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(54) **OPERATOR RIDE ENHANCEMENT SYSTEM**

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(63) Continuation of application No. 16/813,414, filed on Mar. 9, 2020, now Pat. No. Re. 48,991, which is a continuation of application No. 15/476,767, filed on Mar. 31, 2017, now Pat. No. Re. 47,899, which is an application for the reissue of Pat. No. 8,991,904, which is a continuation of application No. 13/091,237, filed on Apr. 21, 2011, now Pat. No. 8,616,603.

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B62D 33/06 (2006.01)
B66F 9/075 (2006.01)

(52) **U.S. Cl.**

CPC **B62D 51/02** (2013.01); **B62D 33/0604** (2013.01); **B66F 9/0759** (2013.01)

(58) **Field of Classification Search**

CPC **B62D 33/0604**; **B62D 51/02**; **B62D 33/06**; **B62D 37/04**; **B66F 9/0759**

See application file for complete search history.

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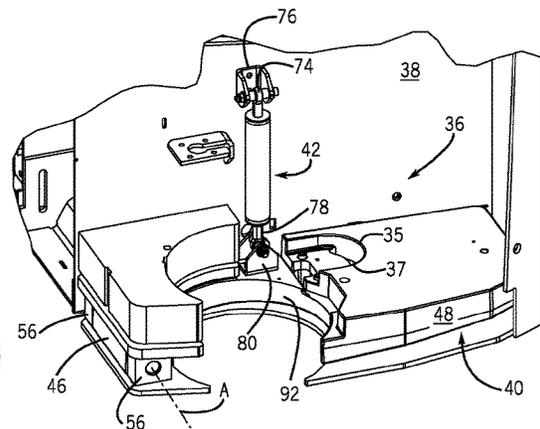
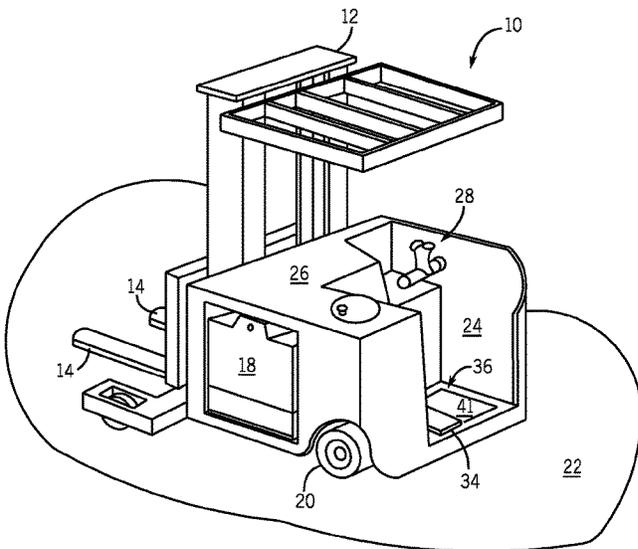
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(57) **ABSTRACT**

An operator ride enhancement system that is coupleable to the frame of a vehicle includes a counterweight platform moveably coupled to the frame, and a resilient member engaged with the frame and the counterweight platform. The mass of the counterweight platform is configured to be approximately at least equal to a total mass supported by the counterweight platform during operation of the vehicle. The operator ride enhancement system attenuates and/or inhibits movement of the counterweight platform during operation of the vehicle.

20 Claims, 8 Drawing Sheets



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FIG. 1

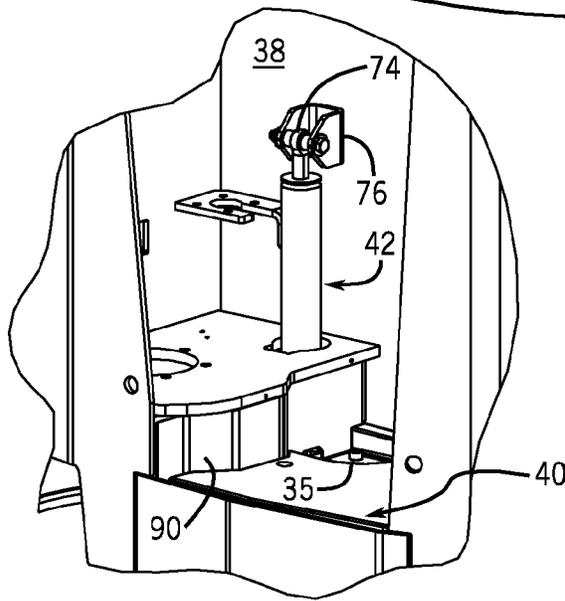
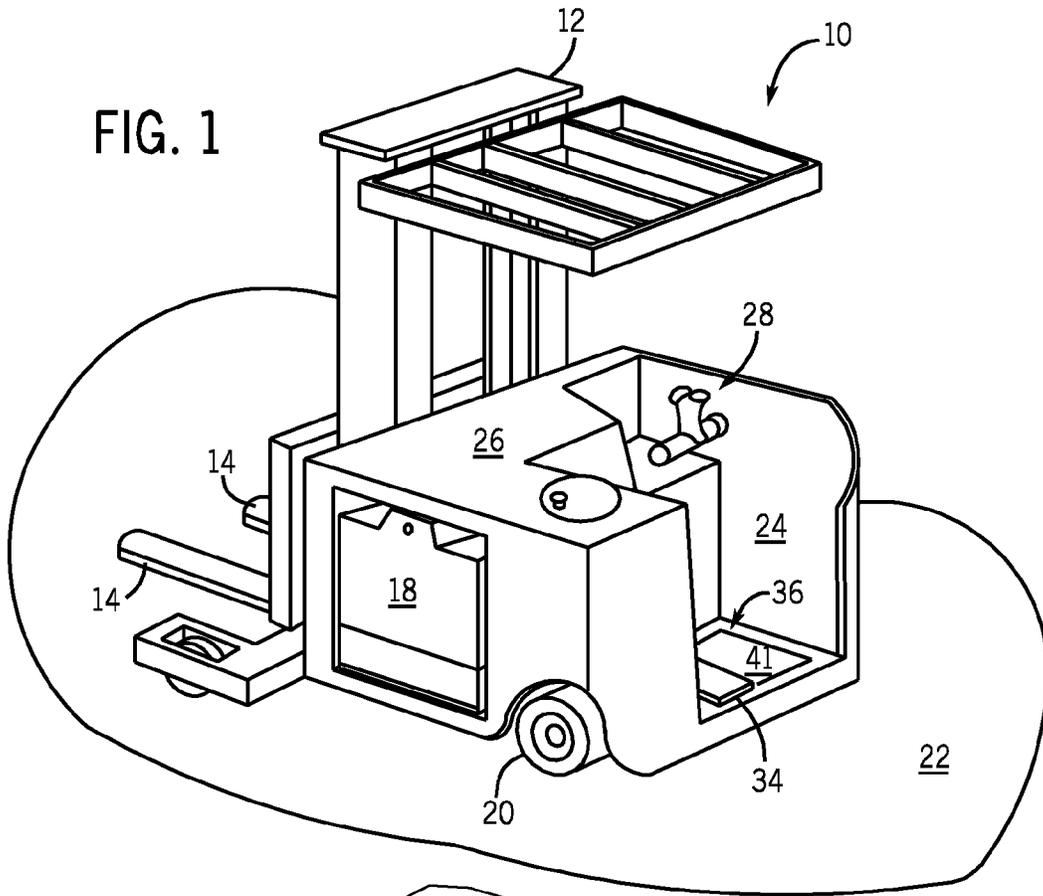


