US 20060104712A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2006/0104712 A1

Bufano et al. (43) Pub. Date: May 18, 2006

(54) TRANSPORTATION SYSTEM

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(21) Appl. No.: **11/211,236**

(22) Filed: **Aug. 24, 2005**

Related U.S. Application Data

(60) Provisional application No. 60/604,406, filed on Aug. 24, 2004.

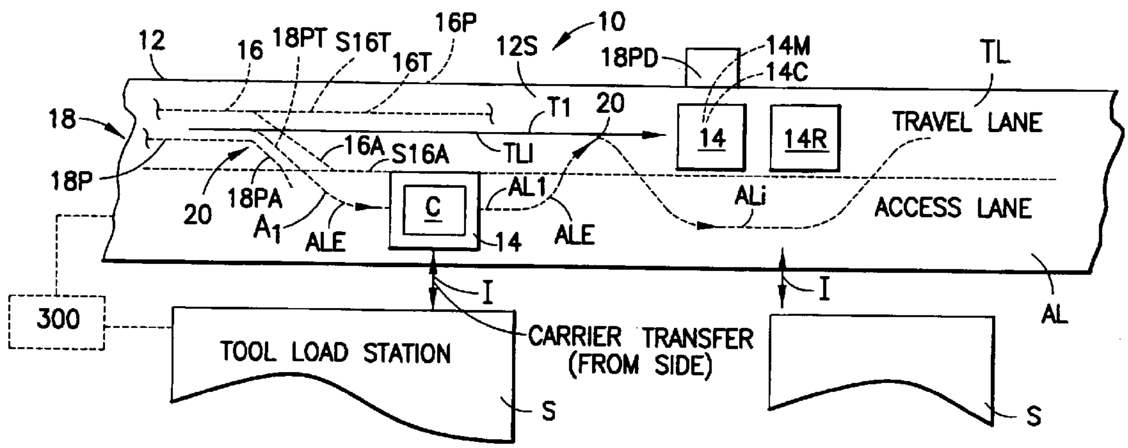
Publication Classification

(51) **Int. Cl.**
E01C 1/00 (2006.01)

(52) **U.S. Cl.** **404/1**

(57) **ABSTRACT**

An exemplary embodiment a substrate transport system is provided. The system has a guideway and at least one transport vehicle. The transport vehicle is adapted for holding at least one substrate and capable of being supported from and moving along the guideway. The guideway comprises at least one travel lane for the vehicle and at least one access lane offset from the travel lane allowing the vehicle selectable access on and off the travel lane.



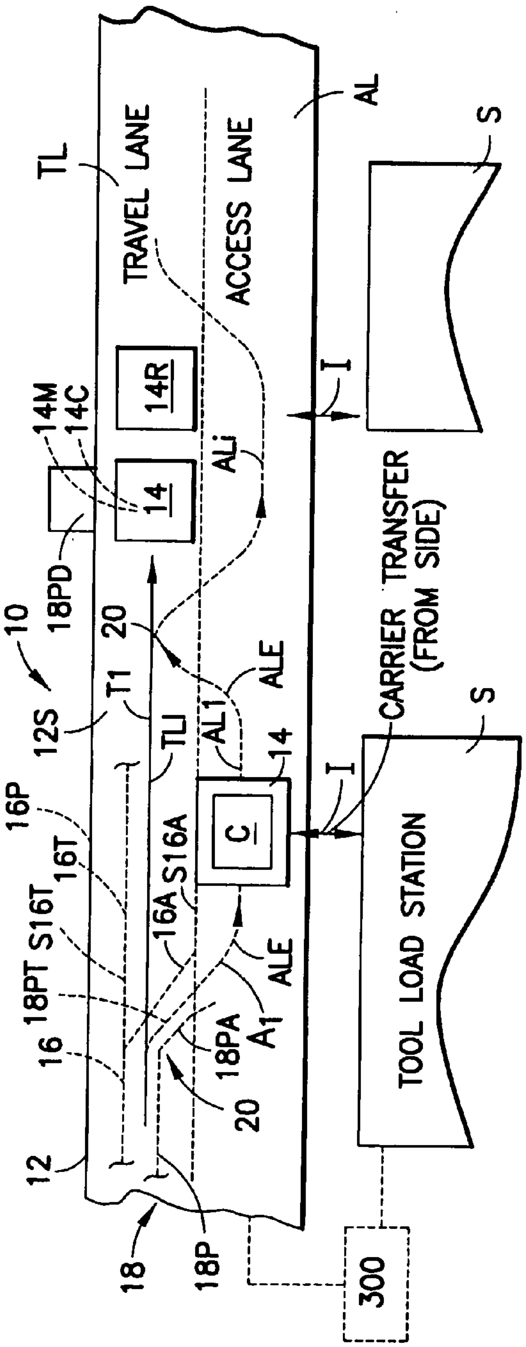

TL
TRAVEL LANE
ACCESS LANE
AL
S
14M
14C
14R
14
18PD
10
20
ALi
I
CARRIER TRANSFER
(FROM SIDE)
12S
T1
TLI
AL1
ALE
16P
16T
S16T
18PT
16A
S16A
C
16
18PA
A1
20
12
18
18P
TOOL LOAD STATION
300

FIG.1

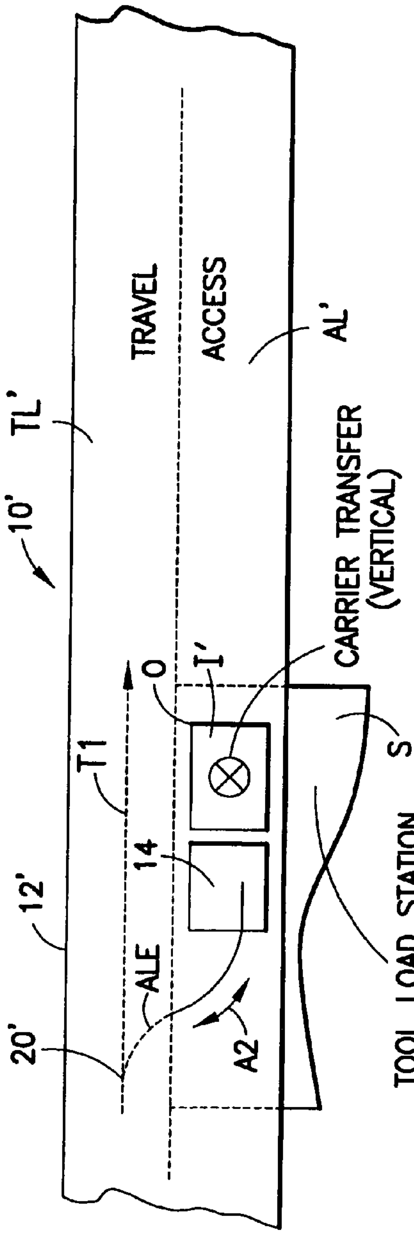
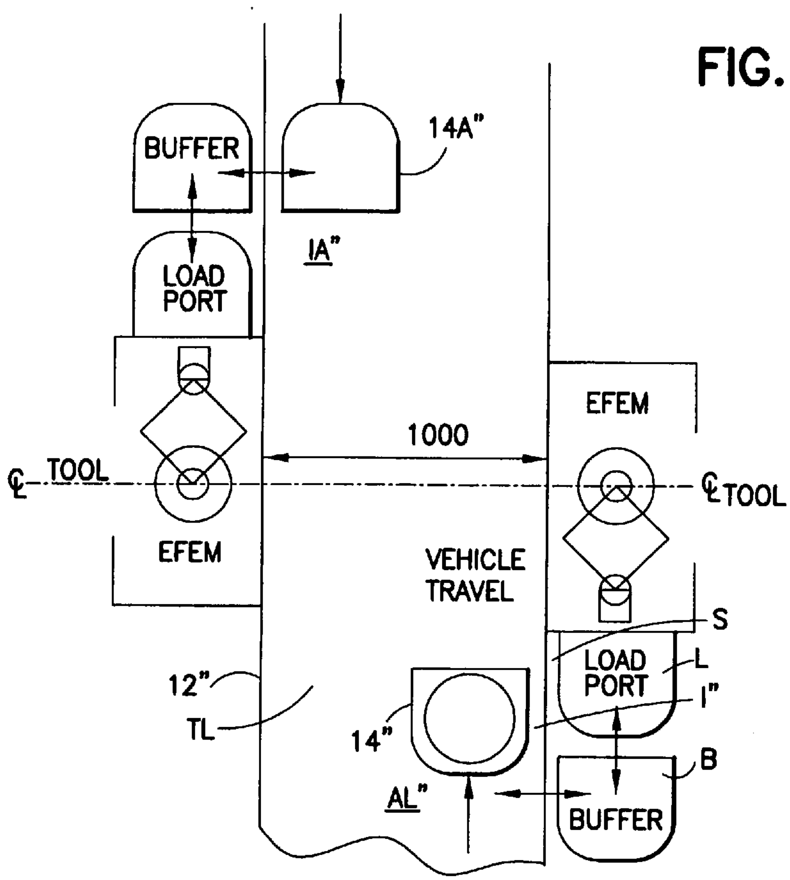
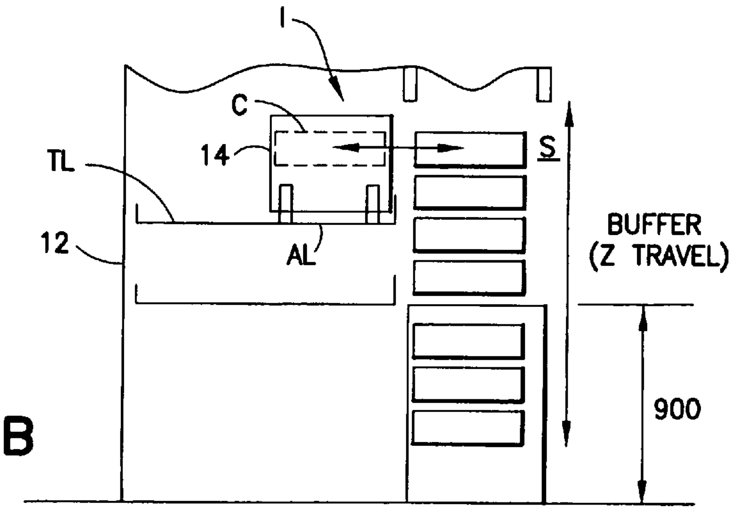

TRAVEL
ACCESS
AL'
TL'
10'
CARRIER TRANSFER
(VERTICAL)
O
I'
T1
S
12'
14
ALE
TOOL LOAD STATION
20'
A2

FIG.2



14A"
BUFFER
LOAD PORT
IA"
EFEM
1000
TOOL
TOOL
EFEM
VEHICLE TRAVEL
S
LOAD PORT
L
I"
12"
TL
14"
B
AL"
BUFFER

FIG.1A



I
C
14
S
TL
12
AL
BUFFER (Z TRAVEL)
900

FIG.1B

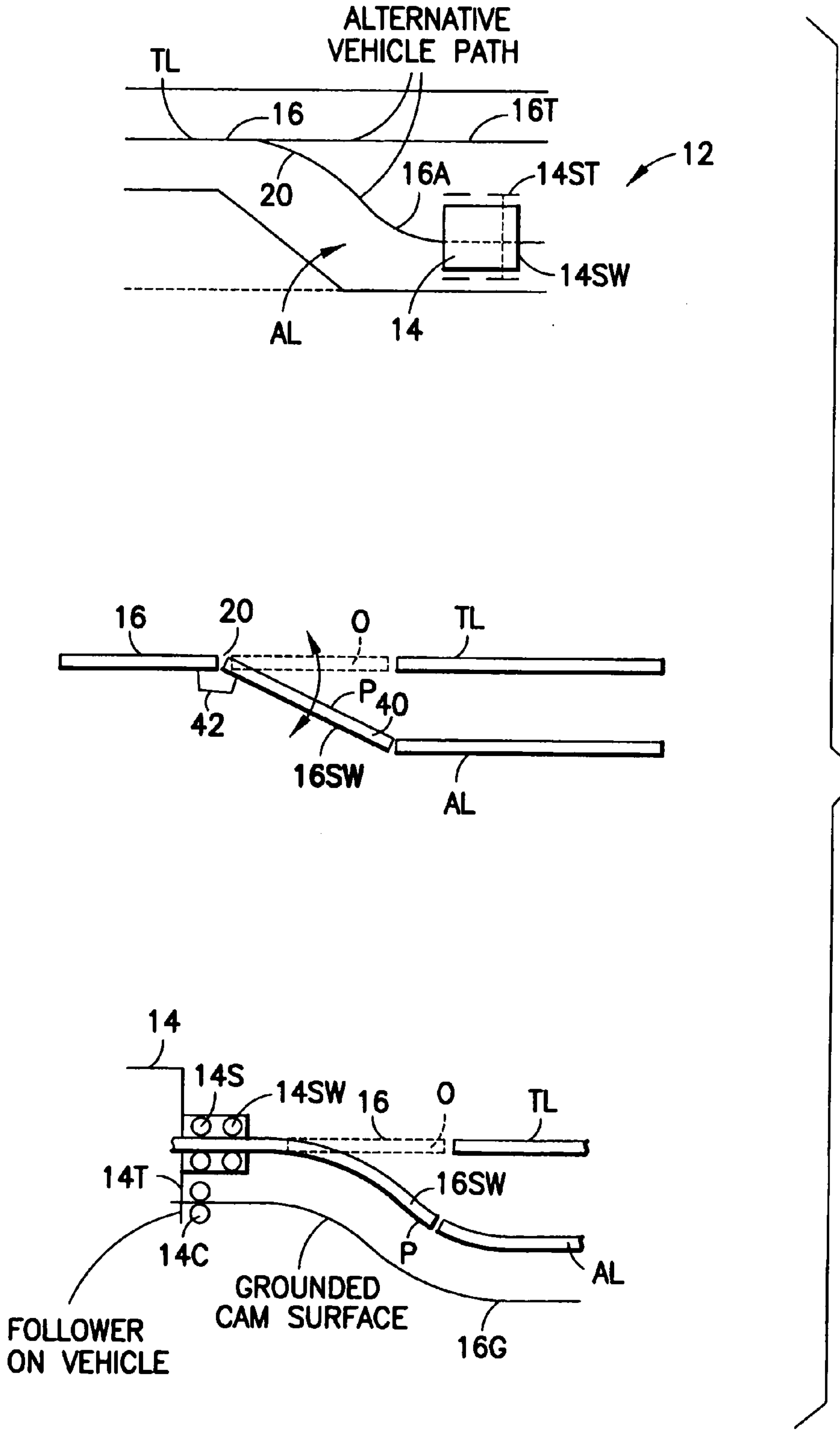

ALTERNATIVE
VEHICLE PATH
TL
16
16T
12
20
16A
14ST
14SW
AL
14
16
20
O
TL
P
40
42
16SW
AL
14
14S
14SW
16
O
TL
14T
16SW
14C
P
AL
GROUNDED
CAM SURFACE
FOLLOWER
ON VEHICLE
16G

