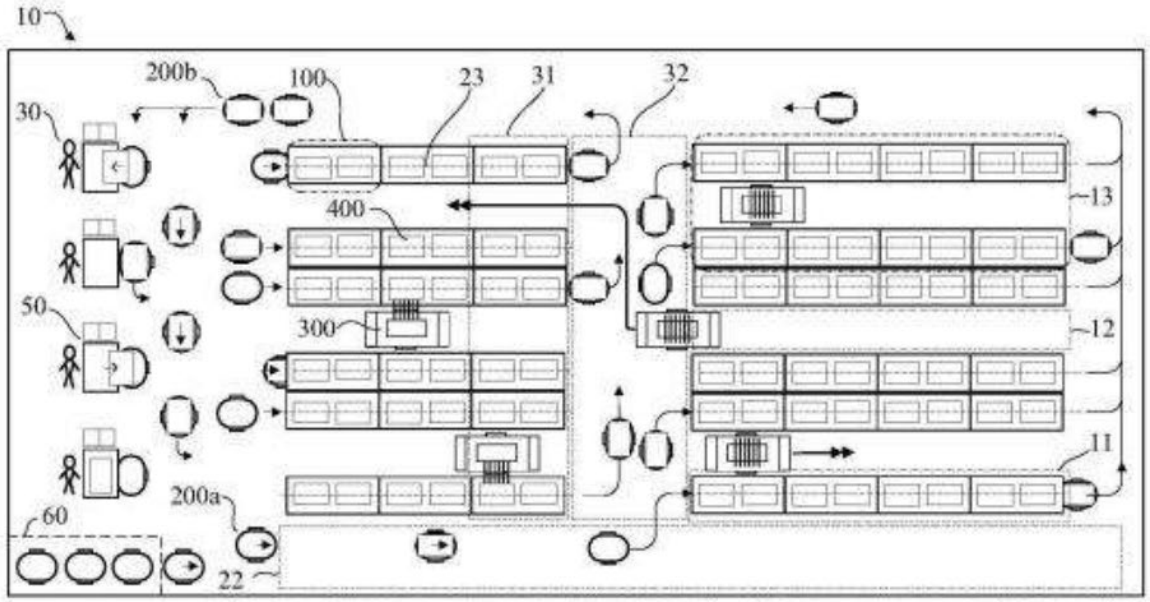


Figure 1

372. A person of ordinary skill in the art would have been motivated to combine *Hangzhou*'s driving of the trolleys underneath the storage shelves in a direction parallel to the aisle with the "three-dimensional navigation and travel capabilities" of *Raizer* to provide the system of *Raizer* with increased travel paths for the robots to reduce congestion, avoid traffic jams, and maintain a more efficient use of space. Notably, such a combination would have been especially desirable to a person of ordinary skill in the art because the *Raizer's* three-dimensional movement capabilities eliminate the need for *Hangzhou's* stacking robot, thus creating even more reduced congestion, and opening up an even a greater number of travel paths (i.e., under storage shelf racks and along aisles). A person of ordinary

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skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

373. Thus, *Raizer* in view of *Hangzhou* renders obvious a first horizontal path that extends under the first rack in a direction parallel to the aisle, as recited in claim element [11.e].

Claim 11, Element [11.f]: a second horizontal path that extends under the first rack in a direction parallel to the aisle;

374. *Raizer* in view of *Hangzhou* renders obvious claim element [11.f]. As discussed with reference to claim elements [11.b3] and [11.e], *Raizer* discloses a plurality of storage racks (shelves) spaced apart from one another forming a plurality of aisles where the row of racks is adjacent the first aisle and paths that extend under the racks in a direction parallel to the aisle.

375. To the extent that *Raizer* does not explicitly disclose a second horizontal path that extends under the first rack in a direction parallel to the aisle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

376. *Hangzhou* discloses the modular shelves "placed in rows and columns to improve the plot ratio." (Ex. 1006, ¶[0037]). "Two shelf rows are usually placed face to face to share a stacking row laneway 12 in the middle," such that the "combination of the stacking row laneway 12 and all the shelf rows 11 facing the

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row laneway is defined as a shelf-laneway combination 13." (Ex. 1006, ¶[0037]). *Hangzhou*, with respect to Figure 1 (reproduced and annotated below) further discloses "two adjacent shelf-laneway combinations 13 preferentially adopt a back-to-back layout to improve the plot ratio." (Ex. 1006, ¶[0038]).

377. As discussed with respect to claim element [1.d1], *Hangzhou* discloses trolleys traveling under the shelves as indicated by the dotted line in Figure 1 (reproduced below). That is, *Hangzhou* explicitly depicts at least two robots entering shelf columns simultaneously and traveling along parallel paths.

Ex. 1006, Figure 1 (annotated)

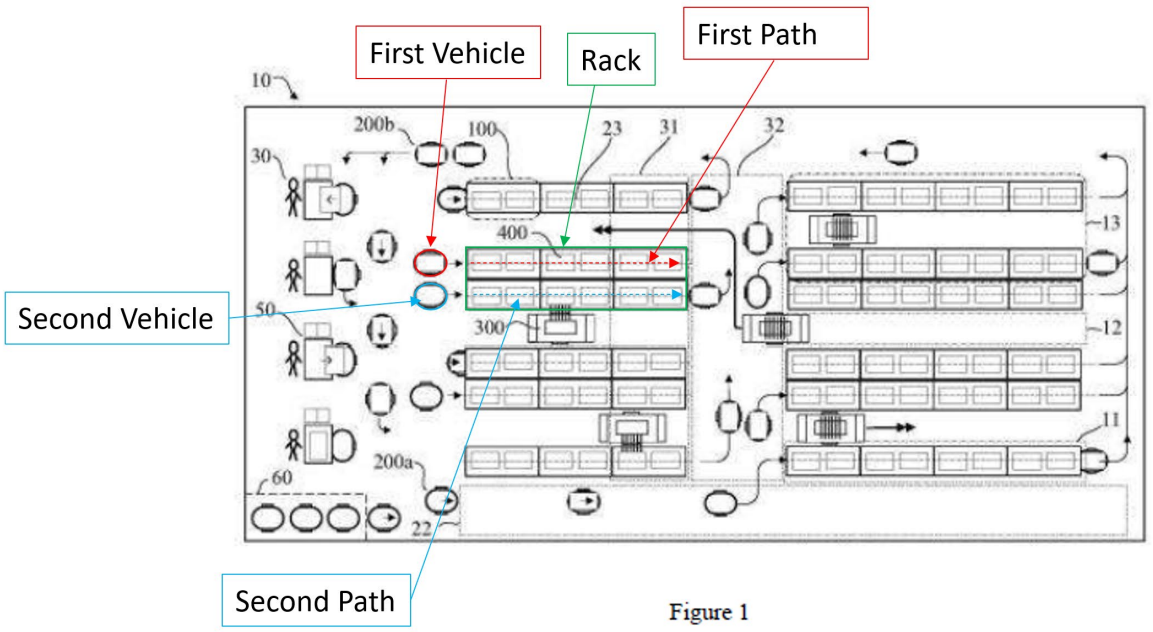


Figure 1

378. *Hangzhou* discloses "a plurality of auto-guided trolleys 200 travel in stacking row laneways 12 and column laneways 32 and in auto guided trolley passage space 122" "to reduce blockage." (Ex. 1006, ¶[0047]).

379. To the extent that *Hangzhou* does not explicitly disclose driving a second of the vehicles under the first rack along a second path parallel to the first path, a person of ordinary skill in the art would have understood that, in view of *Hangzhou's* disclosure of combining two shelf rows to have a single wider shelf to allow for multiple rows of boxes. Additionally, it would have been obvious to a person of ordinary skill in the art given *Hangzhou's* disclosure of allowing multiple auto-guided trolleys to drive underneath the shelves along the column laneways, to have two trolleys entering traveling along parallel paths underneath a singular, wider shelf.

380. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* capability of driving of two trolleys under a rack, in parallel, with the three-dimensional travel capabilities of *Raizer's* robots in order to allow multiple robots to maneuver under the racks and pass each other would further "reduce blockage and shorten the turnover time," and increase the system's output rate. (Ex. 1006, ¶[0072]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

381. Thus, *Raizer* in view of *Hangzhou* renders obvious a second horizontal path that extends under the first rack in a direction parallel to the aisle, as recited in claim element [11.e].

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Claim 11, Element [11.g]: wherein the horizontal drive is configured to turn the vehicle under the first rack by rotating the vehicle about a vertical axis that extends through the vehicle;

382. *Raizer* in view of *Hangzhou* renders obvious claim element [11.g]. As discussed with respect to claim element [11.c3], *Raizer* discloses robots with a horizontal drive system operable to drive the vehicle along a horizontal surface.

383. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). *Raizer* further discloses that "[t]he two front wheels 22 can be independently rotated in any direction by drive and steering units 24. With this arrangement the robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse without the use of a track, embedded wire or any other arrangement to guide it." (Ex. 1005, ¶[0104]).The "motor of the drive assembly is a variable speed motor," making it possible to "steer the robot by activating the drive motors to produce differential rotational speeds of the two front drive wheels." (Ex. 1005, ¶[0109]).

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384. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

385. *Raizer* further discloses that its system is "plug and play in any warehouse, integrating with an already in-use facility, shelving system and infrastructure resources of a conventional warehouse." (Ex. 1005, ¶[0079]). *Raizer* also discloses that its system deploys "a self-learning system where, for example, algorithm [sic] can track the movement of the robots and organize the routes of traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders." (Ex. 1005, ¶[0098]).

386. To the extent that *Raizer* does not explicitly disclose turning the first vehicle while the first vehicle is under the first rack, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

387. As discussed above with respect to claim element [11.e] and [11.f], *Hangzhou* discloses driving the vehicle under the rack. *Hangzhou* further discloses that the "trolleys are generally designed in symmetrical to turn in place [sic]." (Ex. 1006, ¶[0048]).

388. With reference to Figure 10 (reproduced below), *Hangzhou* discloses that "an auto-guided trolley 200 may switch between the row direction and the column direction," noting that "[s]witching the driving direction does not bring a

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problem to auto-guided trolleys because auto-guided trolleys 200 can be small enough to turn in the auto-guided trolley passage space 112." (Ex. 1006, ¶[0072]).

Ex. 1006, Figure 10

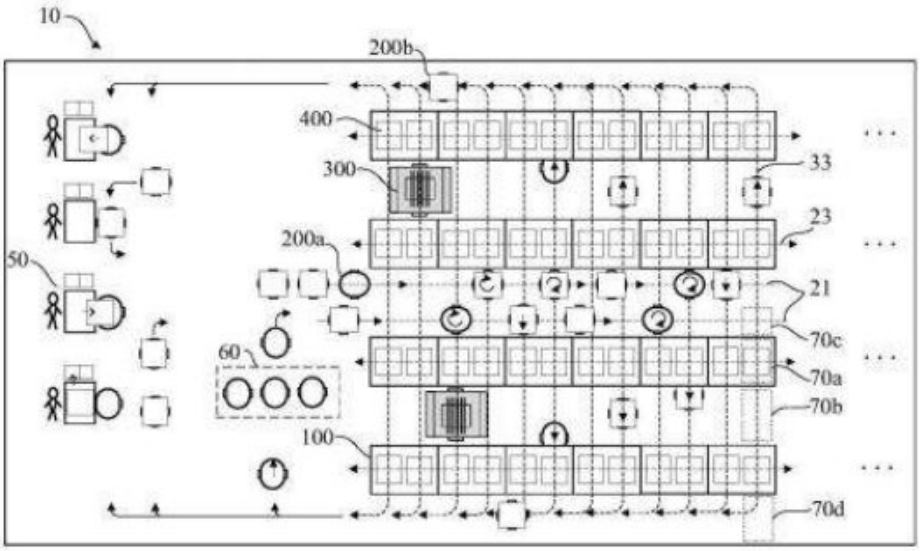


Figure 10

389. *Hangzhou* further discloses that an "auto-guided trolley 200 carrying standardized containers 400 switches between the row and column directions along the traveling direction by performing a series of actions, including dropping and docking the standardized containers on the support members, the trolley turning 90° in place, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

390. The "trolley passage space 112" can be seen in Figure 2 (reproduced and annotated below) as being under the rack. *Hangzhou* discloses that "a row channel, a column channel, or both the row and column channels are provided for

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the auto-guided trolley carrying the standardized container or the moveable bracket to travel under the shelf." (Ex. 1006, ¶[0008]). "[C]ache spaces 113" are disclosed for "docking standardized containers," and "[a] horizontal gap is spared between support members 111, making auto-guided trolley passage space 112 connect the cache spaces 113." (Ex. 1006, ¶[0045]). This "allow[s] auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

Ex. 1006, Figure 2 (annotated)

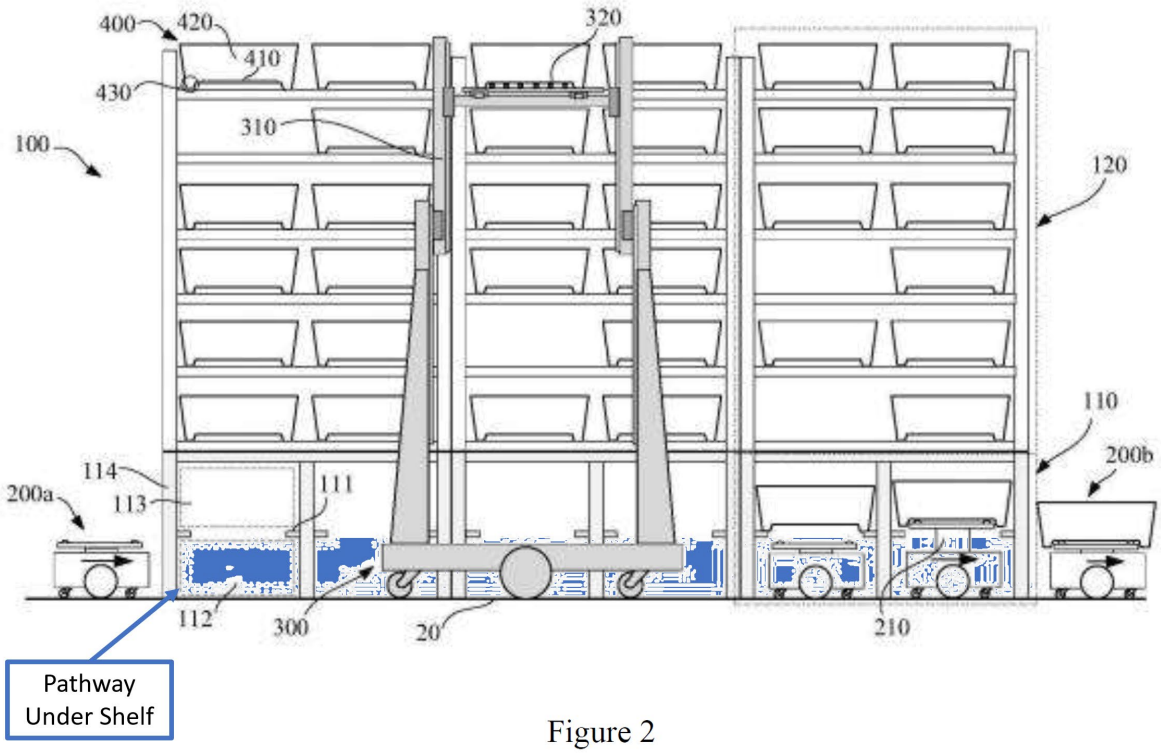


Figure 2

391. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have

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been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf. However, were *Raizer's* disclosure deemed insufficient to disclose this feature, a person of ordinary skill in the art would have been motivated to combine *Hangzhou's* trolley being configured to rotate in place 90° under shelves to switch traveling direction with the three dimensional travel capabilities of *Raizer* because, as taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). Route switching based on such turning also "usually reduce[s] blockage and shorten[s] [trolley] turnover time." (Ex. 1006, ¶[0072]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

392. Thus, *Raizer* in view of *Hangzhou* renders obvious the horizontal drive is configured to turn the vehicle under the first rack by rotating the vehicle about a vertical axis that extends through the vehicle, as recited in claim element [11.g].