FIG. 2

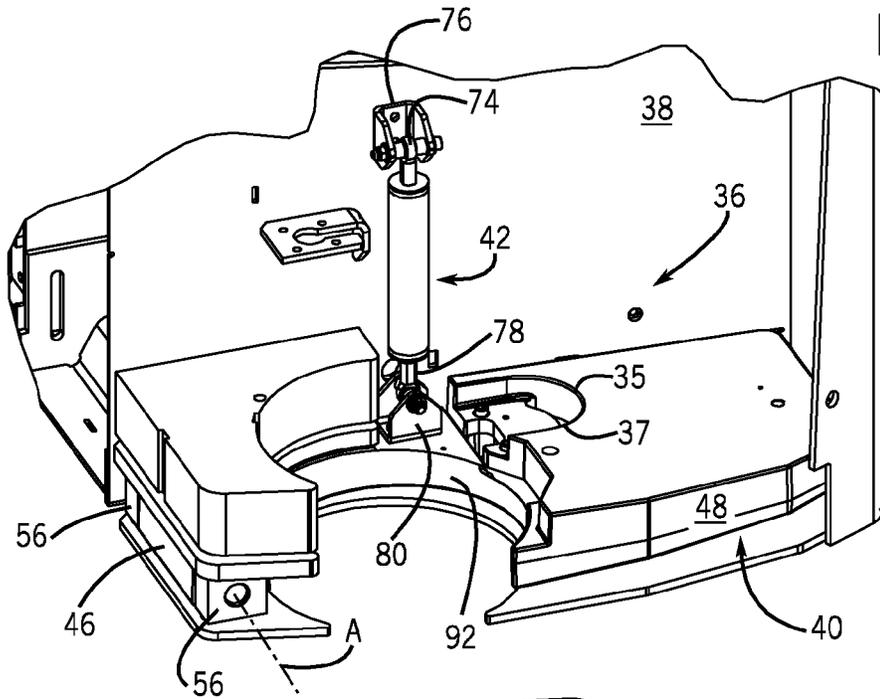


FIG. 3

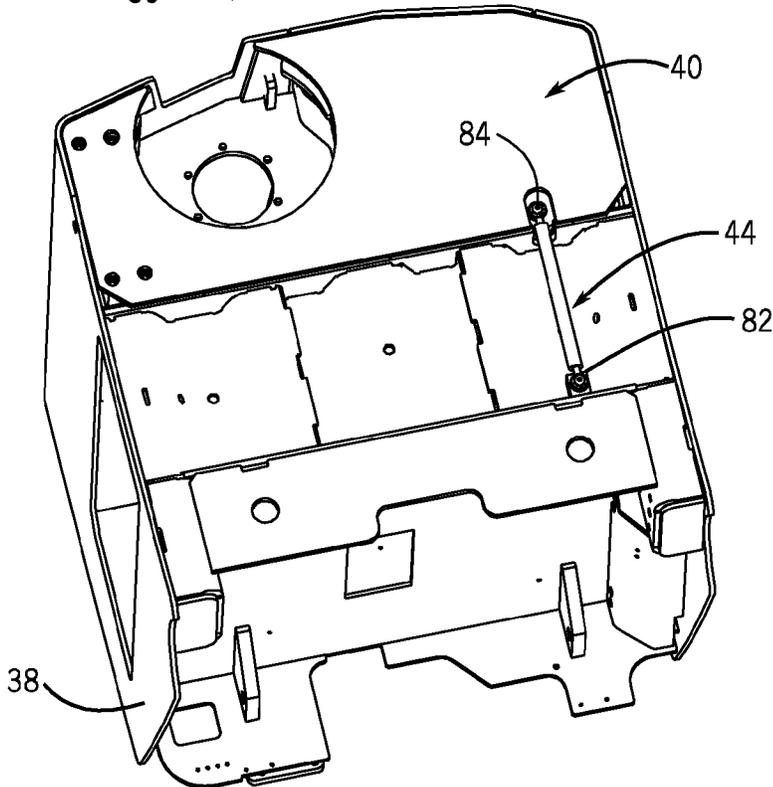


FIG. 4

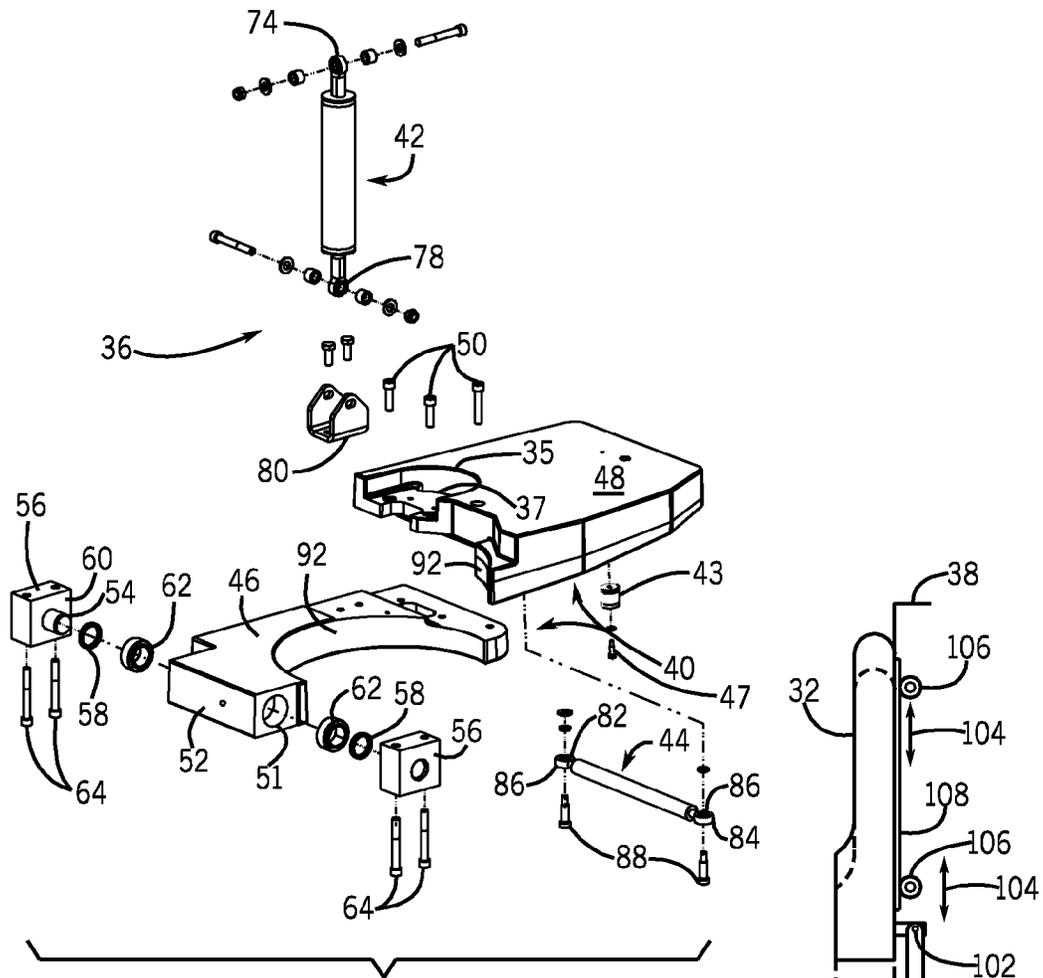


FIG. 5

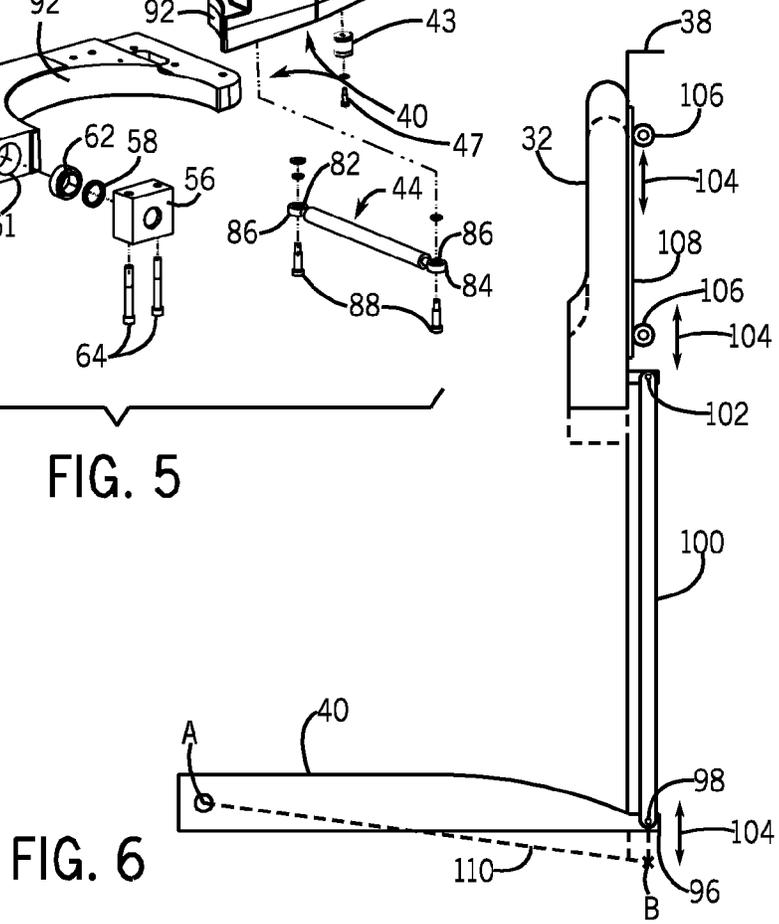


FIG. 6

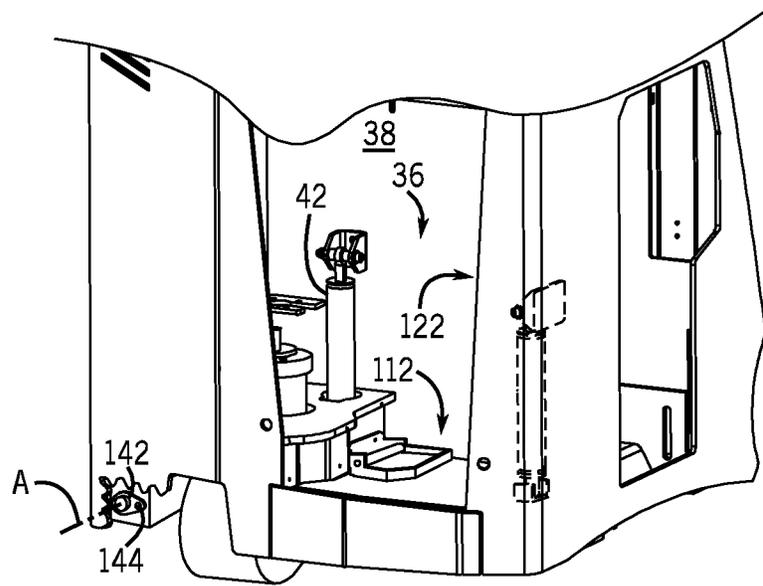


FIG. 7

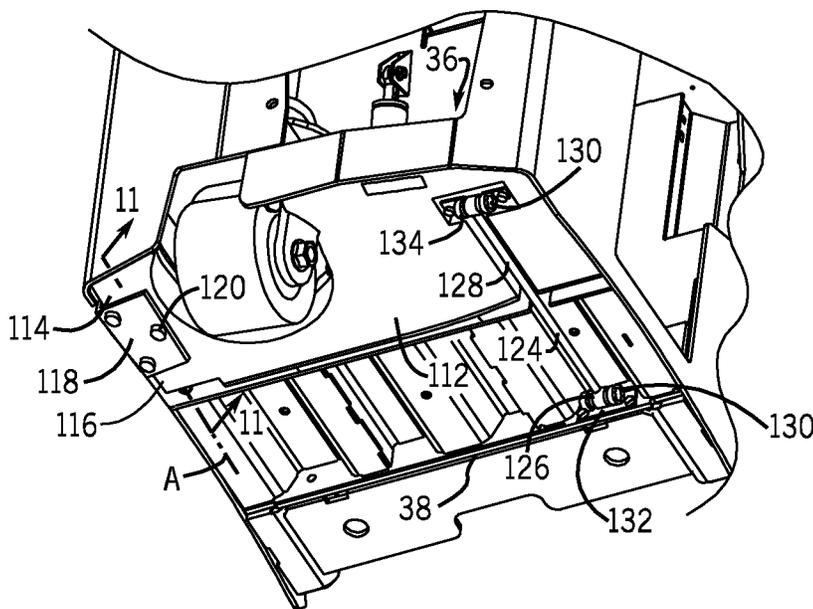


FIG. 8

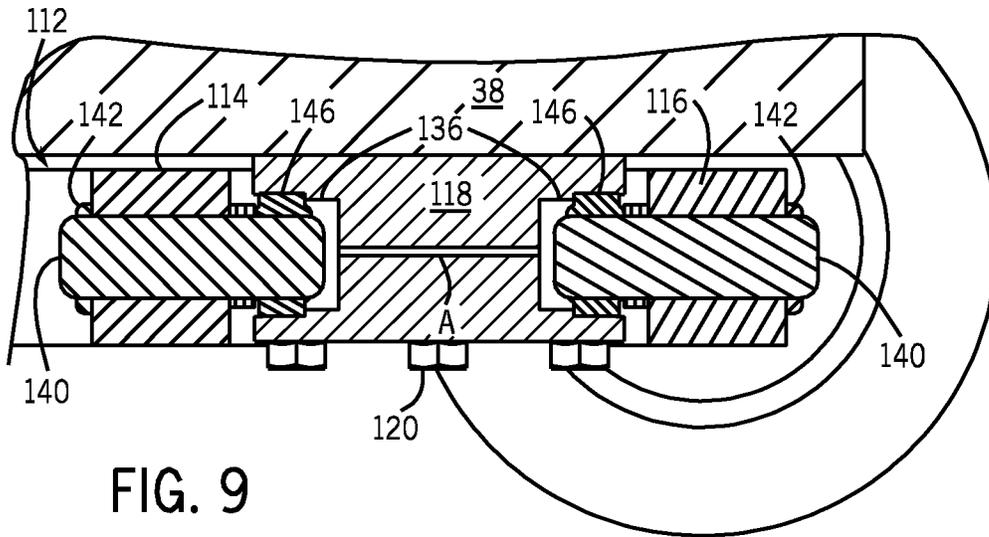


FIG. 9

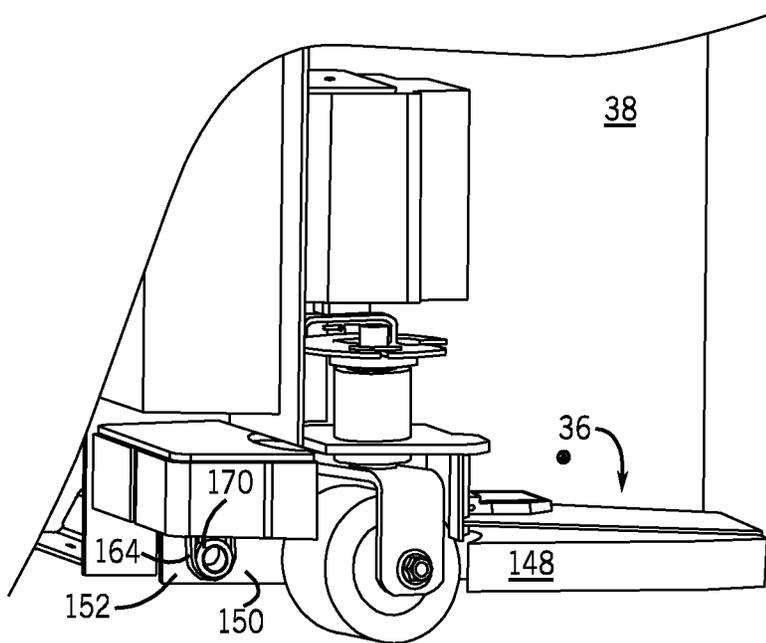


FIG. 10

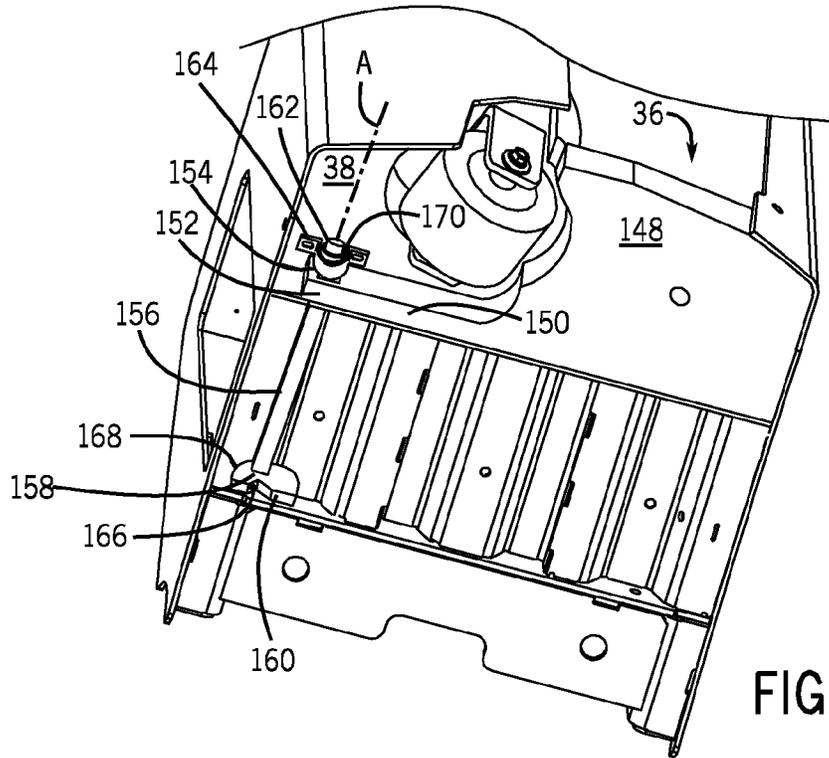


FIG. 11

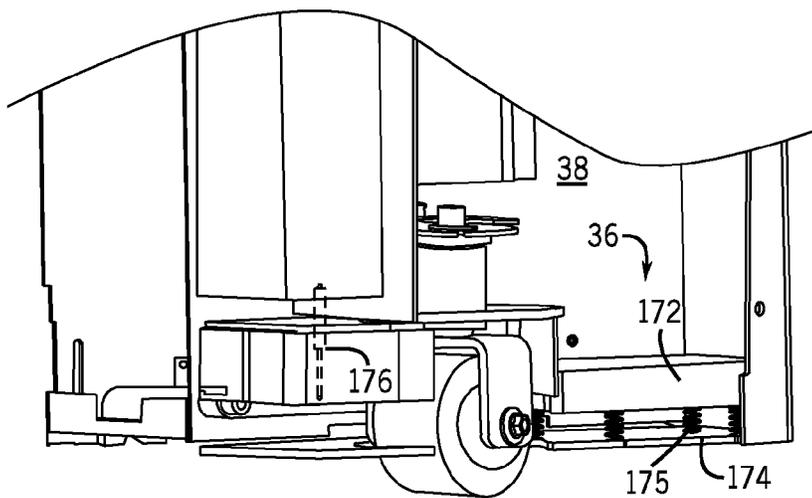


FIG. 12

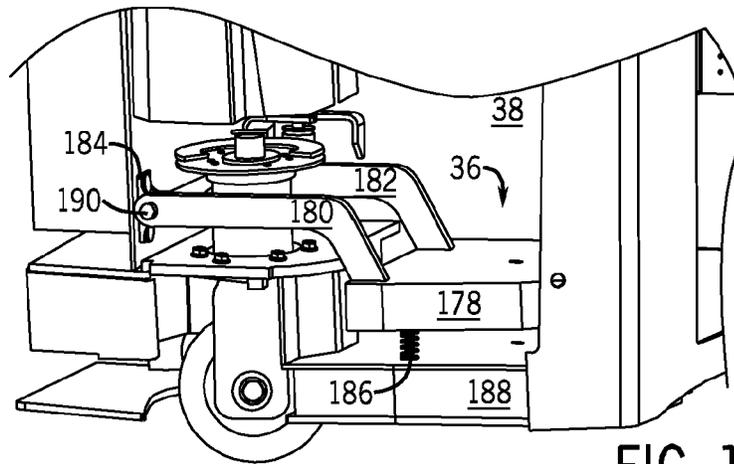


FIG. 13