FIG.3

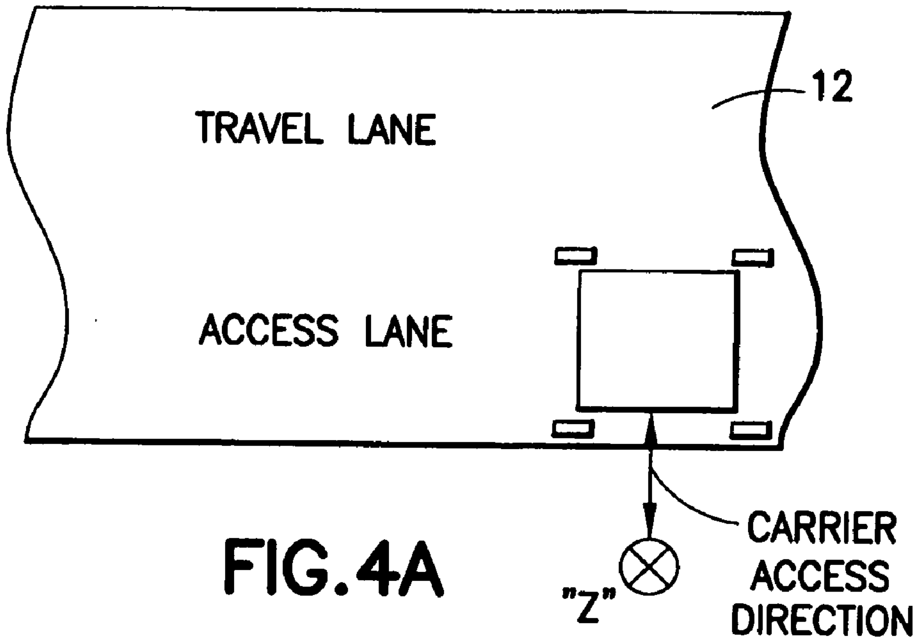

12
TRAVEL LANE
ACCESS LANE
CARRIER ACCESS DIRECTION
"Z"

FIG.4A

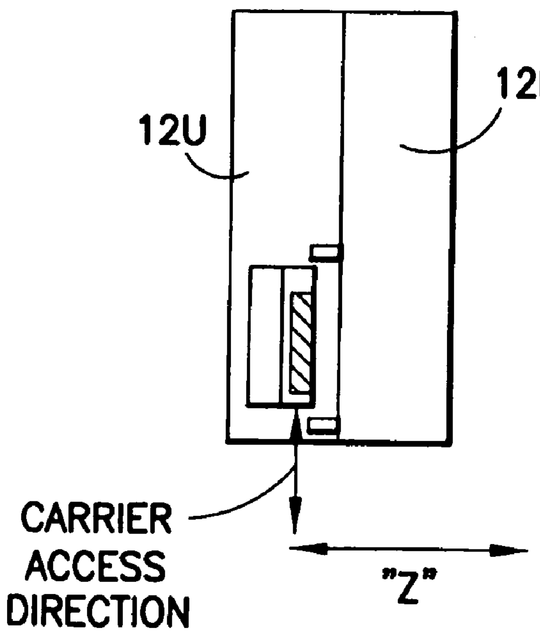

12U
12L
CARRIER ACCESS DIRECTION
"Z"

