



Exotec Product France SAS, Exotec North America, and Exotec Product USA Inc.,
Petitioners,
v.
Opex Corporation
Patent Owner.

U.S. Patent No. 11,472,632

AIA Review No. IPR2024-00850

Petitioners' Demonstratives | Under 37 C.F.R. § 42.70(b)
August 27, 2025, Oral Argument

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE – 1

Petitioners' Exhibit 1013
Exotec v. Opex; No. IPR2024-00850
U.S. Patent No. 11,472,632; Page 1

ROADMAP

- 01** | Overview of the Challenged Patent

- 02** | Overview of the Disputes

- 03** | Combination & Motivation to Combine

- 04** | Challenges to Motivation to Combine Fail

- 05** | Challenges to Reasonable Expectation of Success Fail

ROADMAP

01 | Overview of the Challenged Patent

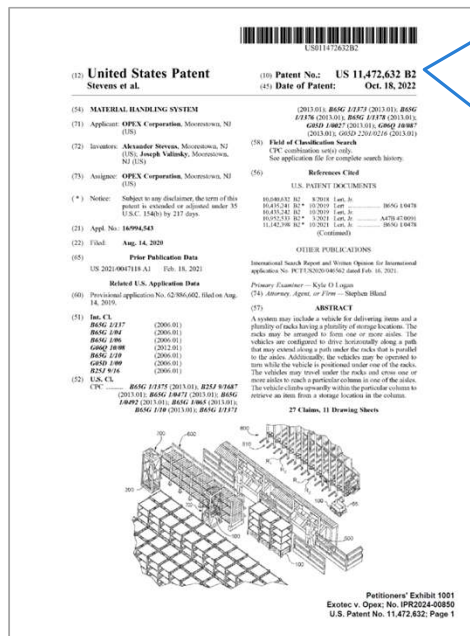
02 | Overview of the Disputes

03 | Combination & Motivation to Combine

04 | Challenges to Motivation to Combine Fail

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OVERVIEW OF THE '632 PATENT



'632 Patent

(12) United States Patent Stevens et al.

(10) Patent No.: **US 11,472,632 B2**
(45) Date of Patent: **Oct. 18, 2022**

(54) MATERIAL HANDLING SYSTEM

(71) Applicant: **OPEX Corporation**, Moorestown, NJ
(US)

(72) Inventors: **Alexander Stevens**, Moorestown, NJ
(US); **Joseph Valinsky**, Moorestown,
NJ (US)

(2013.01); **B65G 1/1373** (2013.01); **B65G 1/1376** (2013.01); **B65G 1/1378** (2013.01); **G05D 1/0027** (2013.01); **G06Q 10/087** (2013.01); **G05D 2201/0216** (2013.01)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(22) Filed: **Aug. 14, 2020**

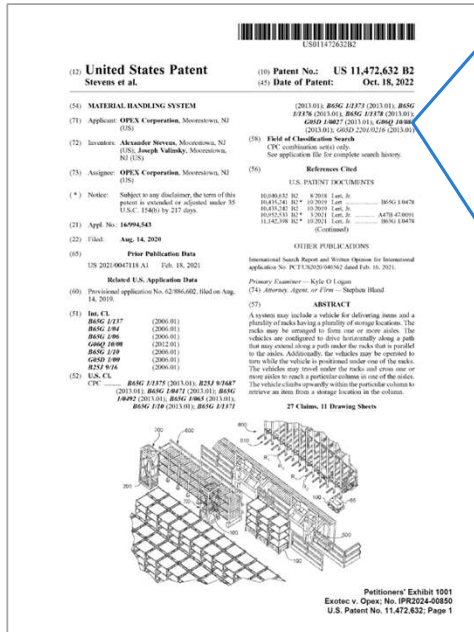
(65) **Prior Publication Data**

US 2021/0047118 A1 Feb. 18, 2021

Related U.S. Application Data

(60) **Provisional application No. 62/886,602, filed on Aug. 14, 2019.**

OVERVIEW OF THE '632 PATENT



'632 Patent

Ex. 1001, FIG. 1

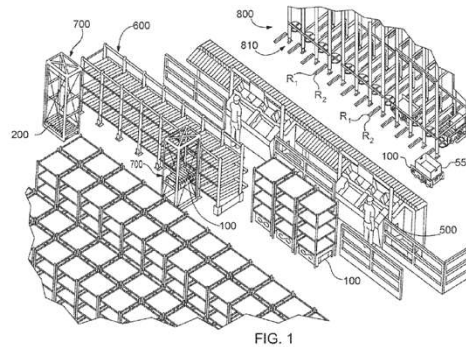


FIG. 1

Ex. 1001, FIG. 2

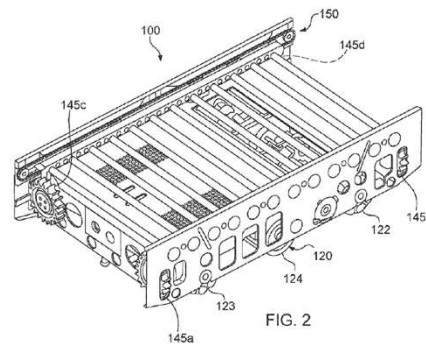


FIG. 2

The '632 Patent purports to solve alleged problems relating to material handling systems (Ex. 1001, 1:12-46, 7:41-52; Ex. 1003, ¶¶52-62).

The '632 Patent discloses a "material handling system" with "storage racks," each "includ[ing] a plurality of storage locations." (Ex. 1001, 7:41-52; FIG. 1; Ex. 1003, ¶¶54-57).

A "delivery mechanism" may "include one or more vehicles that" "retrieve items from storage locations" and "deliver the items to a workstation 500 where an operator can retrieve the item from the vehicle." (Ex. 1001, 7:10-22; Ex. 1003, ¶58).

The '632 Patent discloses a "vehicle" with "a horizontal drive assembly" and a "vertical drive mechanism 140¹." (Ex. 1001, 8:9-19, 9:12-19, FIG. 2, FIG. 9; Ex. 1003, ¶¶58-60).

The vehicles include a "transfer mechanism" "operative to transfer an item between a platform surface of the vehicle and one of the plurality of destination areas," and the "racks may be configured to allow the vehicles to travel under the racks" and "across or along one or more aisles." (Ex. 1001, 10:1-23, 17:7-48; FIG. 2, FIG. 7; Ex. 1001, ¶¶61-62).

Petition for Inter Partes Review

OVERVIEW OF THE '632 PATENT

In some embodiments, traffic management of the AGVs is performed by a traffic management module 470 of controller 450. In such cases, position, speed and direction data is collected from the vehicles at regular intervals by the controller. The position data is analyzed, and path segment selector 474 selects paths for each vehicle over the next control interval to ensure that there are no collisions with other vehicles, with personnel, or with fixed structures. The updated instructions corresponding to the path selections, inclusive of heading and direction, are transmitted by the controller back to the vehicles. In other embodiments, however, the vehicles do not rely on the controller for relative positioning instructions, but rather solely for destination and task assignments, with the vehicles instead relying on internal data gathering and spatial analysis capabilities.

Exemplary position sensing systems utilize a scanning mechanism that operates in conjunction with fixed-location references strategically placed at pre-defined surveyed sites. Such scanning mechanisms may include scanning detectors with fixed active-beacon emitters, scanning emitter/detectors with passive retroreflective targets, scanning emitter/detectors with active transponder targets, and rotating emitters with fixed detector targets.

In one or more illustrative embodiments consistent with the present disclosure, the vehicles may optionally rely on a scanning laser triangulation scheme (SLTS) to provide positional updates to an onboard dead-reckoning system of the vehicle. A laser emitter rotating at, for example, two rpm illuminates passive retroreflective barcode targets affixed to walls or support columns at known locations on the order of fifteen meters away from the vehicle. The barcodes are used to positively identify the reference target and eliminate ambiguities due to false returns from other specular surfaces within the operating area. An onboard computer of each vehicle calculates X-Y positional updates through simple triangulation to null out accumulated dead-reckoning errors.

'632 Patent

OVERVIEW OF THE '632 PATENT

 **UNITED STATES PATENT AND TRADEMARK OFFICE**

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NOTICE OF ALLOWANCE AND FEE(S) DUE

156121 7590 06/27/2022

Opex Corporation
305 Commerce Dr
Moorestown, NJ 08057

EXAMINER
LOGAN, KYLE O

ART UNIT 3655 PAPER NUMBER

DATE MAILED: 06/27/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/994,543	08/14/2020	Alexander Stevens	P10808USO	4292

TITLE OF INVENTION: Material Handling System

APPL. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1200	\$0.00	\$0.00	\$1200	09/27/2022

Allowable Subject Matter

5. Claims 1-27 are allowed.
6. The following is the examiner's statement of reasons for allowance: independent claim 1 is on a method for delivering items to storage locations and retrieving items from storage locations and recites, in part, "driving the first vehicle along a first path under a first one of the racks wherein the first rack is adjacent a first one of the aisles and wherein the first path extends in a direction parallel to the first aisle and spaced apart from the first aisle; turning the first vehicle while the first vehicle is under the first rack; driving the vehicle into the first aisle; driving the first vehicle upwardly in the aisle to a first of the storage locations ... driving the first vehicle downwardly in the aisle until the vehicle is on a horizontal surface; driving the first vehicle across the first aisle after the step of driving the first vehicle downwardly; and driving the vehicle out from under the storage racks after the step of driving the first vehicle across the first aisle."

'632 Patent Notice of Allowance

ROADMAP

01 | Overview of the Challenged Patent

02 | Overview of the Disputes

03 | Combination & Motivation to Combine

04 | Challenges to Motivation to Combine Fail

05 | Challenges to Reasonable Expectation of Success Fail

What is NOT Disputed



PO does not dispute that each of the elements in at least the challenged independent claims is present in the combination of Raizer and Hangzhou.



PO does not dispute that Raizer discloses autonomous robots that can travel horizontally and vertically and be steered by their control systems to any location on the floor of the warehouse. (Ex. 1005, [0104])



PO does not dispute that Hangzhou discloses running of robots in passage spaces beneath shelves and in the aisles, providing increased paths and maximum search space for navigation. (Ex. 1006, Abstract, [0076])



PO does not dispute that robot travel underneath shelves, and elevating shelving units above warehouse floors, was well known to a POSITA.

PO Only Disputes Reasonableness of Combination

- **Patent Owner Criticisms**
 - Combination not set forth in sufficient detail;
 - No motivation to combine separate autonomous vehicle references addressing same problem in field;
 - No reasonable expectation of success;
 - Combination would require modification of robots to meet dependent claims 5, 8, and 9.
- PO criticisms ignore the actual combination and manufacture challenges absent from the claims and references.

