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Yahner

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(54) **OPERATOR RIDE ENHANCEMENT SYSTEM**

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(73) Assignee: **The Raymond Corporation**, Greene, NY (US)

(*) Notice: This patent is subject to a terminal disclaimer.

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Related U.S. Patent Documents

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Appl. No.: **14/089,021**
Filed: **Nov. 25, 2013**

U.S. Applications:
(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 51/02 (2006.01)
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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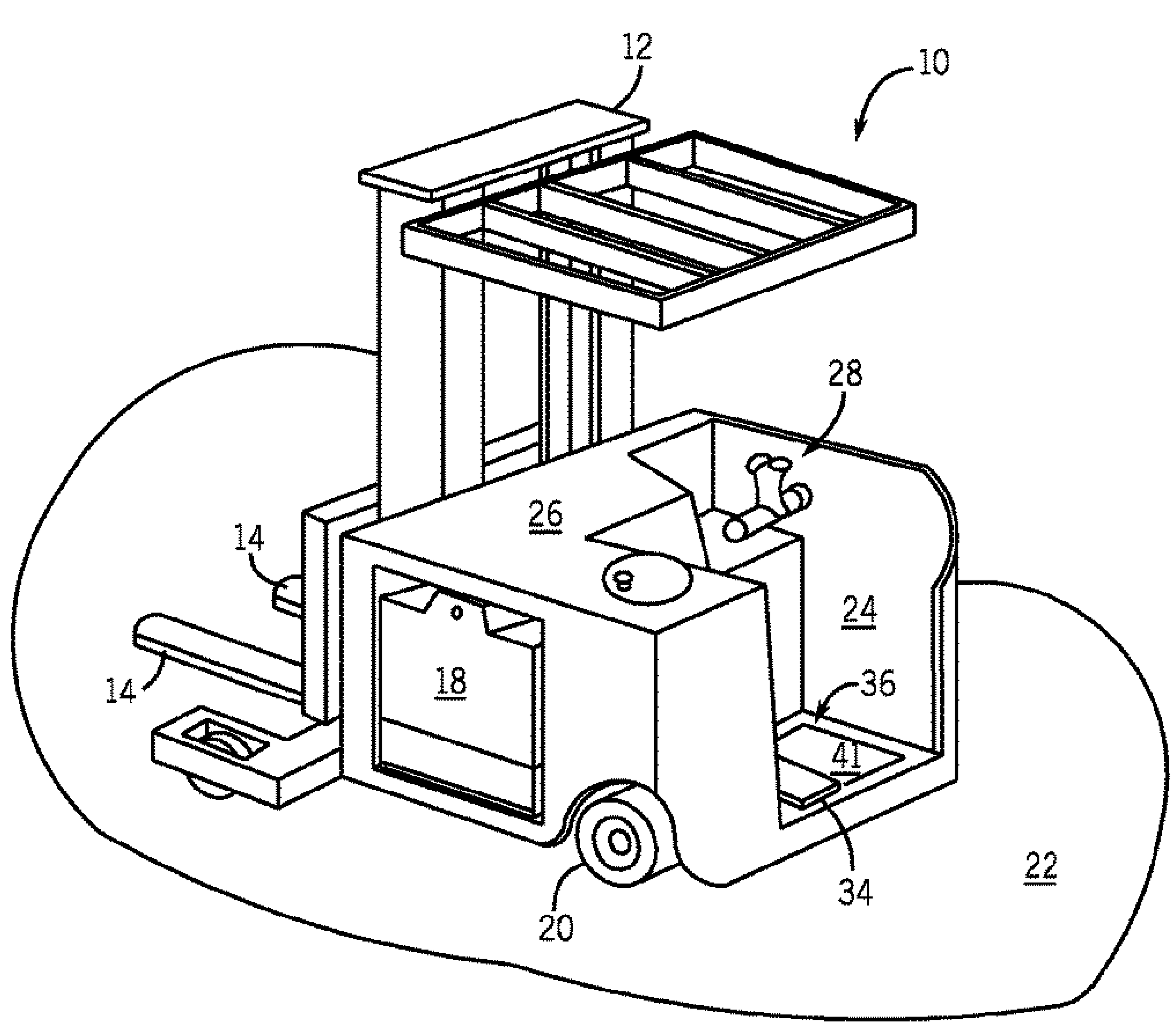
(57) **ABSTRACT**

