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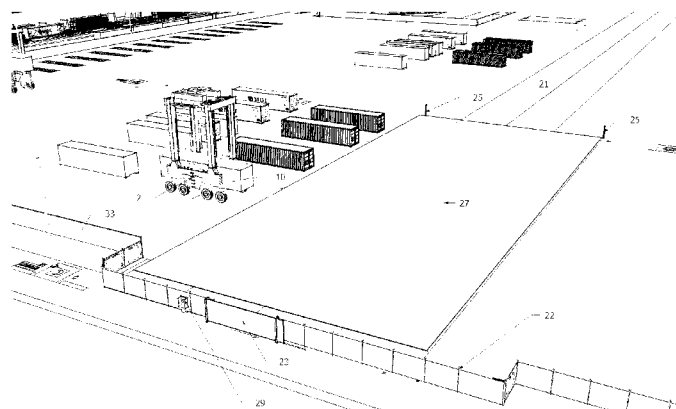


Figure 12

(57) Abstract: A method of moving product about an area, said areas having a number of defined sectors, said method including the use of a central control system for monitoring said sectors of said area and said movement of said product about said area; a first transportation means to move product into said area; a second transportation means to move product out of said area; limit means to monitor and control entry and exit of product, transportation means and personnel into and out of said area; sensor means to advise the second transportation means that said product has entered said area and is now available to exit said area; means to move said product between sectors within said area; and wherein said control system is adapted to provide visual and/or aural communication to a transportation driver related to movement of the first and/or second transportation means within the area.



## **A METHOD OF MOVING PRODUCT ABOUT AN AREA**

### **FIELD**

[0001] The present invention relates to a method of moving product about an area and in particular to a method, systems and associated equipment or apparatus to move product within a distribution facility, such as a port, intermodal distribution hub or the like.

### **BACKGROUND**

[0002] Products throughout the world must be moved from one place to another. For example, products can be moved from one side of a warehouse to another. Products can also be packaged with other products, placed in a box, container or the like and moved between geographical areas or from one warehouse to another, for example. Without the movement of products, the world economies would not function.

[0003] To make such movements work, there is a need for methods, systems and apparatus to achieve effective and efficient product movement, particularly between countries. It is most economical to have the most efficient methods, systems and apparatus to assist with reducing the cost of moving product and also the time taken to deliver products to consumers. Further, where the products are significant in size or weight, there is a safety issue for humans who may be working in or about the products as they are being moved. For example, in such areas as warehouses, port terminals, train terminals, airport terminals, bus stations, truck terminals or the like, there are vehicles or other equipment in motion that create a hazard to humans.

[0004] In a port example, products must be loaded to or unloaded from a ship or vessel and transferred to a landside transport vehicle or equipment by using for example a quay crane or ship to shore (STS) crane. This means that with horizontal container transport mechanisms and container handling equipment (CHE), products must be moved from one place to another within the geographical area of the warehouse, yard or terminal. Products must be efficiently transferred from one transport mechanism to another on site. In existing port systems, cassette automated guided vehicles (CAGV) cannot place/pick (or set) a container on/up from the ground/trailer. That is, containers are transported at ground level and cannot pass over another container. There is a need for automated straddle carriers or automatic van carriers (AVC) and automated shuttle carriers to place/pick (or set) containers on/up from the ground/trailer.

Containers are placed on the ground during exchange with the STS however containers are transported around the yard at ground or at an elevated level. When elevated they can pass over another container.

[0005] Further, with container exchange to/from a truck mechanism, products must be efficiently transferred on to and off of truck trailers for connected road transport. In existing systems, semi-automated or automated remote-controlled bridge cranes are used. There is a need for automated straddle carriers and automated shuttle carriers to be used instead.

[0006] Still further, with container exchange to/from rail wagon/car mechanisms, products must be efficiently transferred on to and off of rail wagons for connected rail transport. In existing systems, semi-automated or automated remote-controlled bridge cranes are used. There is a need for manual, semi-automated, automated, bridge cranes with optional turning head block and optional remote-control to be used.

[0007] Furthermore, where manual operation of a crane or the like exchanges product with an automated vehicle, situational awareness is required by the crane driver or operator to avoid collisions with people, plant, other vehicles or equipment while maximize productivity and efficiency.

[0008] Attempts have been made to try to automate product movements. However, these systems typically rely on too much variability in operations. More predictability in operations creates efficiency.

[0009] Accordingly, there is a need for a system to make the processes automated, reducing variability due to skill levels, care factors, planning and the like whilst improving safety, maintainability and cost and energy efficiency. There is also a need for a better method and systems for moving product about an area, storing product in an area, loading and off loading product from a ship or vessel, truck, train or the like. The better method should be flexibly configurable to best utilise the available space and shape of different areas and where possible automated.

## OBJECT OF THE INVENTION

[0010] It is an object of the present invention to substantially overcome or at least ameliorate one or more of the disadvantages of the prior art, or to at least provide a useful alternative.

## SUMMARY OF INVENTION

[0011] There is disclosed herein a method of moving product about an area, said areas having a number of defined sectors, said method including the use of a central control system for monitoring said sectors of said area and said movement of said product about said area;

- a first transportation means to move product into said area;
- a second transportation means to move product out of said area;
- limit means to monitor and control entry and exit of product, transportation means and personnel into and out of said area;
- sensor means to advise the second transportation means that said product has entered said area and is now available to exit said area;
- means to move said product between sectors within said area; and
- wherein said control system is adapted to provide visual and/or aural communication to a transportation driver related to movement of the first and/or second transportation means within the area.

[0012] Preferably, said central control system monitors said sectors to control entry, exit and storage of product, transportation means and personnel into and out of said sectors by way of said limit means.

[0013] Preferably, the first transportation means is the same as the second transportation means.

[0014] Preferably, the first transportation means is not equal to the second transportation means.

[0015] Preferably, the first transportation means moves product between sectors.

[0016] Preferably, said second transportation means moves product between sectors.

[0017] Preferably, including a third transportation means adapted to store product in said area in a high density arrangement if required.

[0018] Preferably, said limit means includes light beams, physical barriers, gates or the like.

[0019] Preferably, said limit means includes one or more locks having a key to provide access.

[0020] Preferably, only a single key is available for use by personnel at one time.

[0021] Preferably, said control system includes character recognition means to identify said product moving into and out of said area and/or around sectors to determine product identification.

[0022] Preferably, said control system includes exchange optimization and intelligent coordination of products, transportation means and personnel throughout said area in real time to generate and execute solutions to create the most efficient movement of product into and out of said area.

[0023] Preferably, said intelligent coordination includes scheduling means to determine when a particular product will be available for pick up at a particular location.

[0024] Preferably, said control system allocates a location for said transportation means to either offload or load product.

[0025] Preferably, said control system is adapted to operate with minimal human intervention.

[0026] Preferably, said transportation means includes a vehicle, wherein said worker driven vehicles are physically separated from automated vehicles.

[0027] Preferably, said transportation means includes container handling equipment, said container handling equipment includes means to establish and communicate their position within said area.

- [0028] Preferably, said transportation means includes an automated vehicle.
- [0029] Preferably, said transportation means includes a truck.
- [0030] Preferably, said transportation means includes a ship.
- [0031] Preferably, said transportation means includes a train.
- [0032] Preferably, said transportation means includes a straddle or shuttle carrier adapted to load or off load a container and to transport containers at ground or an elevated level, said containers when elevated passing over each other.
- [0033] Preferably, said transportation means includes a stacker.
- [0034] Preferably, said transportation means includes a horizontal transport vehicle.
- [0035] Preferably, said transportation means are at least partly automated.
- [0036] Preferably, said limit means includes selecting an area to be segregated; placing a barrier about said area; said barrier having an entry gate and an exit gate; and said gates adapted to be controlled by the control means to only permit one gate to be opened at one time and only either active vehicles or people to be located within said area at one time

#### **BRIEF DESCRIPTION OF DRAWINGS**

- [0037] A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:
- [0038] Figure 1 shows a plan view of a reefer yard;
- [0039] Figure 2 shows a plan view of a yard segregation;
- [0040] Figure 3 shows a plan view of a truck grid;
- [0041] Figure 4 shows a plan view of a launch pad;

- [0042] Figure 5 shows another view of a yard segregation;
- [0043] Figure 6 shows another view of a launch pad area;
- [0044] Figure 7 shows a view of a gantry exchange area;
- [0045] Figure 8 shows a view of a lane model;
- [0046] Figure 9 shows a view of a rail exchange area;
- [0047] Figure 10 shows another view of a reefer area;
- [0048] Figure 11 shows another view of a truck grid area;
- [0049] Figure 12 shows another view of a yard segregation; and
- [0050] Figure 13 shows control system architecture of an embodiment of the present invention.

## **DESCRIPTION OF EMBODIMENTS**

[0051] There is schematically depicted herein a method, systems and apparatus for moving product about an area having a number of defined sectors such as a port terminal or the like. The sectors can be any shape or size depending upon the area within which loading and unloading of product is to occur. The method in a preferred embodiment includes the use of a central control system for monitoring sectors of the area. An example of a control system architecture is shown at Figure 13.

[0052] In a preferred embodiment, a first transportation means moves product into the area and a second transportation means moves product out of the area. Limit means monitors and controls entry and exit of product, transportation means and personnel into and out of the area. Sensor means advise the second transportation means, for example, that product has entered the area and is now available to be picked up for exiting the area.

[0053] The central control system (as seen in Figure 13) conducts the monitoring by the technologies set out above and below and can be fully automated. It is however preferable that

there is some human supervision preferably from a location overseeing the area and sectors. For example, the movements can be watched and controlled by key personnel on screens in an office, on a mobile device, from a tower overlooking the area or any other location.

[0054] In a preferred embodiment, the first transportation means is the same as the second transportation means and would be an automated vehicle 2. There may however be many similar or different transportation means monitored by the central control system and operating in and out of the areas to provide the most efficient movement combinations removing as much variability as possible.

[0055] In a preferred embodiment and as discussed further later, the limit means includes a combination of light beams 25, physical barriers 22, gates 23 or the like. The limit means may also include one or more locks or the like having only a single key to provide access. That single key can be controlled by a single person. The key could be a physical key or a magnetic card, RFID, passcode or any similar “key” type device, located for example at a lock entry device 29.

[0056] The control system could further include character recognition systems and apparatus to identify product and its attributes moving into and out of the area and about the sectors. The control system could also include intelligent coordination of products, transportation means and personnel throughout sectors in real time. This would include scheduling means to determine when a particular product will be available at a particular location allowing it to be picked up by a particular transportation means providing significant efficiencies in time and space management as products are rarely left to rest in one location for very long. That is, the control system includes predictive intelligence. In a preferred form, the transportation means includes an automated vehicle 2. However, the transportation means could include anything that moves product 10. For example, a vehicle, a trolley, a truck, a ship, a train, a bus, a forklift, a crane, a stacker, a straddle, a bogey, a conveyor, a roller or any other form of container or product handling equipment or the like.