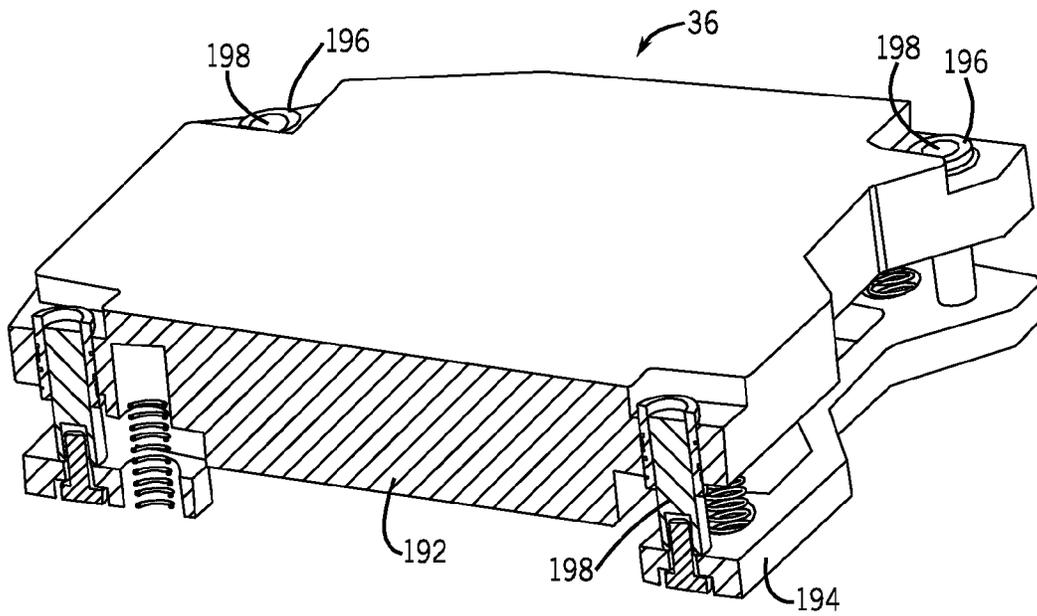


FIG. 14

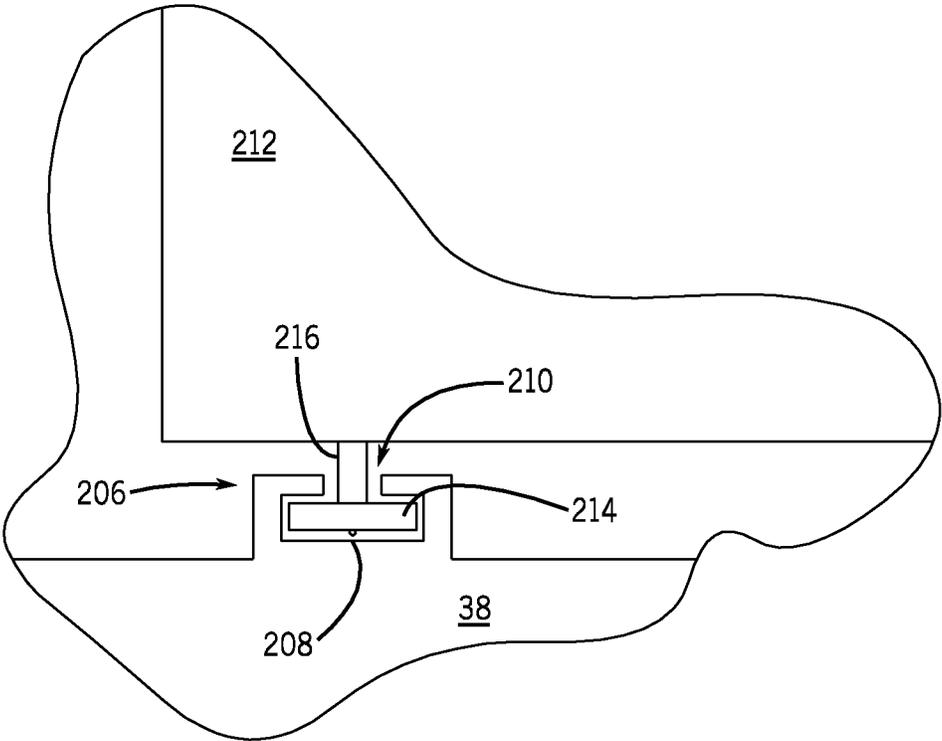


FIG. 15

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a *continuation reissue of application Ser. No. 16/813,414, filed Mar. 9, 2020, which is a continuation reissue of application Ser. No. 15/476,767, filed Mar. 31, 2017, which is now U.S. Reissue Pat. No. RE47,899, which is an application for reissue of U.S. Pat. No. 8,991,904, which is a continuation of U.S. patent application Ser. No. 13/091,237 filed on Apr. 21, 2011, which is now U.S. Pat. No. 8,616,603, which claims priority to U.S. provisional application No. 61/327,434 filed Apr. 23, 2010, [both] all of which are hereby incorporated by reference as if fully set forth herein.*

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

Not applicable.

BACKGROUND

The present disclosure relates generally to an operator ride enhancement system. More particularly, the disclosure describes an operator ride enhancement system incorporating a counterweight platform that is moveably coupled to a vehicle frame and configured to isolate an operator supported on the counterweight platform from disturbances of the vehicle.