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



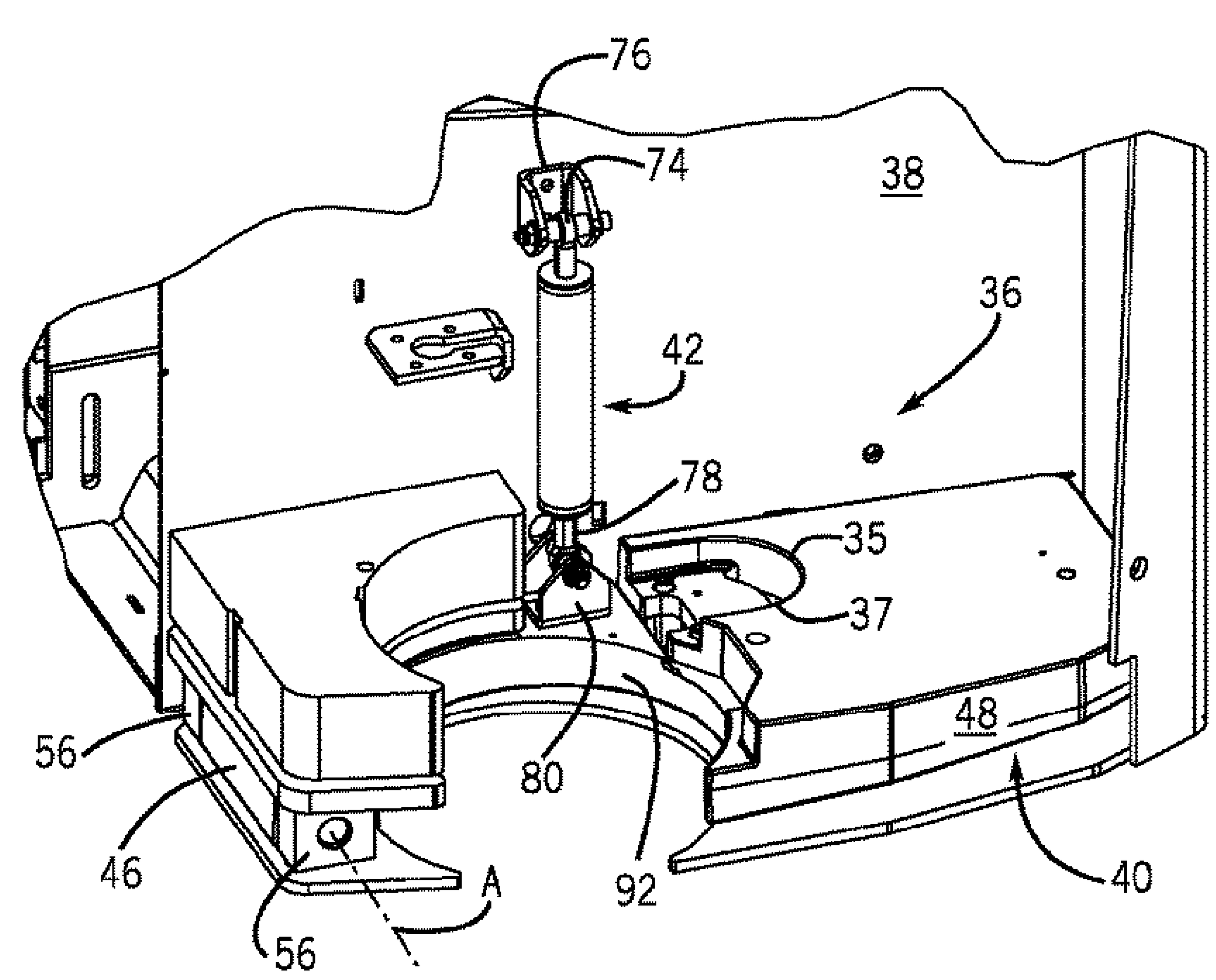


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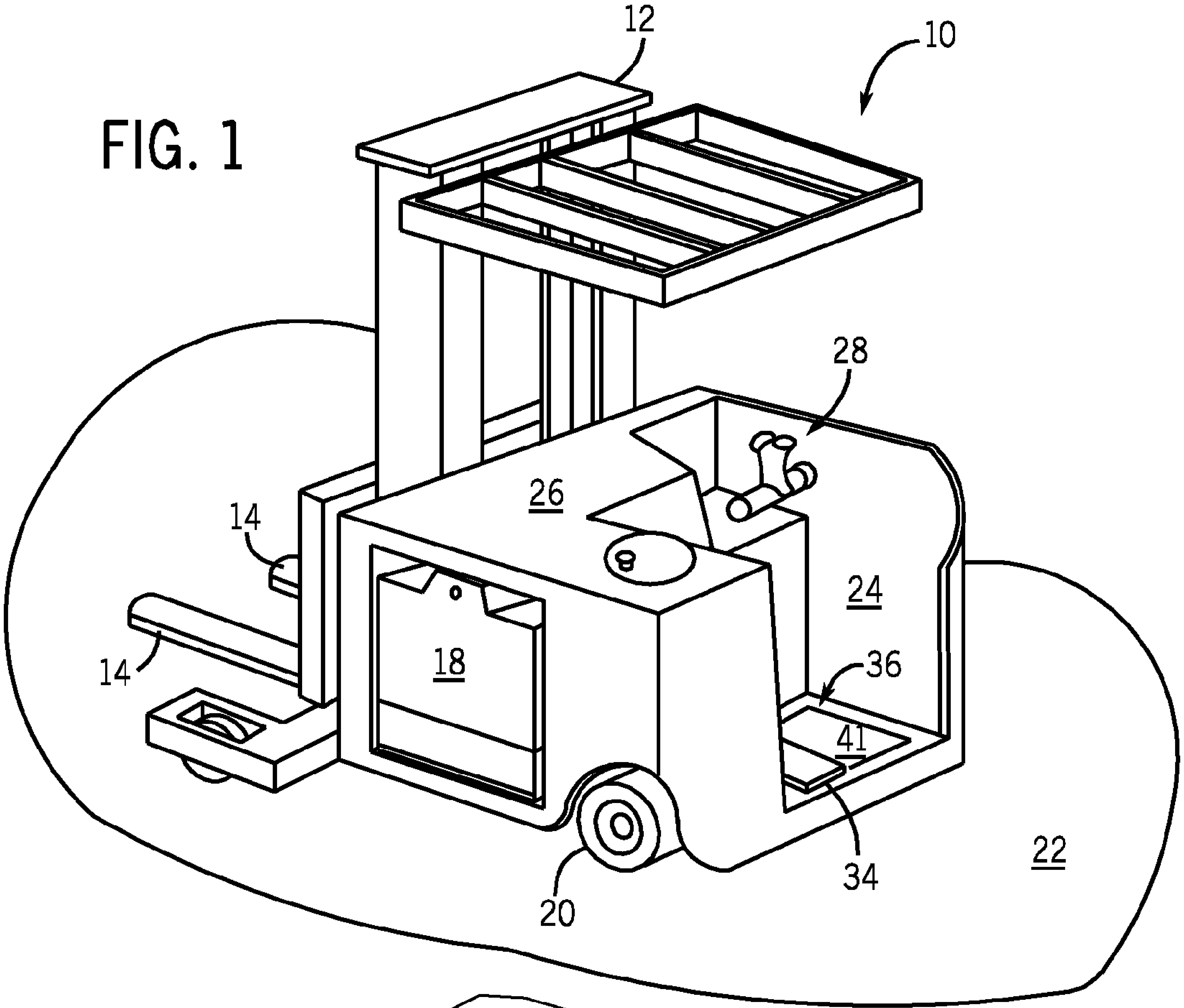
FIG. 1