FIG.4B

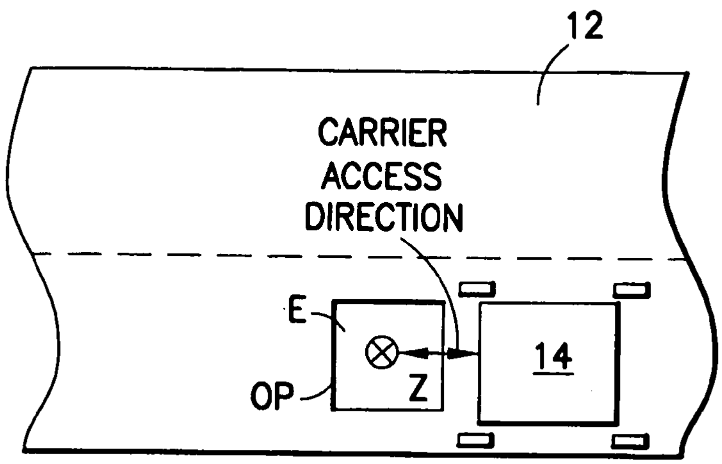


FIG.5A

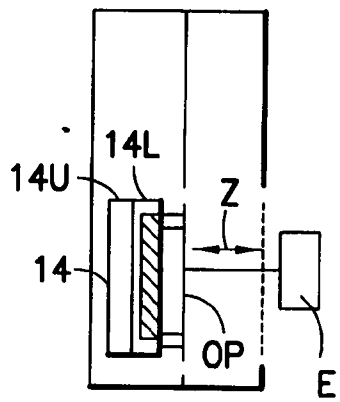


FIG.5B

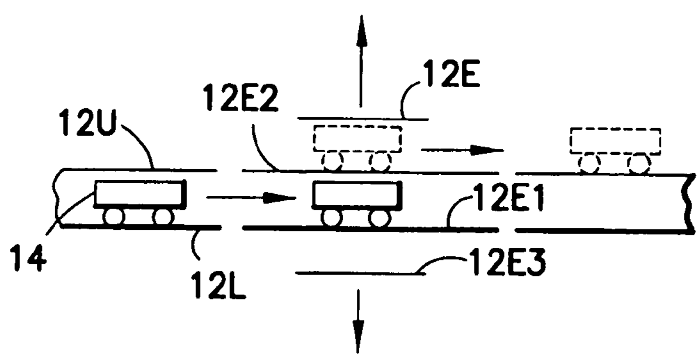


FIG.6

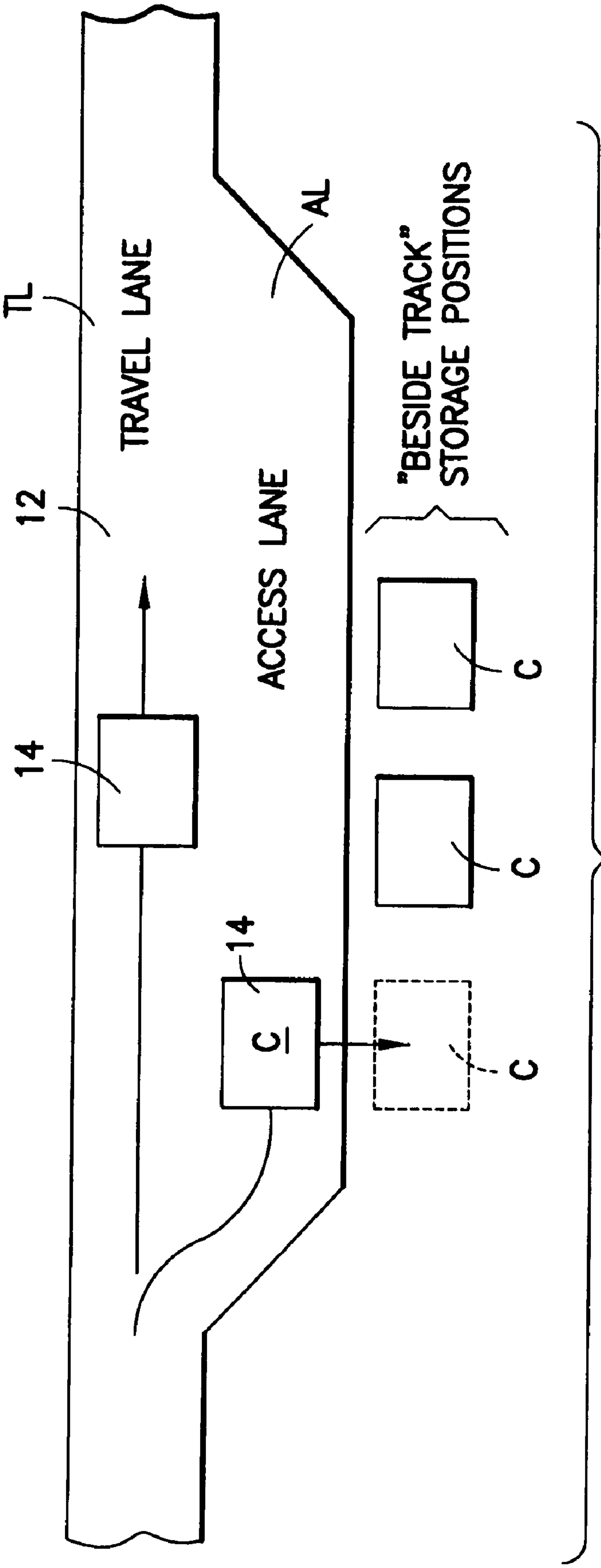

TL
TRAVEL LANE
AL
"BESIDE TRACK"
STORAGE POSITIONS
12
ACCESS LANE
14
C
14
C
C
C
C

FIG. 7

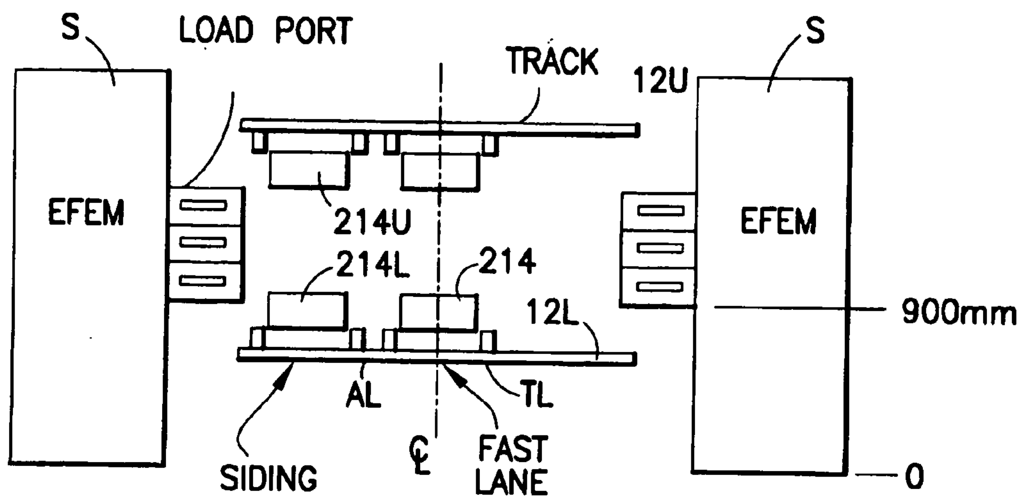


FIG.8A

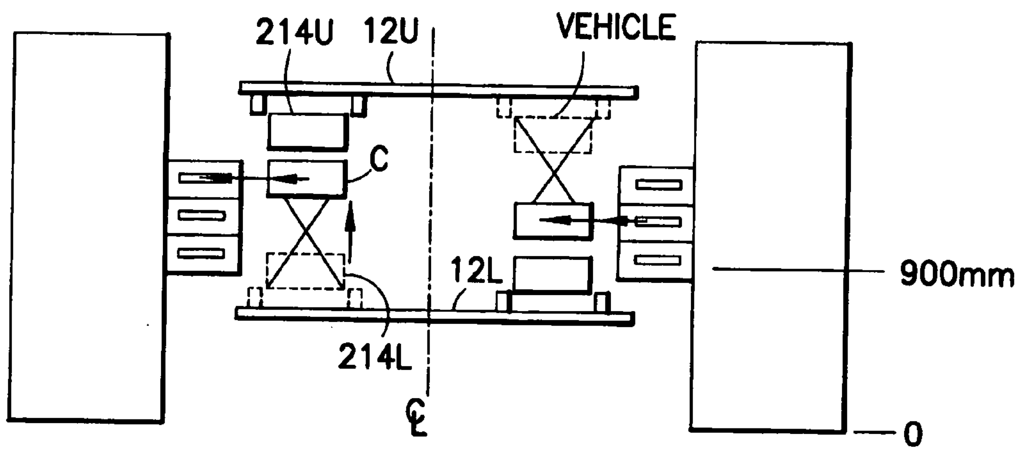


FIG.8B

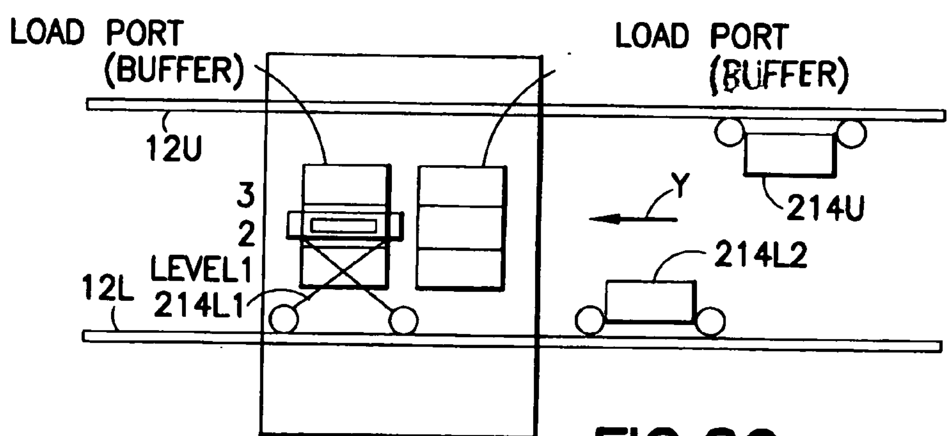


FIG.8C

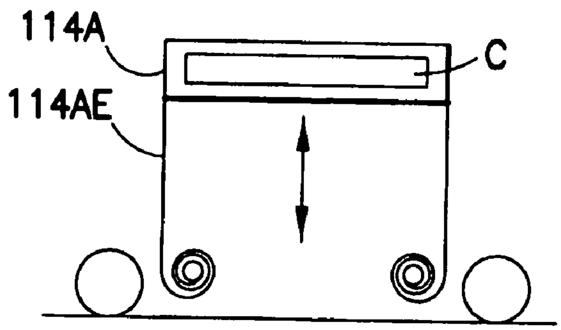


FIG.9A

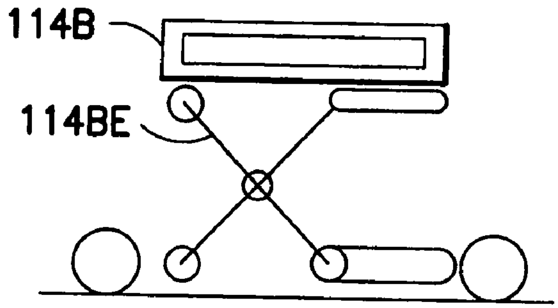


FIG.9B

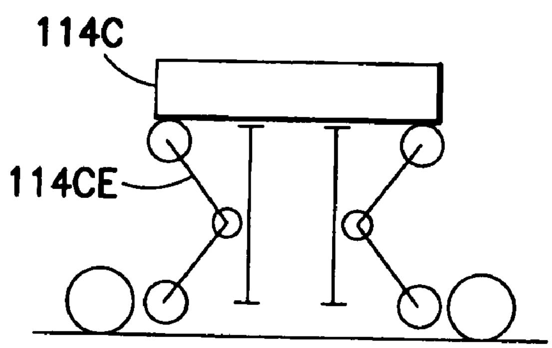


FIG.9C

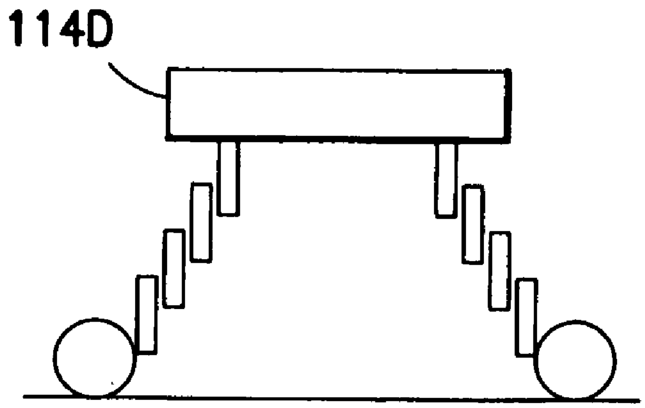


FIG.9D

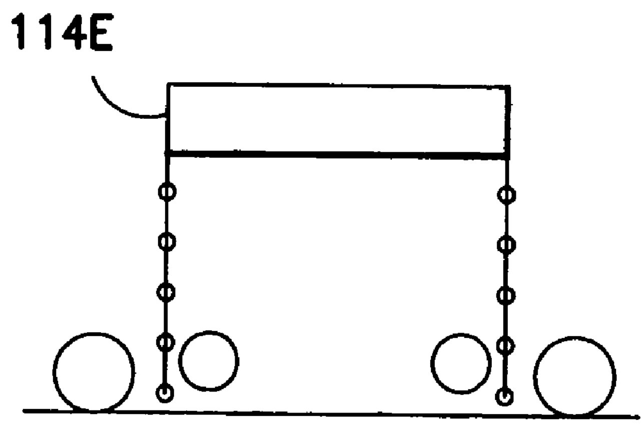


FIG.9E

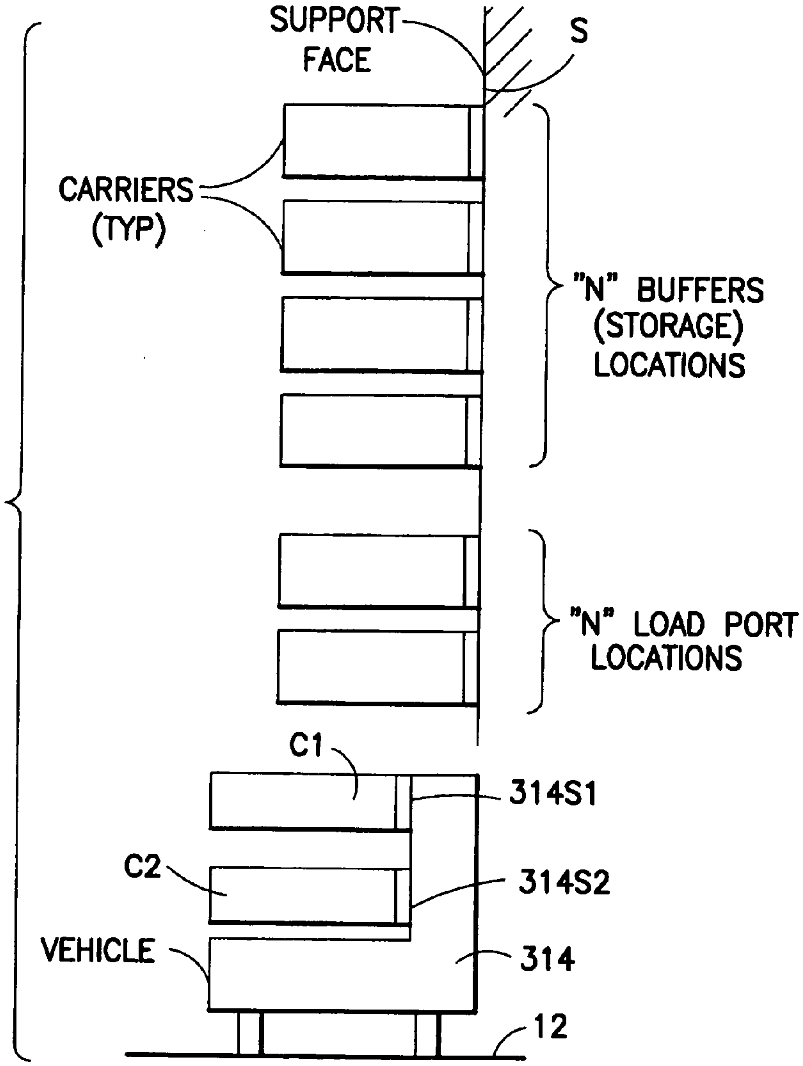

SUPPORT FACE
S
CARRIERS (TYP)
"N" BUFFERS (STORAGE) LOCATIONS
"N" LOAD PORT LOCATIONS
C1
314S1
C2
314S2
VEHICLE
