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(54) **RESTRAINT SYSTEMS FOR USE IN VEHICLES AND METHODS OF RESTRAINT**

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(52) **U.S. Cl.** **280/801.1**

(57) **ABSTRACT**

A safety restraint system to restrain a wheelchair-seated person in a vehicle includes a belt including a pelvic restraining portion connectable between a first side and an second side. The system also includes a structural system to maintain the pelvic restraining portion at a sufficient height when the pelvic restraining portion is connected between the first side and the second side of the vehicle to allow the wheelchair-seated person to move the wheelchair forward to be restrained by the pelvic restraining portion. The structural system can, for example, maintain the pelvic restraining portion above the each of knees of the wheelchair-seated person.

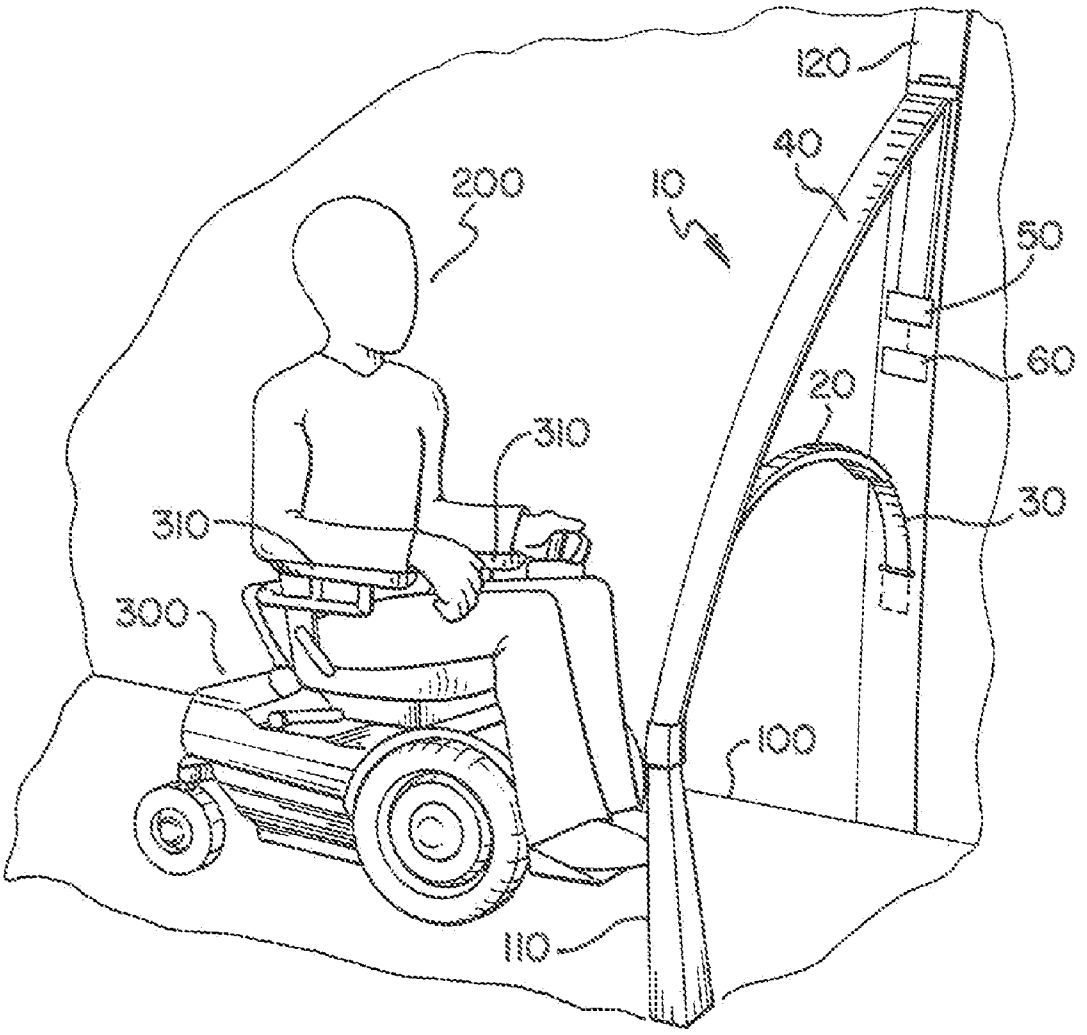


FIG. 1

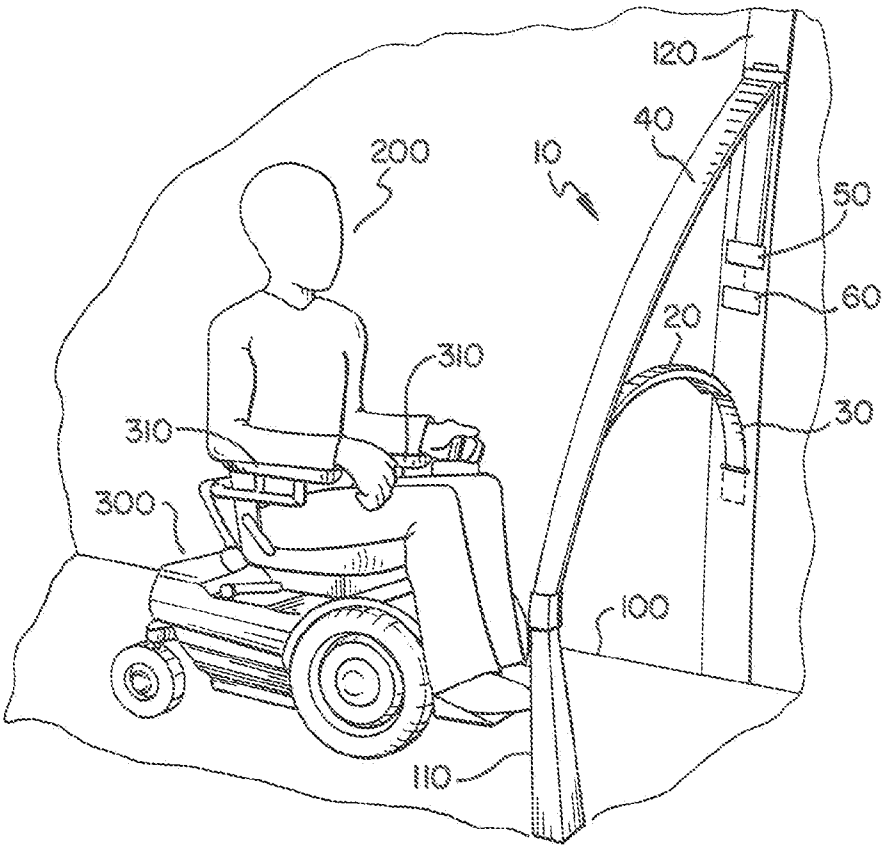
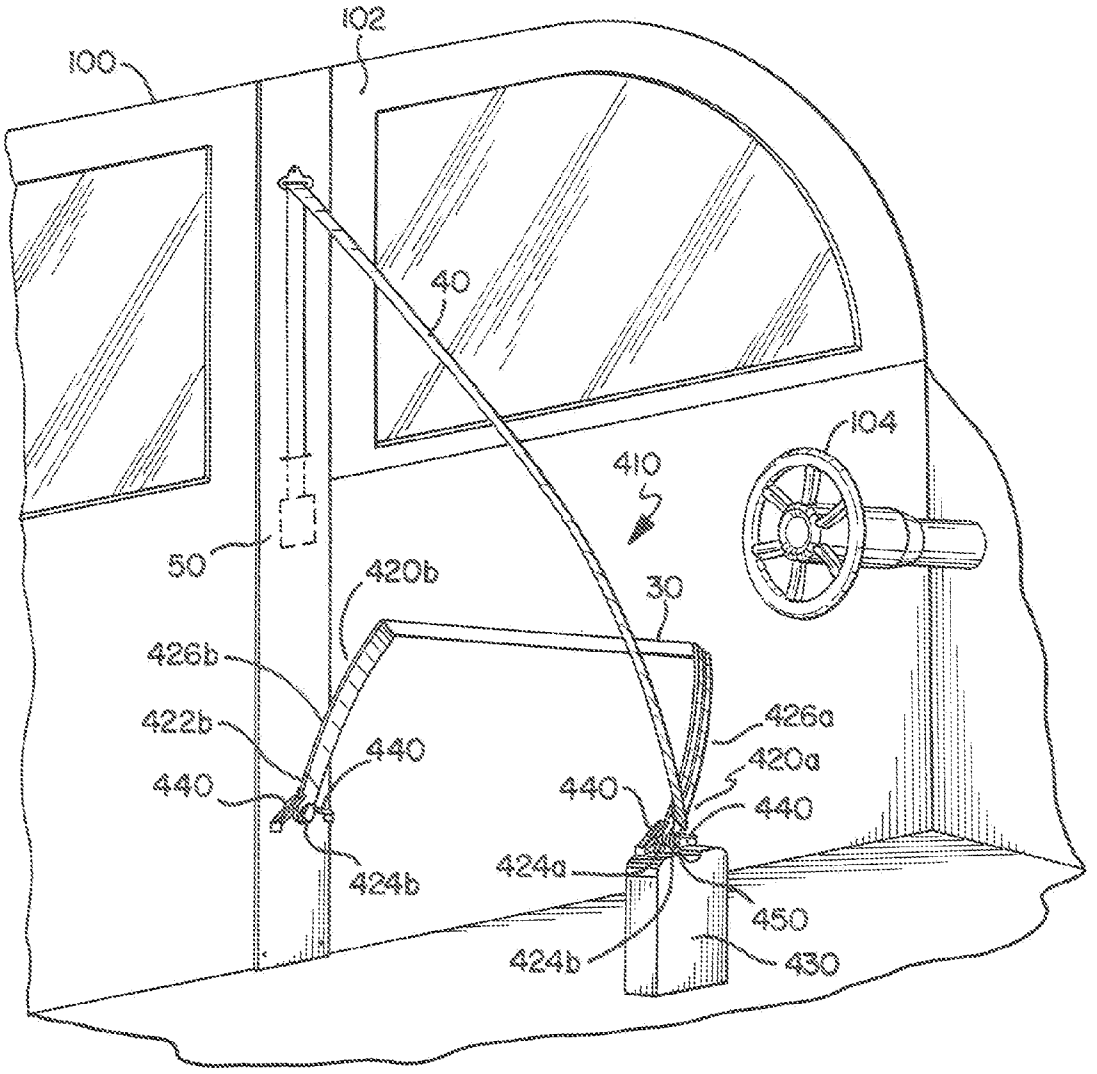


FIG. 2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102
40
104
410
50
420b
30
426b
422b
440
440
424b
426a
420a
440
440
424a
450
424b
430