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COMBINATION

(19) United States
(12) Patent Application Publication
Raizer

(54) AUTOMATIC WAREHOUSE SYSTEM

(71) Applicant: BiosicHIVE Ltd, Moskov, Eilat (IL)

(72) Inventor: Liron Raizer, Moskov

(73) Assignee: BiosicHIVE Ltd (IL)

(21) Appl. No.: 15/325,000

(22) PCT Filed: Jul. 9, 2015

(86) PCT No.: PCT/IL2015/050714
§ 371(c)(1)
(2) Date: Jan. 11, 2017

Related U.S. Application Data
(60) Provisional application No. 62/023,827, filed on Jul. 12, 2014.

Ex. 1005, FIG. 1 (annotated)

Fig. 1

(57) ABSTRACT

The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.

Raizer

Ex. 1006, Figure 10

Figure 10

(57) Abstract

Disclosed in the present invention are an unmanned warehousing system and an inbound and outbound method therefor, which solve the problems of complex deployment, inconvenient maintenance, and high cost of the existing system. In an embodiment of the system, a two-layer channel support frame is provided below a shelf, wherein a lower layer is used to automatically guide a trolley to pass through, an upper layer is used for the temporary cache or passage of a standardized container, and an interlayer support plate runs through along the length or width direction of the entire shelf. When an outbound process of items is implemented, 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. Then, the container is lowered onto the upper layer of the support frame to cache the container on the support plate. Subsequently, an auto-guided trolley travels through the lower layer of the support frame to a position below the container to separate the container from the support member by hoisting the container before entering a sorting site through a channel and a laneway. The steps are reversed for an inbound process. This system is easy to deploy, convenient to maintain, and low in cost. A large number of robots operate concurrently by means of a dispatching system, so that the overall efficiency is high.

Intellectual Property Administration of the People's Republic of China
(12) Patent Application for Invention
(10) Application Publication No. CN 109987366 A
(42) Application Publication Date July 9, 2019

Hangzhou Jueying Intellectual Property Agency Co., Ltd. 31253

7 pages of claims, 19 pages of description, and 8 pages of drawings

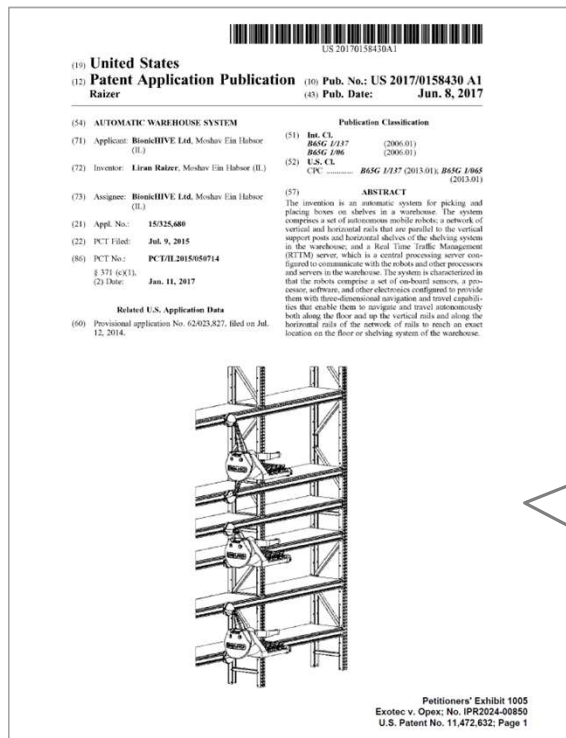
WAREHOUSING SYSTEM AND INBOUND METHOD THEREFOR

ment invention are an unmanned warehousing and an inbound and outbound method therefor, which solve the problems of complex deployment, inconvenient maintenance, and high cost of the existing system. In an embodiment of the system, a two-layer channel support frame is provided below a shelf, wherein a lower layer is used to automatically guide a trolley to pass through, an upper layer is used for the temporary cache or passage of a standardized container, and an interlayer support plate runs through along the length or width direction of the entire shelf. When an outbound process of items is implemented, 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. Then, the container is lowered onto the upper layer of the support frame to cache the container on the support plate. Subsequently, an auto-guided trolley travels through the lower layer of the support frame to a position below the container to separate the container from the support member by hoisting the container before entering a sorting site through a channel and a laneway. The steps are reversed for an inbound process. This system is easy to deploy, convenient to maintain, and low in cost. A large number of robots operate concurrently by means of a dispatching system, so that the overall efficiency is high.

Petitioners' Exhibit 1006
Exotec v. Opex; No. IPR2024-00850
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Hangzhou

MOTIVATION TO COMBINE



Raizer

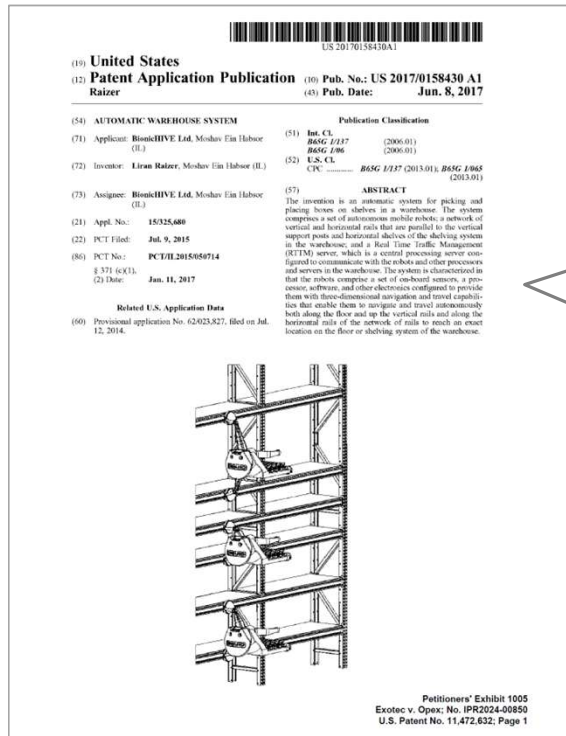
- Raizer discloses an automatic system for picking and placing boxes in a warehouse using autonomous mobile robots configured to travel “both along the floor and up the vertical rails and along the horizontal rails of [a] network of rails to reach an exact location on the floor or shelving system of the warehouse.”
- Raizer discloses that robots can travel to “any location on the warehouse floor” along routes organized to “reduce congestion and prevent traffic jams.”

[0098] Embodiments of the system comprise software that enables advanced capabilities such as realization of Internet of Things (IoT) scenarios. For example, System components will be able to identify, connect and cooperate with other IoT enabled devices like automated hauling devices, smart entry gates and doors, automatic counting & measure systems, cleaning robots and other warehouse IoT participants. the system of the invention is designated as a self-learning system where, for example, algorithm 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. All of these scenarios are possible without any human intervention and relying on accumulated data which collected as a routine daily basis.

[0104] Robot 10 moves along the ground on four wheels. The two rear wheels 30 could be fixed and passive so that they can only rotate about their axes which are perpendicular to the axis of the long beams 28 of the frame and are “dragged along” by the front wheels. In another embodiment the rear wheels could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor. In this later embodiment the front driving wheels 22 dictate the steering angle and differential speeds of the rear wheels. The 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. The drive and steering units 24 are attached to the robot by means of arm units 26. As will be described herein below, arm units 26 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.

MOTIVATION TO COMBINE

- Raizer places no limitations on floor routes.
- Explains that the system can be implemented in any existing or new warehouse.



Raizer

[0016] It is another purpose of the present invention to provide an automatic warehouse system that can be relatively inexpensively and easily added to existing warehouses operated by businesses.

[0112] The rails are designed to be easily attached to the existing shelving in the warehouse by conventional means such as bolts, fasteners or quick-lock mounts. Although a main idea behind the present invention is to retrofit existing warehouses, the system can obviously be installed in new structures, in which case the rails of the invention can be manufactured as an integral feature of the shelving system. In an embodiment of the system the rails are not attached to the shelving but are constructed as free standing structures that stand next to the shelving.

MOTIVATION TO COMBINE

Undershelf travel was known to provide more flexible route planning.

THE WITNESS: I think Goren simply points out that the -- that travelling underneath shelves was well-known at the time that the '632 patent was published.

Dr. Spenko's Testimony

Q Do you recall that Goren describes that it was known at least as early as 2016 to route robots under elevated shelves to allow for flexible route planning?

A I don't recall that, but if you point it to me, I would -- I would probably agree with that.

Dr. Singhose's Testimony

MOTIVATION TO COMBINE

Both directed to automated warehouse systems using autonomous vehicles that navigate warehouse floor to load and retrieve items from shelves.

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2017/0158430 A1
Raizer (43) Pub. Date: Jun. 8, 2017

(54) AUTOMATIC WAREHOUSE SYSTEM

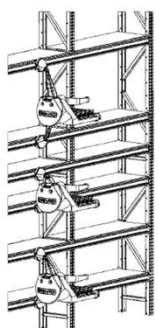
(71) Applicant: Bluelight LLC, Moshe Ein Hahar (IL)
(72) Inventor: Eran Raizer, Moshe Ein Hahar (IL)
(73) Assignee: Bluelight LLC, Moshe Ein Hahar (IL)

(21) Appl. No.: 15/025,000
(22) PCT Filed: Jul. 9, 2015
(86) PCT No.: PCT/IL2015/00714
E 371 (931): Jun. 11, 2017

Related U.S. Application Data
(60) Provisional application No. 62/023,327, filed on Jul. 12, 2014.

Publication Classification
(51) Int. Cl. B65G 1/137 (2006.01)
(52) B65G 1/06 (2006.01)
(52) E24 C3 (2006.01)
(57) CPC B65G 1/137 (2013.01); B65G 1/06 (2013.01)

ABSTRACT
The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.



Petitioners' Exhibit 1005
Exotec v. Opex; No. IPR2024-00850
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Raizer

(57) ABSTRACT
The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.

(57) Abstract
Disclosed in the present invention is an unmanned warehousing system and an inbound and outbound method thereof, which solve the problems of complex deployment, inconvenient maintenance, and high cost of the existing system. In an embodiment of the system, a two-layer channel support frame is provided below a shelf, wherein a lower layer is used to automatically guide a trolley to pass through, an upper layer is used for the temporary cache or passage of a standardized container, and an interlayer support plate runs through along the length or width direction of the entire shelf. When an outbound process of items is implemented, 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. Then, the container is lowered onto the upper layer of the support frame to cache the container on the support plate. Subsequently, an auto-guided trolley travels through the lower layer of the support frame to a position below the container to separate the container from the support member by hoisting the container before entering a sorting site through a channel and a laneway. The steps are reversed for an inbound process. This system is easy to deploy, convenient to maintain, and low in cost. A large number of robots operate concurrently by means of a dispatching system, so that the overall efficiency is high.

