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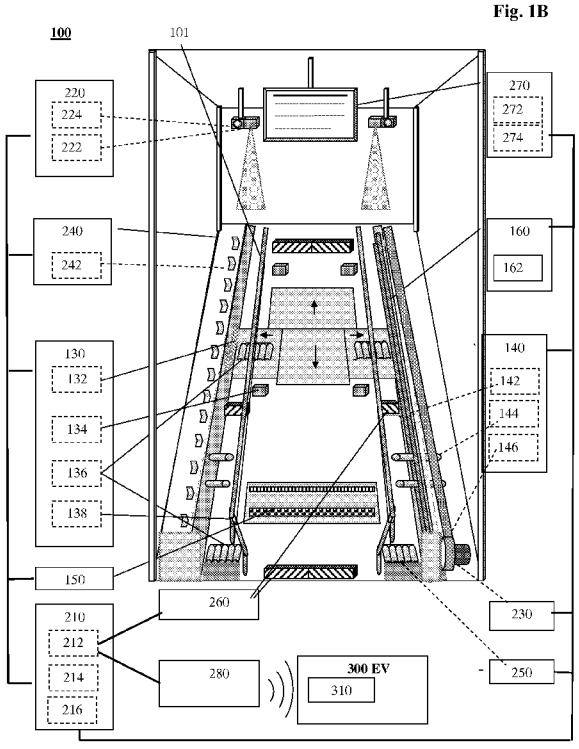
(54) Title: SAFETY SYSTEM FOR BATTERY SWITCH STATIONS

Fig. 1B



(57) Abstract: A battery switch station (BSS) including: a service lane for moving a vehicle through one or more service posts of the BSS, operative modules for servicing the vehicle while on the lane, a detection system adapted to detect one or more safety hazards along the lane, and a control system connected to the detection system and to one or more of the operative modules. The control system is configured and operable to be responsive to detection of one or more safety hazards for controlling operation of the one or more operative modules of the BSS by selectively disrupting or actuating normal operation of at least one of the operative modules.

WO 2013/144958 A1

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SAFETY SYSTEM FOR BATTERY SWITCH STATIONS

FIELD OF THE INVENTION

This invention relates to battery switch stations (BSS) for electric vehicles. Particularly the invention is directed to techniques for improving safety of operation of BSS stations.

BACKGROUND OF THE INVENTION

Battery switch stations (BSS) are generally designed to allow quick replacement of traction batteries of electric and/or hybrid vehicles (generally termed here interchangeably as vehicles or EVs). Replacement of EV traction batteries should preferably be performed within time scales of a few minutes in order to provide cost effectiveness and high throughput of vehicles in the BSS and also to supply efficient services to the vehicle users. Typically, the battery exchange/service procedure (e.g. battery switch process) is an automated process carried out with minimal or no intervention of the vehicle's user during the process. Utilizing an automated procedure provides reliability and quick turnaround of battery replacement for multiple vehicles which is prone to delays which might result from unexpected actions of the vehicle's users/drivers.

Generally, a vehicle's user/driver is requested to drive the vehicle towards the battery switch lane and to neutralize the vehicle's operation before initiation of the battery switch process, and then, on completion of the switch process, the driver of the EV is requested to vacate the BSS lane by driving the vehicle out therefrom. Typically, a vehicle's driver/user is not required to take actions to operate the vehicle during the battery switch process itself. However, in order to provide short battery switch times and quick turnarounds of EVs, EV drivers may be directed to stay in their EVs throughout the battery switch process and then drive vehicles from the station/lane upon

completion. As a BSS may include multiple elements of heavy machinery and high electric currents, very strict security protocols should be followed and enforced in order to prevent any injury to EV users and/or BSS personnel.

GENERAL DESCRIPTION OF THE INVENTION

There is a need in the art for providing safety measures to battery switch and service stations. The present invention provides techniques for improving safe operation of BSS and improving the risk tolerance of the BSS to human misconduct/errors. The present invention is directed to improve the safe operation of a BSS for reducing risks of inflecting injuries on personnel and vehicle users which violate various BSS safety regulations.

As noted above, a BSS typically includes heavy duty machinery and high voltage electronics which may pose potential hazards to users/operators of the station operating in non-compliance with the safety regulations. It may therefore be desired to identify/detect safety hazards in the vicinity of the BSS lane and interrupt the operation of the BSS accordingly. For example, safety hazards may be identified if people are detected in the battery switching lane, if a vehicle's door is opened when the vehicle is in the lane, and/or in case of mis-positioning or improper operation of the vehicle located in the lane. Upon identifying such hazards, it is desired to interrupt the operation of the BSS for example by shutting it down and/or by disconnecting certain instrumentation (electrical/mechanical instruments) of the BSS to reduce risk to persons in the vicinity of the BSS and/or for preventing damage to the BSS instruments.

Thus according to a broad aspect of the present invention there is provided a battery switch station (BSS) including: a service lane for moving a vehicle through one or more service posts of the BSS, operative modules for servicing the vehicle while on the lane, a detection system adapted to detect one or more safety hazards along the lane, and a control system connected to the detection system and to one or more of the operative modules. The control system is configured and operable to be responsive to detection of one or more safety hazards for controlling operation of said one or more operative modules of the BSS by selectively disrupting or actuating normal operation of at least one of the operative modules.

Specifically in response to detection of one or more safety hazards by said detection system the control system may be configured and operable to carry out at least one of the following:

- disrupt normal operation of the BSS in response to such detection;
- operate one or more safety modules in response to such detection; and
- enable normal operation of certain modules of the BSS in response to negative detection of one or more safety hazards.

According to some embodiments of the present invention the one or more operative modules of the BSS include at least one of the following:

- A vehicle's transportation module associated with the service lane and being configured to engage with the vehicle and move it through the lane. The control system operates to selectively disrupt normal operation of the vehicle's transportation upon detecting the one or more safety hazards along the lane.
- One or more alignment modules which are located along the lane and adapted to engage with the vehicle to adjust its position. The control system operates to selectively disrupt normal operation of said one or more alignment modules upon detecting the one or more safety hazards along the lane or enable normal operation of one or more of the alignment modules in the absence of detection of the safety hazards.
- Operative modules of a battery switch post for exchanging batteries from beneath the vehicle. The control system operates to selectively disrupt normal operation of at least one of the modules of the battery switch post upon detecting one or more safety hazards along the lane.
- Operative modules of a cleaning post for cleaning a battery bay located at the bottom of the vehicle. The control system operates to selectively disrupt normal operation of at least one of the modules of the cleaning post upon detecting the one or more safety hazards along the lane.
- Electric modules. The control system operates to selectively disrupt normal operation of the one or more service posts by electrically disconnecting said one or more electric modules upon detecting an electrocuting hazard.

According to various embodiments of the present invention the BSS may include any one or more of the following detection systems:

i. Obstruction detection system configured and operable to detect a safety hazard manifested by the presence of one or more obstructions in the vicinity of the service lane and outside a vehicle being serviced;

ii. Position detection system configured and operable to identify a safety hazard manifested by mis-positioning of a vehicle being serviced along the battery service lane (i.e. battery switch lane);

iii. Weight detection module detecting the position of the vehicle wheels at certain locations along the battery service lane; and

iv. Vehicle status detection system (e.g. a communication system) adapted for communicating with a vehicle controller located onboard the vehicle for receiving therefrom data indicative of an operational and safety state of the vehicle.

Thus, upon detection of a hazard by one or more of the above detection systems, the control system selectively operates the operative modules of the BSS to disrupt normal operation of the BSS and/or operate one or more safety modules of the BSS, such as operating vehicle barriers for preventing undesired motion of the vehicle in the lane. Alternatively or additionally the control system may enable normal operation of operative modules of the BSS (such as alignment modules) only in response to negative detection of the one or more safety hazards. For example the control system may selectively activate sliding operation of one or more tire alignment modules of the BSS only upon detecting that vehicle tires are located on the tire alignment modules.