FIG. 3

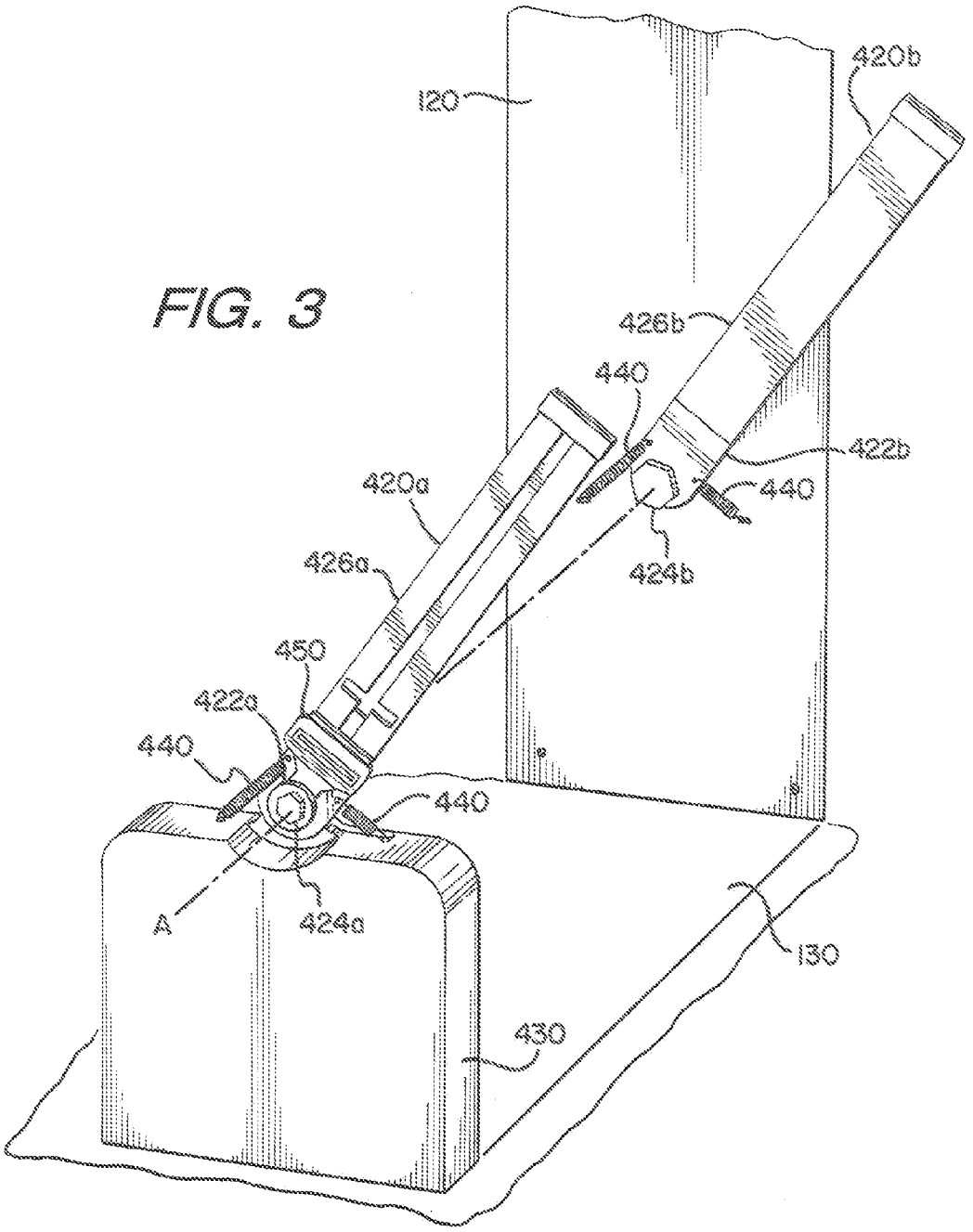
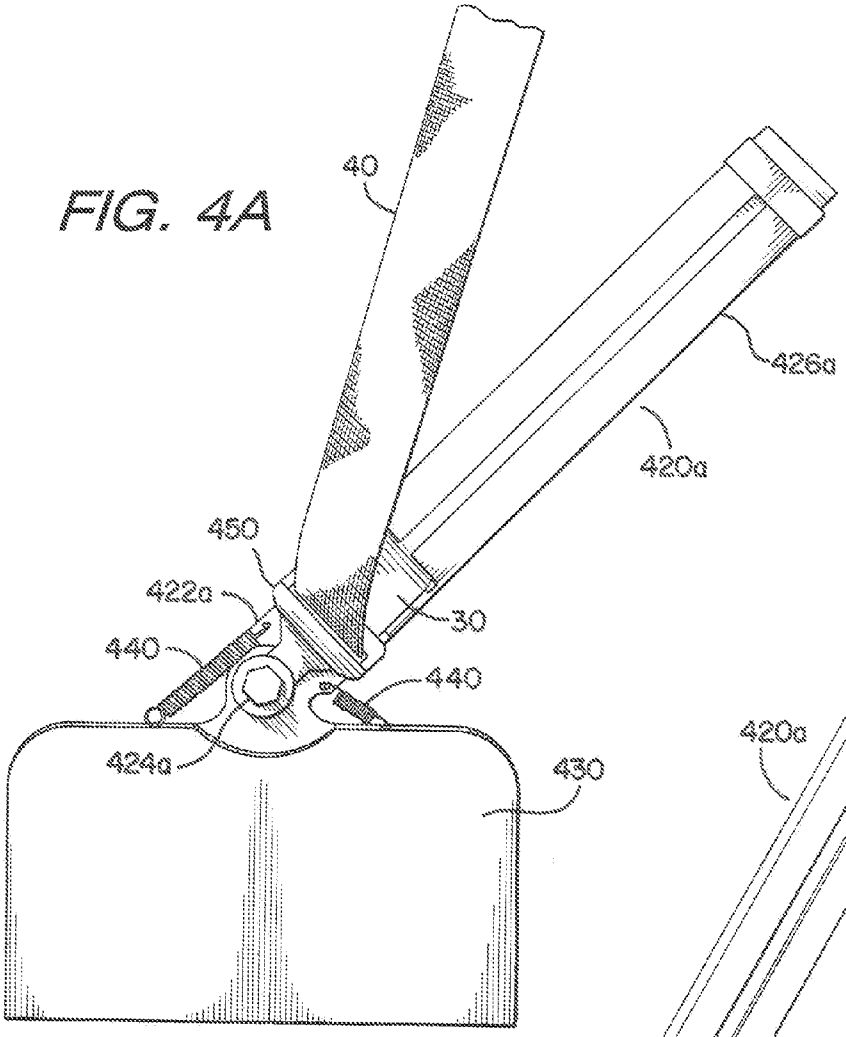

120
420b
426b
440
422b
440
420a
426a
424b
450
422a
440
440
A
424a
130
430

FIG. 4A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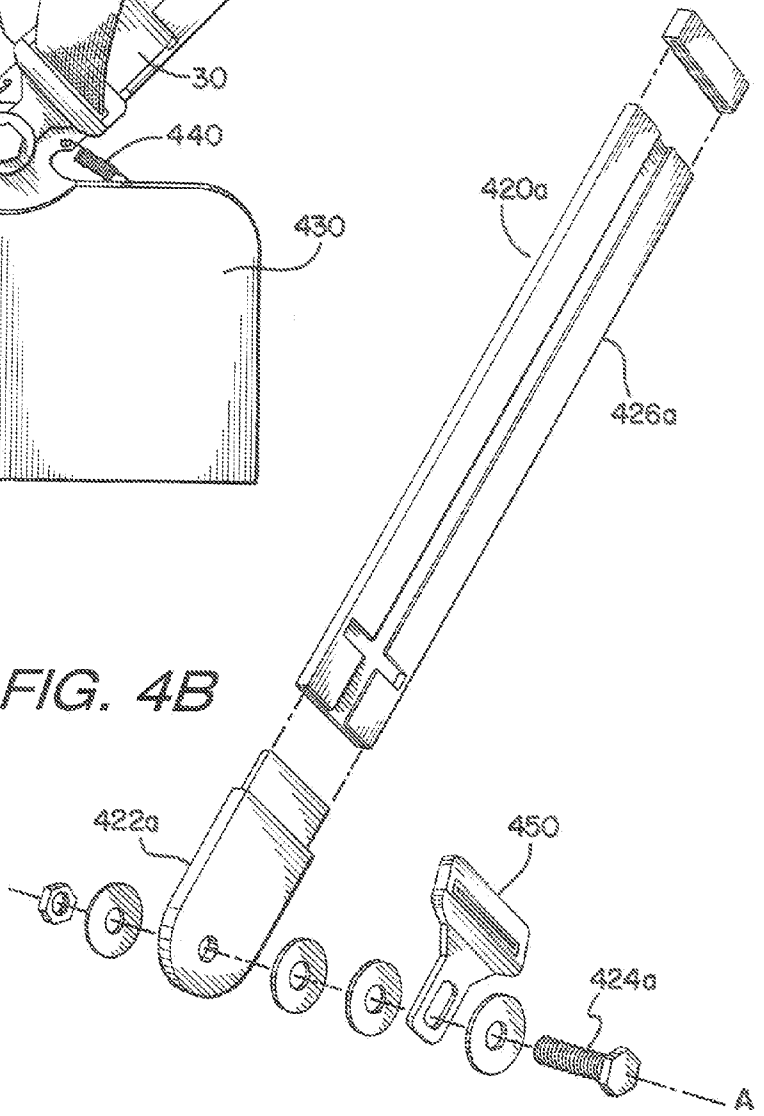
450
422a
30
440
440
424a
430

FIG. 4B


420a
426a
422a
450
424a
A

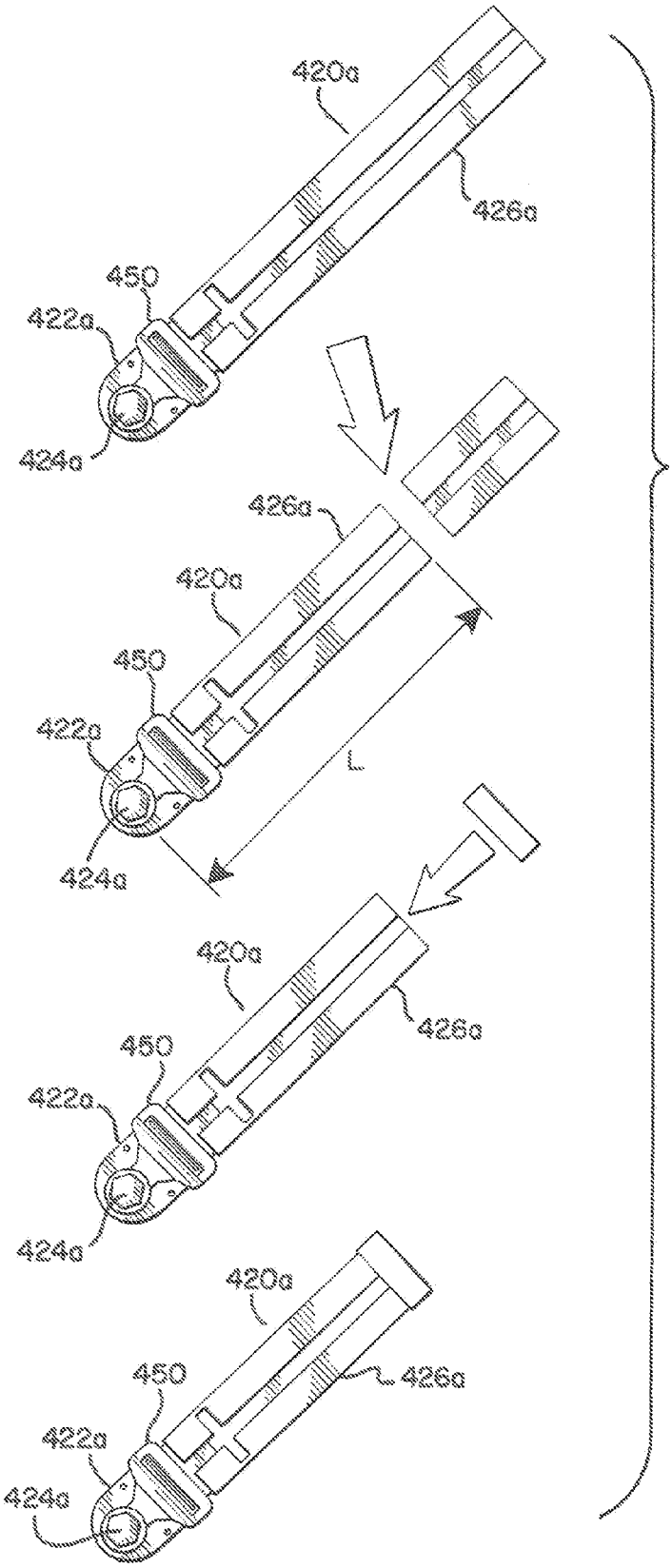
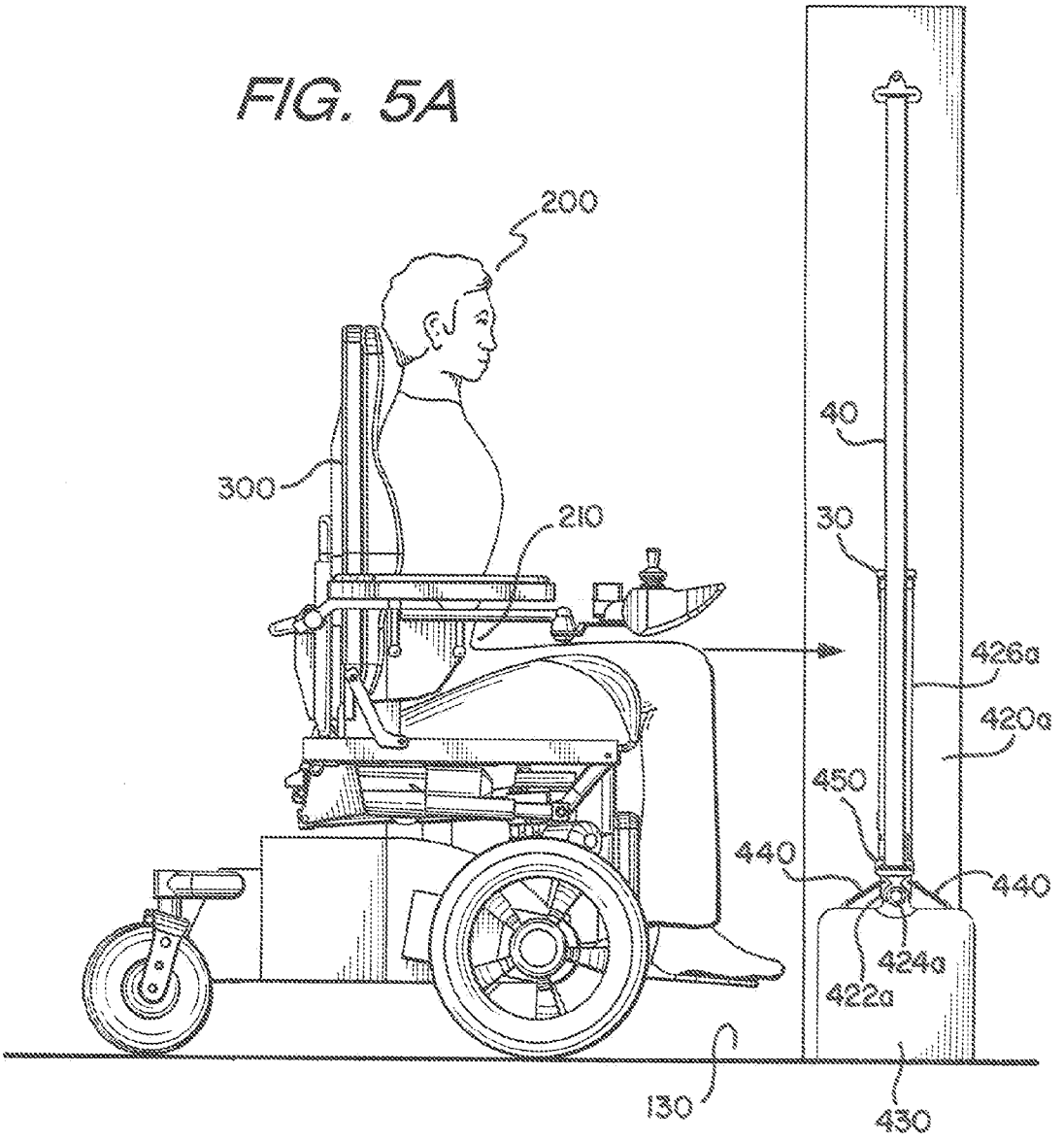