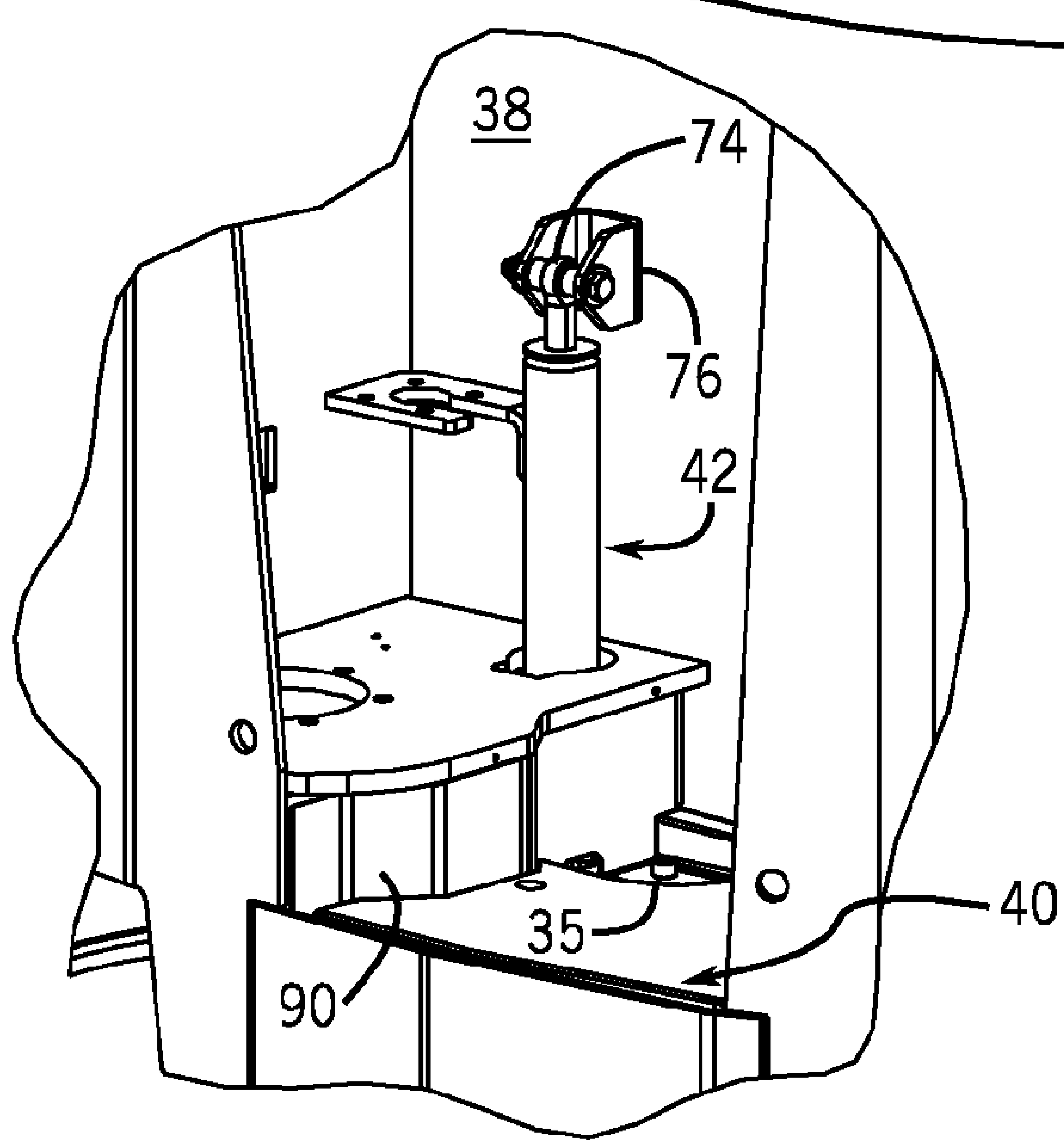


FIG. 2

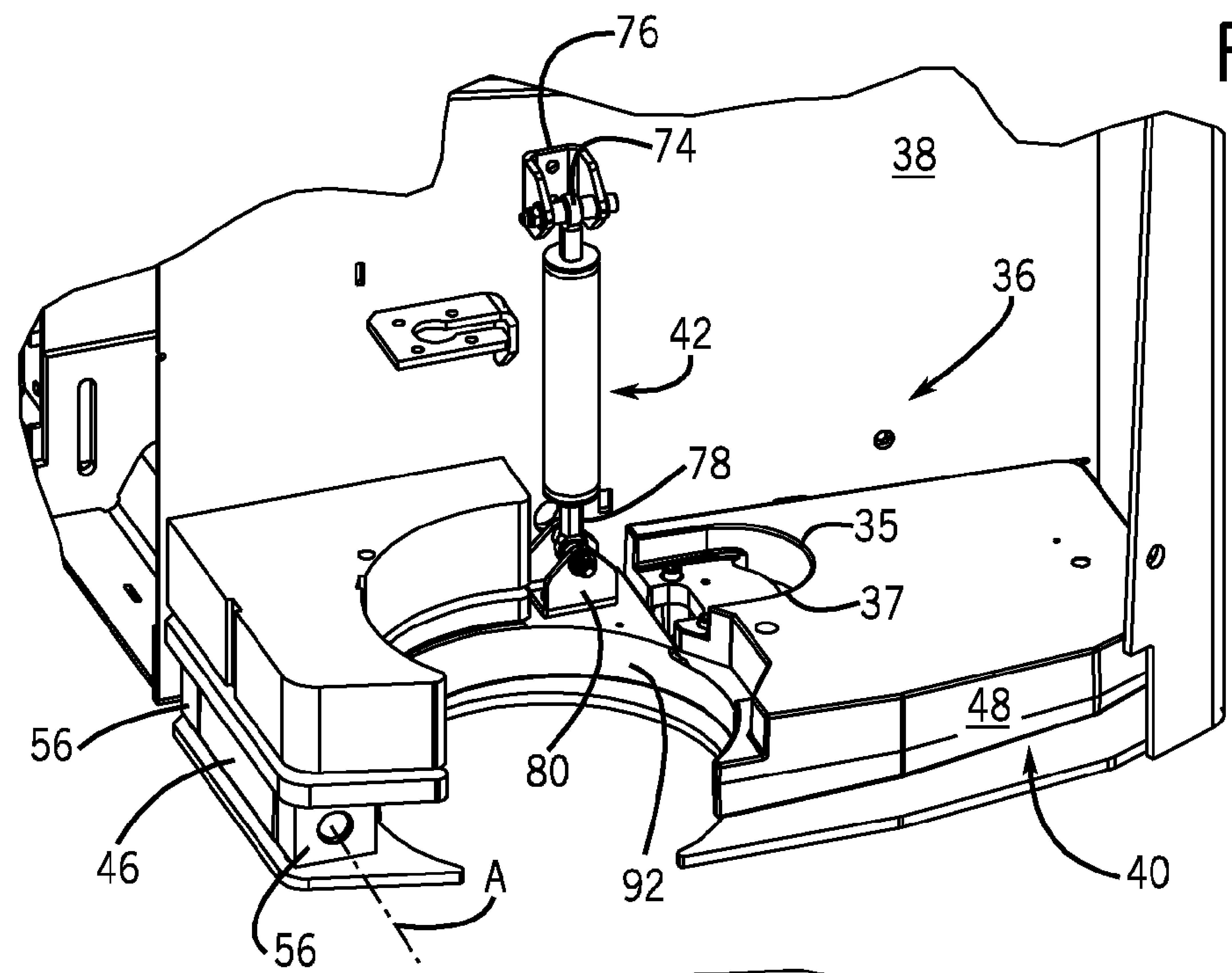


FIG. 3

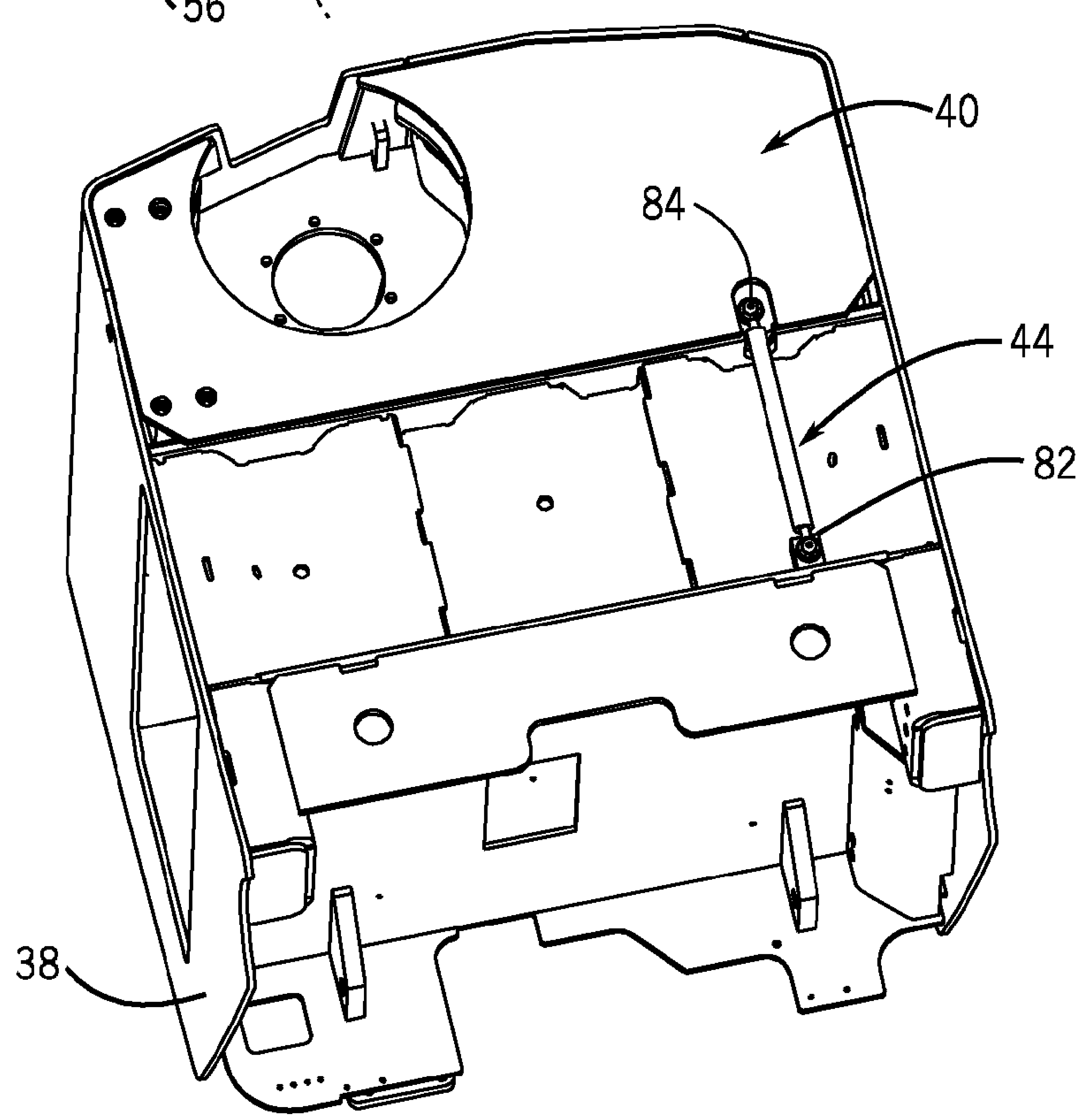


FIG. 4

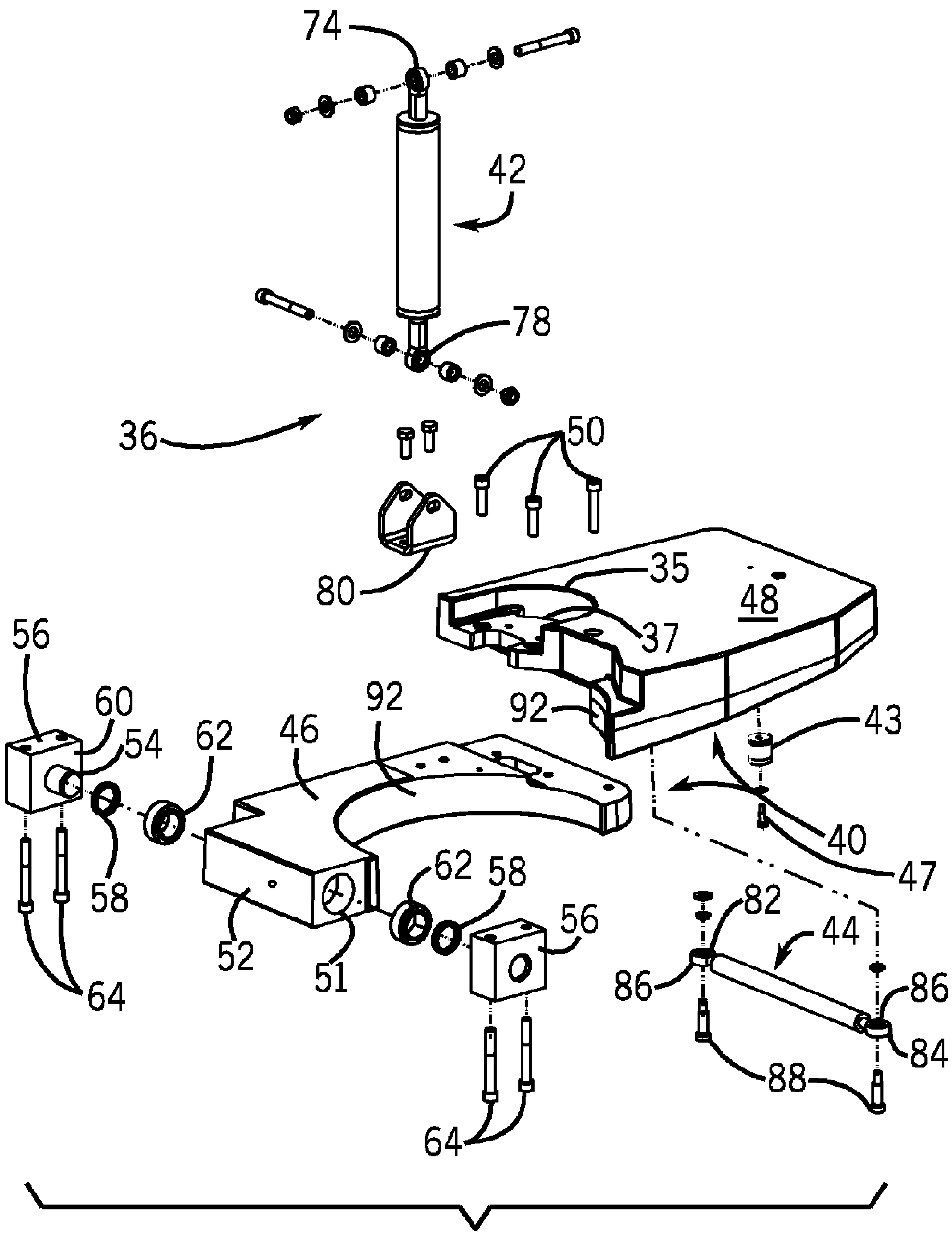