314
12

FIG.10

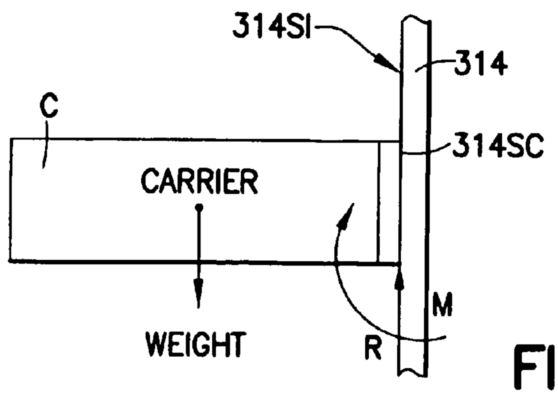

314SI
314
C
314SC
CARRIER
WEIGHT
R
M

FIG.11

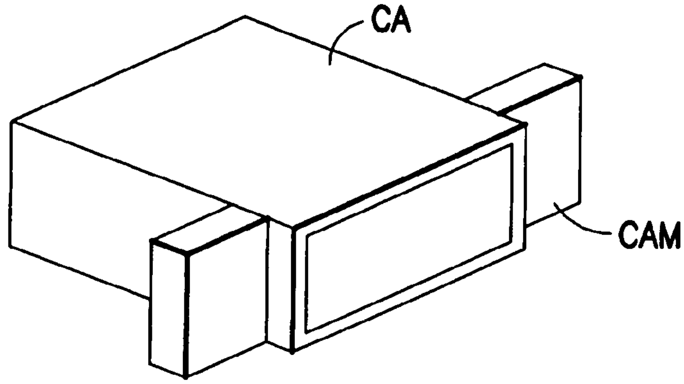


FIG.12A

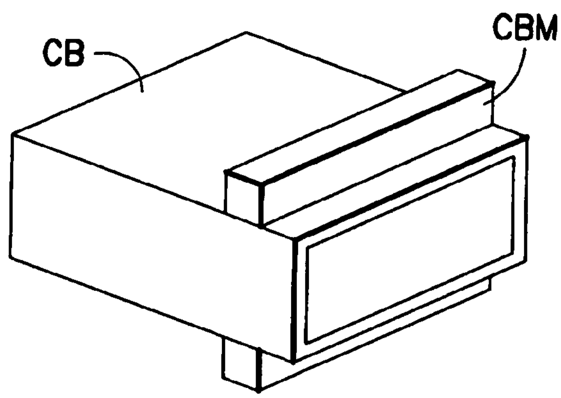


FIG.12B

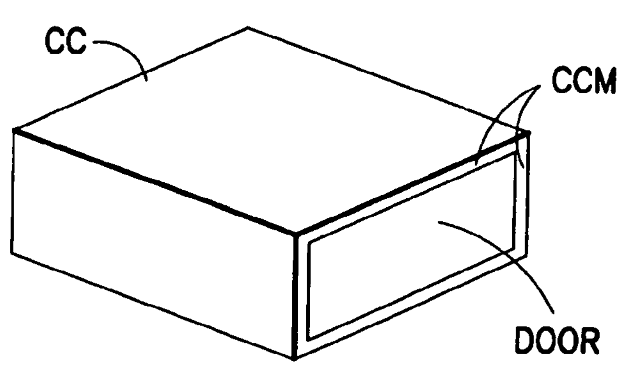


FIG.12C

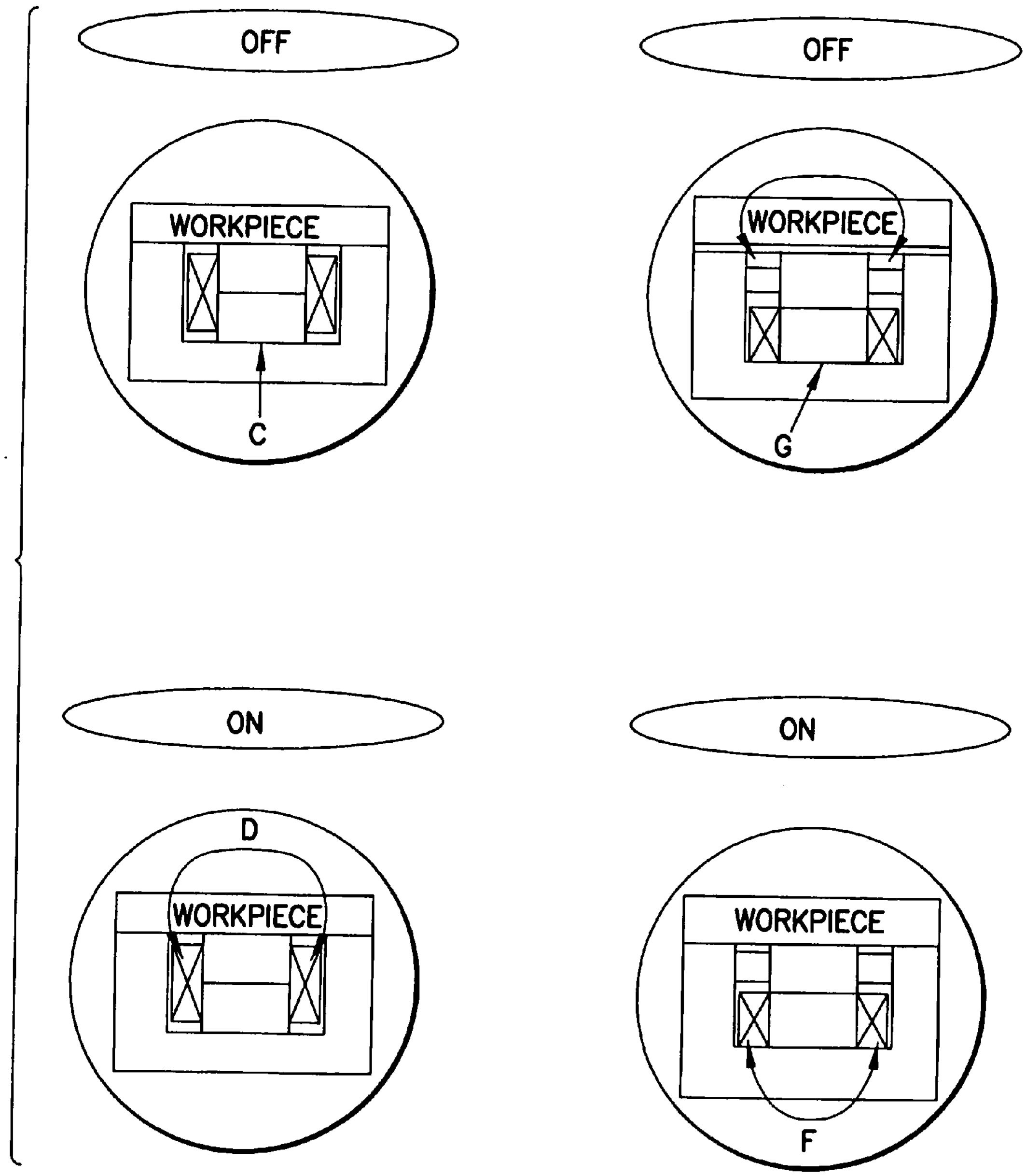

OFF
WORKPIECE
C
OFF
WORKPIECE
G
ON
D
WORKPIECE
ON
WORKPIECE
F

FIG. 12D

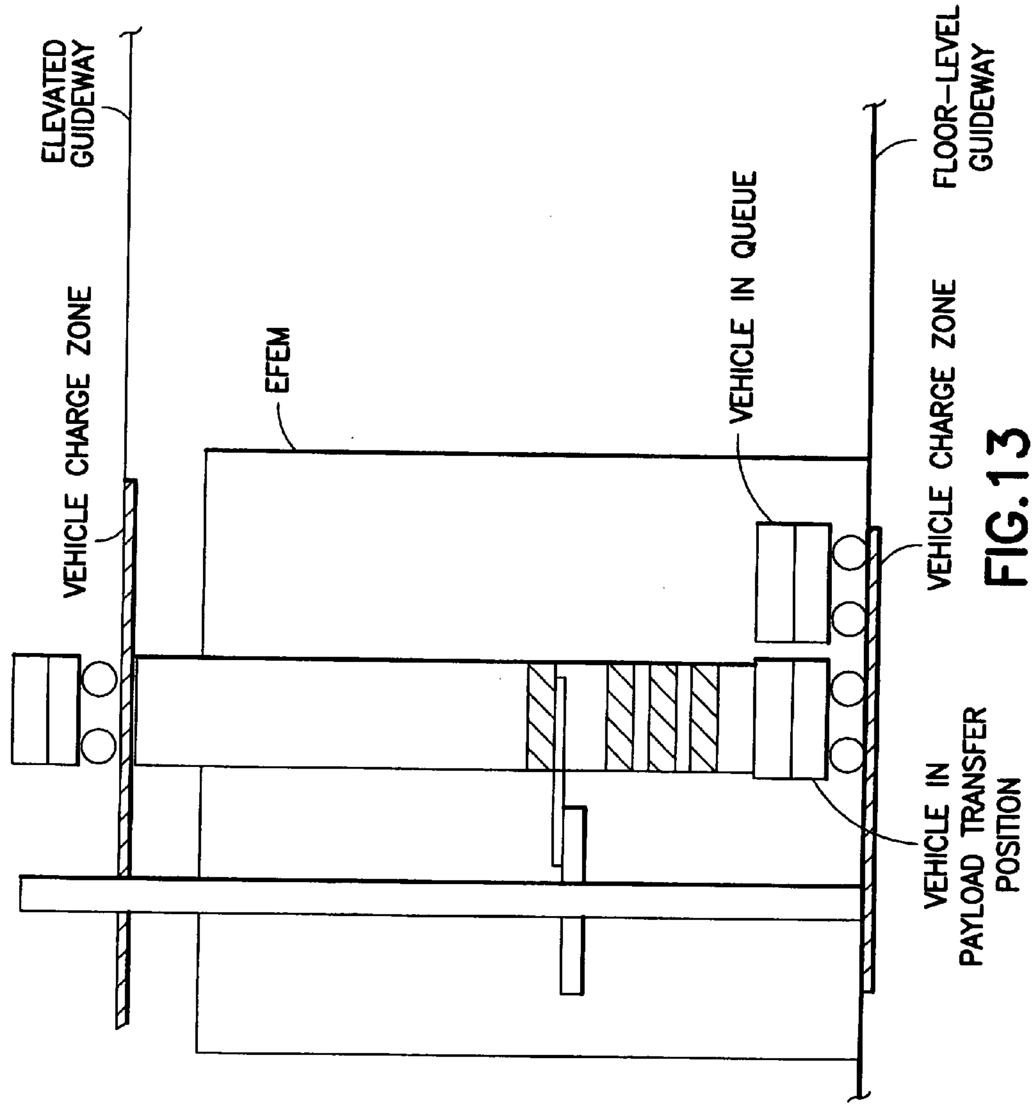

ELEVATED GUIDEWAY
VEHICLE CHARGE ZONE
EFEM
VEHICLE IN QUEUE
FLOOR-LEVEL GUIDEWAY
VEHICLE CHARGE ZONE
VEHICLE IN PAYLOAD TRANSFER POSITION

FIG.13

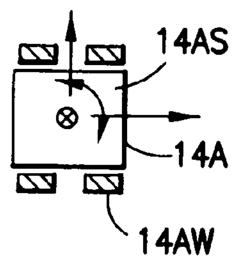


FIG.14A

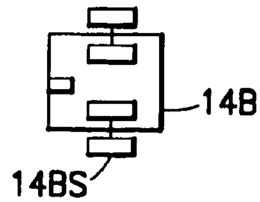


FIG.14B

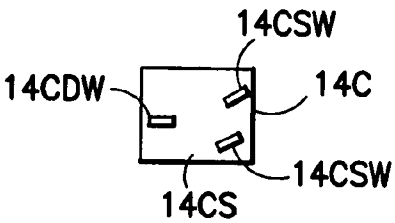


FIG.14C

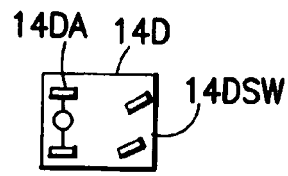


FIG.14D

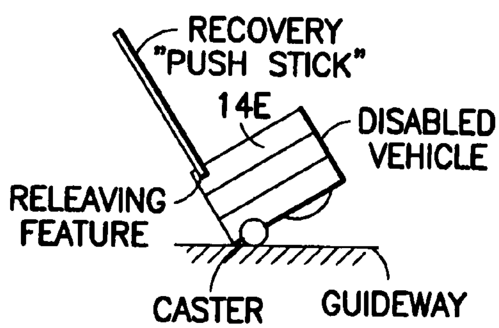
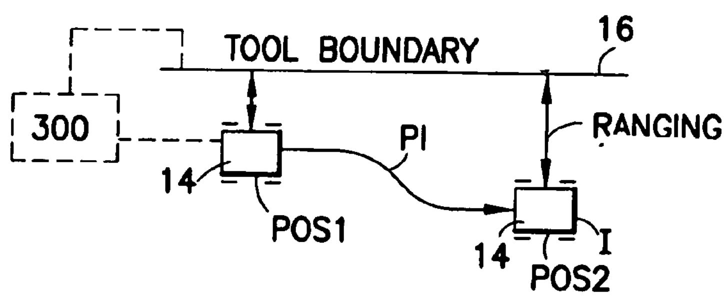