FIG. 4C

FIG. 5A



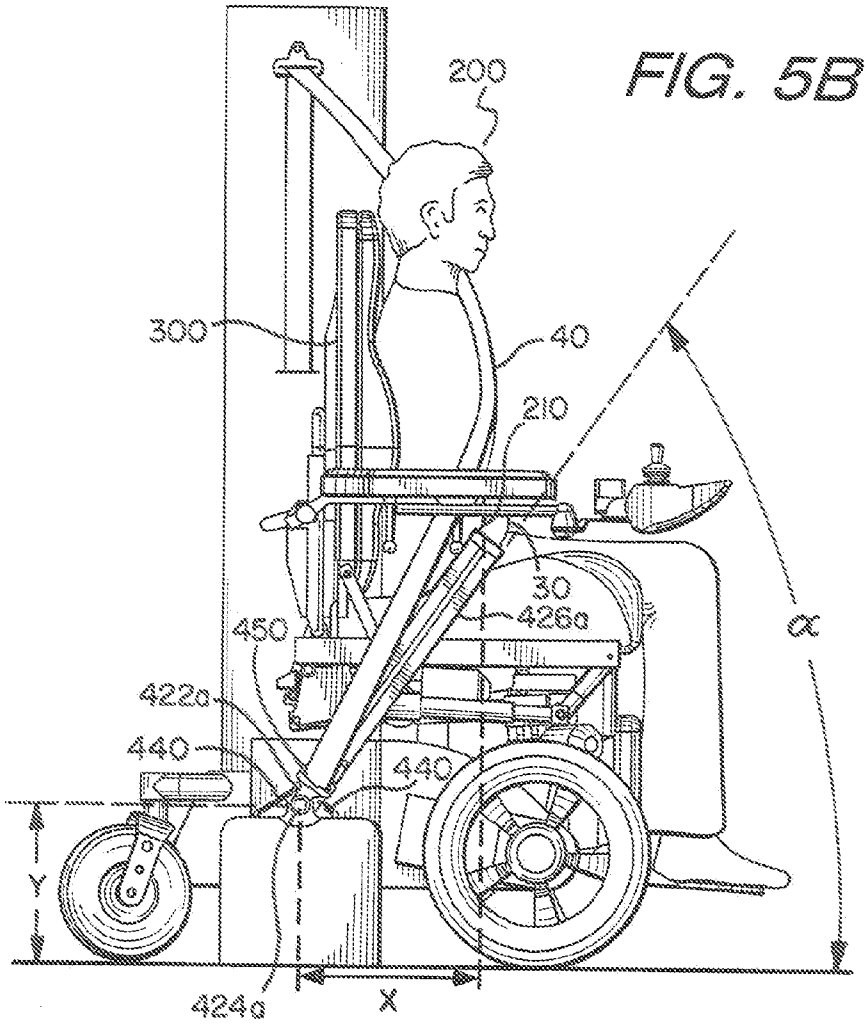


FIG. 5B

FIG. 5C

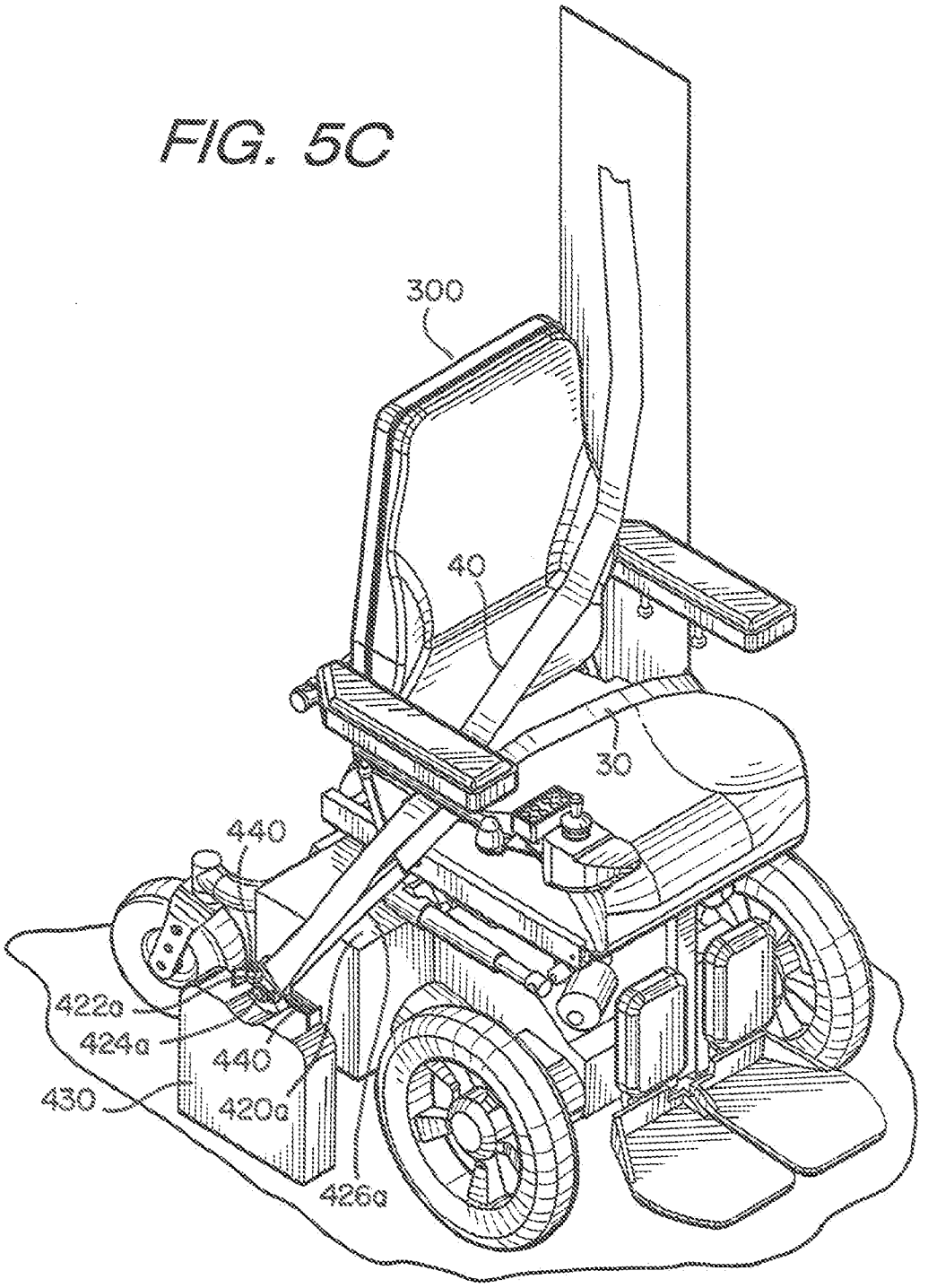
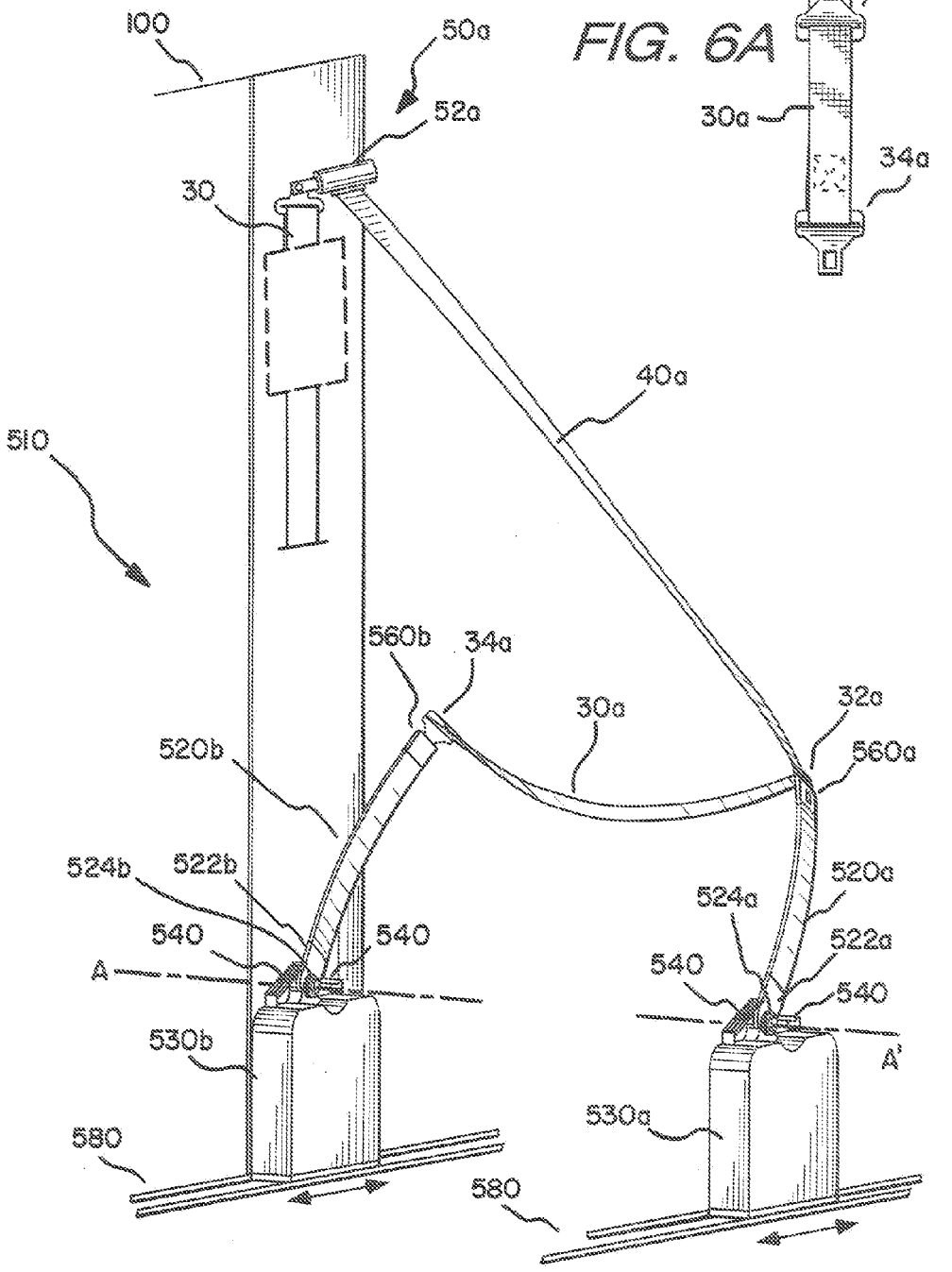