At the outset, we find that Patent Owner's characterization of Raizer's and Hangzhou's systems as "fundamentally different" is difficult to reconcile at this time and on this record. The references are each similarly directed to automated warehouse systems involving operation of autonomous robots or trolleys that navigate a warehouse floor for the purpose of loading items on shelves or retrieving items from those shelves. Compare Ex. 1005, Abstract with Ex. 1006, Abstract. That the references may not convey complete symmetry with one another in connection with particular trolley/robot configurations, navigation techniques, or shelf positioning as a part of a warehouse floorplan does not, in our view, give rise to a fundamental dichotomy or distinction that prohibits the combination of their teachings, as Patent Owner appears to argue.

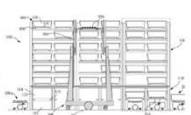
Institution Decision

(19) National Intellectual Property Administration of the People's Republic of China
(12) Patent Application for Invention
(10) Application Publication No. CN 109987366 A
(43) Application Publication Date July 9, 2019

(21) Application No. 201910036500.3
(22) Application Date January 15, 2019
(71) Applicant Hangzhou Dichen Intelligent Technology Co., Ltd.
Address Working Station 614, Floor 2, Building 4, No. 1, Street 8, Economic and Technological Development Zone, Hangzhou, Zhejiang Province, 310018
(72) Inventors Yunsong ZHAO, Meiyao LIU
(74) Patent Agency Shanghai Jingdong Intellectual Property Agency Co., Ltd. 31253
Agent Ziling FENG
(51) Int. Cl. B65G 1/04 (January 2006)
7 pages of claims, 19 pages of description, and 8 pages of drawings

(54) Title of the Invention
UNMANNED WAREHOUSING SYSTEM AND INBOUND AND OUTBOUND METHOD THEREOF

(57) Abstract
Disclosed in the present invention is an unmanned warehousing system and an inbound and outbound method thereof, which solve the problems of complex deployment, inconvenient maintenance, and high cost of the existing system. In an embodiment of the system, a two-layer channel support frame is provided below a shelf, wherein a lower layer is used to automatically guide a trolley to pass through, an upper layer is used for the temporary cache or passage of a standardized container, and an interlayer support plate runs through along the length or width direction of the entire shelf. When an outbound process of items is implemented, 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. Then, the container is lowered onto the upper layer of the support frame to cache the container on the support plate. Subsequently, an auto-guided trolley travels through the lower layer



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Hangzhou

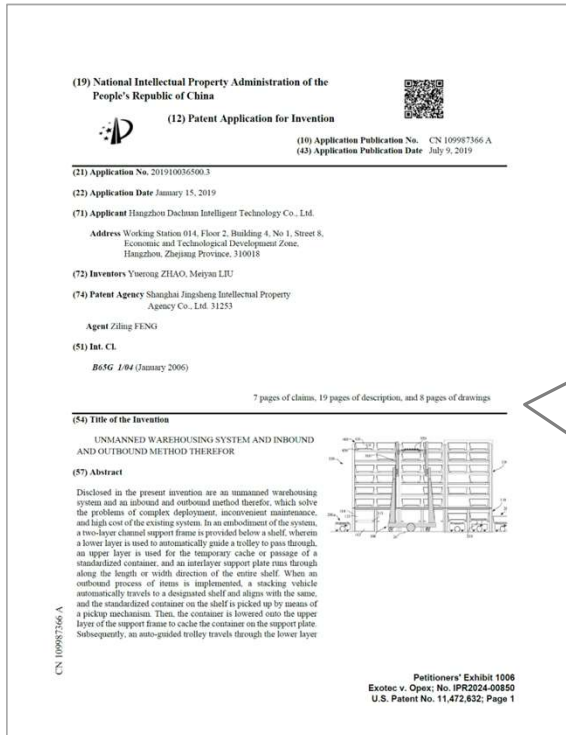
SHARED GOAL of reducing congestion and avoiding traffic jams.

Raizer

Hangzhou

MOTIVATION TO COMBINE

- Motivated to reduce congestion and traffic jams, POSITA would investigate other autonomous system routing, such as that disclosed in Hangzhou.
- Hangzhou discloses auto-guided trolleys that can travel and turn underneath storage racks to avoid collisions.



Hangzhou

[0048] An auto-guided trolley 200 is a small mobile robot with auto-navigation ability, usually driven by a differential gear train, and equipped with four universal wheels. Such a trolley is characterized by a small size and a low cost. In addition, trolleys are generally designed in symmetrical so that they can turn in place. However, the specific driving form is not limited thereto, and may also be an omnidirectional drive wheel train and others. As shown in FIG. 1, in this embodiment, an auto-guided trolley 200 preferentially travels in column laneways 32 and auto-guided trolley passage spaces 112, never entering stacking row laneways 12 to avoid path conflicts with stacking vehicles 300.

[0059] Potential collisions may occur since the stacking device and auto-guided trolleys carrying standardized containers need to use the cache space below shelf rows. In addition to running in a time-shared manner at the dispatch level, auto-guided trolleys 200 also run an obstacle avoidance algorithm to ensure safety and reliability. Generally speaking, stacking vehicle path planning has a higher priority. Therefore, auto-guided trolley path planning will be adjusted based on the information on stacking vehicle path planning. For instance, when an auto-guided trolley carrying standardized containers drives along the row channel below a shelf row and is about to enter the next channel support frame ahead, the auto-guided trolley confirms the absence of obstacles, such as other auto-guided trolleys or standardized containers, in the next channel support frame according to the information obtained via wireless communication and through its sensor system.

Hangzhou's disclosure furthers shared goal and provides motivation to use additional paths.



Spenko



MOTIVATION TO COMBINE

Hangzhou teaches benefits of route flexibility.

(19) National Intellectual Property Administration of the People's Republic of China



(12) Patent Application for Invention

(10) Application Publication No. CN 109987366 A
(43) Application Publication Date July 9, 2019

(21) Application No. 201910035500.3

(22) Application Date January 15, 2019

(71) Applicant Hangzhou Dachuan Intelligent Technology Co., Ltd.

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(72) Inventors Yurong ZHANG, Meiyun LIU

(74) Patent Agency Shanghai Jiazhong Intellectual Property Agency Co., Ltd. 31253

Agent Ziling FENG

(51) Int. Cl.

B65G 1/04 (January 2006)

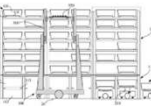
7 pages of claims, 19 pages of description, and 8 pages of drawings

(54) Title of the Invention

UNMANNED WAREHOUSING SYSTEM AND INBOUND AND OUTBOUND METHOD THEREFOR

(57) Abstract

Disclosed in the present invention are an unmanned warehousing system and an inbound and outbound method thereof, which solve the problems of complex deployment, inconvenient maintenance, and high cost of the existing system. In an embodiment of the system, a two-layer channel support frame is provided below a shelf, wherein a lower layer is used to automatically guide a trolley to pass through, an upper layer is used for the temporary cache or passage of a standardized container, and an interlayer support plate runs through along the length or width direction of the same shelf. When an inbound process of items is implemented, 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. Then, the container is lowered onto the upper layer of the support frame to cache the container on the support plate. Subsequently, an auto-guided trolley travels through the lower layer



Petitioners' Exhibit 1008
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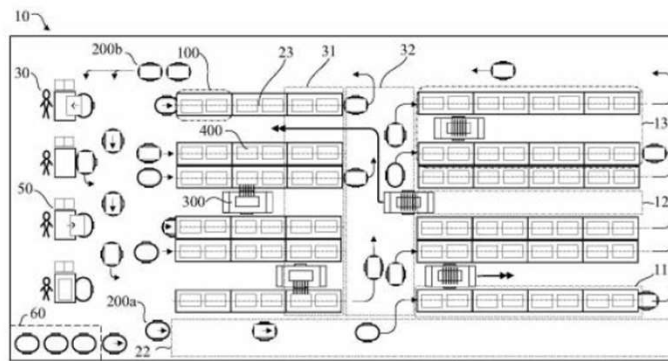


FIG. 1

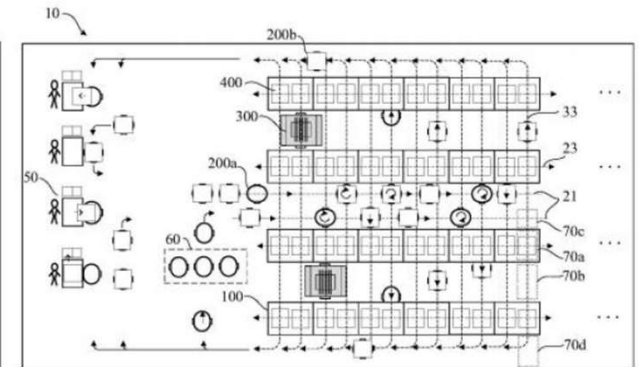


FIG. 10

Hangzhou

ROADMAP

01 | Overview of the Challenged Patent

02 | Overview of the Disputes

03 | Combination & Motivation to Combine

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05 | Challenges to Reasonable Expectation of Success Fail

MOTIVATION TO COMBINE

PO argues that combination would run counter to Raizer's goal of easy retrofit and implementation.

First, a person of ordinary skill in the art would not have combined Raizer with Hangzhou because the proposed modification would have detracted from what Raizer considered to be a primary motivation behind its invention, namely, the ability to retrofit existing warehouses. Therefore, the proposed combination undermines Raizer's intended purpose and most of its purported benefits. Exotec's

Hangzhou teaches away from single-type robot systems, noting that "the number of shelf layers generally does not exceed three to ensure robot movement stability, which limits the storage capacity of warehouses together with the high cost of a single mobile robot." EX1006, ¶4. Instead, Hangzhou specifically employs a multi-type robot system, because it "can take advantage of different robots' strengths" despite the fact that it can "lead[] to a higher deployment cost." EX1006, ¶5.

For example, Petitioner's proposed modification to allow for travel underneath shelves, such as along a "path ... parallel to the aisle" would have required unacceptable modifications of Raizer. Petitioner's only proposed modification to satisfying a "path ... parallel to the aisle" is to modify Raizer's storage racks by "installing shelving units with elevated lower shelves to allow robots loaded with containers to travel underneath." Petition, 7. However, this proposed modification requires large capital equipment investment (new shelving structures), leads to poor modularity, and requires reorganization and downtime. These are exactly the shortcomings that Raizer aims to avoid. See EX1005, ¶¶4-16.

MOTIVATION TO COMBINE

Raizer and Hangzhou both explicitly contemplate retrofit and new or modified floor plans.