According to some embodiments of the invention the BSS includes at least one user interface module that is adapted for providing to a user of a vehicle, which is in the BSS lane, with instructions for conducting the vehicle through the lane. Such a user interface module may include auditory and/or visually informative modules/utilities.

According to some embodiments of the invention, the BSS includes an obstruction detection system and/or a positioning detection system which includes an optical system accommodated such that the lane is at least partially in a field of view of the optical system. The control system is configured and operable for receiving and processing data acquired by the optical system and determining a safety hazard in the lane. The optical system may for example include one or more optical transmitters and optical receivers. The optical transmitters are configured and operable for projecting light beams across the battery service lane and the optical receivers are configured and

operable for detecting light originating from these light beams (e.g. reflected/transmitted through obstacles in the lane) and providing data indicative thereof to the control system. In turn, the control system is configured and operable for processing such data and determining any safety hazard located in the lane.

Alternatively or additionally, according to some embodiments of the invention the BSS includes a positioning detection system including one or more sensors adapted for determining the position of a vehicle along the BSS lane. The sensors may for example include one or more of the following: proximity sensors, electro-magnetic sensors, light sensitive modules, weight modules and imaging modules. The control system may be adapted to acquire data indicative of the type of vehicle being at the BSS lane and to process such data together with data from the one or more sensors to determine the extent of the vehicle's position in said lane.

As noted above, according to some embodiments of the invention, the one or more operative modules of the BSS may include tire alignment modules configured for sliding movement. The control system may include a weight activated controller associated with a weight detection module and configured for operating the tire alignment modules to selectively enable or prevent sliding movement of at least one of the tire alignment modules in response to weight applied to the weight detection module. To this end, the sliding movement may be enabled only upon detection of a vehicle on the weight detection module. The weight activated controller may for example include a mechanical mechanism configured to releasing and activating sliding operation of one or more tire alignment modules in response to weight applied to the weight detection module.

According to some embodiments of the invention the BSS includes a communication system configured and operable as a vehicle status detection system and adapted for receiving from a vehicle in the BSS lane, vehicle operational data. The vehicle operational data may be indicative of any one or more of the following: the state of the vehicle's doors; activation state of the vehicle, gear state of the vehicle; break and hand brake states of the vehicle; position of an ignition key of the vehicle; and operation state of internal high-voltage switches of the battery installed in the vehicle. The vehicle operational data is received by the communication system and provided to the control system. The control system is configured and operable to process such vehicle operational data to determine any safety hazard manifested by improper operation of the

vehicle while on the lane. Accordingly, the control system may carry out operation to disrupt or allow the normal operation of one or more of the BSS modules.

According to another broad aspect of the present invention, there is provided a safety system for use in battery switch stations. The safety system includes a control system configured and operable for communication with a detection system which is located at the BSS. The detection system is configured and operable to detect one or more safety hazards along the lane and the control system is responsive to such detection of safety hazards to selectively disrupt or actuate normal operation of at least one of the operative modules of the BSS.

Thus, the present invention provides novel techniques for detecting various types of hazards at battery switch stations and for controlling the operation of various modules of the battery switch stations to eliminate, or at least reduce, risks associated with such safety hazards. A person of ordinary skill in the art would readily appreciate that various modifications may be applied to the techniques disclosed herein without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1A is a block diagram illustrating safety system **200** according to the present invention configured for use in conjunction with BSS **100**; and

Fig. 1B is an exploded view of a BSS **100** according to the present invention integrated with modules of the safety system **200** of **Fig. 1A**.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference is made together to **Figs. 1A** and **1B** illustrating a BSS safety system **200** according to the present invention. **Fig. 1A** is a block diagram illustrating the safety system **200** according to the invention, configured and operable for use in conjunction with BSS **100**. **Fig. 1B** is an exploded view of a BSS **100** according to the present invention integrated with the safety system **200**.

In the present example the BSS **100** includes a vehicle/service lane **110** along which EVs are transported between various battery servicing posts. Generally the BSS

100 includes heavy mechanical instrumentation and high voltage electrical devices which may pose potential hazards to users/personnel violating the BSS's safety regulations. In the present example, the BSS **100** includes two vehicle servicing posts including a cleaning post **150** that is adapted for underbody cleaning of the battery and battery bay region of an EV **300** and a battery swap/switch post **160** at which the vehicle's battery may be switched with a fully/partially charged battery. The vehicle is typically transported along the BSS service lane **110** and between posts (e.g. **150** and **160**) by means of a transportation assembly (machinery) **140**. Transportation assembly **140** may include for example a wheel engagement assembly **144** that is coupled to an actuation assembly **146**. The wheel engagement assembly **144** is furnished in the present example with wheel grabbing/lifting arms which are configured and operable to controllably engage with the wheels of a vehicle for transporting the vehicle through the BSS lane **110.** Here, wheel engagement assembly **144** is mounted on a leading-rail/track **142** that placed along the sides of the lane **110**. Additionally, the BSS **100** may also include a vehicle positioning assembly **130** that is configured and operable to direct and lead the vehicle to the battery servicing post **160** with a precisely aligned position (of up to 6 degrees of freedom) with respect to a battery exchange machinery (not specifically shown) that is adapted for replacing the vehicle's battery and accommodated at that post **160** (e.g. below the floor doors **162**).

It is noted that examples of battery switch stations and/or modules thereof, with which the techniques (systems and/or methods) of the present invention may be incorporated for improving its safe operation, re disclosed in co-pending Israeli patent application No. 218924, captioned "Battery exchange system and method for electric vehicles" filed on March 29, 2012, which is incorporated herein by reference. Also, an example of a battery exchange machinery (e.g. battery switch module) which may be used in the battery switch stations is disclosed for example in co-pending Israeli patent application No. 218870, captioned "Battery switch module ", filed on March 27, 2012, and incorporated herein by reference.

In the present example the vehicle positioning assembly **130** may include side-alignment module**s** **132**(exemplified in this figure from only one side of the lane **110**) which are adapted to extend and protrude from the sides of the lane to position the vehicle (at its yaw angle) by engaging and pushing the vehicle's wheels from the sides. During alignment of the vehicle **300**, the vehicles wheels are located on positioning-

/wheel-sliders **136** which allow the wheels to slide in the lateral direction thereby enabling smooth positioning and alignment of the vehicle with reduced friction. The positioning and alignment assembly may also include vertical alignment modules **134** configured for lifting and/or orienting the vehicle with respect to its pitch and roll angles. Also the alignment bars **138** which are arranged along the lane are configured and operable for engaging with the vehicle/wheels to direct the vehicle to the proper course.

The BSS instrumentation listed above, including the various positioning and alignment modules (130-138), the transportation assembly/modules (140-146) as well as the service posts (150 & 160) present heavy duty mechanical instrumentation of the BSS **100** which generally operate by exerting substantial forces to direct, position and align the vehicle 300 along the BSS lane **110**. Additionally, the operation of such instrumentation may be associated with high electric voltages which may also pose risks to people violating safety regulations. Accordingly, when battery switch is in process, this instrumentation may present various hazards to persons in the vicinity of the battery service/switch lane **110**.

For example in many cases some of the BSS equipment resides under the BSS lane level. During the battery switch process, the floor doors of the BSS may be opened, presenting a risk to people (users/personnel) falling into the lower parts of the BSS. Also, during vehicle conveying in the lane, driver or passengers of the vehicle may try to exit the vehicle and may be harmed by the BSS lane machinery.

