US010183185B2

(12) **United States Patent**
Carroccia et al.

(10) **Patent No.: US 10,183,185 B2**
(45) **Date of Patent: Jan. 22, 2019**

(54) **FALL ARREST APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 9 days.

(21) Appl. No.: **15/432,224**

(22) Filed: **Feb. 14, 2017**

(65) **Prior Publication Data**

US 2017/0232280 A1 Aug. 17, 2017

Related U.S. Application Data

(60) Provisional application No. 62/295,859, filed on Feb. 16, 2016.

(51) **Int. Cl.**
A62B 35/04 (2006.01)
A62B 35/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A62B 35/04*** (2013.01); ***A62B 35/0006*** (2013.01); ***A62B 35/0043*** (2013.01); ***A62B 35/0068*** (2013.01)

(58) **Field of Classification Search**
CPC B60T 1/14; A62B 35/00; A62B 35/0068; A62B 35/04; A62B 35/0006; A62B 35/0043; B62M 1/10; B62M 1/32; B62M 1/132; F16D 63/006; F16D 2127/008
USPC 182/3; 280/212
See application file for complete search history.

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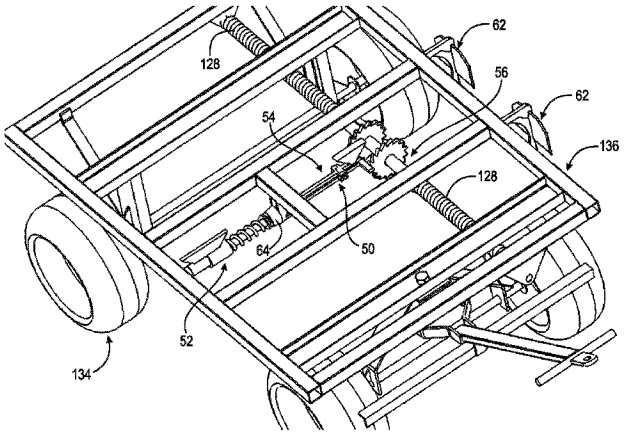
(57) **ABSTRACT**

A fall arrest apparatus including a force damping subsystem having a damper, a brake release mechanism connected to the force damping subsystem and arranged to trigger when a force having a sufficient magnitude is transmitted to the brake release mechanism, and a brake mechanism including an energy storage device arranged to deploy at least one anchor when the brake release mechanism is triggered. The force is provided by a falling object to the force damping subsystem and the force damping subsystem is arranged to decelerate the falling object after the brake release mechanism is triggered.

13 Claims, 15 Drawing Sheets



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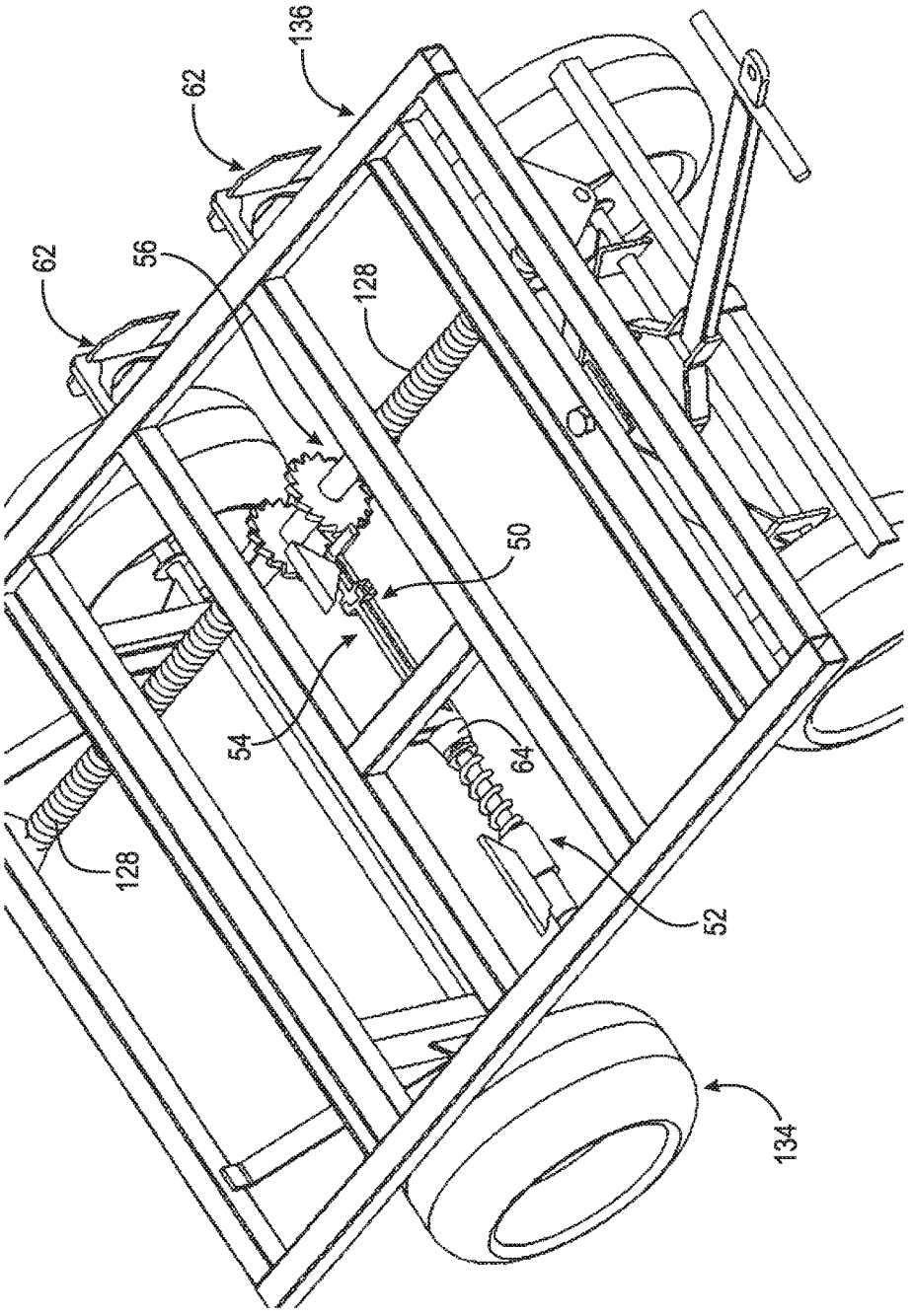

Fig. 1

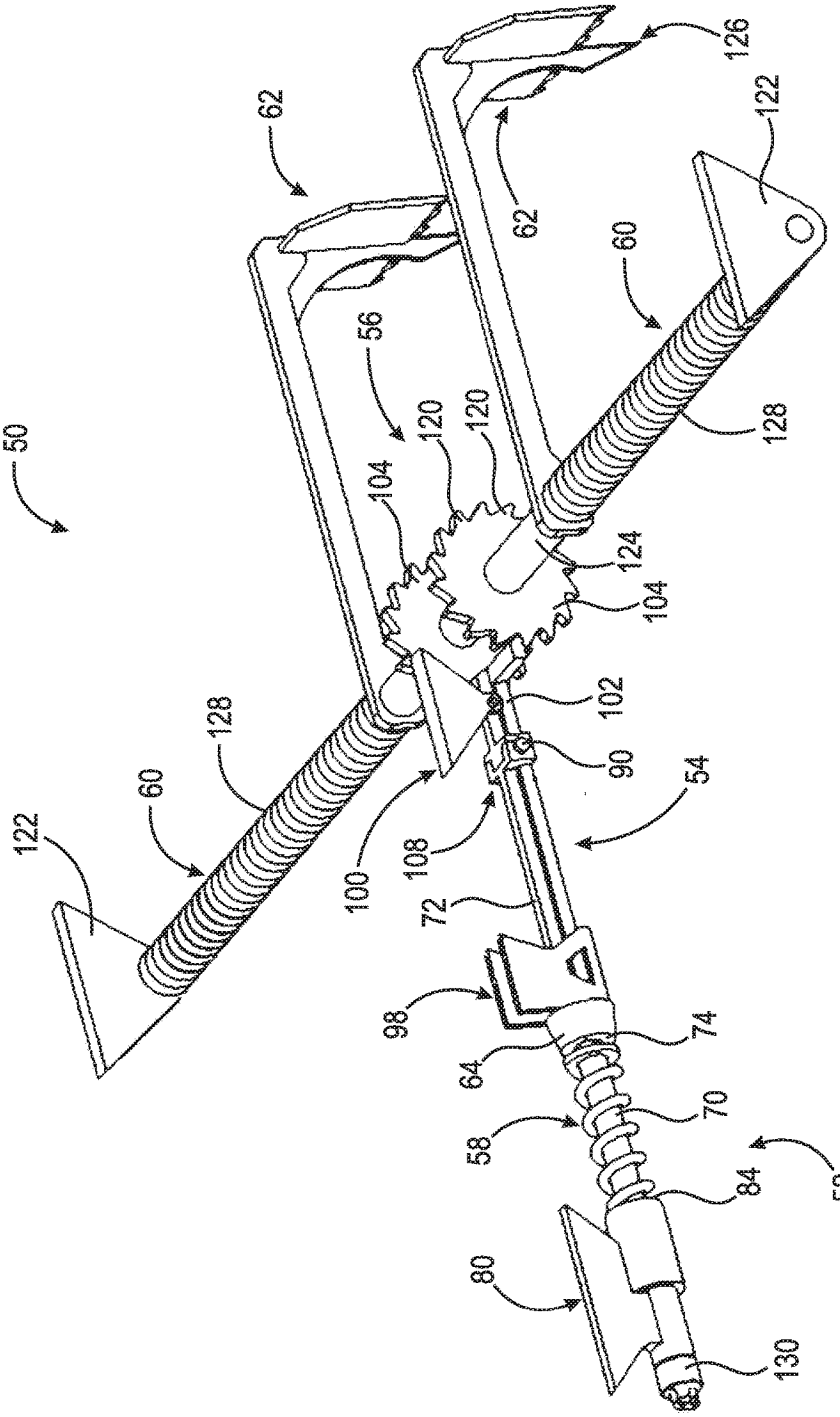
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Fig. 2