[0112] The rails are designed to be easily attached to the existing shelving in the warehouse by conventional means such as bolts, fasteners or quick-lock mounts. Although a main idea behind the present invention is to retrofit existing warehouses, the system can obviously be installed in new structures, in which case the rails of the invention can be manufactured as an integral feature of the shelving system. In an embodiment of the system the rails are not attached to the shelving but are constructed as free standing structures that stand next to the shelving.

Raizer

[0009] Compared with the prior art, the unmanned warehousing system and the inbound and outbound method therefor provided by the present invention achieve efficient transportation of "goods to people" by means of the cooperation of fewer mobile stacking vehicles and more small auto-guided trolleys to complete sorting and transportation of the items, with the help of the cache space below the shelf. The system has the advantages including the following: the existing traditional shelves continue to be used without the addition of wires and auxiliary electromechanical devices; on-site modification is substantially negligible, especially suitable for temporary warehouses; the small auto-guided trolleys only need to transport the items rather than the entire shelf, and only a small load capacity is thus required, so that the cost can be greatly reduced; for the auto-guided trolley and the stacking device, standardized mature products may be used for immediate maintenance outside the site in the case of failure without affecting the continued operation of the whole system. In addition, mobile robots can adopt auto-navigation technology, and it is possible not to mount any navigation assistance device that requires a wire power supply. Such a warehouse can be relocated, expanded, and changed in layout at any time, with characteristics like high flexibility, short implementation cycle, and convenient demolition, transfer, and expansion.

Hangzhou

MOTIVATION TO COMBINE

Any possible modifications to Raizer were contemplated, would not require large capital investment, and PO's expert confirms a POSITA would have understood shelf height to be a freely modified variable.

[0112] The rails are designed to be easily attached to the existing shelving in the warehouse by conventional means such as bolts, fasteners or quick-lock mounts. Although a main idea behind the present invention is to retrofit existing warehouses, the system can obviously be installed in new structures, in which case the rails of the invention can be manufactured as an integral feature of the shelving system. In an embodiment of the system the rails are not attached to the shelving but are constructed as free standing structures that stand next to the shelving.

Raizer

Q And then how would the person of ordinary skill in the art determine dimensions of the storage racks?

A Well, they have a little more freedom. The storage racks could -- could just be bigger than that. Right? They have to be big enough to accommodate the items that you can store, and they have to be big enough for the robot to go up to it and essentially push a box into it or retract a box.

So, again, they would have to be a little bit bigger than those widths.

Q And then how would a person of ordinary skill in the art determine the shelf height?

A Again, there would be a lot of freedom there. They would set the shelf height up to the height they would need to easily store the largest box that they anticipate this warehouse needing to store.

And then also, they would have to take into account the height between the floor and the first shelf. Right? So you would probably take that into account. That's the tallest thing I can drive through there, so then my storage racks can also be determined relative to that.

But there's a whole bunch of freedom basically on the height of the storage areas.

Dr. Singhose's Testimony

MOTIVATION TO COMBINE

PO argues that Hangzhou teaches away from single-robot systems.

Hangzhou teaches away from single-type robot systems, noting that “the number of shelf layers generally does not exceed three to ensure robot movement stability, which limits the storage capacity of warehouses together with the high cost of a single mobile robot.” EX1006, ¶4. Instead, Hangzhou specifically employs a multi-type robot system, because it “can take advantage of different robots’ strengths” despite the fact that it can “lead[] to a higher deployment cost.” EX1006, ¶5.

MOTIVATION TO COMBINE

Hangzhou discusses disadvantages of exemplary Single-Type and Multi-Type Robot Systems, but does not teach away from use of under-rack travel.

[0004] The solution adopting single-type mobile robots is advantaged by easy modularization and standardization, so that a faulty device unit can be replaced quickly. Amazon's Kiva robot system is a typical example. Patent US7826919 introduces using a submersible auto-navigation trolley to move unitized shelves, realizing "goods to people." However, in the solution, the whole shelf is handled, requiring each mobile trolley to be provided with a high load capacity, which greatly increases the device cost. In addition, the shelf should not be too high or it will easily tip over during movement, which restricts the improvement of warehousing capacity. The solution in Patent JP2004277062 owned by Panasonic in Japan is to use single-type mobile robots with lifting platforms and fork means to connect with shelves. However, the number of shelf layers generally does not exceed three to ensure robot movement stability, which limits the storage capacity of warehouses together with the high cost of a single mobile robot.

Single-Type Robot Systems

[0005] The multi-type robot collaboration solution including at least one mobile robot can take advantage of different robots' strengths. The solution in Patent US10138060 owned by Amazon is to mount on the back of each shelf a modularized two-degree-of-freedom leveling mechanism and a telescoping pusher, which can be moved to a position and push items from the inside out; on the other hand, an auto-guided vehicle is mounted with a lifting platform, which can align with a shelf layer after moving to a specified shelf position, so as to catch items before the items are transported to a sorting workstation. The solution has a long deployment cycle, high costs, and low reliability. The solution in Patent US9550624 owned by Dematic in USA is to use a mobile trolley equipped with a joint mechanical arm and a mobile trolley with multi-layer storage baskets to cooperate with each other. The latter follows the former, which transfers items from a shelf to a storage basket. In this solution, despite the easiness of deploying basically without on-site modification, the joint mechanical arm is limited in the pickup range with a low load capacity and a high cost. The solution proposed by Knapp in Germany in Patent EP3170773 is to reserve some space at positions of the bottom layer on both sides of an automatic three-dimensional warehouse for movable multi-layer shelves to be docked therein. A laneway stacker puts items into shelves from the three-dimensional warehouse, and a mobile trolley moves to a position below the shelves to hoist the shelves and then transports them to sorting workstations. The solution requires the installation of the three-dimensional warehouse, leading to a high deployment cost. Also, the three-dimensional warehouse cannot continue to work in the case of internal failure. The mobile trolley can only move in the periphery of the three-dimensional warehouse but not enter its internal space. Moreover, the periphery has less space reserved for deployment, and it is thus unable to increase throughput and efficiency by increasing the number of mobile trolleys.

Multi-Type Robot Systems

MOTIVATION TO COMBINE

PO's expert confirms Hangzhou does not criticize the general class of single-type robot systems nor multi-type robot systems.

Q Is it fair to say that Hangzhou, in Paragraphs 4 and 5, describes drawbacks of five prior art example robot systems with two being single-type and three being multi-type?

A Yes.

Q Do you see any disclosure in Paragraph 4 where Hangzhou criticizes the general class of all single-type robots?

A Not in Paragraph 4.

Q Do you see any disclosure in Paragraph 5 where Hangzhou criticizes the general class of all multi-type robot collaboration solutions?

A No, I do not.

Dr. Singhose's Testimony

ROADMAP

01 | Overview of the Challenged Patent

02 | Overview of the Disputes

03 | Combination & Motivation to Combine

04 | Challenges to Motivation to Combine Fail

05 | Challenges to Reasonable Expectation of Success Fail

REASONABLE EXPECTATION OF SUCCESS

PO argues that a POSITA would not have reasonable expectation of success because combination would require modification of Raizer robots to perform “survey mode” mapping of undershelf pathways.

Importantly, a POSITA is not a person that developed Raizer’s proprietary components. Nor is a POSITA a person working at a company that makes systems using Raizer’s proprietary components. Therefore, a POSITA would not know how to modify Raizer’s proprietary components or have any expectation of success in performing any such modification.

Raizer uses its proprietary software, including a “Survey Mode,” (EX1005, ¶84) to establish the routes and intersections that its robots use to navigate. Because Raizer’s invention does not travel or turn its robots under the shelves, its proprietary software does not establish routes and intersections under the shelves. Therefore, the proposed combination requires that Raizer’s proprietary software be changed so that it can establish the required new routes and intersections. Such modifications would be nonobvious, and not have a reasonable expectation of success.

Raizer’s sensors that perform Raizer’s “Survey Mode” mapping would operate drastically different when driving under a shelf than when driving in the open area of the warehouse. *Id.* Sensors used in such mapping activities generally use beam emitting-and-detecting measurements. *Id.* For example, LiDAR sensors emit laser pulses and measure reflected signals. *Id.* While this can work well in open spaces, such a system being used under shelves would be subject to an array of noisy reflected signals (multipath effects) that bounce off of the overhead shelves and the support legs of the shelves, or distant walls beyond the shelves. *Id.* The reflection patterns in such closed spaces are too complex for a POSITA to work with, especially in conjunction with proprietary software. *Id.*

REASONABLE EXPECTATION OF SUCCESS

The '632 Patent is silent as to mapping (and multi-path effects), and the claims of the '632 Patent do not require a mapping mode.

navigates via alternate means. EX1009, 141:2–142:18.⁴ Looking directly to the specification of the '632 patent, it offers multiple real-time navigational solutions that would not suffer from multipath effects, such as scanning laser triangulation or onboard dead reckoning. EX1001, 11:53–13:33. Crucially, nothing in the '632 Patent requires an initial mapping step to meet its claim limitations, while

PO Sur-Reply

Q Why did you testify earlier that the issue of multipath effects is not a problem for the technology in the '632 patent?

A Because the '632 patent does not operate like Raizer.

Q Why do you say that?

A It -- well, there's a lot of differences. I could spend all day here, but most germane at this point, it doesn't do that survey mode to automatically map and set up its navigation system the way Raizer does. It just doesn't do that.

Q How does the '632 patent do that? Does it provide any examples?

A I'd have to go back and see if it actually says how to do that. I don't -- off the top of my head, I'm not sure that it provides examples on -- on how it does its map. But it doesn't do it in the same way as Raizer.

Dr. Singhose's Testimony

REASONABLE EXPECTATION OF SUCCESS

Raizer makes no mention of multi-path effects, does not disclose that 'Survey Mode' is required, and makes no mention of requiring the use of any sensors for its 'Survey Mode.'

[0084] 1. Robots: A set of autonomous centrally controlled mobile robots that bring desired boxes to and from the picking station. The robots have 3 dimensional travel capabilities enabling them to travel along the ground and up and along the shelves. The robots are pre-loaded with proprietary software which includes the warehouse layout, routes, intersections, and designated areas (this mapping survey is recorded by a "Survey Mode" of the robot's software). Each robot utilizes dedicated maneuvering algorithms and a proprietary "Fine Positioning" procedure to enable precise, quick and efficient loading.