FIG.14E

FIG.15



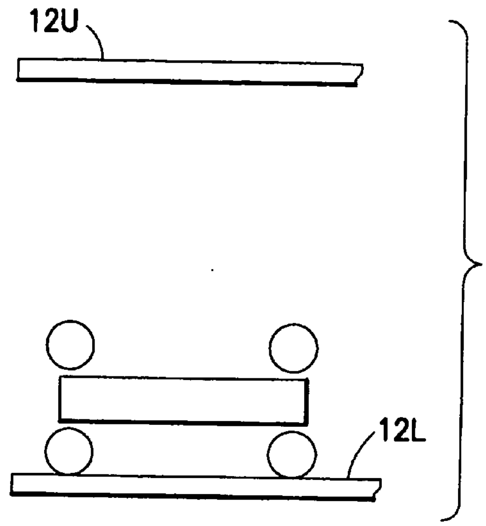


FIG.16A

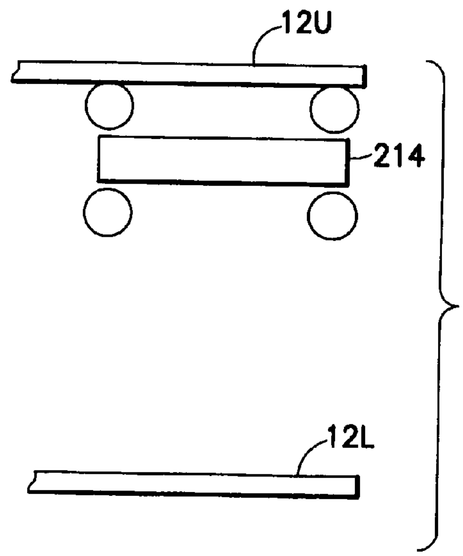


FIG.16C

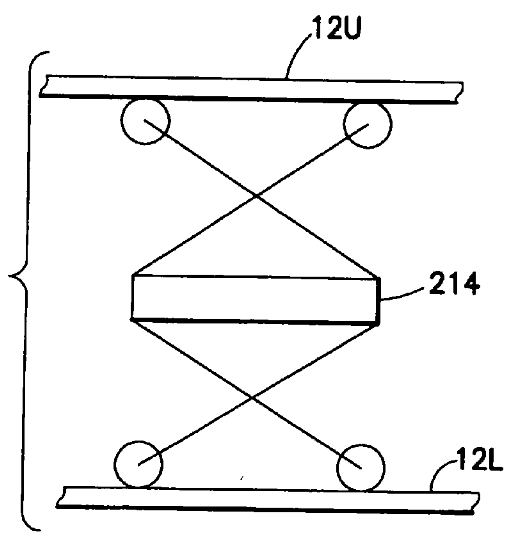


FIG.16B

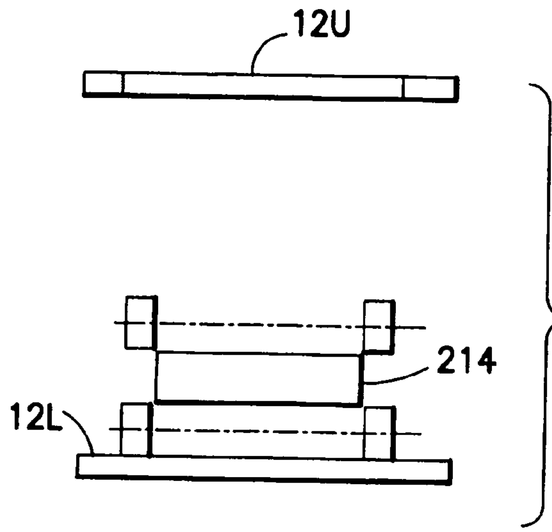


FIG.17A

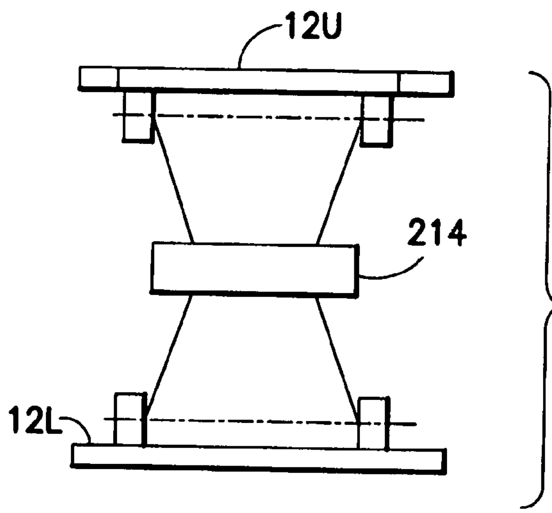


FIG.17B

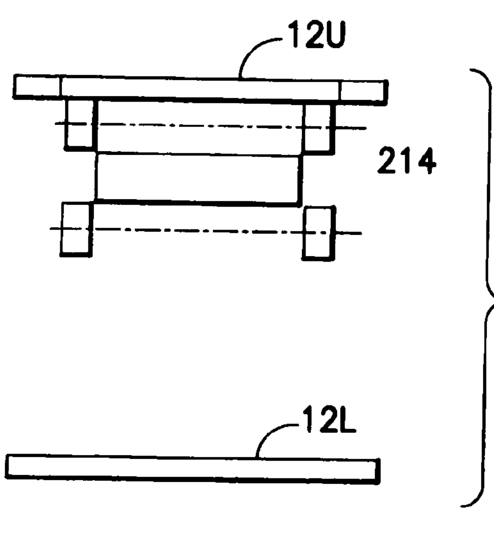


FIG.17C

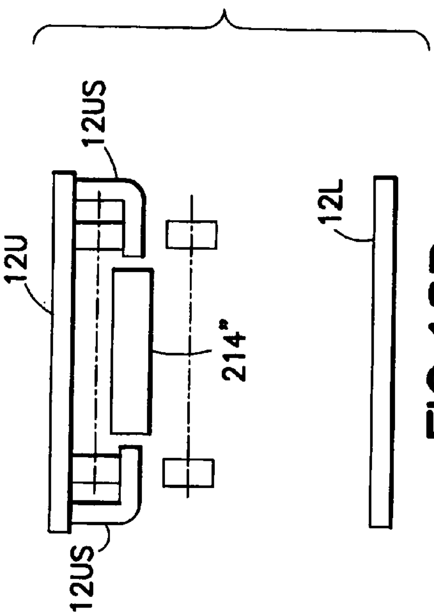


FIG.18B

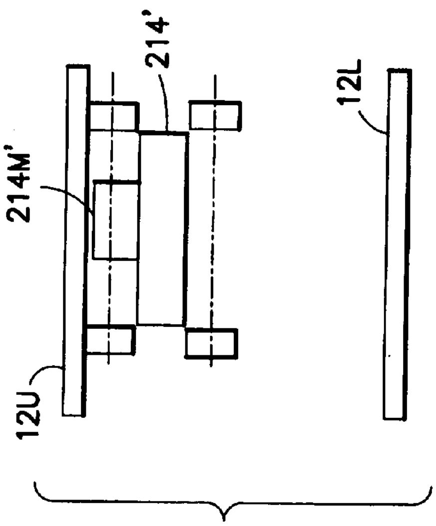


FIG.18A

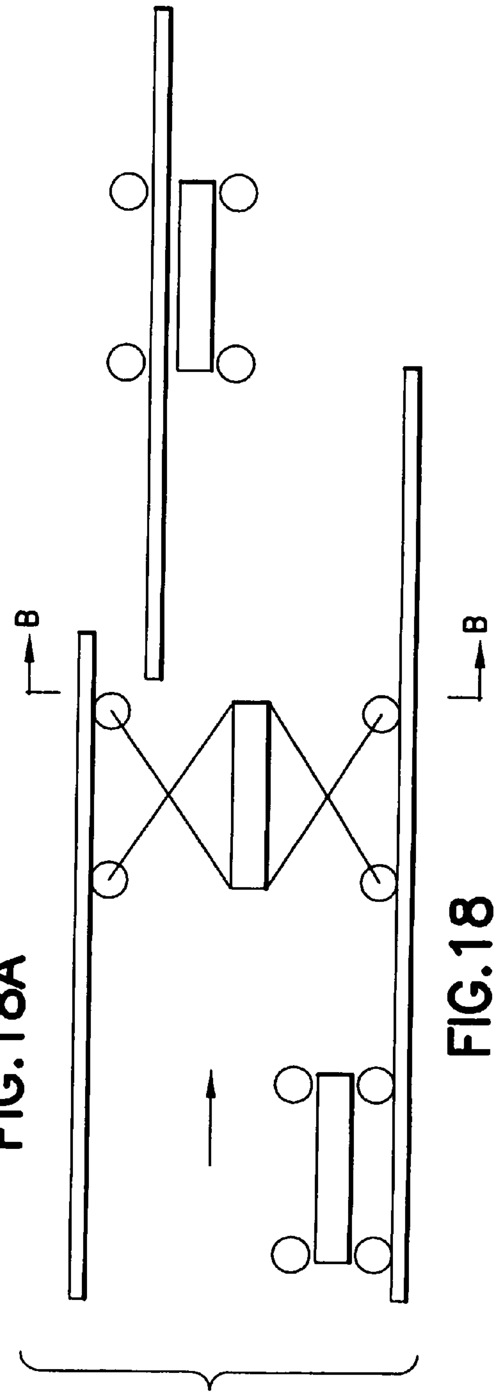


FIG.18

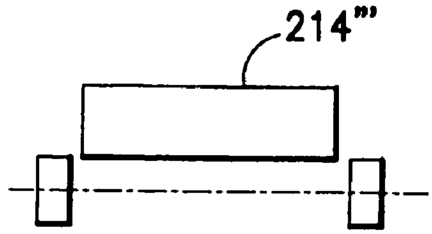


FIG. 19A

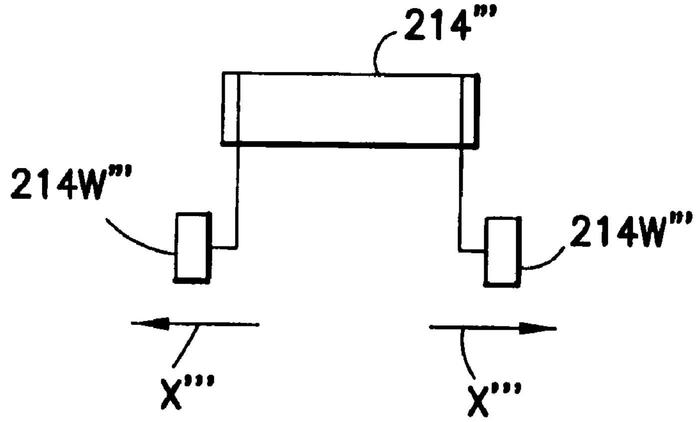


FIG. 19B

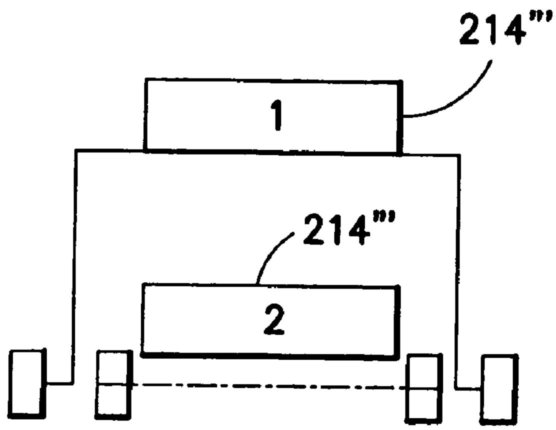


FIG. 19C

TRANSPORTATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. Provisional Application No. 60/604,406 filed Aug. 24, 2004 which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] 1. Field

[0003] A system and method are disclosed for transporting reduced-capacity wafer carriers within a semiconductor fabrication facility.

[0004] 2. Brief Description of Related Developments

[0005] There is a desire in the semiconductor industry to reduce wafer cycle time through the fab and reduce the amount of work in progress as well as to improve wafer safety. Studies have shown that by moving to a single wafer carrier, wafer cycle time and WIP (wafers in process) is significantly reduced. In addition for the next generation wafer size (450 mm) the ITRS roadmap calls for single substrate carriers. Benefits of using single wafer or reduced capacity carriers include WIP reduction, process changeover time reduction and product ramp time improvement. Problems arise where conventional single substrate carriers are employed relative to the ability of both the process tool and material transport system to effectively maintain the higher pace of the factory due to the larger number of carrier transport moves as compared to 13 or 25 wafer carriers. One example of such a problem includes where there is only one slot. It is desired that the robot in the process tool have the capability to quickly swap (fast swap) the wafer in the carrier so the carrier may be able to be replaced with another carrier that has an unprocessed wafer to keep the tool busy. Many such tools do not have the ability to fast swap, as in the case of a conventional single blade three axis robot. Another example of such a problem includes where there is only one slot. It is desired that the material transport system transporting carrier to tools in the IC FAB have the capability to supply carriers, at a high rate and quickly swap the carriers at the process tools load port(s) so that one carrier at the tool may be able to be replaced with another carrier that has an unprocessed wafer to keep the tool busy. Many such material transport systems do not have the ability to supply carriers at a high rate or with the capability to fast swap, as in the case of a conventional (overhead transport) OHT based material transport systems as implemented in conventional 300 mm fabs. Conventional material transport systems are highly rigid in the transport or movement scheme of the carriers transported thereby, and do not offer sufficient transport flexibility desired with carriers having reduced workpiece capacity (e.g. less than conventional 13 or 25 workpiece pods). For example, conventional transport systems, whether a continuous moving support based (e.g. conveyor belt or roller system) or a vehicle based e.g. discrete vehicles traversing on rails, tracks), employ substantially linear travel pathways with intersections or junctions for transport switching between different pathways. The travel pathways are generally unidirectional each allowing vehicles, or otherwise transported materials (e.g. workpiece carriers) moving on the pathway to move serially in sequence along the given direction of the pathway. Thus vehicles or transport material move along the pathway in progression with no availability of passing. Opposing pathways are provided for bidirectional movement (e.g. advance pathway and return pathway). In addition to service pathways, which communicate with the FAB tools/tool stations (i.e. the service pathway has locations where the transport material or vehicles traversing along the pathway may be stopped for interface to FAB tools), the conventional transport systems may have dedicated bypass or high speed (relative to the available transport speed on the service pathway that is limited by the inability to overtake stopped transport) pathways between pathway junctions. Nevertheless, the high speed pathways do not enable transport on a service pathway to pass stopped or slowed transport on the service pathway. Moreover transport along a high speed pathway of a conventional transport system remains linear (in serial sequence) still without ability to pass. Thus, if a transport stops on the high-speed pathway for whatever reason (e.g. breakdown) the other transport on the pathway cannot go around, pass the stopped transport, and continue on the pathway. As may be realized, the rigidity of the transport scheme of conventional material transport systems impairs the ability in directing workpieces to the full advantage of FAB tool availability with a commensurate degradation in the achievable FAB throughput. The exemplary embodiments overcome the problems of conventional systems as will be described in greater detail below.

[0006] Examples of transport systems, carriers and openers may be found in U.S. Pat. Nos. 6,047,812; RE38,221 E; 6,461,094; 6,520,338; 6,726,429; 5,980,183; 6,265,851 United States Patent Publications 2004/0062633, 2004/0081546, 2004/0081545; 2004/0076496 and pending Brooks Automation applications Ser. No. 10/682,808 all of which are incorporated by reference herein in their entirety.