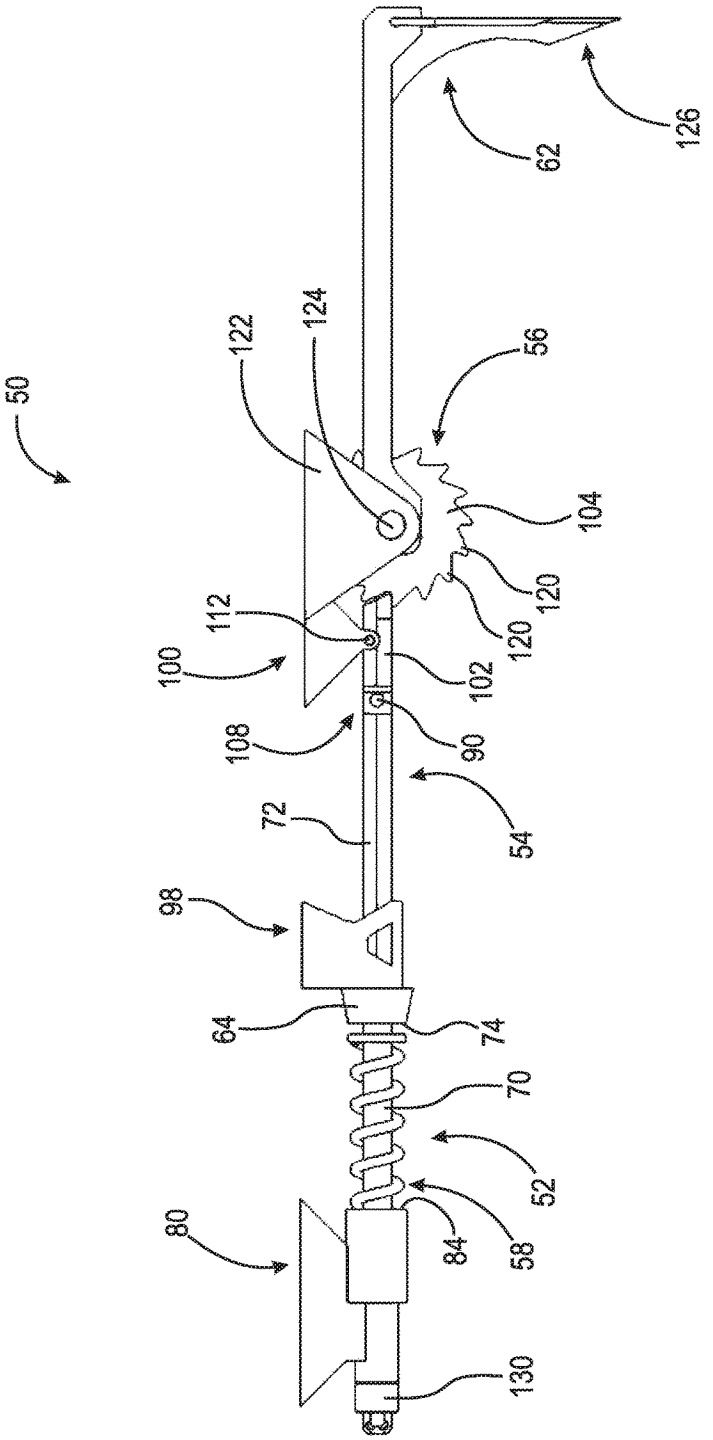
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Fig. 3

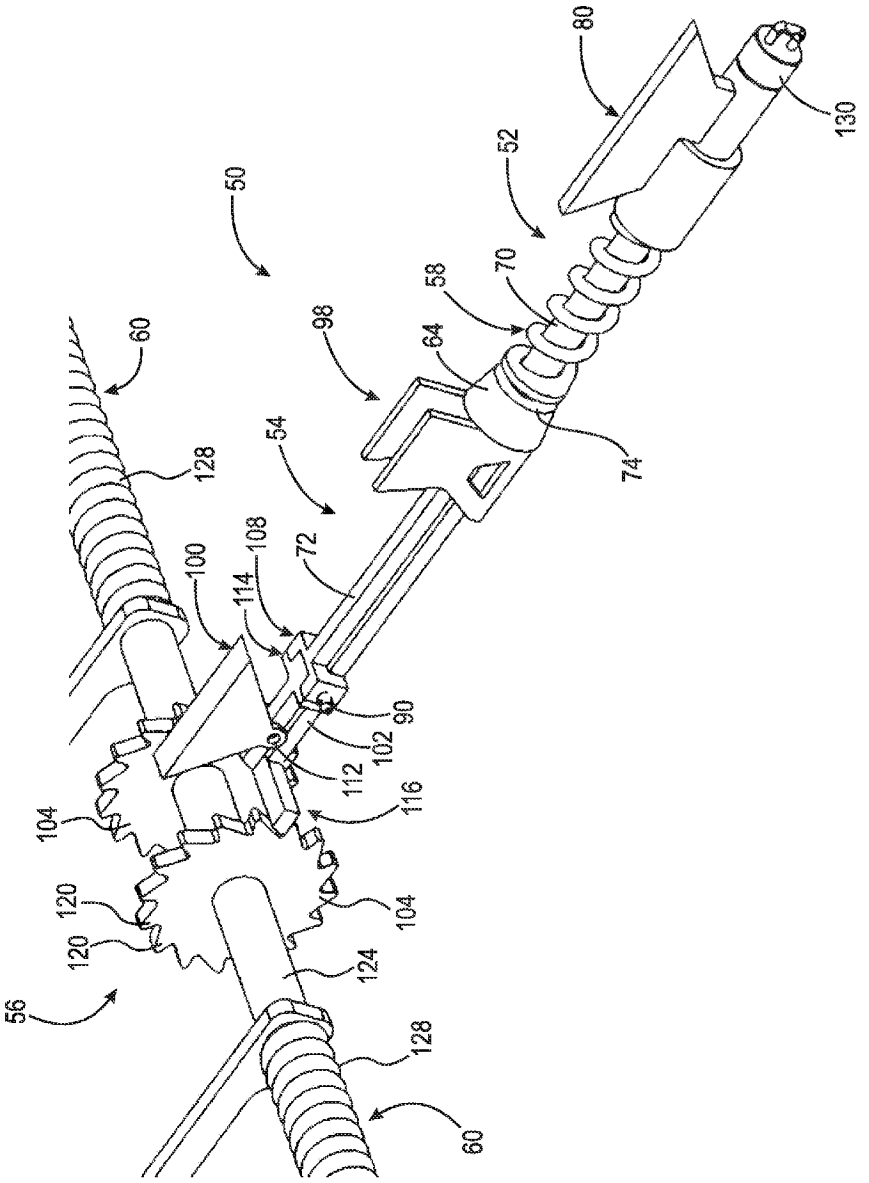
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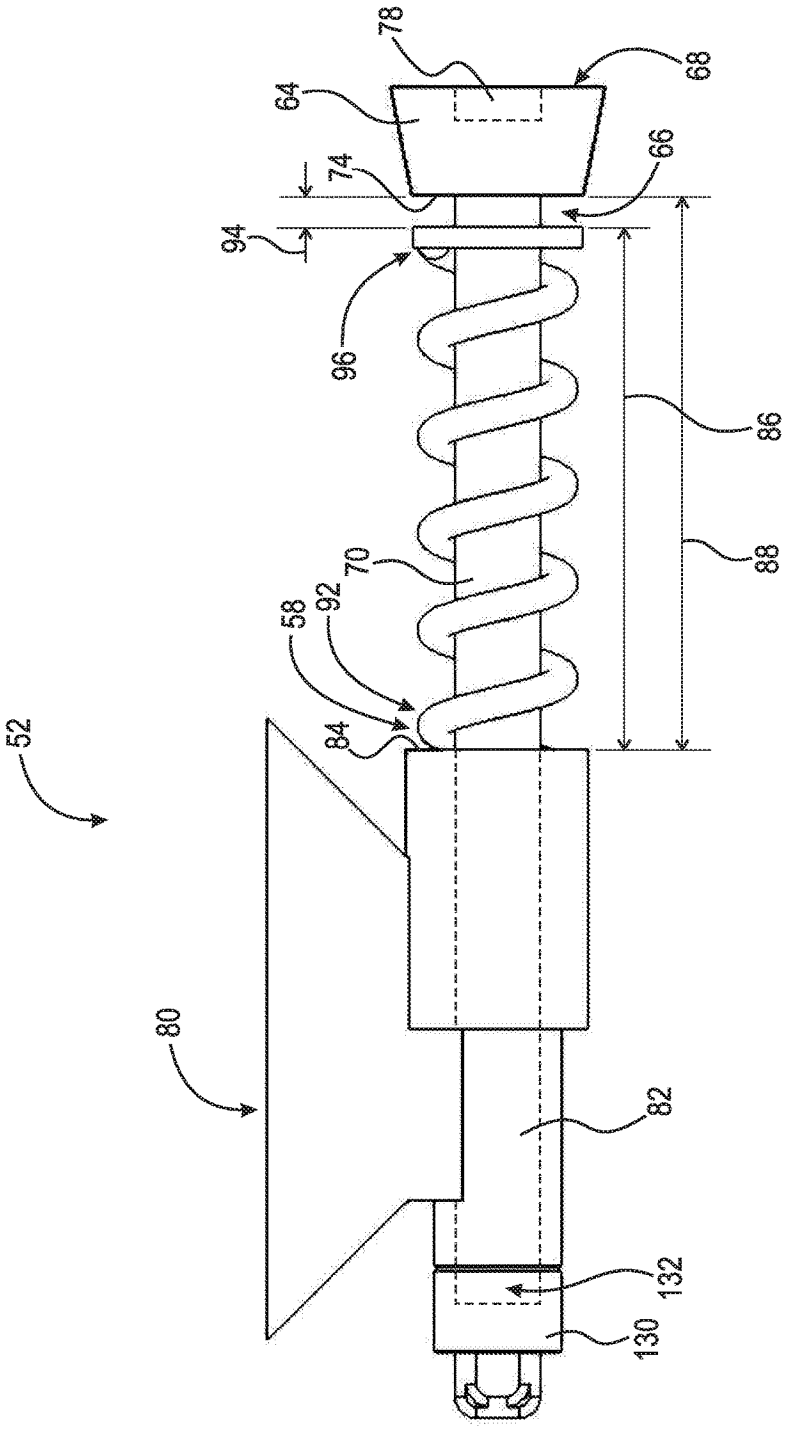
Fig. 4