Repeatedly subjecting a vehicle operator to disturbances (e.g., undulations, etc.) that occur during operation of the vehicle can result in the operator becoming uncomfortable. For example, the operator of a lift truck often stands on an operator platform while controlling the lift truck. Various disturbances occur, for instance, as the lift truck travels along a floor, over expansion joints, across dock plates, and manipulates the forks. Increased focus on efficiency, through increased production, has resulted in faster moving lift trucks, which exacerbates the occurrence and amplitude of the disturbances. Isolating the operator from these and other disturbances may increase operator comfort, especially over prolonged periods of operation.

One technique that has been explored to suppress disturbances involves suspending or supporting the typical, standard platform with a variety of energy absorbing devices (e.g., springs, viscous dampers, rubber bumpers, etc.). However, many of these arrangements are dependent upon configurations that require adjusting or calibrating the energy absorbing devices to accommodate operators of different mass (and hence, weight). Furthermore, these devices often result in increased complexity and maintenance. The remaining less sophisticated arrangements have limited capability to attenuate the transmission of the disturbances over a range of frequencies and amplitudes.

In light of at least the above considerations, a need exists for reducing disturbances experienced by a vehicle operator to enhance the operator's ride on the vehicle.

An operator ride enhancement system that is coupleable to the frame of a vehicle includes a counterweight platform moveably coupled to the frame, and a resilient member engaged with the frame and the counterweight platform. The mass of the counterweight platform is configured to be approximately at least equal to a total mass supported by the counterweight platform during operation of the vehicle. The operator ride enhancement system attenuates and/or inhibits movement of the counterweight platform during operation of the vehicle.

In one aspect, an operator ride enhancement system for use in a vehicle having a frame, comprises a counterweight platform defining a mass, the counterweight platform is coupled to the frame for pivotal movement about an axis. A resilient member is engaged with the frame and the counterweight platform to attenuate movement of the counterweight platform about the axis. A control member is engaged with the frame and the counterweight platform to inhibit movement of the counterweight platform along the axis. The mass of the counterweight platform is configured to be approximately at least equal to a total mass supported by the counterweight platform during operation of the vehicle.

In another aspect, an operator ride enhancement system for use in a vehicle having a frame and defining an operator compartment, comprises a counterweight platform defining a mass, the counterweight platform is moveably coupled to the frame at least partially within the operator compartment. A resilient member is engaged with the frame and the counterweight platform. The mass of the counterweight platform is configured to be approximately at least equal to a total mass supported by the counterweight platform during operation of the vehicle. The mass of the counterweight platform and the resilient member are configured to attenuate disturbances transmitted through the frame to the counterweight platform.

These and still other aspects of the invention will be apparent from the description that follows. In the detailed description, preferred example embodiments will be described with reference to the accompanying drawings. These embodiments do not represent the full scope of the invention; rather, the invention may be employed in many other embodiments. Reference should therefore be made to the claims for determining the full breadth of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a rear isometric view of an example vehicle incorporating an operator ride enhancement system.

FIG. 2 is a partial isometric view of a portion of an example operator ride enhancement system.

FIG. 3 is a partial isometric view of the example operator ride enhancement system of FIG. 2.

FIG. 4 is a simplified isometric view of a portion of the example operator ride enhancement system of FIG. 2.

FIG. 5 is an isometric exploded view of the operator ride enhancement system of FIG. 3.

FIG. 6 is a simplified side view of a portion of an alternative example operator ride enhancement system showing an example operator backrest configuration.

FIG. 7 is a partial rear isometric view of another example operator ride enhancement system.

FIG. 8 is a partial rear isometric view of the operator ride enhancement system of FIG. 7.

FIG. 9 is a partial section view along line 11-11 of FIG. 8.

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FIG. 10 is a partial isometric view of a further example operator ride enhancement system.

FIG. 11 is a partial isometric view of the operator ride enhancement system of FIG. 10.

FIG. 12 is a partial isometric view of yet a further example operator ride enhancement system.

FIG. 13 is a partial isometric view of another example operator ride enhancement system.

FIG. 14 is an isometric view of a further example operator ride enhancement system removed from a vehicle.

FIG. 15 is a partial top view of an additional example guide.

DETAILED DESCRIPTION OF THE PREFERRED EXAMPLE EMBODIMENTS

Several example embodiments of an operator ride enhancement system are described and illustrated in the context of a material handling vehicle commonly referred to as a lift truck. However, given the benefit of this disclosure, one skilled in the art will appreciate the various modifications that can be made to the example embodiments and the various applications in which the operator ride enhancement system may be incorporated. For instance, the operator ride enhancement system concepts described herein may be applied to other material handling vehicles as well as other devices where attenuating disturbances transmitted to an operator or coupled structure/device is beneficial. Furthermore, the terms "fore," "aft," "front," "back," "side," "top," "bottom," "up," "down," "raised," "lowered," "vertical," "horizontal," and other relative directional terms used herein are not to be limiting, but instead are used for convenience in describing the illustrated example embodiments.

An example material handling vehicle, in the form of a lift truck 10 ("lift truck"), is illustrated generally in FIG. 1. The lift truck 10 includes a mast 12 operatively coupled to the fore end of the lift truck 10 and capable of raising and lowering a set of forks 14 attached to the mast 12. A pair of drive wheels (not shown) are rotationally coupled to the fore end of the lift truck 10 and operationally engaged with a drive system (not shown), such as one or more electric motors. When the lift truck 10 incorporates an electrical drive system, the lift truck 10 includes a battery compartment that houses a battery 18, as is understood by one of ordinary skill in the art. In the example illustrated in FIG. 1, a steering wheel 20 operates in conjunction with the drive wheels to allow the lift truck 10 to travel along a floor 22.

An operator compartment 24 is located near the aft end of the lift truck 10 and includes a console 26 having operator controls 28 that allow an operator to control the movement of the lift truck 10, the mast 12, and the forks 14. The operator compartment 24 can also include an armrest and a backrest to accommodate an operator during use of the lift truck 10.

When an operator enters the operator compartment 24, the operator steps up and into the operator compartment 24. In one embodiment, a pedal switch 34 is positioned within the operator compartment 24, such that the location of the pedal switch 34 and operator controls 28 typically result in the operator assuming a left-facing stance. If an armrest and/or backrest are provided, preferably, the operator's back is proximate the backrest and the operator's right arm engages the armrest while the operator is in the left-facing stance.

With continued reference to FIG. 1 and additional reference to FIGS. 2-5 an example embodiment of an operator ride enhancement system 36 is shown moveably coupled to a frame 38 of the lift truck 10. The "frame" is defined

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broadly to include any structure of the lift truck 10 suitable to support the mass of and the mass supported by the operator ride enhancement system 36 during use.

In one example embodiment, the operator ride enhancement system 36 includes a counterweight platform 40, a resilient member 42, and a control member 44. The counterweight platform 40 is shown constructed of a hinged portion 46 and a platform portion 48 that partially overlap and are coupled via fasteners 50, which may make assembly and installation easier as the mass of the counterweight platform 40 may be cumbersome to manipulate. In other forms, the counterweight platform 40 may be formed (e.g., cast, machined, molded, and the like) as a unitary body. The counterweight platform 40 of the example embodiment shown in FIG. 5 is cast from iron (such as grey iron, ductile iron 85-55-06, or may alternatively be made of ASTM A36 grade steel alloy or any other suitable material having sufficient density to provide the requisite counterweight) and has a weight on the order of three hundred and fifty pounds. In one form, the counterweight platform 40 includes a base made of low carbon steel that is approximately three inches thick with a thin angled top plate secured to the base (having a total weight of approximately three hundred and eighty-five pounds). In a preferred form, the counterweight platform 40 is tapered such that the interface between the counterweight platform 40 and the operator is angled down relative to horizontal at approximately 2° to 4°. Additionally, the underside of the counterweight platform 40 may be angled up relative to horizontal at approximately 2° to 4° to accommodate downward, pivotal movement of the counterweight platform 40.