FIG. 6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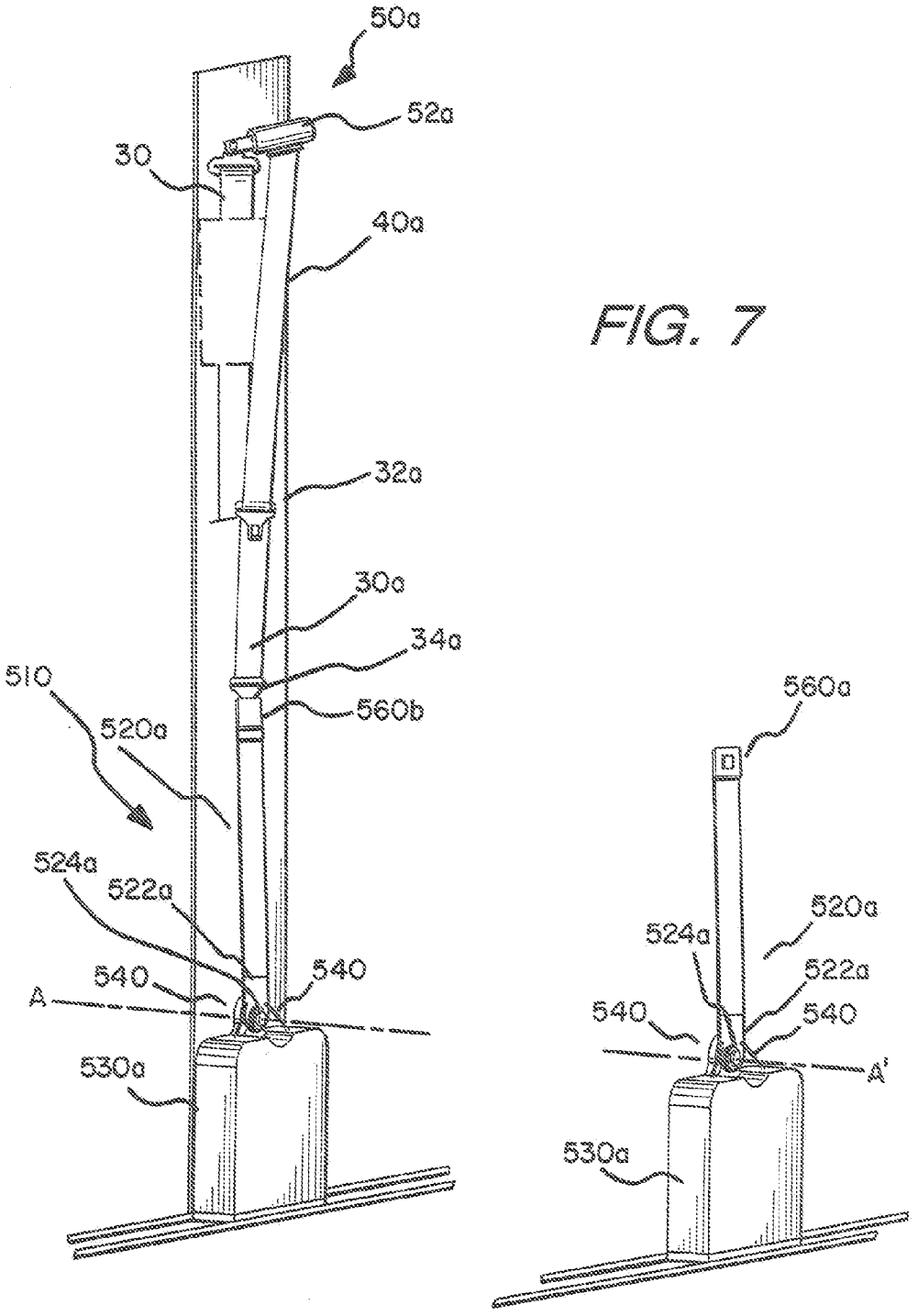
50a
52a
30
40a
510
560b
34a
30a
32a
560a
520b
524b
522b
540
A
530b
580
520a
524a
522a
A'
530a

FIG. 6A

52a
50a
40a
32a
30a
34a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30a
34a
560b
510
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524a
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530a
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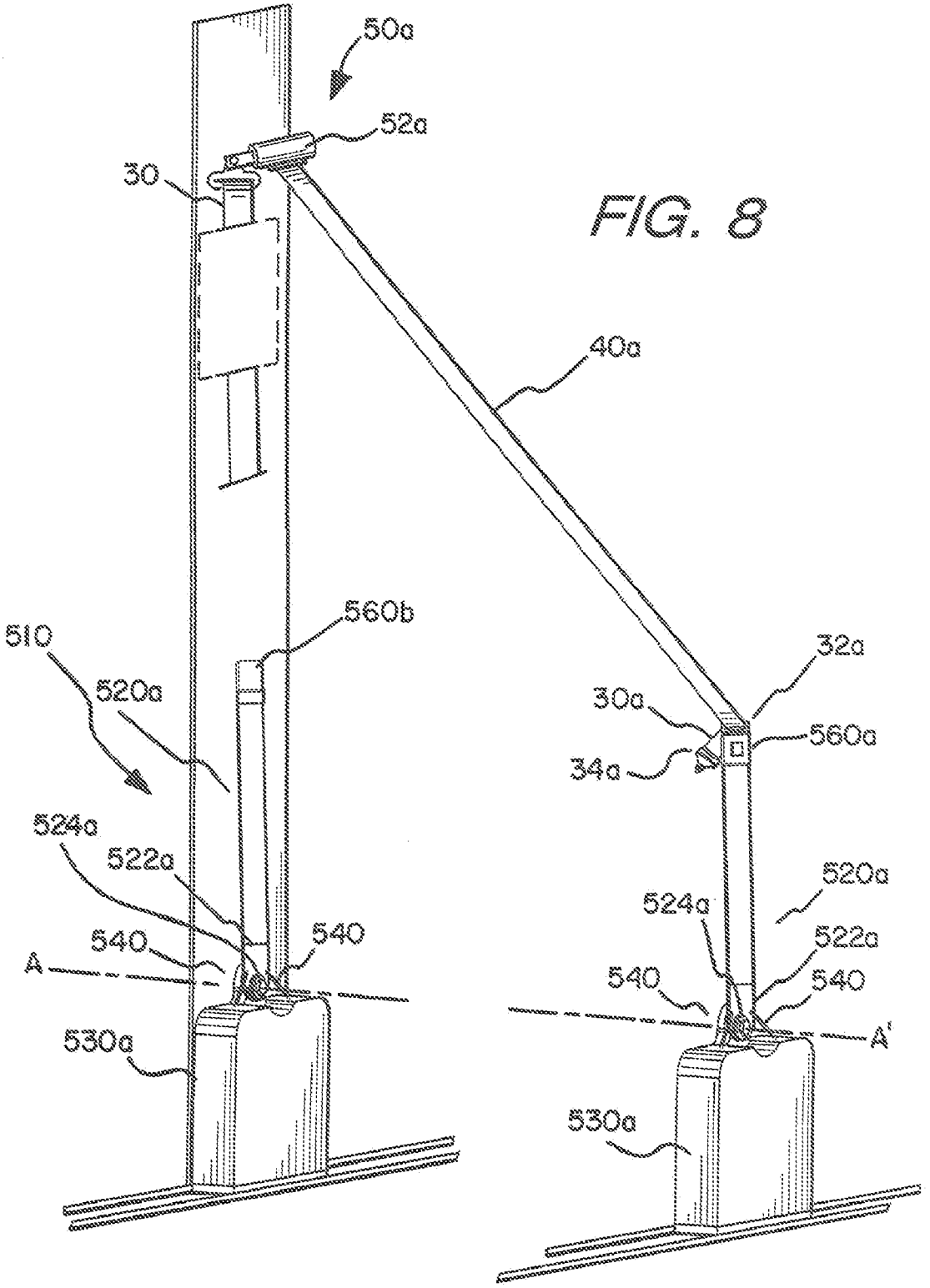
520a
524a
522a
540
540
A'
530a

FIG. 7


50a
52a
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40a
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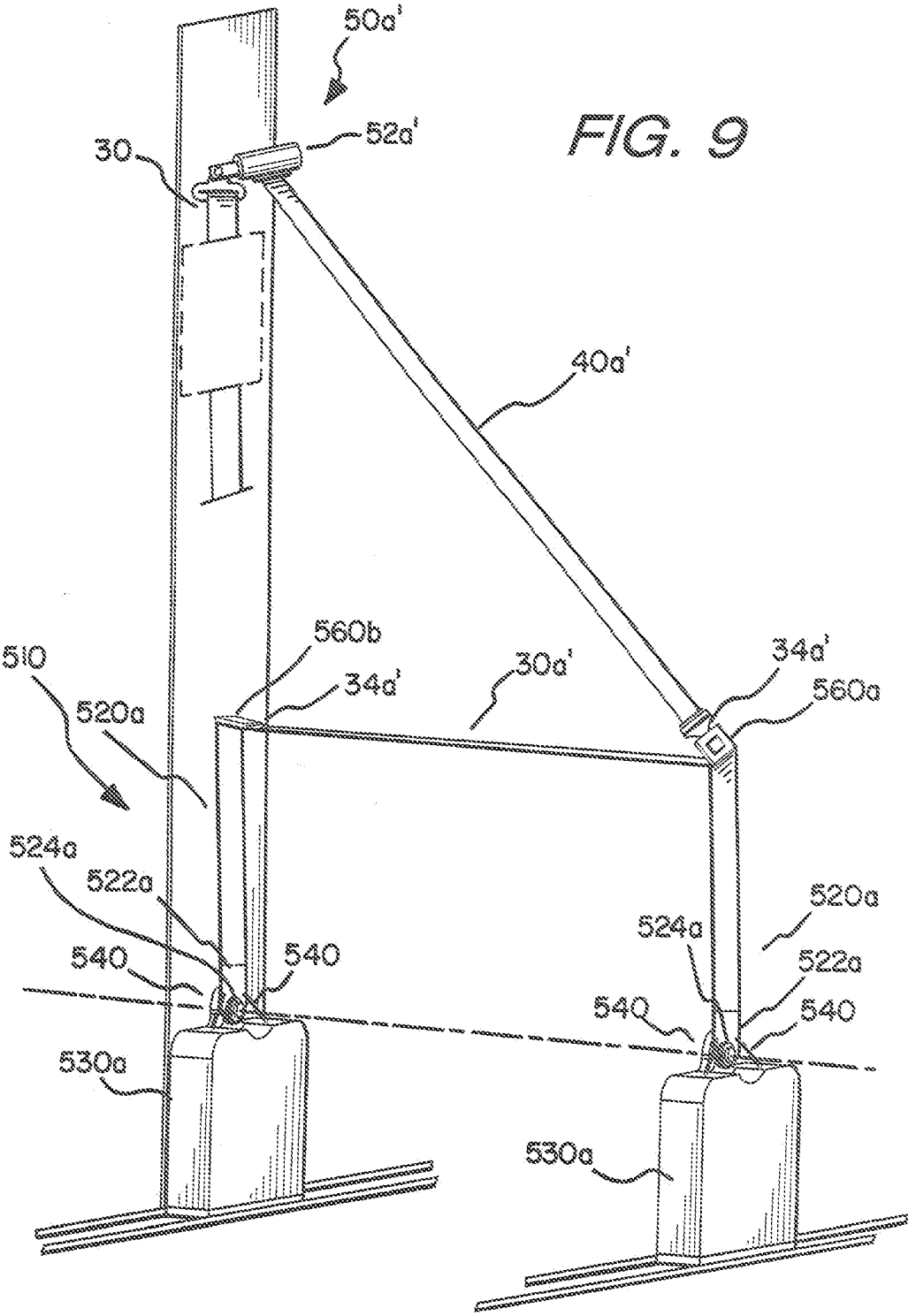
510
520a
524a
522a
540
540
A
530a
32a
30a
560a
34a
520a
524a
522a
540
540
A'
530a