The present invention is directed to detecting potential risks which may be caused by various modules of this instrumentation, and to react accordingly to reduce or eliminate such risks. Some of the possible hazards which may occur in the BSS environment and which may be detected by various embodiments of the safety system **200** of the invention are listed for example in the following. The cleaning post **150** may include injection ports for injecting cleaning fluid (water and or detergents) with possibly high pressure and/or high temperature. The cleaning fluid may typically be injected upwards for cleaning the underbody of the vehicle (e.g. cleaning a vehicle's battery or a battery cover to prepare for battery replacement). In case the cleaning post **150** is operated when a vehicle is not located directly above it, it may present a hazard to people in its vicinity. The transportation and vehicle positioning assemblies, **140** and **130**, are generally configured to mechanically engage with the vehicle (typically with its

wheels but may be with other parts thereof) and apply strong forces thereon for dragging/transporting the vehicle through the lane **110** and for aligning the vehicle to a desired battery switch position. This may present a hazard to people in the vicinity of different parts of these mechanical assemblies **140** and **130** as they may be caught or injured by the heavy mechanical instrumentation. In addition, the wheel-sliders **136** of the positioning/alignment module**130**, which may include an arrangement of rollers (e.g. rolling cylinders) and/or conveyor mechanism, may typically be slippery to persons incidentally passing thereon. Moreover, the battery switch post **160** typically includes one or more floor doors **162** (four sliding doors are illustrated in **Fig. 1B**), which are adapted to open, when the vehicle is positioned thereabove to expose battery switch instrumentation for switching the vehicle's battery. In some BSS types the doors may be opened to variable extents, allowing to service vehicles of various types and sizes. Floor door openings present a hazard of people falling therethrough in case a vehicle is not located thereabove and/or in case the doors are opened to an extent exceeding the vehicle's perimeter.

Typically a driver of the vehicle **300** is requested to remain in the vehicle during the battery switch process (e.g. battery exchange procedure). This may for example shorten the turnaround time of the battery switch by allowing the driver to vacate his vehicle immediately upon completion of the battery switch. However, a driver, being inside his vehicle, presents a human factor which may also cause and/or be exposed to hazardous situations. As typically (according to conventional regulations/rules) the driver remains in control of the vehicle during the battery switch process, he thus might erroneously operate his vehicle **300** in a manner presenting risk to people in the vicinity of the lane **110** or to damage the BSS **100** itself. The driver may also exit the vehicle **300** during the switch process and may thereby be at risk himself if the BSS **100** is in operation.

The present invention provides a safety system **200** which is configured and operable to eliminate or at least diminish some of the risks resulting from the above listed hazards in a BSS. The safety system **200** may be included with the BSS **100** and/or its modules/elements integrated with modules of the BSS **100**. The safety system **200** includes a control system **210** and at least one detection system **215** connectable to the control system **210**. The detection system **215** is configured and operable to detect one or more of the above listed safety hazards along the battery service lane **110** of BSS

100. The control system **210** is responsive to detection of one or more safety hazards by the detection system **215** and is configured and operable to disrupt normal operation of the BSS **100** in response to such detection. The control system **210** includes a computerized system for example including a processor **212** (e.g. CPU) and storage module/memory **214**. Alternatively or additionally, the control system **210** may include mechanical assembly **216** for disrupting operation of one or more of the BSS modules upon mechanical detection of certain hazards. The detection system **215** may include various types of detection modules which may be based on one or more of the following detection technologies: visual detection, electro-magnetic (EM) detection, weighting, distance measurements (for example by using impedance based or magnetic sensors) and more.

For example according to some embodiments of the invention the detection system **215** includes an obstruction detection system **220** that is configured and operable to detect a safety hazard manifested by the presence of one or more obstructions in the vicinity of the service lane and outside a vehicle being serviced. Such obstructions may for example include person(s) at the battery service lane **110**, opening of the vehicle's door during servicing and/or other obstructions. In certain embodiments the obstruction detection system **220** includes one or more EM transmitters **222** and one or more EM receivers **224** which are configured and operable for transmitting EM radiation (e.g. light) and detecting the radiation reflected or scattered from the vicinity of the BSS lane. The detected radiation is then analyzed (e.g. by a controller of the detection system **220** itself and/or by the control system **210**) to detect/identify obstacles/obstructions located along the battery service lane **110**.

Alternatively or additionally, various known in the art detection systems may be used according to the invention for detecting people and/or obstructions in forbidden areas of the BSS. For example infra red laser scanning may be used to detect if a person is located in a forbidden area. Sensor(s) of the infra-red laser scanning system may be configured to detect beams reflected from persons/obstructions in forbidden area(s) and activate an alarm in response thereto. Other types of such detection systems may also be alternatively or additionally utilized. For example, heat emission may be used to detect people in forbidden areas, and also radar transceivers may be utilized to transmit radio waves, receive and analyze their reflections, and detect people in unauthorized areas by utilizing the Doppler effect detection(change in return wave frequency).

Specifically, in certain embodiments of the invention the obstruction detection module **220** includes a set of laser (e.g. a laser array being example of transmitters **222**) or other optical transmitters and a set of one or more receivers **224** such as light sensitive modules**,** CCD cameras and/or other imagers.

The transmitters **224** are arranged to produce light beams that surround the lane **110** (e.g. the EV thereat) from at least one side thereof (preferably from its left and right sides). The receivers may capture an image of the reflected/scattered laser beams and provide the detected signals to the control system **210** and/or to an internal controller of the detection system **210** which in turn operates to identify foreign obstacles in the lane **110** such as vehicle door opening, persons in the lane or other obstacles located near or in the lane and presenting safety violations. According to some embodiments of the invention, the control system **210** is configured and operable to process the detected signals by utilizing data indicative of the type/size of the vehicle located in the lane **110** and thereby distinguish and identify obstacles in the lane which are not part of the vehicle. The exact size of the EV may be fixed (e.g. for lanes **110** facilitating services to single type of EV's) and/or the size of the EV may be provided to the control system **210** based on previous identification of the EV (e.g. such identification may be performed for example before the EV's entrance to the lane). Thus, by obtaining signals indicative of reflection/scattering of the light beams and processing those signals (e.g. by employing any suitable image processing/pattern recognition techniques), the control system **210** may determine the existence of foreign obstructions (e.g. people, vehicle's opened doors) in the vicinity of the lane **110**. Optionally, according to some embodiments of the invention, the control system **210** may be responsive to signals/data indicative of detected obstruction/interference in or near the lane **110** and may be configured and operable to interrupt and/or stop the BSS operation the until interference is resolved (the interfering obstruction is removed) and the BSS operator may resume operation.

It is noted that the obstruction detection module **220** may be used in some embodiments of the invention to detect the vehicle's position along the BSS lane **110**. For example, the obstruction detection module **220** may be configured and operable in accordance with any suitable range detection technique (e.g. laser based range detection) to determine information/ positioning-data indicative of the location of the vehicle with a. To this end, a control system (e.g. **210** or other controller) associated

with the obstruction detection module **220** may utilize the vehicle positioning data together with information regarding the type/model of the vehicle to determine the positioning of the vehicle's battery or battery bay with respect to one or more service posts (e.g. **150** and/or **160**) in the lane **110**. This technique may be used to safely control the operation of the BSS **100** in accordance with the vehicle's position.

Alternatively or additionally, according to some embodiments of the invention, the detection system **215** includes one or more positioning detection module(s) which may include vehicle position detection module **240** and/or wheel positioning detection module **230** and/or the obstruction detection module **220**. The positioning detection module(s) are configured and operable to identify safety hazard(s) manifested by mis-position of a vehicle being serviced, and/or mis-positioning of the vehicle's wheels with respect to various posts along the battery service lane **110**.