[0057] In a preferred form, the control system allocates a location for the transportation means to either offload or load said product. The transportation means can be located within a sector which is also secured and prevents entry and exit without approval from the control system or could be free to move outside the area only. The control system allows safe

interaction with transportation means within each sector of an area. The control system could operate automatically and continuously or include human intervention from personnel in a tower overlooking the area, by personnel carrying a Personal Digital Assistants (PDA) as discussed later or the like.

[0058] One embodiment of the limit means, includes the counting of people through turnstiles 4 or the like and not opening gates 5 or other such barriers to the transportation means (such as with automated vehicles 2) unless there are no people in that sector. The integration of certified safety rated limiting devices on the turnstile or gate itself, would be provided to add to the enhanced safety of the system.

[0059] As best seen in Figures 1 and 10, when moving product 10 such as refrigerated containers (Reefers) they must be located in a designated "Reefer" area 15 that must have power supplies 16 to keep the containers 10 refrigerated. Frequent personnel entry is needed to plug-in, plug-out power and check the temperatures of the reefers 10. Automated vehicles 2 also need access to the area 15 to deliver and drop-off reefers. The concept of counting people through turnstiles 4 (in and out) and not opening the gates 5 to automated vehicles 2 or the like unless there are no people in the area (in the case of reefers) provides significant efficiency and safety advantages over existing techniques. Certified safety rated limits are integrated into the turnstiles 4 to monitor operations, then PLCs (Programmable Logic Control) allow automated vehicles 2 entry to the sector 15 only when there is no-one in the reefer sector 15. This approach maximizes access to the automated vehicles 2 (thus optimizing terminal performance) whilst managing safe access for the reefer personnel. The area 15 can also be surrounded by a barrier such as a fence 22, light beams (not shown) or the like.

[0060] Another embodiment, as best seen in Figure 2, 5 and 12 includes segregating a yard which includes the zoned break-up of the yard 20 or area into sectors 21. Zones 27 are uniquely selected by the control system, and provided with unique "keys" at a localised station 29 at or in the vicinity of the sector. This provides the adjacent and conjoined zones operational functionality. A light beam arrangement or the like provides a level of hazard control such as a fence 22, gate 23 or certified safety light curtain 25 separating each zone 27 or sector. This creates efficiencies as more than one sector can be safely utilised simultaneously whilst automated operations continue elsewhere in the yard.

[0061] In the container terminal example above, there is a need for personnel and transportation to enter specific portions of the yard whilst automated vehicles 2 continue to operate in other parts of the yard. The above yard segregation functionality facilitates safe operation. This can be achieved by breaking-up the yard (area) into specific zones (sectors); selecting the zones that will be accessed at the Local Control Stations (LCS) 29 adjacent to yard access gates 23 using a unique key system; selecting, and releasing, adjacent and conjoined zones as required; controlling the release of gates 23, 25 in a manner that ensures that automated vehicles 2 or the like will have stopped before permitting entry. Gates 23 with safety limits or certified safety light curtains (safety beams) created by sensors 25 or the like and provide a level of hazard control which, if breached, trigger the PLC to stop the automated vehicles 2. The yard control system PLC communicates with the equipment control system to redefine the entry rights for each sector 27 of the yard to automated vehicles 2 as shown in Figure 13.

[0062] After stopping all vehicles, a controlled restart by the control system then expands the segregated zones to re-establish a safety boundary thus allowing the automated vehicles outside of the safety zone to quickly return to operation minimising disruption.

[0063] Another embodiment, as best seen in Figures 3 and 11, an “Airlock” gate 30 system is shown whereby only one side of a gate system is opened at one time. For example, a truck 31 side of an automated vehicle system. The integration of a security card system (such as MSIC (Maritime Security Identification Card) or the like) to automatically identify which truck 31 is in each grid 32 would also be incorporated and provide further safety and security.

[0064] A truck grid 32 is a designated location at which a truck 31 stops and a vehicle (manual or automated) 2 then places or off loads a container 10 on the trailer of the truck or the like. In the “Airlock” gate system, the truck grid 32 is fenced 33 off and only the truck side 35 or yard side gates 34 are open, never both. The integration of the MSIC card or similar identification card swipe at a control point 36 automatically identifies which truck is in each grid and then the system instructs the automated vehicle accordingly. Certified safety rated limits are integrated into the truck grid to monitor operations, then the PLC controls the gates 34, 35 and restricts automated vehicle entry to when there is no-one inside. The truck grids are designed so that they can also function as automated vehicle charging bays and as yard

segregation entry points. The grids could also be used for trains or any other vehicles or the like.

[0065] The “Airlock” gate system (See Figure 11) also transitions the automated vehicles 2 from maintenance into the yard whereby only the maintenance side or automated vehicle side gates are open, never both. The unique key system also provides access to maintenance personnel.

[0066] This is best seen in Figures 4 and 6. A “Launch Pad” 40 is a designated location from which an automated vehicle 2 can be “launched” in/out of the yard 42 to/from the maintenance area 41. For an automated vehicle terminal an “Airlock” gate system (as described above) can be used as a launch pad which is fenced 44 off and only the maintenance side 45 or yard side 46 gates are open, never both. The integration of a unique key, an MSIC card swipe or the like at a control station 47 automatically restricts access to designated technical specialists. Certified safety rated limits can be integrated into the truck grid to monitor its operation, then a PLC controls the gates and restricts automated vehicle entry when there is no-one inside. The launch pads can also function as automated vehicle charging bays, refuelling bays and as yard segregations entry points. A tandem launch pad could also be used that permits one automated vehicle to tow another out of the yard.

[0067] The safety beam and yard gate “Airlock” system as discussed above typically includes a unique key system to ensure the safety of those using the area and the efficient handling of product.

[0068] A manual exchange area or similarly, a rail exchange area (see Figure 9), a gantry exchange (see Figure 7) or a STS exchange (see Figure 8) is a designated location from which an automated vehicle 2 and a fork lift or reach stacker or gantry crane 9, or rail crane 50, spreader 53, STS crane 60 (or any other form of manual container or product handling equipment) can pick or place containers 10 or products in a known location. For the “Airlock” gate system, the exchange area 51 is fenced 52 off and only the reach stacker (or any other form of manual container or product handling equipment) side or yard side is open, never both. The integration of unique key systems controls whether reach stackers (or any other form of manual container or product handling equipment) or automated vehicles have access to the area. Certified safety rated limits have been integrated into the exchange area to monitor its

status, then the PLC controls the gates and restricts entry. As reach stackers are large, the system uses safety beams, fences, gates or the like to segregate the area which is only accessible to trained personnel.

[0069] Another embodiment includes an exchange area 51 whereby only one unit of product or container 10 and one transport means 2 may enter the exchange area at one time. In the exchange, the containers or the like, are typically either placed on the ground, or on top of another container, by one transport means and from there picked up by another transport means as shown for example in Figure 9.

[0070] For each exchange area, as discussed above, typically the system governs ownership of the exchange area and the corresponding rights of access. For example, an exchange area between a crane 50 and horizontal transport means 2, only one transport device can have ownership of the area 51 at one time.

[0071] That is, the crane exchange area or similar is a designated location in which an automated vehicle and a crane (Ship to Shore, Gantry Stacking Crane, or Rail Crane 50) (or any other form of manual container or product handling equipment) can pick or place containers 10 or products in a number of known locations. For the exchange area 51 only the automated vehicle or the crane can enter each exchange area, never both. The location of the crane and position of its hoisting apparatus 53 is known to the crane PLC to allow safe interaction with said automated vehicle. The crane PLC and control system communicate by a defined message set containing all required data such that the control system governs ownership of each exchange area and the corresponding rights of access and applies interlock controls to the crane and straddles/shuttles to prevent collision. The crane may also be remotely controlled and/or may be manually driven, automated or semi-automated. The control system calculates a predicted path of the spreader 53 (for example) and of the automated vehicle 2 to anticipate entry to each exchange area and allocate ownership accordingly thus avoiding collisions.

[0072] Where the crane is manually controlled, the control system provides visual and aural communication to the crane driver or the like related to automated vehicle activities in the exchange areas. The control system generates solutions and executes rules related to productivity and efficiency to guide the crane driver or the like.

[0073] As seen in Figure 8, the STS or quay crane 60 automated landside area 61 is a designated area where containers 10 or product can be exchanged with an automated vehicle 2. The STS crane is typically used to load or off load product or containers on to or off of a ship or vessel that is moored along side the quay (or wharf) 62 and to or from the STS crane automated landside area. The exchange area system described above is typically used to exchange product between the STS crane and an automated vehicle in the STS crane automated landside area.

[0074] As seen in Figure 9, the rail crane automated landside area 51 is a designated area where containers 10 or product can be exchanged with an automated vehicle 2. The rail crane 50 is typically a gantry crane or similar and is used to load or off load product or containers onto or off of rail wagons 54 in sidings under the rail crane gantry and beside the rail crane to or from the automated landside area. The rail crane may optionally include a turning head block to reorientate the container between the exchange areas and the rail wagon. The rail crane may also be remotely controlled and/or may be manually driven, automated or semi-automated.

[0075] For the exchange area, only the automated vehicle or the rail crane can enter each exchange area, never both. The location of the crane and position of its hoisting apparatus must be known to the rail crane PLC to allow safe interaction with an automated vehicle. The rail crane PLC and control system communicate by a defined message set containing all required data such that control system governs ownership of each exchange area and corresponding rights of access and applies interlock controls to the rail crane and straddles/shuttles to prevent collision.

[0076] The high density storage area as shown in Figure 7 typically includes a gantry crane 9 (rail mounted (automated) stacking crane or (automated) rubber tyred gantry) within the automated yard to stack product in a high density fashion. The gantry crane stack is a designated area where containers or product can be stacked on top of each other in blocks several high, wide and long. The gantry crane is typically a crane or similar and is used to load or off load product or containers into or from the high density storage area and to or from the gantry crane exchange area typically beside or at the end of the high density storage area. The gantry crane may optionally include a turning head block to reorientate the container between the exchange area and the storage area.

[0077] The exchange area described above is typically used to exchange product between the gantry crane 9 and an automated vehicle 2. In high density storage areas (up to 6 high), serviced by gantry cranes, and in low density storage areas (up to 3 high), services by shuttle or straddle carriers, the product or containers 10 are typically stored on the ground.