FIG. 8


50a'
52a'
30
40a'
560b
34a'
30a'
34a'
560a
510
520a
524a
522a
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520a
524a
522a
540
540
530a
530a

FIG. 9

FIG. 10A

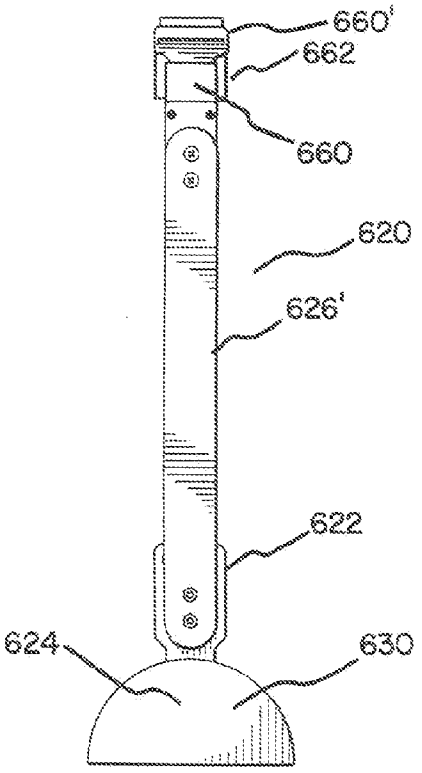


FIG. 10B

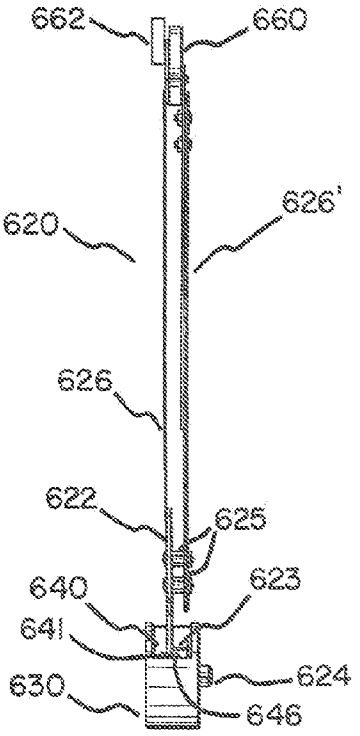


FIG. 10C

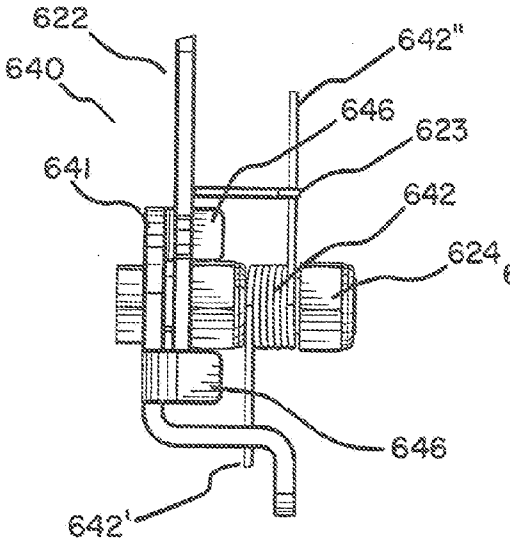
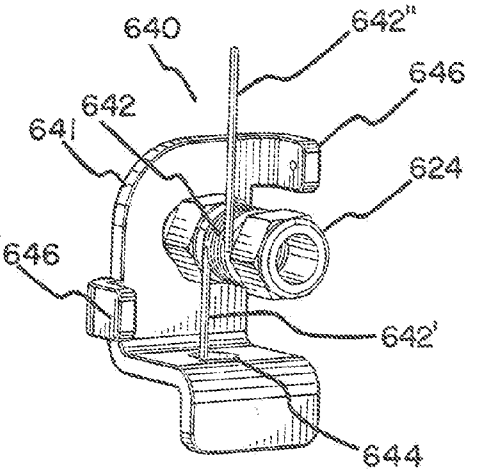


FIG. 10D



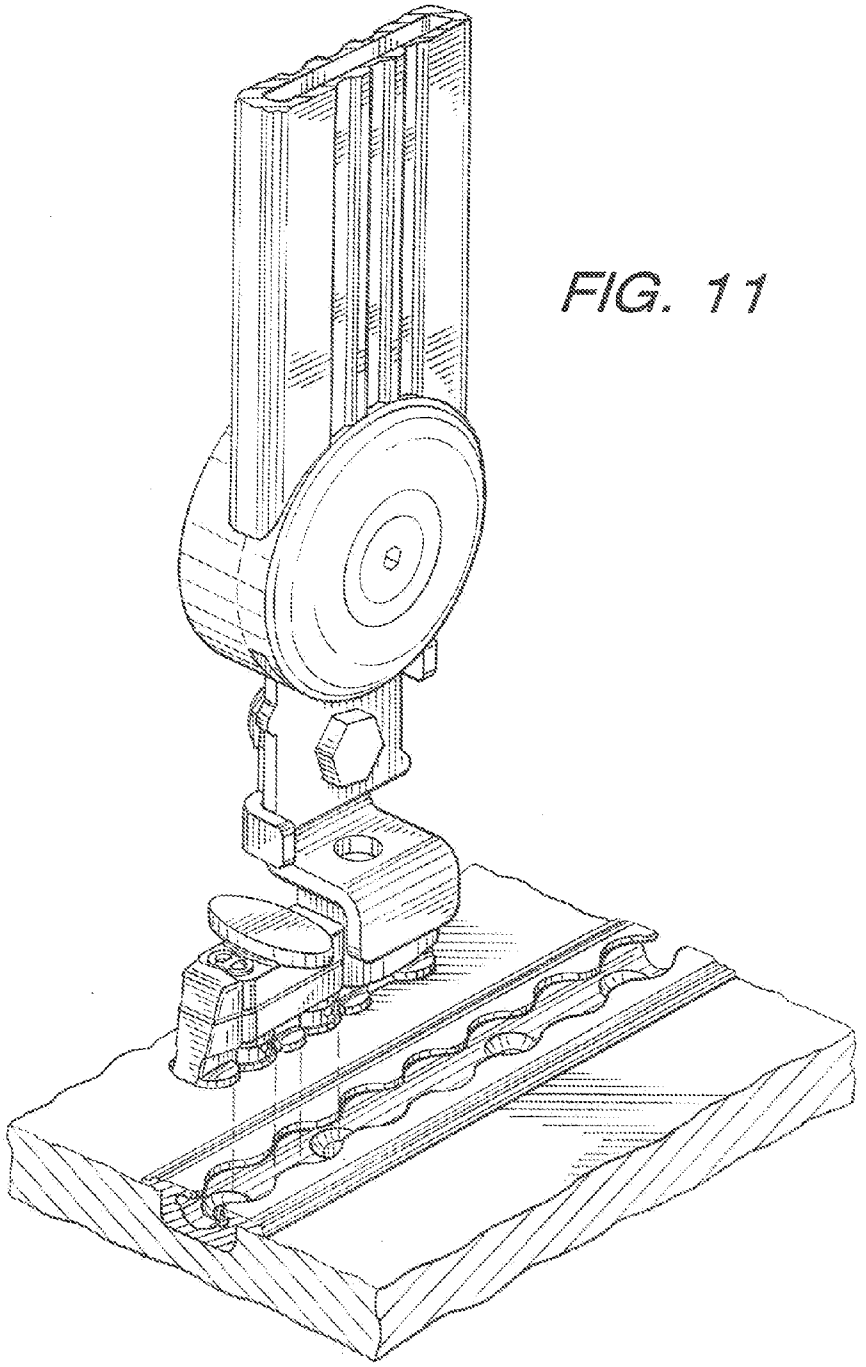


FIG. 11

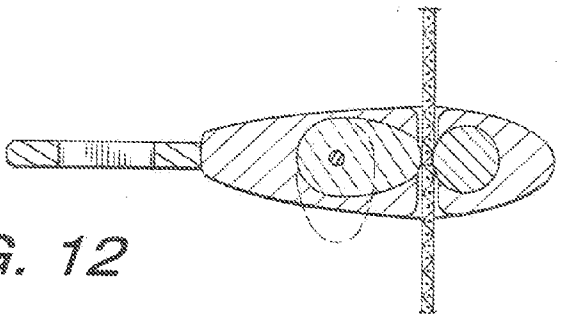


FIG. 12

RESTRAINT SYSTEMS FOR USE IN VEHICLES AND METHODS OF RESTRAINT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims benefit of U.S. Provisional Patent Application No. 61/045,715, filed Apr. 17, 2008, the disclosure of which is incorporated herein by reference.

GOVERNMENTAL INTEREST

[0002] These inventions were made with government support under grant no. H133E060064 awarded by the National Institute on Disability and Rehabilitation Research—Department of Education. The government has certain rights in these inventions.

BACKGROUND OF THE INVENTIONS

[0003] The present inventions relate to safety restraint systems for use in vehicles and to methods of restraint, and, particularly, to wheelchair accessible restraint systems for use in vehicles and to methods of restraining vehicle occupants seated in wheelchairs.

[0004] The following information is provided to assist the reader to understand the embodiments disclosed below and the environment in which they will typically be used. The terms used herein are not intended to be limited to any particular narrow interpretation unless clearly stated otherwise in this document. References set forth herein may facilitate understanding of the present inventions or the background of the present inventions. The disclosure of all references cited herein are incorporated by reference.

[0005] Current Original Equipment Manufacturer (OEM) occupant restraint systems (including, for example, pelvic and/or shoulder restraints or straps) are difficult to use by individuals with limited dexterity and/or arm function. For example, current restraint system buckles and latch plates are often difficult to reach and difficult to use. Such components can, for example, be slippery and difficult to operate or don. Moreover, a precision grip may be needed to place a latch plate into a buckle. In addition, when wheelchairs are used as motor vehicle seats, wheelchair armrests often interfere with the operation of seat belt systems when the individual seated in the wheelchair drives into the driver or passenger station of a motor vehicle. Also, when a wheelchair user wears postural supports they are often unable to rotate and move their upper body, making it difficult to reach for and position the shoulder belt and pelvic belt.

[0006] It is desirable to develop improved occupant restraint devices, systems and methods that reduce or eliminate the above and/or other problems associated with current restraint devices, systems and methods.

SUMMARY OF THE INVENTIONS

[0007] In one aspect, the present inventions provide a safety restraint system to restrain a wheelchair-seated person or a wheelchair occupant in a vehicle including a harness or belt system including a lap or pelvic restraining portion connectable between a first side and a second side. It is contemplated that the safety restraint system would be used in conjunction with a separate restraint for the wheelchair, for example, through the use of four-point tie-down system or a docking system like the QLK-100 docking system sold by Q'Straint of Fort Lauderdale, Fla. USA. As used herein, the term "belt" is used to refer to any type of extending flexible harness used in restraint systems. Such belts often, for example, include flexible webbing formed from polymeric materials as known in the seat belt and/or transportation arts. The system also includes a structural system to maintain the pelvic restraining portion at a sufficient height when the pelvic restraining portion is connected between the first side and the second side to allow the wheelchair-seated person to move the wheelchair forward to be restrained by the pelvic restraining portion. The structural system can, for example, maintain the pelvic restraining portion above the knees of the wheelchair-seated person.

