1-30-2017

Wire neutralization system

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US009557146B2

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

(10) **Patent No.: US 9,557,146 B2**
(45) **Date of Patent: Jan. 31, 2017**

(54) **WIRE NEUTRALIZATION SYSTEM**

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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 199 days.

(21) Appl. No.: **14/302,170**

(22) Filed: **Jun. 11, 2014**

(65) **Prior Publication Data**

US 2015/0362295 A1 Dec. 17, 2015

(51) **Int. Cl.**
F41H 11/24 (2011.01)
F41H 11/30 (2011.01)

(52) **U.S. Cl.**
CPC ***F41H 11/30*** (2013.01); ***F41H 11/24*** (2013.01)

(58) **Field of Classification Search**
CPC F41H 5/0471; F41H 5/04; F41H 5/0414; F41H 5/0428; F41H 5/0442; F41H 5/0457; F41H 5/0478; A01B 13/08; A01B 15/025; A01B 43/00; A01B 39/18; E02F 5/32; E02F 5/102; E02F 9/2875
USPC 89/1.13; 102/402, 403; 172/699, 701; 171/22, 62, 64, 70
See application file for complete search history.

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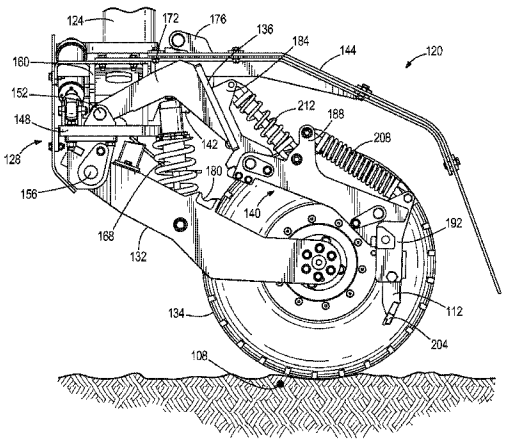
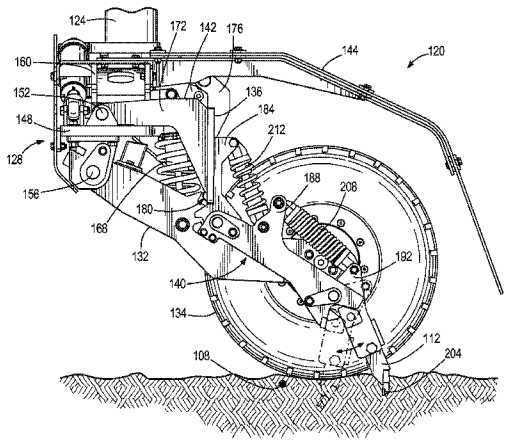
(74) *Attorney, Agent, or Firm* — Michael Best & Friedrich LLP

(57) **ABSTRACT**

A wire neutralizing system for use with a vehicle including a frame adapted to be hitched to a vehicle. At least one wheel supports the frame while a bottom of the wheel rolls over terrain having buried wires. The system also includes a blade movable between a stowed position in which the blade is above the bottom of the wheel and a deployed position in which the blade is below the bottom of the wheel, such that the blade plows through the terrain to disable buried wires when in the deployed position.