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FIG. 5

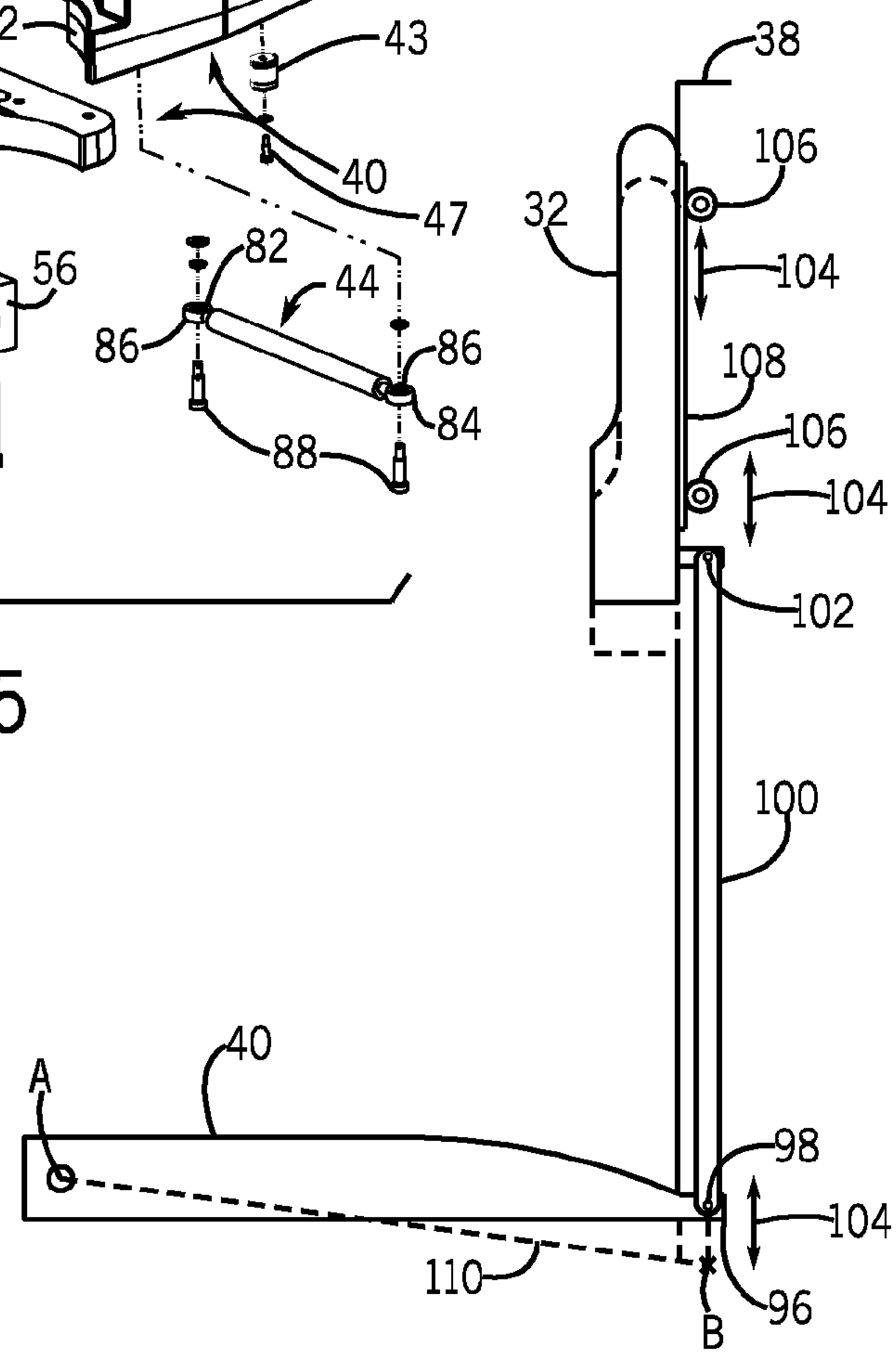
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FIG. 6

