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Mechanically-adaptable hitch guide

Abstract

A hitch guide is provided that has wide ranging use for a plurality of different types of vehicles. The hitch guide can include at least one moveable guiding member, at least one moveable locking member configured to lock the guiding member in at least one fixed position and configured to disengage from the guiding member to enable the guiding member to move freely within an extended, defined range of motion. In various embodiments, a force applied to a portion of the guiding member causes the locking member and the guiding member to engage to lock the guiding member in the fixed position. Further, a force applied to a release of the locking member disengages the locking member and the guiding member is released from the fixed position, which enables a greater range of rotational motion of the guiding member to accommodate tight turns of a vehicle with cart in tow.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application claims benefit of U.S. Provisional Application No. 63/080,300, filed Sep. 18, 2020, and entitled FOLD-AWAY HITCH GUIDE, which is hereby incorporated by reference in its entirety.

FIELD OF INTEREST

(1) The present inventive concepts relate generally to a guide for coupling a payload to a hitch, and more particularly, but not exclusively, to a guide for coupling a payload to a hitch of an autonomous vehicle, such as an autonomous mobile robot, and/or manually operated vehicles.

BACKGROUND

(2) A storage facility is a facility primarily used for storage of goods for commercial purposes, such as a warehouse. The storage is generally intended to be temporary, as such goods ultimately may be intended for a retailer, consumer or customer, distributor, transporter or other subsequent receiver. A warehouse can be a standalone facility, or can be part of a multi-use facility. Thousands of types of items can be stored in a typical warehouse. The items can be small or large, individual or bulk. It is common to load items on a pallet for transportation, and the warehouse may use pallets as a manner of internally transporting and storing items.

(3) A well-run warehouse is well-organized and maintains an accurate inventory of goods. Goods can come and go frequently, throughout the day, in a warehouse. In fact, some large and very busy warehouses work three shifts, continually moving goods throughout the warehouse as they are received or needed to fulfill orders. Shipping and receiving areas, which may be the same area, are the location(s) in the warehouse where large trucks pick-up and drop-off goods. The warehouse can also include a staging area—as an intermediate area between shipping and receiving and storage aisles within the warehouse where the goods are stored. The staging area, for example, can be used for confirming that all items on the shipping manifest were received in acceptable condition. The staging area can also be used to build orders and pallets to fulfill orders that are to be shipped.

(4) Goods in a warehouse tend to be moved in one of two ways, either by pallet or by cart (or trailer). A pallet requires a pallet transport for movement, such as a pallet jack, pallet truck, forklift, or stacker. A stacker is a piece of equipment that is similar to a fork lift, but can raise the pallet to significantly greater heights, e.g., for loading a pallet on a warehouse shelf. A cart requires a tugger (or “tow tractor”), which enables a user to pull the cart from place to place.

(5) A pallet transport can be manual or motorized. A traditional pallet jack is a manually operated piece of equipment, as is a traditional stacker. When a pallet transport is motorized, it can take the form of a powered pallet jack, pallet truck, or forklift (or lift truck). A motorized stacker is referred to as a power stacker. A motorized pallet jack is referred to as a powered pallet jack, which an operator cannot ride, but walks beside. A pallet truck is similar to a powered pallet jack, but includes a place for an operator to stand.

(6) As with motorized pallet transports, a tugger can be in the form of a drivable vehicle or in the form of a powered vehicle along the side of which the operator walks. In either form, a tugger includes a hitch that engages with a companion part on the cart, such as a sturdy and rigid ring or loop.

(7) Various types of vehicles exist that can navigate without direct reliance on a human driver, such as autonomous mobile robots (AMRs), automatic guided vehicle (AGV), vision guided vehicles (VGV), and autonomous guided carts (AGCs), as examples. For purposes of brevity, such vehicles will be collectively referred to as autonomous vehicles. Autonomous vehicles in the form of pallet trucks and powered tuggers also exist. An autonomous vehicle can, therefore, be a mobile robot vehicle that can implement various types of auto-navigation technologies. Some of those technologies require the vehicle to follow markers or wires in the floor, while others use vision or lasers to navigate the vehicle without direct or remote control by an operator. Still other forms of auto-navigation technology can be used. Autonomous vehicles are often used in industrial applications to move materials around a manufacturing facility or a warehouse, such as in the case of AMR forklifts and AMR tuggers.

(8) When connecting a towable payload, such as a cart, to a hitch of an autonomous vehicle, a high degree of precision is required relative to the navigational accuracy of the autonomous vehicle.

Furthermore, payloads are often inconsistently placed at their designated pickup locations. This problem is generally addressed by using fixed guides to passively guide the payload coupling into the jaws of the hitch. Such fixed guides often take the form of a rigid ramp or rigid V-shaped plate secured to the hitch. Even if somewhat effective in guiding the hitch, such guides can limit rotation of the tongue, and therefore the cart, relative to the vehicle. That is, a fixed, rigid, and passive guide will contact the tongue of the cart payload during tight turns, such as when navigating in narrow aisles, and consequently limit the turn radius of the vehicle and payload. Therefore, fixed guides on the left and right sides of the hitch have the disadvantage that they limit the movement of the tongue during turns and, thereby, limit the overall turn radius.

(9) In some instances, a tongue of the payload can pivot on a horizontal axis, with the hitch defining the center of the rotation. A ramp guide with sides located below the hitch (or hitch plane) can guide and center the payload coupler ring and raise it to height of the hitch jaw, where it is captured. The payload tongue is subsequently held above the ramp guide when then hitch couples to the coupler ring. The ramp guide with sides located below the hitch has the disadvantage that it cannot be used for payloads in which the tongue is at a level of the hitch of the cart and above the ramp guide.

(10) FIG. **1**A is a side view of a vehicle **100** having a pintle hitch **110**, in accordance with the prior art. In this embodiment, the vehicle **100** is an autonomous tugger that could optionally be manually operated. In this embodiment, the vehicle includes a body **102**, which can house at least one battery and electromechanical controls used to drive and operate the vehicle. The vehicle can include three or more wheels **104**. Between a backrest **105** and the body **102** can be defined an operator area **106** where an operator can stand and operate the vehicle using operator controls **107** or the operator can ride along while the vehicle auto-navigates. As an autonomous vehicle, an operator is not required. But those skilled in the art will appreciate that the inventive concepts disclosed herein are not limited to autonomous vehicles. Vehicles without a fold-away hitch guide in accordance with the inventive concepts, are known in the art.

(11) In FIG. **1**A, a cart **150** includes payload portion **152**, a tongue **154**, and a tow ring **156**, all of which presently exist in the prior art. In operation, the vehicle's pintle hitch **110** can engage the tow ring **156** so that the vehicle **100** can tow the cart **150**. Guides exist that are configured to help direct a tow ring of a cart toward the pintle hitch. These guides tend to be a rigid piece of a metal that provide a static ramp or static V-shaped member **111** that attaches to the pintle hitch **110** to direct the tow ring **156** toward the pintle hitch **110**.

(12) Referring to FIG. **1**B, the rigid and static nature of the V-shaped guide **111** imposes rotational limitations on the tongue **154** once the tow ring **156** is engaged by the pintle hitch **110**. Without the V-shaped guide **111**, the tongue could rotate about ±100 degrees in the hitch plane P (see FIG. **1**A) with respect to a central axis X of the vehicle, where a Y axis is perpendicular to the X axis and both the X axis and the Y axis lie in the same plane P. But with the rigid V-shaped guide **111**, the tongue is limited in rotational range to a smaller angle (±Θ.sub.1) imposed by the left and right sides of the V-shaped guide, where Θ.sub.1<<100 degrees.