10 Claims, 10 Drawing Sheets





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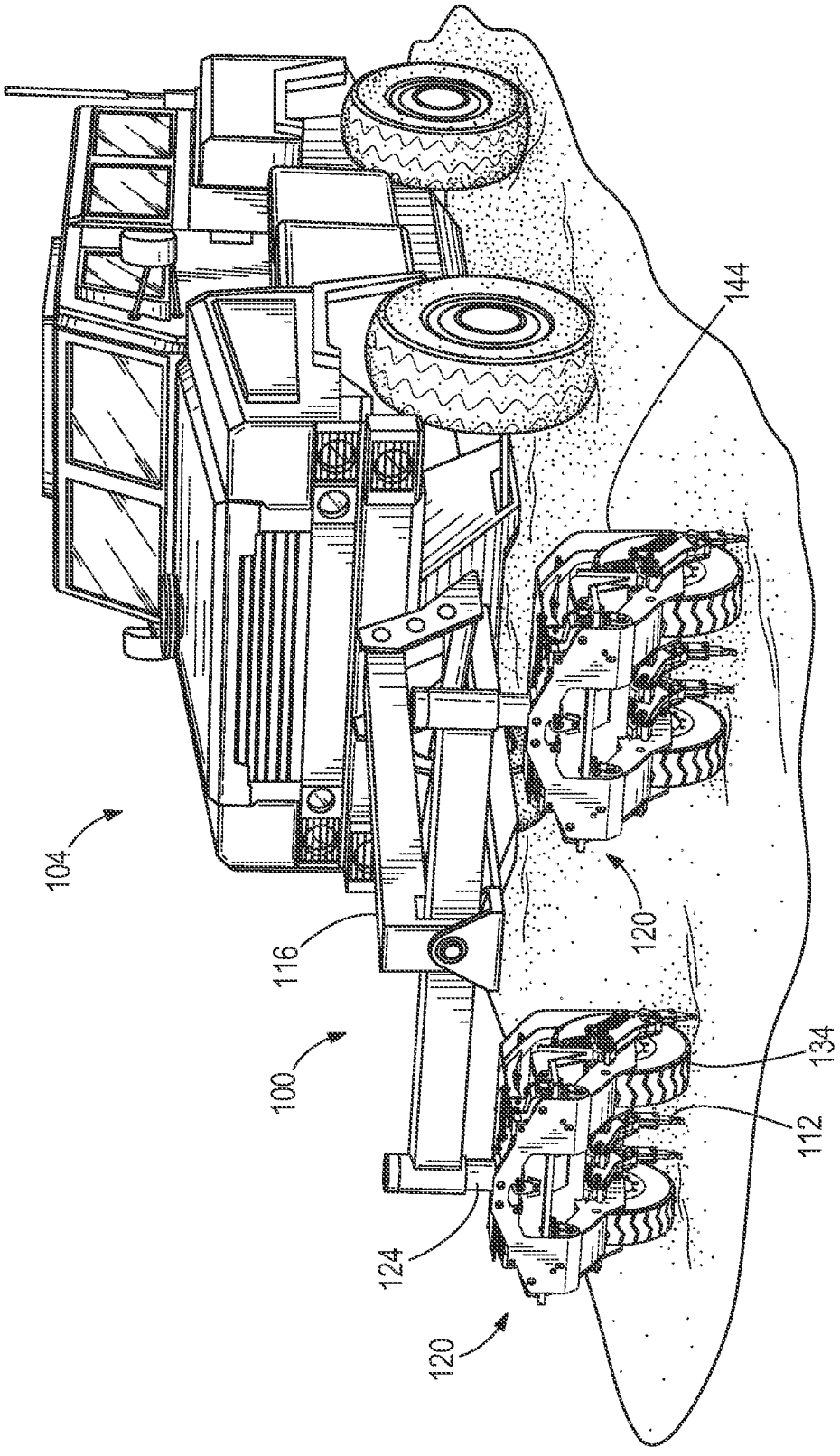
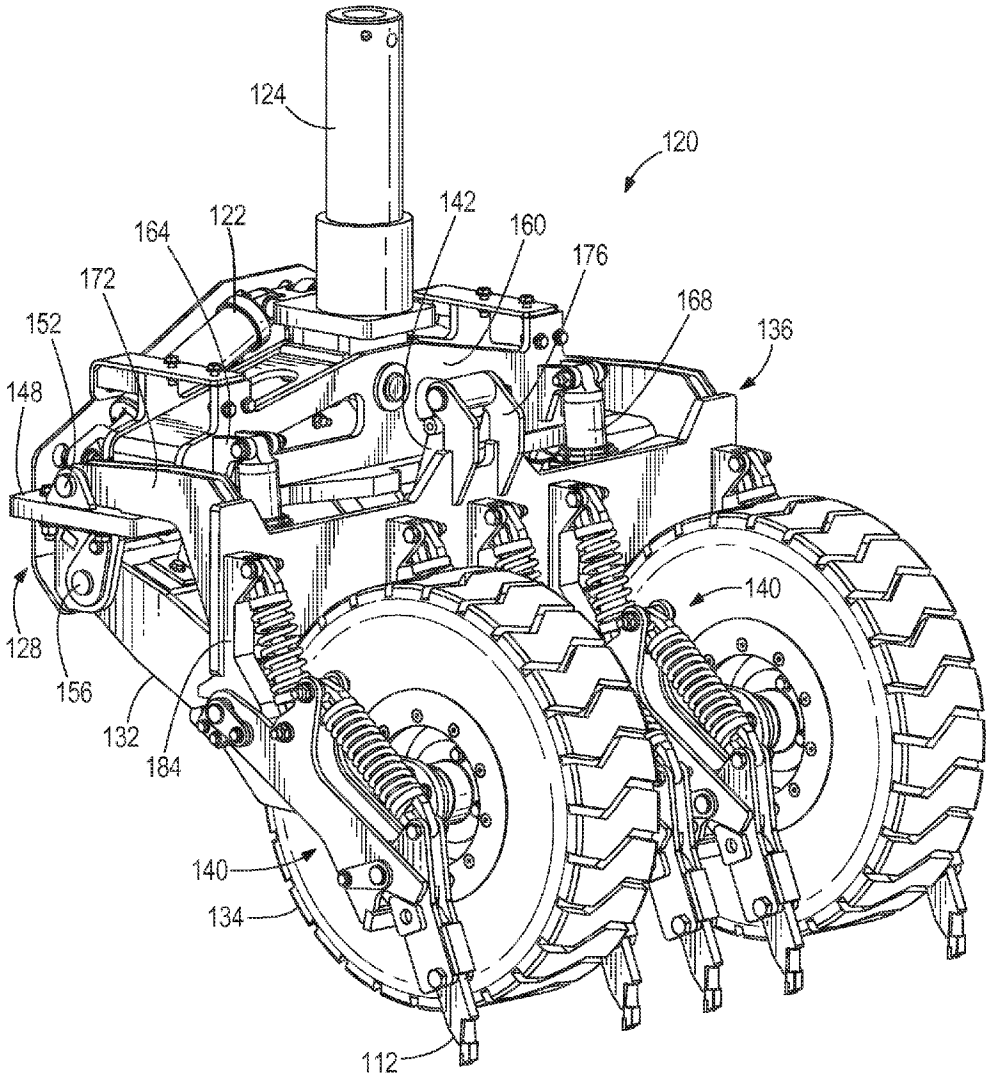