In various embodiments of the invention a vehicle position detection module **240** is employed and may include multiple sensors **242**, such as proximity/pressure sensors, that are disposed along or in the vicinity of the battery service lane **110**. The sensors **242** may be adapted to sense the vehicle in their proximity and provide positioning data (e.g. signals) that are indicative of the vehicle's position and are sufficiently accurate (e.g. with accuracy range of a few tens of centimeters and preferably a few centimeters or less) to enable prevention of hazards resulting from vehicle mis-positioning. Alternatively or additionally, according to some embodiments of the invention the vehicle position may be determined utilizing a wheel positioning detection module **230** that is configured and operable for detecting the position of at least one of the vehicle's wheels. Wheel positioning detection module **230** may be coupled for example to the vehicle transportation assembly **140** of the BSS **100** and configured to determine the position/state of the transportation assembly **140** which is in turn indicative of the vehicle/wheels position. For example, in the transportation assembly **140** exemplified in **Fig. 1B**, electronic sensors (such as electric and/or impedance and/or magnetic sensors; not shown) may coupled to any one of the rail **142**, actuation assembly **146** and/or wheel engagement assembly **144** to determine the position of the wheel engagement assembly **144** and thereby determine positioning data indicative of the position of the vehicle or at least one wheel of the vehicle.

The control system **210** may utilize the positioning data/signals obtained from any of the vehicle/wheel position detection modules **240** and **230** and/or from the

obstruction detection module **220** to determine the vehicle's position in the lane **110** and possibly also to determine/approximate the extent of the vehicle in the lane (back to front extent) and/or the location of the battery bay of the vehicle. As noted above determining the location of the vehicle's battery-bay may be achieved by utilizing additional information regarding the type of the vehicle. The control system **210** may be configured and operable to disrupt normal operation of the BSS in accordance with the determined/estimated positioning data. For example when detecting that during the BSS operation the vehicle is off the normal position at which it should have been, the control system may halt the operation of the BSS or some modules thereof and/or operate one or more safety modules, such as lifting safety barriers **260** to reduce and/or prevent damages.

For detecting/determining whether an EV is off its normal position during the BSS operation, the BSS may include an imager (e.g. CCD camera) imaging the underbody of an EV at the BSS lane. The imager may be connectable to an image analysis controller and configured and operable for analyzing image data received therefrom to determine the EV's alignment with BSS machinery. The analysis controller may be part of the control system and/or associated therewith allowing the control system to interrupt/alter the BSS operation upon detection of misalignment of the EV. Additionally, such an imaging system may also be used to provide damage detection to the EV and determine whether the state of the EV's underbody allows switching the EV's battery. Additionally, such an imaging system may also serve during battery cleaning for detecting when the battery is clean and possibly save battery cleaning time and improve the BSS vehicle throughput.

On the other hand, the control system **210** may be configured and operable to enable normal operation of certain modules of the BSS **100** only in response to negative detection of one or more safety hazards (for example only when detecting that the vehicle is in the desired position, the vehicle doors are closed and no obstacles/people are detected in the lane **100**). Specifically, the control system **210** may be configured and operable for controlling the operation of the cleaning post **150** only when the vehicle is located thereabove (e.g. extending thereabove entirely) to thereby prevent hot/pressurized water/detergents from harming the surroundings. Also, the control system **210** may be configured and operable for controlling the operation of the battery swap post **160**, for example to open the floor doors **162** only to the extent covered by

the vehicle and thereby prevent falling/tripping thereon. Additionally, the control system may operate the transportation and alignment assemblies, **140** and **130**, or certain modules thereof only when detecting no obstructions in the lane **110** thereby safely operating vehicle movement in the lane 110 while reducing risk to harm people on the lane **110** and/or damage the BSS **100**/vehicle **300** due to obstacles in the lane **110.**

It should be noted that alternatively or additionally to the above described positioning detection system, in some embodiments of the invention the detection system **215** includes weight detection module **250**. The weight detection module is configured and operable for detecting the position of one or more of the vehicle's wheels pressing at certain specific locations along the battery service lane **110**. This thereby enables activation of certain of the BSS modules, such as wheel-sliders **136**, only when the vehicle wheels are located thereon. It is noted that the weight detection module **250** and possibly also a control system **210** coupled thereto may be configured as electric modules, mechanical modules, hydraulic/pneumatic modules as well as a combination of such modules.

Specifically, as noted above in some embodiments of the invention the BSS may include wheel-sliders **136** which may be part of the alignment assembly **130** and/or part of the sliding floor doors **162**. The wheel-sliders **136** may typically include a set of rolling cylinders and/or low friction conveyor which allows a vehicle wheel located thereon to slide with low friction (e.g. in the lateral direction of the lane **110**) with respect to the wheel-sliders **136**. This allows the vehicle's alignment (with respect to the Yaw axis) at the entrance of the lane and /or allowing sliding doors **162** to slide beneath the vehicle's wheels with minimal friction from the tires.

As the wheel-sliders **136** (rolling cylinders) provide low friction they are therefore extremely slippery and may present a danger to people standing thereon. In order to prevent users or personnel that walk through this lane from tripping, the wheel-sliders **136** are coupled, in some embodiments of the invention, with the weight detection module **250**, which is responsive to the weight applied on the wheel-sliders **136**. The weight detection module **250** may for example include an electronic weight and/or a mechanical weight which is adapted to carry vehicle loads and to allow release of the low friction wheel-sliders **136** only when such loads (e.g. of a few hundreds of kilograms or more) are applied to the wheel-sliders **136**.

For example, a mechanical type weight detection module **250** may include a set of vertical springs which carry the wheel-sliders **136** (e.g. coupled to a frame upon which the rolling cylinders of a wheel-slider **136** are mounted). The frame may also be coupled to a control system **210** which in this example includes a mechanical module **216** including a breaking/locking system (e.g. including brake-pads and/or locking gears etc.) for locking the rolling cylinders of the wheel-sliders **136.** The control system **210** may also include a mechanical displacement actuator (e.g. a push-rod and/or a gear system and/or an eccentric-mechanism/shaft) which is coupled to the breaking system and to at least one of the frame of the rolling cylinders and the springs upon which the frame is mounted. The operation and configuration of the displacement actuator is such that the braking system is released only when the springs are pressed to a certain degree which is indicative of a vehicle weight located thereon. To this end, the springs may be configured with spring constants that are selected such that braking is released only when sufficient weight (e.g. 100Kg or more) is applied to the wheel-sliders **136**. Thus, the weight detection module **250** is directly or indirectly coupled to the locking mechanism (e.g. to the braking pads of the braking system). Accordingly, the control system **210** (including such a locking mechanism) is configured for braking/locking the wheel-sliders **136** in cases where low weights, which are less than a weight a vehicle applies to one wheel, are applied on the wheel-sliders **136**.

Typically, the weighting detection module **250** and the control system **210** are configured such that the force required to release the cylinders to move is in the order of a few hundreds of kilograms. Namely, in the mechanical example above, it corresponds to the force that is needed to contract the springs to the point where they release the cylinders. Accordingly, a person standing on these cylinders would not contract the springs sufficiently to release the locking/braking on the cylinders and thus would not slip, while an EV would provide enough force to the springs and release the lock/brake. This also protects service and maintenance personnel present in the BSS lane during time of maintenance.

Indeed, the control system **210** may include a mechanical assembly, such as that described above. However, alternatively or additionally according to some embodiments of the present invention, the control system **210** and the weight detection module **250** or both may include electric modules that may be respectively configured and operable for weight detection and for locking/braking the wheel-sliders **136** when

insufficient weight is applied thereto. For example, the wheel-sliders **136** may be mounted on an electric weighting module **250** that is configured to provide, to the control system **210**, data/signals indicative of the weight measured thereby. The control system **210** may include an electric controller connectable to an electrically operated braking /locking system that is coupled to the cylinders of the wheel-sliders **136**. The controller may utilize electric signals/data to engage and/or release the electrically operated braking/locking system based on the weight detected by the electric weighting module **250**.