(13) It would be advantageous to provide a hitch guide that can effectively guide a hitch coupling to a hitch in the plane of the hitch, without significantly limiting the rotational range of payload tongue in tight turns. It would be advantageous to provide a hitch guide with movable parts, e.g., a hitch guide that can mechanically adapt to engage and guide a misaligned hitch coupling to a greater degree than provided by existing static, fixed, and passive guides. Other advantages of the inventive concepts will be apparent from this disclosure.

SUMMARY

(14) In accordance with aspects of the inventive concepts, provided is a vehicle hitch guide apparatus configured to couple to a vehicle and/or a hitch and to guide a hitch coupling to the hitch. The apparatus comprises at least one linkage configured to take one of a plurality of linkage configurations in response to an external force, the plurality of linkage configurations includes at

least one locked configuration to guide the hitch and at least one movable configuration having a defined range of motion.
(15) In various embodiments, the at least one linkage is configured to adapt to take a first linkage configuration in response to the external force and to transition to a second linkage configuration in response to a change in the external force.
(16) In various embodiments the first linkage configuration is a first locked configuration having a first angle relative to the hitch and the second linkage configuration is a second locked configuration having a second angle relative to the hitch that is different from the first angle.
(17) In various embodiments, the first linkage configuration is a locked configuration having a first angle relative to the hitch and the second linkage configuration is a movable configuration wherein at least a portion of the at least one linkage is rotatable within the defined range of motion.
(18) In various embodiments, the at least one movable configuration includes a movable configuration structured to that at least a portion of the linkage has a rotational range of motion of up to about 100 degrees relative to the hitch.
(19) In various embodiments, the at least one linkage includes a first guiding member configured to be disposed on a first side of the hitch and a second guiding member configured to be disposed on a second side of the hitch, opposite the first side of the hitch. The first guiding member can be adaptable to take a first set of the plurality of linkage configurations on the first side of the hitch and the second guiding member can be adaptable to take a second set of the plurality of linkage configurations on the second side of the hitch.
(20) In various embodiments, the at least one linkage comprises at least one locking member configured to lock or release the first guiding member to enable to the first guiding member to take each of the first set of the plurality of linkage configurations, and/or lock or release the second guiding member to enable to the second guiding member to take each of the second set of the plurality of linkage configurations.
(21) In various embodiments, the at least one locking member comprises a first locking member configured to mechanically lock and release the first guiding member and a second locking member configured to mechanically lock and release the second guiding member.
(22) In various embodiments, the first guiding member includes a first contact surface and the first locking member is configured to lock the first guiding member into a locked configuration in response to application of the external force to the first contact surface. Additionally, or alternatively, in various embodiments, the second guiding member includes a second contact surface and the second locking member is configured to lock the second guiding member into a locked configuration in response to application of the external force to the second contact surface.
(23) In various embodiments, the first locking member includes a first release surface and the first locking member is configured to disengage from and release the first guiding member from a locked configuration in response to application of the external force to the first release surface. Additionally, or alternative, in various embodiments, the second locking member includes a second release surface and the second locking member is configured to disengage from and release the second guiding member from a locked configuration in response to application of the external force to the second release surface.
(24) In various embodiments, the at least one locked configuration includes a plurality of locked configurations, each locked configuration having a different fixed angle relative to the hitch.
(25) In various embodiments, the at least one movable configuration includes a movable configuration having a range of rotation with a magnitude of up to about 100 degrees relative to the hitch.
(26) In various embodiments, the hitch apparatus can include one or more combinations of the above.
(27) According to another aspect of the inventive concepts, provided is a hitch guide apparatus, including at least one linkage configured to couple to a vehicle and/or a hitch. The apparatus

comprises a moveable guiding member configured to direct a hitch coupling to a hitch location and a moveable locking member responsive to an external force to lock the guiding member in at least one locked position and to disengage from and release the guiding member depending on a contact point of the external force on the guiding member and/or the locking member.
(28) In various embodiments, the locking member is configured to lock the guiding member in a locked position in response to a force applied to the guiding member.
(29) In various embodiments, the locking member is configured to disengage from and release the guiding member from a locked position when the external force is applied to the locking member.
(30) In various embodiments, the locking member is configured to lock the guiding member in a locked position when the external force is transitioned from the locking member to the guiding member.
(31) In various embodiments, the locking member and the guiding member are rotatable relative to the hitch.
(32) In various embodiments, the locking member and the guiding member are configured to rotate about different axes.
(33) In various embodiments, the different axes are parallel to each other.
(34) In various embodiments, the guiding member and the locking member are rotatable up to about 100 degrees away from the hitch.
(35) In various embodiments, the apparatus further comprises a base configured to couple to the vehicle and/or the hitch, wherein the locking member and/or the guiding member are coupled to the base.
(36) In various embodiments, the guiding member is rotatably coupled to the base at a first axis and the locking member is rotatably coupled to the base at a second axis that is parallel to the first axis.
(37) In various embodiments, the base comprises a stop configured to limit the rotation of the guiding member and/or the locking member.
(38) In various embodiments, the locking member is configured to lock the guiding member in one of a plurality of locked positions.
(39) In various embodiments, the locking member is configured to disengage from and release the guiding member to enable the guiding member to transition from a first locked position to a second locked position.
(40) In various embodiments, an angle of the guiding member to the hitch is greater in the second locked position than in the first locked position.
(41) In various embodiments, the locking member is configured to disengage and release the guiding member from any of the plurality of locked positions to enable the guiding member to move freely within a defined range of motion.
(42) In various embodiments, the locking member and the guiding member are each biased to a home position by one or more springs when the external force is not applied.
(43) In various embodiments, the guiding member has a distal end that includes a contact surface configured to receive the external force, the locking member has a distal end that includes a release surface configured to receive the external force, and in the home position, the release surface of the locking member extends beyond the contact surface of the guiding member
(44) In various embodiments, the home position, the release surface of the locking member extends through an opening defined by or in the guiding member.
(45) In various embodiments, the guiding member and the locking member have coplanar travel paths.
(46) In various embodiments, the guiding member and the locking member rotate within the same plane about different axes.
(47) In various embodiments, the locking member includes at least one notch configured to receive a portion of the guiding member to lock the guiding member in the at least one locked position. Additionally, or alternatively, in various embodiments, the guiding member includes at least one