Claim 11, Element [11.h1]: wherein the storage rack comprises a plurality of vertical posts and

393. *Raizer* discloses claim element [11.h1]. As discussed with respect to claim elements [11.a1] and [11.b1], *Raizer* discloses a "plurality of shelving units"

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with "a network of vertical and horizontal rails" that are "parallel to" "vertical support posts and horizontal shelves."

394. Thus, *Raizer* discloses the storage rack comprises a plurality of vertical posts, as recited in claim element [11.h1].

Claim 11, Element [11.h2]: the first and second horizontal paths are each spaced apart from the vertical posts a distance greater the one half the length of the vehicles;

395. *Raizer* in view of *Hangzhou* renders obvious claim element [11.h2]. As discussed with respect to claim elements [11.e] and [11.f], *Raizer* in view of *Hangzhou* renders obvious a first and second horizontal paths extending under the shelves.

396. To the extent that *Raizer* does not explicitly disclose the first and second horizontal paths spaced apart a distance greater the one half the length of the vehicles, a person of ordinary skill in the art would have turned to *Hangzhou* for such a teaching.

397. *Hangzhou* discloses "support members 111 divid[ing] the space inside channel support frames 110 into an auto-guided trolley passage space 112 and a cache space 113 for docking standardized containers." (Ex. 1006, ¶[0045]). There exists a "horizontal gap . . . between support members 111, making auto-guided trolley passages spaces 112 connect the cache space 113 in the row direction of the

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shelf to form a row channel 23 in that direction to allow auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

398. *Hangzhou* discloses that the trolleys traveling under the shelves may "switch between trolley-special row laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006, ¶[0072]). The trolleys perform route switching by "dropping and docking the standardized containers on the support members, the trolley turning 90° in place, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

399. *Hangzhou* discloses that the "diameter of the trolley 200 is less than the short side of the channel support frame 110," and that "[w]hen the trolley 200 travels to the center of the channel support frame 110, the trolley 200 may turn in place without movement interference." (Ex. 1006, ¶[0073]).

400. Given *Hangzhou's* disclosure of trolleys moving in column and row channels beneath shelves and being small enough to rotate in place 90° to switch traveling directions, a person of ordinary skill in the art would have understood that the first and second horizontal paths the trolleys travel along would be spaced apart from the vertical posts by a distance greater than half the length of the vehicle in order to allow the trolleys to turn without colliding with the support members or each other and to allow the robots of *Raizer* to engage with the vertical rails once in the aisle between the shelves.

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401. A person of ordinary skill in the art would have been motivated to combine *Hangzhou's* spacing of the trolley away from the shelf in order to move in column and row channels beneath shelves and being small enough to rotate in place 90° with the three-dimensional travel capabilities and rectangular shape of *Raizer's* robots to space the vehicle's path a distance greater than half the length of the vehicle in order to allow the vehicles to turn properly without colliding with the support members. Such rotation also allows the *Raizer* robot, which is "completely autonomous and can be steered by its control system to any location on the floor of the warehouse" (Ex. 1005, ¶[0104]), to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). Route switching based on such turning also "usually reduce[s] blockage and shorten[s] [trolley] turnover time." (Ex. 1006, ¶[0072]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

402. Thus, *Raizer* in view of *Hangzhou* renders obvious the first and second horizontal paths are each spaced apart from the vertical posts a distance greater the one half the length of the vehicles, as recited in claim element [11.h2].

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Claim 11, Element [11.i]: where the first horizontal path under the first rack is spaced apart from the second horizontal path a distance greater than the width of the vehicles.

403. *Raizer* in view of *Hangzhou* renders obvious claim element [11.i]. As discussed with respect to claim elements [11.e] and [11.f], *Raizer* in view of *Hangzhou* renders obvious first and second horizontal paths extending under the shelves.

404. To the extent that *Raizer* does not explicitly disclose the first and second horizontal paths spaced apart a distance greater than the width of the vehicles, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

405. *Hangzhou* discloses "support members 111 divid[ing] the space inside channel support frames 110 into an auto-guided trolley passage space 112 and a cache space 113 for docking standardized containers 400." (Ex. 1006, ¶[0045]). There exists a "horizontal gap . . . between support members 111 making auto-guided trolley passages spaces 112 connect the cache spaces 113 in the row direction of the shelf to form a row channel 23 in that direction to allow auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

406. With further reference to Figure 1 (reproduced and annotated in two manners below), *Hangzhou* discloses that a "dotted line displayed on the center line of each shelf row is used to indicate the row channel 23 for auto-guided trolleys 200

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under the shelf, which is a path parallel to the stacking row laneway 12." (Ex. 1006, ¶[0040]). *Hangzhou* explicitly depicts at least two robots entering shelf columns simultaneously and traveling along parallel paths.

Ex. 1006, Figure 1 (annotated)

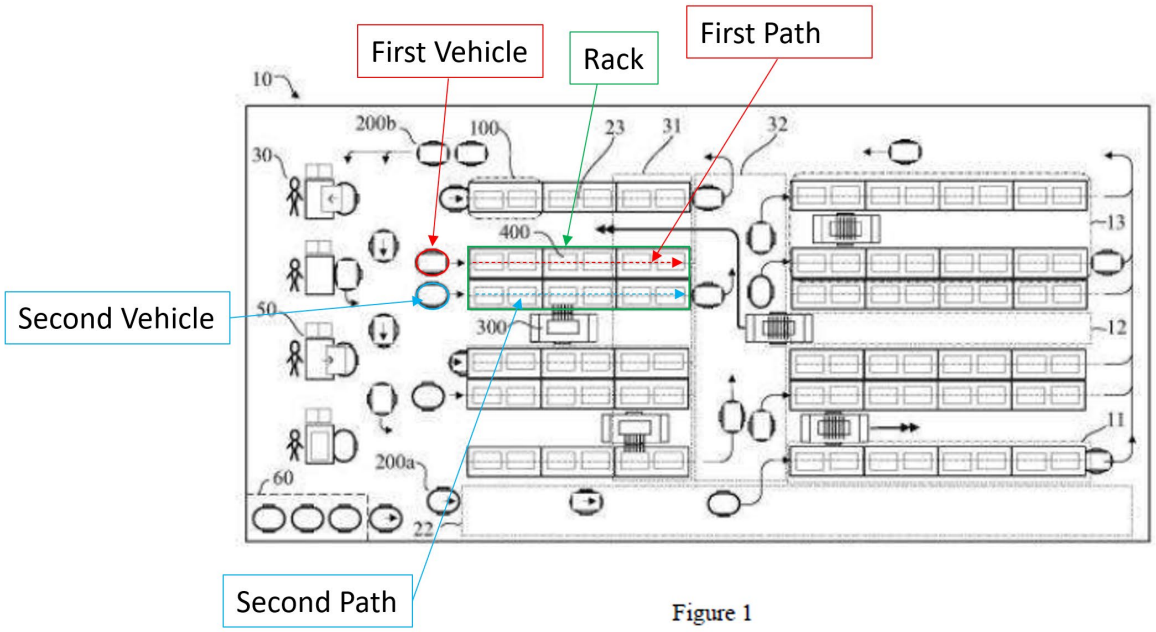


Figure 1

407. *Hangzhou* discloses that the trolleys traveling under the shelves may "switch between trolley-special row laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006), ¶[0072]). The trolleys perform route switching by "dropping and docking the standardized containers on the support members, the trolley turning 90° in place, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

408. *Hangzhou* discloses that the "diameter of the trolley 200 is less than the short side of the channel support frame 110," and that "[w]hen the trolley 200 travels

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to the center of the channel support frame 110, the trolley 200 may turn in place without movement interference." (Ex. 1006, ¶[0073]).

409. *Hangzhou* discloses "a plurality of auto-guided trolleys 200 travel in stacking row laneways 12 and column laneways 32 and in auto guided trolley passage space 122" "to reduce blockage." (Ex. 1006, ¶[0047]).

410. Given *Hangzhou's* disclosure of multiple trolleys moving in column and row channels beneath shelves, trolleys rotating in place underneath the shelves, and Hangzhou's attempt to solve blockages and congestion, a person of ordinary skill in the art would have understood that the first and second horizontal paths would be spaced apart a distance greater than the width of the vehicles in order to avoid collisions between trolleys traveling beneath the shelves.

411. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

412. Thus, *Raizer* in view of *Hangzhou* renders obvious where the first horizontal path under the first rack is spaced apart from the second horizontal path a distance greater than the width of the vehicles, as recited in claim element [11.i].

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Dependent Claim 12

Claim 12, Element [12.pre]: The system of claim 11

413. *Raizer* in view of *Hangzhou renders* obvious claim element [12.pre]. As set forth above, *Raizer* in view of *Hangzhou renders* obvious all of the elements of claim [12]. Thus, *Raizer* in view of *Hangzhou renders* obvious [12.pre].

Claim 12, Element [12.a] wherein the vertical drive comprises a plurality of rotatable elements that each rotate about a horizontal axis and

414. Raizer discloses claim element [12.a].

415. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the

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vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

416. With reference to FIG. 9A (reproduced and annotated below), *Raizer* shows "a bottom view of the shell 38 of drive and steering unit 24," noting that in the figure "[t]he wheel 22 and all other components of the drive and steering unit have been removed to show the small wheels 36 that lock the robot to the rails." (Ex. 1005, ¶[0122]). As can be seen in FIG. 9A, "on each side of the shell 38 there is a group of five small wheels 36." (Ex. 1005, ¶[0122]). "Each group comprises two wheels mounted with their axles parallel to the sides of the shell and three wheels mounted with the axels [sic] perpendicular to the sides of the shell." (Ex. 1005, ¶[0122]).

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Ex. 1005, FIG. 9A (annotated)

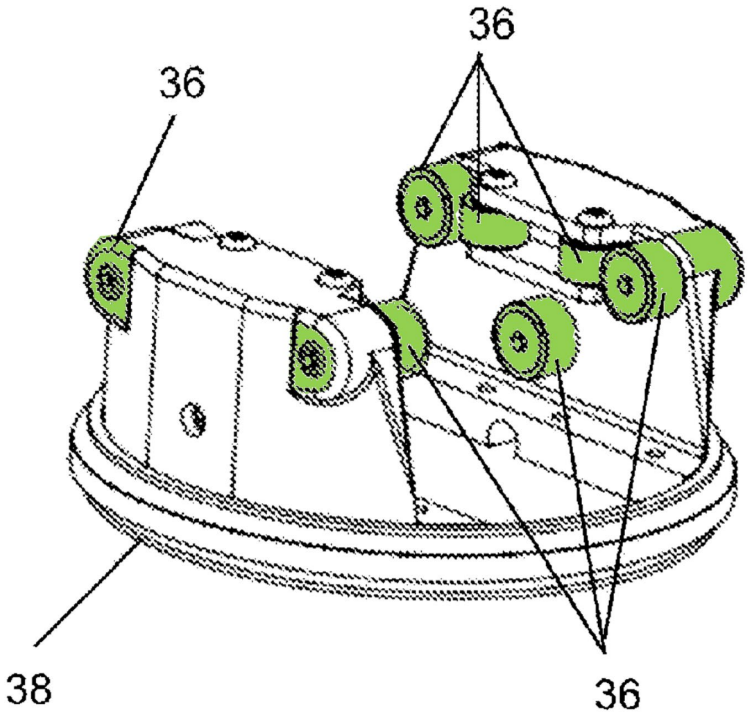


Fig. 9A

417. With reference to FIG. 9B (reproduced and annotated below), *Raizer* discloses "when the drive wheel 22 enters the U shaped channel 46 in rail 42 the small wheels 36 lock the drive wheel on the rail." (Ex. 1005, ¶[0122]).

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Ex. 1005, FIG. 9B (annotated)

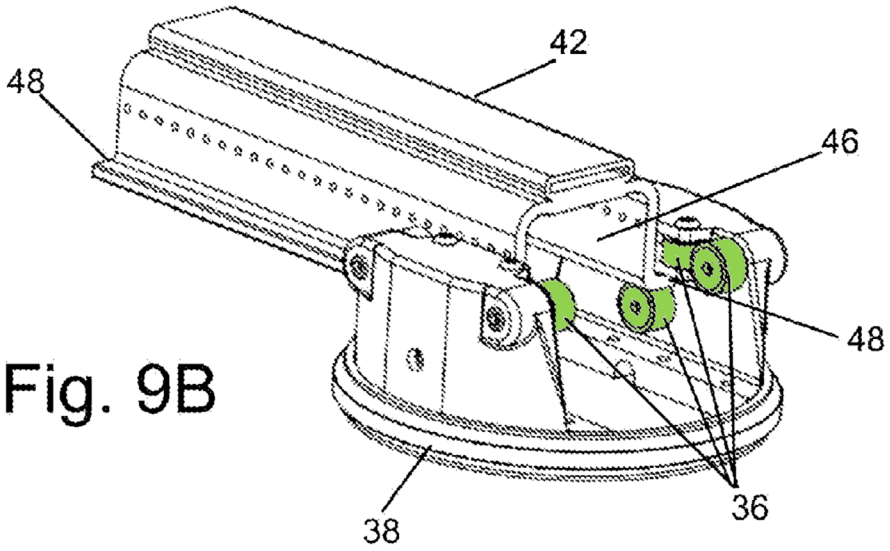


Fig. 9B

418. With reference to FIG. 8A (reproduced and annotated below), *Raizer* discloses that "the robot 10 has used the set of on-board sensors to travel using anchor point navigation to the designated vertical rail 42 that it has been instructed to ascend to reach one of the shelves in the warehouse." (Ex. 1005, ¶[0115]). *Raizer* further discloses "[t]he electric steering motors in the drive and steering units 24 are activated to *turn both front wheels 22 by ninety degrees* so that they are exactly facing the 'U'-shaped channel 46 in terminal 44." (Ex. 1005, ¶[0115]). When engaged with the 'U'-shaped channel, wheels 22 of the vertical drive rotate about a horizontal axis to enable the robot to climb the rails vertically and lock the robot in place.

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Ex. 1005, FIG. 8A (annotated)

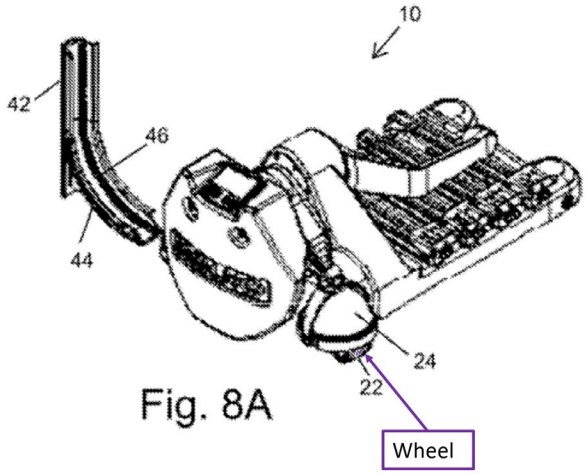


Fig. 8A

419. Thus, *Raizer* discloses the vertical drive comprises a plurality of rotatable elements (wheels 22) that each rotate about a horizontal axis, as recited in claim element [12.a].

> ***Claim 12, Element [12.b]: wherein the horizontal drive comprises a plurality of rotatable elements that each rotate about a horizontal axis transverse that axes of rotation of the vertical drive elements.***

420. *Raizer* discloses claim element [12.b].

421. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other

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degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground," (i.e., along a horizonal surface), "and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving, [and] are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

422. *Raizer* discloses that a robot "travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

423. With reference to FIGs. 5A and 5B (reproduced and annotated below), *Raizer* discloses that the "[r]obot 10 moves along the ground on four wheels," where "two rear wheels 30 could be fixed and passive so that they can only rotate about their axles which are transverse to the axis of the long beams 28 of the frame and are 'dragged along' by the front wheels," or "the rear wheels could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor." (Ex. 1005, ¶[0104]). "The front driving wheels 22 dictate the steering angle and

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differential speeds of the rear wheels," and/or "can be independently rotated in any direction by drive and steering units 24." (Ex. 1005, ¶[0104]). The rear wheels (which form a part of the horizontal drive) rotate along a horizontal axis that is transverse to the horizontal axes about which wheels 22 of the vertical drive (vertical drive elements) rotate.

Ex. 1005, FIG. 6C (annotated)

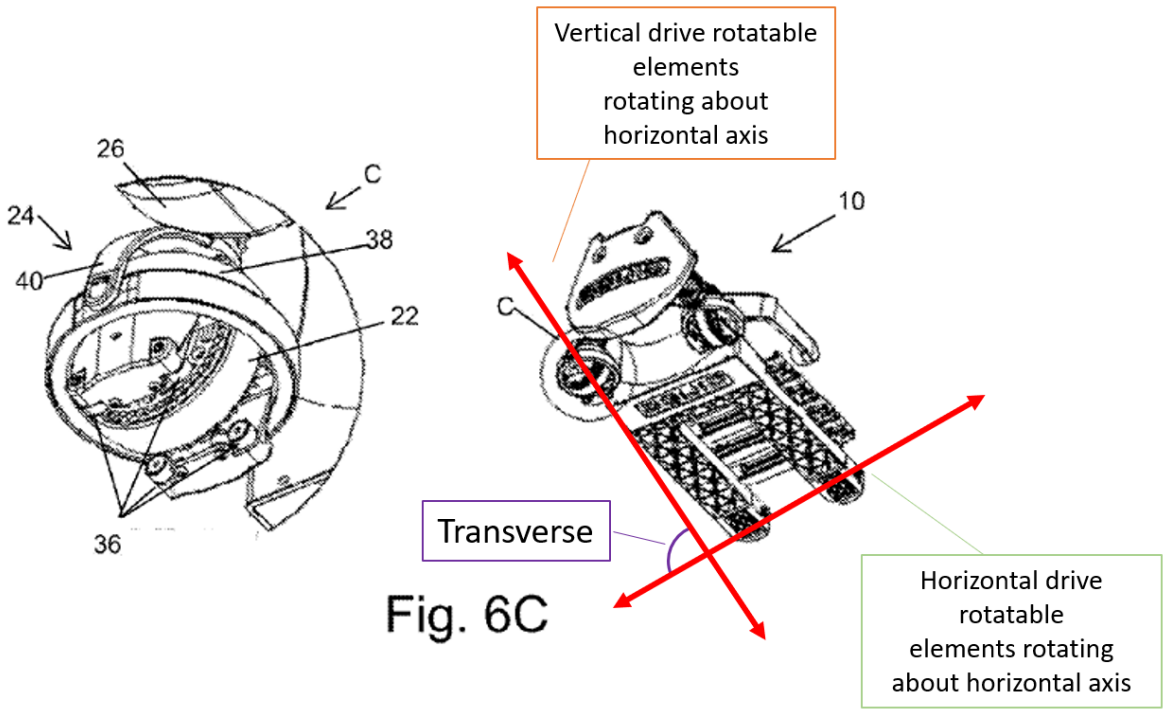


Fig. 6C

424. When the front wheels of the robot are rotated and positioned to engage the vertical rails and raising the robot, the rear wheels (of the horizontal drive) rotate about a horizontal axis that is transverse to the horizontal axes about which the vertical drive elements (wheels 22) are rotating. Thus, *Raizer* discloses the

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horizontal drive comprises a plurality of rotatable elements that each rotate about a horizontal axis transverse that axes of rotation of the vertical drive elements, as recited in claim element [12.b].

Dependent Claim 14

Claim 14, Element [14.pre]: The system of claim 11

425. *Raizer* in view of *Hangzhou* renders obvious claim element [14.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the elements of claim [12]. Thus, *Raizer* in view of *Hangzhou* renders obvious [14.pre].

Claim 14, Element [14.a] wherein the track comprises drive elements configured to cooperate with the vertical drive so that rotating the vertical drive about a horizontal axis operates to drive the vehicle upwardly along the track.

426. *Raizer* discloses claim element [14.a].

427. With reference to FIG. 7A (reproduced below), *Raizer* discloses vertical and horizontal rails "made from 'U'-shaped profiles—that could be made from different materials or with different thickness depending on the strength required—with a channel 46 in which the front wheels 22 of robot 10 travel and two flanges 48 on either side of channel 46." (Ex. 1005, ¶[0111]).

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Ex. 1005, Figure 7A

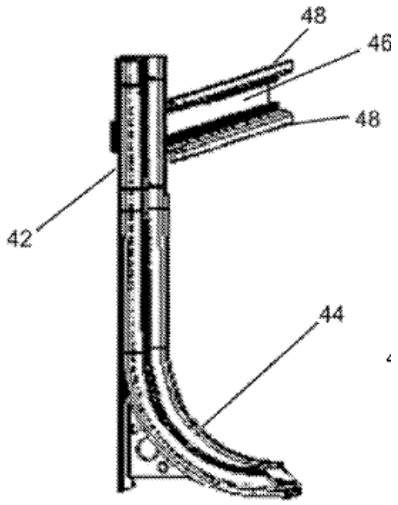


Fig. 7A

428. *Raizer* further discloses "a curved piece of rail called a terminal 44 is attached to the bottoms of the vertical rails where they reach the ground, which "is the only place where robots 10 can connect or disconnect from the rails 42 in order to climb to or descend from the shelves." (Ex. 1005, ¶[0111]).

429. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and

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"are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

430. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

431. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

432. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are

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responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

Ex. 1005, FIG. 8B (annotated)

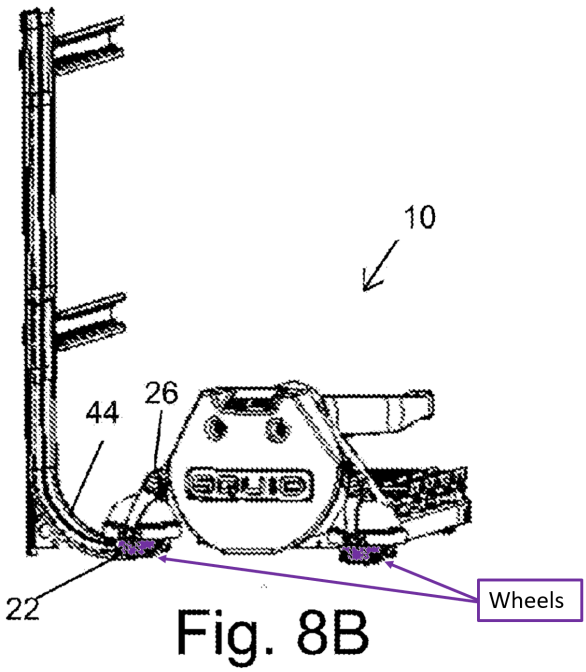


Fig. 8B

433. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

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Ex. 1005, FIG. 8F (annotated)

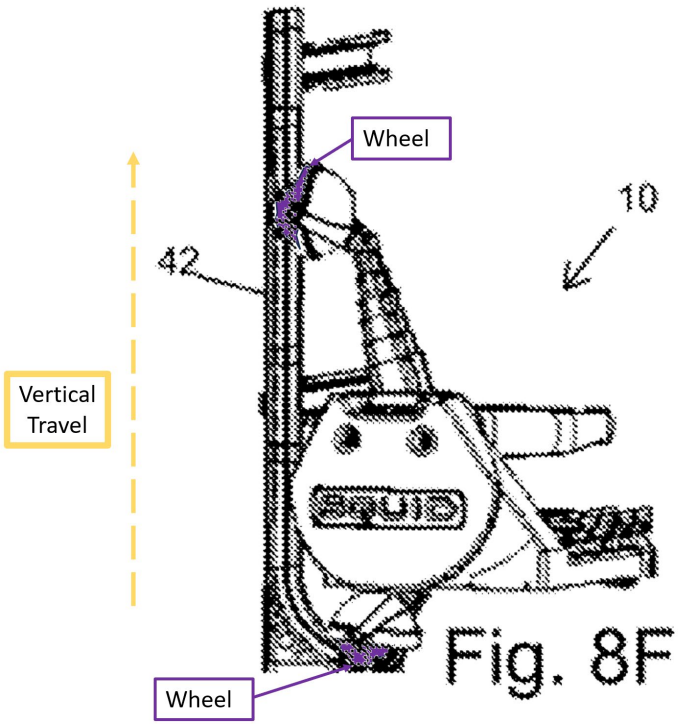


Fig. 8F

434. The 'U'-shaped rails of *Raizer* comprise drive elements that are configured to cooperate with the wheels 22 of the vertical drive to allow the robot to climb vertically while locked into the rail by wheels 36 so that rotating wheels 22 of the vertical drive about a horizontal axis drives the robot vertically upward along the rail. Thus, *Raizer* discloses the track comprises drive elements configured to cooperate with the vertical drive so that rotating the vertical drive about a horizontal axis operates to drive the vehicle upwardly along the track, as recited in claim element [14.a].

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Independent Claim 23

Claim 23, Element [23.pre]: A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of:

435. To the extent that element [23.pre] is found to be limiting, *Raizer* discloses claim element [23.pre].

436. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, Abstract). *Raizer* further discloses that the system is comprised of "a set of autonomous mobile robots," "a network of vertical and horizontal rails" that are "parallel to" "vertical support posts and horizontal shelves," and "a Real Time Traffic Management (RTTM) server." (Ex. 1005, Abstract).

437. *Raizer* discloses that the robots comprise various electronics "configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of [a] network of rails." (Ex. 1005, Abstract).

438. Thus, *Raizer* discloses claim element [23.pre].

Claim 23, Element [23.a1]: providing a plurality of storage racks spaced apart from one another forming a plurality of aisles,

439. *Raizer* discloses claim element [23.a1].

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440. With reference to FIG. 1 (reproduced and annotated below), *Raizer* discloses a "floor plan of a typical warehouse" having a "storage area" with "a plurality of shelving units." (Ex. 1005, ¶[0092]). The shelving units consist of "a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves." (Ex. 1005, ¶[0092]). The "vertical supports divide shelving units into bays (B1, B2, …)." (Ex. 1005, ¶[0092]). The "sides of the shelving units that face the aisles between units are called faces (F1, F2, …)." (Ex. 1005, ¶[0092]).

Ex. 1005, FIG. 1 (annotated)

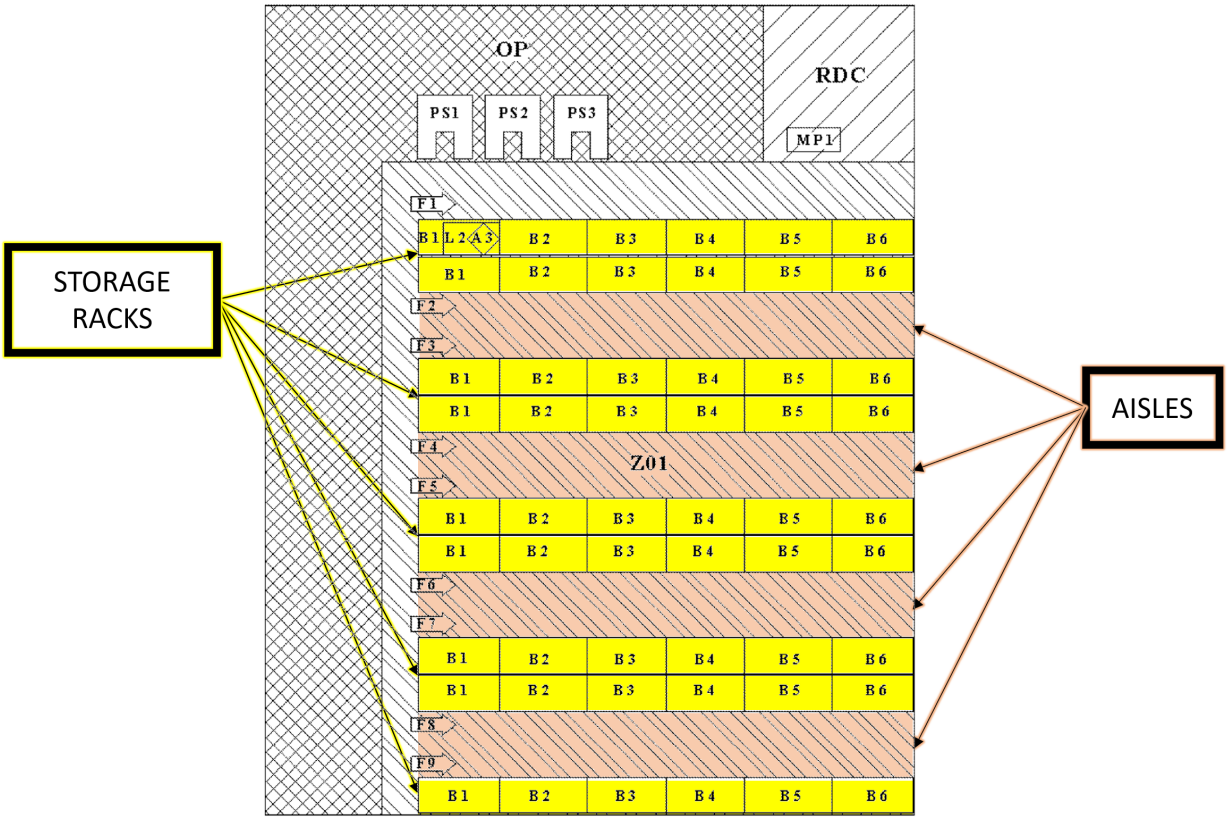


Fig. 1

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441. Thus, *Raizer* discloses providing a plurality of storage racks spaced apart from one another forming a plurality of aisles, as recited in claim element [23.a1].

Claim 23, Element [23.a2]: wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;

442. *Raizer* discloses claim element [23.a2].

443. *Raizer*'s "storage area" has "a plurality of shelving units consisting of a framework commonly made up of horizontal and vertical pieces of angle iron that support the shelves. The vertical supports divide the shelving unit into sections call [sic] bays" and that "a given row of shelves in a bay . . . can hold several boxes arranged in one or more side-by-side stacks each comprising one or more boxes stacked one upon the other." (Ex. 1005, ¶[0092]).

444. *Raizer* discloses that the "exact location of a box in the warehouse is designated by an address comprising numbers, letters, signs, color, etc. representing the zone, face, bay, level, and specific location." (Ex. 1005, ¶[0092]). *Raizer* also discloses that the "location of a specific box in the storage area can be designated in other ways, for example using x, y, z coordinates in a coordinate system of the rail system," highlighting the verticality of the system. (Ex. 1005, ¶[0092]).

445. Thus, *Raizer* discloses each storage rack comprises a plurality of columns defined by the vertical supports and each column comprises a plurality of

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storage locations such as the bays along a given row of shelves, as recited in claim element [23.a2].

Claim 23, Element [23.b1]: providing a plurality of delivery vehicles

446. *Raizer* discloses claim element [23.b1].

447. *Raizer* discloses "an automatic system for picking and placing boxes on shelves in a warehouse." (Ex. 1005, ¶[0018]). The system comprises "a set of autonomous mobile robots." (Ex. 1005, ¶[0019]). The robots "comprise a gripper mechanism" "that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The robots "complete [a] mission of removing a box from (or delivering a box to) a specific location on a shelf." (Ex. 1005, ¶[0114]).

448. Thus, *Raizer* discloses providing a plurality of delivery vehicles, as recited in claim element [23.b1].

Claim 23, Element [23.b2]: wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,

449. *Raizer* discloses claim element [23.b2].

450. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached

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to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

451. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground," (i.e., along a horizonal surface), "and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving, [and] are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

452. *Raizer* discloses that a robot "travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

453. With reference to FIGs. 5A and 5B (reproduced and annotated below), *Raizer* discloses that the "[r]obot 10 moves along the ground on four wheels," where "two rear wheels 30 could be fixed and passive so that they can only rotate about their axles which are perpendicular to the axis of the long beams 28 of the frame and are 'dragged along' by the front wheels," or "the rear wheels could be multi

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directional wheels which allow movement to any direction, about an axis vertical to the floor." (Ex. 1005, ¶[0104]). "The front driving wheels 22 dictate the steering angle and differential speeds of the rear wheels," and/or "can be independently rotated in any direction by drive and steering units 24." (Ex. 1005, ¶[0104]).

Ex. 1005, FIG. 5A (annotated)

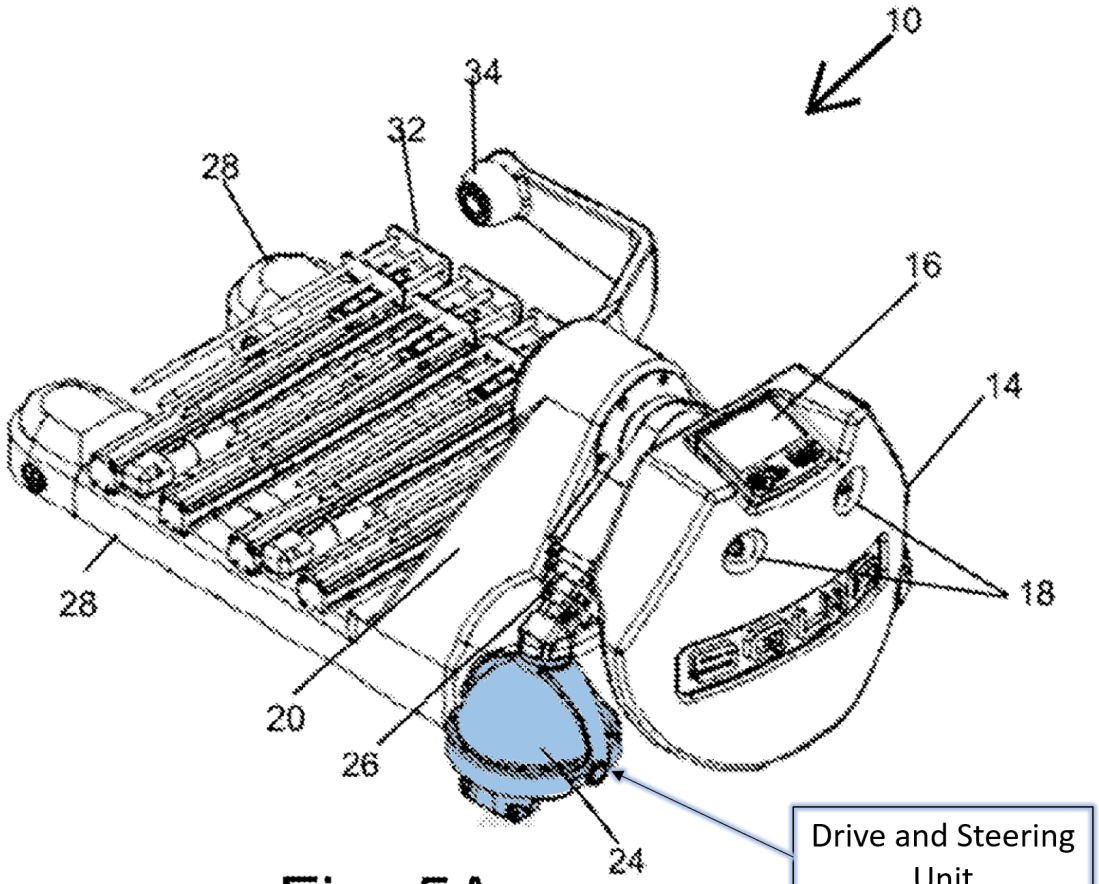


Fig. 5A

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Ex. 1005, FIG. 5B (annotated)

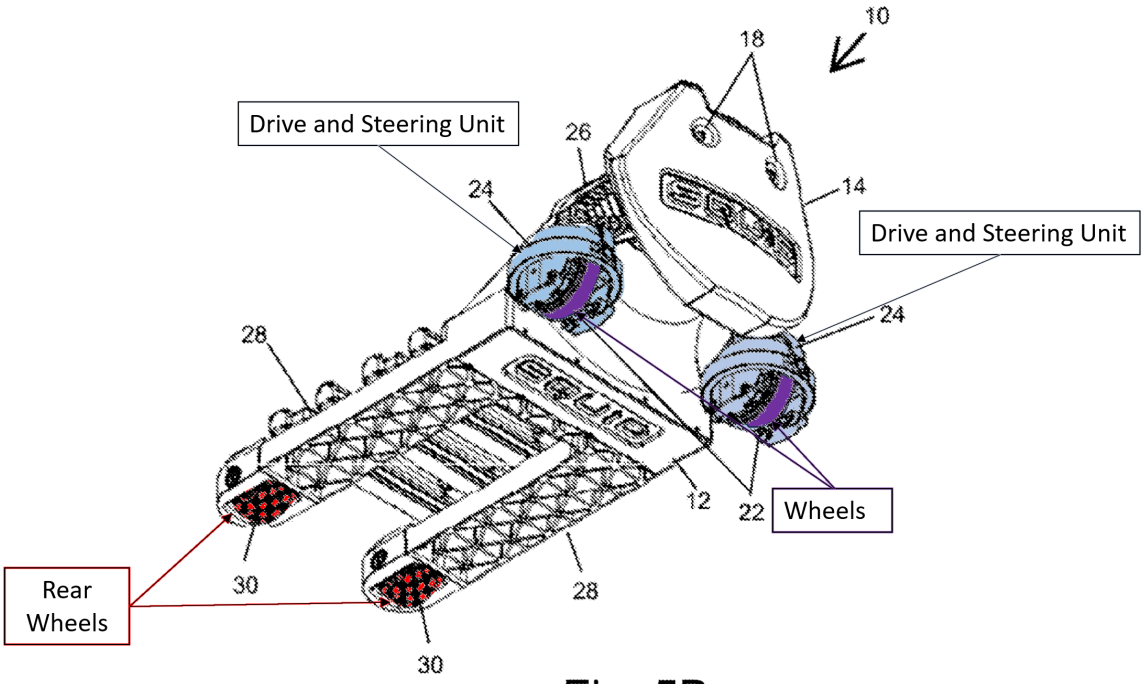


Fig. 5B

454. Thus, *Raizer* discloses each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface, as recited in claim element [23.b2].

Claim 23, Element [23.b3]: a vertical drive operable to drive the vehicle vertically and

455. *Raizer* discloses claim element [23.b3].

456. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units 24," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an

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axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). The "drive and steering units are attached to the robot by means of arm units configured to expand, contract, and have other degrees of freedom that allow the robot to engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0030]).

457. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]).

458. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail." (Ex. 1005, ¶[0114]).

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459. In FIG. 8B (reproduced and annotated below), *Raizer* shows "a synchronized movement tak[ing] place between the driving motor of the right front wheel 22, and electric motors and actuators … inside the right arm unit 26 that are responsible for changing the length and angle of the arm unit advancing the right wheel into the 'U'-shaped channel 46 in terminal 44 while the robot 10 remains in position on the floor." (Ex. 1005, ¶[0116]). As "right wheel 22 enters the terminal it is geometrically locked to the rail." (Ex. 1005, ¶[0116]). "The synchronized movement between the driving motor of the right front wheel 22 and right arm unit 26 continues to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0117]; FIG. 8C).

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Ex. 1005, FIG. 8B (annotated)

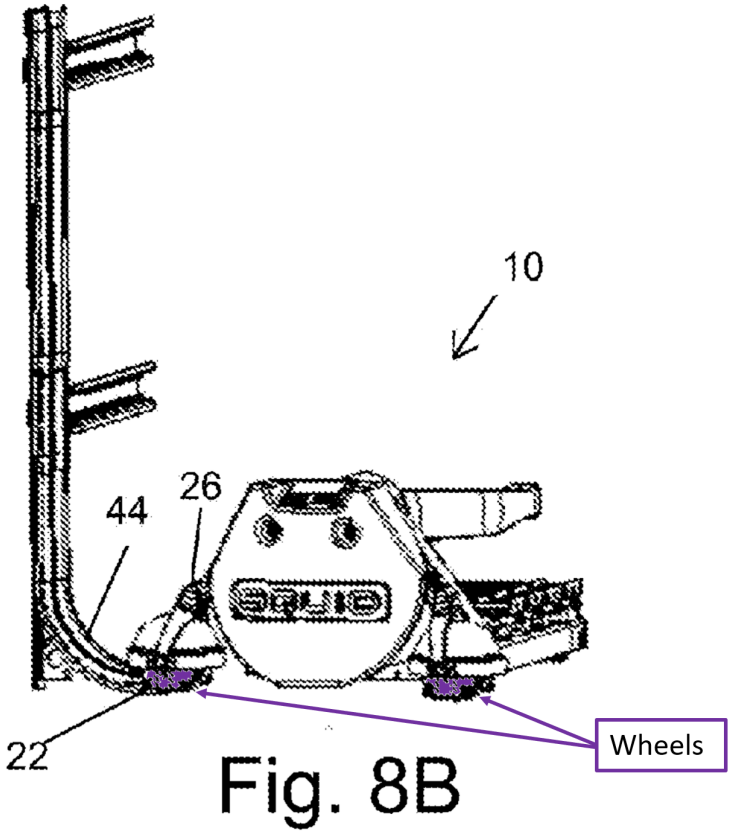


Fig. 8B

460. In FIG. 8D (reproduced below), *Raizer* depicts, "the right front wheel 22 and right arm unit 26 continu[ing] to extend the right arm unit as right wheel 22 moves further up terminal 44." (Ex. 1005, ¶[0118]).

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Ex. 1005, FIG. 8D

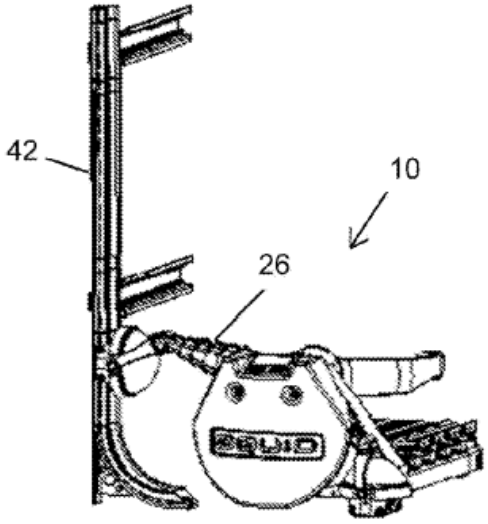
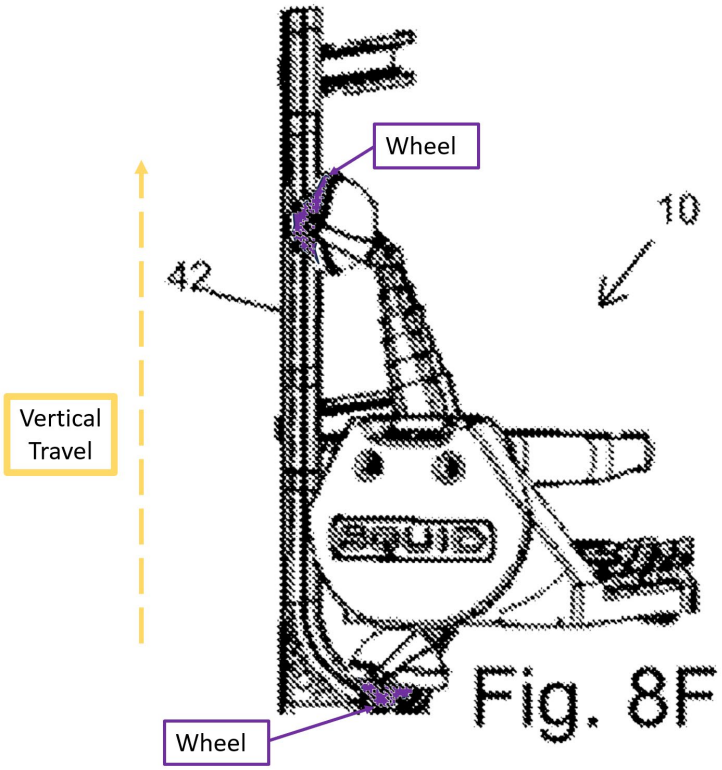


Fig. 8D

461. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

Ex. 1005, FIG. 8F (annotated)



462. With reference to FIG. 9A (reproduced and annotated below), *Raizer* shows "a bottom view of the shell 38 of drive and steering unit 24," noting that in the figure "[t]he wheel 22 and all other components of the drive and steering unit have been removed to show the small wheels 36 that lock the robot to the rails." (Ex. 1005, ¶[0122]). As can be seen in FIG. 9A, "on each side of the shell 38 there is a group of five small wheels 36." (Ex. 1005, ¶[0122]). "Each group comprises two wheels mounted with their axles parallel to the sides of the shell and three wheels mounted with the axels [sic] perpendicular to the sides of the shell." (Ex. 1005, ¶[0122]).

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Ex. 1005, FIG. 9A (annotated)

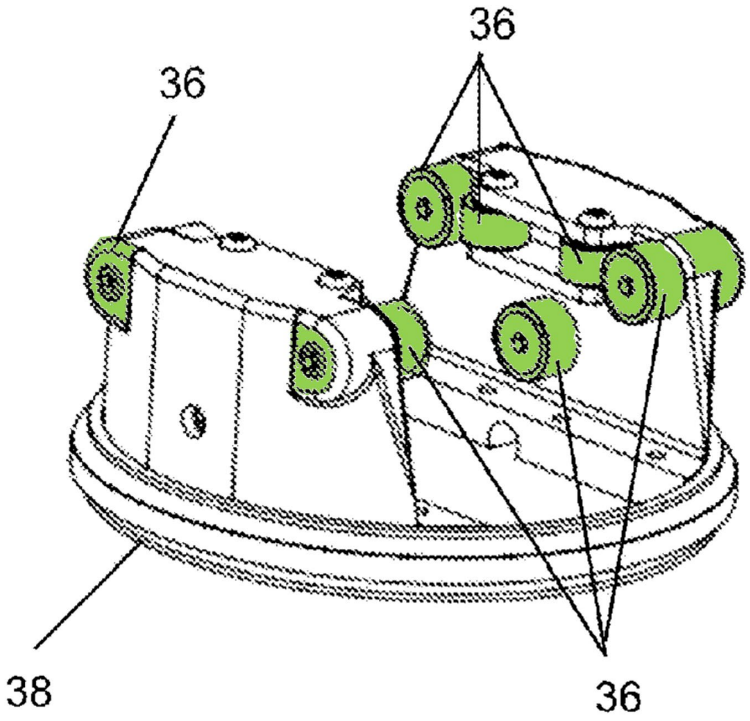


Fig. 9A

463. With reference to FIG. 9B (reproduced and annotated below), *Raizer* discloses "when the drive wheel 22 enters the U shaped channel 46 in rail 42 the small wheels 36 lock the drive wheel on the rail." (Ex. 1005, ¶[0122]).