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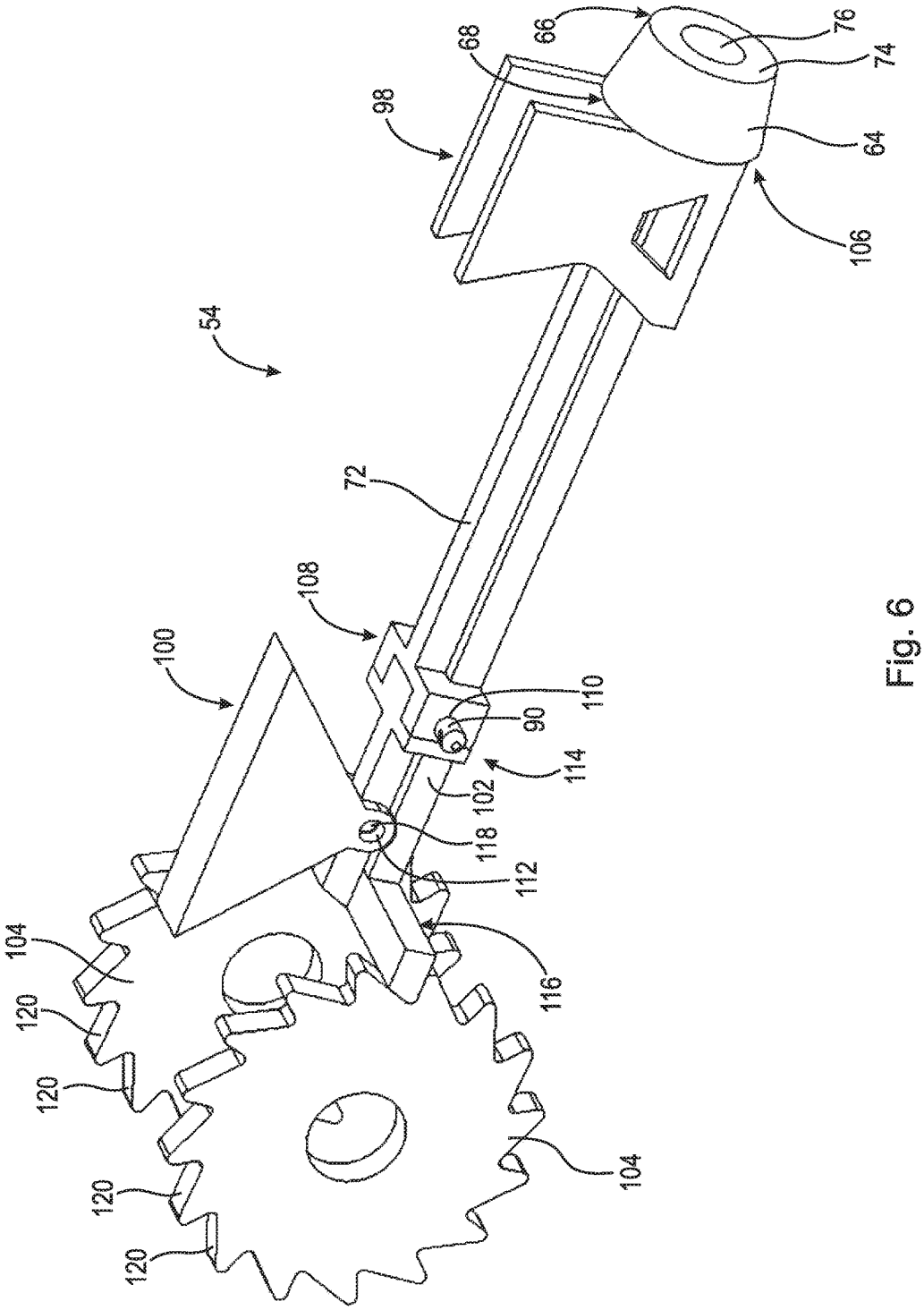
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Fig. 6

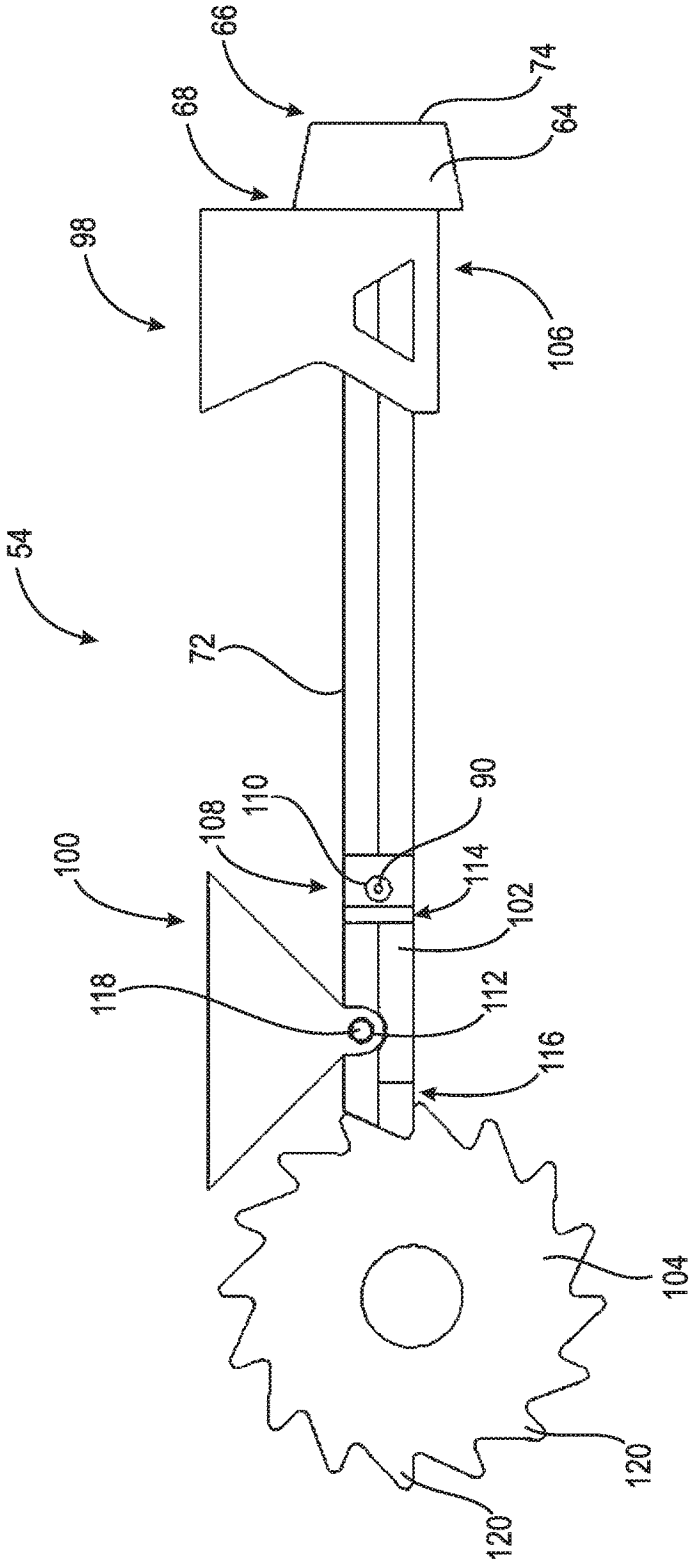
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Fig. 7