As was also noted above, typically a vehicle's driver may be requested to remain in his vehicle during a battery service procedure provided to his vehicle **300** by the BSS **100**. In some embodiments of the invention the BSS **100** provides the user/driver of the vehicle with operational instructions regarding actions/operations that should be carried out by the driver and/or regarding the state at which the vehicle **300** should be at during various stages of the battery switch process. The user/driver should follow these instructions in order to safely operate the vehicle **300** during the switch process. For example the user may be requested not to drive the vehicle through the lane **100** and/or to neutralize certain controls of the vehicle, maintain the vehicle doors closed etc.

According to some embodiments of the invention, the control system **210** is configured and operable to verify that the vehicle's operation and state complies with the stage of the battery service procedure at which the vehicle is being serviced. Specifically, the control system **210** may be adapted for obtaining (e.g. from the vehicle's controller/on-board computer) data indicative of the vehicle's operational state and determine if the vehicle's operational state is in agreement with the current stage of the battery service procedure at which the vehicle is being serviced (e.g. verifying that the driver of the vehicle complies with the operational instructions provided to him). The control system may also be configured to interrupt or stop the normal operation of one or more of the BSS modules in cases where it is determined that the vehicle is not being properly operated (e.g. violating the safety regulations concerning vehicle operation during the battery switch process).To this end, in case two or more vehicles are being serviced at different posts along the lane **110**, the control system may operate to interrupt the operation of only those posts which service the safety violating vehicle, or only those posts in which continued operation may present risks (e.g. according to the safety violation scenario).

For example, during a typical battery switch process (i.e. during passage of the vehicle through the BSS lane **110**) the vehicle should be operated in one or more operational states corresponding to different stages of the battery switch process and/or different positions along the lane **110**. For example, in some stages the EV has to be driven through the lane while during other stages it should be shut down and/or neutralized (e.g. put in neutral gear state, release of brakes/hand-brakes, maintain closed vehicle-doors) etc.

Some types of EVs are equipped with an onboard controller **310** (e.g. vehicle computer) which has access to information regarding the vehicle's operational state. In accordance with some embodiments of the present invention, this feature is advantageously utilized by the control system to monitor the operation state of an EV **300** being serviced and determine if its operational state presents a safety hazard/violation. To this end, according to some embodiments of the invention the detection system **215** includes a vehicle status detection system (hereinafter also referred to as communication utility) **280** that is configured and operable for communicating with a vehicle's onboard controller **310** for receiving therefrom information regarding the vehicle's operational state (e.g. of operational parameters of the vehicle). The communication utility **280** may for example include wireless communication modules, such as Bluetooth and Wi-Fi, to communicate with the vehicle's on-board computer **310**. The on-board computer **310** may in turn be configured and operable to respond to such communication by sending to the communication utility **280** data indicative of the vehicle's operational state. The network address/identifier of the on-board computer **310** of the vehicle **300** being serviced may for example be obtained via vehicle identification procedure occurring at the entrance to the battery service lane **110** (e.g. through image identification of the vehicle and/or near field communication with the vehicle).

Accordingly, the communication utility **280** is configured and operable for receiving from the on-board computer **310** vehicle's operational state data indicative of certain parameters of the vehicle's state such as the state of the vehicles doors, gear, brakes etc. The control system **210**, being responsive to such vehicle's state data, may compare this data with the state at which the vehicle should be maintained during the current phase/stage of the battery switch process and thereby determine if the vehicle is being properly operated (e.g. in accordance with operational instructions which are

provided to the vehicle's user). In case the vehicle is not being properly operated and/or it is identified to pose risk and/or cause BSS failure, the control system **210** may be operated to interrupt/disrupt the BSS's operation and/or operate protective measures, such as vehicle barriers **260** in order to reduce potential hazards.

An important safety aspect of a battery switch process is to ensure that the battery high voltage (HV) connector is not energized before the battery is removed from the EV. The battery has internal contactors/switches that open before the battery is switched. In case these internal contactors/switches fail, the HV connector is energized and powerful sparks and plasma arc may be generated between vehicle and battery upon disconnection of the HV connector from the battery. To this end according to some embodiments of the invention the control system is configured and operable for communicating with the EV's onboard computer for receiving therefrom information about failure in the internal contactors of the battery. Upon detecting such failure, the control system may operate to interrupt the battery switch procedure.

Another important safety aspect is associated with activation state of the EV and more specifically with the position/state of the EV's ignition (key). Typically, the battery switch process should not be initiated until the vehicle's powertrain is turned off, and should be interrupted/stopped in case the vehicle's powertrain is turned on during the battery switching process (e.g. if driver turns ON the ignition key during the switch process). Thus, in some embodiments of the invention the control system is configured and operable for communicating with the EV's onboard computer (e.g. by wireless communication between the EV and the BSS) for receiving therefrom information indicative of the state of the vehicle's powertrain (e.g. about the position/state of the EV's ignition). Upon detection that the vehicle's powertrain is turned on, the control system may operate to interrupt/prevent the battery switch procedure.

In this regard it should also be noted that according to some embodiments of the invention, the control system **210** and the communication utility **280** may be configured and operable to provide operational instructions to be presented to the vehicle's driver by audio/visual means connectable to the onboard computer **310** of the vehicle. The control system **210** may utilize any of the above described detection modules to determine the vehicle's position along the lane and thereby determine appropriate instructions to be provided to the vehicle's user/driver. To this end the control system **210** may utilize any of the obstruction detection **220**, vehicle positioning detection **240**,

wheels positioning detection **230**, weight detection **250** and/or other detection modules not specified here. The control system **210** may utilize data (e.g. a lookup-table) stored in memory/data-base **214** of the control system which includes various operational instructions to be provided to vehicles' users in accordance with the position of their vehicles in the lane **110** (e.g. in accordance with the stage of service provided to their vehicles). The thus determined operational instructions may then be transmitted to the onboard computer **310** of the vehicle **300**. Having received data indicative of the operational instructions from the communication utility **280**, the onboard computer **310** may, in turn, operate to present the instructions to the vehicle's driver. Alternatively or additionally the onboard computer **310** may also be configured to determine whether the vehicle's operational state is in agreement with the operational instructions and to communicate the result of such determination back to the communication utility **280**.To this end, the onboard computer **310** may monitor internal events of the vehicle and track if the user complies with the operational instructions (it can see if gear state has changed, if EV engine has been shutdown, if doors have been opened etc.). The onboard computer **310** may report these events, or failure to comply to the operational instructions, back to the control system (i.e. through communication with the communication utility **280**). In case of disagreement between the operational instructions and the actual operational state of the vehicle, the control system **210** may respond by re-instructing the user to comply with the instructions and/or stopping/interrupting operation of certain modules of the BSS **100** to prevent any hazard/injury.

As described above, the control system **210** is generally connectable to the detection system **215** and is configured and operable for controlling and/or disrupting normal operation of the BSS **100** in response to detection of one or more hazards by the detection system **215**. Various possible operations of the control system **210** which may be carried out, in various embodiments of the invention, in response to detection of various hazards will now be described more specifically. According to various embodiments of the invention the control system **210** is connectable to one or more modules of the BSS **100** and configured and operable for carrying out at least one of the following: disrupt normal operation of said BSS **100** in response to detection of one or more safety hazards; operate one or more safety modules in response to detection of one

or more safety hazards; and enable normal operation of certain modules of the BSS **100** in response to negative detection of one or more safety hazards.