[0078] Yet further, the present invention at least in a preferred embodiment, includes a crane tracking and monitoring system that facilitates the crane - automated vehicle interaction. The crane automation PLC interfaces to the control system for the control of the automated vehicles to compare the automated vehicle's position with that of a crane and crane spreader in order to establish ownership of the shared exchange areas. The crane automation PLC signals a crane driver or the like through a crane driver display of the ownership status, thus optimizing crane efficiencies and maintaining safety. The crane driver display also signals a crane driver or the like when to discharge/pick-up containers 10. The crane control system includes means to autonomously control movement of the crane spreader 53 and the picking and placing of containers within the automated compound, based on the ownership status of each exchange area and the sequence of exchangers. The control system monitors the crane spreader movement to predict entry to each exchange area.

[0079] The control system of the present invention, at least in a preferred embodiment, further includes yard control interfacing where a PLC connects to the automated vehicle control system using a defined interface. Permissions, requests and rules about how this interface operates and the message set within the interface provide uniqueness. Although today the PLC only connects to a specific computer control system for the control of automated vehicles of a particular brand, the defined interface can interact with a generic automated machine and machine management system and thus applies to alternative automated terminal solutions. The interface of the present invention ensures that the workers are safe by informing the automated vehicle control system of the exclusion sectors. The computer control system can also deactivate an automated vehicle within the exclusion sectors and contains functionality to ensure that automated vehicles can only move about autonomously in zones designated by the computer control system as automated operation zones.

[0080] Another embodiment of the present invention provides that lighting levels about the yard can be reduced or switched off as the automated machines do not need light, thus saving energy and costs.

[0081] The control systems of the present invention, at least in a preferred embodiment, can also include PDAs or tablet computers to improve the efficiency of ship to shore data capture in the example of a container terminal. For example, the crane crew could have a PDA to capture container details as discharged by the STS crane and transmit data to the control systems. For automated vehicle terminals, where there is no driver that can verify a container ID, a vessel discharge PDA allows the crane team to enter the container numbers as the cranes pick them up from the ship and transmit this data to the control system. This improves the efficiency of ship to shore data capture and consequently ship to automated vehicle interfacing, thus optimizing terminal operations. The PDA, tablet computer or even a mobile phone application could operate the control system.

[0082] The present invention yet further includes unidentified container identification systems which improves the efficiency of ship to shore exception handling. Integration of automated vehicle control system and CCTV solutions to efficiently identify and resolve exceptions during vessel discharge are also used.

[0083] For automated vehicle terminals, if the vessel PDA fails to capture the container ID, the unidentified container identification system utilizes the existing assets of the terminal CCTV system to quickly capture the container ID without delaying ongoing crane operations. The integrated CCTV system linked to the automated vehicle control system allows images of the unidentified container to quickly capture and prompt personnel to confirm the data. This minimized human interaction relieves the need to install expensive crane OCR systems or have personnel chase after product in a hazardous environment.

[0084] Further, efficiencies can be found by adding CCTV located away from the terminal to advise the control system when a truck and container, for example, is approaching. This will add to the predictive intelligence of the control system.

[0085] The control system of the present invention at least in a preferred embodiment further includes an interface from the automated vehicle control system to the terminal operating system (TOS) to automatically communicate the work instructions to the automated vehicles.

[0086] Yet further, the present invention at least in a preferred embodiment provides training materials and processes which are critical to the safe and efficient operations of an area

to move product. These include training course materials; operating plans; process diagrams; standard operating procedures and forms; solutions architecture; drawings; test plans and requirements documents.

[0087] Still further, with horizontal container transport mechanism container handling equipment (CHE), products must be moved from one place to another within the geographical area of the warehouse, yard or terminal. Products must also be efficiently transferred from one transport mechanism to another. In existing systems cassette automated guided vehicles (CAGV) cannot place /pick (or set) a container on/up from ground/trailer. Containers are transported at ground level and cannot pass over another container. There is a need to utilise automated straddle carriers or automatic van carriers (AVC) and automated shuttle carriers which can place/pick (or set) a container on/up from the ground/trailer. Containers are placed on ground during exchange with STS. Containers are transported at ground or at an elevated level. When elevated they can pass over another container.

[0088] Further, products must be efficiently transferred on to and off of truck trailers for connected road transport or on to and off rail wagons for connected rail transport. Existing systems use semi-automated or automated remote-controlled bridge cranes. There is a need to use automated straddle carriers and automated shuttle carriers and manual, semi-automated, automated bridge cranes with optional turning head block optional and remote-control.

[0089] In existing systems rail mounted automatic stacking cranes (ASC) interact with CAGVs at both ends of the stack. In an embodiment of the present invention automated straddle carriers, rail mounted automatic stacking cranes which interact with automated straddle/shuttle carriers at both ends of the stack are used. Rubber tyred gantries (manual or automated) which interact with automated straddle/shuttle carriers underneath the span are also used.

[0090] The orientation of storage stack blocks must be flexible to best utilise the available space in different facilities. In existing systems, the storage stack blocks can be orientated perpendicular or parallel to the quay. In an embodiment of the present invention the storage stack blocks can be orientated at any angle as best suits the land envelope of the terminal.

[0091] Products must be temporarily located during transfer from one transport mechanism to another. In existing systems containers are held on container cassette platforms until they

are moved. Containers are temporarily stored 1 high only. In an embodiment of the present invention, containers are stored on the ground or temporarily stored up to 3 high.

[0092] Workers need to enter the robot zone (ROZ) using a safe mechanism yet minimise the impact on operations. In existing systems containerised worker platforms (CWP) on CAGV are located within the ROZ. In an embodiment of the present invention, worker driven vehicles are physically separated from automated vehicles by the temporary reconfiguration of the ROZ perimeter.

[0093] Quay crane positional information is important. The location of quay cranes and the position of their hoisting apparatus must be known to allow interaction with straddle/shuttle vehicles. In one embodiment of the present invention, quay cranes and their hoisting apparatus are equipped to establish position. Quay cranes and ECS must exchange information to allow interaction. Quay cranes and ECS communicate by a defined message set containing all required data. Quay crane spreaders and straddle/shuttle carriers must avoid collision. The system governs ownership of exchange areas and corresponding rights of access to that area. The system also applies interlock controls to quay crane and straddles/shuttles to prevent collision.

[0094] Manual operation of a quay crane when exchanging with an automated system requires situational awareness. The control system of at least a preferred embodiment of the invention provides visual and aural communication to the crane driver related to straddle/shuttle activities in the exchange area. The movement of quay cranes and robotic vehicles must be coordinated to avoid wasting resources and to maximise productivity. The control system described above generates solutions and executes rules related to productivity and efficiency.

[0095] Where the products are significant in size or weight, there is a safety issue for humans who may be in or about the products as they are being moved. Vehicles or other automated equipment in motion creates a hazard to humans (i.e. truck drivers) and must be kept separate. In existing systems a trucker waits in a trucker safety zone beside the trucker pedestal. In the preferred embodiment safety segregated “airlock” fences and gates separate the truck and driver from the automated vehicle.

[0096] Further, in existing systems, workers are transported to a reefer platform in specialised CWP on CAGV within the ROZ or allowed direct access to the ROZ. In the preferred embodiment reefers are segregated from the ROZ by safety rated gates so that workers can access the reefers.

[0097] Workers also need to move under the legs of quay cranes to access the cranes and attend to the product. In existing systems workers are located within the ROZ. In a preferred embodiment, workers are located outside of the ROZ.

[0098] When an automated vehicle breaks down there is a need to move it from the robotic operating zone to the maintenance shed in a safe manner with minimum operational disruption. Safety segregated "airlock" fences and gates separates maintenance staff from the automated vehicle. Double length segregated "airlock" facilitates the towing of one automated vehicle by another safely.

[0099] Workers also need to enter the ROZ using a safe mechanism yet minimise the impact on operations. In a preferred embodiment a safety rated yard segregation mechanism separates workers and plant from automated vehicles. The yard segregation system informs ECS of the excluded zone.

[00100] Shipping containers need to have twist locks (cones, inter-box connector (IBC)) inserted/removed before being loaded/unloaded from the above deck storage of a container ship. If within the ROZ, workers are typically transported to an area in a specialised CWP on CAGV from which they access the twist locks. In the present invention, workers handle twist locks outside of the ROZ.

[00101] Product needs to be safely and efficiently exchanged between a manual operating zone and a robotic operating zone in large batches. In the present invention, manual exchange areas are segregated from the ROZ by safety rated gates so that workers can drop-off/collect containers using manual CHE (container handling equipment) in a controlled manner.

[00102] The unique number of each container and its physical attributes must be identified when it is discharged from a ship so that it is efficiently moved to the correct location. In the present invention a vessel discharge PDA and/or CCTV as a back-up identification mechanism are used.

[00103] The unique number of each container and its physical attributes is identified when it is delivered and collected by a truck using OCR. Similarly operations within the ROZ are supervised remotely so as to identify and resolve any difficulties using CCTV.

[00104] Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms. For example, the present invention is not limited to container terminals and can be utilised in any area where products need to be moved.

## CLAIMS

1. A method of moving product about an area, said areas having a number of defined sectors, said method including the use of a central control system for monitoring said sectors of said area and said movement of said product about said area;
  - a first transportation means to move product into said area;
  - a second transportation means to move product out of said area;
  - limit means to monitor and control entry and exit of product, transportation means and personnel into and out of said area;
  - sensor means to advise the second transportation means that said product has entered said area and is now available to exit said area;
  - means to move said product between sectors within said area; and
  - wherein said control system is adapted to provide visual and/or aural communication to a transportation driver related to movement of the first and/or second transportation means within the area.
2. The method of claim 1, wherein said central control system monitors said sectors to control entry, exit and storage of product, transportation means and personnel into and out of said sectors by way of said limit means.
3. The method of claim 1, wherein the first transportation means is the same as the second transportation means.
4. The method of claim 1, wherein the first transportation means is not equal to the second transportation means.
5. The method of claim 1, wherein the first transportation means moves product between sectors.
6. The method of claim 1, wherein said second transportation means moves product between sectors.
7. The method of claim 1, further includes a third transportation means adapted to move and store product in said area in a high density arrangement.

8. The method of claim 1, wherein said limit means includes light beams, physical barriers, gates or the like.
9. The method of claim 1, wherein said limit means includes one or more locks having a key to provide access.
10. The method of claim 9, wherein only a single key is available for use by personnel at one time.
11. The method of claim 1, wherein said control system includes character recognition means to identify said product moving into and out of said area and/or around sectors to determine product identification.
12. The method of claim 1, wherein said control system includes exchange optimization and intelligent coordination of products, transportation means and personnel throughout said area in real time to generate and execute solutions to create the most efficient movement of product into and out of said area.
13. The method of claim 12, wherein said intelligent coordination includes scheduling means to determine when a particular product will be available for pick up at a particular location.
14. The method of claim 1, wherein said control system allocates a location for said transportation means to either offload or load product.
15. The method of claim 1, wherein said control system is adapted to operate with minimal human intervention.
16. The method of claim 1, wherein said transportation means includes a vehicle, wherein said worker driven vehicles are physically separated from automated vehicles.
17. The method of claim 1, wherein said transportation means includes container handling equipment, said container handling equipment includes means to establish and communicate position within said area.
18. The method of claim 1, wherein said transportation means includes an automated vehicle.