FIG. 1


124
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142
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112

FIG. 2

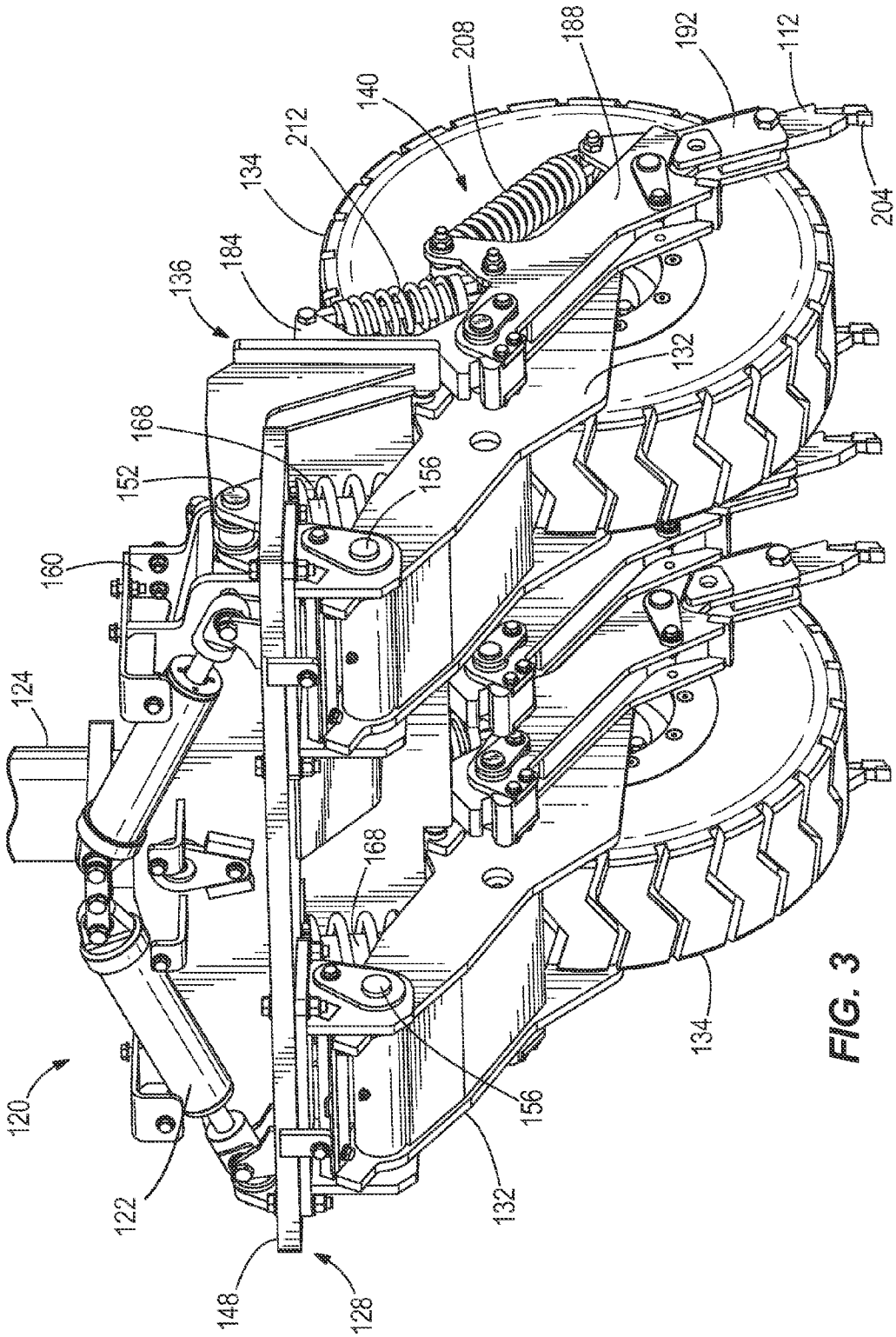
208
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FIG. 3