[0008] The first side can, for example, be on an inboard side of the vehicle and the second side can, for example, be on an outboard side of the vehicle. Other orientations of the safety restraint systems of the present inventions within a vehicle are possible. In general, the wheelchair-seated person drives the wheelchair forward (with respect to the orientation of the wheelchair-seated person) into the safety restraint systems described herein, sometime referred to herein as a "rear entrance". As the wheelchair-seated person locks the vehicle into the docking system (if used), they are also securing themselves into the safety restraint system. As clear to one skilled in the art, the safety restraint systems described herein can be present in many types of vehicles for restraint at a drive station or at a passenger station. Passenger stations can be in the front of the vehicle or in the rear of the vehicle. Passenger stations need not be oriented in the same orientation as the vehicle. Indeed, the passenger station may be oriented in a forward facing, rear facing, side facing, or other direction. Moreover, multiple safety restraint systems can be included in a single vehicle.

[0009] In several embodiments, the structural system includes a guide member, such as a sleeve or channel, through which the pelvic restraining portion passes, the guide member being stiffer than the belt. In several such embodiments, the structural system includes a first sleeve through which the pelvic restraining portion passes on the first (for example, inboard) side of the pelvic restraining portion and a second sleeve through which the pelvic restraining portion passes on the second (for example, outboard) side of the pelvic restraining portion. The first sleeve and the second sleeve can be of sufficient length and sufficient stiffness to maintain the pelvic restraining portion at the sufficient height. The sufficient height can, for example, be above the knees of the wheelchair-seated person. Preferably, the sufficient height is below at least a forward portion of an armrest of the wheelchair so that the pelvic restraining portion can contact the person in the vicinity of the thigh-abdominal junction of the person. The belt can further include a shoulder restraint portion.

[0010] In a number of embodiments, the structural system includes a first support structure on the first side and a second support structure on the second side. The pelvic restraining portion can extend between an end of the first support structure and an end of the second support structure. The first support structure and the second supports structure can, for example, maintain the pelvic restraining portion at a height above the knees of the wheelchair-seated person (for example, as the wheelchair is moved into connection with the safety restraint system). In several embodiments, the first support structure is in pivotable connection with the vehicle and the second support structure is in pivotable connection with the vehicle. A first axis about which the first support structure is pivotable can be positioned at a first position to the

rear of the thigh-abdominal junction (with reference to the orientation of the wheelchair-seated person) of the person when the person is restrained within the safety restraint system. Also, a second axis about which the second support structure is pivotable can be positioned at a second position to the rear of the thigh-abdominal junction of the person when the person is restrained within the safety restraint system. The first axis and the second axis can be generally collinear. Each of the first support structure and the second support structure can, for example, independently form an angle in the range of approximately 45 to 75° with respect to vehicle the floor when the person is restrained within the safety restraint system, in order to comply with the preferred current lap/shoulder belt geometries referred to in SAE J2249 guidelines. However, the support structures may have a free range of movement well in excess of that range. In some of the embodiments, the first support structure and second support structure are capable of forming an angle of approximately 90° with respect to the vehicle floor to maintain the pelvic restraining portion at a height above the knees of the wheelchair-seated person as he/she enters the safety restraint system, and can rotate to an angle of 30° or more as the person is steering into position.

[0011] In several embodiments, a length of the first support structure is adjustable and a length of the second support structure is adjustable. The length of the first support structure can, for example, be adjustable via cutting and/or telescoping, and the length of the support structure sleeve can, for example, be adjustable via cutting and/or telescoping.

[0012] In several embodiments, the first support structure includes a first sleeve through which the pelvic restraining portion passes on the first side and a the second support structure includes a second sleeve through which the pelvic restraining portion passes on the second side. The first sleeve and the second sleeve can, for example, be formed from a polymeric material.

[0013] In another aspect, the present inventions provide a method of restraining a wheelchair-seated person in a vehicle, including: providing a belt comprising a pelvic restraining portion connected between a first side and a second side, and providing a structural system to maintain the pelvic restraining portion at a sufficient height between the first side and the second side of the pelvic restraining portion to allow the wheelchair-seated person to move the wheelchair forward to be restrained by the pelvic restraining portion.

[0014] In a further aspect, the present inventions provide a safety restraint system to restrain a wheelchair-seated person in a vehicle, including a first support structure on a first side, the first support structure being pivotable to a first range of angles, a second support structure on a second side, the second support structure being pivotable to a second range of angles, and a belt system comprising a pelvic restraining portion connectable between the first side support structure and the second support structure. The pelvic restraining portion can, for example, be removably connectable to one or more of the first support structure and the second support structure.

[0015] In several embodiments, a first axis about which the support structure is pivotable is positioned at a first position to the rear of the thigh-abdominal junction of the person when the person is restrained within the safety restraint system and a second axis about which the second supports structure is pivotable is positioned at a second position to the rear of the thigh-abdominal junction of the person when the person is restrained within the safety restraint system. The first axis and the second axis can be generally collinear. The first position can be adjustable, and the second position can be adjustable.

[0016] The first support structure can be biased to return to a first predetermined position when the wheelchair-seated person is not restrained by the safety restraint system. Likewise, the second support structure can be biased to return to a second predetermined position when the wheelchair-seated person is not restrained by the safety restraint system. The first support structure and the second supports structure can, for example, maintain the pelvic restraining portion at a height above the knees of the wheelchair-seated person when the first support structure is in the first predetermined position and the second support structure is in the second predetermined position.

[0017] The devices, systems and methods described herein allow a wheelchair-seated individual to remain seated in their wheelchair when driving or riding in a motor vehicle. The individual can drive the wheelchair into the driver station or a passenger station of a vehicle to achieve a "rear entrance" into a restraint system of the present inventions.

[0018] The present inventions, along with the attributes and attendant advantages thereof, will best be appreciated and understood in view of the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** illustrates a perspective view of one embodiment of a restraint system of the present inventions including a support structure in the form of a sleeve to maintain a lap or pelvic belt portion of a seat belt above a wheelchair-seated user's knees.

[0020] FIG. **2** illustrates a perspective view of another embodiment of a restraint system of the present inventions including an inboard support structure and an outboard support structure to maintain a lap or pelvic belt portion of a seat belt above a wheelchair-seated user's knees.

[0021] FIG. **3** illustrates an enlarged perspective view of the inboard and outboard support structures of the system of FIG. **2**.

[0022] FIG. **4**A illustrates an enlarged side view of the inboard support structure.

[0023] FIG. **4**B illustrates an enlarged, perspective disassembled or exploded view of the rotatable or pivotable connection of the inboard support structure.

[0024] FIG. **4**C illustrates a method of adjusting the length of an inboard or outboard sleeve of the present inventions, wherein the inboard sleeve is depicted as a representative example.

[0025] FIG. **5**A illustrates a side view a wheelchair-seated user in motion toward the system of FIG. **2**.

[0026] FIG. **5**B illustrates a side view of a wheelchair-seated user restrained within the system of FIG. **2**.

[0027] FIG. **5**C illustrates a perspective view of a wheelchair positioned within the system of FIG. **2** without a user therein.

[0028] FIG. **6** illustrates a perspective view of another embodiment of a restraint system of the present inventions including an inboard support structure or member and an outboard support structure or member to support a lap or pelvic belt portion of a seat belt.

[0029] FIG. **6**A illustrates an embodiment of a dedicated belt system suitable for use in the restraint systems of the present inventions.

[0030] FIG. **7** illustrates a perspective view of the restraint system of FIG. **6** wherein a connector of the pelvic belt portion is removed from operative connection with the inboard support structure and maintained or "stored" in connection with a cooperating connector of the outboard support structure so that the pelvic belt portion does not extend between the inboard and outboard support structures.

[0031] FIG. **8** illustrates a perspective view of the restraint system of FIG. **6** wherein a connector of the pelvic belt portion is removed from connection with a cooperating connector of the outboard support structure and maintained or "stored" in operative connection with the inboard support structure so that the pelvic belt portion does not extend between the inboard and outboard support structures.

[0032] FIG. **9** illustrates a perspective view of the restraint system of FIG. **6** wherein the belt system includes a separate shoulder restrain belt and pelvic restraint belt.

[0033] FIG. **10**A illustrates a side view of an embodiment of a floor-mounting support structure, which is an alternative to the support structure shown in FIG. **4**A.

[0034] FIG. **10**B illustrates a rear view of the support structure of FIG. **10**A.

[0035] FIG. **10**C illustrates an enlarged rear view of a biasing connector bracket assembly of the support structure of FIG. **10**A.

[0036] FIG. **10**D illustrates an enlarged perspective view of a biasing connector bracket assembly of the support structure of FIG. **10**A.

[0037] FIG. **11** illustrates an alternate embodiment of the support structure that is mounted to the floor of a vehicle using an L-Track and fitting.

[0038] FIG. **12** illustrates a side sectional view of an alternate embodiment of a male connector which includes a belt tensioning mechanism.

DETAILED DESCRIPTION OF THE INVENTIONS

[0039] In several embodiments, the devices, systems and methods of the present inventions address the problems of wheelchair-seated individuals who find it difficult or impossible to use standard (Original Equipment Manufacturer—OEM) or even non-standard, specialized vehicle mounted seat belts or to drive into a vehicle mounted seat belt system when preparing to operate or to be a passenger in a motor vehicle.

[0040] In several embodiments, the devices, systems and methods of the present inventions enable wheelchair-seated individuals, including those with limited reach, hand and arm function or limited dexterity, to easily and independently drive into a pre-buckled or pre-connected, vehicle-mounted seat belt system, without the need to reach for, lift over knees or touch (with hands) the belt(s) and/or buckles, or otherwise connect a pelvic belt and/or a shoulder belt. The systems of the present inventions are readily adapted for use with currently available OEM seatbelts used in vehicles.

[0041] Currently available pelvic restraint systems include flexible webbing-style belts that are typically connected to the bottom of the B-pillar on the vehicle outboard side and are run directly to be connected to a buckle receiver on the inboard side of the vehicle. The B-pillar is the roof support and structural member located between a vehicle's front door and rear side window.

[0042] In one embodiment of the present inventions as illustrated in FIG. **1**, a system **10** includes a relatively stiff seat belt sleeve **20** that can, for example, include a preformed, semi-stiff polymeric or plastic cover. Cover or sleeve **20** is placed around a part of a lap belt or pelvic restraining portion **30** of the seat belt. Sleeve **20** is preferably sufficiently stiff to prevent pelvic belt portion **30** from hanging down, making it unnecessary for a user **200** to reach for it and lift the pelvic belt up when driving into pre-connected seat belt system **10**. However, sleeve **20** is also preferably sufficiently flexible to maintain the user in comfort. Sleeve **20** can be used in combination with a standard seat belt system including pelvic belt **30** and a shoulder belt or shoulder restraining portion **40** as illustrated in FIG. **1**. Pelvic belt portion **30** and a shoulder belt portion **40** (which, in the illustrated embodiment, are portions or sections of the same continuous belt) can be connected to a vehicle **100** at a console **110** on the inboard side and at B-pillar **120** on an outboard side. Sleeve **20** can, for example, be rotatably connected to console **110** and extend a sufficient length to prevent pelvic belt portion **30** from hanging down below the knees of wheelchair-seated user **200**. In the illustrated embodiment, system **10** remains in a connected state so that user **200** can drive the user's wheelchair **300** into the system. When the user drives into system **10**, the seat belt is, for example, pulled out of its retractor **50** at the outboard shoulder belt anchor (as known in the art). Retractor **50** can, for example, be in operative connection with a control system **60** which can, for example, include a motor, one or more sensors and a controller so that tension of the seat belt restraint is automatically regulated to provide the user with a snug and safe fit when the user is positioned within safety restraint system **10**. Sleeve **20** is readily customizable or adjustable to any height to, for example, ensure that pelvic belt portion **30** of the seat belt is higher than the user's knee, but lower than optional armrests **310** of wheelchair **300**. User **200** then drives in the system, pulling the seat belt with user **200** as it comes in contact with the thigh-abdominal junction of user **200**. System **10** and other systems of the present inventions can, for example, be readily adapted for use with wheelchairs conforming to the WC19 standard (WC19 Wheelchairs Used as Seats in Motor Vehicles approved by ANSI/RESNA) and/or other design guidelines and having an "open armrest" design.