19. The method of claim 1, wherein said transportation means includes a straddle or shuttle carrier adapted to typically transport containers at ground or an elevated level, said containers passing over each other.
20. The method of claim 1, wherein said transportation means includes a stacker.
21. The method of claim 1, wherein said transportation means includes a horizontal transport vehicle.
22. The method of claim 1, wherein said transportation means are at least partly automated.
23. The method of claim 1, wherein said limit means includes selecting an area to be segregated;
  - placing a barrier about said area;
  - said barrier having an entry gate and an exit gate; and
  - said gates adapted to be controlled by the control means to only permit one gate to be opened at one time and only either active transportation means or people to be located within said area at one time.
24. The method of claim 1, wherein the control system includes means to deactivate transportation means that moves into an area without authorisation.

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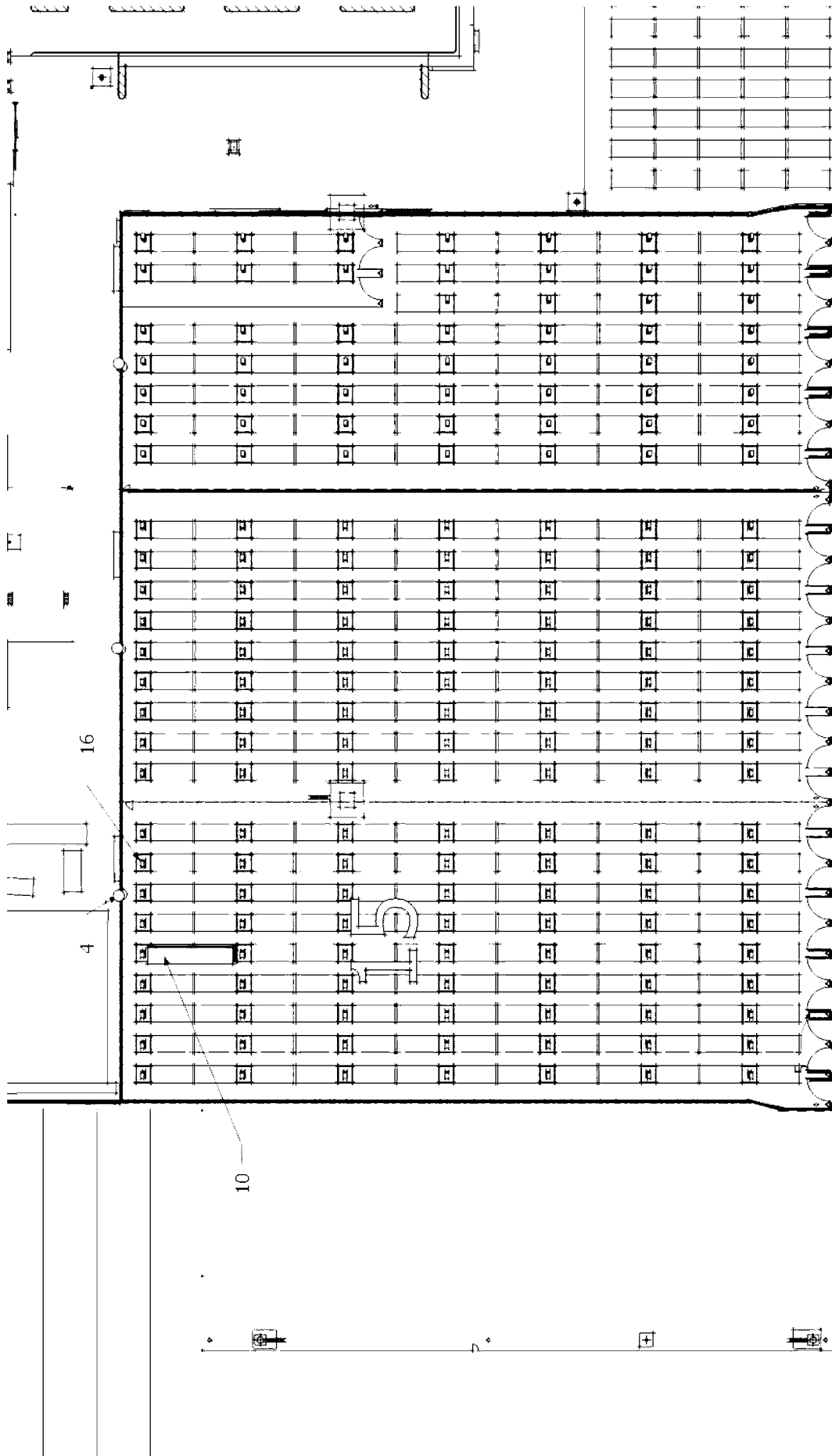