Raizer's Sole Mention of 'Survey Mode'

[0096] FIG. 3 is a flow chart that symbolically shows the main steps in picking and put-away carried out inside a warehouse comprising the system of the invention. When an order is received by WMS 128 it generates a message by communication link 144 with order details like item number, quantity, address in storage, priority and other information to RTTM 146. RTTM 146 analyzes the most effective path 152 and determines the best robot to execute the task. A task message is sent via wireless communication links 150 to the robot 10 and a status message via communication link 148 to the picking station 108 containing order details to be verified when items arrive. Robot 10 periodically reports its progress and status to RTTM 146 via communication link 150. RTTM 146 may change the task assigned to robot 10 when a higher priority task is received from WMS 128. For example, the software in robot 10 calculates its path 152 to address 134 and robot 10 self-navigates to address 134. After picking the item 140 at address 134 the robot navigates to picking station 108 and unloads. In some cases where the order requires only some of the items in the box—the robot will get the same or a new address relayed to it from WMS 128 via communication links 150 and 144 and will navigate to put away the box. Picking station software directs the worker by light indexing or other methods known in the art to consolidate the orders and move the completed orders 154 for shipping through RDC 102. A verification note is then sent from picking station 108 to RTTM 146 via communication link 148. RTTM 146 sends a confirmation message via communication link 144 to WMS128. A delivery note 156 is generated to RDC 102 where it is printed and attached to the shipment box. Wireless communication links 144, 148, and 150 are two way links allowing, for example: the robots to report any obstacles they encounter or technical failures to the RTTM 146; the picking station 108 to query RTTM 146 if an unexpected delay occurs in delivery of an item; or RTTM 146 to report to WMS 128 that the robots are carrying out their missions successfully or if any problems have been encountered.

Raizer's Robots Are Autonomous & Self-Navigating

REASONABLE EXPECTATION OF SUCCESS

POSITA was well-equipped to write software for a robot to perform the basic operations claimed in the '632 Patent.

3 Q The '632 patent claims a number of
4 software-enabled steps, right?
5 A I'm just opening up the claims here.
6 Do you have anything in particular in mind
7 you want me to look at? I mean, a lot of them are
8 not software related. So if there's any
9 software-related ones, limitations that come to
10 mind that you want me to discuss that you can
11 point me to.
12 Q Any of the driving and turning steps of
13 zero robots?
14 A Okay. Yeah, the driving and turning, you
15 could do it without programming. It just wouldn't
16 work very well. So they would be programmed to
17 get these to drive safely.

5 A There's nothing in claim 1 that would
6 require an infringer to have Opex's specific code.
7 That's all stuff that could be reproduced and
8 practiced without having Opex's source code.
9 Q And why is that?
10 A Well, there's nothing in here that is so
11 specific as could not be figured out by someone
12 reading the specification. If you read the
13 specification, it provides a fair number of
14 details about how the system works. So by the
15 time you got to these claims and you start
16 marching through here, given the teachings in the
17 specification, you're certainly going to be able
18 to generate a system that practices this method
19 that -- that has some limitations.
20 Q They can presumably write their own code
21 to drive and turn a robot, right?
22 A Yes.

Dr. Singhose's Testimony

18 BY MR. PATNAIK:
19 Q. Do you -- well, let me ask, do you
20 need the software to understand how Raizer works?
21 MR. DOUGLAS: Object to form.
22 THE WITNESS: Like do I need -- like
23 you're saying like Raizer wrote some software,
24 programmed his robots, and I need to have access to
25 understand -- to that actual software?

1 BY MR. PATNAIK:
2 Q. Yeah. To understand how the software
3 works to accomplish what Raizer is disclosing.
4 A. I think that there are -- I think
5 that there are -- a POSITA would understand --
6 would not need to read Raizer's soft -- you know,
7 source code in order to enact this patent here. I
8 think that patent is the set of instructions to --
9 to make this patent is perfectly fine.

Dr. Spenko's Testimony

REASONABLE EXPECTATION OF SUCCESS

Both '632 Patent and Raizer disclose navigation using known routing techniques and sensors.

[0103] FIGS. 5A to 5D are schematic top perspective, bottom perspective, side, and top views respectively of the robot 10 of the system of the invention. The main components of robot 10 which are shown in these figures are mounted on a frame comprised of two long beams 28 that are rigidly connected together at one end by a shorter beam 12. On top of the frame sits an array of micro-pallet lifters 32 which are used to place boxes on the shelves of the warehouse and to remove them from the shelves. The micro-pallet lifters serve to lift the boxes and as a platform on which boxes are transported to and from the shelves by the robot. Also seen in the figures is a fine positioning sensor 34 used to aid in removing and replacing boxes from the shelves. On top of beam 12 is located a battery case 20 that houses the batteries that power the robot. At the front of the robot is 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. Visible in the figures on the outside surface of command module 14 are a user interface 16 and two ports 18 for charging the batteries. Not shown in the figure are a set of on-board sensors that are located at various locations on the robot to aid the robot in navigation and to identify obstacles. The sensors are of various types, e.g. optical, RFID, magnetic and indoor triangulation system that form a virtual "bubble" around the robot as it travels. Those sensors are also servicing the safety module which allow the robot to be safe enough to operate in a human environment and interact with workers

Raizer

Exemplary position sensing systems utilize a scanning mechanism that operates in conjunction with fixed-location references strategically placed at pre-defined surveyed sites. Such scanning mechanisms may include scanning detectors with fixed active-beacon emitters, scanning emitter/detectors with passive retroreflective targets, scanning emitter/detectors with active transponder targets, and rotating emitters with fixed detector targets.

In one or more illustrative embodiments consistent with the present disclosure, the vehicles may optionally rely on a scanning laser triangulation scheme (SLTS) to provide positional updates to an onboard dead-reckoning system of the vehicle. A laser emitter rotating at, for example, two rpm illuminates passive retroreflective barcode targets affixed to walls or support columns at known locations on the order of fifteen meters away from the vehicle. The barcodes are used to positively identify the reference target and eliminate ambiguities due to false returns from other specular surfaces within the operating area. An onboard computer of each vehicle calculates X-Y positional updates through simple triangulation to null out accumulated dead-reckoning errors.

'632 Patent

REASONABLE EXPECTATION OF SUCCESS

A POSITA would know how to avoid any multipath issues.

Q And what does the knowledge of the person of ordinary skill in the art provide as part of that?

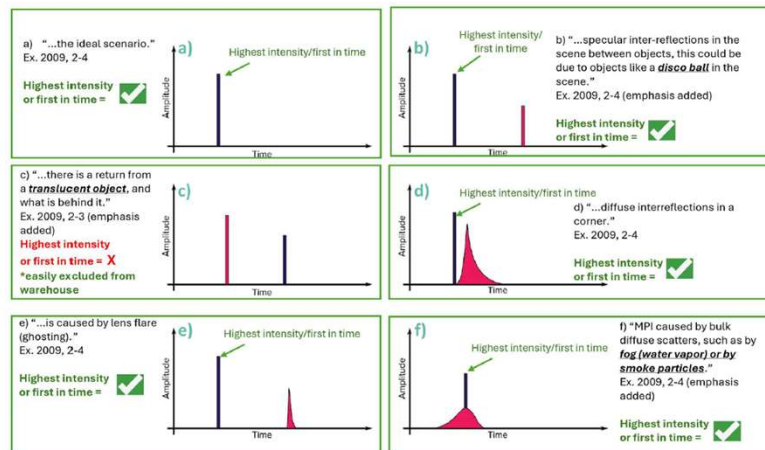
A Well, a person of ordinary skill in the art would understand multipath effects, and they would understand if they were going under the shelf, they would not rely on a sensor that could suffer from multipath effects that could cause it to stop operating.

Singhose's Testimony

REASONABLE EXPECTATION OF SUCCESS

A POSITA was well-equipped to deal with multi-path effects.

Ex. 2009, 5 (annotated)



Minimize Multipath Interference

The first method of resolving multipath interference is to setup the scene to minimize the amount of multipath interference being caused.

PO's Exhibit 2009

DEPENDENT CLAIMS

**PO does not present individual challenges with respect to the remaining
Challenged Claims.**

Claim 3	Claim 12
Claim 4	Claim 14
Claim 6	Claim 24
Claim 7	Claim 25
Claim 10	Claim 26
Claim 27	

**PO argues that the Petition has not demonstrated that claims 5, 8, and 9
are obvious.**

DEPENDENT CLAIM 5

'632 Patent, Claim [5.PRE-5.B]

The method of claim 1 wherein the first storage rack is formed of a plurality of vertical posts and

the first vehicle has a length and a width and the length is greater than the width and

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 [sic] half the length of the vehicle.***

Ex. 1005, FIG. 5D (annotated)

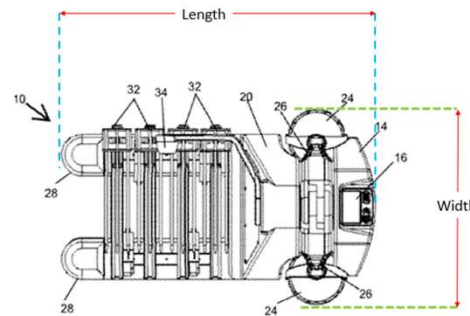


Fig. 5D

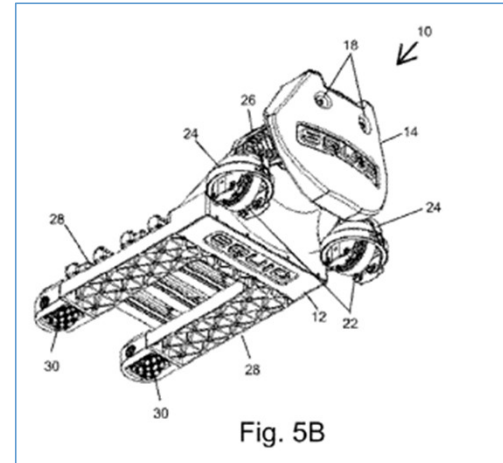


Fig. 5B

- Raizer discloses a vehicle having a length greater than the width.
- Raizer and Hangzhou render obvious driving a vehicle along a first path under the storage racks.
- Hangzhou discloses trolley travel such that the trolleys can rotate in place 90° to switch traveling directions.