[0043] The vertical height of the sleeve **20** can adjusted by the sleeve length. The preformed sleeve **20** is attached to upper arms **426***a*. The shorter the sleeve **20** is, the lower the arc across the user **200** becomes. Alternatively, the sleeve can be formed of a firm and flexible material that can be shaped, for example, via hand or by the use of heat and or tools.

[0044] FIGS. **2** through **5**C illustrates another embodiment of a system **410** of the present inventions positioned at a drivers station of a vehicle **100** adjacent driver's side door **102** and steering wheel **104**. System **410** includes a support system including an inboard support structure **420***a* and an outboard support structure **420***b* which can, for example, rotate or pivot about an axis A which is located to the rear of the thigh-abdominal junction **210** (see, for example, FIGS. **5**A and **5**B) of wheelchair-seated occupant or user **200** when user **200** is restrained within system **410**. Alternatively, inboard support structure **420***a* and outboard support structure **420***b* can be fixed at a desired angle or range of angles for a particular user. The terms "inboard" and "outboard" are used to refer to a first side and a second side in connection with several embodiments of the present inventions as, for example, illustrated in FIGS. **2** through **5**C. Once again, however, passenger restraint stations need not be oriented in the

same orientation as the vehicle; thus, use of the term "inboard" and "outboard" is used herein for convenience purposes only and is not intended to limit the passenger station to any particular orientation in a vehicle.

[0045] In the illustrated embodiment, each of support structures **420***a* and **420***b* includes an anchor member **422***a* and **422***b*, respectively, which is rotatably or pivotably mounted to vehicle **100** via bolt members **424***a* and **424***b*, respectively. Support structures **420***a* and **420***b* also include sleeves **426***a* and **426***b*, respectively, through which pelvic belt portion **30** is passed. As described above, pelvic belt portion **30** and shoulder belt portion **40** can be portions or sections of the same continuous seat belt. Pelvic belt portion **30** and shoulder belt portion **40** can also be formed separately. In the illustrated embodiment, the seat belt begins at anchor member **422***b*, passes through outboard sleeve **426***b*, exits the top of outboard sleeve **426***b*, extends generally parallel to vehicle floor **130**, enters the top of inboard sleeve **426***a*, exits the bottom of inboard sleeve **426***a*, forming pelvic or pelvic belt portion **30**. After exiting the bottom of inboard sleeve **426***a*, the seat belt passes through a connector **450** (for example, a male buckle latch, as known in the seat belt or transportation arts, which is rotatably or pivotably connected to bolt member **424***a*), and extends upward to terminate at a connector system **50** (see FIG. **2**; which can include a retraction or tensioning system) to form shoulder belt portion **40**.

[0046] The anchor points (defined by the shafts of bolts **424***a* and **424***b*) defining axis A can, for example, be installed to ensure that the pelvic belt portion **30** of the seat belt makes an angle within a desired range of angles α (for example, in the range of approximately 45° to 75°) with respect to vehicle floor **130** upon driving wheelchair **300** into system **410** to its secured position into an automated or manual wheelchair securement system. The anchor points can be chosen for the comfort of the user so that an angle in the desired range (for example, 45° to 75°) is formed. A distance can be calculated from the thigh-abdominal junction, using the following formula:

$$\text{Tan } \alpha = (\text{abdominal junction height} - y)/x, \text{ where}$$
$$45° \leqq \alpha \leqq 75° \text{ for effective restraint}$$

wherein, x (see FIG. **5**B) is the distance between the installation spot (securement location, i.e., axis A) and the (forward positioned) thigh-abdominal junction of the user and y (see FIG. **5**B) is the height of axis A (in the shown embodiment, bolts **424***a* and **424***b*) above the vehicle floor.

[0047] As described above, in system **410**, pelvic or pelvic belt portion **30** of the seat belt rises up adjacent the vehicle outboard side B-pillar **120** through relatively stiff outboard sleeve **426***b* that is rotatably or pivotably connected at the lower end thereof to vehicle **100**, for example, at B-pillar **120** (alternatively, the sleeve **426***b* can be pivotably connected at the lower end thereof to the floor of the vehicle **100**). At the top of outboard sleeve **426***b*, the pelvic belt **30** runs out generally horizontally (that is, generally parallel to vehicle floor **130**) toward inboard sleeve **426***a* to preferably maintain pelvic belt **30** above the knees of wheelchair-seated user **200**. Inboard sleeve **426***a* is rotatably or pivotably mounted to the inboard side of vehicle floor **130** via a structure or console **430**. Each of sleeves **422***a* and **422***b* of support structures **420***a* and **420***b* is thus pivotably connected to vehicle **100** so that user **200** can drive into lap or pelvic belt/restraint portion **30** (with knees underneath generally horizontal pelvic belt portion **30**) of the seat belt and tension the seat belt. The pivoting of support structures **420***a* and **420***b*, upon forward movement of wheelchair occupant **200** and contact with pelvic belt **30**, thus results in automatic positioning and tightening of pelvic belt **30** around the wheelchair occupant's pelvis. Such positioning and tightening occurs, at least in part, as a result of the pivoting (forward and downward) motion of pelvic belt **30** which extends between the upper ends of pivotable support structures **420***a* and **420***b*.

[0048] As illustrated in FIGS. **3** and **4**, one or more biasing element such as springs **440** can be provided in operative connection with, for example, the lower portions of one or both of support structures **420***a* and **420***b* to bias/return pelvic belt portion **30** to a desired position after user **200** backs wheelchair **300** out of system **410**. In the examples illustrated, the support structures are biased to return to a 90° position in order to "reset" the system and allow the user to re-enter.

[0049] As illustrated in FIG. **4**C, inboard sleeve **426***a* and outboard sleeve **426***b* (which can be generally identical) can be adjusted to a desired length L, for example, by cutting. Alternatively the sleeves can be formed to telescope to various positions to adjust height.

[0050] As described above in connection with system **10**, tension of the seat belt restraint can readily be automatically regulated to provide the user with a snug and safe fit when the user is positioned within safety restraint system **410**.

[0051] FIG. **6** illustrates another embodiment of a system **510** of the present inventions. System **510** includes an inboard support structure **520***a* and an outboard support structure **520***b* which can, for example, rotate or pivot about axes A and A', respectively, which are, for example, located to the rear of the thigh-abdominal junction **210** (see, for example, FIGS. **5**A and **5**B) of wheelchair occupant **200** (not shown in FIG. **6**) when the wheelchair occupant is restrained within system **510**. Inboard support structure **520***a* and/or outboard support structure **520***b* can be movably pivotable during use or can be fixed at a desired angle for a particular user.

[0052] Similar to support structures **420***a* and **420***b*, each of support structures **520***a* and **520***b* includes a connector or anchor member **522***a* and **522***b*, respectively, which is rotatably or pivotably mounted to vehicle **100** via, for example, shaft or bolt members **524***a* and **524***b*, L-track fittings, and L-tracks. (the L-track fittings and L-tracks are shown in schematic form in FIGS. **6-9**; see FIG. **11** for an actual view of an L-track fitting and L-track). Alternatively, support structures **520***a* and **520***b* can be bolted directly to the floor of the vehicle **100** or other fittings and track such common within the transportation arts. Unlike the case of support structures **420***a* and **420***b*, however, a pelvic belt portion **30***a* is not passed through support structures **520***a* and **520***b*, but simply spans between the upper ends thereof.

[0053] In the illustrated embodiment, a dedicated belt system **50***a* (also illustrated in FIG. **6**A) is provided, which can, for example, be attached to the B-pillar of the vehicle at a same upper attachment point to which an upper connector or guide of the OEM belt system is attached. In FIG. **6**, a portion of the OEM belt system is showed schematically to be stowed in the area of the vehicle B-pillar as represented by a dashed rectangle. In this manner, the securement system **510** does not interfere with the OEM belt system, which therefore can be used by an able-bodied person to drive the vehicle as well, by means of replacing the regular driver/front passenger pilot chairs. Pelvic belt portion **30***a* and shoulder belt portion **40***a* of dedicated belt system **50***a* are portions or sections of the

same continuous belt or webbing, but pelvic belt portion **30***a* and shoulder belt portion **40***a* can be formed separately as described above.

[0054] In the embodiment illustrated in FIG. **6**, shoulder belt portion **40***a* of the belt or harness system begins at a source **52***a* (for example, a retractor) connected to the vehicle and passes through a connector or guide **32***a* (for example, a male buckle latch as known in the seat belt or transportation arts), which can be movable or slidable on the continuous belt. In general, the position of connector **32***a* defines the separation point between shoulder belt portion **40***a* and pelvic belt portion **30***a*. As described further below, the position of guide **32***a* on the continuous belt can be fixable or lockable in several embodiments. Pelvic belt portion **30***a* of the continuous belt terminates in a connector **34***a* (for example, a male buckle latch as known in the seat belt or transportation arts).

[0055] Connector **32***a* is connectable to a cooperating connector **560***a* (for example, a female buckle connector as known in the seat belt or transportation arts) at the upper end of support structure **520***a*. Upon connection of connector **32***a* to cooperating connector **560***a*, pelvic belt portion **30***a* is extended generally parallel to vehicle floor **130** or horizontally, and connector **34***a* is connected to a cooperating connector **560***b* (for example, a female buckle connector as known in the seat belt or transportation arts) at the upper end of support structure **520***b*.

[0056] In the illustrated embodiment, inboard support structure **520***a* is rotatably or pivotably mounted to the inboard side of vehicle floor **130** via a base, structure or console **530***a*. Similarly, outboard support structure **520***b* is rotatably or pivotably mounted to the outboard side of vehicle floor **130** via a base, structure or console **530***b*. Each of support structure **520***a* and **520***b* is thus pivotably connected to vehicle **100** so that wheelchair occupant **200** can, for example, drive into pelvic or lap belt/restraint portion **30***a* (with knees underneath generally horizontal pelvic belt portion **30***a*) of the seat belt and tension the seat belt. The distance between bases or console structure **530***a* and **530***b* can be relatively wide, and one or both of support structures **520***a* and **520***b* can, for example, can have an inwardly bending or arced shape (as illustrated in FIG. **6**) so that the upper ends of pivoting support structures **520***a* and **520***b* are positioned close to the wheelchair occupant's hip point during use.

[0057] Similar to system **410**, one or more biasing elements **540** (for example, one or more spring loaded elements as known in the mechanical arts) can be provided in operative connection with, for example, the lower portions of one or both of support structures **520***a* and **520***b* to return support structures **520***a* and **520***b* to a desired position after user **200** backs wheelchair **300** out of system **510**.

[0058] As illustrated in FIGS. **7** and **8**, in certain circumstances connector **34***a* or connector **32***a* can be disconnected from cooperating connectors **560***b* or **560***a*, respectively, during entry of wheelchair user **200** into a suitable position to use system **510** and/or prior to exit of wheelchair user **200** from connection to system **510**. The ability to thereby disconnect pelvic belt portion **30***a* from connection between support structures **520***a* and **520***b* can, for example, facilitate suitable positioning and restraint for individuals seated in a wheelchair that has closed or partially closed or obstructed armrests. Closed or partially closed armrests can interfere with or prevent pelvic belt portion **30***a* (when connected to extend between support structures **520***a* and **520***b*) from being positioned across the pelvis and below the abdominal area during forward movement of the wheelchair. Disconnection of pelvic belt connector **30***a* enables routing of connector **34***a* and pelvic belt **30***a* underneath a wheelchair armrest after positioning the wheelchair within support system **510** so that connector **34***a* can be placed in operative connection with cooperating connector **560***b*.