Figure 1

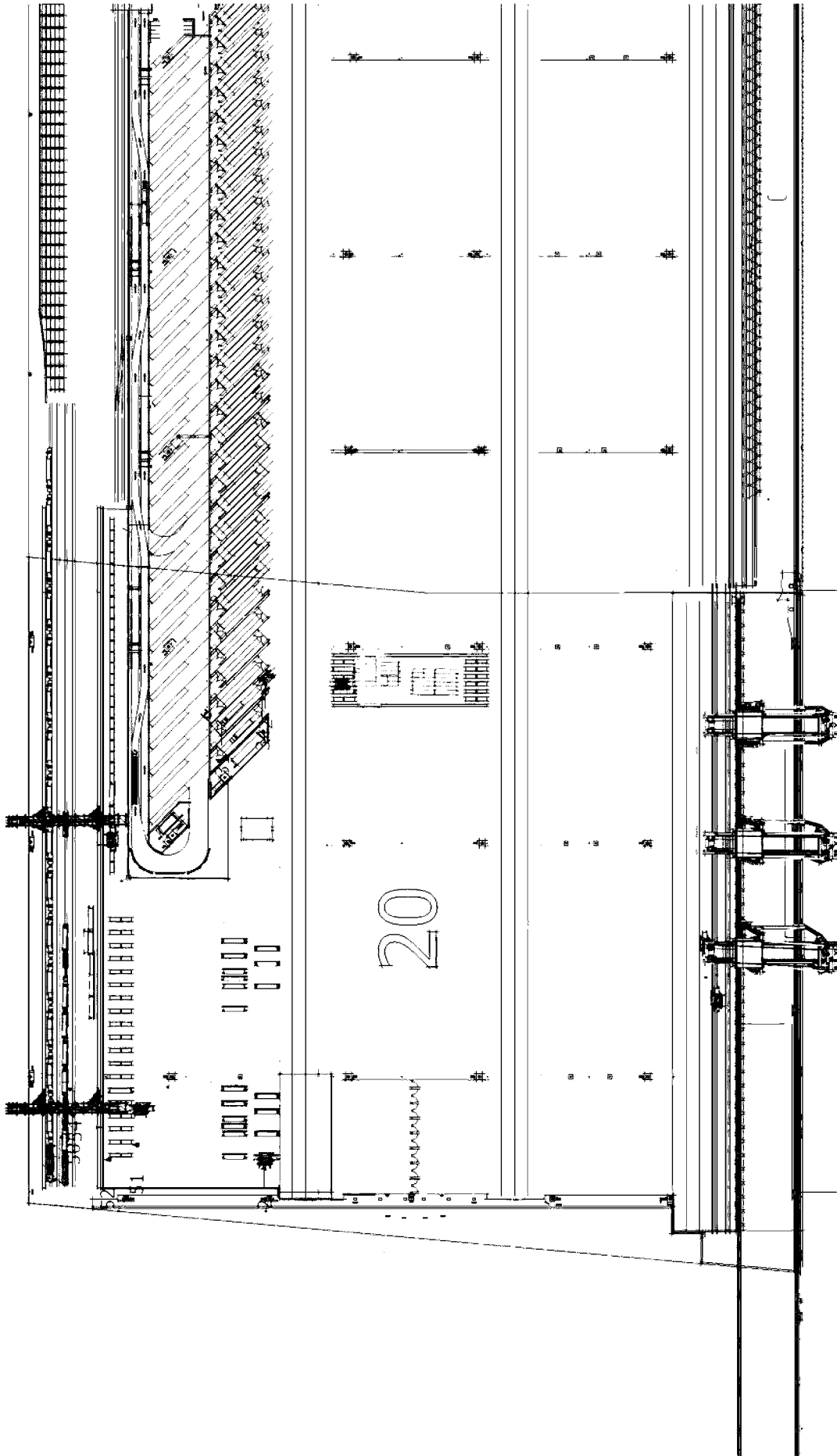


Figure 2

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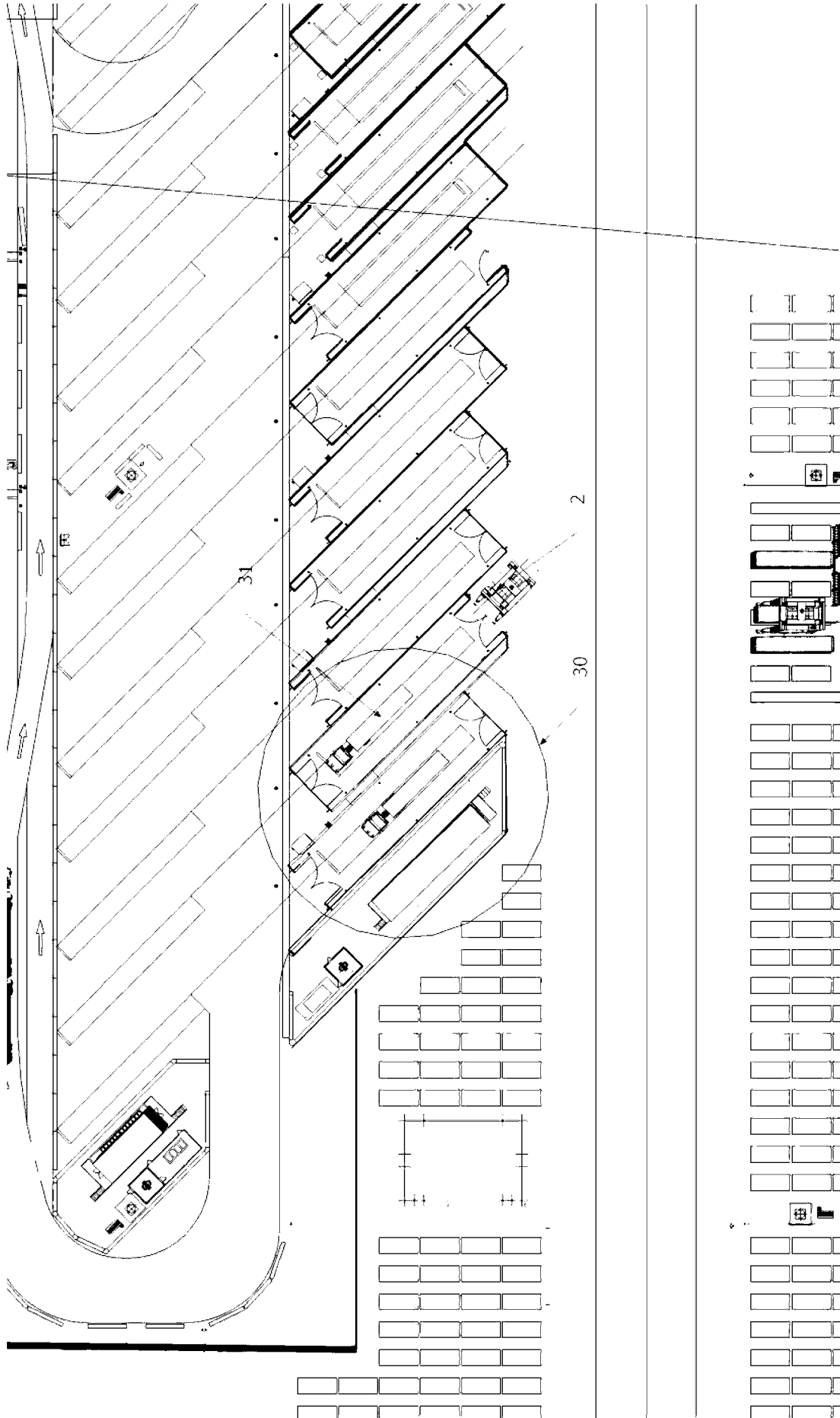


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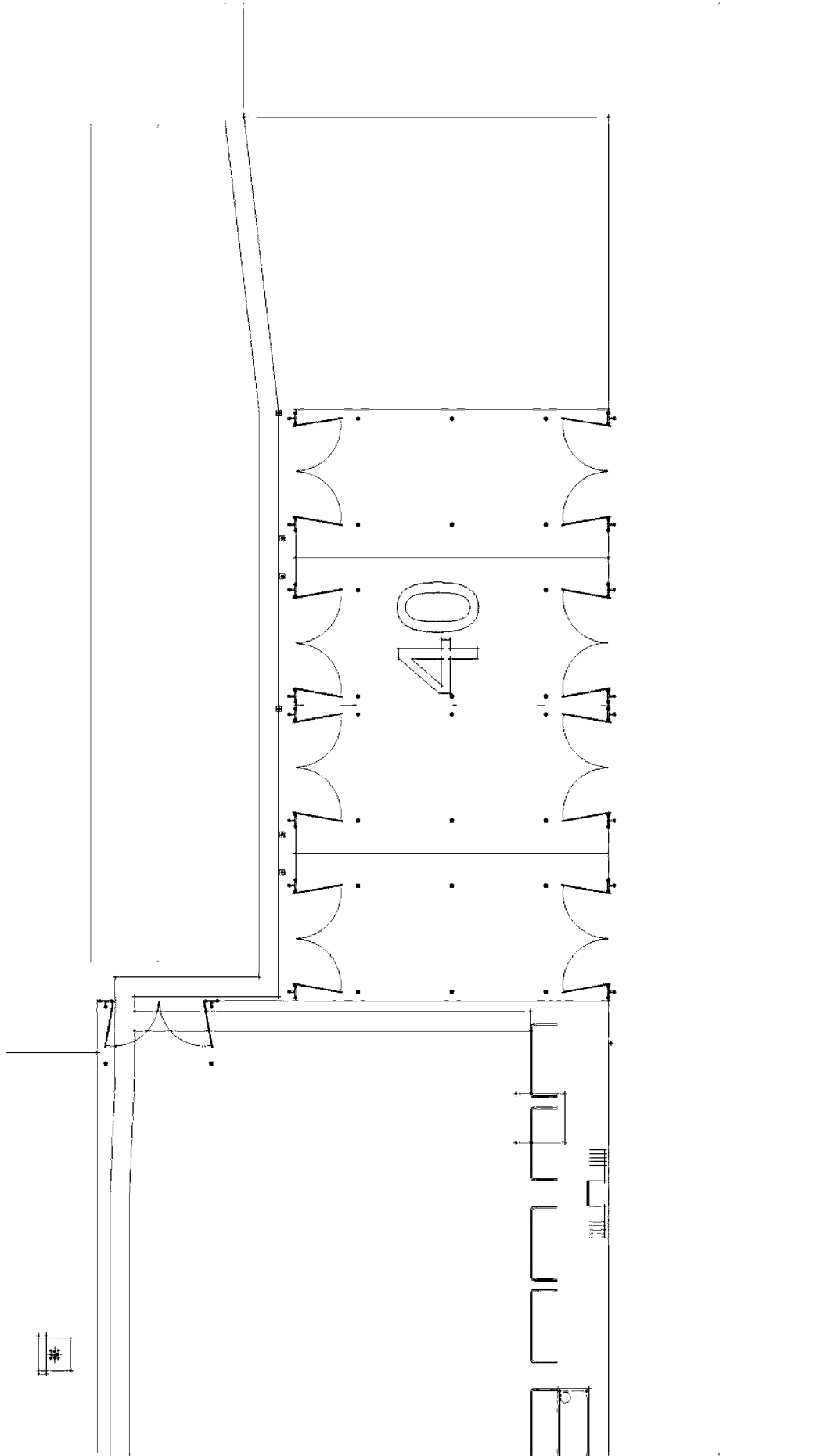


Figure 4

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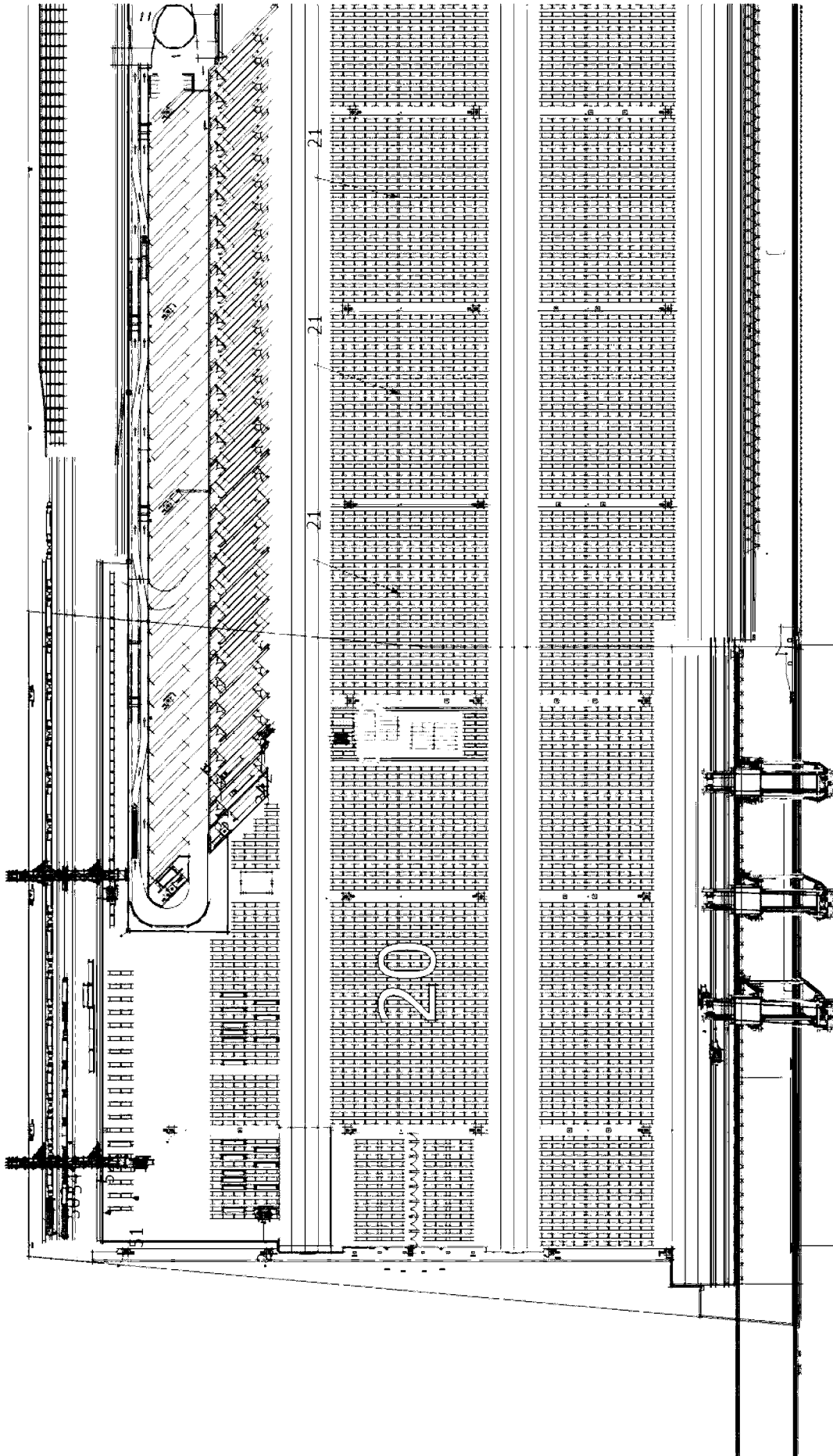