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Ex. 1005, FIG. 9B (annotated)

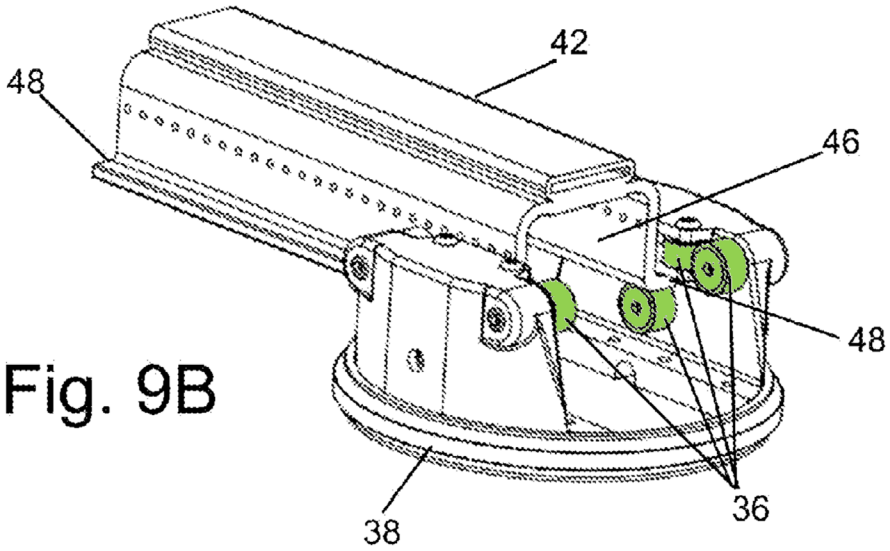


Fig. 9B

464. To be clear, *Raizer* discloses a vertical drive comprising drive wheels 22, drive and steering units 24, and small wheels 36 that are operable to drive the vehicle vertically.

465. Thus, *Raizer* discloses a vertical drive operable to drive the vehicle vertically, as recited in claim element [23.b3].

Claim 23, Element [23.b4]: a transfer mechanism operable to transfer an item between the vehicle and one of the storage locations;

466. *Raizer* discloses claim element [23.b4].

467. *Raizer* discloses that the "robots of the system comprise" a "gripper mechanism attached to the top side of the [robot] frame that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The "gripper mechanism comprises an array of micro-pallet lifters" where "each micro-pallet in the array can be independently operated of the others thereby allowing the robot to handle different sized boxes and

maximizing the efficient use of shelf space." (Ex. 1005, ¶[0031]). The "robot" can "grab and lift [a] carton" "[i]n order to be able to place the cartons on the shelves or to pick them up." (Ex. 1005, ¶[0101]).

468. *Raizer* discloses that "[t]he combination of the capability of independently changing the lengths and angles of the two arm units 26 and the capability of activating the two drive and steering units 24 independently allows the robot, with the assistance of fine positioning sensor 34, to place a box on a shelf or remove it from any height or any orientation on the shelf." (Ex. 1005, ¶[0133]).

469. With reference to FIG. 14A (reproduced below), *Raizer* shows a "robot 10 positioning a box 158 on top of a stack of three other boxes on a shelf in the storage area of the warehouse." (Ex. 1005, ¶[0138]).

Ex. 1005, FIG. 14A

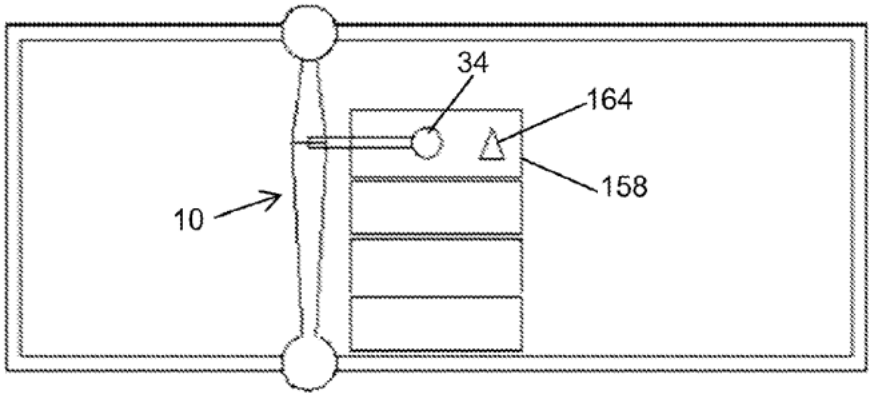


Fig. 14A

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470. Thus, *Raizer* discloses a transfer mechanism (the "gripper mechanism") operable to transfer an item between the vehicle and one of the storage locations claim element [23.b4].

Claim 23, Element [23.c1]: driving a first of the vehicle under one or more of the storage racks along a path that crosses one or more aisle,

471. *Raizer* in view of *Hangzhou* renders obvious claim element [23.c1].

472. As discussed with reference to claim element [23.b1], [23.b2], [23.b3], and [23.b4], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

473. To the extent *Raizer* does not explicitly disclose driving a first of the vehicle under one or more of the storage racks along a path that crosses one or more aisle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

474. *Hangzhou* discloses "an unmanned warehousing system" where "a two-layer channel support frame is provided below a shelf." (Ex. 1006, Abstract). Of the two layers, "[the] lower layer is used to automatically guide a trolley to pass through," (i.e., under the shelf). (Ex. 1006, Abstract). That is, an "auto-guided trolley travels through the lower layer of the support frame to a position below the container." (Ex. 1006, Abstract). The "auto-guided trolley" "is a small mobile robot with auto-navigation ability" "driven by a differential gear train." (Ex. 1006,

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¶[0048]). The "auto-guided trolley preferentially travels in column laneways 32" and "in auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]).

475. *Hangzhou*, with reference to Figure 2 (reproduced and annotated below), discloses "[s]everal modular channel support frames may be mounted below a shelf 100" to raise the shelf to a height "slightly higher than the trolley." (Ex. 1006, ¶[0044]). "Support members 111 divide the space inside channel support frames 110 into an auto-guided trolley passage space 112." (Ex. 1006, ¶[0045]).

Ex. 1006, Figure 2 (annotated)

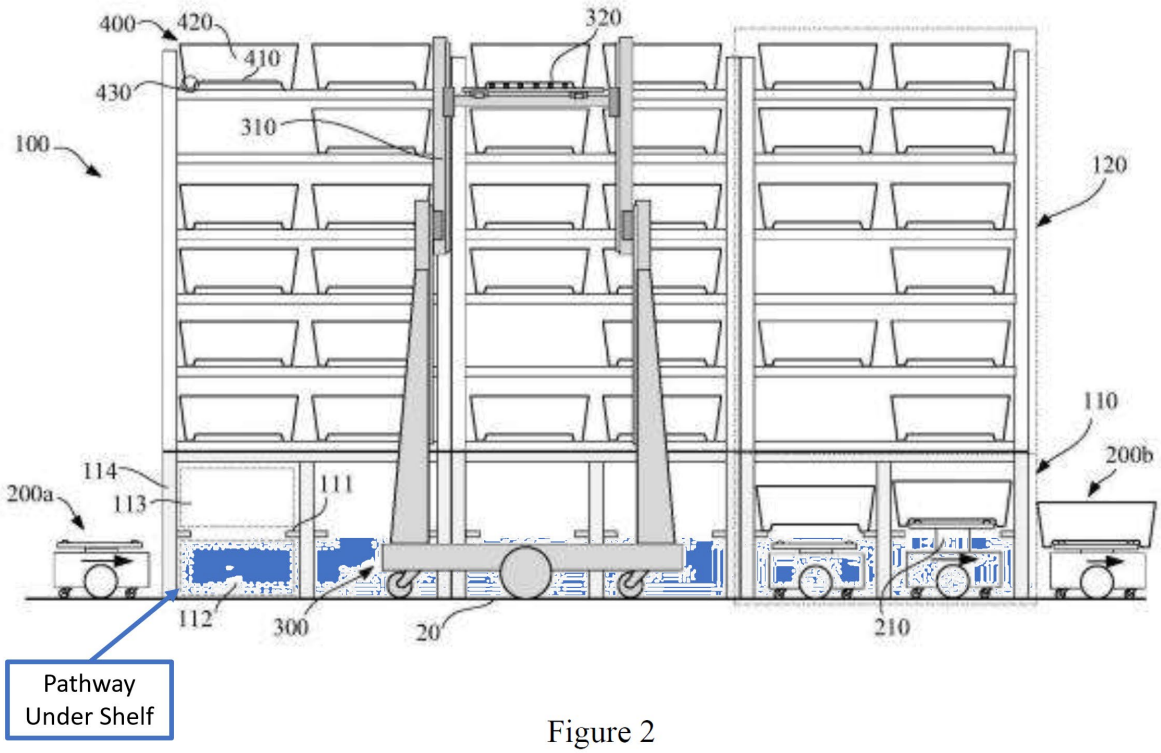


Figure 2

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476. That is, *Hangzhou* discloses a shelf (e.g., a first rack), with a lower layer of a channel support frame that is set up under the shelf, and that the automatically guided trolley (e.g., first vehicle) passes through the lower layer (e.g., is driven via a path that extends under at least one of the storage racks).

477. Figure 10 (reproduced below) of *Hangzhou* is a general form of the previous three embodiments," (Ex. 1006, ¶[0076]), including Embodiment 2 as illustrated in Figure 8, and provides the "stacking row aisles 12" and "column channel 33 where auto-guided trolleys 200 travel" as described with respect to Figure 8 (Ex. 1006, ¶[0062]) as well as additional pathways that may be traveled along the warehouse floor. With reference to Figure. 10 (reproduced below), *Hangzhou* discloses that the "auto-guided trolleys" can "switch between trolley-special laneways 21 and column channels 33 and between column channels 33 and row channels 23." (Ex. 1006, ¶[0072]). As illustrated by Figure 10, the trolley can move underneath the shelving units in a path parallel to the aisles (such as row channels 23), and then turn to travel from underneath the shelving unit and across aisles (such as row laneways 21 along the column channels 33).

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Ex. 1006, Figure 10

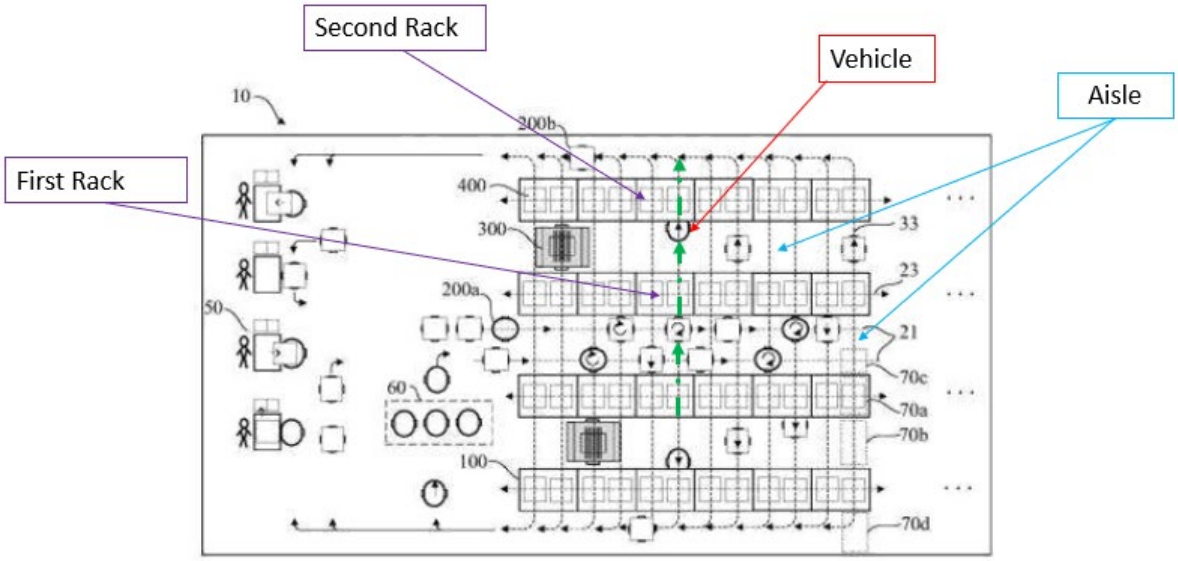


Figure 10

478. *Hangzhou* discloses that because the trolley moves into the "stacking row laneway 12 for stacking vehicles 300," a "path planning algorithm is needed to avoid the collision between [the] auto-guided trolleys 200 and [the] stacking vehicles 300." (Ex. 1006, ¶[0062]). *Hangzhou* discloses that the trolley will "[o]btain information on the stacking vehicles and space occupancy on the route ahead from the dispatch control system when [the] auto-guided trolley 200 has reached the edge of a stacking row laneway 12 the trolley is about to enter," and "conduct an analysis" to "determine whether the time for passing through the stacking row laneway 12 is intersected with the time for stacking vehicles 300 to running [sic] through the section of the row laneway." (Ex. 1006, ¶[0063]). The trolley has "opportunities to

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cross the row laneway" and will "[m]ove forward if there is no intersection" (Ex. 1006, ¶[0063]). "After the auto-guided trolley 200 enters the opposite auto-guided trolley passage space 112, the next step is based on the carrying of standardized containers and the occupancy of the cache space ahead." (Ex. 1006, ¶[0064]).

479. A person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*) and in the sections above discussing claim elements [1.j] and [7.a].

480. Thus, *Raizer* and *Hangzhou* render obvious driving a first of the vehicle under one or more of the storage racks along a path that crosses one or more aisle, as recited in claim element [23.c1].

Claim 23, Element [23.c2]: wherein the step of driving the first vehicle includes driving the first vehicle into a first of the columns in a first of the aisles;

481. *Raizer* in view of *Hangzhou* renders obvious claim element [23.c2]. As discussed with respect to claim elements [23.a1] and [23.a2], *Raizer* discloses a plurality of storage shelves spaced apart forming a plurality of aisles and wherein each storage rack comprises a plurality of columns.

482. The '632 patent, with reference to FIG. 1 (reproduced and annotated below), depicts a "vertical column[] 810." (Ex. 1001, 7:45). A vehicle may be driven

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into a column before the vehicle is driven vertically upward along the column while protruding into the aisle.

Ex. 1001, FIG. 1 (annotated)

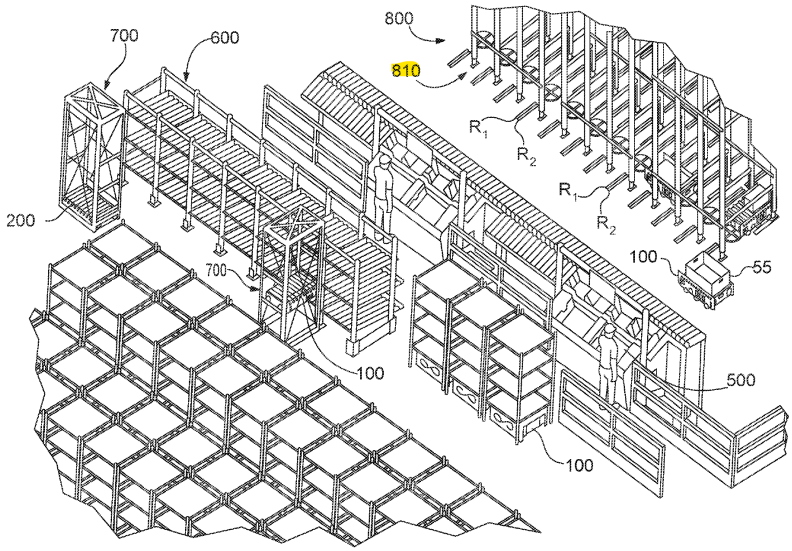


FIG. 1

483. *Hangzhou* also discloses driving the vehicle into a first of the columns in the first aisle. With reference to Figure 10 (reproduced and annotated below), *Hangzhou* discloses that the "auto-guided trolleys 200" can "switch between trolley-special row laneways 21 and column channels 33." (Ex. 1006, ¶[0072]). As illustrated in Figure 10, the trolleys can move underneath the shelving units in a path parallel to the aisles (such as row channels 23), and then turn to travel from underneath the shelving unit and across aisles (such as row laneways 21) along the column channels 33.