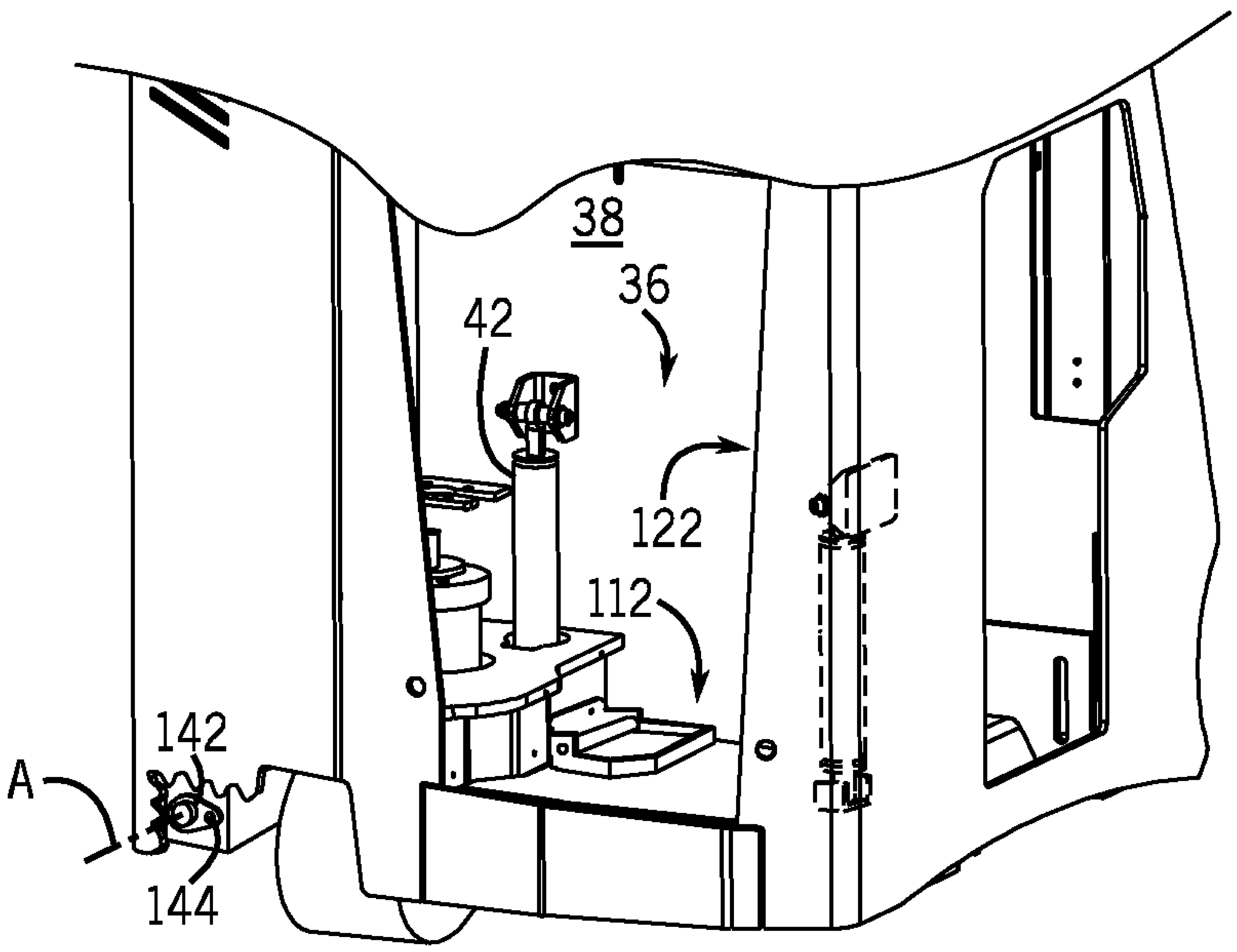
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FIG. 7

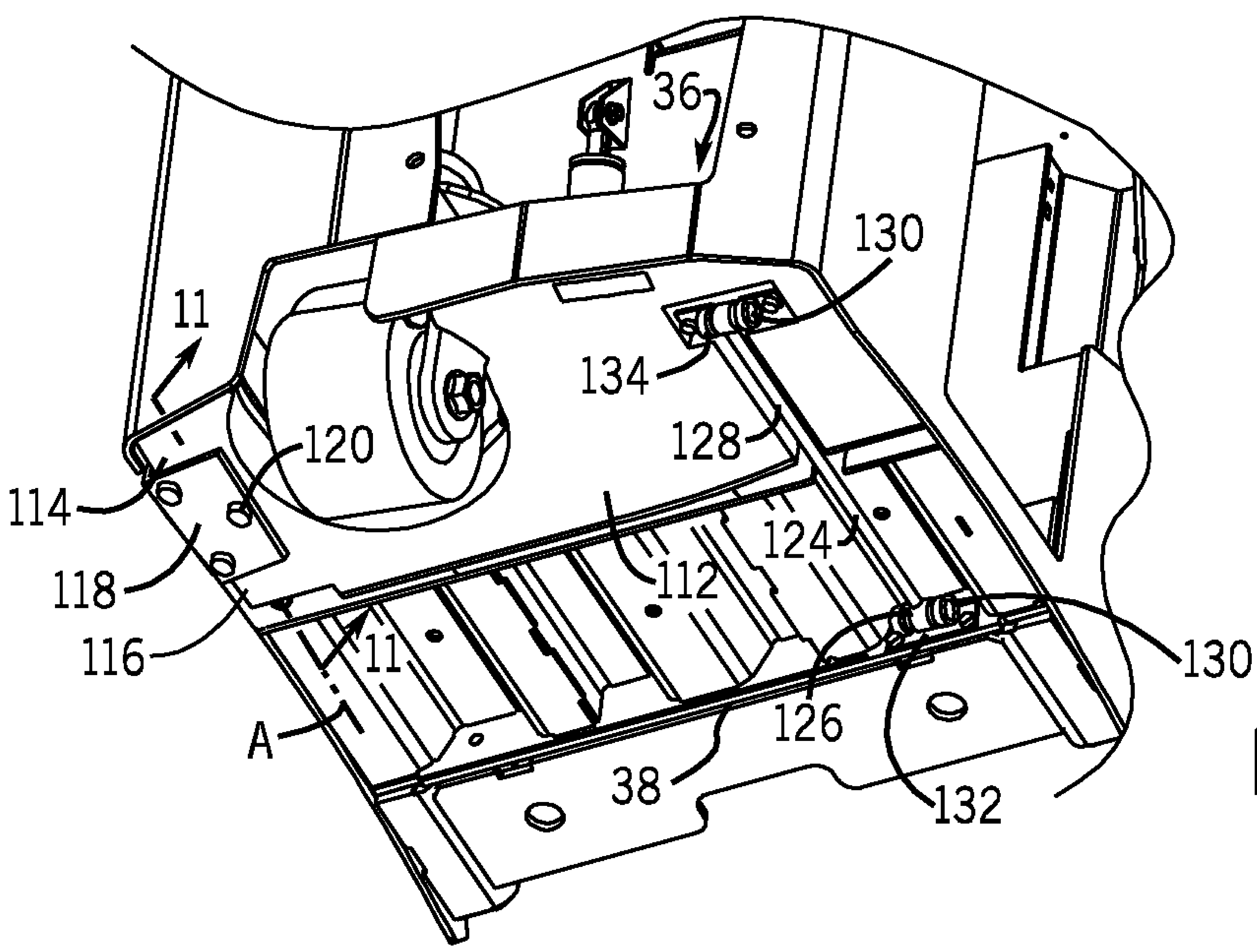
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FIG. 8

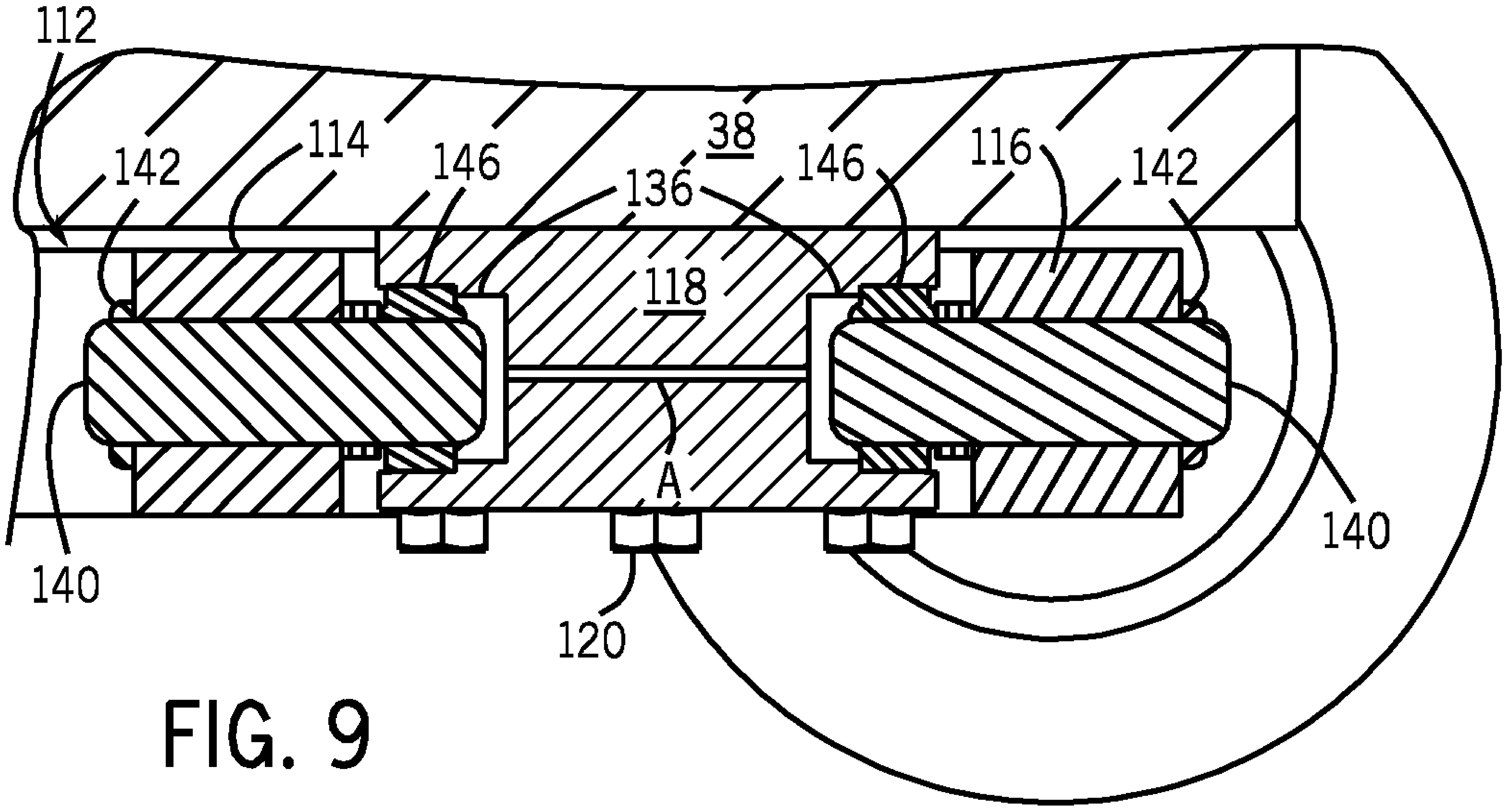
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FIG. 9