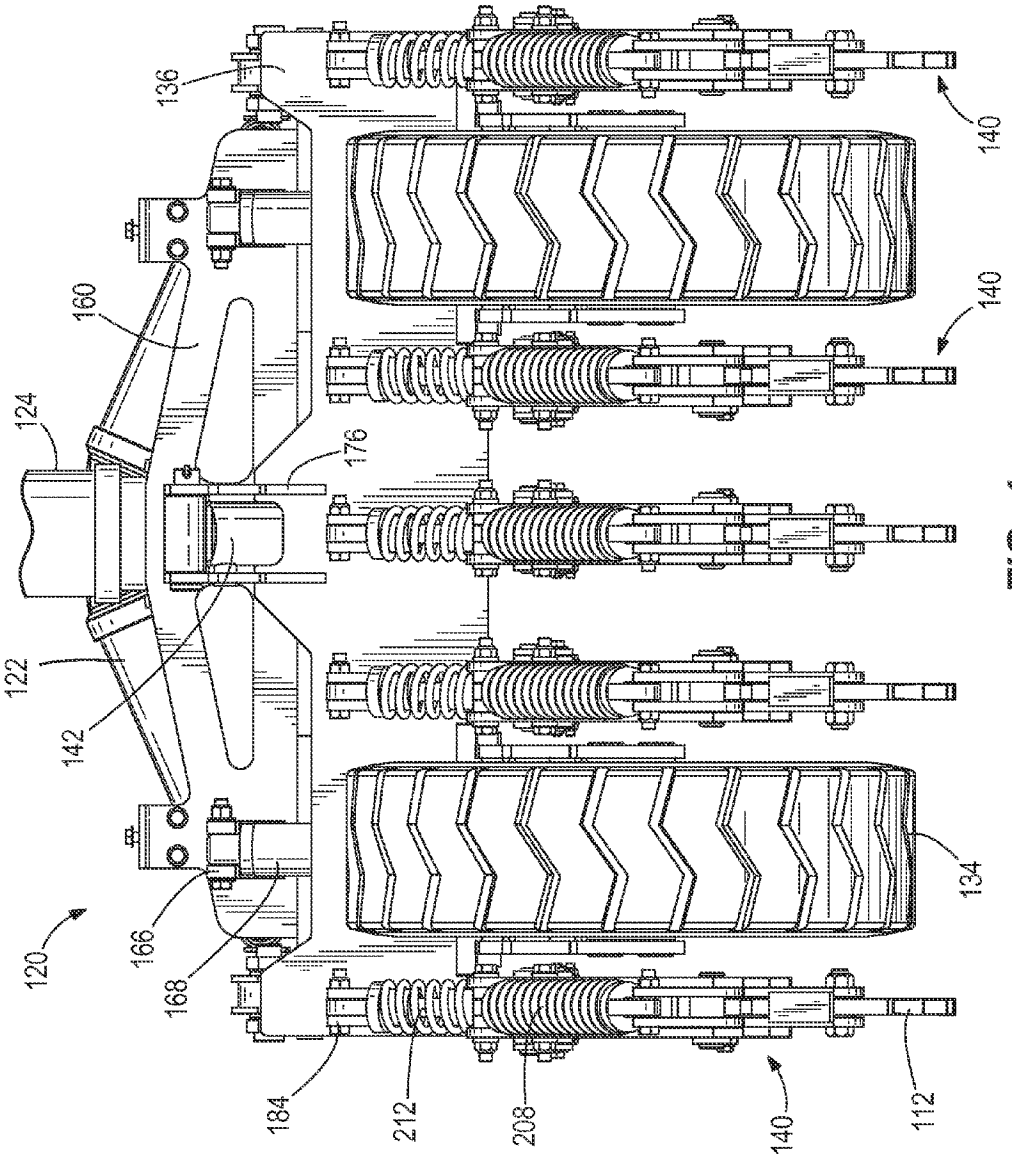
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FIG. 4