notch configured to receive a portion of the locking member to lock the guiding member in the at least one locked position.
(48) In various embodiments, the at least one linkage includes a first linkage and a second linkage configured to be coupled to the vehicle and/or hitch on opposite sides of the hitch.
(49) In various embodiments, the first linkage comprises a first movable guiding member configured to direct a hitch coupling to a hitch location and a first moveable locking member responsive to an external force to lock the first guiding member in at least one locked position and to disengage from and release the first guiding member depending on a contact point of the external force on the first guiding member and/or the first locking member. And the second linkage comprises a second moveable guiding member configured to direct a hitch coupling to a hitch location and a second moveable locking member responsive to an external force to lock the second guiding member in at least one locked position and to disengage from and release the second guiding member depending on a contact point of the external force on the second guiding member and/or the second locking member.
(50) In various embodiments, the hitch apparatus can include one or more combinations of the above.
(51) In accordance with aspects of the inventive concepts, provided is a hitch guide apparatus, including a first base configured to couple to a vehicle and/or a hitch at a first side of the hitch; a first guiding member rotatably coupled to the first base and including a first guide surface to guide a hitch coupling; a first locking member rotatably coupled to the first base and responsive to an external force to lock the first guiding member in at least one locked position and to disengage from and release the first guiding member depending on a contact point of the external force on the first guiding member and/or the first locking member; a second base configured to couple to the vehicle and/or the hitch at a second side of the hitch; a second guiding member rotatably coupled to the second base and including a second guide surface to guide the hitch coupling; and a second locking member rotatably coupled to the second base and responsive to an external force to lock the second guiding member in at least one locked position and to disengage from and release the second guiding member depending on a contact point of the external force on the second guiding member and/or the second locking member.
(52) In various embodiments, the first and second locking members are configured to lock the respective first or second guiding member in a locked position in response to a force applied to the first or second guiding member.
(53) In various embodiments, the first and second locking members are configured to disengage from and release the respective first or second guiding member from a locked position when the external force is applied to the first or second locking member.
(54) In various embodiments, the first and second locking members are configured to lock the respective first or second guiding member in a locked position when the external force is transitioned from the first or second locking member to the respective first or second guiding member.
(55) In various embodiments, the first locking member and the first guiding member are configured to rotate about different axes. Additionally, or alternatively, in various embodiments, the second locking member and the second guiding member are configured to rotate about different axes.
(56) In various embodiments, the different axes are parallel to each other.
(57) In various embodiments, the first guiding member and the first locking member are rotatable up to about 100 degrees away from the hitch. Additionally, or alternatively, in various embodiments, the second guiding member and the second locking member are rotatable up to about 100 degrees away from the hitch.
(58) In various embodiments, the first base comprises a first stop configured to limit the rotation of the first guiding member and/or the first locking member. Additionally, or alternatively, in various embodiments, the second base comprises a second stop configured to limit the rotation of the

second guiding member and/or the second locking member.
(59) In various embodiments, the first locking member is configured to lock the first guiding member in one of a plurality of locked positions. Additionally, or alternatively, in various embodiments, the second locking member is configured to lock the second guiding member in one of a plurality of locked positions.
(60) In various embodiments, the first locking member is configured to disengage from and release the first guiding member to enable the first guiding member to transition from one locked position to another locked position. Additionally, or alternatively, in various embodiments, the second locking member is configured to disengage from and release the second guiding member to enable the second guiding member to transition from one locked position to another locked position.
(61) In various embodiments, an angle of the first or second guiding member relative to the hitch is different in each of the plurality of locked positions.
(62) In various embodiments, the first locking member is configured to disengage and release the first guiding member from any of the plurality of locked positions to enable the first guiding member to move freely within a defined range of motion. Additionally, or alternatively, in various embodiments, the second locking member is configured to disengage and release the second guiding member from any of the plurality of locked positions to enable the second guiding member to move freely within a defined range of motion.
(63) In various embodiments, the first locking member and the first guiding member are each biased to a first home position by one or more first springs when the external force is not applied. Additionally, or alternatively, in various embodiments, the second locking member and the second guiding member are each biased to a second home position by one or more second springs when the external force is not applied.
(64) In various embodiments, the first guiding member has a distal end that includes a first contact surface configured to receive the external force, the first locking member has a distal end that includes a first release surface configured to receive the external force, and in the first home position, the first release surface of the first locking member extends beyond the first contact surface of the first guiding member.
(65) In various embodiments, in the first home position, the first release surface of the first locking member extends through an opening defined by or in the first guiding member.
(66) In various embodiments, the second guiding member has a distal end that includes a second contact surface configured to receive the external force, the second locking member has a distal end that includes a second release surface configured to receive the external force, and in the second home position, the second release surface of the second locking member extends beyond the second contact surface of the second guiding member.
(67) In various embodiments, the second home position, the second release surface of the second locking member extends through an opening defined by or in the second guiding member.
(68) In various embodiments, the first guiding member and the first locking member have coplanar travel paths. Additionally, or alternatively, in various embodiments, the second guiding member and the second locking member have coplanar travel paths.
(69) In various embodiments, the first guiding member and the first locking member rotate within the same plane about different axes. Additionally, or alternatively, in various embodiments, the second guiding member and the second locking member rotate within the same plane about different axes.
(70) In various embodiments, the first locking member includes at least one notch configured to receive a portion of the first guiding member to lock the first guiding member in the at least one locked position. Additionally, or alternatively, in various embodiments, the first guiding member includes at least one notch configured to receive a portion of the first locking member to lock the first guiding member in the at least one locked position.
(71) In various embodiments, the second locking member includes at least one notch configured to

receive a portion of the second guiding member to lock the second guiding member in the at least one locked position. Additionally, or alternatively, in various embodiments, the second guiding member includes at least one notch configured to receive a portion of the second locking member to lock the second guiding member in the at least one locked position.
(72) In various embodiments, the hitch apparatus can include one or more combinations of the above.
(73) In accordance with aspects of the inventive concepts, provided is an automatic guided vehicle, comprising a hitch and the hitch guide as described herein and/or above
(74) In various embodiments, the vehicle is a warehouse vehicle.
(75) In various embodiments, the warehouse vehicle is a tugger.
(76) In various embodiments, the hitch is a pintle hitch.
(77) In accordance with another aspect of the inventive concepts, provided is a hitch guiding method, comprising configuring a vehicle with a hitch and the hitch guide apparatus as described herein and/or above. If a hitch coupling applies the external force to a guiding member, locking the guiding member into a locked position by a locking member. If the hitch coupling applies the external force to the locking member, the locking member disengaging from the guiding member and, when disengaged, the guiding member transitioning to another locked position. In each locked position, the guiding member directing the hitch coupling toward the hitch. The method further includes capturing the hitch coupling by the hitch.
(78) In various embodiments, the method further comprises after hitch capture, in response to an external force applied to the locking member, the locking member disengaging from and releasing the guiding member to enable the guiding member to rotate within a defined range of motion with respect to the hitch.
(79) In various embodiments, the defined range of motion with respect to the hitch is +/−100 degrees with respect to the hitch.
(80) In accordance with another aspect of the inventive concepts, provided is a hitch guide apparatus including at least one moveable guiding member, at least one moveable locking member configured to lock the guiding member in a fixed position and configured to disengage from the guiding member to enable the guiding member to move freely within a defined range of motion. A vehicle can be configured with the hitch guide apparatus and a hitch.
(81) In various embodiments, pressure applied to a portion of the guiding member causes the locking member and the guiding member to engage to lock the guiding member in the fixed position.
(82) In various embodiments, pressure applied to a release surface of the locking member disengages the locking member and the guiding member is released from the fixed position to enable motion of the guiding member within the defined range of motion.
(83) In various embodiments, the locking member comprises a distal end having a portion that includes a release surface and the release surface extends beyond a front face of the guiding member.
(84) In various embodiments, the locking member and the guiding member are each biased to a home position by one or more springs.
(85) In various embodiments, the guiding member and the locking member have coplanar travel paths.
(86) In various embodiments, the guiding member and the locking member are rotatable within the same plane but about different axes.
(87) In various embodiments, the locking member and/or the guiding member includes at least one notch configured to receive a portion of the guiding member and/or locking member to lock the guiding member in the fixed position.
(88) In various embodiments, the guiding member and the locking member form an apparatus having a proximal end configured for fixed coupling at a side of a hitch, wherein the guiding