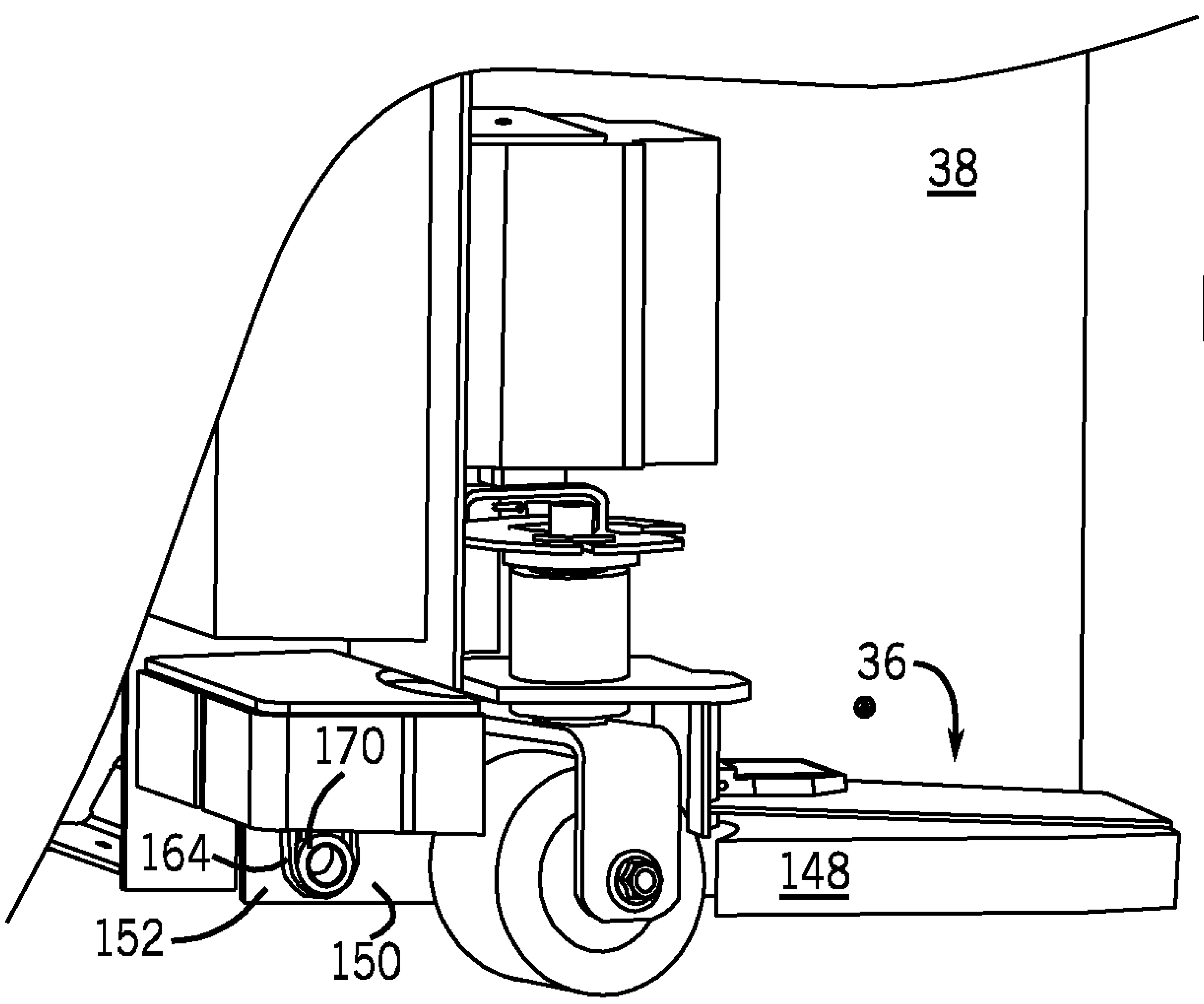
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FIG. 10

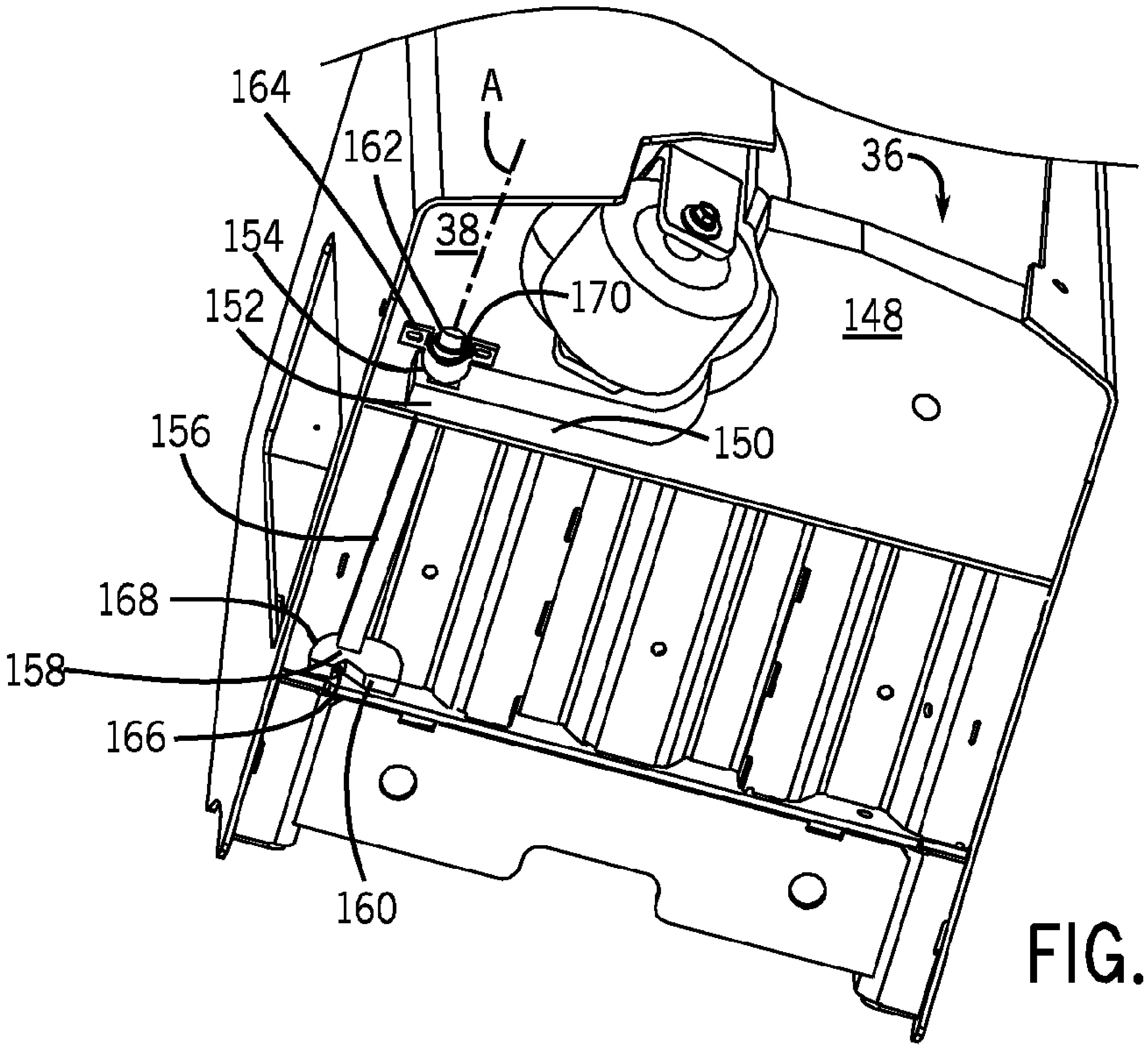
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FIG. 11