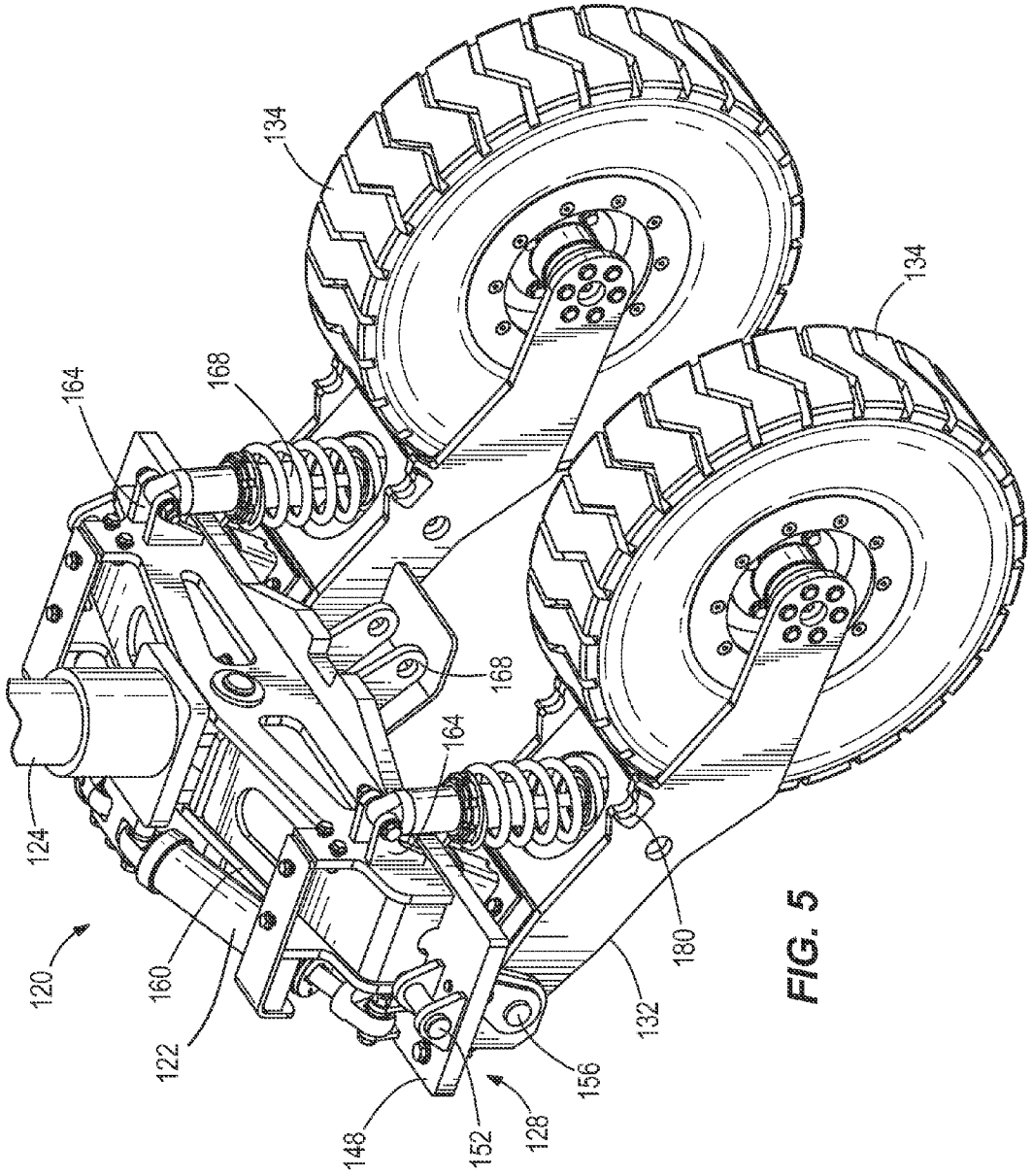

FIG. 5