[0059] Pivotable support structures **520***a* and **520***b* ensure that the pelvic belt portion **30***a* of the seat belt makes an angle within a desired range of angles α (as described above) with respect to vehicle floor **130** whether pelvic belt portion **30***a* is connected across support structures **520***a* and **520***b* before entry of wheelchair **300** into position within system **510** or after wheelchair **300** is so positioned. In FIG. **6**, support structures **520***a* and **520***b* are illustrated as pivoted forward with respect to the direction of entry or to the right (in the orientation of FIG. **6**) as would be the case if a use of a wheelchair such as wheelchair **300** were in restraining connection therewith.

[0060] As described above, support structures **520***a* and **520***b* can, for example, be fixed or locked at a desired angle α (for example, at an angle between 45° to 75°) or a range of angles α, which can facilitate use with a wheelchair having closed or partially closed armrests. As described above, disconnection of connector **34***a* from connection with cooperating connector **560***a*, or disconnection of connector **34***b* from connection with cooperating connector **560***b*, enables routing of connector **34***a* or **34***b* and pelvic belt **30***a* underneath a wheelchair armrest after positioning the wheelchair within support system **510**. However, disconnection of pelvic belt **30***a* prevents automatic positioning of supports structures **520***a* and **520***b* as occurs when a user's abdomen contacts pelvic belt **30***a* in embodiments in which pelvic belt **30***a* is connected between support structures **520***a* and **520***b* before the wheelchair is brought into position within system **510**. Locking support structures **520***a* and/or **520***b* at a desired angle or range of angles for a particular user can also ensure that connector **34***a* and cooperating connector **560***b* are at proper positions for ready access.

[0061] For example, in the configuration shown in FIG. **7**, it is contemplated that support structure **520***a* could be locked at approximately a 45° position. Once the wheelchair-seated occupant is in position, they are able to manually pull connector **32***a*, through or behind closed armrest and down into connection cooperating connector **560***a*. As the occupant manually pulls connector **32***a*, the support structure **522***b* is able to move forward to the approximately 45° position. Alternatively, both support structure **522***a* and **522***b* could be locked at approximately a 45° position.

[0062] In the configuration shown in FIG. **8**, it is contemplated that support structure **520***b* could be locked at approximately a 45° position. Once the wheelchair-seated occupant is in position, they are able to manually pull connector **34***a*, through or behind closed armrest and down into connection cooperating connector **560***b*. As the occupant manually pulls connector **34***a*, the support structure **522***a* is able to move forward to the approximately 45° position. Alternatively, both support structure **522***a* and **522***b* could be locked at approximately a 45° position.

[0063] The support structure **520***a* and **520***b* can be locked at a desired angle by tightening bolt **524***a* and bolt **524***b*, respectively, or through use of a separate lock structure.

[0064] Bases **530***a* and **530***b* can, for example, be movably mounted on track systems **580** (set forth schematically in FIGS. **6**, **7** and **8**) to provide independent adjustment of the

position thereof on vehicle floor **130** (and thus adjustment of the angle α). In most circumstances, the position of bases **530***a* and **530***b* is adjusted so that the axis of rotation of each base **530***a* and **530***b* (A and A' respective in FIGS. **6** through **8**) is generally collinear. Suitable track systems are, for example, available from Q'Straint of Fort Lauderdale, Fla. USA (e.g. L-track fitting model Q5-3053-4-2 and flanged L-Track piece Q5-6008-F). One such track system is shown in FIG. **11**, connected to a lower end of an alternative embodiment of a support structure.

[0065] FIG. **9** illustrates system **510** in which a separate shoulder belt portion **40***a*' and pelvic belt portion **30***a*' are used. Shoulder belt portion **40***a*' can, for example, include a connector **32***a*' such as a male tongue or latch plate which connects to cooperating connector **560***a*. Similarly, pelvic portion **30***a*' can, for example, include a connector **34***a*' such as a male tongue or latch plate which connects to cooperating connector **560***b* as described above.

[0066] FIGS. **10**A through **10**D illustrate another embodiment of a support structure **620** and an associated base **630** of the present inventions. In the illustrated embodiment, support structure **620** includes connector member **622** which is pivotably connected to a shaft or bolt member **624** as described above. Support structure **620** further includes a first extending member **626** and a second extending member **626**' (spaced from first extending member **626** via spacers **625**—see FIG. **10**B), which are connected at first (or lower) end thereof to connector member **622**. A second (or upper) end of each of extending member **626** and **626**' is operatively connected to a connector **660** such as a buckle mechanism. When used on an inboard side of a vehicle, connector **660** can, for example, be operatively connected to a belt or webbing connector or guide **660**' such as a male latch plate (see FIG. **10**A) as described above (for example, for use in connection with an integral shoulder/pelvic restraint belt system, which is not shown in FIGS. **10**A through **10**D).

[0067] Inboard side, belt/webbing guide or pass-through **660**' can include or have in operative connection therewith a tensioning or locking mechanism **662** (shown schematically in FIGS. **10**A and **10***b* with an alternate embodiment of a connector with tensioning mechanism shown in FIG. **12**) to hold onto or tension the belt/webbing, thereby allowing wheelchair occupants to more easily stabilize themselves during, for example, turning and braking. Tensioning or locking mechanism **662** can also provide for slack in the pelvic belt portion of the belt/webbing system (see FIG. **6**, although supports **520***a* and **520***b* could be oriented at 90° to the floor, and not locked) to, for example, enable the pelvic belt portion to be raised over and possibly behind closed or partially closed armrests while the wheelchair occupant is engaging the system, such that the pelvic belt portion is placed at the thigh-abdominal junction of the person. At this point, the person could manually release the tensioning or locking mechanism **662** to allow the retractor or connector system **50** to remove the excess slack. When the user is ready to exit the system, they may either release the buckle or simply pull out the pelvic belt portion and raise above the wheelchair armrests.

[0068] In the embodiment of FIGS. **10**A through **10**D, a bracket assembly **640** biases support structure **620** into an upright, generally vertical engagement position. Bracket assembly **640** includes a torsion spring **642** through which shaft or bolt member **624** passes before passing through connector **622**. Torsion spring **642** includes a first extending member **642**', which engages a passage **644** formed in bracket base **641**. A second extending member **642**" engages an abutment member **623** extending from connector **622**. In the illustrated embodiment, bracket base **641** includes extending stops, limiters or abutment members **646** to limit the degree of pivoting of connector **622** (and thereby support structure **620**). Connector **622** is removed in FIG. **10**D to more clearly illustrate bracket assembly **640**.

[0069] Systems **10**, **410**, **510** and other systems of the present inventions are readily retrofitted into existing vehicles and can utilize or complement the vehicle OEM shoulder and pelvic restraint belting. In that regard, a separate or dedicated belt system can be provided in the systems of the present inventions. In such a belt system, the shoulder belt can be installed to be tight (that is, without a retractor/no belt slack) to maintain a fixed belt length, which can assist in maintaining a wheelchair occupant/driver with poor upper torso control balanced during turning and braking. Further, the length of the pelvic belt/webbing can, for example, be maintained at a defined length (for example, by locking or tensioning at the location of one support structure end), and/or the shoulder belt/webbing can, for example, be maintained at a defined length (for example, via locking a retractor) so that the wheelchair bound user has better postural support during turns and braking. When an OEM seat is placed in the vehicle, a dedicated belt system of the present inventions can be stowed out of the way and the OEM restraint system can be used for the driver or passenger.

[0070] The foregoing description and accompanying drawings set forth the preferred embodiments of the inventions at the present time. Various modifications, additions and alternative designs will, of course, become apparent to those skilled in the art in light of the foregoing teachings without departing from the scope of the inventions. The scope of the inventions is indicated by the following claims rather than by the foregoing description. All changes and variations that fall within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A safety restraint system to restrain a wheelchair-seated person in a vehicle, comprising:

a pelvic restraint extending between a first side and a second side of a wheelchair securement area, and

at least one support holding the pelvic restraint at a sufficient height to allow the wheelchair-seated person to move the wheelchair into the wheelchair securement area to be restrained by the pelvic restraint.

2. The safety restraint system of claim **1** wherein the at least one support holds the pelvic restraint above a knee of the wheelchair-seated person.

3. The safety restraint system of claim **1** wherein the at least one support comprises a sleeve through which the pelvic restraint passes, the sleeve being stiffer than the pelvic restraint.

4. The safety restraint system of claim **1** wherein the at least one support comprises a first support structure on the first side and a second support structure on the second side, the pelvic restraint extending between an end of the first support structure and an end of the second support structure.

5. The safety restraint system of claim **1** wherein the at least one support comprises a sleeve through which the pelvic restraint passes.

6. The safety restraint system of claim **1** wherein the system further comprises a shoulder restraint extending between the first side and the second side of the wheelchair securement area.

7. The safety restraint system of claim **1** wherein the at least one support is in pivotable connection with the vehicle so that the pelvic restraint has an adjustable angle.

8. The safety restraint system of claim **7** wherein an axis about which the at least one support is pivotable is positioned to a rear of a thigh-abdominal junction of the wheelchair-seated person when the wheelchair-seated person is restrained within the safety restraint system.

9. The safety restraint system of claim **8** wherein the at least one of support forms a first angle in the range of approximately 45° to 75° with respect to a vehicle floor when the wheelchair-seated person is restrained within the safety restraint system.

10. The safety restraint system of claim **1** wherein a length of the at least one support is adjustable.

11. The safety restraint system of claim **7** wherein the at least one support is biased to return to a predetermined position when the wheelchair-seated person is not restrained by the safety restraint system.

12. The safety restraint system of claim **6** wherein at least one of the pelvic restraint and the shoulder restraint is maintained at a predefined length to provide postural support.

13. A method of restraining a wheelchair-seated person in a vehicle, comprising:

providing a pelvic restraining portion in a wheelchair securement area of the vehicle, whereby the pelvic restraining portion extends between a first side of the wheelchair securement area and a second side of the wheelchair securement area, and

providing a support to maintain the pelvic restraining portion at a sufficient height to allow the wheelchair-seated person to move the wheelchair into the wheelchair securement area to be restrained by the pelvic restraining portion.

14. A safety restraint system to restrain a wheelchair-seated person in a vehicle, comprising:

a first support structure on a first side of a wheelchair securement area, the first support structure being pivotable to a first range of angles;

a second support structure on a second side of the wheelchair securement area, the second support structure being pivotable to a second range of angles;

a pelvic restraint extendable between the first support structure and the second support structure;

a shoulder restraint extendable between the vehicle and the first support structure;

the first support structure and the second support structure adapted to hold the pelvic restraining portion at a height above a knee of the wheelchair-seated person

15. The safety restraint system of claim **14** wherein the pelvic restraint is removably connectable to at least one of the first support structure and the second support structure.

16. The safety restraint system of claim **14** further comprising at least one locking mechanism for locking at least one of the first support structure and the second support structure at an angle.

17. The safety restraint system of claim **14**, wherein the shoulder restraint and the pelvic restraint form a continuous belt, the continuous belt having a first connector for connecting with a first complementary connector on the first support structure and a second connector for connecting with a second complementary connector on the second support structure.

18. The safety restraint system of claim **14** wherein a first axis about which the first support structure is pivotable is positionable at a first range of positions to the rear of a thigh-abdominal junction of the wheelchair-seated person when the wheelchair-seated person is restrained within the safety restraint system and a second axis about which the second supports structure is pivotable is positionable at a second range of positions to the rear of the thigh-abdominal junction of the wheelchair-seated person when the wheelchair-seated person is restrained within the safety restraint system.

19. The safety restraint system of claim **14** wherein the first support structure is biased to return to a first predetermined position when the wheelchair-seated person is not restrained by the safety restraint system and the second support structure is biased to return to a second predetermined position when the wheelchair-seated person is not restrained by the safety restraint system.

20. A method for using the safety restraint system of claim **15** to restrain a wheelchair-seated person, wherein the wheelchair has a closed armrest, the method comprising the steps of:

disconnecting the pelvic restraint from one of the first support structure and the second support structure;

steering the wheelchair into the wheelchair securement area until the thigh-abdominal junction of the wheelchair-seated person is positioned forward of a first pivot axis of the first support structure and a second pivot axis of the second support structure;

feeding the pelvic restraint through the closed armrest of the wheelchair; and,

reconnecting the pelvic restraint to the first support structure or the second support structure.

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