Figure 5

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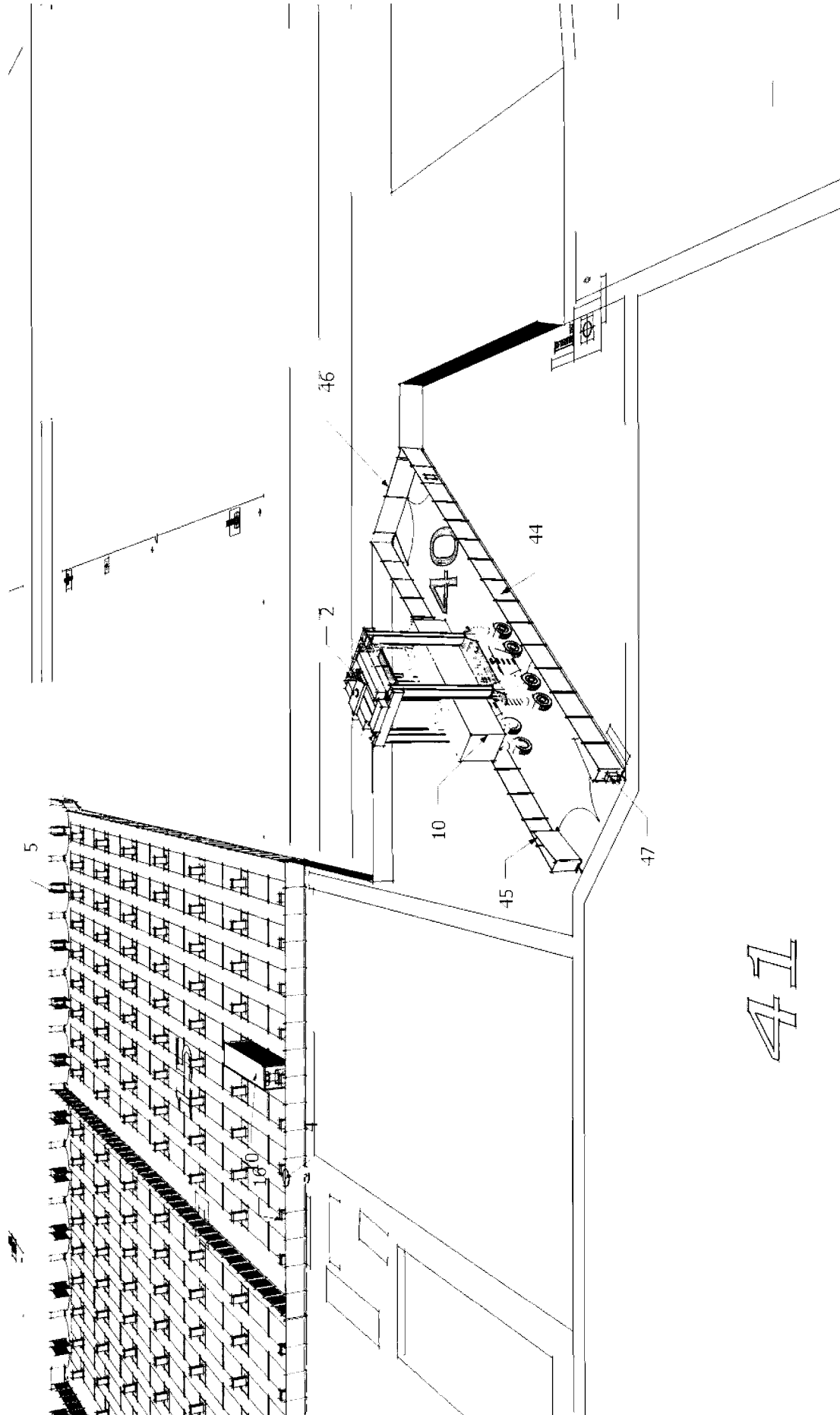


Figure 6

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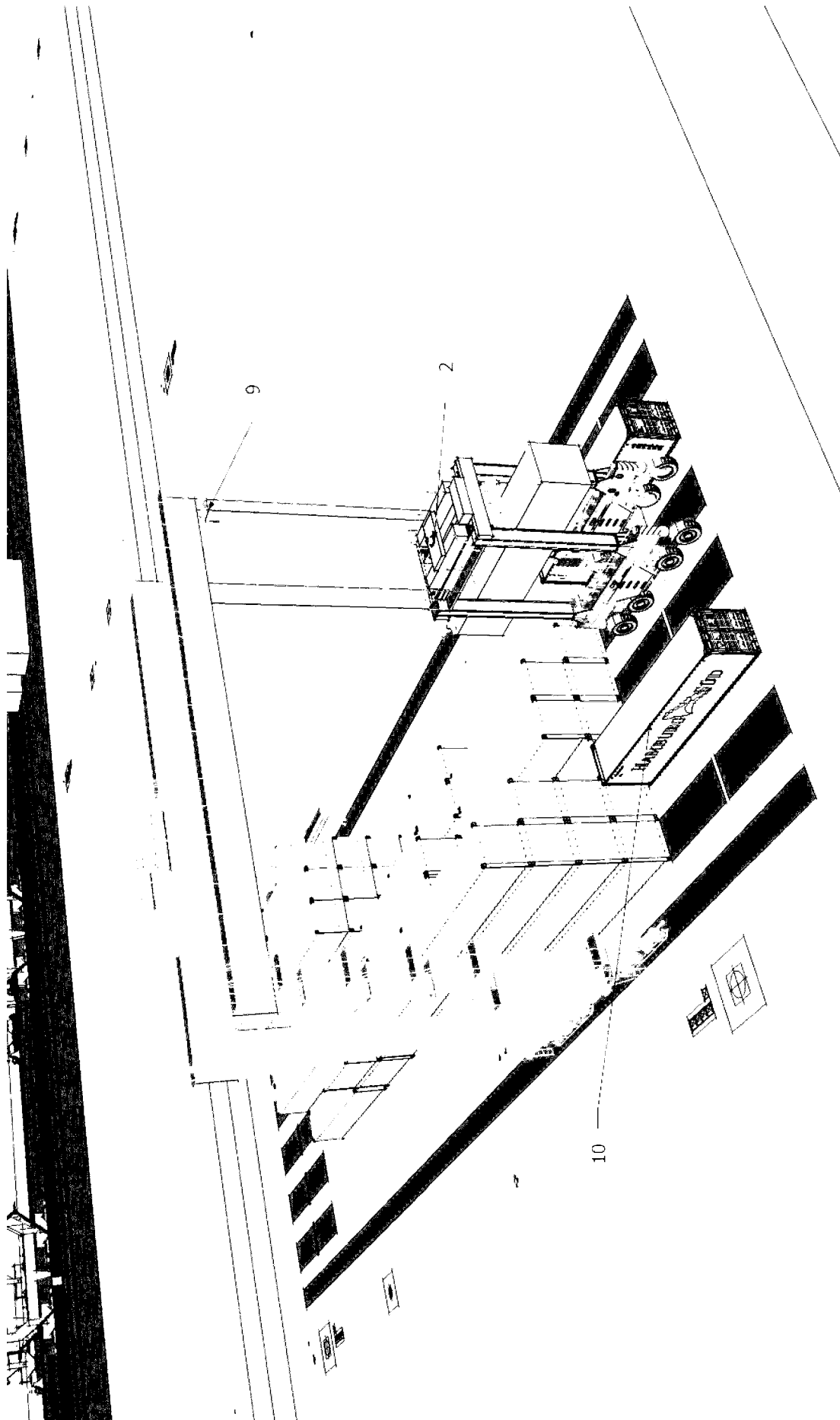