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Ex. 1006, Figure 10 (annotated)

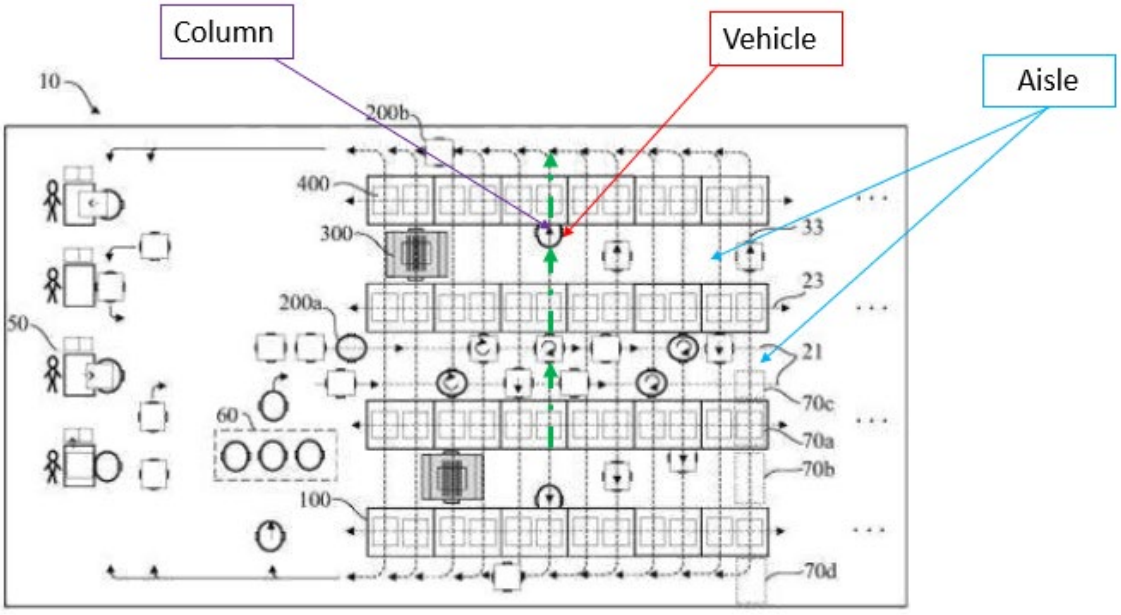


Figure 10

484. The embodiment illustrated in Figure 10 is "a general form of the previous three embodiments," (Ex. 1006, ¶[0076]) including Embodiment 1, as illustrated in Figures 1-6, and provides additional pathways that may be traveled along the warehouse floor. A person skilled in the art would have understood that the additional pathways shown in Figure 10 allow for travel underneath the shelves and across aisles.

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485. Given *Hangzhou's* disclosure of trolleys moving along a path underneath the shelving units and across multiple aisles along the column channels as discussed with respect to claim element [23.b2] and [23.c1], it would have been obvious to a person of ordinary skill in the art to combine *Hangzhou's* movement capabilities underneath the shelves and across multiple aisles to *Raizer's* system because to do so allows *Raizer's* robots to move more directly to and from picking stations while also reducing congestion and more efficiently using warehouse space.

486. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf and then travel across an aisle as disclosed in *Hangzhou*. As taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*) and in the sections above discussing claim elements [1.j].

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487. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of driving the first vehicle includes driving the first vehicle into a first of the columns in a first of the aisles, as recited in claim element [23.c2].

Claim 23, Element [23.d]: driving the first vehicle vertically upwardly within the first aisle until the first vehicle is adjacent a first of the storage locations;

488. *Raizer* discloses claim element [23.d].

489. *Raizer* discloses that, "[i]n order to complete its mission of removing a box from (or delivering a box to) a specific location on a shelf the robot travels vertically with both front wheels in the same vertical rail and travels horizontally with one of its front wheels in a horizontal rail that is attached to the shelf on which the box is located and the other front wheel in a horizontal rail that is attached to the shelf above the first shelf." (Ex. 1005, ¶[0114]).

490. *Raizer* discloses a "network of vertical and horizontal rails that are parallel to the vertical support posts and horizontal shelves of the shelving system in the warehouse." (Ex. 1005, ¶[0020]). A "curved piece of rail called a terminal 44 is attached to the bottom of the vertical rails where they reach the ground." (Ex. 1005, ¶[0111]). "This is the only place where robots 10 can connect or disconnect from the rails 42 in order to climb or descend from the shelves." (Ex. 1005, ¶[0111]).

491. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal

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rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves," (i.e., vertically), "to the exact desired location." (Ex. 1005, ¶[0078]). The system disclosed by *Raizer* includes rails, "which allow for the vertical and horizontal movement capabilities of the robots along the shelving," and "are mounted on or parallel to the vertical supports and shelves of the warehouse." (Ex. 1005, ¶[0078]). These vertical rails are engaged by the robots in the aisles between the shelves.

492. With reference to FIGs. 8A – 8G, *Raizer* shows "different stages in the process of the robot" "leaving the floor of the warehouse and climbing a vertical rail attached to the shelving." (Ex. 1005, ¶¶[0114-0121]; FIGs. 8A-8G). *Raizer* discloses that a "robot travels vertically with both front wheels in the same vertical rail," while in the aisle (Ex. 1005, ¶[0114]).

493. In FIG. 8F (reproduced and annotated below), *Raizer* depicts, after "the right wheel has advanced further up vertical rail 42 and start[ed] to pull the robot 10 slightly off the ground," the "left front wheel 22 mov[ing] into the 'U'-shaped channel 46 in terminal 44 and [being] locked to the rail." (Ex. 1005, ¶¶[0119-0121]).

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Ex. 1005, FIG. 8F (annotated)

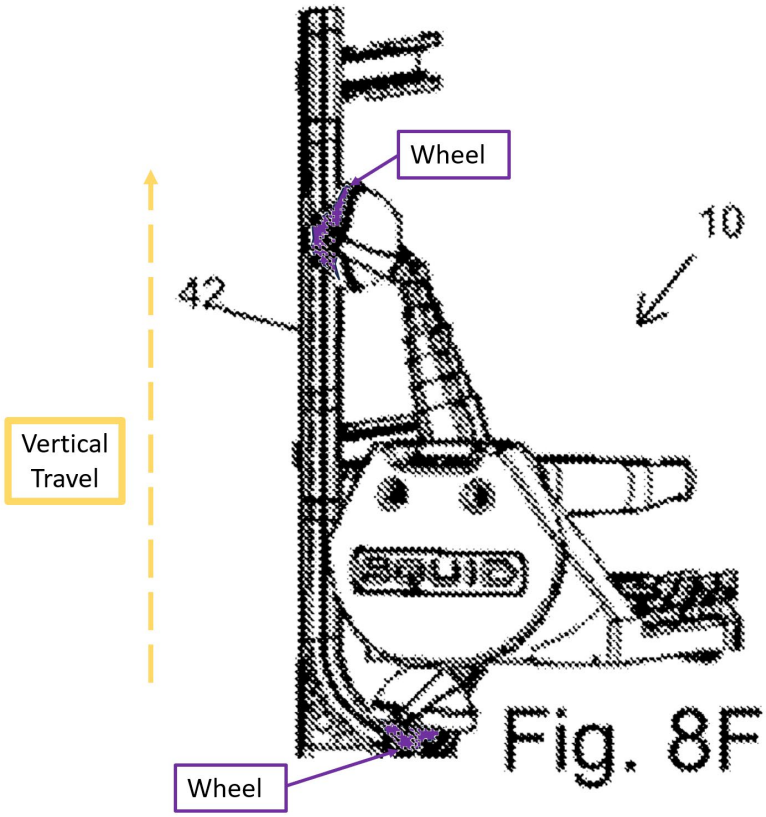


Fig. 8F

494. With respect to FIG. 11E (reproduced below) *Raizer* discloses "the robot 10 is shown travelling along two adjacent horizontal rails towards its target location on the shelf." (Ex. 1005, ¶[0129]).

Ex. 1005, FIG. 11E

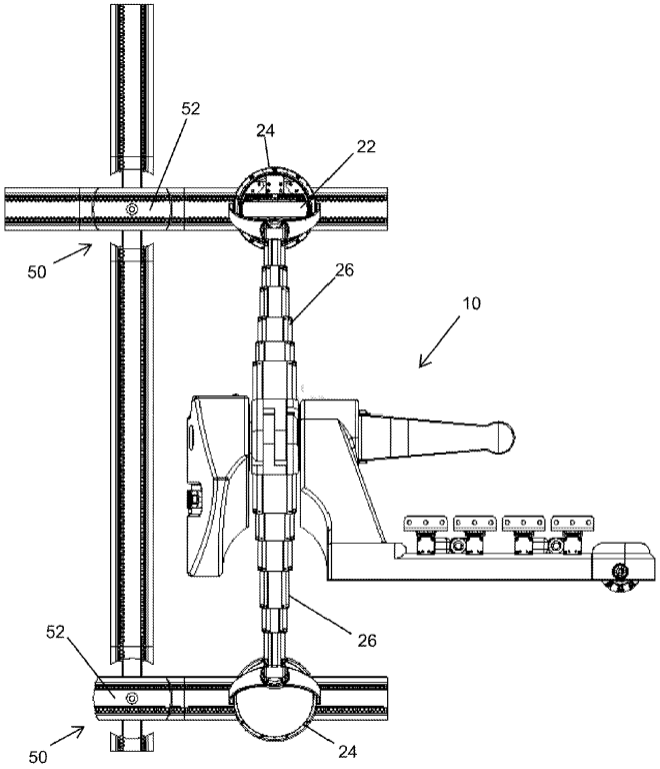


Fig. 11E

495. Thus, *Raizer* discloses driving the first vehicle vertically upwardly within the first aisle until the first vehicle is adjacent a first of the storage locations, as recited in claim element [23.d].

Claim 23, Element [23.e]: transferring an item from the first storage location to the first vehicle;

496. *Raizer* discloses claim element [23.e].

497. *Raizer* discloses that the "robots of the system comprise" a "gripper mechanism attached to the top side of the [robot] frame that is configured to pick up and place boxes." (Ex. 1005, ¶[0027]). The "gripper mechanism comprises an array

of micro-pallet lifters" where "each micro-pallet in the array can be independently operated of the others thereby allowing the robot to handle different sized boxes and maximizing the efficient use of shelf space." (Ex. 1005, ¶[0031]). The "robot" can "grab and lift [a] carton" "[i]n order to be able to place the cartons on the shelves or to pick them up." (Ex. 1005, ¶[0101]).

498. *Raizer* discloses that "[t]he combination of the capability of independently changing the lengths and angles of the two arm units 26 and the capability of activating the two drive and steering units 24 independently allows the robot, with the assistance of fine positioning sensor 34, to place a box on a shelf or remove it from any height or any orientation on the shelf." (Ex. 1005, ¶[0133]).

499. With reference to FIGs. 14A-14G (14G reproduced below), *Raizer* shows "how the fine positioning feature of the system" "allows a robot to very precisely locate and pick or place a box on a shelf." (Ex. 1005, ¶¶[0138-0141]).

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Ex. 1005, FIG. 14G

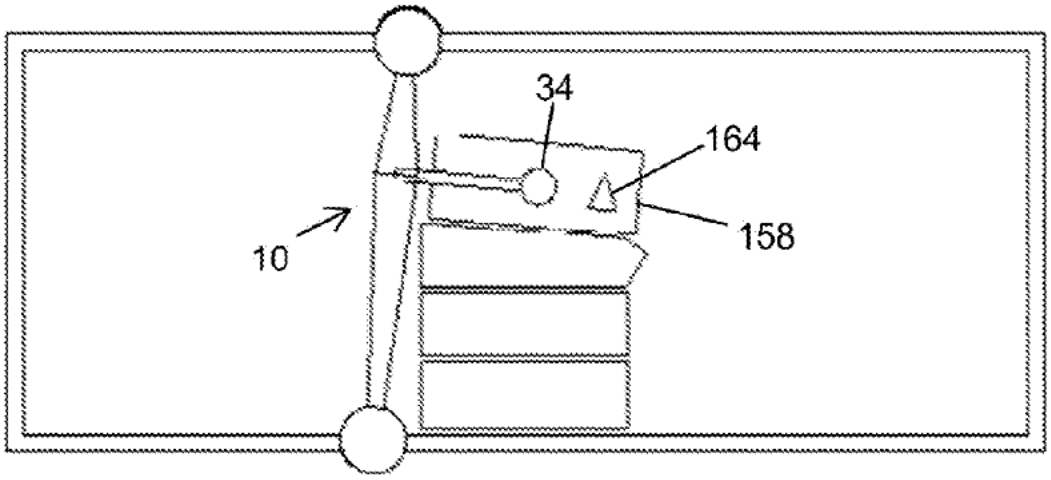


Fig. 14G

500. Thus, *Raizer* discloses transferring an item from the first storage location to the first vehicle, as recited in claim element [23.e].

Claim 23, Element [23.f]: driving the first vehicle downwardly within the first aisle;

501. *Raizer* discloses claim element [23.f].

502. *Raizer* discloses that the "robot [can] engage a vertical rail, to raise itself off the floor, and to move up and along the network of vertical and horizontal rails." (Ex. 1005, ¶[0056]). *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

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503. *Raizer* further discloses that the "three-dimensional navigation and travel capabilities" enable a robot "to navigate and travel autonomously both along the floor and up and down the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Claim 1; emphasis added; see also Claims 4, 18).

504. Thus, *Raizer* discloses driving the first vehicle downwardly within the first aisle, as recited in claim element [23.f].

Claim 23, Element [23.g]: driving the vehicle out of the first aisle via a path that extends under at least one of the storage racks.

505. *Raizer* in view of *Hangzhou* renders obvious claim element [23.g]. As discussed with reference to claim elements [23.b1], [23.b2], [23.b3], [23.b4], [23.c], and [23.e], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

506. *Raizer* discloses "a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots" and that "the robots comprise a set of on-board sensors, a processor, software, and other electronics configured to provide them with three-dimensional navigation and travel capabilities that enable them to navigate and travel autonomously both along the floor and up the vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor or shelving system of the warehouse." (Ex. 1005, Abstract, ¶[0022]).

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507. *Raizer* discloses that the robots have "[a] processor, software, and a set of on-board sensors" that are "configured to enable each robot to employ anchor point navigation method to carry out tasks assigned to it by the RTTM." (Ex. 1005, ¶[0034]). By employing "anchor point navigation," the robots "use less accurate sensing and motions when travelling on the floor in order to arrive at the designated destination as rapidly and efficiently as possible." (Ex. 1005, ¶[0080]).

508. *Raizer* further discloses that the robots may "employ dedicated algorithms and more precise sensing only when near anchor points, i.e. fixed specific locations in the warehouse such as terminals (locations at which the robot leaves the floor and climbs a vertical rail of the shelving system)." (Ex. 1005, ¶[0080]).

509. To the extent that *Raizer* does not explicitly disclose driving the vehicle out of the first aisle via a path that extends under at least one of the storage racks, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

510. *Hangzhou* discloses driving the vehicle via a path that extends under at least one of the storage racks. As discussed with reference to claim element [1.e], *Hangzhou* discloses that "auto-guided trolley 200 preferentially travels along column laneways 33 and in auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]). With reference to Figure 10 (reproduced and annotated below), *Hangzhou* depicts a trolley (designated "vehicle" in the annotated Figure 10), that had driven

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into a column, and then proceeds along a path that extends under another storage rack.