See also [1.PRE-1.K]

5b (the first vehicle has a length and a width and the length is greater than the width)

PO argues that Petitioner cannot rely on Figure 5D to establish that the length of the robot is longer than the width. (Paper 16 at 56-57)

Raizer explicitly discloses that “beams 28” are “two long beams 28” “rigidly connected together at one end by a shorter beam 12.” – Ex. 1005, [0103]

[0103] FIGS. 5A to 5D are schematic top perspective, bottom perspective, side, and top views respectively of the robot 10 of the system of the invention. The main components of robot 10 which are shown in these figures are mounted on a frame comprised of two long beams 28 that are rigidly connected together at one end by a shorter beam 12. On top of the frame sits an array of micro-pallet lifters

Ex. 1005, FIG. 5D (annotated)

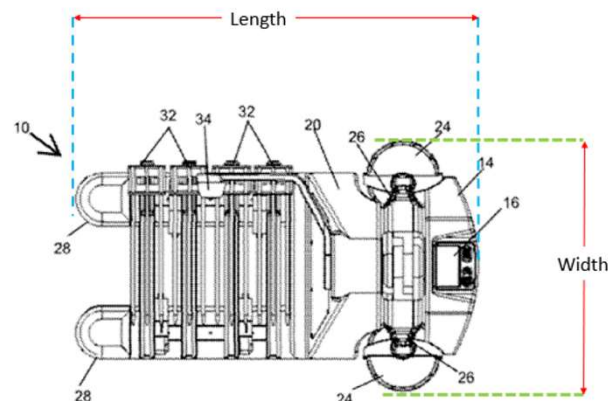


Fig. 5D

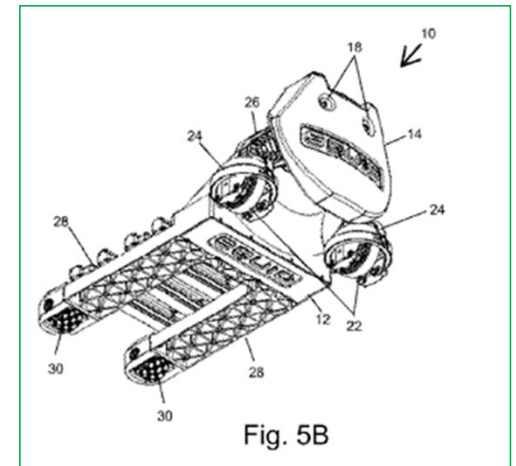


Fig. 5B

5c (...by a distance greater the [sic] half the length of the vehicle)

PO argues that Petitioner relies on Hangzhou's robots' characteristics rather than Raizer's robots.
(Paper 16 at 56-57)

The Petition is clear that Hangzhou's paths (not robots) are relied upon.

Opex's mischaracterizations regarding 5c also fail. Petitioner does not "interject[] *Hangzhou's* robots when needed," as Opex alleges. POR, 58. Claim element 5c requires "driving the vehicle *along a path spaced apart from the vertical posts by a distance greater the half the length of the vehicle.*" The Petition explains that, "[a]llowing the robots of *Raizer* to travel *along the various paths* in *Hangzhou* is additionally obvious because such a combination relies on known solutions to improve similar systems and methods in the same way." Petition, 8. Indeed, the Petition explains, "[s]hould *Raizer* be determined to not 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 POSITA would have looked to *Hangzhou*," and goes on to detail the "horizontal gap" disclosed by *Hangzhou* that makes space for the trolleys to travel. Petition, 45. That teaching at minimum renders obvious this limitation, which permits the robot to travel and turn underneath the rack as taught by *Hangzhou*.

DEPENDENT CLAIMS 8-9

'632 Patent, Claim 8

The method of claim 1 wherein the step of turning comprises rotating the first vehicle about a vertical axis that extends through the first vehicle.

'632 Patent, Claim 9

The method of claim 8 wherein the vertical axis extends through the first path.

See also [1.E]

- Raizer discloses that the vehicle rotates about a vertical axis that extends through the vehicle.

[0056] h. two drive and steering units each unit comprising one front wheel and components configured to rotate the front wheel 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, wherein 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.

- Raizer and Hangzhou render obvious a vehicle capable of traveling in a manner such that the vehicle rotates 360 degrees about a vertical axis that extends through the vehicle's body while the vehicle is under a storage rack.
- Hangzhou discloses trolley travel such that the trolleys can rotate in place 90° to switch traveling directions.

[0073] For example, an auto-guided trolley 200 is driven by the differential gear train. The equivalent diameter of the trolley 200 is less than the short side of the channel support frame 110. When the trolley 200 travels to the center of the channel support frame 110, the trolley 200 may turn in place without movement interference. The 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.

DEPENDENT CLAIMS 8-9

PO argues that Petitioner relies on Hangzhou's robots' characteristics rather than Raizer's robots.

The Petition is clear that Hangzhou's paths are relied upon.

Allowing the autonomous robots of *Raizer* to travel along the various paths described in *Hangzhou* is additionally obvious because such a combination relies on known solutions to improve similar systems and methods in the same way. Here, “when a patent ‘simply arranges old 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, the combination is obvious.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). A POSITA would have known that implementing the under-rack travel and turning routing of *Hangzhou* with *Raizer*’s autonomous robots having three-dimensional navigation and travel capabilities would have led to a predictable result of reducing congestion and preventing traffic jams as taught by both *Raizer* and *Hangzhou*. (Ex. 1003, ¶¶110, 114).

Should *Raizer* be determined to not disclose turning where the vertical axis extends through the first path, a POSITA would have looked to *Hangzhou*. (Ex. 1003, ¶293).

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,” such that 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]; Figures 1, 10¹⁰; Ex. 1003, ¶¶294-295).

A POSITA would have been motivated to combine the teachings of *Hangzhou* into those of *Raizer*. (see [1.e], [8] *supra*; Ex. 1003, ¶296; see also Motivation to Combine *supra*).

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.PRE]

A method for delivering items to storage locations and retrieving items from storage locations, comprising the steps of:

- Raizer discloses a method for delivering items to storage locations and retrieving items from storage locations (e.g., an “automatic system for picking and placing boxes on shelves in a warehouse.”).

 US 20170158430A1	
(19) United States	
(12) Patent Application Publication	(10) Pub. No.: US 2017/0158430 A1
Raizer	(43) Pub. Date: Jun. 8, 2017
(54) AUTOMATIC WAREHOUSE SYSTEM	Publication Classification
(71) Applicant: BionicHIVE Ltd, Moshav Ein Habsor (IL)	(51) Int. Cl. B65G 1/137 (2006.01) B65G 1/06 (2006.01)
(72) Inventor: Liran Raizer, Moshav Ein Habsor (IL)	(52) U.S. Cl. CPC B65G 1/137 (2013.01); B65G 1/065 (2013.01)
(73) Assignee: BionicHIVE Ltd, Moshav Ein Habsor (IL)	(57) ABSTRACT
(21) Appl. No.: 15/325,680	The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.
(22) PCT Filed: Jul. 9, 2015	
(86) PCT No.: PCT/IL2015/050714	
§ 371 (c)(1), (2) Date: Jan. 11, 2017	
Related U.S. Application Data	
(60) Provisional application No. 62/023,827, filed on Jul. 12, 2014.	

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.A1]

providing a plurality of storage racks spaced apart from one another forming a plurality of aisles,

- Raizer discloses providing a plurality of storage racks spaced apart from one another forming a plurality of aisles.

[0092] FIG. 1 schematically shows the floor plan of a typical warehouse, which has been automated by addition of the system of the invention. The warehouse is divided into three main sections: a Receiving and Dispatch Center (RDC), an Operations Area (OP), and a storage area, which can be divided into zones (for example zone Z01 is shown in FIG. 1). All bulk goods from suppliers enter and filled orders of customers leave the warehouse through the RDC. The operations area comprises at least one picking station; the number depending on the size of the warehouse and the number/size of the orders to be filled, for example three picking stations PS1, PS2, and PS3 are shown in the figure. Human workers man the picking stations and load boxes containing merchandise for the robots of the system to place on the shelves in the storage area or to receive boxes containing items required to fill customer's orders that the robots have retrieved from the storage area. In a warehouse comprising a system of the invention the RDC also may comprise at least one micro-pallet stand 110 (designated MP1 in FIG. 1). Micro-pallets, which will be described herein below, are one method that can be used to engage and carry boxes to obtain the maximum benefit from the system.

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. The vertical supports divide the shelving unit into sections called bays (B1, B2, . . .). The sides of the shelving units that face the aisles between units are called faces (F1, F2, . . .). 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. In order to be able 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. Thus 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. 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 of the invention or an indoor positioning system.

Ex. 1005, FIG. 1 (annotated)

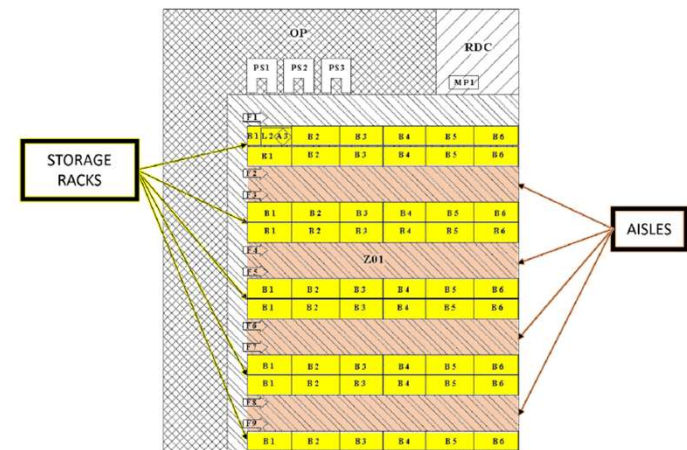


Fig. 1

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.A2]

wherein each storage rack comprises a plurality of columns and each column comprises a plurality of storage locations;

- Raizer discloses a storage racks comprising a plurality of columns comprising a plurality of storage locations.

[0092] FIG. 1 schematically shows the floor plan of a typical warehouse, which has been automated by addition of the system of the invention. The warehouse is divided into three main sections: a Receiving and Dispatch Center (RDC), an Operations Area (OP), and a storage area, which can be divided into zones (for example zone Z01 is shown in FIG. 1). All bulk goods from suppliers enter and filled orders of customers leave the warehouse through the RDC. The operations area comprises at least one picking station; the number depending on the size of the warehouse and the number/size of the orders to be filled, for example three picking stations PS1, PS2, and PS3 are shown in the figure. Human workers man the picking stations and load boxes containing merchandise for the robots of the system to place on the shelves in the storage area or to receive boxes that the robots have retrieved from the storage area. In a warehouse comprising a system of the invention the RDC also may comprise at least one micro-pallet stand 110 (designated MP1 in FIG. 1). Micro-pallets, which will be described herein below, are one method that can be used to engage and carry boxes to obtain the maximum benefit from the system. 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. The vertical supports divide the shelving unit into sections call bays (B1, B2, . . .). The sides of the shelving units that face the aisles between units are called faces (F1, F2, . . .). 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. In order to be able 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. Thus 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. 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 of the invention or an indoor positioning system.

Ex. 1005, FIG. 1 (annotated)

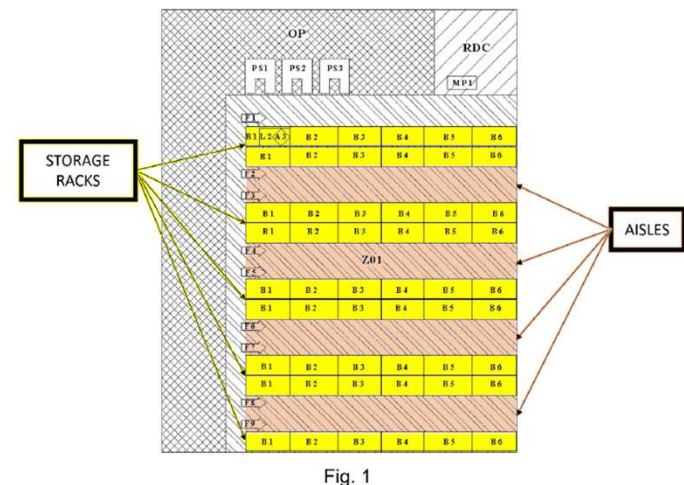


Fig. 1

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.B1]

providing a plurality of delivery vehicles

- Raizer discloses providing a plurality of delivery vehicles.