By providing a counterweight platform 40 having a mass in excess of the mass required to perform the structural function of supporting a weight range of operators (e.g., between approximately one hundred pounds and three hundred and fifty pounds), the mass of the counterweight platform 40 reduces the influence that the total mass supported by the counterweight platform 40 during use (including the mass of the operator) has on the overall dynamic response of the operator ride enhancement system 36. For instance, the variable mass of each operator (i.e., different operators may define different masses) has a diminished impact on the dynamic response of the operator ride enhancement system 36 as the mass of the operator represents a reduced percentage of the overall mass (i.e., the sum of the mass of the counterweight platform 40 and the total mass supported by the counterweight platform 40). Therefore, the attenuation characteristics of the operator ride enhancement system 36 may be designed to maintain the typical dynamic response of the operator ride enhancement system 36 within a predefined range of characteristics (e.g., frequency range, maximum amplitude, maximum cycles post-disturbance, etc.) given that the mass of the counterweight platform 40 dominates the dynamic response. The mass of the counterweight platform 40 may be equal to or greater than the expected mass of the range of operators (e.g., approximately forty-five kilograms to approximately one hundred and sixty kilograms), about equal to or greater than the mass of a particular operator, or preferably approximately at least equal to the total mass supported by the counterweight platform 40.

Returning to the counterweight platform 40, the hinged portion 46 includes a pair of axially aligned bores 51 at a hinged end 52. Each bore 51 receives a post 54 that extends from a respective mounting block 56. A spacer 58 is slid over each post 54 and positioned against a bearing face 60 of the mounting block 56. A spherical bearing 62 is then fit over

each post **54** and fit within the respective bore **51**. The mounting blocks **56** are secured to the frame **38** via fasteners **64** such that the hinged portion **46** and coupled platform portion **48** can pivot about an axis A (shown generally in FIG. 3) that is substantially parallel with a fore-aft axis of the lift truck **10**. In preferred forms, the pivot arm (i.e., the approximately perpendicular distance from the axis A to the distal end of the counterweight platform **40**) is as long as possible to more closely approximate linear, vertical movement of the operator supported on the counterweight platform **40** as it pivots through a relatively acute arc (e.g., 3°-5° and typically less than 3°).

It is preferred, in some configurations, to have the substantially horizontal axis A about which the counterweight platform **40** pivots be oriented substantially parallel with the fore/aft orientation of the lift truck **10** to minimize the inertial disturbances that may occur about an axis that is oriented more perpendicular to the fore/aft orientation of the lift truck **10**. If the axis A is perpendicular to the fore/aft orientation of the lift truck **10**, the counterweight platform **40** may have a tendency to rotate about the perpendicular axis during acceleration and deceleration of the lift truck **10**, thus a more parallel orientation of the axis A reduces the tendency of the counterweight platform **40** during acceleration and deceleration to rotate about the axis A. Other orientations of the axis A are available depending upon the particular application requirements for the operator ride enhancement system **36**.

With continued reference to FIGS. 1-5, the example embodiment of the operator ride enhancement system **36** includes the resilient member **42**. The example resilient member **42** may be one or more helical springs captured in a cylindrical housing between a fixed end plate and a plunger slideably positioned within the cylindrical housing. The plunger may also function as a dampener member by frictionally engaging the cylindrical housing as it slides. Alternatively, the plunger may divide the cylindrical housing into two chambers such that a fluid is urged through an orifice between chambers as the plunger slides within the cylindrical housing. One example embodiment of the resilient member **42** may include that described in U.S. Pat. No. 6,773,002, which is hereby incorporated by reference as if fully set forth herein. The resilient member **42** may further include an auxiliary spring at the extreme end of the stroke of the plunger, thereby providing additional resilience for severe disturbances. In addition, as shown in FIG. 5, a bumper **43** may be secured (e.g., via a fastener **47**) to the underside of the counterweight platform **40**. The example bumper **43** is elastomeric and configured to establish a flexible interface between the frame **38** and the underside of the counterweight platform **40** in the event that the counterweight platform **40** over pivots about the axis A.

The resilient member **42** is engaged with the frame **38** and the counterweight platform **40** to at least partially attenuate disturbances imparted through the frame **38** to the counterweight platform **40** when the lift truck **10** is in use (e.g., as the lift truck **10** travels along the floor **22**, over an expansion joint, along a loading dock ramp, into a storage container, and the like). Specifically, the example resilient member **42** includes a first end **74** attached to the frame **38** via a clevis **76** extending from the frame **38**, and a second end **78** attached to the counterweight platform **40** via a clevis **80** extending, in the example embodiment, from the hinged portion **46** of the counterweight platform **40**.

The resiliency (e.g., spring constant, elasticity, and the like) of the resilient member **42** is preferably selected in combination with the mass of the counterweight platform **40**

to control the maximum static deflection of the counterweight platform **40** as it pivots about the axis A, and to reduce the transmission of disturbances to the operator supported on the counterweight platform **40**. Other considerations, such as the natural frequency of the operator ride enhancement system **36** and the maximum dynamic deflection of the counterweight platform **40**, may also be factors in selecting/configuring a resilient member **42** for a specific application. In one example form, a resilient member includes a coil spring having preload of approximately 1025 Newtons (approximately 230 pounds force) and a spring rate of approximately 3300 Newtons per centimeter (approximately 1888 pounds force per inch).

In the example shown in FIGS. 1-5, the control member **44** inhibits movement of the counterweight platform **40** in the fore/aft direction generally along the axis A. The control member **44** may reduce undesired movement of the counterweight platform **40** in the fore/aft orientation during acceleration and deceleration of the lift truck **10**. Specifically, the control member **44** includes a first end **82** engaged with the frame **38** and a second end **84** engaged with the counterweight platform **40** to inhibit movement of the counterweight platform **40** along the axis A (i.e., along the length of the control member **44**). In the example shown best in FIGS. 4 and 5, the control member **44** is in the form of a rod that may be adjustable in length and include a knuckle **86** at the first end **82** and another knuckle **86** at the second end **84**, with fasteners **88** securing the knuckles **86**. Other forms of the control member **44** may used, such as a beam, a channel, a rigid damper, stiff spring, guide roller(s), and the like without departing from the scope of the invention.

In some applications, the operator ride enhancement system **36** utilizes the inherent damping within the system (e.g., frictional losses due to compressing the spring in the resilient member **42**, frictional losses related to the spherical bearings **62**, and the like), and therefore no distinct dampener member is required. In other instances, for example, the resilient member **42** may further include a dampener member (e.g., a hydraulic shock absorber), separately or in combination with the resilient member **42**, to provide the desired dampening of the counterweight platform **40** and operator supported thereon. Dampener members integrated into the operator ride enhancement system **36** are preferably configured to return the counterweight platform **40** to a neutral (i.e., static) position in a relatively short time post-disturbance (e.g., within two cycles of the counterweight platform **40**) while still providing the application-specific disturbance-attenuation capability.

As best shown in FIG. 2, during use, the platform portion **48** of the counterweight platform **40** is positioned generally within the bounds of the operator compartment **24**. A hinge shield **90** provides a general separation between the platform portion **48** and the hinged portion **46**. In the preferred form, and in accordance with maximizing the mass within the available space, the counterweight platform **40** includes an arcuate surface **92** that provides clearance for the steering wheel **20** (not shown in FIGS. 2-5 for clarity). In addition, the platform portion **48** can include a recess **35** sized to support and accommodate the pedal switch **34** (shown in FIG. 1); the recess **35** may also include a drain opening **37** to reduce fluid retention near the counterweight platform **40** and around the pedal switch **34**. The operator ride enhancement system **36** shown in FIG. 1 may further include a covering in the form of a resilient mat **41** upon which an operator stands when within the operator compartment **24**.

As a result of the operator ride enhancement system **36**, disturbances input to the frame **38** of the lift truck **10** are at

least partially attenuated due to the configuration and arrangement of the various components of the operator ride enhancement system 36. Furthermore, as noted above, the mass of the counterweight platform 40 minimizes the dynamic influence resulting from operators of varying mass.

Turning to FIG. 6, a simplified alternative arrangement of the counterweight platform 40 and a backrest 32 are shown. In the illustrated configuration, a distal end 96 of the counterweight platform 40 is pivotally coupled to a lower end 98 of a link 100 that extends between the counterweight platform 40 and the backrest 32. Specifically, an upper end 102 of the link 100 is pivotally coupled to the backrest 32. The backrest 32 is slidable up and down (shown by arrows 104), such as by rollers 106 extending from the backrest 32 and engaged with a track 108 fixed to the frame 38. As the counterweight platform 40 deflects and/or pivots about the axis A (shown simplistically by dashed line 110), the distal end 96 of the counterweight platform 40 and coupled lower end 98 of the link 100 are moved down to point B. This results in the backrest 32 translating downward accordingly such that relative movement between the operator, counterweight platform 40, and backrest 32 is minimized.