member is configured to guide a hitch coupler to the hitch.
(89) In various embodiments, the hitch coupler is a tow ring coupler.
(90) In accordance with aspects of the inventive concepts, provided is a hitch guide system including a first and a second moveable guiding member and a first and a second moveable locking member. Each locking member is configured to lock the respective guiding member in a fixed position and configured to disengage from the respective guiding member to enable the respective guiding member to move freely within a defined range of motion.
(91) In various embodiments, each guiding member and respective locking member form an apparatus having a proximal end configured for fixed coupling at a side of an opposite side of a hitch, wherein each guiding member is configured to guide a hitch coupler to the hitch.
(92) In various embodiments, the hitch coupler is a tow ring coupler.
(93) In accordance with aspects of the inventive concepts, provided is an automatic guided vehicle including the hitch guide system as described above and a hitch.
(94) In various embodiments, the vehicle is a warehouse vehicle.
(95) In various embodiments, the warehouse vehicle is a tugger.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The present invention will become more apparent in view of the attached drawings and accompanying detailed description. The embodiments depicted therein are provided by way of example, not by way of limitation, wherein like reference numerals refer to the same or similar elements. In the drawings:
(2) FIG. **1**A is a side view of a vehicle having a hitch and towing a cart, in accordance with the prior art;
(3) FIG. **1**B is a top view of the vehicle with the cart in tow of FIG. **1**A, in accordance with the prior art;
(4) FIG. **2** is a top view of vehicle having a mechanically adaptable hitch guide, in accordance with the inventive concepts;
(5) FIG. **3**A is a perspective view of a hitch guide, in accordance with aspects of the inventive concepts;
(6) FIG. **3**B is a top view of the hitch guide of FIG. **3**A, in accordance with aspects of the inventive concepts;
(7) FIG. **3**C is a side view of the hitch guide of FIG. **3**A, in accordance with aspects of the inventive concepts;
(8) FIG. **3**D is a partial top view of the hitch guide of FIG. **3**A, in accordance with aspects of the inventive concepts;
(9) FIG. **4** is a perspective view of a base member of the hitch guide of FIG. **3**A, in accordance with aspects of the inventive concepts;
(10) FIG. **5** is a perspective view of the hitch guide of FIG. **3**A guiding a tow ring, in accordance with aspects of the inventive concepts;
(11) FIGS. **6**A and **6**B are perspective views of the hitch guide of FIG. **3**A with the tow ring captured, in accordance with aspects of the inventive concepts;
(12) FIGS. **7**A through **7**C are perspective views of the hitch guide of FIG. **3**A with the tow ring captured, in accordance with aspects of the inventive concepts;
(13) FIG. **8** is a perspective view of the hitch guide of FIG. **3**A with the tow ring captured and a cart tongue at about 100 degrees from a central axis, in accordance with aspects of the inventive concepts;
(14) FIG. **9** is a perspective view of another embodiment of a hitch guide, in accordance with

aspects of the inventive concepts;
(15) FIG. **10**A is a top view of the hitch guide of FIG. **9**, in accordance with aspects of the inventive concepts;
(16) FIG. **10**B is a top view of a portion of the hitch guide of FIG. **9**, in accordance with aspects of the inventive concepts; and
(17) FIGS. **10**C-**10**E are perspective views of portions of the hitch guide of FIG. **9** with a captured tow ring, in accordance with aspects of the inventive concepts.
DETAILED DESCRIPTION OF PREFERRED EMBODIMENT
(18) It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are used to distinguish one element from another, but not to imply a required sequence of elements. For example, a first element can be termed a second element, and, similarly, a second element can be termed a first element, without departing from the scope of the present invention. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.
(19) It will be understood that when an element is referred to as being “on” or “connected” or “coupled” to another element, it can be directly on or connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being “directly on” or “directly connected” or “directly coupled” to another element, there are no intervening elements present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., “between” versus “directly between,” “adjacent” versus “directly adjacent,” etc.).
(20) The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes” and/or “including,” when used herein, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof.
(21) In accordance with aspects of the inventive concepts, provided is a vehicle hitch guide apparatus configured to couple to a vehicle and/or a hitch and to guide a hitch coupling to the hitch. In various embodiments, the apparatus comprises at least one linkage configured to take one of a plurality of linkage configurations in response to an external force, the plurality of linkage configurations includes at least one locked configuration and at least one movable configuration having a defined range of motion. In a locked configuration, at least a portion of the linkage, e.g., a guiding member, is configured to take a locked position to stably guide the hitch coupling to the hitch. In a movable configuration, at least a portion of the linkage, e.g., the guiding member, can move to a different locked position, e.g., to widen a capture angle relative to the hitch. In another movable configuration, at least a portion of the linkage, e.g., the guiding member, can move freely within a limited and defined range of motion to avoid obstruction of a cart tongue to which the hitch coupling is attached, e.g., after hitch capture and in tight turns.
(22) FIG. **2** is a top view of a vehicle, a hitch, and cart in tow, and a hitch guide, in accordance with the inventive concepts. In this view, the vehicle **100**, the hitch **110**, and the cart **150** are similar to those of FIGS. **1**A and **1**B. In this embodiment, the vehicle includes a hitch guide **120** in accordance with aspects of the inventive concepts. The hitch guide **120** enables a greater range of capture and rotation than other hitch guides. As an example, in FIG. **2**, the hitch guide enables a rotation ±≈100 degrees (i.e., ±Θ.sub.2) of the cart **150** and cart tongue **154**, e.g., up to about 180 degrees. When compared to FIG. **1**A, Θ.sub.2>Θ.sub.1. The hitch guide can include at least one linkage that is adaptable in response to at least one external force, wherein each linkage can take a plurality of different linkage configurations. The plurality of linkage configurations can include at least one locked guiding linkage configuration and at least one unlocked linkage configuration.

(23) FIGS. **3**A-**3**D are views of an embodiment of the hitch guide **120**, in accordance with aspects of the inventive concepts. The hitch guide **120** can be mounted to or otherwise form part of a wide variety of hitches and/or vehicles. Such vehicles can include, but are not limited to, autonomous tuggers (e.g., see FIGS. **1**A, **1**B, and **2**). In various embodiments, the hitch guide **120** is mechanically-adaptable to effectively guide a hitch coupling to a hitch and enable a greater rotational range of a cart about or around a vertical axis Z of the hitch **110** once the cart's hitch coupling is captured by the hitch.
(24) In various embodiments, the hitch guide **120** can include two mechanically adjustable linkages, one on each side of the hitch. Each linkage can be adaptable to mechanically adjust its angle relative to the hitch, as well as to a central axis X of the vehicle and the vertical axis Z of the hitch. Each linkage is adaptable to take one of a plurality of fixed or locked positions, states, and/or configurations while guiding a hitch coupling to the hitch. Therefore, the hitch guide is mechanically adaptable during the guide and capture operation. Each linkage is also configured to mechanically adjust its angle relative to the hitch (and relative to the central axis X) during and after hitch capture. During capture, the linkage can widen its angle relative to the hitch (and central axis X) to guide a hitch coupling offset beyond the range of the linkage in a first locked position. After capture of the hitch coupling by the hitch, the linkage can unlock to enable a greater rotational range of motion of a tongue of a cart in tight turns, wherein the maximum angle is greater than the angle with the linkage in a locked position. These can be referred to as movable linkage configurations, rotational linkage configurations, and/or passive configurations. In various embodiments, therefore, the hitch guide **120** includes movable parts that can mechanically adapt to engage and guide a misaligned hitch coupling, e.g., a tow ring, to a greater degree than provided by existing static, fixed, and passive guides. In various embodiments, the movable parts of the hitch guide **120** can also mechanically adapt to enable a cart tongue to move without obstruction from the hitch guide within a limited and defined range of motion, e.g., ±100 degrees, after capture.
(25) In FIGS. **3**A-**3**D, the hitch **110** is a pintle hitch having jaws that open to receive a tow ring and that close to capture and secure the tow ring. Thus, hitch **110** is configured to receive and capture the hitch coupling **156** to accomplish a secure towable engagement. In other embodiments, the hitch and hitch coupling could take other forms, so long as the hitch is configured to receive and form a towable engagement with the hitch coupling. The hitch coupling **156** is located at a distal end of a tongue **154** of the cart **150**, i.e., distal from a cargo portion **152** of the cart (see FIG. **2**).
(26) In various embodiments, such as those of FIGS. **3**A through **3**D, the hitch guide **120** comprises a plurality of linkages. In this embodiment, the hitch guide includes a linkage **200** and a linkage **300**. Linkage **200** can be disposed on a first, or left, side of the hitch **110** and linkage **300** can be disposed on a second, or right, side of the hitch. That is, the linkages can be disposed on opposite sides of the hitch.
(27) Linkage **200** can comprise a moveable guiding member **220** and a corresponding moveable locking member **230**. The locking member **230** is configured to mechanically restrain motion of the moveable guiding member **220** during hitch coupling in some cases and to enable an increased range of motion of the guiding member **220** during hitch coupling in other cases. The locking member **230** is also configured to enable an increased range of motion of the guiding member **220** after hitch coupling, e.g., during tugging of a payload (e.g., a cart) by the vehicle **100**. In some embodiments, after capture of the hitch coupling, the linkage **200** can open to about 100 degrees relative to the central axis X of the vehicle (see Θ.sub.2 of FIG. **2**), wherein the hitch coupling **156** and tongue **154** rotate about the vertical axis Z of the hitch. In various embodiments, the locking member **230** can secure the guiding member **220** in one of a plurality of locked positions during the guiding and capture process.
(28) Linkage **300** can comprise a moveable guiding member **320** and a corresponding moveable locking member **330**. The locking member **330** is configured to mechanically restrain motion of the moveable guiding member **320** during hitch coupling in some cases and to enable an increased