[0018] In a first aspect the invention is an automatic system for picking and placing boxes on shelves in a warehouse. The system comprises:

[0019] a. a set of autonomous mobile robots;

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.B2]

wherein each vehicle comprises a horizontal drive system operable to drive the vehicle along a horizontal surface,

- Raizer discloses a horizontal drive system comprising drive wheels 22, rear wheels 30, and drive and steering units operable to drive the vehicle along a horizontal surface.

Ex. 1005, FIG. 5A (annotated)

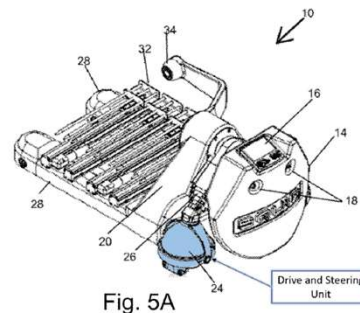


Fig. 5A

Ex. 1005, FIG. 5B (annotated)

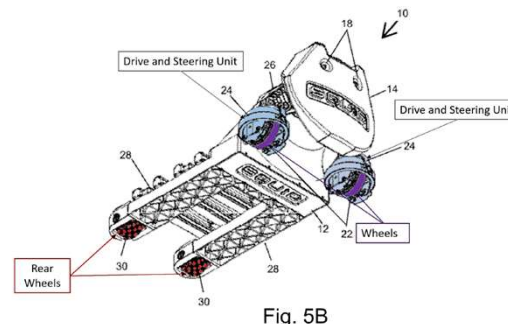


Fig. 5B

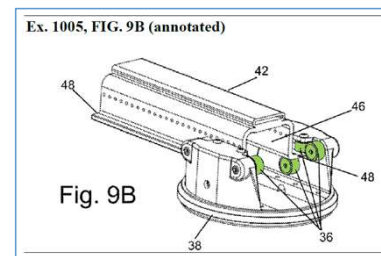
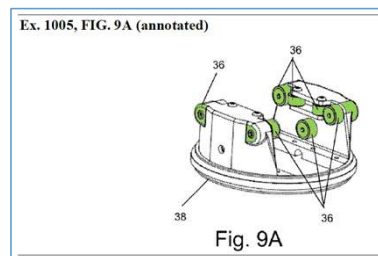
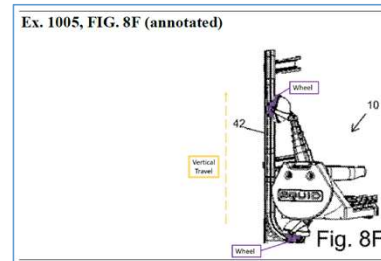
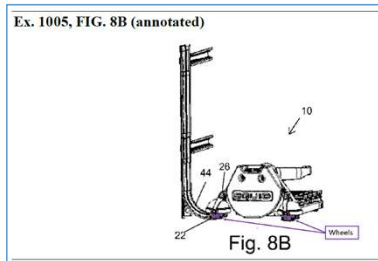
[0104] Robot 10 moves along the ground on four wheels. The two rear wheels 30 could be fixed and passive so that they can only rotate about their axles which are perpendicular to the axis of the long beams 28 of the frame and are “dragged along” by the front wheels. In another embodiment the rear wheels could be multi directional wheels which allow movement to any direction, about an axis vertical to the floor. In this later embodiment the front driving wheels 22 dictate the steering angle and differential speeds of the rear wheels. The 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. The drive and steering units 24 are attached to the robot by means of arm units 26. As will be described herein below, arm units 26 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.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.B3]

a vertical drive operable to drive the vehicle vertically and

- Raizer discloses a vertical drive system comprising drive wheels 22, small wheels 36, and drive and steering units 24 operable to drive the vehicle vertically.



[0122] FIG. 9A schematically shows a bottom view of the shell 38 of drive and steering unit 24. The 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. As can be seen on each side of the shell 38 there is a group of five small wheels 36. Each group comprises two wheels mounted with their axles parallel to the sides of the shell and three wheels mounted with the axles perpendicular to the sides of the shell. FIG. 9B schematically shows how, 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. The two wheels mounted with their axles parallel to the sides of the shell roll along the rail pressing against opposite sides of the outside of the channel 46 to prevent twisting and two of the other wheels roll along the rail pressing on flange 48 from above and the third wheel roll along the rail pressing on flange 48 from below to prevent the robot from falling off the rail.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.B4]

a transfer mechanism operable to transfer an item between the vehicle and one of the storage racks;

- Raizer discloses a transfer mechanism.

Ex. 1005, FIG. 14A

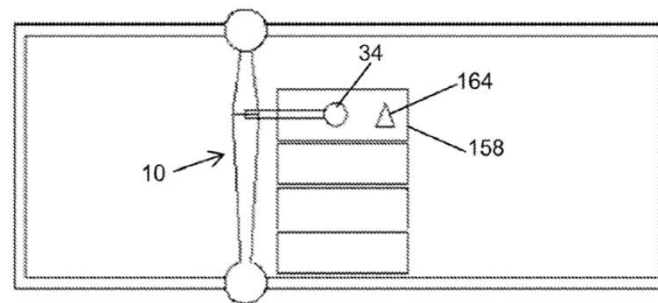


Fig. 14A

[0025] The robots of the system comprise:

[0026] a. a frame;

[0027] b. a gripper mechanism attached to the top side of the frame that is configured to pick up and place boxes;

[0133] The 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 as shown in FIGS. 13A to 13C.

[0101] In order to be able to place the cartons on the shelves or to pick them up, the robot must both grab and lift the carton. Herein the invention is illustrated by a specific embodiment of gripper mechanism; however, in principle the gripper mechanism can be any of the different types known in the art. In this embodiment the robots are equipped with mechanisms, known herein as micro-pallet lifters, which comprise sets of tines and operate in a manner similar to a fork lift. To work with the micro-pallet lifters the bottom of each carton in the warehouse must comprise a relatively thin layer of corrugated fiberboard, known herein as a micro-pallet.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.C]

driving a first one of the vehicles to drive the first vehicle to the storage racks;

- Raizer discloses a driving its vehicles to various locations, including any location on the floor of the warehouse.

(57)

ABSTRACT

The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.

[0022] The 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.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.D1]

driving the first vehicle along a first path under a first one of the racks

- Raizer discloses a plurality of storage racks and driving its vehicles to various locations, including any location on the floor of the warehouse.
- Hangzhou discloses auto-guided trolleys that travel through the lower layer of a support frame to a position below the containers.

Ex. 1006, Figure 2 (annotated)

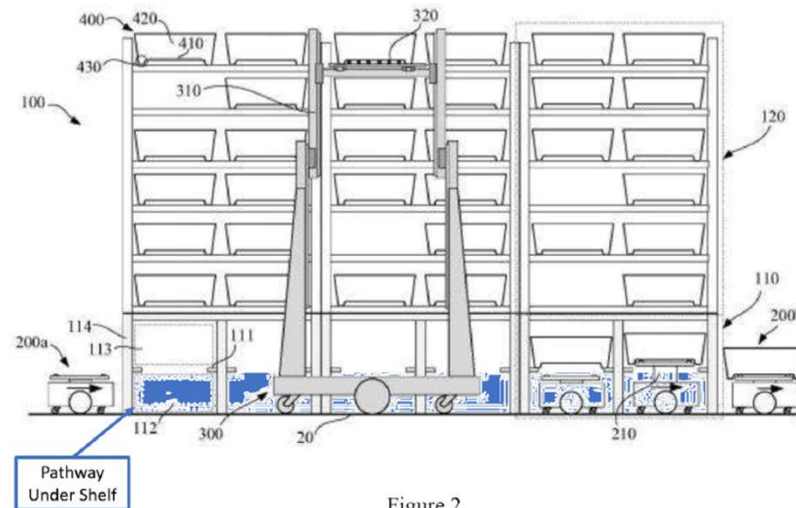


Figure 2

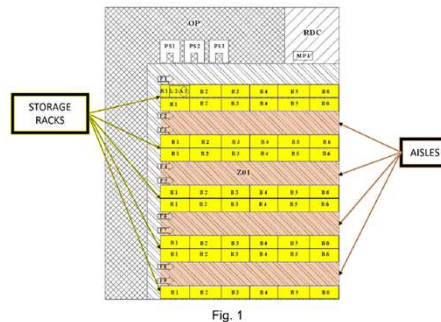
GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.D2]

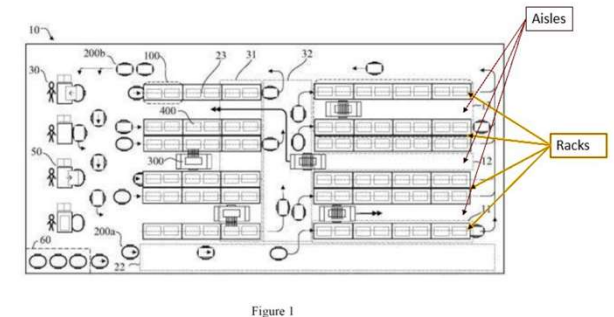
wherein the first rack is adjacent a first one of the aisles and

- Raizer discloses a plurality of storage racks spaced apart from one another forming a plurality of aisles where a row of racks is adjacent on an aisle.
- Hangzhou discloses trolley travel along a path under a rack where the path is adjacent an aisle.