SUMMARY OF THE EXEMPLARY EMBODIMENTS

[0007] In accordance with an exemplary embodiment a substrate transport system is provided. The system has a guideway and at least one transport vehicle. The transport vehicle is adapted for holding at least one substrate and capable of being supported from and moving along the guideway. The guideway comprises at least one travel lane for the vehicle and at least one access lane offset from the travel lane allowing the vehicle selectable access on and off the travel lane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing aspects and other features of the present invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

[0009] **FIG. 1** is a schematic top plan view of a substrate processing system incorporating features in accordance with an exemplary embodiment;

[0010] **FIGS. 1A-1B** are respectively another schematic top plan view and a schematic elevation view of the substrate processing system in **FIG. 1**;

[0011] **FIG. 2** is a schematic plan view of a substrate processing system in accordance with another exemplary embodiment;

[0012] **FIG. 3A** is a schematic to plan view of a transport system guideway and transport vehicle of the substrate processing system in accordance with another exemplary embodiment;

[0013] **FIG. 3B** is a schematic top plan view of a guide portion of the transport system guideway in accordance with another exemplary embodiment;

[0014] **FIG. 3C** is a schematic top plan view of the transport system guideway and a portion of the transport vehicle in accordance with another exemplary embodiment;

[0015] **FIGS. 4A-4B** are respectively a schematic plan view and elevation view of a transport system guideway and transport vehicle in accordance with another exemplary embodiment;

[0016] **FIGS. 5A-5B** are respectively a schematic plan view and elevation view of a transport system guideway and transport vehicle in accordance with another exemplary embodiment;

[0017] **FIG. 6** is a schematic elevation view of the transport system guideway and transport vehicles in accordance with another exemplary embodiment, the vehicles being shown in different positions on the guideway;

[0018] **FIG. 7** is a schematic top plan view of the transport system guideway, transport vehicle and carriers in accordance with another exemplary embodiment;

[0019] **FIGS. 8A-8C** are elevation views of the transport system guideways, transport vehicles and processing apparatus in accordance with still another embodiment; **FIGS. 8A-8B** are end elevations and **FIG. 8C** is a side elevation, and each respectively show the transport vehicles in different positions;

[0020] **FIGS. 9A-9E** are schematic elevation views showing a transport vehicle in accordance with respectively different exemplary embodiments;

[0021] **FIG. 10** is a schematic elevation view of the transport vehicle, carriers C on the vehicle, in accordance with another exemplary embodiment, buffer and load port stations of a processing tool;

[0022] **FIGS. 11 and 12**A-12C are respectively an elevation view of a portion of the transport vehicle and a carrier C registered to the vehicle, perspective views of carriers each having registration features in accordance with different exemplary embodiments, and **FIG. 12D** is a schematic cross-sectional view of a chuck in accordance with the prior art;

[0023] **FIG. 13** is a schematic elevation view of the transport system guideways, transport vehicle and a substrate processing station in accordance with another exemplary embodiment;

[0024] **FIGS. 14A-14D** are schematic plan views showing the motive system of the transport vehicle in accordance with different respective exemplary embodiments, and **FIG. 14E** is a schematic elevation view of the transport vehicle;

[0025] **FIG. 15** is a schematic plan of the transport vehicle control system;

[0026] **FIGS. 16A-16C** are side elevation views of a portion of transport system guideways and transport vehicle respectively showing the transport vehicle in three different positions, and **FIGS. 17A-17C** are end elevation views corresponding to the side views in **FIGS. 16A-16C**;

[0027] **FIG. 18** is a schematic side elevation view of transport system guideways and transport vehicle in accordance with another exemplary embodiment, the vehicle being shown in different positions; and **FIGS. 18A-18B** are cross-section views respectively taken along view lines A-A and B-B in **FIG. 18**; and

[0028] **FIGS. 19A-19C** are end elevation views of transport vehicle of the transport system in accordance with another exemplary embodiment, respectively showing the vehicle in different configurations.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0029] Referring to **FIG. 1**, a schematic plan view of a substrate processing system incorporating features of the disclosed embodiments, located in a fabrication facility or FAB is illustrated. Although the embodiments disclosed will be described with reference to the embodiments shown in the drawings, it should be understood that the embodiments disclosed can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

[0030] The substrate processing system **10** in the exemplary embodiment shown in **FIG. 1** is representative of any suitable processing system and generally comprises processing tools S (two are shown for example purposes) transport system **10** and system controller **300**. The transport system **10** generally comprises a guideway **12** and transport vehicles **14**. In the exemplary embodiment shown, the guideway **12** may be a passive guideway providing transport lanes TL, AL for the transport vehicles **14**. There is at least one travel lane TL and at least one access lane AL. The transport vehicles **14**.may be capable of autonomous travel (as will be described below) on paths along the lanes TL/AL formed by the guideway **12**. The transport vehicles **14** (two vehicles **14** as well as a recovery vehicle **14**R, described later are shown in **FIG. 1** for example purposes) are each capable of holding and transporting one or more substrate carriers C along the guideway to the desired processing tools or processing tool stations S connected by the guideway **12**. Vehicles **14** may be seated over or suspended from the guideway **12**. Vehicles may access the process tools S from the access lane AL. The travel lane TL is available to vehicles for bypassing stopped or slowed vehicles in the access lane AL. The vehicles may move freely between travel and access lanes and vice versa.

[0031] **FIG. 1** illustrates merely a representative portion of the guideway **12**, and the guideway may extend as desired, and have any suitable shape so that the transport paths provided thereby for the vehicles **14** allow the vehicles access to any desired number of tool stations S in any desired locations for transfer of carrier C between tool station and vehicle. The substrate processing tool at a given tool station S may be of any desired type such as a fabrication tool (e.g. The GX series tool from Brooks Automation Inc.), a stocker or sorter. The tool may have a casing or enclosure defining an interior space into which substrates (independent of carriers) or the carriers themselves are loaded/unloaded. A suitable example of a tool is disclosed in U.S. Patent Application titled "ELEVATOR-

BASED TOOL LOADING AND BUFFERING SYSTEM", attorney docket No. 390P011937-US(PAR), filed Aug. 23, 2005, incorporated by reference herein in its entirety. The carrier C may be any suitable type of carrier capable of holding workpieces such as substrates (e.g. 200, 300, 450 mm (or any other diameter/size semiconductor wafer, rectile or flat panel for flat panel displays). The carrier may have a casing capable of holding the substrates in a controlled atmosphere. The carrier C may be a reduced capacity carrier. Reduced capacity carriers may have a capacity of fewer than the conventional 13 or 25 wafers and may be constructed in a manner similar to the FOUP defined in SEMI 347, but characterized by reduced height and weight. A suitable example of a substrate carrier is disclosed in U.S. Patent Application titled "REDUCED CAPACITY CARRIER AND METHOD OF USE", attorney docket No. 390P011935-US(PAR), filed Aug. 19, 2005, which is incorporated by reference herein in its entirety. The carrier may be front (side) opening or bottom opening. In alternate embodiments, the carriers may be any other desired type of carrier as the features of the exemplary embodiments disclosed are equally applicable to transport system for any kind of workpiece carrier. The guideway **12** may be formed from any suitable structure and is shaped (i.e. has suitable rides surfaces **12**S for vehicles **14** to ride on and adequate width) in this embodiment to provide both, what shall be referred to as, a travel lane TL and an access lane AL (as will be further described). The guideway **12** may be located at any desired height in the FAB. For example, the guideway may be at floor level of the FAB (the edges or borders of the guideway shown in **FIG. 1** in such a case may not substantively exist (i.e. may not be formed by structure) but rather are virtually defined by the travel paths of the vehicles traversing along the lanes TL, AL (i.e. space envelope of the vehicles moving on the lanes). The guideway **12** may also be elevated, for example suspended from above or supported from below at a distance above the floor. As seen in **FIG. 1**, the guideway **12** may be positioned along a desired interface side of the tool stations S (or alternatively the tool stations may be located along the side of the guideway). The guideway **12** has interface stations I, corresponding to the locations of the tool stations S, where the vehicle may be stopped for transfer of carriers C between vehicle **14** and tool station S. The tool stations are located in the access lane AL. In this embodiment the transfer of carriers between tool station and vehicle at an interface station I is in a lateral direction to the guideway **12** (see also **FIG. 1B** which is an end elevation of interface station I). Referring also to **FIG. 2**, there is shown a schematic plan view of a transport system guideway **10'** in accordance with another exemplary embodiment. In the embodiment shown in **FIG. 2**, the guideway **12'**, which is generally similar to guideway **12** in the embodiment shown in **FIG. 1**, is located overhead the tool station S. In this exemplary embodiment, the interface station I on the guideway (which as seen in **FIG. 2** is in the access lane AL') may be defined by an opening O in the guideway structure. The opening is sized to allow carrier transfer to/from the vehicle **14'** in a direction normal (i.e. down) to the guideway. Such a pass-through O enables placement of the access lane directly over the loadports, thereby reducing the aisle width used to accommodate elevated guideways. The active element transitioning carriers to and from vehicles may reside on the vehicle or the mating equipment, or be grounded at the point of transfer. In alternate embodiments, the transfer direction from an overhead guideway may be a combination of lateral (outward) and down, and the guideway may not have a through hole for carrier passage during transfer (e.g. carrier transfer would be over the side). The vehicle is configured to be able to traverse the opening. As seen in **FIGS. 1-2**, in this embodiment the travel and access lanes TL, AL of the guideway are substantially co-planar and communicate with each other in a substantially unrestricted manner along the length of the guideway **12**. As may be realized the designation of the lanes as travel or access lanes is discretionary (the lane designation shown in the figures is for example purposes) as whether a lane serves as access or travel lane (or both) is related to the arrangement of the interface stations I (i.e. locations of tool stations). Moreover, the designation of access travel lane may be transient. For example, tool stations S, and hence interface stations I may be located in both lanes of a guideway **12"** (see **FIG. 1A**). In the exemplary embodiment shown in **FIG. 1A**, a vehicle **14"** is stopped at an interface station I", in what may be referred to, at least while the vehicle **14"** is stopped, as access lane AL". The adjoining lane serves as a travel lane for passing vehicles **14**A", and hence may be referred to as a travel lane. As seen in **FIG. 1A**, an interface station IA" may be located in that lane as well. However, the interface station IA" is unoccupied by a vehicle and hence the lane may operate as a travel lane. When locations of occupied interface stations I", IA" become reversed, then the designations of travel and access lanes respectively reverse. In alternate embodiments, the interface stations. I", IA" in the different lanes may be sufficiently distanced along the guideway so that a vehicle may weave around occupied interface stations in opposite lanes. In that case, each lane would have an access lane portion, generally commensurate with the interface station, and a travel lane portion located substantially across from the interface station in the opposite lane. The transport vehicle may transition/cross freely between lanes to continue unimpeded travel along the travel lane(s).

[0032] The guideway **12** may have a guidance system **16** connected to controller **300** for enabling vehicle guidance on transport paths T1, ALE, A1 along the travel lanes TL, AL of the guideway **12** (see **FIG. 1**). The travel paths on the travel lanes illustrated in **FIG. 1** are merely representative, and the vehicles may move along any desired transport path. In the exemplary embodiment shown in **FIG. 1**, the guidance system **16** may include positioning devices **16**A allowing for position determination of the vehicles **14** moving on the guideway lanes. The positioning devices may be of any suitable type such as continuous or distributed devices **16**T, such as optical, magnetic, bar-code, fiducial strips, that extend along the guideway and across (strip **16**A) the guideway. The distributed devices **16**P, **16**A may be read or otherwise interrogated by a suitable reading device on the vehicle **14** to allow controller **30** to establish one or both of longitudinal and/or lateral position of the vehicle on the travel, access lanes TL AL of the guideway as well as kinematic state of the vehicle. Alternatively, the devices LGP may sense, interrogate a sensory item on the vehicle to identify position/kinematics. The positioning devices **16**P may also include, alone or in combination with distributed devices **16**T, **16**A, discrete positioning devices (e.g. laser ranging device, ultrasonic ranging device, or internal positioning system akin to internal GPS, or internal reverse GPS) able to sense the position of the moving vehicle. The controller **300** may combine information from the guidance system **16** with position feed back information from the vehicle as will be described further below, to establish and maintain the transport path(s) of the vehicle along and between the travel and access lanes TL, AL of the guideway.

[**0033**] The guideway surface **12**S may also be formed to define vehicle physical guides S**16**T, S**16**A that may, if desired form part of guiding system **16**. In alternate embodiments the guideway may be provided with a guidance system with no physical guides. In other alternate embodiments, the guidance system may not have remote sensors. The guideway surface may include or have grooves, rails, tracks or any other suitable structure forming structural or mechanical guide surfaces to cooperate with mechanical guidance features on the vehicles **14**. The guideway surface **12**S may also include electrical lines, such as a printed strip, or conductor providing electronic guidance for the vehicles (e.g. electrical lines sending a suitable electromagnetic signal that is detected by suitable guidance system on the vehicles **14**). The guideway **12** also has power system **18** incorporated therein for powering the vehicles. The power system **18** may include a continuous power system **18**P, **18**T, **18**A, such as conductors or a printed strip, disposed on the guideway structure and capable of supplying power (e.g. AC current) to the vehicle **14** as it travels. Although in this embodiment the continuous power lines **18**P, **18**T, **18**A are shown separate from the guidance system **16**, **16**T, **16**A, in alternate embodiments the power lines may be incorporated into guidance means (e.g. the power lines may be used to provide electronic/electrical guidance for the vehicle). The power system **18** may also include for example discrete power supply stations **18**PD, where the vehicles **14** may be charged. The power supply stations **18**PD (one is shown only for example purposes) may be located as desired, such as at locations where the vehicles **14** are expected to stop, such as for example an interface station I where transfer of carriers may occur, as illustrated in **FIG. 13**. In embodiments where present, the guide surface S**16**T, S**16**A of the guidance system **16**, may define the paths T**1**, AL**1**, ALi on lanes TL, AL on which the vehicles **14** may travel (though it may also be possible for the vehicles **14** to travel on the guideway **12** off the paths on lanes TL, AL). Though only one lane TL, and accompanying access lane AL is shown for example in **FIG. 1**, the guideway **12** may encompass any desired number of travel and access lanes and any desired number of travel and access paths on the corresponding travel and access lines similar to lanes TL and AL. The other lanes may be parallel to lanes TL, AL, or may be disposed in any other orientation. The travel paths in travel lanes TL may include furcations **20** (structural in the case of physical guides, or virtual where no physical guides are used) where paths onto the access lane AL, AL**1**-Ali merge/diverge from the travel lanes TL paths. As seen in **FIG. 1A**, the access paths AL**1** (though only two are shown in **FIG. 1A**, the access lane AL of guideway **12** may have any desired number of access paths similar to path AL**1**, Ali disposed serially along path TL and/or in parallel at each furcation **20**) connect the travel path TLI to interface I where carrier transfer may occur between the vehicles **14** and an intermediate transport (not shown) servicing corresponding stations S. The access paths on the access lane AL may be defined by guidance system **16**, and again may be virtual in the case where no physical guides exist, or may be structural defined by portions S**16**A (and power supply means **18**PA), and may in this embodiment have two entry/exit portions at opposite ends of the access path as shown in **FIG. 1**. As seen in **FIGS. 1-2**, the access path AL**1**-Ali provides an access way as well as a side path or siding to travel path TL**1** (the vehicles **14** may be moved onto the access lane AL without having to transfer containers from or onto the vehicle at the interface) station. Thus, vehicles may be paused if desired on the access lane. Also, inoperable vehicles may be moved, for example using another vehicle, or manually onto the access lane. Further, the access lane may have as a buffer for queuing vehicle.