range of motion of the guiding member **320** during hitch coupling in other cases. The locking member **330** is also configured to enable an increased range of motion of the guiding member **320** after hitch coupling, e.g., during tugging of a payload (e.g., a cart) by the vehicle **100**. In some embodiments, after capture of the hitch coupling, the linkage **300** can open to about 100 degrees relative to the central axis X of the vehicle (see Θ.sub.2 of FIG. **2**), which can be measured from and pass through a vertical axis Z of the hitch. In various embodiments, the locking member **330** can secure the guiding member **320** in one of a plurality of locked positions during the guiding and capture process.

(29) In various embodiments, the guiding members **220**, **320** function to guide the hitch coupling **156** into the jaws of the pintle hitch **110**. The locking members **230**, **330** function to constrain movement of its respective guiding member **220**, **320** between a plurality of locked positions while the hitch coupling **156** is in contact with and travels along the guiding member **220**, **320** as the guiding member guides the hitch coupling **156** to the hitch **110** until the hitch coupling is captured by the hitch. In various embodiments, the locking members **230**, **330** are configured to limit a range of motion of their respective guiding members **220**, **320** in the horizontal direction, e.g., in the hitch plane P, while the guiding member guides the hitch coupling to the hitch. Additionally, in various embodiments, each locking member **230**, **330** is configured to release (or unlock) its respective guiding member **220**, **320** to allow its guiding member to move within a larger, extended range of motion, e.g., ±Θ.sub.2 of FIG. **2**, in the horizontal direction, e.g., within the hitch plane P. Each of the locking members **230**, **330** is configured to release its guiding member **220**, **320** in response to physical engagement by the hitch coupling **156** of the cart **150** prior to capture, or in response to physical engagement by the cart tongue **154** after capture.

(30) In various embodiments, each linkage includes a base. In this embodiment, linkage **200** includes base **240** and linkage **300** includes base **340**. The base **240**, **340** can be steadfast and immovable with respect to the hitch **110**, the vehicle **100** from which the hitch extends, the guiding member **220**, **320**, and the locking member **230**, **330**. In this embodiment, each base **240**, **340** securely couples to the hitch **110** and/or to the vehicle **100** to which the hitch is connected. For linkage **200**, the guiding member **220** and the locking member **230** are coupled to the base **240** by hinge pins. Similarly, for linkage **300**, the guiding member **320** and the locking member **330** are coupled to the base **340** by hinge pins. The linkages **200**, **300** are disposed sufficiently close to the hitch **110** so that a hitch coupling **156** traveling along a guiding member **220**, **320** would be led by the guiding member to be received by the hitch **110**. In various embodiments, the linkages **200**, **300** guide the hitch coupling **156** in the hitch plane P (see FIG. **1**A), wherein the hitch plane can be considered to be parallel to the ground surface on which the vehicle and cart travel. The hitch and hitch coupling can be considered to lie in the hitch plane P. The vertical hitch axis Z can be perpendicular to the hitch plane P.

(31) In various embodiments, the linkages **200**, **300** are structured and arranged so that each guiding member **220**, **320** and its locking member **230**, **330** have horizontal travel directions. Additionally, in various embodiments, the guiding members **220**, **320** and the locking members **230**, **330** have different vertical axes of rotation, wherein the different axes can be parallel to each other. These axes of rotation of each guiding member **220**, **320** and its locking member **230**, **330** are defined by the hinge pin connections to the base.

(32) Various hinge pins **245**, **247**, **345**, **347** connecting the guiding members and the locking members to their respective bases **240**, **340** enable rotational travel of each member. This configuration enables the hitch guide **120** to guide the hitch coupling **156** of the cart **150** to a hitch **110** of a vehicle for capture, even when the alignment of the hitch coupling is off-centered relative to the hitch **110**, e.g., offset to the right side or left side of the hitch. In either case, the hitch guide **120** is configured to guide the off-centered or offset hitch coupling **156** to the hitch **110** so that the hitch coupling **156** is effectively directed to and captured by the hitch **110**. Once engaged in this manner, towing of the cart **150** can commence.

(33) FIG. **4** is a perspective view of an embodiment of the base **240** of first linkage **200** of the hitch guide **120** of FIGS. **3**A-**3**D, in accordance with aspects of the inventive concepts. The base **240** includes first and second sides **241***a*,*b* extending in the same direction from a central portion **243**. The first and second sides **241***a*,*b* can be parallel or substantially parallel to each other. In this embodiment, the central portion **243** lies in a plane that is perpendicular or substantially perpendicular to the first and second sides **241***a*,*b*.

(34) A base stop **242** extends from the central portion **243** of the base **240**, in this embodiment. The stop **242** can provide a fixed limit to the range of rotational motion of the guiding member **220**. In this embodiment, the stop **242** takes the form of a tab formed from a cutout of the central portion **243** that is bent between the first and second sides **241**,*a*,*b*. A slot **248** is formed in the central portion **243** of the base **240**, wherein the slot is adjacent to the stop and between the first and second sides **241***a*,*b*. In this embodiment, the base **240** is formed so that when the tongue **154** of the cart **150** rotates and the hitch guide **120** linkage **200** is in an unlocked state, e.g., as seen in FIG. **8**, the tongue **154** of the cart moves within the slot or cutout **248** of the base **240** as it rotates. That is, in various embodiments, other than the stop **242**, the base does not limit the range of motion of the guiding member **220**, locking member **230**, or tongue **154** of the cart during turns. The stop **242** restricts or limits the movement of the guiding member **220**, and thereby the tongue **154** of the cart, and defines a terminus of the slot **248** and rotation of the guiding member and locking member. The stop, therefore, can define the maximum rotation of the guiding member, or define a range of motion or limit of the guiding member.

(35) In the embodiment shown, the first side **241***a* is arranged as a top side of the base and the second side **241***b* is arranged as a bottom side of the base, opposite the top side. The first side and the second side include corresponding first hinge pin holes **244** that are vertically aligned to define a first axis of rotation for the locking member **230**. The first side and the second side include corresponding second hinge pin holes **246** that are vertically aligned to define a second axis of rotation for the guiding member **220**, which is different form the first axis of rotation of the locking member. In various embodiments, the first and second axes of rotation are in parallel.