Ex. 1005, FIG. 1 (annotated)



Ex. 1006, Figure 1 (annotated)



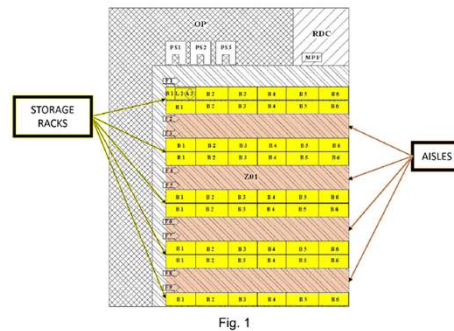
GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.D3]

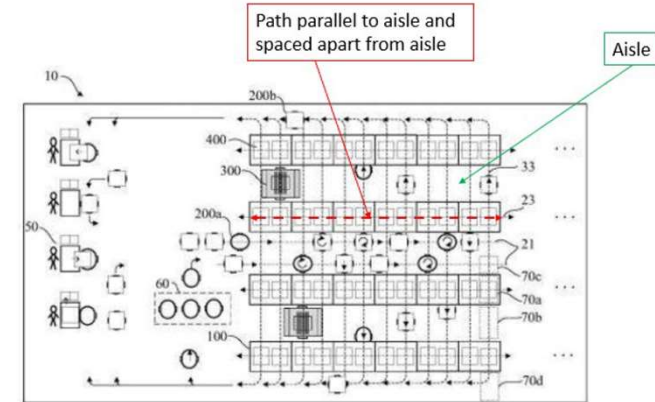
wherein the first path extends in a direction parallel to the first aisle and spaced apart from the first aisle;

- Raizer discloses a plurality of storage racks spaced apart from one another forming a plurality of aisles adjacent to the row of racks under which the robot may travel in a first path spaced apart from and parallel to a first aisle.
- Hangzhou discloses trolley travel along a path under a shelf that extends in a direction parallel to the first aisle and spaced apart from the first aisle.

Ex. 1005, FIG. 1 (annotated)



Ex. 1006, Figure 10 (annotated)

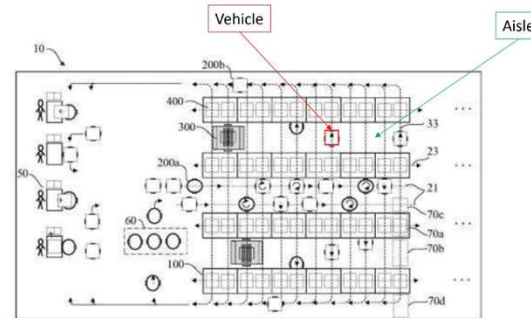


GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.E]

turning the first vehicle while the first vehicle is under the first rack;

Ex. 1006, Figure 10 (annotated)



- Raizer discloses that the vehicles can travel in any direction and to various locations.
- Hangzhou discloses driving the vehicle under the rack and that the trolley can turn to travel from under rack and across aisles.

See also [1.B1-B4], [1.C], [1.E]

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.F]

driving the vehicle into the first aisle;

- Raizer discloses that the vehicles can travel in any direction and to various locations.
- Hangzhou discloses a trolley traveling under a rack, and travel of the trolley such that it can turn to travel from under a rack and across aisles.

(57)

ABSTRACT

The invention is an automatic system for picking and placing boxes on shelves in a warehouse. 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 of the shelving system in the warehouse; and a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse. The 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.

[0022] The 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. 1006, Figure 10 (annotated)

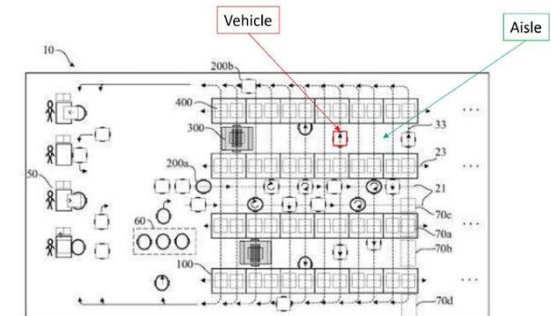


Figure 10

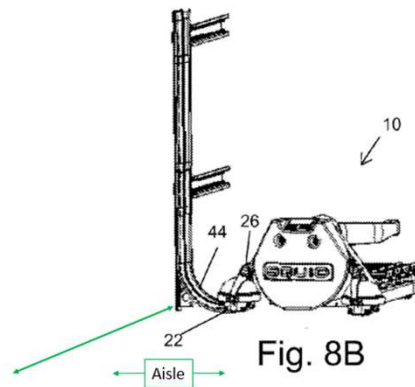
GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.G]

driving the first vehicle upwardly in the aisle to a first of the storage locations;

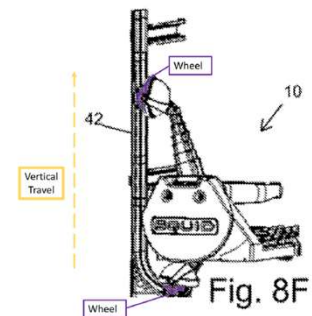
- Raizer discloses that the vehicles travel vertically to complete missions of removing a box from or delivering a box to a specific location on a shelf.

Ex. 1005, FIG. 8B (annotated)



[0114] FIGS. 8A to 8G symbolically show 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. In 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, FIG. 8F (annotated)



GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.H]

transferring an item between the first vehicle and the first storage location;

- Raizer discloses a robot positioning a box on a shelf in the storage area and discloses that robots complete missions of removing a box from or delivering a box to a specific location on a shelf.

Ex. 1005, FIG. 14A

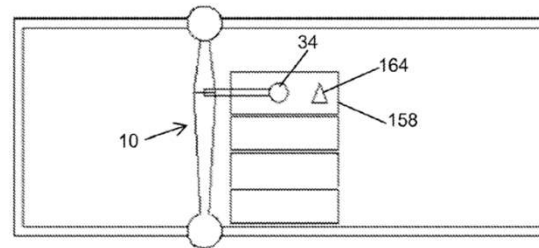


Fig. 14A

[0025] The robots of the system comprise:

[0026] a. a frame;

[0027] b. a gripper mechanism attached to the top side of the frame that is configured to pick up and place boxes;

[0133] The 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 as shown in FIGS. 13A to 13C.

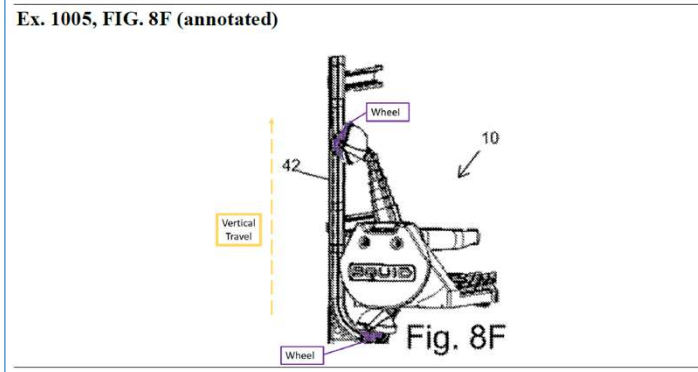
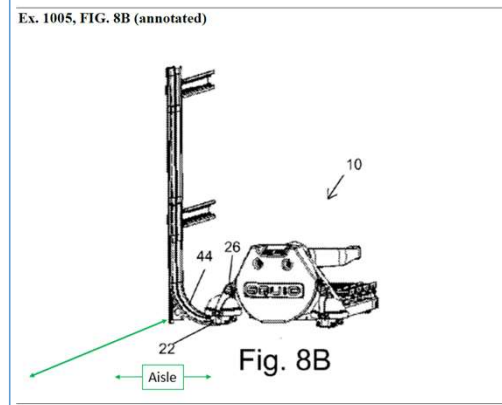
[0101] In order to be able to place the cartons on the shelves or to pick them up, the robot must both grab and lift the carton. Herein the invention is illustrated by a specific embodiment of gripper mechanism; however, in principle the gripper mechanism can be any of the different types known in the art. In this embodiment the robots are equipped with mechanisms, known herein as micro-pallet lifters, which comprise sets of tines and operate in a manner similar to a fork lift. To work with the micro-pallet lifters the bottom of each carton in the warehouse must comprise a relatively thin layer of corrugated fiberboard, known herein as a micro-pallet.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.I]

driving the first vehicle downwardly in the aisle until the vehicle is on a horizontal surface;

- Raizer discloses that the vehicles travel vertically including “down the vertical rails.”



1. An automatic system for picking and placing boxes on shelves in a warehouse, the system comprising:
 - a. a set of autonomous mobile robots, each robot comprising two front driving wheels;
 - b. a network of vertical and horizontal rails that function as or are parallel to the vertical and horizontal supports of the shelves of the shelving system in the warehouse; and
 - c. a Real Time Traffic Management (RTTM) server, which is a central processing server configured to communicate with the robots and other processors and servers in the warehouse;characterized in that:

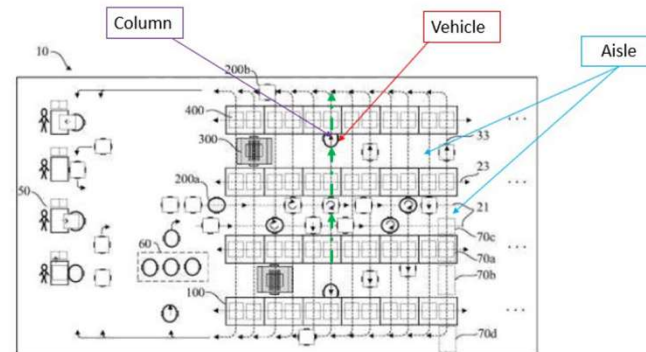
each robot comprises: components configured to engage and mechanically secure the two front driving wheels to the vertical and horizontal rails allowing the robot to travel on the network of rails; and a set of on-board sensors, a processor, software, and other electronics configured to provide the robot with three-dimensional navigation and travel capabilities that enables it 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.

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.J]

driving the first vehicle across the first aisle after the step of driving the first vehicle downwardly; and

Ex. 1006, Figure 10⁶ (annotated)



- Raizer discloses driving the vehicle downwardly.
- Hangzhou discloses trolleys traveling underneath the shelving units and across multiple aisles along the column channels.

See also [1.D1], [1.D2], [1.D3], [1.F]

GROUND 1 – RAIZER & HANGZHOU

'632 Patent, Claim [1.K]

driving the vehicle out from under the storage racks after the step of driving the first vehicle across the aisle.

Ex. 1006, Figure 10⁶ (annotated)

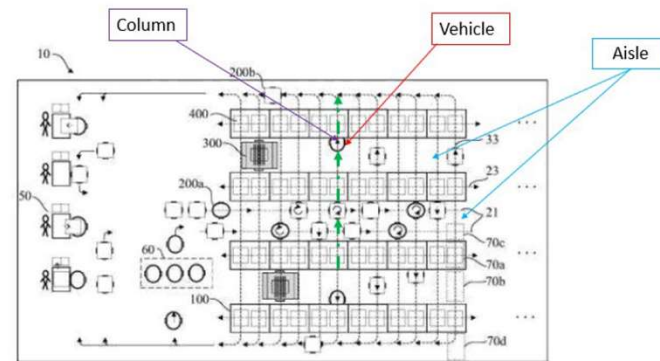


Figure 10

- Raizer and Hangzhou disclose driving the vehicle into or across an aisle, and that a vehicle could be driven out from under the storage racks after having been driven across an aisle.

See also [1.D1], [1.F], [1.J]