Another example embodiment of an operator ride enhancement system 36 is generally illustrated in FIGS. 7-9. The operator ride enhancement system 36 incorporates a counterweight platform 112 formed (e.g., machined) of a single body and having a pair of arms 114, 116 hinged to a centralized mounting block 118. The mounting block 118 is fixed to the frame 38 via fasteners 120 (best shown in FIGS. 8 and 9). Additionally, the operator ride enhancement system 36 includes a pair of resilient members 42 having a first end engaged to the counterweight platform 112 and a second end mounted to the frame 38. One of the resilient members may be mounted as described in reference to FIGS. 1-5, alternatively, or in addition, the resilient member 42 may be mounted to a side portion 122 of the frame 38. Thus, as illustrated, the resilient member(s) 42, similar to the other components (e.g., dampener member(s), control member(s), etc.), may be mounted in a variety of locations relative to the counterweight platform 40 (and axis A), but is preferably mounted to not interfere with the operator. Furthermore, the resilient member 42 is designed to account for the static and dynamic forces acting on the resilient member 42 given the particular mounting location.

A control member 124 (shown in FIG. 8) is preferably adjustable in length and includes a first end 126 pivotally coupled to the frame 38 and a second end 128 pivotally coupled to the counterweight platform 112. A rubber bushing is preferably seated in the first end 126 and second end 128 of the control member 124. A fastener 130 secures the first end 126 to a clevis 132 that is in turn fastened to the frame 38. Also, another fastener 130 secures the second end 128 to another clevis 134 that is in turn fastened to the counterweight platform 112. Again, the control member 124 inhibits movement of the counterweight platform 112 generally in a direction along a pivot axis A about which the counterweight platform 112 may rotate.

With specific reference to FIGS. 7 and 9, the counterweight platform 112 is shown pivotally coupled to the frame 38 via mounting block 118. The mounting block 118 defines a pair of aligned bores 136. Each bore 136 receives a shaft 138 extending through an opening 140 in respective arms 114, 116 of the counterweight platform 112. The outer end of the shaft 138 includes a tab 142 radially extending from the shaft 138 that prevents the shaft 138 from sliding through the opening 140 in the respective arm 114, 116. As best shown in FIG. 7 a fastener 144 extends through an opening

in the tab 142 and is fastened to the respective arm 114, 116, thereby securing the shaft 138 to the respective arm 114, 116 and in the respective bore 136.

The opposite end of the shafts 138 accept a radial spherical bearing 146 that is inserted into the respective bore 136 in the mounting block 118. Therefore, the counterweight platform 112 is hinged to the mounting block 118, and hence frame 38, such that the counterweight platform 112 may pivot about the axis A. As with the previous example operator ride enhancement system 36, a dampener member (e.g., a hydraulic shock absorber) may be engaged between the frame 38 and the counterweight platform 112 to attenuate disturbances input to the frame 38, thereby ultimately reducing the transmission of the disturbance to the counterweight platform 112 and operator supported thereon.

Another example embodiment of an operator ride enhancement system 36 is illustrated generally in FIGS. 10 and 11. In this arrangement, a counterweight platform 148 includes a single arm 150 that is hinged to the frame 38 at a distal end 152. Specifically, the arm 150 includes a square opening 154 through which a resilient member in the form of a square torsion bar 156 is rotatably interlocked, such that pivoting the counterweight platform 148 about the axis A applies a rotational torque to the torsion bar 156. Given that one end 158 of the torsion bar 156 is rotatably fixed to the frame 38 via a preload member 160 and the opposite end 162 of the torsion bar 156 is rotatably captured to the frame 38 via a bracket 164, the counterweight platform 148 is pivotally coupled to the frame 38.

The preload member 160 is fixed to the torsion bar 156 and rotatably coupled to the frame 38 such that rotating the preload member 160 alters the static location of the counterweight platform 148. For instance, the preload member 160 includes an adjustment bolt 166 that extends into and through a threaded opening in the preload member 160. A tip 168 of the adjustment bolt 166 bears against the frame 38 urging the torsion bar 156 to rotate about the axis A in a direction to move the counterweight platform 148 upward, and thus reducing the static deflection from horizontal.

A dampener member in the form of an elastomeric bushing 170 frictionally engages the end 162 of the torsion bar 156 and is supported by the bracket 164. As a result, the elastomeric bushing 170 at least partially attenuates the disturbances imparted through the frame 38 to the counterweight platform 148 and helps reduce the oscillations of the counterweight platform 148 that may occur in response to the disturbances. Of course, the dampener member may include a variety of configurations, such as a hydraulic damper, a pneumatic damper, a magneto-rheological damper, an electro-rheological damper, and a friction damper. One skilled in the art, given the benefit of this disclosure will appreciate the variety of dampener member devices and arrangements.

In another example operator ride enhancement system 36 illustrated in FIG. 12, a counterweight platform 172 may be hinged to the frame 38 similar to that shown and described with reference to FIGS. 10 and 11, but may also include resilient members in the form of compression springs 175. The springs 175 are illustrated as being positioned between the counterweight platform 172 and a subfloor 174 that is secured to the frame 38. Additionally, a dampener member 176 (shown in simplified form) may be engaged between the counterweight platform 172 and the frame 38 to again inhibit movement of the counterweight platform 172 during use.

Turning next to FIG. 13, another alternative example operator ride enhancement system 36 is illustrated. This

embodiment includes a counterweight platform **178** having a pair of arms **180, 182** extending upward and away from the counterweight platform **178** toward a pair of mounting blocks **184** that are secured to the frame **38**. A resilient member, in the form of one or more springs **186** is again positioned between the counterweight platform **178** and a subfloor **188**. Given the benefit of this disclosure, one skilled in the art will appreciate that the resilient member may alternatively be any other suitable device, such as an extension spring, a torsion spring, an air spring, and an elastomeric spring.

Additionally, or alternatively, a torsion bar **190** may be fixed to the frame **38** and one or more of the arms **180, 182** such that rotating the counterweight platform **178** about the axis A established by the mounting blocks **184** torques the torsion bar **190**.

A further example operator ride enhancement system **36** is illustrated in FIG. **14**. In this embodiment, the operator ride enhancement system **36** includes a counterweight platform **192** that is not hinged to the frame **38**, but is instead supported by a sub-frame **194** that is fixed to the frame **38** (not shown). The counterweight platform **192** includes a series of guides in the form of vertical cylindrical passageways **196** into which guide pins **198** (extending upward from the sub-frame **194**) engage. The cylindrical passageways **196** may be lined with bearings to aid relative movement of the counterweight platform **192**. As a result, the counterweight platform **192** can translate vertically along the axis of the guide pins **198** during use in response to disturbances, as the guide pins **198** are slideably received in the vertical cylindrical passageways **196**.

Resilient members in the form of coil springs **200** are located between the sub-frame **194** and the counterweight platform **192** to at least partially attenuate disturbances imparted through the frame **38** to the counterweight platform **192**. A dampener member in the form of a hydraulic shock absorber (not shown) may also be secured to the counterweight platform **192** with an upper end of the dampener member fixed to the frame **38** (not shown). As a result, the hydraulic shock absorber at least partially attenuates the disturbances imparted through the frame **38** to the counterweight platform **192**.

An alternative guide is illustrated in FIG. **15**. The guide **206** generally comprises a channel **208** fixed to (or integral with) the frame **38** and a carriage **210** fixed to a counterweight platform **212**. The carriage **210** includes a roller **214** rotatably captured on a spindle **216**. As such, the carriage **210** (and thus counterweight platform **212**) is captured within and slides along the channel **208** as the roller **214** rolls.

The above-described operator ride enhancement systems may require application specific adjustments to achieve desired levels of disturbance attenuation. Several general considerations may aid the design and development of a suitable operator ride enhancement system given particular application requirements. For instance, when considering a resilient member, higher spring rates are generally less sensitive to variances in operator mass and result in less static deflection of a counterweight platform supporting a mass. In some applications, a balance must be struck between the natural frequency, static deflection, dynamic deflection, spring rate, and counterweight platform mass. The counterweight platform mass is often restricted by packaging limitations; however, other options for increasing the mass of the counterweight platform may include rearranging various vehicle components, such as motors, controllers, hydraulics, etc. to alter the dynamics of the operator

ride enhancement system. As a specific example, a battery of a fork truck may be structurally coupled to a counterweight platform, thereby substantially increasing the mass of the counterweight platform as compared to the mass of an operator, further reducing the impact that the mass of an operator has on the dynamic response of the operator ride enhancement system.