(36) In accordance with aspects of the inventive concepts, the second linkage **300** of the hitch guide **120** of FIGS. **3**A-**3**D includes a base **340** that is substantially similar to base **240**. In various embodiments, base **340** is the mirror of base **240**.

(37) In the present embodiment, hinge pins **245** couple the locking member **230** to the base **240** through first hinge pin holes **244** and hinge pins **247** couple the guiding member **220** to the base **240** through second hinge pin holes **246**. Similarly, hinge pins **345** couple the locking member **330** to the base **340** through first hinge pin holes **344** and hinge pins **347** couple the guiding member **320** to the base **340** through hinge pin holes **346**. In other embodiments, a bolt or a post could be an alternative to hinge pins, as examples.

(38) In FIGS. **3**A-**3**D, both of the guiding members **220**, **320** and the locking members **230**, **330** are spring loaded to remain in a home or neutral position when no external forces are acting on the guiding members **220**, **320** or on the locking members **230**, **330**. In various embodiments, a single spring provides tension to both the locking member and a corresponding guiding member. In the present embodiment, proximate to the first side **241***a* of the base **240**, the first linkage **200** includes a first spring **232** that has one end coupled to a proximal end (closest to the base **240**) of the guiding member **220** and its opposite end coupled to a proximal end of the locking member **230**. The first linkage **200** could also include a second spring similarly oriented at the second side **241***b* of the base **240** and coupled to the proximal ends of the guiding member **220** and the locking member **230**. In the present embodiment, proximate to the first side **341***a* of the base **340**, the second linkage **300** includes a third spring **332** that has one end coupled to a proximal end of the guiding member **320** (closest to the base **340**) and its opposite end coupled to a proximal end of the locking member **330**. The second linkage **300** could also include a fourth spring similarly oriented at the second side **341***b* of the base **340** and coupled to the proximal ends of the guiding member

320 and the locking member **330**.
(39) In various embodiments, each guiding member **220**, **320** includes a flat or substantially flat front surface **222**, **322** along which the hitch coupling **156** can travel toward the hitch **110**. Therefore, the front surface **222**, **322** is configured as a guide surface for a hitch coupling. In various embodiments, the front surface **222**, **322** can be substantially straight, flat, and smooth. In other embodiments, the front surface need not be straight; it could be curved or have curved portions. In some embodiments, the front surface could be concave or convex, or include at least one concave portion and/or at least one convex portion. In some embodiments, the front surface can include at least one curved portion and at least one straight portion. In some embodiments, the front surface can include portions that are not smooth. For example, some portions could be textured, or the entire front surface could be textured. The front surface **222**, **322** is structured, shaped, and arranged to guide a hitch coupling to a hitch. Those skilled in the art will appreciate that the front surface can take different forms in different embodiments.
(40) In various embodiments, the front surface **222**, **322** of each guiding member **220**, **320** can include at least one contact **228**, **328**. In some embodiments, each contact **228** can comprise at least one bumper, such as a rubber, silicone, or other durable cushioning piece. In some embodiments, the contact need not include at least one bumper. The contact **228** can be configured as a contact point for a hitch coupling during the guiding and capturing process and as a contact point for a hitch tongue **154** during a towing operation. In various embodiments, this contact point can also be formed from each guiding member **220**/**320**.
(41) In various embodiments, each guiding member **220**, **320** can comprise a locking portion **225**, **325** configured to engage with a respective locking member **230**, **330**. The locking portion **225**, **325** can take the form of at least one notch, groove, recess, protrusion, or the like in different embodiments. In this embodiment, each locking portion **225**, **325** comprises at least one notch formed at a distal end and rear side **224**, **324** of the guiding member **220**, **320**. In this embodiment, each locking portion **225**, **325** includes a plurality of notches. For example, in this embodiment, the locking portion **225** of the guiding member **220** include first notch **225***a* and second notch **225***b*. And, in this embodiment, the locking portion **325** of the guiding member **320** includes first notch **325***a* and second notch **325***b*. In various embodiments, the locking portion **225**, **325** includes a stepped portion including the plurality of notches.
(42) In various embodiments, each of the locking members **230**, **330** is structured to include a distal end having a capture **234**, **334** configured to engage a portion of the respective guiding member **220**, **320** to lock the guiding member **220**, **320** in place, i.e., in a fixed or locked position or linkage configuration. In various embodiments, each locking member **230**, **330** the capture **234**, **334** includes a U-shaped portion configured to engage a notch from the plurality of notches **225**, **325** of the guiding member **220**, **320**. For example, the U-shaped capture **234** of the locking member **230** can be configured to engage the first notch **225***a* of the guiding member **220** in a first locked position and engage the second notch **225***b* in a second locked position. The linkage **300** can include similar parts, structured and arranged for similar operations, including first and second locking positions.
(43) In various embodiments, the locking member **230**, **330** is also structured to include a distal end having a portion that includes the release **238**, **338** that, when engaged, disengages the locking member **230**, **330** from its corresponding guiding member **220**, **320**. In some embodiments, the release **238**, **338** extends beyond or in front of the front face **222**, **322** of the guiding member **220**, **230**. In some embodiments, the release **238**, **338** passes though an opening defined at a distal end of the corresponding guiding member **220**, **320**. Therefore, at least a portion of the release **238**, **338** is engageable from and/or through the front surface **222**, **322** of the guiding member **220**, **320**.
(44) In some embodiments, the release **238**, **338** includes at least one bumper, such as a rubber, silicone, or other durable cushioning piece. The release or bumper **238**, **338** can be configured as a contact point for a hitch coupling during the guiding and capturing process and as a contact point

for a hitch tongue **154** during a towing operation. For example, the bumper can extend past the front face of the guiding member **220**, **320** so that the release/bumper is engageable from and/or through the front surface **222**, **322** of the guiding member **220**, **320**. In some embodiments, the release **238**, **338** need not include a bumper.

(45) The locking member **230**, **330** is also formed such that when the hitch coupling **156** is captured, e.g., a tow ring is physically engaged with a pintle hitch **110**, the locking member **230**, **330** can be moved out of a locking position when engaged by a part of the payload structure, e.g., a tongue **154** of the cart **150**, thereby unlocking the guiding member **220**, **320** to enable the guiding member to move freely within a defined, extended range of motion. In this embodiment, the hitch guide **120** includes the two linkages **200**, **300**, one on either side of the hitch **110**. In various embodiments, each linkage enables an extended range of motion for the cart **150** and/or its tongue **154** of up to about ±100 (±θ) degrees about a vertical axis Z passing through the engagement of the hitch coupling **156** and the hitch **110**. Together, the two linkages, one left and one right of the hitch **110**, can enable an extended range of motion for the cart **150** and/or its tongue **154** of up to about 180 degrees about the vertical axis Z passing through the engagement of the hitch coupling **156** and the hitch **110**.

(46) Guided Capture

(47) The hitch guide **120** includes linkages **200**, **300** that can mechanically adapt based on an initial point of contact by a hitch coupling **153**. In various embodiments, if the hitch coupling **153** initially contacts the guiding member **220**, **320**, the locking member **230**, **330** locks the guiding member **220**, **320** in a first locked position. In various embodiments, if the hitch coupling **153** initially contacts the locking member **230**, **330**, the locking member releases the guiding member **220**, **320** from the first locked position so that the guiding member can open wider. Then, the locking member **230**, **330** locks the guiding member **220**, **320** in a second locked position, wherein an angle of the guiding member **220**, **320** is with respect to the central axis X in the second locked position. In various embodiments, as the hitch coupling **153** travels down the front face of the guiding member toward the hitch, the guiding member can return to the first locked position.