[**0034**] As noted before, at least one autonomous wheeled vehicle **14** is employed on the passive guideway **12**. The vehicle **14** may be propelled, for example, by an on-board electric motor **14**M through a friction drive. Energy for traction and other uses can be stored on the vehicle in ultra-capacitors and/or batteries, or as mechanical energy (e.g., with a flywheel). Recharging the stored energy can be accomplished at discrete locations **18**PD or continuously along the guideway **18**P, **18**PT, **18**PA through contacting or non-contacting means.

[**0035**] In the exemplary embodiment, ultra-capacitors **14**C may serve as the primary energy storage devices due to their potential for rapid recharge. While charging, energy is transferred from guideway **12** to vehicle **14** across mating contacts (not shown) in the form of alternating current. Transferring AC is desired to DC because it is inherently self-quenching relative to arcing, a common failure mode in DC contact charging. Additionally, there may be significant material cost and cost-of-ownership savings associated with the elimination of grounded DC supplies and improved distribution efficiency. In alternate embodiments however, DC current may be used.

[**0036**] As noted before, the exemplary embodiment, position feedback for vehicle trajectory control may be achieved by continuous odometry, using encoders and/or resolvers at the vehicle wheels, periodically updated using external references (e.g., optical or magnetic encoding, bar-codes, fiducials, laser- or ultrasonic-ranging, etc.) of the guideway guidance system **16**. **FIG. 15** is a schematic plan view of a vehicle **14** being guided between two positions (POS**1**, POS**2**). In this embodiment, POS**2** represents the position of the vehicle at an exemplary interface station I of the guideway and may be a final position. In **FIG. 15**, the initial position of the vehicle identified as POS**1** may be located anywhere on the guideway. For example, POS**1** may be on the access lane, or on the travel lane. The path PT between the initial and final positions of the vehicle is representative in this embodiment, and any suitable path may be selected by the controller **300**. The controller may identify initial position POS **1** of vehicle **14** from the vehicle encoder information, or guidance system **16** or both. The controller may continuously monitor the vehicle position, or may employ selective monitoring for example, arrival of the vehicle at position POS **1** (identified to the controller by the vehicle odometry information, or sensed by guidance system **16**) may cause the controller to identify the vehicle location. The controller may be suitably programmed to identify the destination of the vehicle (e.g. POS **2** or some other position past POS **2** and with respect to which POS **2** is a waypoint) and to send steering commands to the vehicle causing the vehicle to move along path PT to POS **2**. Position feedback when the vehicle is traversing along path PT may be provided as noted before.

[**0037**] **FIGS. 14A-14D** illustrate a vehicle capable of steering autonomously to merge and diverge among various travel and access lanes in accordance with different exemplary embodiments. The vehicles **14**A-**14**D illustrated in **FIGS. 14A-14D** are generally similar to each other and to vehicles **14** shown in **FIGS. 1-2**, except as otherwise noted. The vehicles **14**A-**14**D in accordance with the exemplary embodiments in **FIGS. 14A-14D**, have a substantially or near holonomic and substantially no-scuff steering system **14**AS, **14**BS, **14**CS, **14**DS. In the embodiment shown in **FIG. 14A**, the vehicle steering system **14**AS has four independently powered and steerable wheels **14**AW to provide near holonomic movement without scuffing. The embodiment shown in **FIG. 14B** has independently drive wheels, (on opposite sides) of the vehicle and a free caster. The exemplary embodiment shown in **FIG. 14C** has two steerable wheels **14**CSW at one side of the vehicle **14**C, and a single centered drive wheel **14**CDW at the other end of the vehicle. The exemplary embodiment in **FIG. 14D** has two steerable wheels **14**DSW and two wheels on a differential drive axis **14**DA. In alternate embodiments, the vehicle may have any other desired steering system. The autonomous steering allows the vehicles substantially free movement between travel and access lanes (TL, AL, see **FIGS. 1-2**) of the guideway. The location of points of furcation between travel and access lanes may be located as desired with minimal or no infrastructure impact (to facilitate tool movement, for example) or even dynamically (to avoid unexpected obstacles such as a disabled vehicles). Each vehicle may have an on board processor (not shown) with suitable memory to store a facility "map" to facilitate self-directed routing to the desired destination. If a blocked path is encountered, the vehicle may have the capability to adjust the trajectory to navigate around the obstruction along the guideway or to select an alternative path or guideway. Vehicles may also be provided with a wireless communication device (not shown) for wireless communication with other vehicles and/or base stations to enable information sharing for purposes such as dispatch coordination, location verification, error reporting, and path accessibility status. As noted before, the exemplary vehicles may traverse one or more flat, substantially featureless surfaces—ideally, the floor of the facility to minimize guideway capital investment and facilitate retrofitting to existing fabs. Such vehicles are contrasted with traditional (autonomous guided vehicles) AGVs that have been employed in semiconductor material handling. Typically, conventional AGVS load and unload payloads at operator interface points (e.g., at the 900 mm elevation in 300 mm wafer processing facilities) while navigating along the floor. To accommodate dynamic loads, conventional AGVs are tall; to prevent tip-over, particularly during seismic events, they are designed with a low center of gravity, and possess a mass much greater than that of the payload. As a consequence, robust operator integrity systems and performance limitations (such as reduced speed) are employed to allow them to properly co-exist with human operators. The vehicles **14** in this embodiment are intended to be used for point-to-point transfer only, on the floor or on dedicated guideway decks, therefore their (size and mass) scale is closer to that of the payload to be conveyed and rendering them dramatically more user friendly to operators. The small size of the vehicles allows them also to be manipulated easily by installation and/or service personnel. Referring to **FIG. 14E**, accommodations may be added to the vehicle **14**E to assist in manual handling (e.g., for recovery) such as features which accept a pole to allow manipulation of the vehicle without compromising ergonomics.

[**0038**] As noted before, in the vicinity of process tools, or, more generally, sources and destinations S, an access lane (or siding) AL is provided where vehicles **14** may decelerate, stop, and if desired transfer carriers (**FIG. 1**). The vehicle **14** moves from the high-speed travel lane into the access lane and decelerates to a stop then the vehicle delivers the carrier to a process tool, a tool buffer, or a storage shelf via interface I. When the carrier transfer is complete, the vehicle **14** accelerates in the access lane AL and merges back into a travel lane TL. While in the travel lane TL, the vehicle **14** may travel at a relatively constant velocity directly to a siding AL**1**, Ali on travel lane AL associated with the new destination. Thus, access lane AL provides sidings for the travel path TL, and conversely, the portions TLT of the travel path TL adjoining the access path AL provide a bypass to the sidings AL.

[**0039**] Referring now to **FIGS. 3A-3C**, routing may be accomplished with a binary (merge-diverge) path selection scheme, with the active switching elements **14**SW, **14**ST located on the vehicles **14**. **FIG. 3A** shows an exemplary embodiment in which the vehicle has active switching elements **14**SW, **14**ST. In this embodiment, the vehicle has guidance or switching element **14**SW at an end of the vehicle facing the travel direction T, A (one element **14**SW is shown, though the vehicle may have a switching element at each end). The switching element **14**SW may be mechanical or electronic. For example, the mechanical switch may include a cam surface, such as formed by a cam plate or cam rollers that is pivotably mounted to the vehicle chassis. The cam surface may be actuated or passive, and cooperates with the guidance surface S**16**T, S**16**A of the guidance system **16** in the guideway **12** (see **FIG. 1**) to position the cam surface in the direction of the path T**1**, AL**1**, Ali desired (see **FIG. 1**). The cam surface is connected by a suitable transmission mechanism or system (not shown) to steering system **14**ST (e.g. steerable wheels/rollers as shown in **FIGS. 14A-14D**, steerable magnets in the case the vehicle is borne by a magnetic levitation system). The input from the cam surface is transmitted mechanically or electronically to the steering gear **14**ST to steer movement of the vehicle on the desired path TL, AL. In the case the switching element **14**SW is electronic, a suitable sensor or detector is included to sense a desired characteristics (e.g. magnetic field, optical or RF signals) from the electronic guidance means **16**, and generate a steering signal processed by a servo or any other suitable steering motor controller to effect steering form the steering gear **14**ST. The active switching elements **14**SW, **14**ST on the vehicle **14** allow the vehicle to perform the switch, rather than relying on active track elements. This eliminates a potential single point of failure that could disable a portion of the network. It also affords flexibility in accommodating distributed or centralized control with minimal communication overhead.

[**0040**] **FIG. 3B** illustrates another exemplary embodiment, wherein moveable switches **16**W may be incorporated in the track, for example, to minimize the complexity of the vehicles. As seen in **FIG. 3B**, in this embodiment, the guidance system **16** has a switching element **16**SW located at furcation **20** along travel path TL. The switching element **16**SW is illustrated in this embodiment as being a mechanical element, though the switching element may also be electronic (with no moving parts). For example, the mechanical element has a switch plate or member **40** that is actuated by a suitable motor or actuator **42**. The switch plate **40** is actuated by actuator **42** between a first position O, in which the switch plate directs/guides the vehicle **14** to continue on travel path TL, and a second position P in which the switch plate directs the vehicle away (or onto depending on direction) from path TL and onto access path AL. Electronic switching (not shown) may be used in the embodiments where the vehicle is supported and traverses in guideway **12** (see **FIG. 1A**) using contactless means such as magnetic levitation or air bearings. The electronic switch is electronically analogous to the mechanical switching **16**SW shown in **FIG. 3B** but in place of the movable switch plate, generating for example a magnetic force operating to direct the vehicle to continue along travel path TL or move onto access path AL. A possible hybrid approach involves using the vehicle to deflect a selectively compliant track section by adhering to a cam surface as shown in **FIG. 3C**. In this exemplary embodiment, the guide means **16** include passively selectable switch element **16**SW located at a furcation **20** merging/diverging paths TL, AL. The switch element **16**SW is pivotable or movable between position O (substantially aligned with path TL) and position P (for transfer to path AL). The guide means **16** may also have a grounded cam surface **16**G as shown. The vehicle **14**, has a switch element **14**SW, similar to the embodiment in **FIG. 1**, but in this embodiment the switching element **14**SW on the vehicle operates to cause move of the switch **16**SW on the guideway thereby effecting desired steering of the vehicle **14**. The vehicle switching element here includes cam follower **14**C following grounded cam surface **16**G on the guideway, and actuation member **14**S connected to the cam follower **14**C by a suitable transmission system **14**T. The actuation member **14**S is positioned, based on input (mechanical or otherwise) from the cam follower **14**C, and in turn acts on the movable switch element **16**SW of the guideway **12** to position it in either position O or position P.

[**0041**] In addition to merging to and from access lanes, vehicles may switch between converging and diverging travel lanes to optimize their path from source to destination. Note that transport capacity may be increased by employing additional local, or fab-wide, vertically stacked parallel guideways **12**D, **12**L, as shown in **FIGS. 4A-4B**, and **5**A-5B. Several travel "decks"**12**U, **12**L may be stacked and have similar or opposed desired travel directions. In the embodiments shown in **FIGS. 4A-4B**, **5**A-5B, only two decks are shown for example purposes. Though in alternate embodiments any desired number of decks may be used. Decks **12**U, **12**L are each substantially similar to guideway **12** described before. Such decks may be adjacent to one another as shown, or deployed at different heights, as for example, one elevated guideway and one floor-level guideway. In the embodiment shown in **FIGS. 5A-5B**, a carrier transfer opening is located in the decks **12**V, **12**L as seen in **FIG. 5B**, in this embodiment, the carrier openings OP are aligned with each other. This allows a vehicle on the upper deck to transfer a carrier through the lower deck. In alternate embodiments, only the lower deck may have carrier openings.

[**0042**] The horizontal displacement between travel and access lanes in the exemplary embodiment described before is but one method to effect the desired separation between transport paths (where vehicles may travel between sources and destinations at a substantially constant speed) and access paths (where vehicles may accelerate/decelerate and stop—e.g., to transfer loads and/or recharge). Alternatives include merging and diverging between and among vertically displaced tracks, and allowing vehicles to pass other vehicles stopped in the same track by displacing some or all of the vehicle structure as desired.