Figure 7

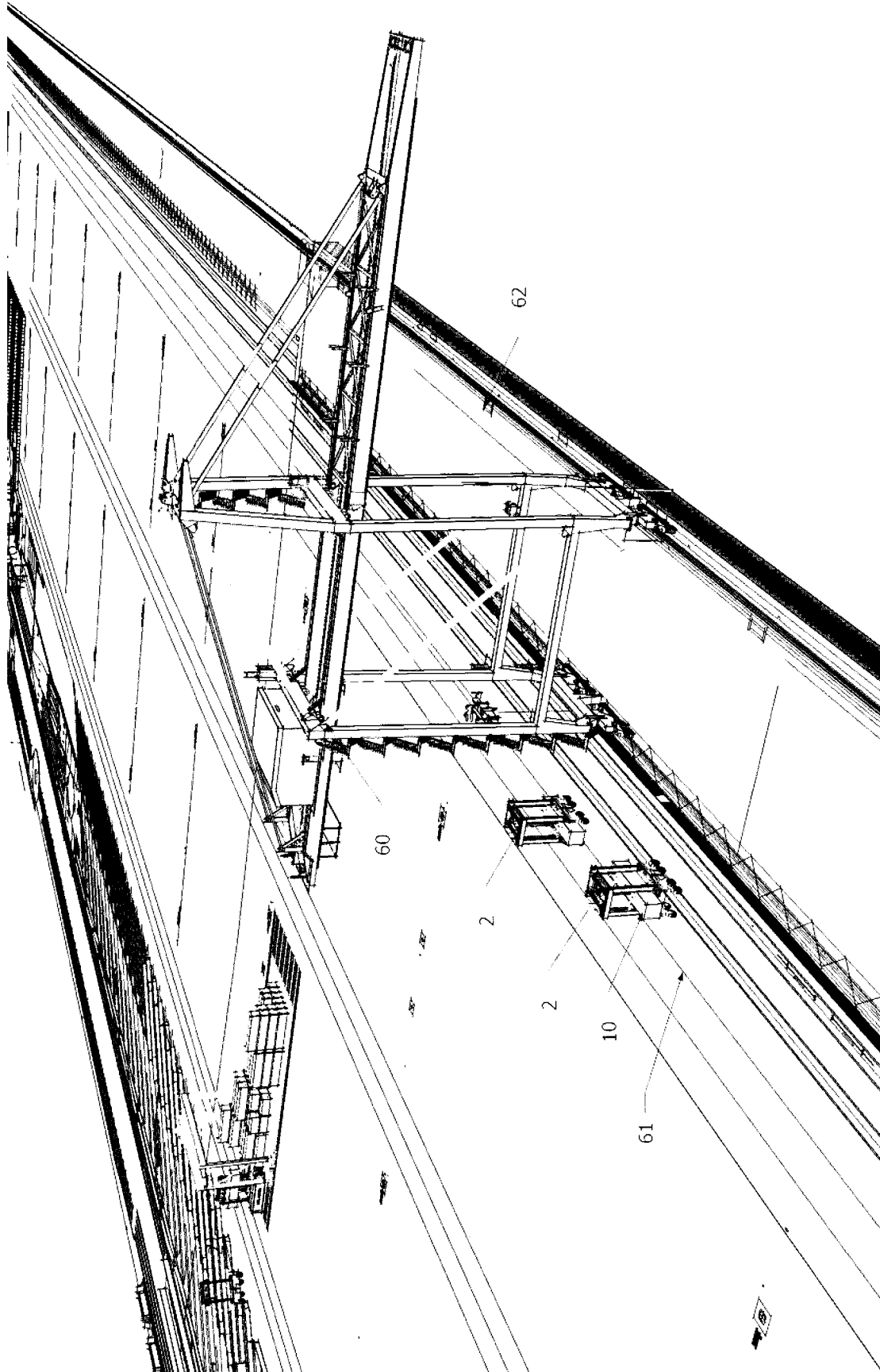


Figure 8

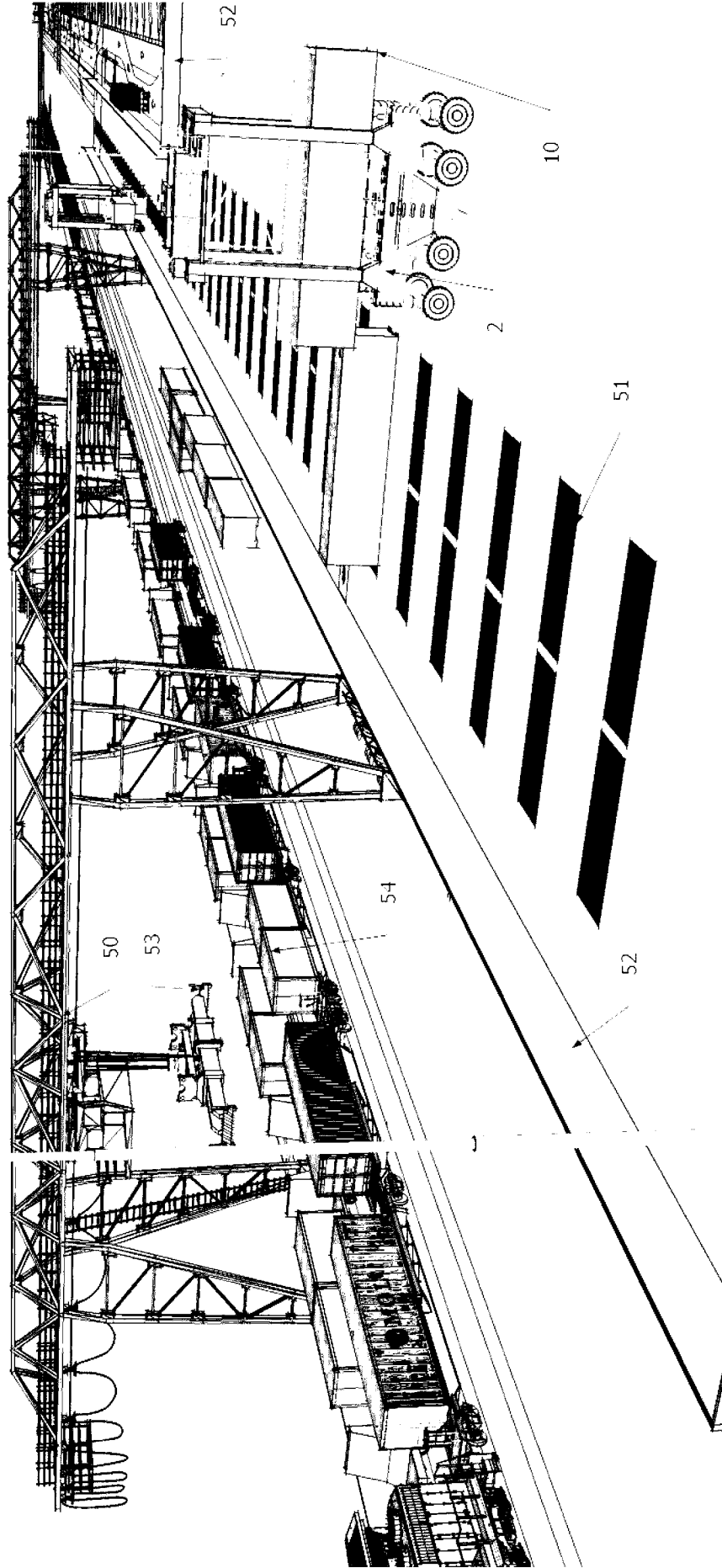


Figure 9

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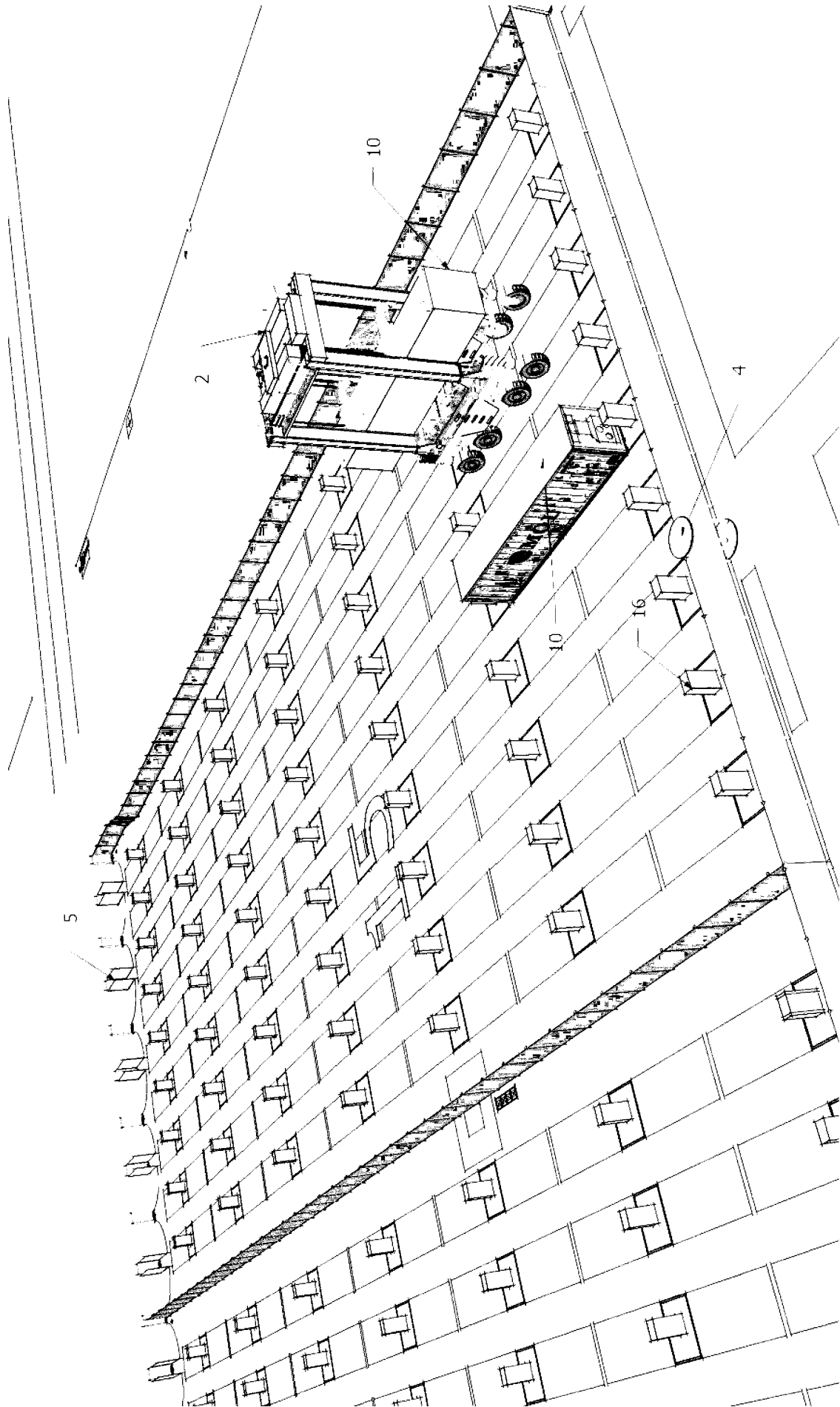