(48) While guiding the hitch coupling **156** toward the hitch **110** for capture, each linkage **200**, **300** is structured and arranged such that, in response to initial contact by the hitch coupling **156**, the locking member **230**, **330** engages and locks the guiding member **220**, **320** to limit and/or prevent movement of the guiding member **220**, **320**, e.g., in the horizontal direction toward the vehicle **100**. Otherwise, during the process of guiding the hitch coupling **156** toward the hitch **110**, each of the two linkages **200**, **300** is structured and arranged such that in response to initial contact of a release **226** of the locking member **230** by the hitch coupling **156**, the locking member **230** disengages and unlocks (or releases) the guiding member **220** to enable movement of the guiding member **220**, e.g., rotation in the horizontal direction, which allows the linkage to further open (outward and toward the vehicle) so that the hitch coupling engages the guiding member **220**, **320** after initially engaging the release surface **238**, **338** of the locking member **230**, **330**. In either case, the guiding member **220**, **320** ultimately guides the hitch coupling **156** to be captured by the hitch **110**.

(49) FIG. **5** is a perspective view illustrating an embodiment of a guided capture by the hitch guide **120** of FIGS. **3**A-**3**D, in accordance with aspects of the present invention. In this embodiment, the hitch coupling **156** has contacted linkage **200** at a front face **222** of the guiding member **220**. The locking member **230** has locked the guiding member **220** in place. In FIG. **5**, the U-shaped capture **234** of the locking member **230** is engaged with the first notch **225***a* of the guiding member to lock the guiding member in place. As the coupling ring **156** at the end of the tongue **154** of the cart **150** engages with the front face **222** of the guiding member **220**, the hitch guide **120** is maintained in the locked position or state. When the guiding member **220** is locked in place it acts as a rigid guide to the coupling ring **156**, and the coupling ring **156** is directed toward the jaw of the hitch **110**. In the locked position or state, the pressure applied to the guiding member **220** by the coupling ring **156** pushes the first notch **225***a* of the guiding member and the capture **234** at the distal end of the

locking member **230** into a locked engagement, thereby locking the guiding member **220** in place.
(50) Post-Capture Adjustments
(51) FIGS. **6**A and **6**B are perspective views of the hitch guide **120** of FIG. **3**A with the tow ring captured and partially rotated, in accordance with aspects of the inventive concepts. FIGS. **7**A through **7**C are perspective views of the hitch guide **120** of FIG. **3**A with the tow ring captured and further rotated, in accordance with aspects of the inventive concepts. And FIG. **8** is another perspective view of the hitch guide **120** of FIG. **3**A with the tow ring **156** captured and a cart tongue **154** at about 100 degrees from a central axis X, in accordance with aspects of the inventive concepts.
(52) Referring to FIGS. **6**A-**6**B, the tow ring **156** has been captured by the hitch **110**. After capture, the vehicle **100** has initiated a turn, such as a left turn, causing the cart **150** and its cart tongue **154** to rotate about the hitch axis Z. Therefore, the cart tongue is rotated off of and away from the central axis X, about the hitch axis Z.
(53) As the cart tongue **154** rotates, it first contacts release (bumper) **238** of the locking member **230**. This contact disengages the guiding member **220** and the locking member **230**. In various embodiments, this contact pushes the locking member **230**, causing it to rotate outward relative to its base **240**, toward the vehicle, and away from the central axis X This rotation disengages the U-shaped capture **234** from the first notch **225***a* of the guiding member **220**. By unlocking the guiding member **220**, the guiding member is free to rotate outward relative to the base, toward the vehicle, and away from the central axis X The locking member **230** rotates about the axis defined by hinge pins **245** and the guiding member **220** rotates about the axis defined by hinge pins **247**. The spring **232** biases the guiding member **220** and the locking member **230** together, in the absence of external forces, e.g., from the tow ting **156** or tongue **154**. In various embodiments, linkage **300** operates in the same manner as described for linkage **200**.
(54) Referring to FIGS. **7**A-**7**C, the cart **150** and tongue **154** continue to rotate relative to the central axis X and the vertical hitch axis Z. In these figures, the tongue is rotated to a greater degree than in FIGS. **6**A-**6**B. In these figures, the guiding member **220** is disengaged and unlocked from the locking member by the external force of the rotating tongue **154** applied to the locking member. Since the guiding member **220** and the locking member **230** have different axes of rotation, their travel paths differ. As the rotation continues, the tongue eventually simultaneously contacts the release/bumper **238** of the locking member **230** and the contact/bumper **228** of the guiding member **220**, at least for a portion of their travels, e.g., see FIG. **7**B.
(55) As the rotation of the tongue **154**, the guiding member **220**, and the locking member **230** continues further, the locking member distal end is pushed further rearward by the guiding member **220** until the release bumper **238** of the locking member **230** no longer contacts the tongue **154** and the tongue primarily or solely contacts the contact/bumper **228** of the guiding member **220**, e.g., see FIG. **7**C. As the rotation continues, the locking member and its release/bumper **238** slides further behind the guiding member. The guiding member pushes the locking member rearward as the guiding member further rotates away from the central axis X.
(56) Referring to FIG. **8**, the cart **150** and tongue **154** continue to rotate relative to the central axis X and the vertical hitch axis Z. In these figures, the tongue is rotated to a greater degree than in FIGS. **7**A-**7**C. In these figures, the guiding member **220** continues to be disengaged and unlocked from the locking member and the tongue continues to provide an external rotational force to the guiding member. Since the guiding member **220** and the locking member **230** have different axes of rotation, their travel paths differ. As the rotation continues, the tongue primarily or only contacts the contact/bumper **228** of the guiding member **220**, as the guiding member continues to rotate outwardly, toward the vehicle and away from the central axis X. Through this rotation, the guiding member applies a rotational force to the locking member so that the guiding member and the locking member simultaneously rotate to accommodate rotations of the tongue. In FIG. **8**, the tongue is rotated about 100 degrees with respect to the central axis X The stop **242** of base **240**