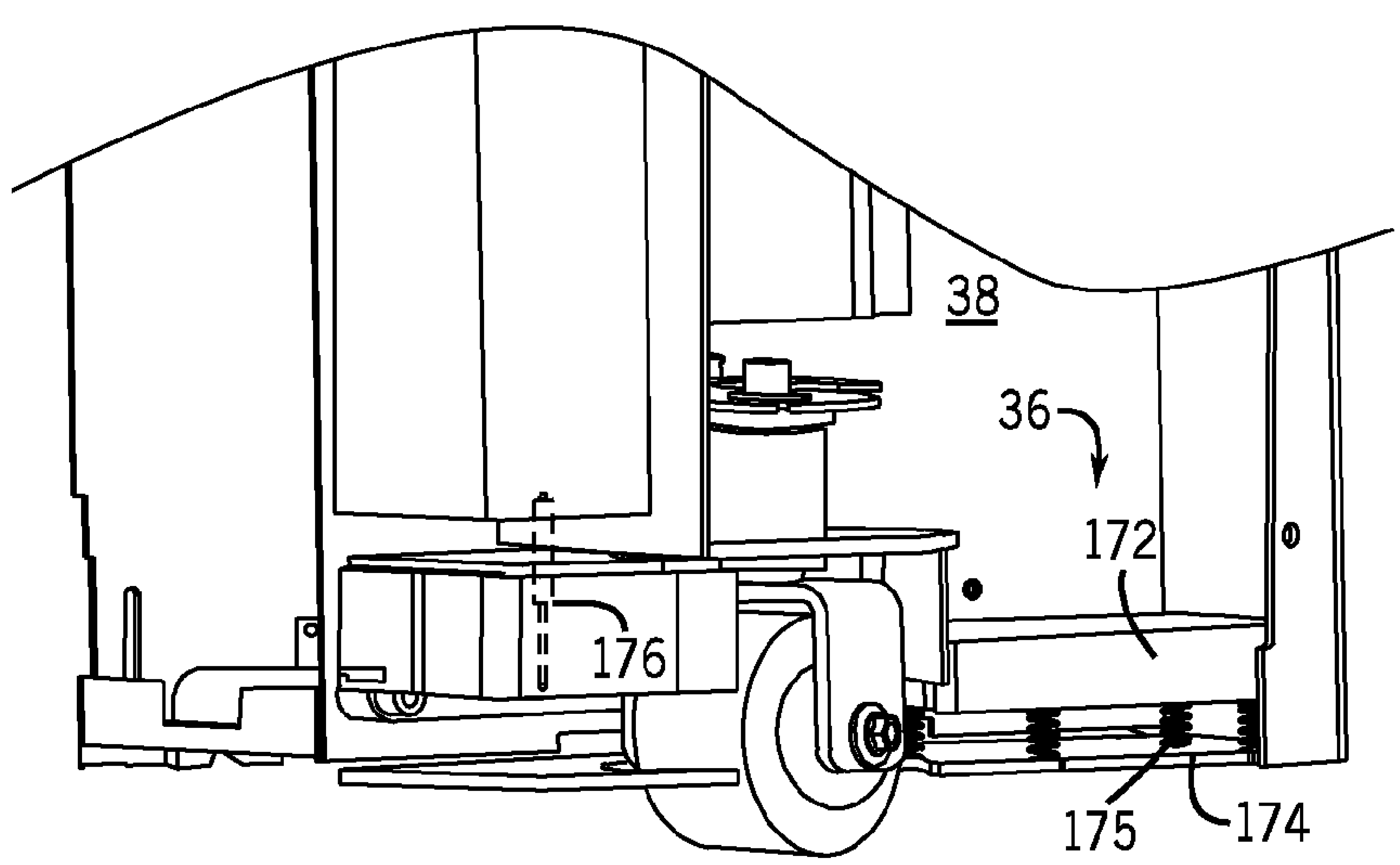
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FIG. 12