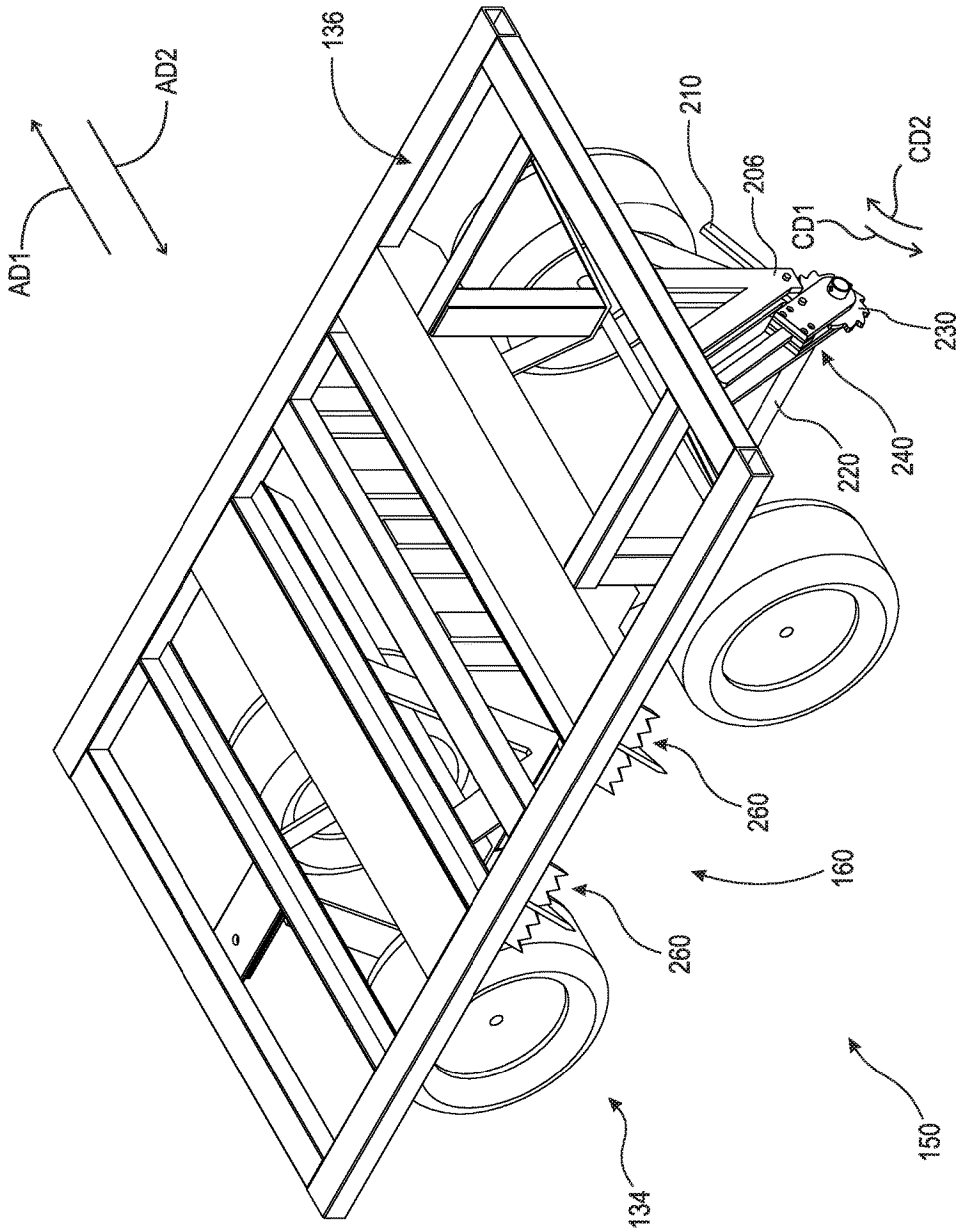

Fig. 8

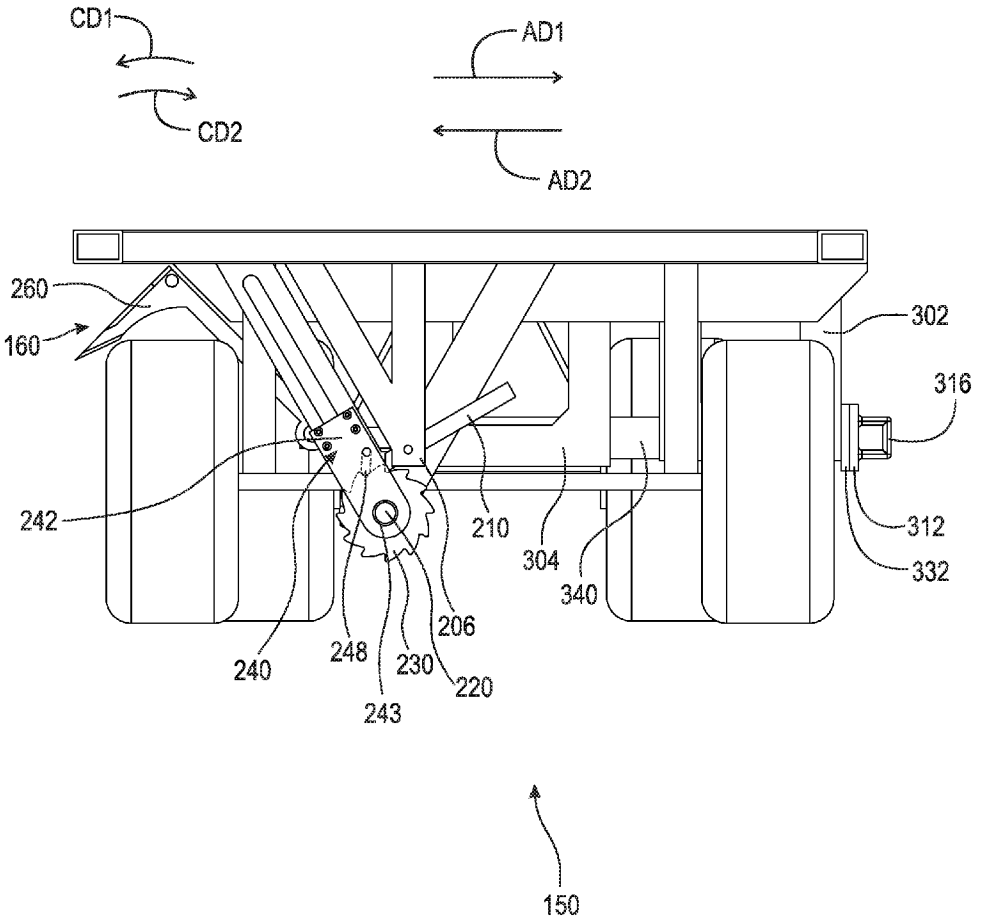
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Fig. 9

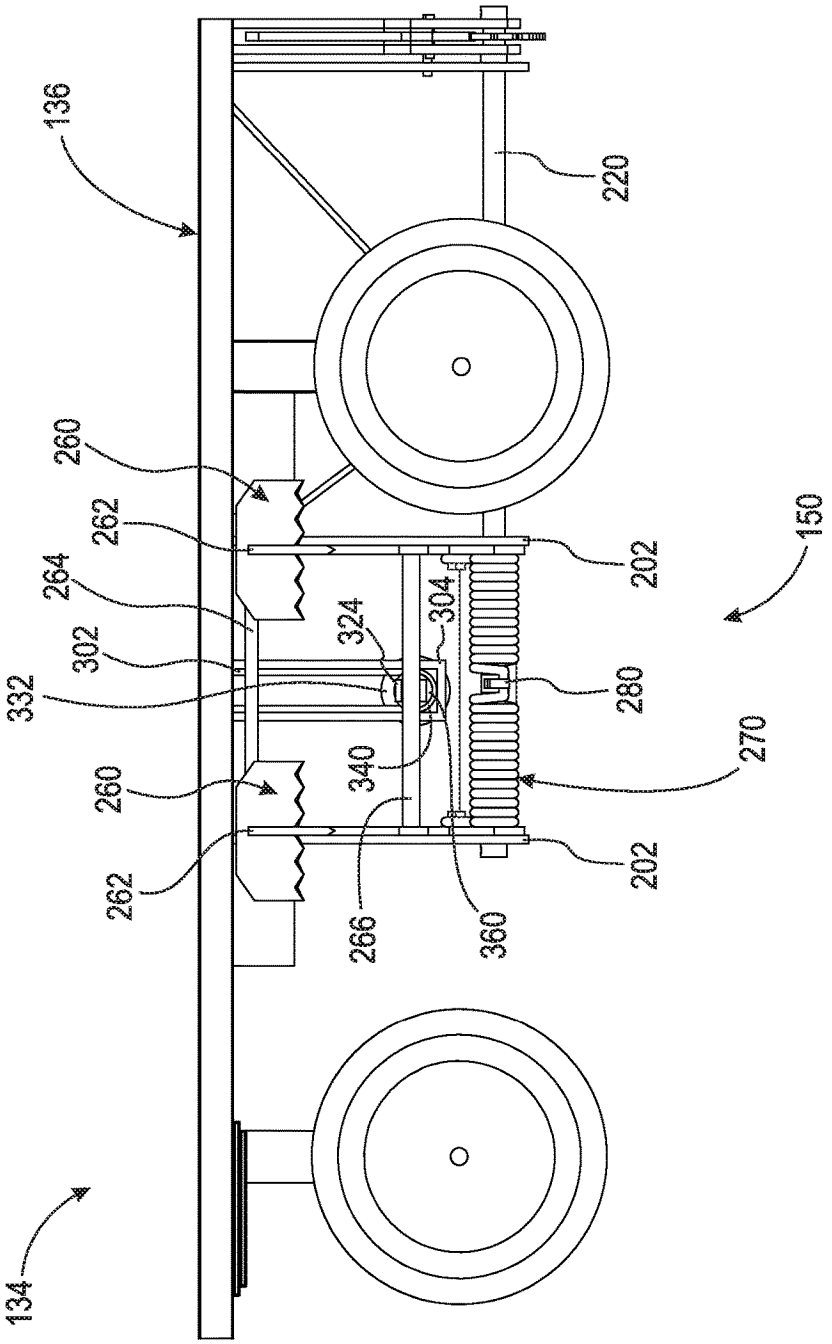
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Fig. 10

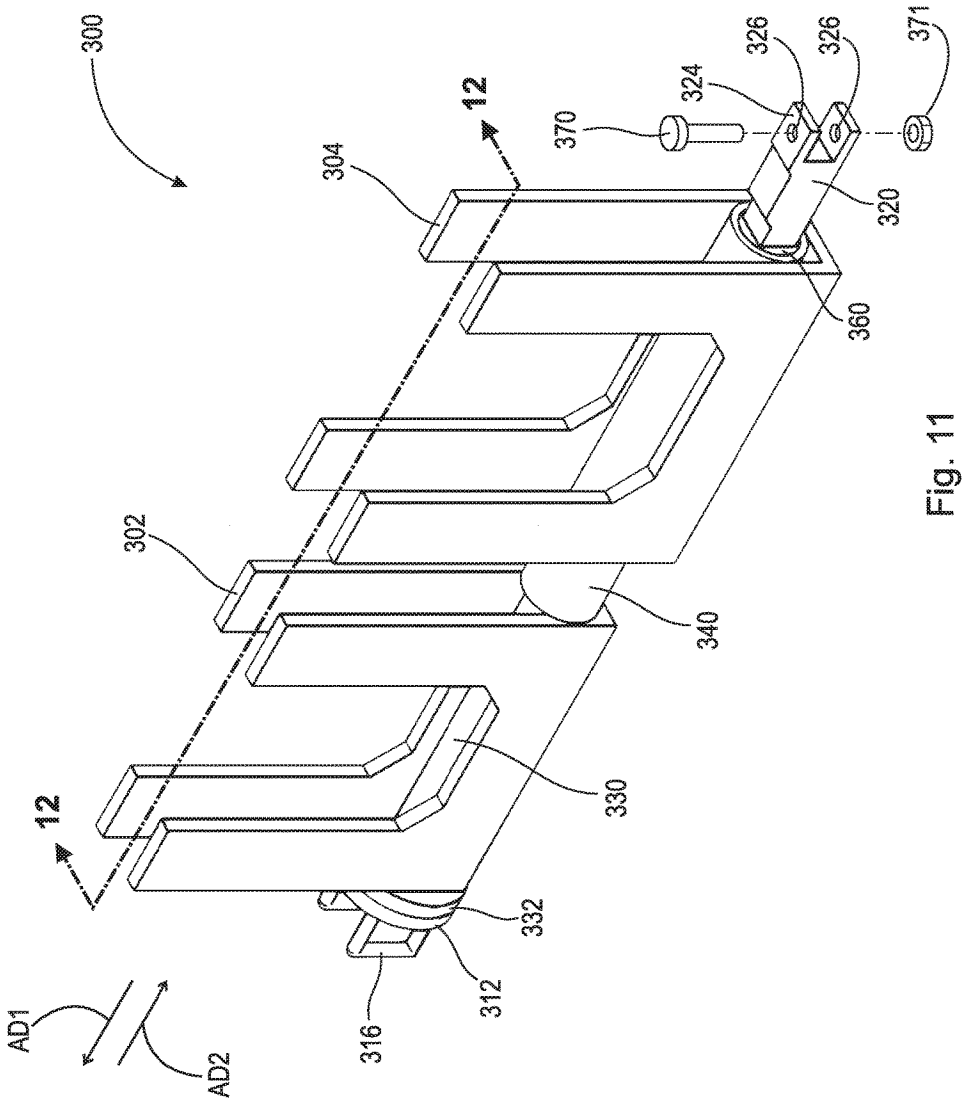
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Fig. 11

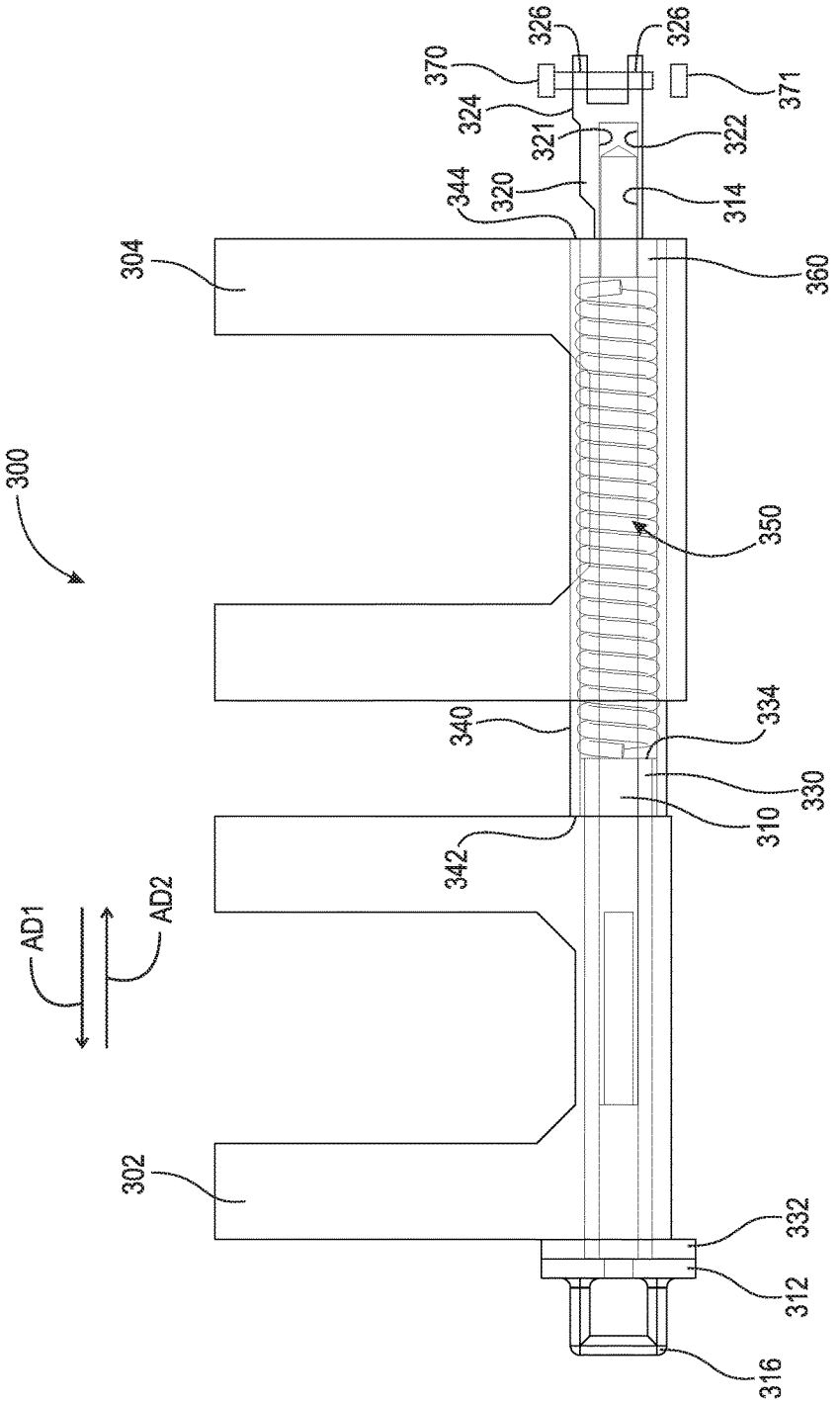
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Fig.12