While there has been shown and described what is at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications can be made, given the benefit of this disclosure, without departing from the scope of the invention defined by the following claims.

I claim:

[1. An operator ride enhancement system for use in a vehicle having a frame, the operator ride enhancement system comprising:

a counterweight platform pivotally coupled to the frame of the vehicle about an axis and configured to support an operator engaging the operator ride enhancement system, the counterweight platform having a counterweight platform mass that is greater than approximately forty-five kilograms;

a resilient member engaged with the frame and the counterweight platform to attenuate movement of the counterweight platform about the axis; and

a control member engaged with the frame and the counterweight platform to inhibit movement of the counterweight platform along the axis.]

[2. The operator ride enhancement system of claim **1**, wherein:

the axis is oriented substantially parallel with a fore-aft axis of the vehicle; and

the control member is oriented substantially parallel with the fore-aft axis of the vehicle.]

[3. The operator ride enhancement system of claim **1**, wherein the counterweight platform comprises:

a hinged portion pivotally coupled to the frame; and

a platform portion coupled to the hinged portion;

wherein the platform portion is tapered toward a distal end that is opposite to the hinged portion.]

[4. The operator ride enhancement system of claim **1**, wherein the counterweight platform is configured to at least partially surround a steering wheel of the vehicle.]

[5. The operator ride enhancement system of claim **1**, wherein the counterweight platform mass is at least one hundred and sixty kilograms.]

[6. An operator ride enhancement system for use in a vehicle having a frame and defining an operator compartment, the operator ride enhancement system comprising:

a counterweight platform movably coupled to the frame of the vehicle and configured to support an operator within the operator compartment engaging the operator ride enhancement system, the counterweight platform having a counterweight platform mass that is greater than approximately forty-five kilograms to reduce the influence that an operator mass of the operator has on a dynamic response of the operator ride enhancement system; and

a resilient member engaged with the frame and the counterweight platform to attenuate movement of the counterweight platform and the operator supported by the counterweight platform.]

[7. The operator ride enhancement system of claim **6**, wherein the counterweight platform is pivotally coupled to the frame for pivotal movement about an axis.]

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[8. The operator ride enhancement system of claim 7, further comprising a control member engaged with the frame and the counterweight platform to inhibit movement of the counterweight platform along the axis.]

[9. The operator ride enhancement system of claim 6, wherein the resilient member is a torsion member having a first end rotatably fixed to one of the frame and the counterweight platform and a second end rotatably fixed to the other of the frame and the counterweight platform.]

[10. The operator ride enhancement system of claim 9, further comprising:

a preload member proximate the first end of the torsion member; and

a dampener member engaged with the frame and the second end of the torsion member to at least partially attenuate the disturbances transmitted through the frame to the counterweight platform.]

[11. The operator ride enhancement system of claim 6 further comprising at least one guide coupled to the frame and engaged with the counterweight platform to allow the counterweight platform to translate along the guide in response to the disturbances.]

[12. The operator ride enhancement system of claim 6, further comprising a dampener member engaged with the frame and the counterweight platform to attenuate the disturbances transmitted through the frame to the counterweight platform.]

[13. The operator ride enhancement system of claim 6, wherein the counterweight platform mass is at least one hundred and sixty kilograms.]

[14. The operator ride enhancement system of claim 6, wherein the counterweight platform comprises:

a hinged portion coupled to the frame for pivotal movement about an axis; and

a platform portion coupled to the hinged portion.]

[15. A method of attenuating disturbances transmitted between a frame of a vehicle and an operator ride enhancement system comprising a counterweight platform moveably coupled to the frame of the vehicle and configured to support an operator, the method comprising the steps of:

determining an expected minimum operator mass of the operator supported by the operator ride enhancement system; and

adjusting a counterweight platform mass of the counterweight platform to be at least equal to the expected minimum operator mass.]

[16. The method of claim 15 wherein the expected minimum operator mass is approximately forty-five kilograms.]

[17. The method of claims 16 wherein the counterweight platform mass is approximately one hundred and sixty kilograms.]

18. A vehicle comprising:

a frame;

a counterweight platform supported by the frame, the counterweight platform configured for translational movement relative to the frame and along a vertical axis; and

a resilient member configured to attenuate the translational movement of the counterweight platform, and a dampener member configured to inhibit the translational movement of the counterweight platform, the resilient member having a preload of approximately 1025 Newtons and a spring rate of approximately 3300 Newtons per centimeter to control the natural frequency of the counterweight platform.

19. The vehicle of claim 18, further including a channel and a carriage, the channel fixed to or integral with the

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frame, and the carriage fixed to the counterweight platform, the carriage including a roller rotatably captured within and slidable along the channel.

20. The vehicle of claim 19, wherein the counterweight platform is configured to surround a portion of a wheel of the vehicle to allow the counterweight platform to translate vertically relative to the wheel of the vehicle.

21. The vehicle of claim 20, further including a pedal switch, the pedal switch to translate with the counterweight platform.

22. The vehicle of claim 21, wherein the resilient member and the dampener member are engaged with the frame and the counterweight platform.

23. The vehicle of claim 22, wherein the resilient member is a spring and the dampener member is a shock absorber.

24. The vehicle of claim 18, further including a guide including a channel and a roller, the channel fixed relative to the frame, the roller coupled to the counterweight platform and received in the channel, the guide to allow the counterweight platform to translate relative to the frame in response to disturbances transmitted to the counterweight platform;

a pedal switch, the pedal switch to translate with the counterweight platform, the pedal switch positioned within the operator compartment; and

wherein the counterweight platform includes an opening to allow the counterweight platform to surround a portion of a wheel of the vehicle and translate vertically relative to the wheel.

25. The vehicle of claim 24, wherein the pedal switch is positioned within a recess in the counterweight platform.

26. The vehicle of claim 25, wherein the resilient member is a spring and the dampener member is a shock absorber.

27. The vehicle of claim 18, further including a drain opening in the counterweight platform.

28. A vehicle including an operator ride enhancement system, the vehicle comprising:

a frame, the frame defining a portion of an operator compartment of the vehicle, the operator compartment including operator controls, an armrest and a backrest; a counterweight platform having a surface, the counterweight platform positioned within the operator compartment and being movably coupled to the frame and configured to support an operator standing on the surface within the operator compartment, the counterweight platform having a counterweight platform mass to reduce the influence that an operator mass has on a dynamic response of the counterweight platform; and a resilient member, the resilient member including a first end engaged to the frame, and the resilient member including a second end engaged to the counterweight platform, the resilient member having a preload of approximately 1025 Newtons and a spring rate of approximately 3300 Newtons per centimeter to control the natural frequency of the counterweight platform.

29. The vehicle of claim 28, further including a guide, the guide including a channel and a carriage, the channel fixed to or integral with the frame, and the carriage fixed to the counterweight platform, the carriage including a roller captured within and slidable along the channel.

30. The vehicle of claim 29, wherein the counterweight platform includes a cutout to allow the counterweight platform to surround a portion of a wheel of the vehicle and translate vertically relative to the wheel.

31. The vehicle of claim 30, wherein the resilient member includes a spring and a shock absorber.

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32. An operator ride enhancement system for use in a vehicle having a frame and defining an operator compartment, the operator ride enhancement system comprising:

- a counterweight platform to be movably coupled to the frame of the vehicle, the counterweight platform to support an operator within the operator compartment, the counterweight platform having a mass to reduce the influence that an operator mass has on a dynamic response of the counterweight platform; and
- a resilient member to attenuate movement of the counterweight platform and the operator supported by the counterweight platform, the resilient member having a preload of approximately 1025 Newtons and a spring rate of approximately 3300 Newtons per centimeter to control the natural frequency of the counterweight platform.

33. The operator ride enhancement system of claim 32, further including a pedal switch, the pedal switch to move

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with the counterweight platform, the pedal switch positioned within a recess in the counterweight platform.

34. The operator ride enhancement system of claim 32, further including a drain opening in the counterweight platform.

35. The operator ride enhancement system of claim 34, wherein the pedal switch is positioned within the operator compartment to allow an operator to assume a left-facing stance.

36. The operator ride enhancement system of claim 35, wherein the counterweight platform is formed as a unitary body.

37. The operator ride enhancement system of claim 36, wherein the resilient member includes a spring and a shock absorber.

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