Figure 10

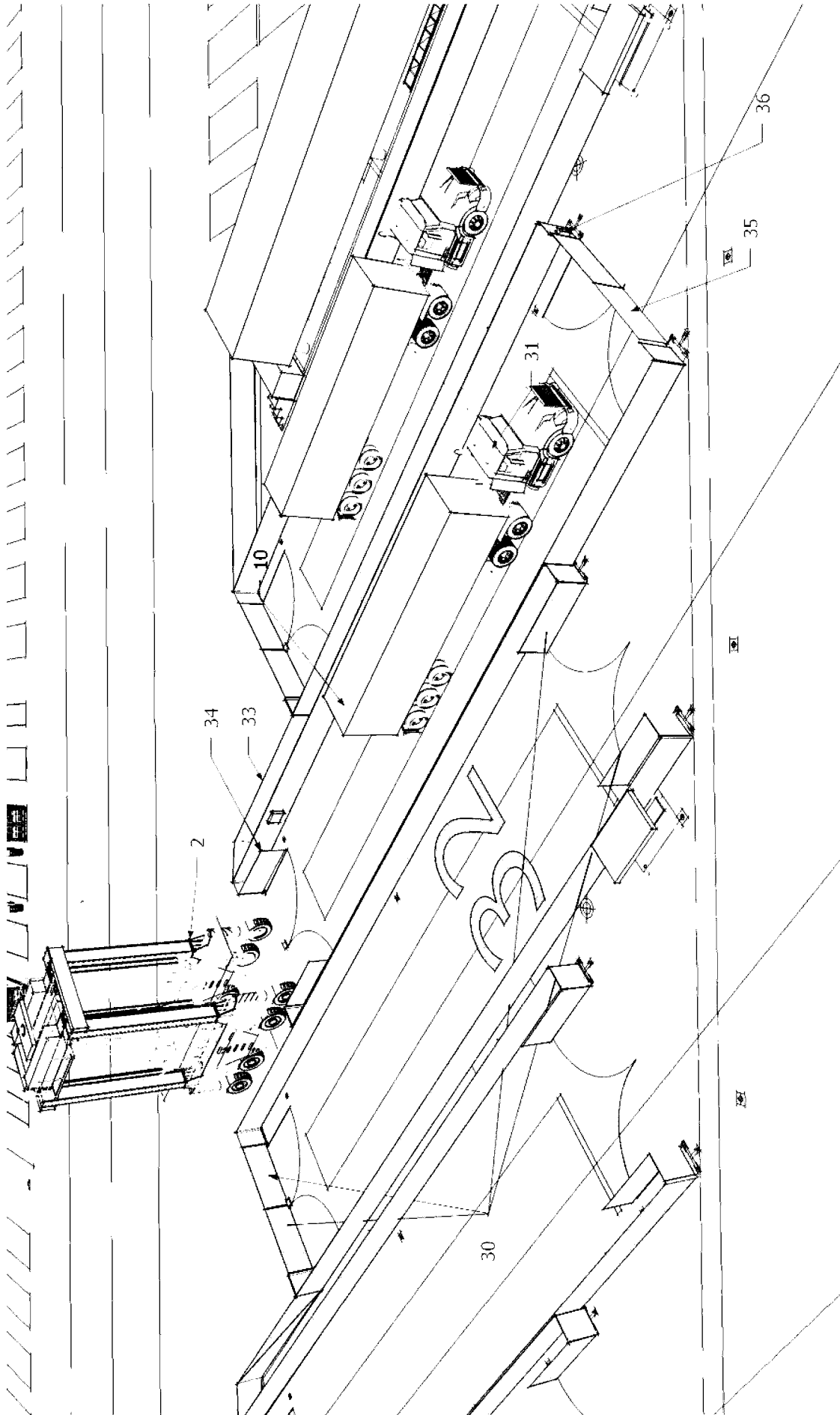


Figure 11

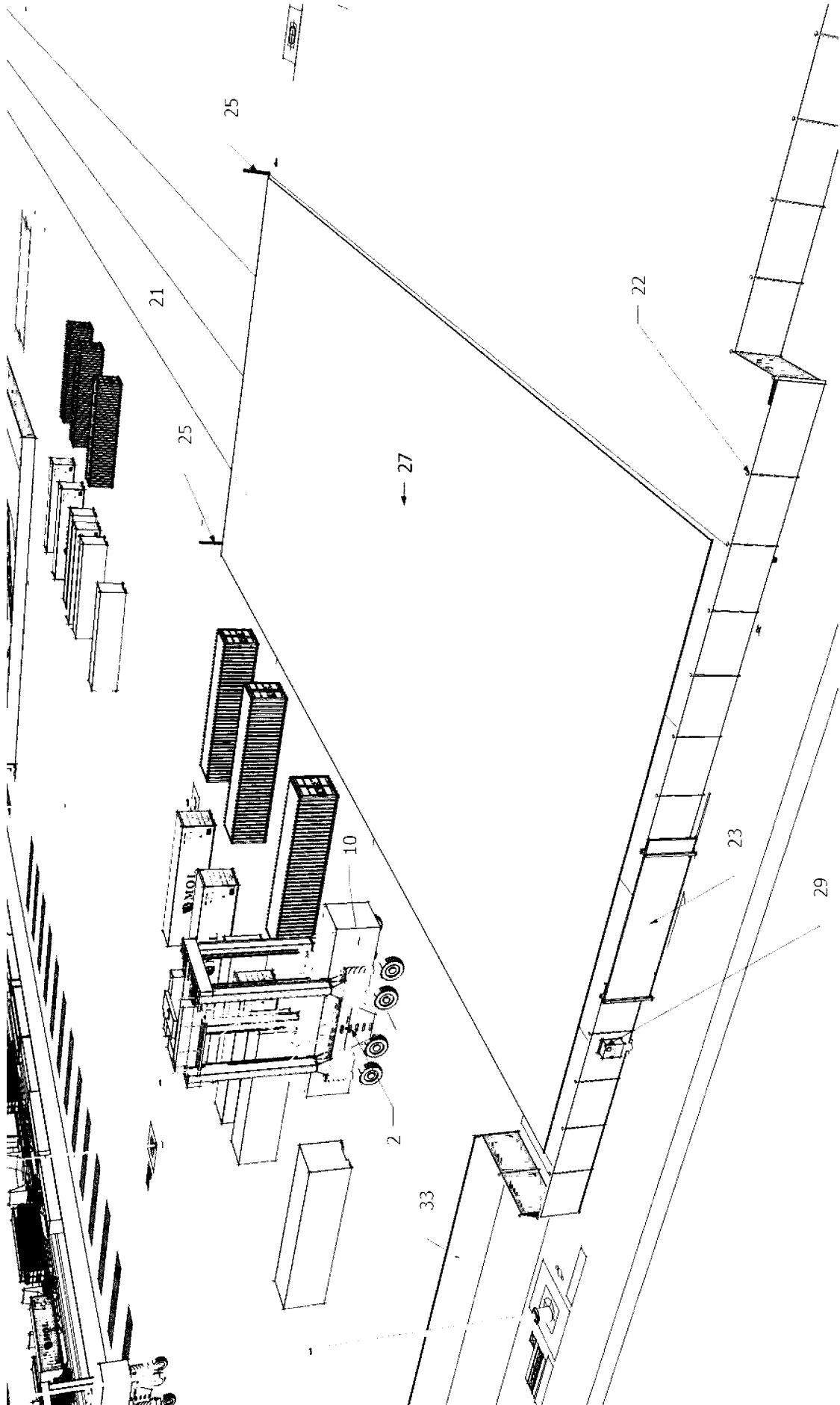


Figure 12

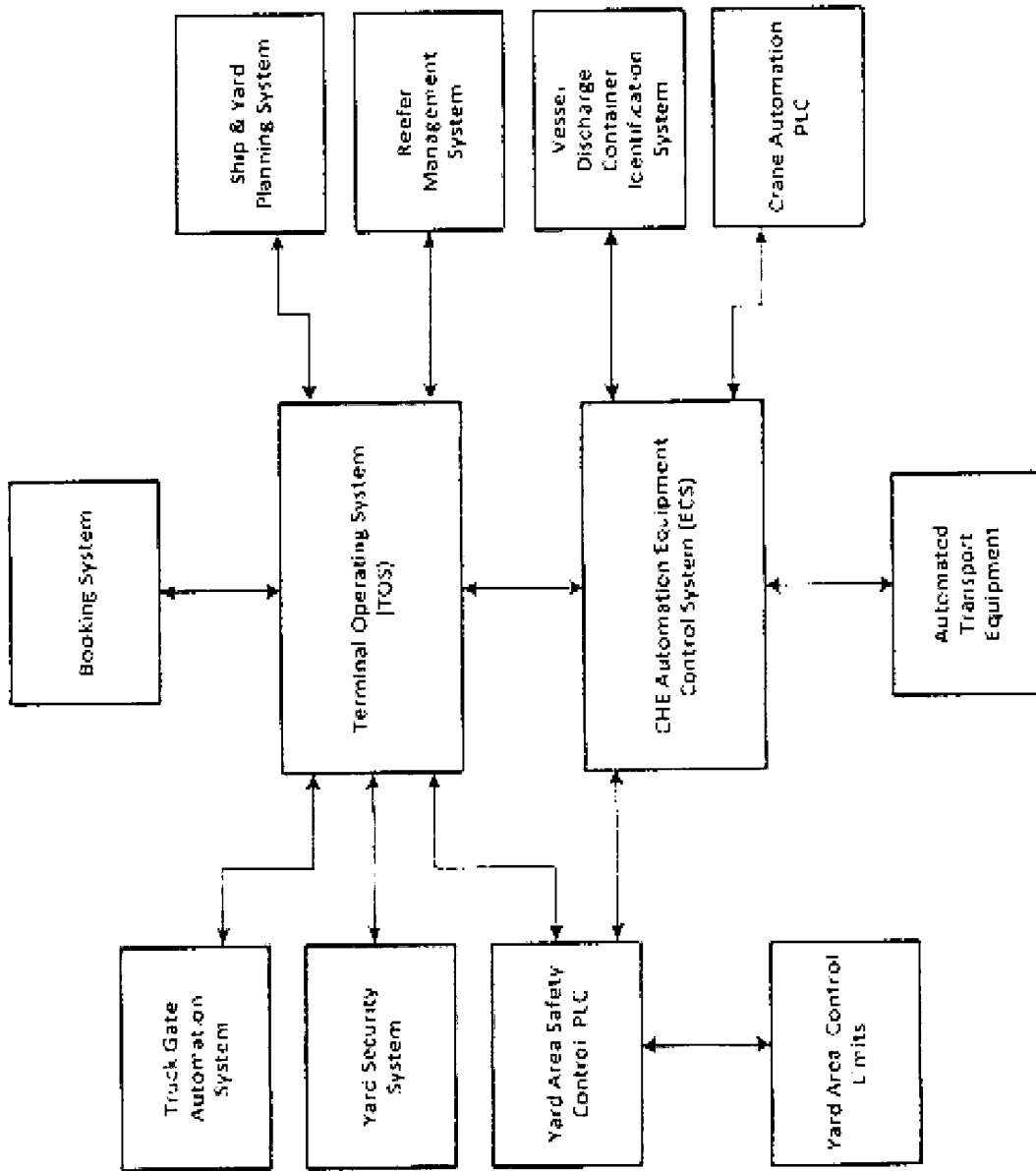


Figure 13

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU2016/000218

## A. CLASSIFICATION OF SUBJECT MATTER

**B65G 63/00 (2006.01) B65G 65/00 (2006.01) B65G 69/00 (2006.01) B28C 9/00 (2006.01) G06Q 10/08 (2012.01)**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**Databases: EPODOC, WPIAP - IPC/CPC marks:** B65G63/00, B65G65/00, B65G69/003, B28C9/00, G06Q10/08, G08G1/20 **Keywords:** gate, barrier, fence, boundary, entry, exit, sensor, alarm, communication, notification and similar terms.**Database: TXTE - Keywords:** gate, barrier, fence, boundary, entry, exit, sensor, alarm, communication, notification, deactivate, disengage, remote, wireless, unauthorised, kill switch, command and similar terms.**Database: AusPat, Espacenet, Google Patents, Google - IPC/CPC marks:** B65G63/00, B65G65/00, B65G69/003, B28C9/00, G06Q10/08, G08G1/20 **Keywords:** dock monitoring, signal, control system, automated, traffic control, zone, asset tracking, fleet management, sensor, alarm and similar terms.**Applicant name also searched on Espacenet, AusPat and internal databases provided by IP Australia.**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search  
15 August 2016Date of mailing of the international search report  
15 August 2016

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		<b>PCT/AU2016/000218</b>
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0112476 A1 (NAVIS LLC) 23 April 2015 Abstract, Figure 6 and paragraphs [0008], [0012], [0013], [0039] and [0059]	1-24
X	US 2014/0188749 A1 (MI-JACK PRODUCTS INC.) 03 July 2014 Abstract, Figures 1-4 and paragraphs [0050], [0054], [0060], [0174], [0199], [0200], [0223], [0224], [0226]	1-24
X	US 7,216,806 B2 (KURITA ET AL.) 15 May 2007 Abstract, Figures 1 and 6 with page 1 'summery of the invention'	1-24
X	US 6,148,291 A (RADICAN) 14 November 2000 Abstract, Figures 1, 2 and 14a-14c with page 1 'summery of the invention'	1-24
X	US 2006/0220851 A1 (WISHERD) 05 October 2006 Abstract, Figures 1 and 6 with paragraphs [0009], [0010], [0029], [0030] and [0088]	1-24
X	US 2011/0251716 A1 (BUZZONI ET AL.) 13 October 2011 Abstract, figures 7, 9, 10 and 17 and paragraphs [0009 – 0016], [0051], [0177], [0121], [0168]	1-24

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2016/000218

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

Form PCT/ISA/210 (Family Annex)(July 2009)

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/AU2016/000218**

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<b>Patent Document/s Cited in Search Report</b>		<b>Patent Family Member/s</b>	
<b>Publication Number</b>	<b>Publication Date</b>	<b>Publication Number</b>	<b>Publication Date</b>
US 2011/0251716 A1	13 October 2011	US 2011251716 A1	13 Oct 2011
		US 8306649 B2	06 Nov 2012
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**End of Annex**

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