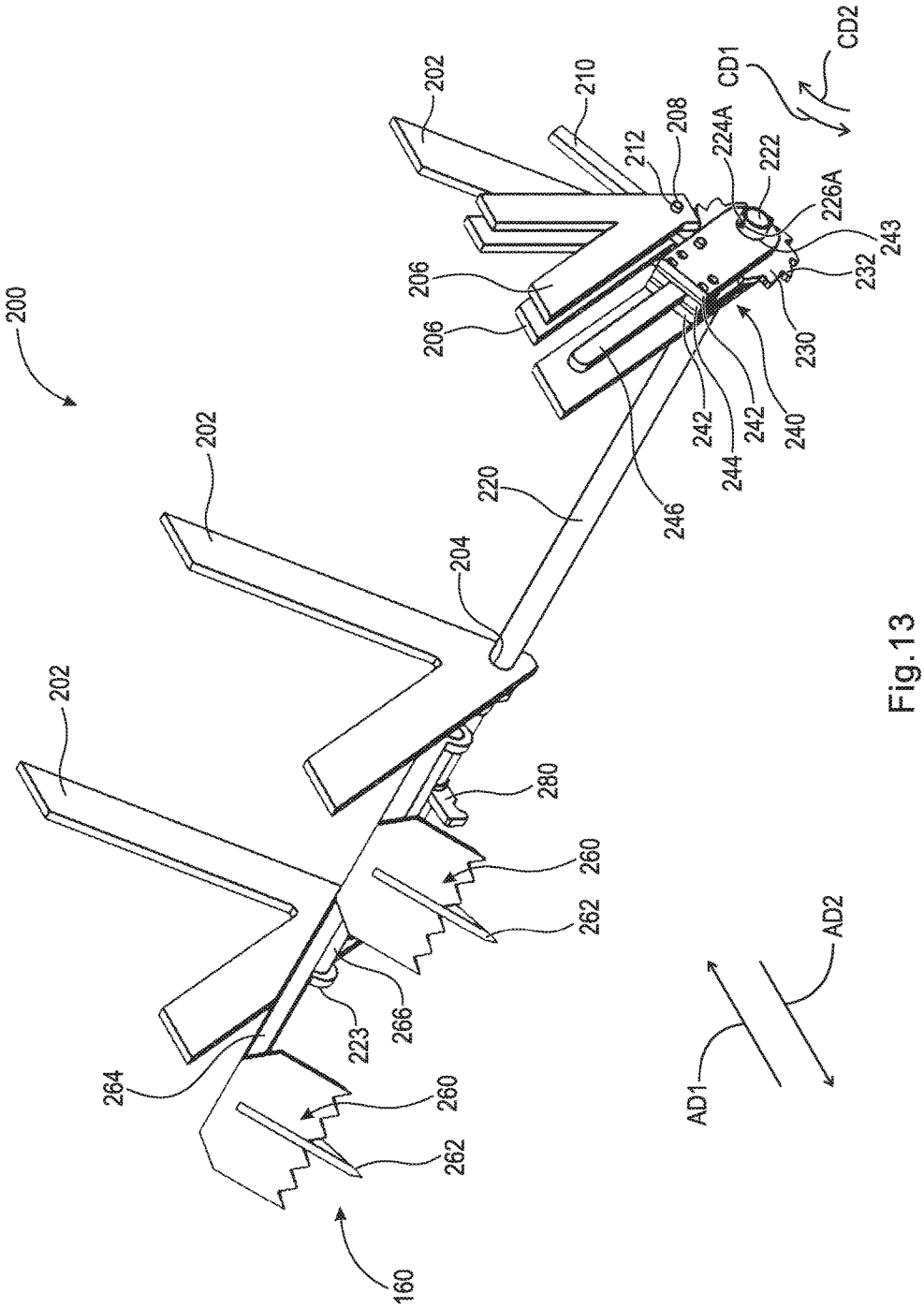
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Fig.13

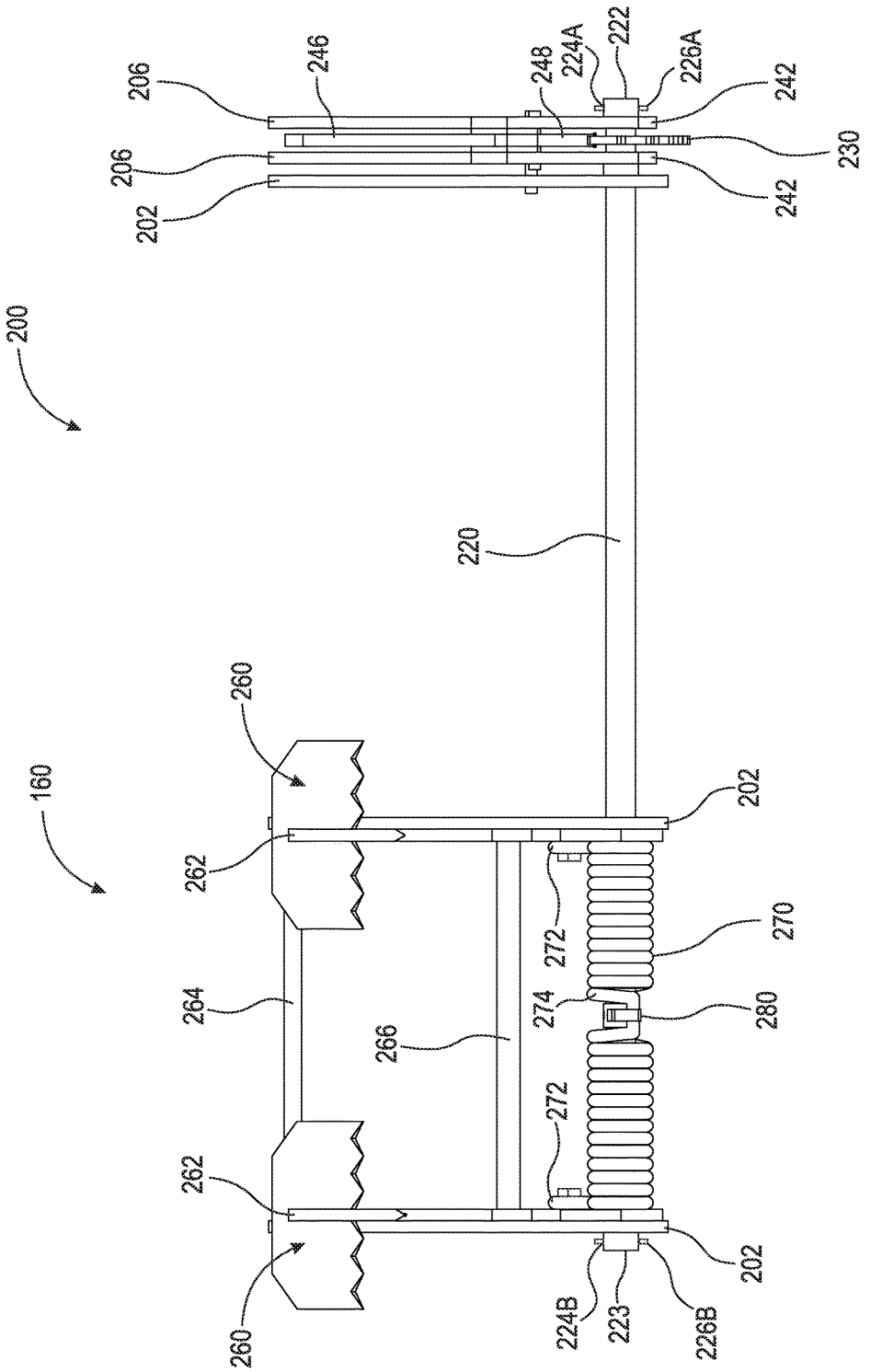
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Fig.14