ultimately limits the rotation of the guiding member to ensure that the tongue does not impact the vehicle **100**.
(57) As the force from the tongue **154** is removed and the tongue rotates back toward the central axis X, the guiding and locking members ultimately return to their original positions, e.g., a home position, when the tongue no longer applies a force to linkage **200**. The spring or springs **232** coupling the locking member and the guiding member supply the necessary forces to return the locking member and guiding member to their home positions.
(58) FIG. **9** is a perspective view of another embodiment of a hitch guide, in accordance with aspects of the inventive concepts. FIG. **10**A is a top view of the hitch guide of FIG. **9**, in accordance with aspects of the inventive concepts. FIG. **10**B is a top view of a portion of the hitch guide of FIG. **9**, in accordance with aspects of the inventive concepts. And FIGS. **10**C-**10**E are perspective views of portions of the hitch guide of FIG. **9** with a captured tow ring, in accordance with aspects of the inventive concepts. In the embodiment of FIGS. **9**-**10**E, elements corresponding to like elements in the embodiment of FIGS. **3**A-**8** have the same reference numbers.
(59) In this embodiment, the guiding member **220** has an open distal end, furthest from the hitch **110**. The release **238** of the locking member **230** can move though the open distal end of the guiding member **230**, e.g., in response to an external force by the tow ring **156** or tongue **154**. While not shown, one or more springs may connect between the guiding member and locking member to bias the two members back to the home position as an external force is removed.
(60) Referring to FIG. **9**, the tow ring **156** has been captured by the hitch **110**. The tongue **154** of the cart **150** has not been rotated relative to the central axis X and the vertical hitch axis Z sufficiently to contact either linkage **200**, **300**.
(61) FIG. **10**A shows a top view of linkage **200** of FIG. **9** with a top half of the locking member **230** cutaway and removed. Therefore, in this view, a cross section of locking member **230** is shown. FIG. **10**B shows a portion of the same view as FIG. **10**A. In these views, the U-shaped capture **234** of the locking member **230** is engaged with the first notch **225***a* of the guiding member **220**, thereby locking the guiding member in place. In various embodiments, this arrangement is the home position of the guiding member and locking member, without external forces applied. This position is also the guide position when a tow ring engages or contacts the front face **222** of the guiding member during the guide and capture process.
(62) FIG. **10**C shows that the release **238** of the locking member **230** has been pushed outwardly by a force F, which could be applied by the tow ring **156** during the guide and capture process or by the cart tongue **154** after capture and during transit when the vehicle **100** and cart **150** engage in a turn. In this embodiment, when the release **238** and locking member **230** are pushed and rotated outwardly, the U-shaped capture **234** disengages from the first notch **225***a* of the guiding member **220**, thereby releasing the guiding member from its first locked position or state. In various embodiments, after the U-shaped capture **234** releases, it then engages the next notch **225***b*, from the plurality of notches **225**, to lock the guiding member in a second locked position or state.
(63) This transition from the first locked position or state to the second locked position or state can occur when the tow ring initially contacts the release **238** of the locking member, rather than the front face **222** or contact **228** of the guiding member. Contacting the release **238** allows the linkage to increase its angle relative to the central axis X, thereby opening the linkage to accommodate tow rings substantially offset from the central axis X The tow ring, after contacting the release **238** and opening the linkage and guiding member, then travels down the front face **222** of the guiding member to be captured by the hitch **110**. In this manner, the hitch guide **120** is adaptable to accommodate tow rings (or other hitch couplings) offset from the hitch to a greater degree than if the guide were not adaptable.
(64) Referring to FIGS. **10**D-**10**E, portions of the linkage **200** of FIG. **9** are shown. In FIG. **10**D, the tongue **154** has applied an external force to the release **238** of the locking member **230**, which has disengaged the locking member U-shaped capture from the notches **225** of the guiding member

220. In FIG. **10**E, as the tongue continues to apply an external force to the release **238**, the locking member **230** and the guiding member **220** rotate outwardly, away from the central axis X and toward the vehicle. As the rotation of the guiding member and locking member increase relative to the central axis X, the locking member slides behind the guiding member and the tongue applies the external force to the contact **228** of the guiding member. Therefore, after capture of the tow ring **156**, as the tongue **154** rotates outwardly about the vertical hitch axis Z, the force from the tongue is initially applied to the locking member and then transitions to the guiding member.

(65) As will be apparent to those skilled in the art having the benefit of this disclosure, a hitch guide according to the embodiments of the present invention expands the types of carts that can be accommodated with an auto-hitch system, without placing additional limits on maneuverability of the system. The hitch guide is adaptable to allow for wider guiding and capture and, after capture, an improved turning radius over prior hitches and hitch guides.

(66) The hitch guide according to aspects of the inventive concepts includes a plurality of movable members which that mechanically adapt in response to different applied forces. In some cases, the members are locked to provide a rigid guide to a tow ring or other hitch coupling mechanism. In other cases, the members unlock to open and allow an expanded, defined range of motion, e.g., during tight radius turns.

(67) While the foregoing has described what are considered to be the best mode and/or other preferred embodiments, it is understood that various modifications may be made therein and that the invention or inventions may be implemented in various forms and embodiments, and that they may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim that which is literally described and all equivalents thereto, including all modifications and variations that fall within the scope of each claim.

(68) It will be understood that the inventive concepts can be defined by any combination of the claims, regardless of the stated dependencies, wherein different combinations of claims can represent different embodiments of the inventive concepts.

Claims

1. A hitch guide apparatus, including: at least one linkage configured to couple to a vehicle and/or a hitch, the apparatus comprising: a moveable guiding member configured to direct a hitch coupling to a hitch location; and a moveable locking member responsive to an external force to lock the guiding member in at least one locked position and to disengage from and release the guiding member depending on a contact point of the external force on the guiding member and/or the locking member, wherein the locking member is configured to lock the guiding member in a locked position in response to a force applied to the guiding member by the hitch coupling.

2. The apparatus of claim 1, wherein the locking member is configured to disengage from and release the guiding member from a locked position when the external force is applied to the locking member.

3. The apparatus of claim 1, wherein the locking member is configured to lock the guiding member in a locked position when the external force is transitioned from the locking member to the guiding member.

4. The apparatus of claim 1, wherein the locking member and the guiding member are rotatable relative to the hitch.

5. The apparatus of claim 4, wherein the locking member and the guiding member are configured to rotate about different axes.

6. The apparatus of claim 5, wherein the different axes are parallel to each other.

7. The apparatus of claim 4, wherein the guiding member and the locking member are rotatable up to about 90 degrees away from the hitch.

8. The apparatus of claim 1, further comprising: a base configured to couple to the vehicle and/or

the hitch, wherein the locking member and/or the guiding member are coupled to the base.
9. The apparatus of claim 8, wherein: the guiding member is rotatably coupled to the base at a first axis; and the locking member is rotatably coupled to the base at a second axis that is parallel to the first axis.
10. The apparatus of claim 8, wherein the base comprises a stop configured to limit the rotation of the guiding member and/or the locking member.
11. The apparatus of claim 1, wherein the locking member is configured to lock the guiding member in one of a plurality of locked positions.
12. The apparatus of claim 11, wherein the locking member is configured to disengage from and release the guiding member to enable the guiding member to transition from a first locked position to a second locked position.
13. The apparatus of claim 12, wherein an angle of the guiding member to the hitch is greater in the second locked position than in the first locked position.
14. The apparatus of claim 11, wherein the locking member is configured to disengage and release the guiding member from any of the plurality of locked positions to enable the guiding member to move freely within a defined range of motion.
15. The apparatus of claim 1, wherein the locking member and the guiding member are each biased to a home position by one or more springs when the external force is not applied.
16. The apparatus of claim 15, wherein: the guiding member has a distal end that includes a contact surface configured to receive the external force; the locking member has a distal end that includes a release surface configured to receive the external force, and in the home position, the release surface of the locking member extends beyond the contact surface of the guiding member.
17. The apparatus of claim 16, wherein, in the home position, the release surface of the locking member extends through an opening defined by or in the guiding member.
18. The apparatus of claim 1, wherein the guiding member and the locking member have coplanar travel paths.
19. The apparatus of claim 1, wherein the guiding member and the locking member rotate within the same plane about different axes.
20. The apparatus of claim 1, wherein: the locking member includes at least one notch configured to receive a portion of the guiding member to lock the guiding member in the at least one locked position; and/or the guiding member includes at least one notch configured to receive a portion of the locking member to lock the guiding member in the at least one locked position.
21. The apparatus of claim 1, wherein the at least one linkage includes a first linkage and a second linkage configured to be coupled to the vehicle and/or hitch on opposite sides of the hitch.
22. The apparatus of claim 21, wherein: the first linkage comprises: a first movable guiding member configured to direct a hitch coupling to a hitch location; and a first moveable locking member responsive to an external force to lock the first guiding member in at least one locked position and to disengage from and release the first guiding member depending on a contact point of the external force on the first guiding member and/or the first locking member; and the second linkage comprises: a second moveable guiding member configured to direct a hitch coupling to a hitch location; and a second moveable locking member responsive to an external force to lock the second guiding member in at least one locked position and to disengage from and release the second guiding member depending on a contact point of the external force on the second guiding member and/or the second locking member.