Ex. 1006, Figure 10 (annotated)

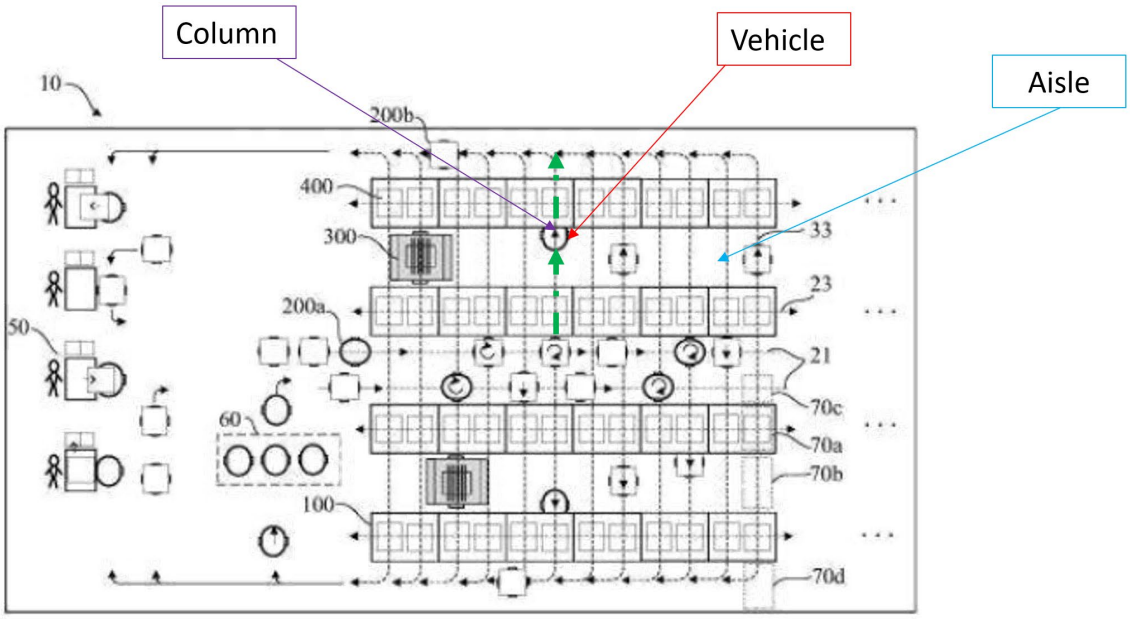


Figure 10

511. Given *Hangzhou's* disclosure of trolleys "carrying standardized containers" "in row and column directions" (Ex. 1006, ¶[0050]) underneath the shelving units and across multiple aisles as illustrated above with respect to Figure 10, it would have been obvious to a person of ordinary skill in the art to combine *Hangzhou's* movement capabilities underneath the shelves and across multiple aisles to *Raizer's* system because to do so allows *Raizer's* robots to move more directly to

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and from picking stations while also reducing congestion and more efficiently using warehouse space. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

512. Thus, *Raizer* in view of *Hangzhou* renders obvious driving the vehicle out of the first aisle via a path that extends under at least one of the storage racks, as recited in claim element [23.g].

Dependent Claim 24

Claim 24, Element [24.pre]: The method of claim 23

513. *Raizer* in view of *Hangzhou* renders obvious claim element [24.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 23. Thus, *Raizer* in view of *Hangzhou* renders obvious [24.pre].

Claim 24, Element [24.a]: wherein the path includes a portion passing under one of the racks and extending parallel to one of the aisles.

514. *Raizer* in view of *Hangzhou* renders obvious claim element [24.a]. As discussed above, *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

515. To the extent *Raizer* does not explicitly disclose the path including a portion passing under one of the racks and extending parallel to one of the aisles, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

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516. *Hangzhou* discloses "an unmanned warehousing system" where "a two-layer channel support frame is provided below a shelf." (Ex. 1006, Abstract). Of the two layers, "[the] lower layer is used to automatically guide a trolley to pass through," (i.e., under the shelf). (Ex. 1006, Abstract). That is, an "auto-guided trolley travels through the lower layer of the support frame to a position below the container." (Ex. 1006, Abstract). The "auto-guided trolley" "is a small mobile robot with auto-navigation ability" "driven by a differential gear train." (Ex. 1006, ¶[0048]). The "auto-guided trolley 200 preferentially travels in column laneways 32 and in auto-guided trolley passage spaces 112." (Ex. 1006, ¶[0048]).

517. *Hangzhou*, with reference to Figure 2 (reproduced and annotated below), discloses "[s]everal modular channel support frames may be mounted below a shelf 100" to raise the shelf to a height "slightly higher than the trolley." (Ex. 1006, ¶[0044]). "Support members 111 divide the space inside channel support frames 110 into an auto-guided trolley passage space 112." (Ex. 1006, ¶[0045]).

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Ex. 1006, Figure 2 (annotated)

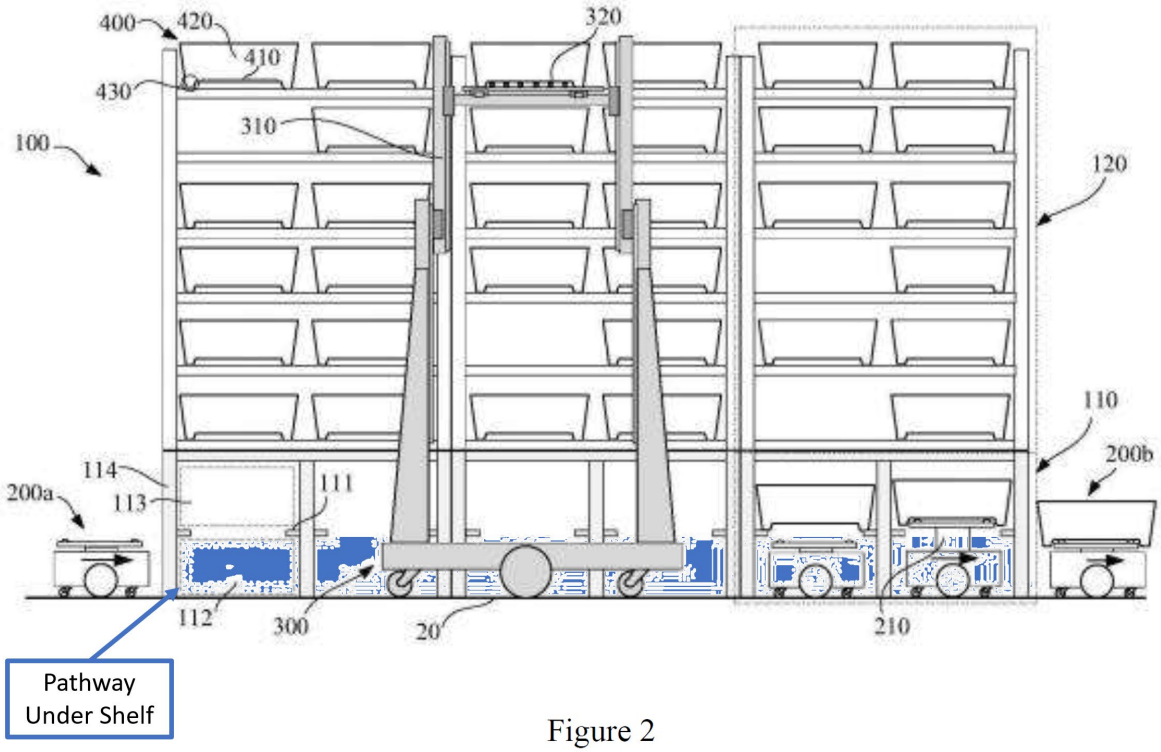


Figure 2

518. That is, *Hangzhou* discloses a shelf (e.g., a first rack), with a lower layer of a channel support frame that is set up under the shelf, and that the automatically guided trolley (e.g., first vehicle) passes through the lower layer (e.g., is driven along a first path that is under one the first rack).

519. With further reference to Figure 1 (reproduced and annotated below), *Hangzhou* discloses that a "dotted line displayed on the center line of each shelf row is used to indicate the row channel 23 for auto-guided trolleys 200 under the shelf, which is a path parallel to the stacking row laneway 12." (Ex. 1006, ¶[0040]).

Ex. 1006, Figure 1 (annotated)

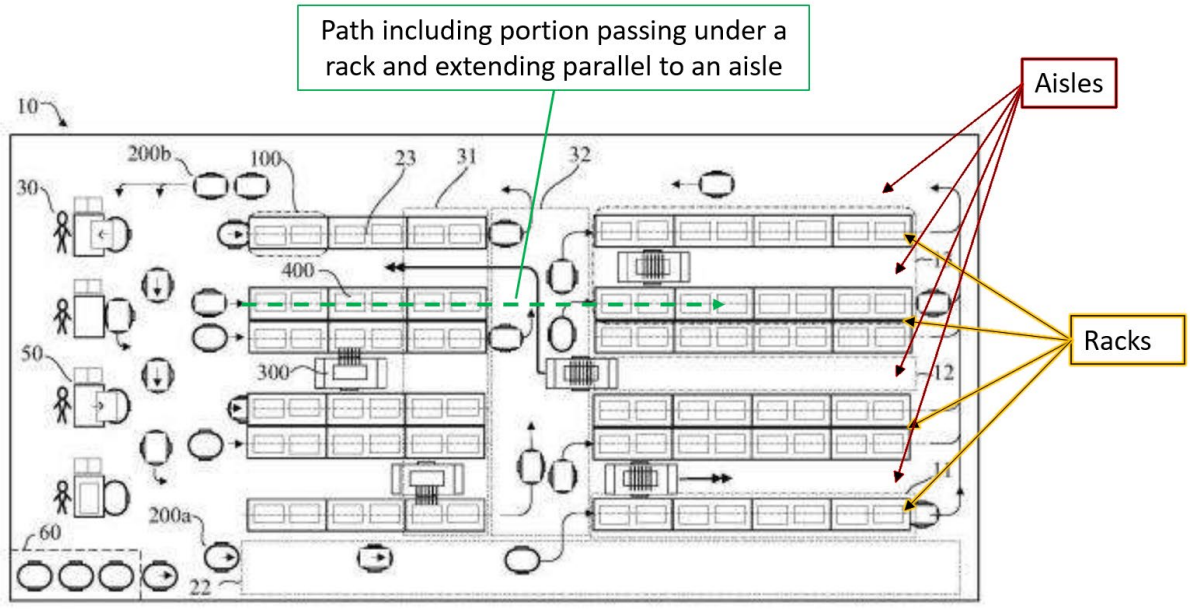


Figure 1

520. That is, the "auto-guided trolleys 200" travel "under the shelf," as indicated by the dotted line in Figure 1, and *Hangzhou* explicitly refers to that path as "a path parallel to the stacking row laneway 12" (i.e., an aisle). (Ex. 1006, ¶[0040]). Further, because the "auto-guided trolleys 200" travel "under the shelf" and not in "the stacking row laneway," the path of the "auto-guided trolleys 200" is spaced apart from the aisle. *Hangzhou* further discloses that pathways of Embodiment 1 as illustrated and described with respect to Figures 1 and 2 may be implemented in connection with Figure 10, which is a "general form of the previous three embodiments." (Ex. 1006, ¶[0076]). A person of ordinary skill in the art would

have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

521. Thus, *Raizer* in view of *Hangzhou* renders obvious the path includes a portion passing under one of the racks and extending parallel to one of the aisles, as recited in claim element [24.a].

Dependent Claim 25

Claim 25, Element [25.pre]: The method of claim 24 comprising

522. *Raizer* in view of *Hangzhou* renders obvious claim element [25.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 24. Thus, *Raizer* in view of *Hangzhou* renders obvious [25.pre].

Claim 25, Element [25.a]: the step of driving a second of the vehicles past the first vehicle under the one rack as the first vehicle is driven along the portion of the path under the one of the racks.

523. *Raizer* in view of *Hangzhou* renders obvious claim element [25.a]. As discussed with respect to claim element [23.b1], [23.b2], and [23.c1], *Raizer* and *Hangzhou* disclose a set of autonomous robots capable of traveling in any direction, including along a first path under the storage shelves.

524. To the extent that *Raizer* does not explicitly disclose the step of driving a second vehicle under the first rack along a second path parallel to the first path so that the second vehicle passes the first vehicle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

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525. *Hangzhou* discloses the modular shelves "placed in rows and columns to improve the plot ratio." (Ex. 1006, ¶[0037]). "Two shelf rows are usually placed face to face to share a stacking row laneway 12 in the middle," such that the "combination of the stacking row laneway 12 and all the shelf rows 11 facing the row laneway is defined as a shelf-laneway combination 13." (Ex. 1006, ¶[0037]). *Hangzhou*, further discloses "two adjacent shelf-laneway combinations 13 preferentially adopt a back-to-back layout to improve the plot ratio." (Ex. 1006, ¶[0038]).

526. As discussed with respect to claim element [1.d1], *Hangzhou* discloses trolleys traveling under the shelves as indicated by the dotted line in Figure 1 (reproduced and annotated below). That is, *Hangzhou* explicitly depicts at least two robots entering shelf columns simultaneously and traveling along parallel paths.

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Ex. 1006, Figure 1 (annotated)

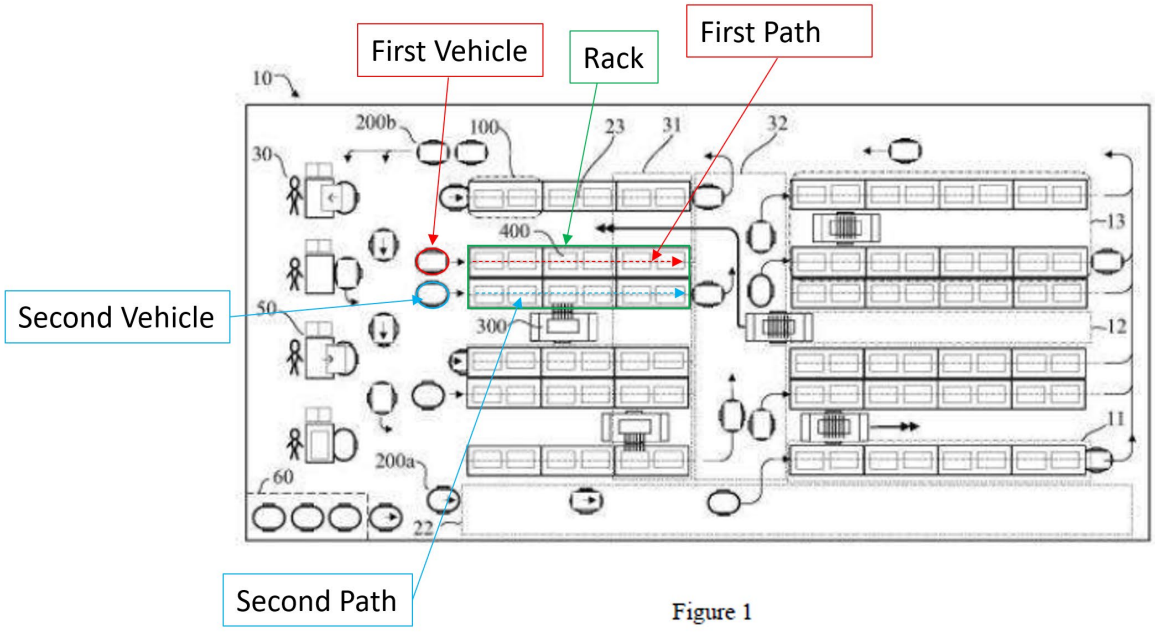


Figure 1

527. *Hangzhou* discloses "a plurality of auto-guided trolleys 200 travel in stacking row laneways 12 and column laneways 32 and in auto guided trolley passage space 122" "to reduce blockage." (Ex. 1006, ¶[0047]). A person of ordinary skill in the art would have understood that allowing the second vehicle traveling in parallel to pass the first vehicle would result in less congestion and increased efficiency. A person of ordinary skill in the art would have further understood that allowing two robot laneways underneath a shelf (rack) would allow for more efficient use of shelving space by increasing the amount of shelving space relative to unused space in the aisles between the shelves. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the

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reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

528. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of driving a second of the vehicles past the first vehicle under the one rack as the first vehicle is driven along the portion of the path under the one of the racks, as recited in claim element [25.a].

Dependent Claim 26

Claim 26, Element [26.pre]: The method of claim 23

529. *Raizer* in view of *Hangzhou* renders obvious claim element [26.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 23. Thus, *Raizer* in view of *Hangzhou* renders obvious [26.pre].

Claim 26, Element [26.a]: comprising the step of turning the vehicle while the vehicle is under one of the racks,

530. *Raizer* in view of *Hangzhou* renders obvious claim element [26.a]. As discussed with respect to claim elements [23.b1], [23.b2], [23.b3], [23.b4], and [1.c], *Raizer* discloses that the vehicles can travel in any direction and to various locations in the warehouse and different storage locations.

531. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units," where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees about an axis vertical to the floor in order to steer the robot," and "to rotate the front wheel about a

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horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). *Raizer* further discloses that "[t]he two front wheels 22 can be independently rotated in any direction by drive and steering units 24. With this arrangement the robot is completely autonomous and can be steered by its control system to any location on the floor of the warehouse without the use of a track, embedded wire or any other arrangement to guide it." (Ex. 1005, ¶[0104]). The "motor of the drive assembly is a variable speed motor," making it possible to "steer the robot by activating the drive motors to produce differential rotational speeds of the two front drive wheels." (Ex. 1005, ¶[0109]).

532. *Raizer* discloses that the "robots of the system have 3 dimensional movement capabilities," such that they "navigate both along the ground and up and along the shelves to the exact desired location." (Ex. 1005, ¶[0078]).

533. *Raizer* further discloses that its system is "plug and play in any warehouse, integrating with an already in-use facility, shelving system and infrastructure resources of a conventional warehouse." (Ex. 1005, ¶[0079]). *Raizer* also discloses that its system deploys "a self-learning system where, for example, algorithm [sic] can track the movement of the robots and organize the routes of traffic in and around the warehouse to reduce congestion and prevent 'traffic jams' when the robots are busy filling orders." (Ex. 1005, ¶[0098]).

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534. To the extent that *Raizer* does not explicitly disclose turning the first vehicle while the first vehicle is under the first rack, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

535. As discussed above with respect to claim elements [23.c1] and [24.a], *Hangzhou* discloses driving the vehicle under the rack. *Hangzhou* further discloses that the "trolleys are generally designed in symmetrical [sic] to turn in place." (Ex. 1006, ¶[0048]).

536. Figure 10 (reproduced and annotated below) of Hangzhou is a "general form of the previous three embodiments," (Ex. 1006, ¶[0076]), including embodiment 1 as illustrated in Figures 1 and 2. *Hangzhou* discloses that "at the position where the dotted lines intersect, an auto-guided trolley 200 may switch between the row direction and the column direction," noting that "[s]witching the driving direction does not bring a problem to auto-guided trolleys because auto-guided trolleys 200 can be small enough to turn in the auto-guided trolley passage space 112." (Ex. 1006, ¶[0072]).

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Ex. 1006, Figure 10 (annotated)

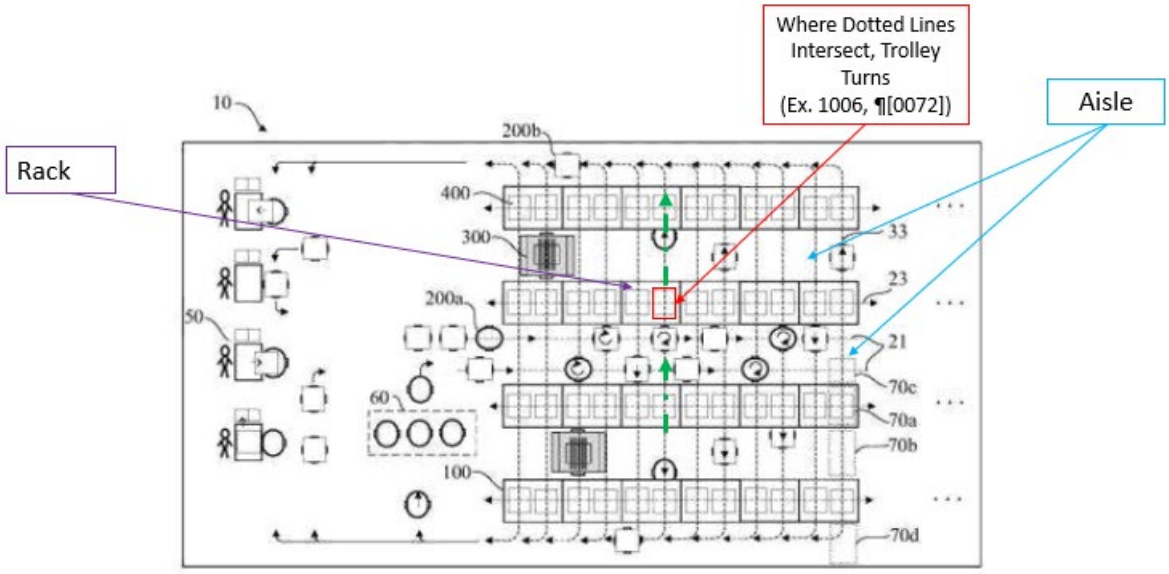


Figure 10

537. *Hangzhou* further discloses that an "auto-guided trolley 200 carrying standardized containers 400 switches between the row and column directions along the traveling direction by performing a series of actions, including dropping and docking the standardized containers on the support members, the *trolley turning 90° in place*, and hoisting the standardized containers." (Ex. 1006, ¶[0073]).

538. The "trolley passage space 112" can be seen in Figure 2 (reproduced and annotated below) as being under the rack. *Hangzhou* discloses that "a row channel, a column channel, or both the row and column channels are provided for the auto-guided trolley carrying the standardized container or the moveable bracket

to travel under the shelf." (Ex. 1006, ¶[0008]). "[C]ache spaces 113" are disclosed for "docking standardized containers," and "[a] horizontal gap is spared between support members 111, making auto-guided trolley spaces 112 connect the cache spaces 113." (Ex. 1006, ¶[0045]). This "allow[s] auto-guided trolleys 200 carrying customized containers 400 to travel." (Ex. 1006, ¶[0045]).

Ex. 1006, Figure 2 (annotated)

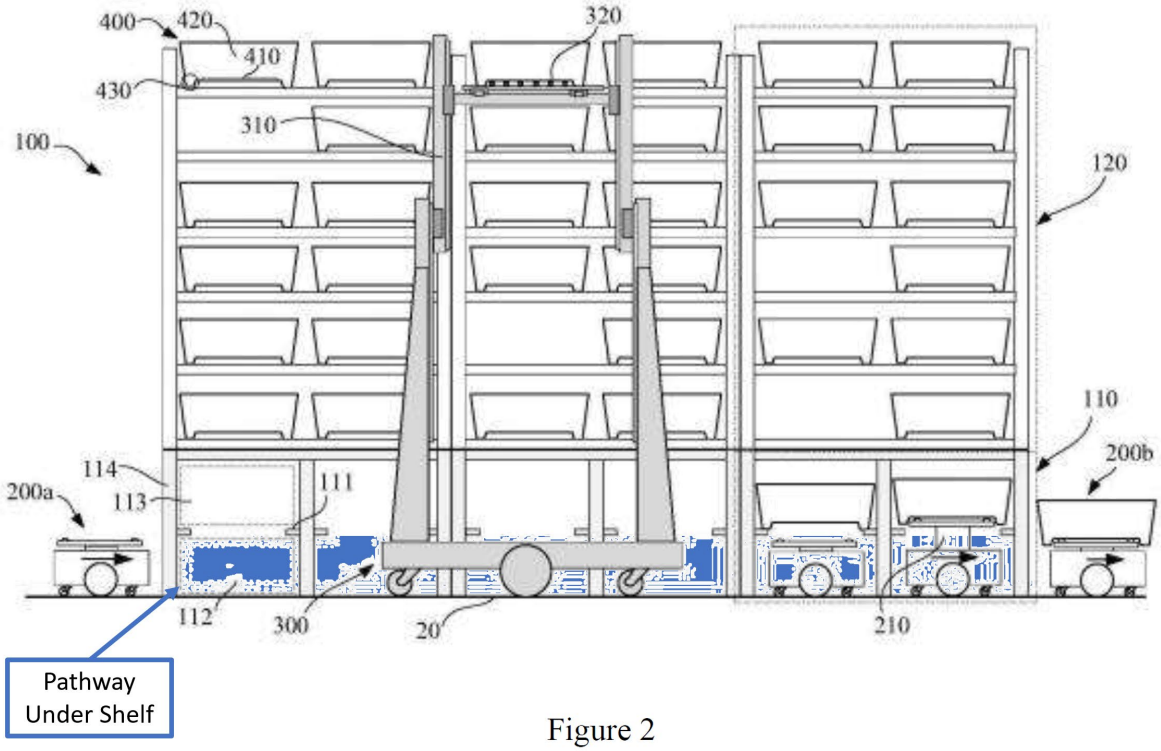


Figure 2

539. Given *Raizer's* disclosure of three-dimensional movement capabilities and ability to turn "360 degrees about an axis vertical to the floor," it would have been obvious to a person of ordinary skill in the art that *Raizer's* robot would have the ability to turn underneath a storage shelf. However, were *Raizer's* disclosure

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deemed insufficient to disclose this feature, a person of ordinary skill in the art would have been motivated to combine *Hangzhou's* trolley being configured to rotate in place 90° under shelves to switch traveling direction with the three dimensional travel capabilities of *Raizer* because, as taught by *Hangzhou*, such functionality allows the Raizer robot to "choose among all possible paths" thereby further reducing congestion, avoiding traffic jams, and maintaining a more efficient use of space. (Ex. 1006, ¶[0076]). Route switching based on such turning also "usually reduce[s] blockage and shorten[s] [trolley] turnover time." (Ex. 1006, ¶[0072]).

540. Further, given *Raizer's* robots are configured to move vertically up "vertical rails and along the horizontal rails of the network of rails to reach an exact location on the floor to reach an exact location on the floor or shelving system," to retrieve item, thereby eliminating the need for *Hangzhou's* stacking robot, such a combination would be simplified. A person of ordinary skill in the art would have further been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

541. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of turning the vehicle while the vehicle is under one of the racks, as recited in claim element [26.a].

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Claim 26, Element [26.b]: wherein the step of turning comprises turning the vehicle to align the vehicle with a path perpendicular to the first aisle.

542. *Raizer* in view of *Hangzhou* renders obvious claim element [26.b]. As discussed with respect to claim element [1.e], *Raizer* discloses turning a vehicle.

543. To the extent *Raizer* does not explicitly disclose turning the vehicle to align the vehicle with a path perpendicular to the first aisle, a person of ordinary skill in the art would have looked to *Hangzhou* for such a teaching.

544. With reference to Figure 10 (reproduced and annotated below), *Hangzhou* discloses that "an auto-guided trolley 200 may switch between the row direction and the column direction," noting that "[s]witching the driving direction does not bring a problem to auto-guided trolleys because auto-guided trolleys 200 can be small enough to turn in the auto-guided trolley passage space 112." (Ex. 1006, ¶[0072]).

545. *Hangzhou* discloses, with respect to Figure 10, "[t]he counterclockwise and clockwise arrows on the trolleys indicate the trolley is turning in position." (Ex. 1006, ¶[0068]). Further, "where the dotted lines intersect, an auto-guided trolley 200 may switch between the row direction and the column direction," (i.e., turn). (Ex. 1006, ¶[0072]).

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Ex. 1006, Figure 10 (annotated)

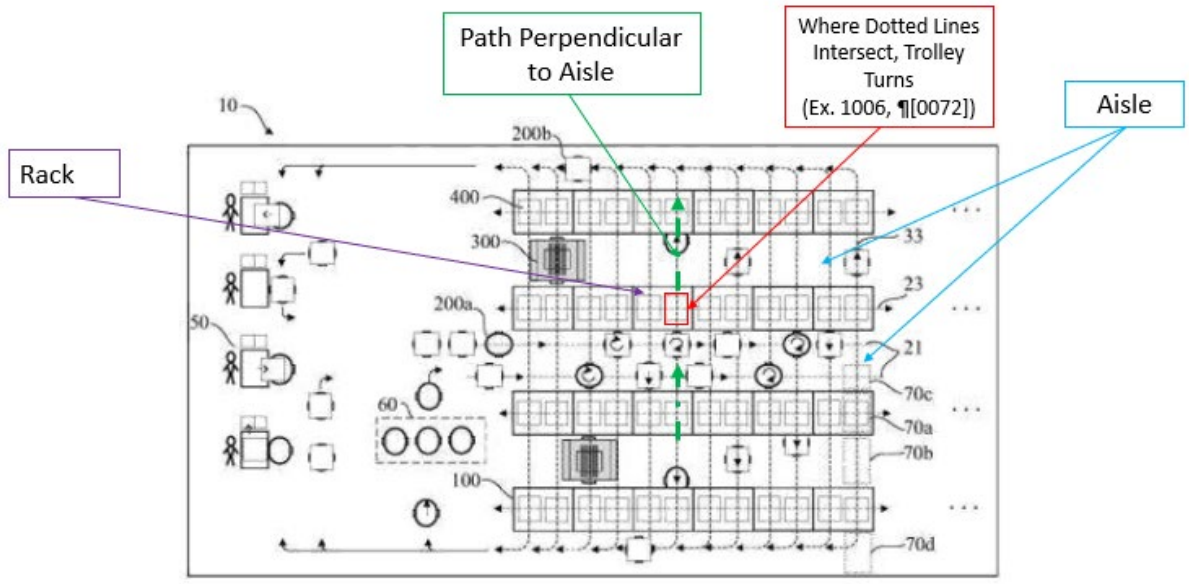


Figure 10

546. *Hangzhou* further discloses that an "auto-guided trolley 200 carrying standardized containers 400 switches between the row and column directions along the traveling direction by performing a series of actions, including dropping and docking the standardized containers on the support members, the trolley turning 90° in place, and hoisting the standardized containers." (Ex. 1006, ¶[0073]). That is, *Hangzhou* discloses turning the trolleys to travel along the column directions (i.e., turning the vehicle to align the vehicle with a path perpendicular to the first aisle.). A person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section titled *Motivation to Combine Raizer and Hangzhou* (*supra*).

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547. Thus, *Raizer* and *Hangzhou* render obvious the step of turning comprises turning the vehicle to align the vehicle with a path perpendicular to the first aisle, as recited in claim element [26.b].

Dependent Claim 27

Claim 27, Element [27.pre]: The method of claim 26

548. *Raizer* in view of *Hangzhou* renders obvious claim element [27.pre]. As set forth above, *Raizer* in view of *Hangzhou* renders obvious all of the claim elements of claim 26. Thus, *Raizer* in view of *Hangzhou* renders obvious [27.pre].

Claim 27, Element [27.a]: wherein the step of turning the vehicle comprises rotating the vehicle about a vertical axis passing through the vehicle.

549. *Raizer* in view of *Hangzhou* renders obvious claim element [27.a].

550. *Raizer* discloses that the "robots of the system comprise" "two drive and steering units, " where "each unit compris[es] one front wheel and components configured to rotated [sic] the front wheel at least 360 degrees *about a vertical axis* to the floor in order to steer the robot" and "to rotate the front wheel about a horizontal axis in order to cause the robot to move in the direction that the front wheel is pointing." (Ex. 1005, ¶[0056]). *Raizer* discloses that "[t]he front wheels 22 of robot 10 can be independently rotate 360 degrees about an axis vertical to the floor by their respective drive and steering units 24." (Ex. 1005, ¶[0107]). The "motor of the drive assembly is a variable speed motor," making it possible to "steer

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the robot by activating the drive motors to produce differential rotational speeds of the two front drive wheels." (Ex. 1005, ¶[0109]) .

551. To the extent that *Raizer* does not disclose rotating the first vehicle about a vertical axis that extends through the first vehicle while underneath a rack, a person of ordinary skill in the art would have turned to the teachings of *Hangzhou* as set forth above with respect to claim element [1.e]. A person of ordinary skill in the art would have been motivated to combine *Raizer* and *Hangzhou* for the reasons set forth in the section title *Motivation to Combine Raizer and Hangzhou (supra).*

552. Thus, *Raizer* in view of *Hangzhou* renders obvious the step of turning the vehicle comprises rotating the vehicle about a vertical axis passing through the vehicle, as recited in claim element [27.a].

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X. CONCLUSION

I declare that all statements made herein of my own 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.

Dated: May 2, 2024

Stephen Derby, Ph.D.

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