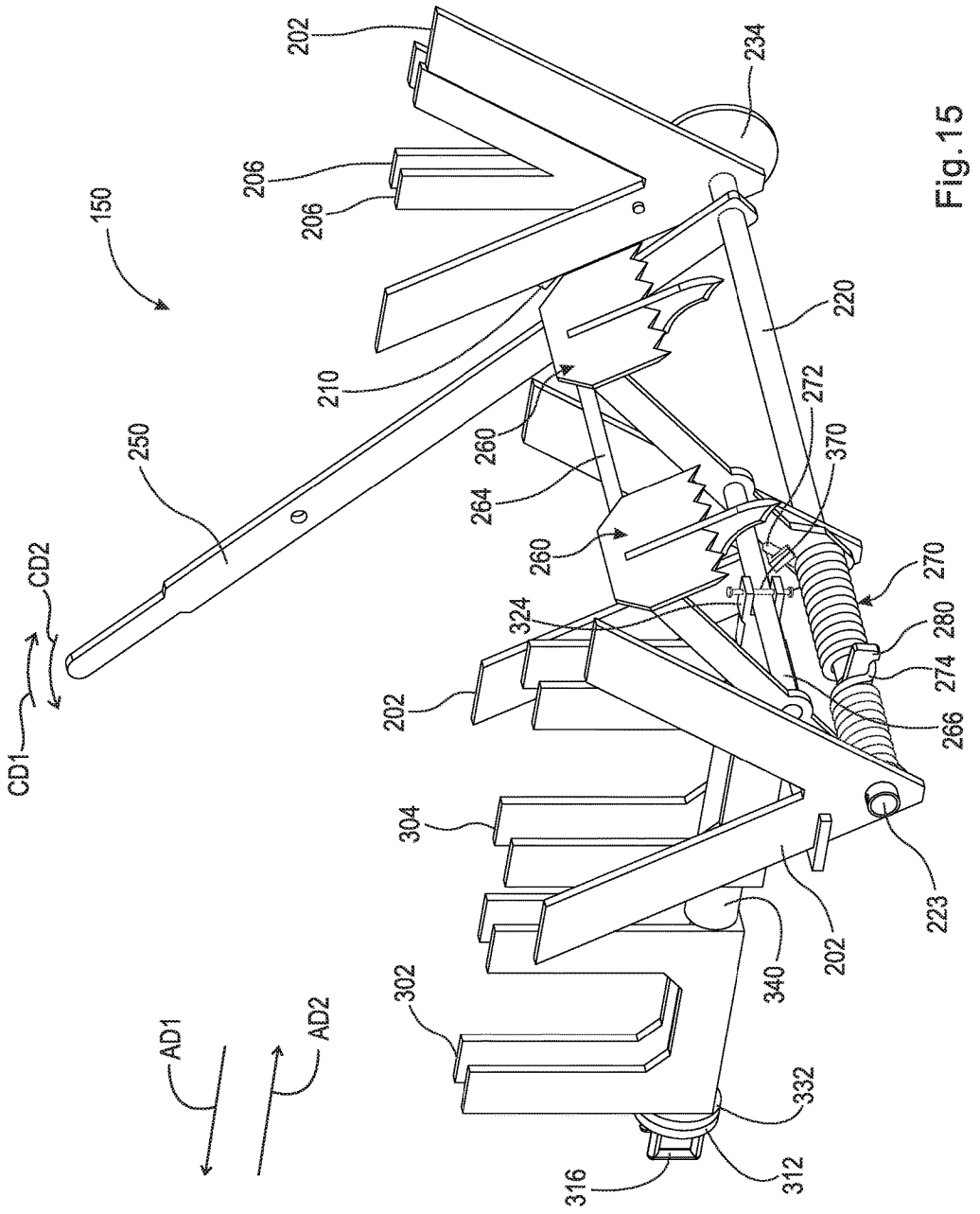
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Fig. 15

FALL ARREST APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 62/295,859, filed Feb. 16, 2016, which application is incorporated herein by reference.

FIELD

The invention broadly relates to a fall prevention device, more specifically to a fall prevention cart having an attached fall arrest system, and even more particularly to a fall prevention cart having an attached fall arrest system initiated by a falling object, e.g., a roofing construction worker, and actuated by an energy storage device, e.g., a torsion spring.

BACKGROUND

Fall prevention or fall arrest systems are known in the art. For example, one such system is disclosed in U.S. Pat. No. 8,240,431. This patent discloses a roofing worker safety device that delivers a resistive force in response to a worker falling from an elevated work surface such as a roof via a safety cable connecting the worker to the safety device. In this device, the cable transmitting the force of the falling worker to the device activates an arrestor arm that is forced into the surface on which the safety device is placed thereby stopping the fall of a worker from the roof. Although this device may prevent a worker from falling from an elevated height, the fall arrest system is dependent upon and in fact fully actuated by the weight of the falling worker. In other terms, the weight of the falling worker is solely responsible for the actuation of the arrestor arm. Various other means of arranging such fall arrest systems have been developed.

As can be derived from the variety of devices and methods directed at arresting the fall of an object from an elevated height, many means have been contemplated to accomplish the desired end, i.e., safety for the worker or object secured to the fall arrest system and safety for people and property below the area where workers or other objects may fall. Heretofore, tradeoffs between safety and cost were required. Thus, there is a long-felt need for a fall arrest system that is easy to operate, inexpensive to build and performs repeatably for the safety of all people and property on a work site.

SUMMARY

The present invention broadly comprises a fall arrest apparatus including a force damping subsystem having a damper, a brake release mechanism connected to the force damping subsystem and arranged to trigger when a force having a sufficient magnitude is transmitted to the brake release mechanism, and a brake mechanism including an energy storage device arranged to deploy at least one anchor when the brake release mechanism is triggered. The force is provided by a falling object to the force damping subsystem and the force damping subsystem is arranged to decelerate the falling object after the brake release mechanism is triggered.

The present invention also broadly comprises a method of arresting a fall of an object. The method including: a) transmitting a force via a connection between the object and a force damping subsystem; b) transmitting the force to a brake release mechanism via a connector arranged between the force damping subsystem and the brake release mechanism, the connector including a first side oppositely disposed relative to a second side; c) triggering the brake release mechanism via the force transmitted from the force damping subsystem; d) actuating a brake mechanism with an energy storage device; and, e) absorbing the force with the force damping subsystem.

Furthermore, the present invention broadly comprises a fall arrest apparatus including a force damping subsystem, a brake release mechanism, a connector and a brake mechanism. The force damping subsystem includes a damper, a first mounting bracket having a through bore and a first compression surface, and a first shaft slidingly disposed within the through bore of the first mounting bracket. The brake release mechanism is arranged to trigger when a force having a sufficient magnitude is transmitted to the brake release mechanism. The brake release mechanism includes a second mounting bracket, a second shaft having a first end opposite a second end, the second shaft slidingly disposed within the second mounting bracket, the second end including a through bore, a third mounting bracket having a through bore, a pawl including a first end opposite a second end, the first end having a through bore, a ratchet including a plurality of teeth engageable by the pawl, and a shear pin. The connector includes a first side oppositely disposed relative to a second side and fixedly connecting the force damping subsystem to the brake release mechanism. The brake mechanism is arranged to deploy at least one anchor when the brake release mechanism is triggered. The brake mechanism includes an energy storage device, at least one fourth mounting bracket, a fourth shaft disposed within the at least one fourth mounting bracket, and at least one anchor fixedly secured to the fourth shaft. The force is provided by a falling object to the force damping subsystem and the force damping subsystem is arranged to decelerate the falling object after the brake release mechanism is triggered. The damper includes a damper length, the first shaft is fixedly secured to the first side of the connector, the first side of the connector forming a second compression surface, the damper length is less than the distance between the first and second compression surfaces prior to triggering the brake release mechanism. The second shaft is fixedly secured to the second side of the connector, the through bore of the second shaft is in registered alignment with the through bore of the pawl, the shear pin is disposed within the through bore of the second shaft and the through bore of the pawl, and the brake release mechanism is triggered upon fracture of the shear pin. The energy storage device rotates the fourth shaft thereby deploying the at least one anchor.

Moreover, the present invention broadly comprises a force damping system including a bracket, a shaft and a damper. The bracket is fixedly secured to an object, and the bracket includes a first surface. The shaft is slidingly secured to the bracket. The shaft includes a first shaft end operatively arranged to connect to a falling object, and a second shaft end having a stop. The damper includes a first damper end abutting against the first surface, and a second damper end abutting against the stop.

These and other objects and advantages of the present invention will be readily appreciable from the following description of preferred embodiments of the invention and from the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The nature and mode of operation of the present invention will now be more fully described in the following detailed description of the invention taken with the accompanying drawing figures, in which:

FIG. **1** is a front top perspective view of a cart having an embodiment of a present fall arrest apparatus secured to the underside of the cart;

FIG. **2** is a top perspective view of an embodiment of a present fall arrest apparatus;

FIG. **3** is a side elevational view of an embodiment of a present fall arrest apparatus;

FIG. **4** is a partial top perspective view of an embodiment of a present fall arrest apparatus;

FIG. **5** is a side elevational view of an embodiment of a force damping subsystem used in a present fall arrest apparatus;

FIG. **6** is a top perspective view of an embodiment of a brake release mechanism used in a present fall arrest apparatus;

FIG. **7** is a side elevational view of an embodiment of a brake release mechanism used in a present fall arrest apparatus;

FIG. **8** is a rear top perspective view of a cart having an embodiment of a present fall arrest apparatus secured to the underside of the cart;

FIG. **9** is a rear elevational view of an embodiment of a present fall arrest apparatus;

FIG. **10** is a left side elevational view of an embodiment of a present fall arrest apparatus;

FIG. **11** is a top perspective view of an embodiment of a force damping subsystem used in a present fall arrest apparatus;

FIG. **12** is a cross-sectional view of the three damping subsystem shown in FIG. **11**, taken generally along line **12-12**;

FIG. **13** is a top perspective view of an embodiment of a brake release mechanism used in a present fall arrest apparatus;

FIG. **14** is a side elevational view of the brake release mechanism shown in FIG. **13**; and,

FIG. **15** is a top perspective view of an embodiment of a fall arrest apparatus showing a force damping subsystem engaged with a brake release mechanism with the cart removed for clarity.

DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements of the invention. While the present invention is described with respect to what is presently considered to be the preferred aspects, it is to be understood that the invention as claimed is not limited to the disclosed aspects.

Furthermore, it is understood that this invention is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the present invention, which is limited only by the appended claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the invention, the preferred methods, devices, and materials are now described.

It should be understood that use of "or" in the present application is with respect to a "non-exclusive" arrangement, unless stated otherwise. For example, when saying that "item x is A or B," it is understood that this can mean one of the following: (1) item x is only one or the other of A and B; (2) item x is both A and B. Alternately stated, the word "or" is not used to define an "exclusive or" arrangement. For example, an "exclusive or" arrangement for the statement "item x is A or B" would require that x can be only one of A and B. Furthermore, as used herein, "and/or" is intended to mean a grammatical conjunction used to indicate that one or more of the elements or conditions recited may be included or occur. For example, a device comprising a first element, a second element and/or a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element.

It should be appreciated that the term "substantially" is synonymous with terms such as "nearly," "very nearly," "about," "approximately," "around," "bordering on," "close to," "essentially," "in the neighborhood of" "in the vicinity of," etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby," "close," "adjacent," "neighboring," "immediate," "adjoining," etc., and such terms may be used interchangeably as appearing in the specification and claims. The term "approximately" is intended to mean values within ten percent of the specified value.

By "non-rotatably connected" elements, we mean that: the elements are connected so that whenever one of the elements rotate, all the elements rotate; and relative rotation between the elements is not possible. Radial and/or axial movement of non-rotatably connected elements with respect to each other is possible, but not required.

Adverting now to the figures, it should be appreciated that the figures depict various embodiments of the present fall arrest apparatus. The elevated work surface, e.g., roof, the falling object, e.g., a worker, a tool, a container filled with materials, etc., and a top surface on the cart to which a present fall arrest apparatus in secured are not shown in the figures. One of ordinary skill in the art will readily appreciate the type, form and arrangement of each of the foregoing structures and therefore depiction in the figures is unnecessary. For the purpose of clarity in the detailed description, these structures are not included in the figures; however, the structures are discussed herebelow.