For example, the control system **210** may be configured and operable for disrupting the operation of the vehicle's transportation assembly **140** of the BSS **100** which is configured to engage with the vehicle and drive it through the lane **110**. To this end, the control system **210** may be connectable with the vehicle's transportation assembly **140** and may be configured for example for halting the operation of the transportation assembly **140** by disconnecting power from its actuation assembly **146** and/or from the wheel engagement assembly **144**.

Alternatively or additionally the control system **210** may be configured and operable for disrupting the operation of one or more alignment modules (e.g. **132**, **134** and/or **136**) of the alignment assembly **130** which are located along the lane **110** and adapted to engage with the vehicle. This may be used to prevent hazards of persons being caught between the alignment modules and the vehicle, tripping on the alignment modules etc. To this end, the control system **210** may be connectable with the alignment assembly **130** and may be configured and operable for halting and/or interrupting the normal operations of the alignment assembly **130** for example by disconnecting power to one or more of its modules.

Moreover, in some embodiments of the present invention the control system **210** may be configured and operable for disrupting the operation of the battery swap post **160** which serves for exchanging/switching batteries from beneath the vehicle. For example the control system **210** may be connectable to one or more of the floor doors **162** of the battery switch post **160** and configured for disrupting the opening of these floor doors **162**, and/or limiting their opening, in case of detection of certain hazards along the lane **110**. To this end, the control system **110** may be connectable to the controller of the doors **162** for interrupting their normal operation. Also, the control system **110** may be configured and operable for disconnecting power from the doors in case of detection of certain hazards. Such actions may be carried out when floor door opening is identified to an extent which is not covered by the body of a vehicle located above the doors. Alternatively or additionally the control system may be configured and operable for ensuring safe operation of the battery swap post **160**. For example, the control system **210** may operate to limit the opening of the floor door(s) **162** only to the extent covered by the vehicle.

Furthermore, in some embodiments of the present invention the control system **210** may be configured and operable for disrupting the operation of cleaning post **150** which serves for underbody cleaning a battery and/or battery-bay and/or battery-cover that is located at the bottom of the vehicle. To this end normal operation of the cleaning post may be enabled only when a vehicle is located above cleaning post **150**. Alternatively, operation of the cleaning post **150** may be disrupted if mis-location of the vehicle is detected (e.g. if the vehicle incidentally moves from the cleaning post **150**). Also, in some embodiments of the invention, the control system **210** may be configured and operable for disrupting the operation of the BSS **100** by electrically disconnecting one or more electric modules which may for example present an electrocuting hazard.

It should be noted that according to some embodiments of the invention the control system **210** may be configured for and operable to enable normal operation of certain modules of the BSS **100** in response to negative detection of one or more safety hazards. Any one of the modules of the BSS **100**, such as parts of the alignment assembly **130** and/or transportation assembly **140** and/or cleaning post **150** and/or battery switch post **160**, may be selectively and controllably operated by the control system **210** only upon negative detection of safety hazards.

Specifically according to some embodiments, prior to operation of certain BSS **100** modules, the control system **210** may be configured and operable to process detection data provided to it from various modules of the detection system **215.** Then, only upon verifying that no hazards have been detected (e.g. determining that the vehicle is properly operated and correctly located and no obstacles/obstructions appear to be in the vicinity of the BSS lane **110**), the control system operates the BSS **100** modules. For example, the control system **210** may be configured and operable to activate the sliding operation of one or more tire alignment modules (wheel-sliders) **136** only after detecting that the vehicle tires are located on thereon and no obstructions are detected in the relevant part of the lane **110**.

According to some embodiments of the present invention the BSS **100** may also include one or more safety modules which may be operated by the control system **210** to improve safe operation of the vehicles through the BSS lane **110** and/or to prevent risks due to mis-operation of the vehicle or other possible failures. For example, the BSS may include at least one user interface module **270** which is configured and operable for providing to the user of the vehicle **300** being serviced with instructions for

conducting the vehicle through the lane **110**. The control system **210** may optionally be connected to one or more positioning systems (e.g. **220** and/or **230** and/or **240**) which are capable of monitoring the vehicle's position in the lane **110**. In accordance with the vehicle's position, the control system **210** may operate to determine proper operational instructions to be provided to the user of the vehicle **300**. Determining the operational instructions may be achieved in a manner similar to that described above with respect to provision of operational instructions to the vehicles on-board computer **310** (e.g. utilize a lookup table relating to various operational instructions to various positions of the vehicle in the lane **110**). The user interface module **270** may be connectable to the control system **210** and may be configured and operable for presenting the instructions to the user/driver of the vehicle **300** when he is inside the vehicle at the lane **110**. The user interface module **270** may optionally include an auditory informative module(s) **274** (e.g. sound equipment), and/or visual module(s) **272** (e.g. graphical equipment) and/or network module (e.g. **280**) which may be used to communicate operational instructions to the vehicle's on-board controller as described above **310**.

Vehicle stop structures/barriers **260** are additional types of safety modules which are included in the BSS **100** according to some embodiments of the present invention. The stop-structures/barriers **260** may include fixed structures (e.g. for preventing the vehicle from deviating from a designated path through the lane **110**) and/or controllable barriers which can be lifted (e.g. removed from the lane **110**) and lowered (introduced in the lane **110**) according to the battery exchange/switch operational stage at which the vehicle is being serviced.

The control system **210** may be connectable to the vehicle barriers **260** and may be configured and operable for closing the barriers **260** in response to detection of one or more safety hazards, or for opening them upon non-detection of one or more safety hazards. To this end, the vehicle barriers **260**, or some of them, may be operated in a normally-off mode in which they are normally maintained in an open (e.g. lowered) state. In this operational mode the barriers **260** are closed (e.g. raised) in response to a control signal sent from the control system **210** upon detection/identification of a potential hazard by the detection system **215**. Alternatively or additionally, the vehicle barriers **260**, or some of them, may be operated in a normally-on mode in which they are normally maintained in a closed state. In this case the barriers may be opened upon negative detection/identification of a potential hazard in their vicinity/course.

Also, the control system **210** may be configured and operable for selective operation of the barriers in accordance with the vehicle position and the stage of the battery switch process. For example the control system may operate the barriers selectively to open only certain barriers at certain times to allow selective passage of a vehicle from a certain servicing post to the successive servicing post. To this end, barriers may be located in between various service posts which are arranged along the lane **110** and may be operated by the control system **210** to regulate the vehicle movement between posts and regulate the services to multiple vehicles along the lane such as to reduce/prevent risks of vehicle collision. In certain embodiments of the present invention, barriers **260** are located between the following successive posts: lane-entrance post (not specifically shown in the figure), cleaning post **150**, battery switch post **160**, lane-exit post (not specifically shown in the figure). Barriers **260** may also for example be raised to prevent the vehicle **300** from moving too far forward entering the next/successive post. For example, the control system **210** may operate for controlling the stop structure **260** which is located between cleaning post **150** and the battery switch position **160**, for lifting it when a first EV is occupying the battery switch position **160** and a second EV is entering into the battery washing position **150**. The barrier may be lowered when the first EV has cleared out from the battery switch position **160** and the washing process has ended by enabling passage of the second EV to the battery switch position **160**.

Thus, vehicle barriers **260** may be operated by the control system to prevent and/or reduce risks which may be caused due to mis-operation of the vehicle or other possible failures by which the vehicle is improperly driven across the lane **110**. The barriers **260** may be selectively operated by control system **210** for stopping a braking vehicle's movement through the lane **110** by engaging with any of the vehicle's body and/or with its wheels.