[**0043**] **FIGS. 9A-9E** are schematic elevation views of a transport vehicle **114A-114**E of the transport system provided with an integral elevator mechanism in accordance with different respective exemplary embodiments. Except as otherwise noted, the vehicles are generally similar to each other, each having carrier support **114**ACS capable of supporting at least one carrier, and an elevator mechanism for raising and lowering the carrier support. In the embodiment shown in **FIG. 9A**, the elevator mechanism **1I4**AE may comprise substantially rigid reel members that are wound and unwound to raise and lower the support. In the embodiment shown in **FIG. 9B**, the elevator mechanism **114**BE may have scissoring members which are slidable at one end relative to the vehicle frame. Height adjustment is achieved by scissoring the members as desired via a motor and lead screw. In the embodiment shown in **FIG. 9C**, the elevator **114**CE has a three or four point link system that folds up and down when powered by a motor and lead screw. In the embodiment shown in **FIG. 9D**, the elevator **114**DE may have a telescoping rail or column arrangement, and in the embodiment shown in **FIG. 9E**, the elevator may have interlocking chain links capable of being wound and unwound. As may be realized, in alternate embodiment, any suitable elevating system (including fluidic and/or magnetic) may be used. Vehicles may also be provided with elevator mechanism both top and bottom as shown in **FIGS. 16A-16C** and **17**A-**17**C. Referring to **FIGS. 16A-16C** and **17**A-**17**C a vehicle **214** transitioning from the lower **12**L to upper track **12**U. The vehicle **214** in this embodiment is generally similar to vehicles **114A-114**E shown in **FIG. 9A-9E**, except in this embodiment vehicle **214** has top and bottom elevator mechanisms as shown. As may be realized from **FIGS. 16B and 17B**, one mechanism is to raise half-way up from the lower wheels while the upper mechanism raises the upper wheels the remainder of the way to the upper track. In alternate embodiments, the vehicle may have a single elevator with sufficient reach. After the upper wheels are attached to the upper track the lower wheels may be retracted and result in the configuration shown in **FIGS. 16C and 17C**. Transition of the vehicle from top to bottom guideways would be performed in the reverse manner. In this manner, the vehicle may hop over or under impeding vehicles on either upper or lower tracks. In this exemplary embodiment, the vehicle when riding along the upper track **12**U, is suspended from the upper track. The vehicle upper wheels may be held onto the upper track by any suitable means. For example, in the exemplary embodiment illustrated in **FIG. 18A** a vehicle **214'** is attached to the upper track by magnetic attraction. In this embodiment the upper track includes magnetic material, and the vehicle has a magnet **214**M' (permanent or electro/magnetic) or a permanent/electromagnetic chuck, as shown in **FIG. 12D**, that may be activated to hold the vehicle to the upper track. The chuck has a safe mode to maintain the vehicle on the track in the event of power interruption. In alternate embodiments, the vehicle may include magnetic material attracted to a suitable magnet in the track. **FIG. 18** shows a vehicle **214**" on the upper track supported by a support surface **12**US under the wheels. **FIG. 18** is a side view that shows vehicle **214**" transitioning from the lower to the upper track with the mechanical configuration in this exemplary embodiment. The upper support track **12**US may have openings where the upper wheels could pass through after which they would engage with the upper support track, followed by the retraction of the lower wheels. To lower from the upper to lower track, the lower wheels may be lowered in contact with the lower track before an opening in the upper support track released the upper wheels.

[**0044**] **FIGS. 19A-19C** illustrate a vehicle **214**", in accordance with another exemplary embodiment, passing another vehicle **214**A'" on the same track. **FIG. 19A** shows vehicle **214**'" in a first running position. **FIG. 19B** shows vehicle **214**'" as it raises its payload. At the same time as the payload is being raised the wheels **214**W'" are moved outward in the direction of arrows X'". This may be done by steering the wheels **214**W'" (which may be mounted on laterally displaceable linkage (not shown) as the vehicle moves forward. **FIG. 19C** shows vehicle **214**'" in its up position with wheels in an out position. In this condition, vehicle **214**A'" may pass under vehicle **214**'" between its wheels as shown. The opposite (i.e. inverted position) of this can be accomplished for a vehicle running on an upper track.

[**0045**] In alternate embodiments, transition between vertically displaced tracks if desired, may be accomplished by incorporating ramps (similar to access lanes AL shown in **FIG. 1** but providing offsets from travel path TL in both horizontal and vertical directions) along with horizontal vehicle steering or horizontal switches similar to those in **FIG. 3A-3C**. In this case vehicles would merge to a ramp, follow the ramp to the desired elevation, then merge into the appropriate travel deck. If such vertical displacement of vehicles were desired in an access lane, a vertical track switch as depicted in **FIG. 6** could be employed. In this case, the vertical displacement may be achieved by driving a vehicle **14** to an elevator **12**E that moves vehicles between vertically offset lanes **12**U, **12**L. Such an elevator may have extra guideway decks **12**E**1**-**12**E**3**, as depicted in **FIG. 6**, to replace the section used to transfer the vehicle, thus restoring a travel path for following vehicles.

[**0046**] As noted before, it may be desired to provide guideways **12** with default travel directions, indicated by arrows T**1**, A**1**, in **FIG. 1**, the vehicles **14** may have the capability of bi-directional travel to accommodate flexible routing and anomaly (e.g., obstructed path) handling. Bi-directional motion is achieved by controlling the vehicle drive motors **14**M in a forward and reverse direction. If a vehicle **14** becomes disabled, the drive motors may be neutralized and the vehicle may be pushed or pulled to a suitable siding by another vehicle. The "towing" vehicle may be another standard vehicle or a dedicated recovery vehicle **14**R (see **FIG. 1A**). In either case, the towing vehicle has the capability of overriding the switching element **14**SW (see **FIGS. 3A-3C**) or steering (see **FIGS. 14A-14D**) of the disabled vehicle to force its transition to an access lane. In the exemplary embodiment, this may be accomplished with a mechanical engagement using any suitable coupling (not shown). Alternatively, other vehicles may simply avoid a disabled vehicle by selecting alternate paths to their destinations (until the disabled vehicle is recovered by an operator) and/or steering around the disabled vehicle using a local obstacle detection sensing and a collision avoidance algorithm.

[**0047**] Referring now to **FIG. 10**, there is shown a schematic elevation view of a vehicle **314** at an interface station I of guideway **12** in accordance with another exemplary embodiment. Except as otherwise noted vehicle **314** is substantially similar to vehicles **14**, **114**, **214** described before. In this exemplary embodiment, vehicles **314** may have the capacity to hold two or more carriers C**1**, C**2** simultaneously. Two carriers C are shown in **FIG. 10** for example purposes, though the vehicle capacity may be any desired number of carriers. In this embodiment, vehicle **314** generally transport one carrier C fewer than the maximum, capacity leaving an open position **314**S**1**, **324**S**2** to enable "fast-swapping" (i.e., the introduction of one carrier immediately prior to, or simultaneously with, the extraction of another) The vehicle may interface with a handling system located at the tool station S to effect the fast swap transfer of carriers between vehicle **314** and handling system. In this embodiment, the handling system may transport the carriers to desired buffer and/or load port stations at the tool stations. The carrier **314** supports **314**S**1**, **314**S**2**, (as noted above two supports are shown, but the vehicle may have any desired number of carrier storage spaces) may be stacked vertically to accommodate side access or side-by-side for top access (e.g., by an overhead hoist). In either case, carriers may be supported from below (e.g., nesting on a horizontally disposed kinematic coupling) or using features on the top or sides of the carrier. For example, in the embodiment illustrated in **FIG. 10**, the carrier supports on the vehicle are configured to employ a side coupling which may be used alone if desired in cooperation with suitable carriers (e.g., reduced lot carriers as described before. **FIG. 11** illustrates a representative support **314**S' of the vehicle **314** (see **FIG. 10**) coupled to a face/side of carrier C. The coupling between support **314**S' and carrier may be at the kinematic registration/coupling face of the carrier used when the carrier is registered to a tool station load port. In this embodiment, the carrier may be a face opening carrier with the registration features located on the face with the opening. In this manner a single set of registration may be provided to the carrier commonly used for all carrier docking whether to a tool station, transport vehicle, etc. In alternate embodiments, coupling between the carrier support structure on the vehicle and carrier may be to any desired face/surface of the carrier. The coupling **314**SC between support structure **314**S**1** and carrier may be of any suitable type. For example, passive coupling or active coupling systems may be used similar to the registration systems disclosed in U.S. Patent Application titled "ELEVATOR-BASED TOOL LOADING AND BUFFERING SYSTEM" previously incorporated by reference. By way of example, the coupling **314**SC may include a permanent electro-magnetic chuck as illustrated in **FIG. 12D** that interacts with magnetic material in the carrier C. **FIGS. 12A-12C** show a carrier CA, CB, CC having magnetic material CAM, CBM, CCM positioned at or proximate the registration face of the carrier in accordance with a number of different embodiments. The permanent electromagnetic chuck is located in the vehicle support structure **314S1** and is arranged to suit the placement of the magnetic material in the carrier. Activation of the chuck captures the carrier to the vehicle and deactivation releases the carrier vehicle coupling. In any case, as noted before the configuration of support may be common among the vehicle nests and carrier nesting locations associated with tool interface devices (buffers, loadports, and the like) to minimize overall automation hardware complexity. Such a pass-through D enables placement of the access lane directly over the loadports, thereby reducing the aisle width required to accommodate elevated guideways. The active element transitioning carriers to and from vehicles may reside on the vehicle or the mating equipment, or be grounded at the point of transfer.

[**0048**] In the exemplary embodiment illustrated in **FIGS. 8A-8C**, the vehicle drives directly to the tool loadport, eliminating a separate carrier loading mechanism for transferring carriers from vehicle to load port docking stations. In the exemplary embodiment shown, upper and lower guideways **12**U, **12**L are located at elevations above and below the tool loading height. The upper and lower guideway **12**U, **12**L and vehicles are similar to those previously described. **FIG. 8A** shows a section view through the aisle of the FAB in which the guideways **12**U, **12**L are situated with tool stations S on either side of the guideways. This arrangement is exemplary and any other suitable arrangement may be provided. A load-port is attached to the front face of the tool station at a desired elevation (e.g. above) 900 mm. The vehicles **214** are located on the guideways as shown. The guideways in this embodiment are spaced vertically apart such that the vehicles on the lower and upper guideways do not interfere with each other at any time. Similar to **FIGS. 1-2**, the upper and lower guideways may each have a travel or a "fast" lane similar to lane TL in **FIG. 1**). In this embodiment, the travel/fast lane is located down the center and vehicles **214** may run freely at high speed while sidings (similar to access lanes AL in **FIG. 1**) next to the load-ports are used for the vehicles **214** to "pull off". When a vehicle **214**L has "pulled off" at a load-port, **FIG. 8B**. The vehicle is capable of raising, or conversely lowering, the payload C as desired to be level with any of a number of port locations thereby allowing access to any desired port locations. When the payload is at the appropriate level a mechanism located at the load-port may be used to transfer the payload to or from the vehicle. In a similar fashion, a payload may be transferred to/from a vehicle on the upper track except that the payload would be lowered from the vehicle. In this embodiment, running of the vehicles may be done with the payloads normally retracted. Although only one carrier payload is shown, the vehicle may as noted before also accommodate more than one payload at a time, (e.g. one above the other). Both payload positions may move simultaneously. **FIG. 8C** shows a front view of an EFEM with two load-ports, each for example with three reduced capacity carrier positions. The vehicle **214**L**1** on the lower track **12**L is shown with its payload raised to the second level. If vehicle travel is in the direction of the arrow Y it can be seen that another vehicle **214**L**2**, **214**V on the lower or upper track **12**L, **12**U may access the remaining load-port to either deposit or pick-up a payload. A vehicle **214**V on the upper track **12**U may also pull-off above the vehicle **214**L**1** on the lower track and wait until the lower vehicle has retracted its payload before the upper vehicle proceeds to access the ports at this location from above. As a completed payload is being removed and replaced by a vehicle, the process tool is accessing any one of the other locations as necessary.

[**0049**] As noted before the guideway **12** may be positioned at any desired elevation in the FAB. Such as the FAB floor (which uses minimal added infrastructure and enables easy operator access to vehicles), and the elevated right-of-way reserved in SEMI E**15** for overhead transportation. Alternatively, the guideway could be placed at other convenient elevations (e.g., below the raised metal floor, or near the loadport height). The vehicles are an exemplary flexibly deployable on guideways at any or several locations. In this way additional transport network capacity and coverage may be modified to suit the needs of a particular facility.

[**0050**] Security of the carrier "hand-off" between the transport system and tool loading/buffering stations may be managed by a time-optimized parallel I/O scheme similar to SEMI standards E

[**0051**] 23 and E84. Alternatively, the transportation and tool loading hardware can be treated as an integrated system, with all sensing and computation necessary to guarantee a safe transition residing locally.

[**0052**] Referring now to **FIG. 7**, if desired, carriers C may be transitioned to positions next to one or more of the access lanes AL to provide storage or buffering of the carriers at the process tools and fab wide buffering.

[**0053**] It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

1. A substrate transport system comprising:

a guideway; and

at least one transport vehicle adapted for holding at least one substrate and capable of being supported from and moving along the guideway;

wherein the guideway comprises at least one travel lane for the at least one vehicle and at least one access lane offset from the travel lane allowing the vehicle selectable access on and off the travel lane.

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