The present invention broadly includes a fall arrest apparatus, e.g., fall arrest apparatus **50**. Apparatus **50** comprises force damping subsystem **52**, brake release mechanism **54** and brake mechanism **56**. Subsystem **52** comprises damper **58**. Brake release mechanism **54** is connected to force damping subsystem **52** and is arranged to trigger when a force having a sufficient magnitude is transmitted to brake release mechanism **54**. A more detailed description of a force having a sufficient magnitude is included infra. Brake mechanism **56** comprises energy storage device **60** arranged to deploy at least one anchor, e.g., anchors **62**, when brake release mechanism **54** is triggered. The force is provided by a falling object (not shown) to force damping subsystem **52**. Force damping subsystem **52** is arranged to decelerate the falling object after brake release mechanism **54** is triggered.

In some embodiments, fall arrest apparatus **50** comprises connector **64**. In some embodiments, connector **64** comprises first side **66** oppositely disposed relative to second

side **68**. As can be seen in the figures, connector **64**, in some embodiments, is arranged between force damping subsystem **52** and brake release mechanism **54**. It should be appreciated that although in the embodiments depicted in the figures, connector **64** is included as a separate element, in other embodiments, shaft **70** of force damping subsystem **52** and shaft **72** brake release mechanism **54** may be integrally formed, i.e., a continuous piece of material, and the features of connector **64**, e.g., compression surface **74**, are included in the collective integral shaft. In some embodiments, connector **64** comprises first partial through bore **76** arranged in first side **66** and first shaft **70** is fixedly secured to first side **66** of connector **64** in first bore **76**. In some embodiments, connector **64** comprises second partial through bore **78** arranged in second side **68** and second shaft **72** is fixedly secured to second side **68** of connector **64** in second bore **78**. In some embodiments, connector **64** comprises first partial through bore **76** arranged in first side **66** and second partial through bore **78** arranged in second side **68**. In these embodiments, first shaft **70** is fixedly secured to first side **66** of connector **64** in first bore **76** and second shaft **72** is fixedly secured to second side **68** of connector **64** in second bore **78**.

In some embodiments, force damping subsystem **52** comprises first mounting bracket **80** and first shall **70**. First mounting bracket **80** comprises through bore **82** and first compression surface **84**. First shaft **70** is slidingly disposed within through bore **82** of first mounting bracket **80**. Damper **58** comprises damper length **86**, first shaft **70** is fixedly secured to first side **66** of connector **64**, and first side **66** of connector **64** forms second compression surface **74**. Damper length **86** is less than the distance between first and second compression surfaces **84** and **74**, respectively, i.e., length **88**, prior to triggering brake release mechanism **54**. Thus, prior to triggering brake release mechanism **54**, e.g., by fracturing shear pin **90**, first end **92** of damper **58** contacts first compression surface **84** and gap **94** is present between second end **96** of damper **58** and second compression surface **74**. After triggering brake release mechanism **54**, i.e., after an object begins to fall and shear pin **90** has fractured, second compression surface **74** contacts second end **96** of damper **58** and begins to compress damper **58** between first and second compression surface **84** and **74**, respectively. The compression of damper **58** assists with deceleration of the falling object.

In some embodiments, brake release mechanism **54** comprises second mounting bracket **98**, second shaft **72**, third mounting bracket **100**, pawl **102**, ratchet **104** and shear pin **90**. Second shaft **72** comprises first end **106** opposite second end **108**. Second shaft **72** is slidingly disposed within second mounting bracket **98** and second end **108** comprises through bore **110**. Third mounting bracket **100** comprises through bore **112**. Pawl **102** comprises first end **114** opposite second end **116** and first end **114** comprises through bore **118**. Pawl **102** is pivotably secured to third mounting bracket **100** at through bore **112**. Ratchet **104** comprises a plurality of teeth engageable by pawl **102**, e.g., teeth **120**. Second shaft **72** is fixedly secured to second side **68** of connector **64**. Through bore **110** of second shaft **72** is in registered alignment with through bore **118** of pawl **102**. Shear pin **90** is disposed within through bore **110** of second shaft **72** and through bore **118** of pawl **102**. Brake release mechanism **54** is triggered upon fracture of shear pin **90**. As used herein, a "force having sufficient magnitude" is intended to mean a force sufficient to fracture shear pin **90**. It should be appreciated that various embodiments of apparatus **50** may have different force values, i.e., different shear pins requiring different fracture forces.

In some embodiments, brake mechanism **56** comprises fourth mounting brackets **122**, fourth shaft **124** and anchors **62**. It should be appreciated that one or more brackets **122** may be included, and in embodiments having only a single bracket **122**, the positioning of bracket **122** must permit the free rotation of fourth shaft **124**, e.g., a single bracket **122** may be positioned approximately at the middle of the length of shaft **124**. Fourth shaft **124** is rotatably disposed within fourth mounting bracket **122**. Anchors **62** are fixedly secured to fourth shaft **124**. Anchors **62** may include a variety of features designed to maximize the holding force of anchors **62** relative to the work surface. For example, anchors **62** may include chisel tips **126** as depicted in the accompanying figures. Energy storage device **60** rotates fourth shaft **124** thereby deploying anchors **62**. In other terms, upon the triggering of brake release mechanism **54**, energy storage device **60** causes shaft **124** to rotate in a direction that drives anchors **62** into a work surface, e.g., a roof. In some embodiments, energy storage device **60** is one or more torsion springs, e.g., springs **128**. It should be appreciated that prior to use, energy storage device **60** must be tensioned such that upon the triggering of brake release mechanism **54**, energy storage device **60** drives anchors **62** downwardly and into the work surface. The foregoing tensioning of energy storage device **60** may be accomplished by a variety of means, e.g., a hand crank installed at an end or at any point along the length of shaft **124**.

In some embodiments, the falling object (not shown) is connected to force damping subsystem **52** by a line (e.g., a rope, a cable, a harness, a belt, or a tether). Such connection is made at a first end to the falling object and at the second end to fitting **130** positioned at end **132** of shaft **70**.

In view of the foregoing, it should be appreciated that the present disclosure further includes a method of arresting a fall of an object. The method comprises: a) transmitting a force via a connection between the object and force damping subsystem **52**, e.g., a rope, a cable, a harness, a belt or a tether; b) transmitting the force to brake release mechanism **54** via connector **64** arranged between force damping subsystem **52** and brake release mechanism **54**, wherein connector **64** comprises first side **66** oppositely disposed relative to second side **68**; c) triggering brake release mechanism **54** via the force transmitted from force damping subsystem **52**; d) actuating brake mechanism **56** with energy storage device **60**; and, e) absorbing the force with three damping subsystem **52**. In some embodiments, the step of triggering brake release mechanism **54** occurs upon fracture of shear pin **90**.

In other terms, present fall arrest system **50** may function as follows. An object falls from a work surface such as a roof. The object is secured to fall arrest system **50** by a connection such as a harness and/or a rope at first end **132** of shaft **70** in force damping subsystem **52**. Shear pin **90** fractures thereby permitting pawl **102** to rotate within through bore **112** and out of locking engagement with ratchet **104**. As ratchet **104** is no longer prevented from rotating and is fixedly secured to shaft **124**, shaft **124** is rotated by energy storage device **60**. Rotation of shaft **124** in turn causes the deployment of anchors **62** into the work surface. Subsequently, second compression surface **74** contacts second end **96** of damper **58** and begins to compress damper **58** between first and second compression surfaces **84** and **74**, respectively. The compression of damper **58** acts to reduce the forces acting on the falling object, i.e., damper **58** decelerates the falling object.

The present fall arrest apparatus may be installed on a variety of larger devices. For example, in some embodiments, fall arrest apparatus **50** may be installed on the

underside of cart **134**. It should be appreciated that for clarity, the top surface of cart **134** has been removed from the figures. Typical top surfaces or top plates may be formed from a thick segment of sheet metal and may comprise significant mass, e.g., six hundred pounds (600 lbs.) or more. Mounting brackets **80**, **98**, **100** and **122** may be secured to frame **136** anchor the top plate of cart **134**. Moreover, the cart may include a counter weight positioned above or nearly above anchors **62** to ensure that the downward force of anchors **62** during deployment does not cause undesirable movement of cart **134**, e.g., upward or lateral movement. Additionally, the inclusion of counterweights further ensures that sufficient weight will be present in and on cart **134** in order to arrest the momentum of the falling object, e.g., a worker, a tool, a container of materials, etc.

The following description should be viewed in light of FIGS. **8-15**. FIG. **8** is a rear top perspective view of cart **134** having an embodiment of fall arrest apparatus **150** secured to the underside of cart **134**. Fall arrest apparatus **150** is mounted to frame **136** and generally comprises brake mechanism **160**, brake release mechanism **200** and force damping subsystem **300**.

FIG. **9** is a rear elevational view of fall arrest apparatus **150**. Handle assembly **240** is rotatably secured on first shaft **220** and comprises handle **246**, outer brackets **242** which include through bores **243**, inner bracket **244**, ratchet **230** and pawl **248**. Inner bracket **244**, ratchet **230** and pawl **248** are secured to, and between, outer brackets **242**. Handle **246** is secured to inner bracket **244**. Handle assembly **240** operatively engages ratchet **230** with pawl **248**. Handle assembly **240** is arranged as a ratchet system to non-rotatably connect to ratchet **230** in circumferential direction CD**1** (i.e., pawl **248** engages teeth **232**), and to rotate with respect to ratchet **230** in circumferential direction CD**2**, opposite circumferential direction CD**1** (i.e., pawl **248** disengages teeth **232**, or in other terms, pawl **248** is permitted to freely pass over teeth **232**). Handle assembly **240** is displaced in first circumferential direction CD**1** to load energy storage device or torsion spring **270**, and can be done repeatedly to load the required amount of force into torsion spring **270**. The ratchet and pawl function of handle assembly **240** and ratchet **230** is well known to those having ordinary skill in the art.

FIG. **10** is a left side elevational view of fall arrest apparatus **150**. Fall arrest apparatus **150** is generally secured to frame **136** of cart **134** via third mounting brackets **202**. As shown, fork portion **324** is engaged with support bar **266**. Shear pin **370** has been removed in FIG. **10** to better show the other components of fall arrest apparatus **150**. Second tube **340** is secured to second mounting bracket **304**. Bushing **360** is arranged within second tube **340**. Flange **332** abuts against first mounting bracket **302**. Anchors **260** comprise chisel tips **262** and are connected via support bars **264** and **266**. Torsion spring **270** is arranged around first shaft **220** and axially between anchors **260**. Hook **280**, which is fixedly secured to shaft **220**, engages torsion spring **270**. It should be appreciated that torsion spring **270** may be a single torsion spring or a double torsion spring as required by the arrangement of the system, e.g., a single torsion spring may be used for a system having a single anchor.