In certain embodiments of the present invention the stop-structures/barriers **260** may also include/accommodate one or more sensors that are connectable to the control system **210**. Such sensors may operate to provide the control systems with data/signals indicative of the stop-structures/barriers **260** being hit. In turn, the control system **210** may be configured and operable for stopping and/or fully or partially disrupting the normal operation of the BSS **100** and/or issue a warning to the user(s)/driver(s) of vehicles in the lane (e.g. through the user interface **270**).

The present invention thus provides a battery switch station system **100** including a safety system **200** that is configured and operable for providing safe operation of the BSS **100**. The safety system **200** includes a detection system **215** in which various types of detection modules may be included and which is capable of detection/identification of various hazardous situations in the vicinity of the BSS **100** and BSS lane **110**. The safety system **200** also includes a control system **210** that is connectable (electrically, mechanically and/or wirelessly) to the various detection modules and configured and operable to determine hazard situations and to accordingly operate to reduce or eliminate risks embodied in such situations. The control system may for example be connected to various modules of the BSS **100** and be operable for controlling their safe operation. Additionally, the control system may be associated with safe modules of the safety system **200** and may operate these modules to improve the safe operation of the BSS **100**.

It should be noted that various detection modules described herein present only a partial, non-exhausting list of the possible detection modules which may be used for detection of hazards in a BSS environment. Additionally, the BSS modules exemplified herein present a partial list of possible BSS modules which may be part of a BSS station and whose safe operation may be controlled by the safety system of the present invention. Moreover, additional or other safety modules, which have not been specifically described herein, may also be used in the present invention to prevent and/or reduce hazards. Accordingly, without departing from the scope of the present invention, the safety system **210** described above may be configured to operate and may include other types of detection module(s), BSS modules and safety modules which were not specifically described herein. In this regard, a person of ordinary skill in the art would readily appreciate that various modifications may be applied to the various embodiments of invention as described herein without departing from the scope of the present invention.

CLAIMS:

1. A battery switch station (BSS) comprising:

a service lane for moving a vehicle through one or more service posts of the BSS,

operative modules for servicing the vehicle while on the lane,

a detection system adapted to detect one or more safety hazards along the lane, and

a control system connected to the detection system and to one or more of the operative modules, the control system being configured and operable to be responsive to detection of one or more safety hazards for controlling operation of said one or more operative modules of the BSS, said controlling comprising selectively disrupting or actuating normal operation of at least one of the operative modules.

2. The BSS of claim 1, wherein the detection system comprises at least one of the following:

i. Obstruction detection system configured and operable to detect a safety hazard manifested by presence of one or more obstructions on or in the vicinity of the service lane;

ii. Position detection system configured and operable to identify a safety hazard manifested by mis-position of a vehicle being serviced along the service lane;

iii. Weight detection module detecting a position of the vehicle's wheels at certain locations along the service lane; and

iv. Vehicle status detection system adapted for communicating with a vehicle controller located onboard the vehicle for receiving therefrom data indicative of an operational and safety state of the vehicle.

3. The BSS of claim 1, wherein said one or more operative modules comprise at least one of the following:

i. a vehicle's transportation module associated with the service lane and being configured to engage with the vehicle and move it through the lane, said control system operating to selectively disrupt normal operation of the vehicle's transportation upon detecting the one or more safety hazards along the lane;

ii. one or more alignment modules which are located along the lane and adapted to engage with the vehicle to adjust its position, said control system operating to selectively disrupt normal operation of said one or more alignment modules upon detecting the one or more safety hazards along the lane or enable normal operation of one or more of the alignment modules in the absence of detection of the safety hazards;

iii. operative modules of a battery switch post for exchanging batteries from beneath the vehicle, said control system operating to selectively disrupt normal operation of at least one of the modules of the battery switch post upon detecting the one or more safety hazards along the lane;

iv. operative modules of a cleaning post for cleaning a battery bay located at the bottom of the vehicle, said control system operating to selectively disrupt normal operation of at least one of the modules of the cleaning post upon detecting the one or more safety hazards along the lane;

v. electric modules, said control system operating to selectively disrupt normal operation of the one or more service posts by electrically disconnecting said one or more electric modules upon detecting an electrocuting hazard.

vi. vehicle barriers arranged along the lane, said control system operating to selectively operate one or more of the vehicle barriers for preventing undesired motion of the vehicle in said lane.

4. The BSS of claim 1, comprising at least one user interface module adapted for providing a user of a vehicle at said BSS lane with instructions for conducting the vehicle through the lane.

5. The BSS of claim 4, wherein said user interface module comprises at least one of an auditory and visually informative utility.

6. The BSS of claim 2, wherein at least one of said obstruction detection system and position detection comprises an optical system accommodated such that the lane is at least partially in a field of view of the optical system; the control system being configured and operable for receiving and processing data acquired by the optical system and determining any safety hazard in the lane.

7. The BSS of claim 2, wherein said position detection system comprises one or more sensors determining the position of the vehicle along the lane, said one or more

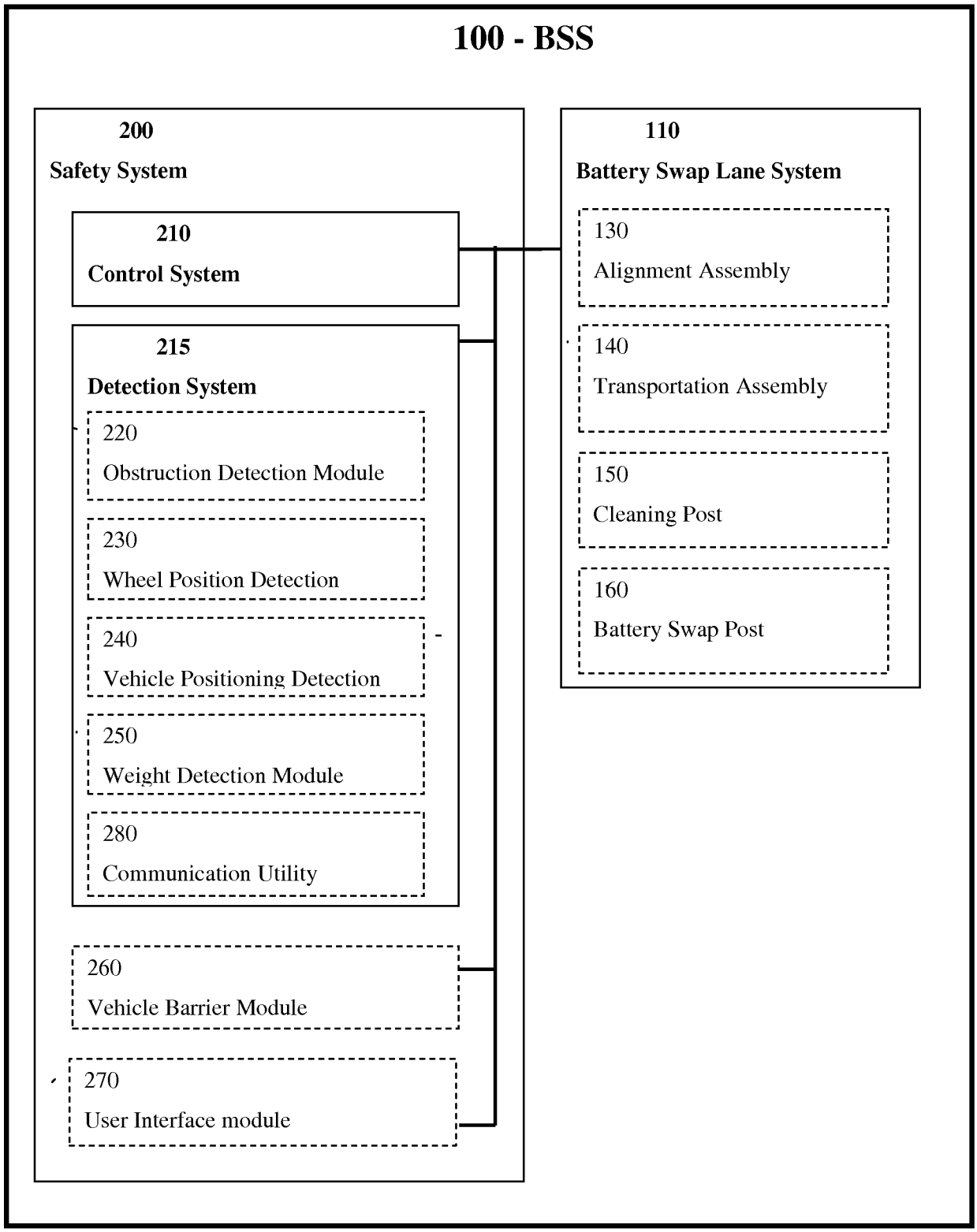
sensors comprising at least one of the following: proximity sensor, electro-magnetic sensor, light sensitive module, weight module and imaging module.