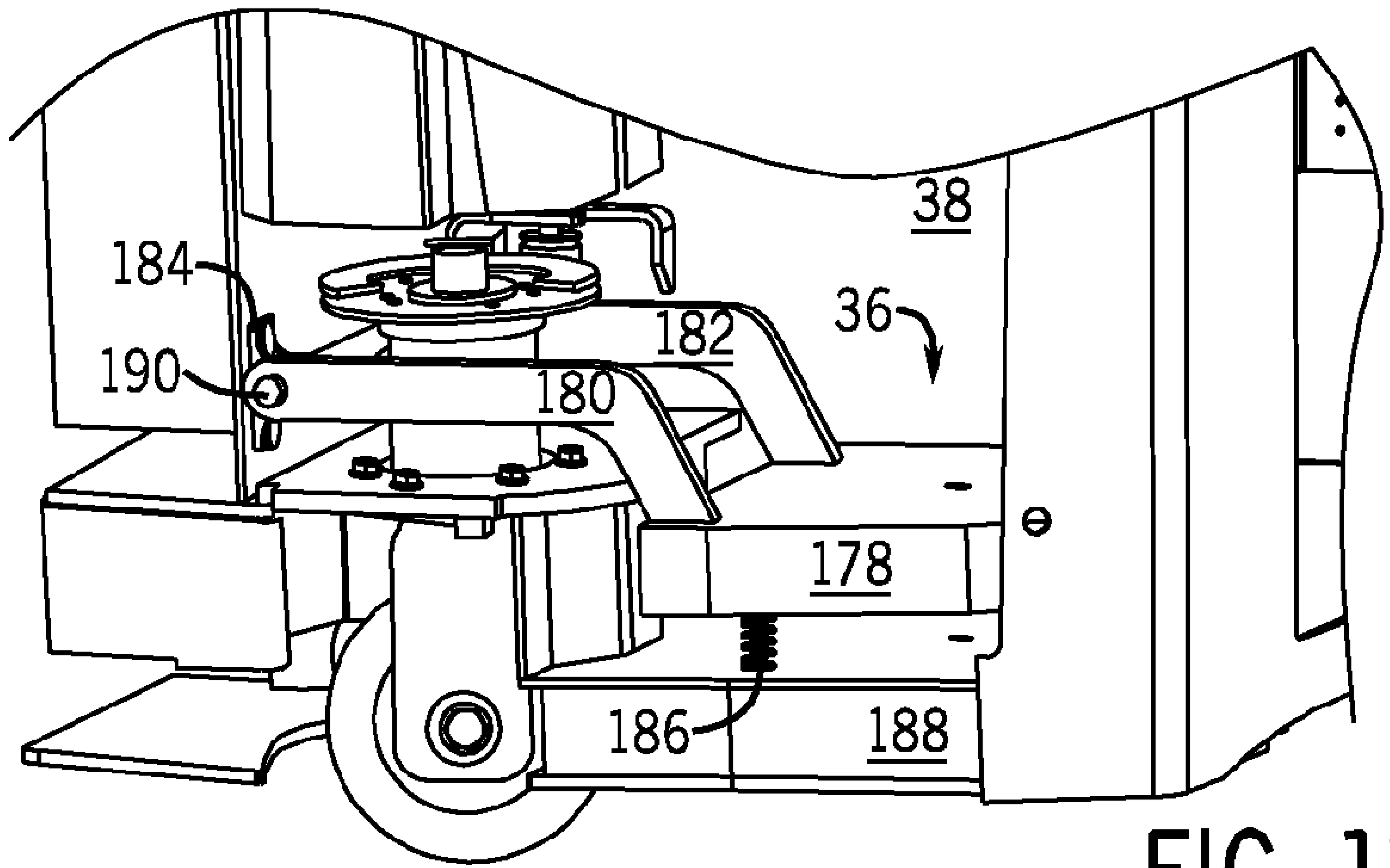

FIG. 13

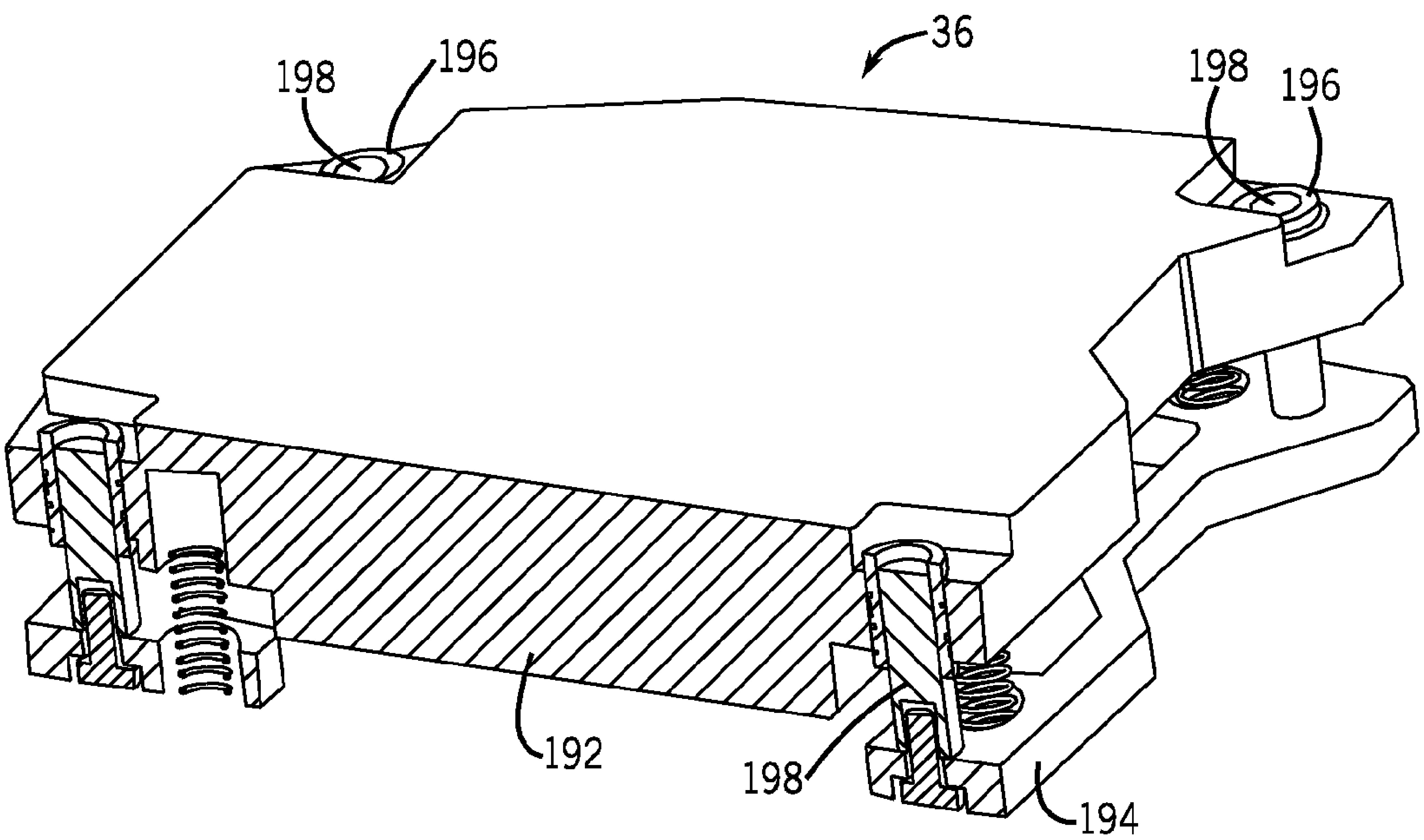

FIG. 14

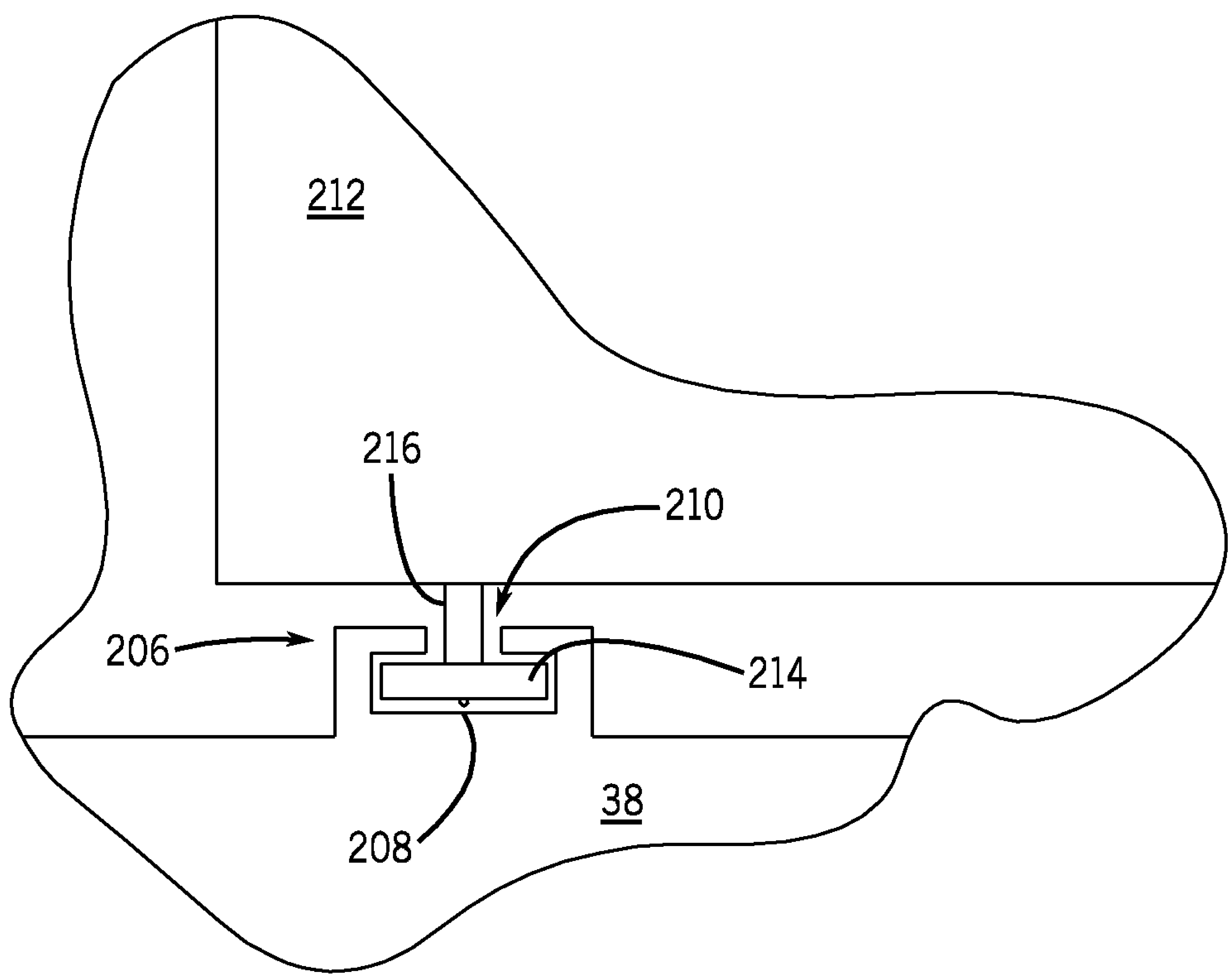

FIG. 15

OPERATOR RIDE ENHANCEMENT SYSTEM

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.

SUMMARY

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**.

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 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° andtypically 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.]

[**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 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.

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 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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