FIG. **11** is a top perspective view of force damping subsystem **300** used in fall arrest apparatus **150**. FIG. **12** is a cross-sectional view of force damping subsystem **300**, taken generally along line **12-12** in FIG. **11**. Force damping subsystem **300** comprises first mounting bracket **302**, second mounting bracket **304**, second shaft **310**, third shaft **320**, first tube **330**, second tube **340**, bushing **360**, and shear pin **370**. First tube **330** is secured to first mounting bracket **302**. First tube **330** comprises flange **332** and end **334**. Second tube **340** is secured to second mounting bracket **304**. Second tube **340** comprises end **342** and end **344**. End **342** abuts against, and may be secured to, first mounting bracket **302** as shown in FIGS. **11** and **12**. Second shaft **310** is arranged in first tube **330** and second tube **340**. Second shaft **310** comprises flange **312**, which abuts against flange **332**, and outer threads **314**. Fitting **316** is secured to flange **312**. Third shaft **320** comprises a radially inward facing surface **321** having inner threads **322**, fork portion **324**, and through bores **326**. Third shaft **320** is secured to second shaft **310** via inner threads **322** and outer threads **314**. Fork portion **324** engages support bar **266** and secured there around via shear pin **370**. Shear pin **370** engages the two fork arms of fork portion **324** via through bores **326**. Shear pin **370** may optionally be secured to fork portion **324** with securing device **371**. Securing device **371** may be a nut, cotter pin, clamp, or any other suitable device for securing shear pin **370** in fork portion **324**. Bushing **360** is arranged around second shaft **310** and within second tube **340**. Third shaft **320** abuts against bushing **360**. Damper **350** is arranged around second shaft **310** and within second tube **340**. Damper **350** is a compression spring that abuts against end **334** at a first end and bushing **360** at a second end. However, it should be appreciated that damper **350** may be any suitable means for damping a linear force, e.g., a resilient polymer such as rubber or the like, a leaf spring, a shock absorber (gas, oil or air charged), a stitched nylon tether, a stretchable cable, a tension spring, etc., and such variations fall within the scope of the claims below. In some embodiments, the falling object (not shown) is connected to force damping subsystem **300** by a line, for example, a rope, cable, harness, belt, or tether. Such connection is made at a first end to the falling object (e.g., a person) and at the second end to fitting **316**. In the event of a fall, fitting **316** is pulled in axial direction AD**1**. When there is enough force to break shear pin **270**, brake release mechanism **200** is activated. In such an event, second shaft **310** pulls third shaft **320**, and thus bushing **360**, in axial direction AD**1** and damper **350** is compressed to help soften the impact on the falling object, i.e., damper **350** imparts a force on bushing **360** in axial direction AD**2**.

FIG. **13** is a top perspective view of brake release mechanism **200** used in fall arrest apparatus **150**. FIG. **14** is a side elevational view of brake release mechanism **200**. Brake release mechanism **200** comprises third mounting brackets **202** having through bores **204**, fourth mounting brackets **206** having through bores **208**, pawl **210**, ratchet **230**, handle assembly **240**, first shaft **220**, anchors **260**, torsion spring **270**, and support bars **264** and **266**. Torsion spring **270** is removed in FIG. **13** to better show other features of brake release mechanism **200**. First shaft **220** is secured to frame **136** via third mounting brackets **202**. First shaft **220** is rotatable within through bores **204** of third mounting brackets **202**. First shaft **220** is secured in an axial direction using any suitable method known in the art. In an example embodiment, first shaft **220** comprises through bore **224**A at first end **222** and through bore **224**B at second end **223**. Pins **226**A and **226**B engaged through bores **224**A and **224**B to secure first shaft **220** in an axial direction. Pawl **210** is secured to frame **136** via fourth mounting brackets **206**. Pawl **210** is rotatably connected to fourth mounting brackets **206** via pin **212**, which engages through bores **208**. Pawl **210** is operatively arranged to engage teeth **232** such that, when engaged, it allows ratchet **230** to move in circumferential direction CD**1** but prevents ratchet **230** from moving in circumferential direction CD**2**. Pawl **210** can be disengaged

from teeth **232** to allow ratchet to move in circumferential direction CD**2**. Pawl **210** is used to rotationally secure ratchet **230** while handle assembly is rotated in circumferential direction CD**2**. Teeth **232** are arranged completely around ratchet **230**. In some embodiments, teeth **232** are arranged only partially around ratchet **230**. Hook **280** is non-rotatably secured to first shaft **220** and arranged axially between anchors **260**. Hook **280** may be secured to first shaft **220** by any suitable method, for example, a bolt or pin, or a weld. Torsion spring **270** is arranged around first shaft **220**. Torsion spring **270** comprises ends **272** and middle loop **274**. Ends **272** are secured to anchors **260** and middle loop is secured to hook **280**. Anchors are rotatably secured to first shaft **220**. Anchors **260** are secured together via support bars **264** and **266**. Fork portion **324** engages support bar **266** and is secured there around via shear pin **270** (see discussion of FIG. **15** below). Anchors **260** may further comprise chisel tips **262**. Anchors **260** and chisel tips **262** are designed to engage and/or pierce the surface of the roof on which cart **134** rests to provide added fall security.

FIG. **15** is a top perspective view of an embodiment of fall arrest apparatus **150** showing force damping subsystem **300** engaged with brake release mechanism **200**. As shown, anchors **260** are set in an elevated position and fork portion **324** is engaged with support bar **266**. Shear pin **370** is then secured in fork portion **324**. Torsion spring **270** is arranged around first shaft **220** axially between anchors **260**. Ends **272** are secured to anchors **260**. It should be appreciated that although torsion spring **270** is depicted as being secured to anchors **260** via tab like structures, ends **272** of spring **270** may be secured to anchors **260** by any means known in the art, e.g., by positioning ends **272** above support bar **266**, by welding ends **272** to anchors **260**, etc. Hook **280** engages middle loop **274**. FIG. **15** shows ratchet **234**. Ratchet **234** comprises teeth **236** (not shown). Teeth **236** are arranged only partially around ratchet **234**. In some embodiments, teeth **236** are arranged completely around ratchet **234**, while in some embodiments teeth **236** are arranged partially around ratchet **234**, e.g., about one quarter of the circumference. Handle **250** is non-rotatably connected to first shaft **220**. FIG. **15** shows handle **250** in a first position, at which fall arrest apparatus **150** is not loaded. To load fall arrest apparatus **150**, handle **250** is displaced in circumferential direction CD**1** to a second position (i.e., a loaded position), at which sufficient force is loaded into torsion spring **270**. By sufficient force, it is meant that when shear pin **370** breaks and fork portion **324** disengages support bar **266**, torsion spring **270** causes anchors **260** to rotate in circumferential direction CD**1** with enough force to engage and/or pierce the surface of the roof on which cart **134** rests to provided added fall security.

Thus, it is seen that the objects of the present invention are efficiently obtained, although modifications and changes to the invention should be readily apparent to those having ordinary skill in the art, which modifications are intended to be within the spirit and scope of the invention as claimed. It also is understood that the foregoing description is illustrative of the present invention and should not be considered as limiting. Therefore, other embodiments of the present invention are possible without departing from the spirit and scope of the present invention.

What is claimed is:

1. A fall arrest apparatus configured to be used on a surface, the fall arrest apparatus comprising: a force damping subsystem comprising a damper;

a brake release mechanism connected to the force damping subsystem and arranged to trigger when a force having a sufficient magnitude is transmitted to the brake release mechanism; and,

a brake mechanism comprising an energy storage device arranged to deploy at least one anchor when the brake release mechanism is triggered, wherein said anchor is configured to engage said surface when said anchor is deployed and wherein said anchor does not contact the surface prior to deployment,

wherein the force is provided by a falling object attached to the force damping subsystem and the force damping subsystem is arranged to decelerate the falling object after the brake release mechanism is triggered.

2. The fall arrest apparatus of claim **1** further comprising:

a connector comprising a first side oppositely disposed relative to a second side and arranged between the force damping subsystem and the brake release mechanism.

3. The fall arrest apparatus of claim **2** wherein the force damping subsystem comprises:

a first mounting bracket comprising a through bore and a first compression surface; and,

a first shaft slidingly disposed within the through bore of the first mounting bracket,

wherein the damper comprises a damper length, the first shaft is fixedly secured to the first side of the connector, the first side of the connector forming a second compression surface, the damper length is less than the distance between the first and second compression surfaces prior to triggering the brake release mechanism.

4. The fall arrest apparatus of claim **3** wherein the connector comprises a first partial through bore arranged in the first side and the first shaft is fixedly secured to the first side of the connector in the first partial through bore.

5. The fall arrest apparatus of claim **2** wherein the brake release mechanism comprises:

a second mounting bracket;

a second shaft comprising a first end opposite a second end, the second shaft slidingly disposed within the second mounting bracket, the second end comprising a through bore;

a third mounting bracket comprising a through bore;

a pawl comprising a first end opposite a second end, the first end comprises a through bore;

a ratchet comprising a plurality of teeth engageable by the pawl; and,

a shear pin,

wherein the second shaft is fixedly secured to the second side of the connector, the through bore of the second shaft is in registered alignment with the through bore of the pawl, the shear pin is disposed within the through bore of the second shaft and the through bore of the pawl, and the brake release mechanism is triggered upon fracture of the shear pin.

6. The fall arrest apparatus of claim **5** wherein the connector comprises a second partial through bore arranged in the second side and the second shaft is fixedly secured to the second side of the connector in the second partial through bore.

7. The fall arrest apparatus of claim **1** wherein the force damping subsystem comprises:

a bracket fixedly secured to an object, the bracket comprising a first surface;

a shaft slidingly secured to the bracket, the shaft comprising:

a first shaft end operatively arranged to connect to the falling object; and,

a second shaft end having a stop; and,

the damper comprising:

a first damper end abutting against the first surface; and,

a second damper end abutting against the stop.

8. The fall arrest apparatus of claim **7** wherein the damper is operatively arranged around the shaft.

9. The fall arrest apparatus of claim **7** wherein the brake release mechanism comprises:

a fork portion fixedly secured to the second shaft end and comprising first and second fork arms, the first fork arm comprising a first fork arm through bore and the second fork arm comprising a second fork arm through bore, the first and second fork arm through bores in alignment; and,

a shear pin disposed within the first and second fork arm through bores,

wherein the first and second fork arms capture a portion of the energy storage device and the shear pin, in part, maintains the portion of the energy storage device within the fork portion.

10. The fall arrest apparatus of claim **1** wherein the brake mechanism comprises:

at least one fourth mounting bracket;

a fourth shaft disposed within the at least one fourth mounting bracket; and,

at least one anchor fixedly secured to the fourth shaft,

wherein the energy storage device rotates the fourth shaft thereby deploying the at least one anchor.

11. The fall arrest apparatus of claim **1** wherein the energy storage device comprises a torsion spring.

12. The fall arrest apparatus of claim **1** wherein the falling object is connected to the force damping subsystem by a rope, a cable or a tether.

13. The fall arrest apparatus of claim **1** wherein the falling object is connected to the force damping subsystem by a harness or a belt.

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