8. The BSS of claim 7, wherein said control system is adapted to acquire data indicative of the type of vehicle being at the BSS lane and process that data together with sensing data from at least one of said sensors to determine an extent of the vehicle's position in said lane.

9. The BSS of claim 1, wherein said one or more of the operative modules comprise tire alignment modules configured for sliding movement, the control system comprising a weight activated controller associated with the weight detection module and being configured for operating said tire alignment modules; said operating comprising selectively enabling or preventing sliding movement of at least one of the tire alignment modules in response to weight applied to said weight detection module such that said sliding movement is enabled only upon detection of a vehicle on said weight detection module.

10. The BSS of claim 2, wherein said vehicle status detection system is adapted to detect vehicle operational data indicative of at least one of the following: state of the vehicle's doors, activation of the vehicle, gear state of the vehicle and brake and hand brake states of the vehicle, position of an ignition key of the vehicle and operation state of internal high-voltage switches of the battery; said vehicle operational data being communicated to the control system which processes said data to determine safety hazard manifested by improper operation of the vehicle while in said lane.

11. A safety system for use in battery switch stations (BSSs), the safety system comprising a control system configured and operable for communication with a detection system which is located at the BSS and is configured and operable to detect one or more safety hazards along a BSS lane; said control system is responsive to detection of one or more safety hazards by said detection system to selectively disrupt or actuate normal operation of at least one of the operative modules of the BSS.


100 - BSS
200
Safety System
210
Control System
215
Detection System
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Obstruction Detection Module
230
Wheel Position Detection
240
Vehicle Positioning Detection
250
Weight Detection Module
280
Communication Utility
260
Vehicle Barrier Module
270
User Interface module
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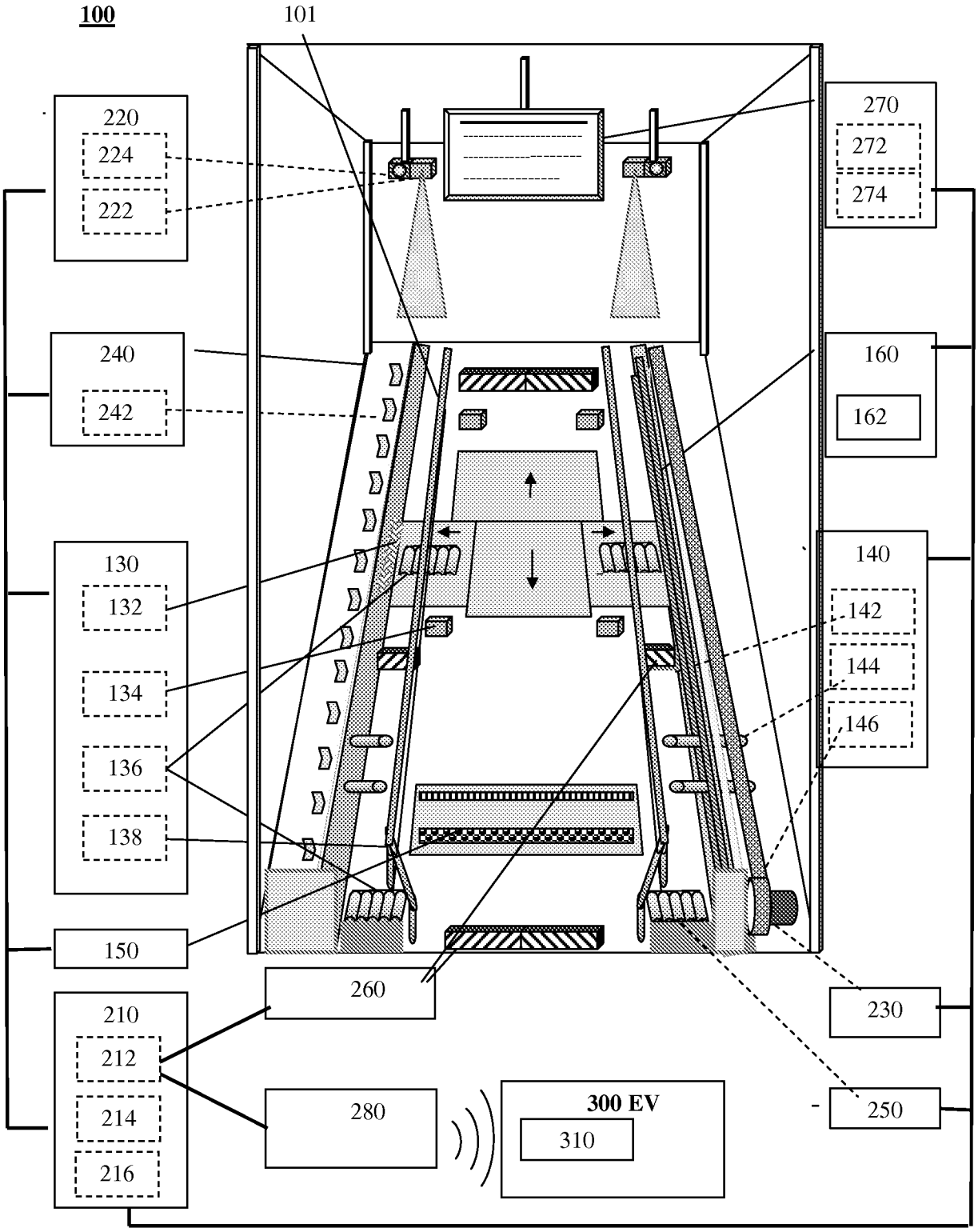
Battery Swap Lane System
130
Alignment Assembly
140
Transportation Assembly
150
Cleaning Post
160
Battery Swap Post

Fig. 1A

Fig. 1B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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2013/050279

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60S 5/00 (2013.01)
USPC - 414/800
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60S 3/00; B60S 5/00; B65G 37/00; F16M 13/00 (2013.01)
USPC - 414/800, 806, 812

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC- B60S 3/00; B60S 5/00; B65G 37/00; F16M 13/00 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2008/110175 A1 (MOGENSEN) 18 September 2008 (18.09.2008) entire document	1-11
Y	US 2011/0044791 A1 (AGASSI et al) 24 February 2011 (24.02.2011) entire document	1-11
Y	US 2011/0057816 A1 (NOBLE et al) 10 March 2011 (10.03.2011) entire document	8
Y	US 2008/0028974 A1 (BIANCO) 07 February 2008 (07.02.2008) entire document	9
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Y	US 2011/0279082 A1 (HAGENMAIER, JR. et al) 17 November 2011 (17.11.2011) entire document	10

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