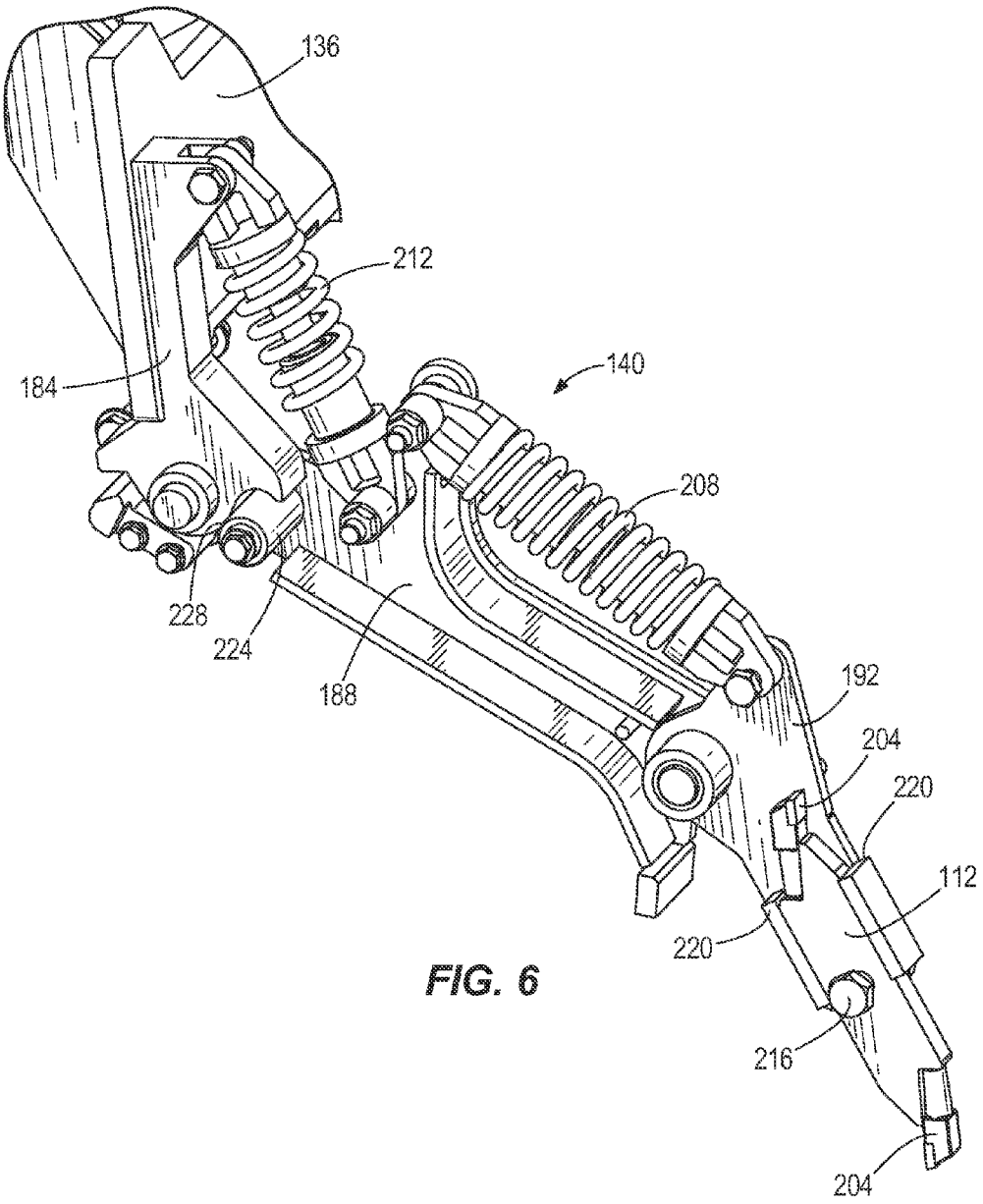

FIG. 6

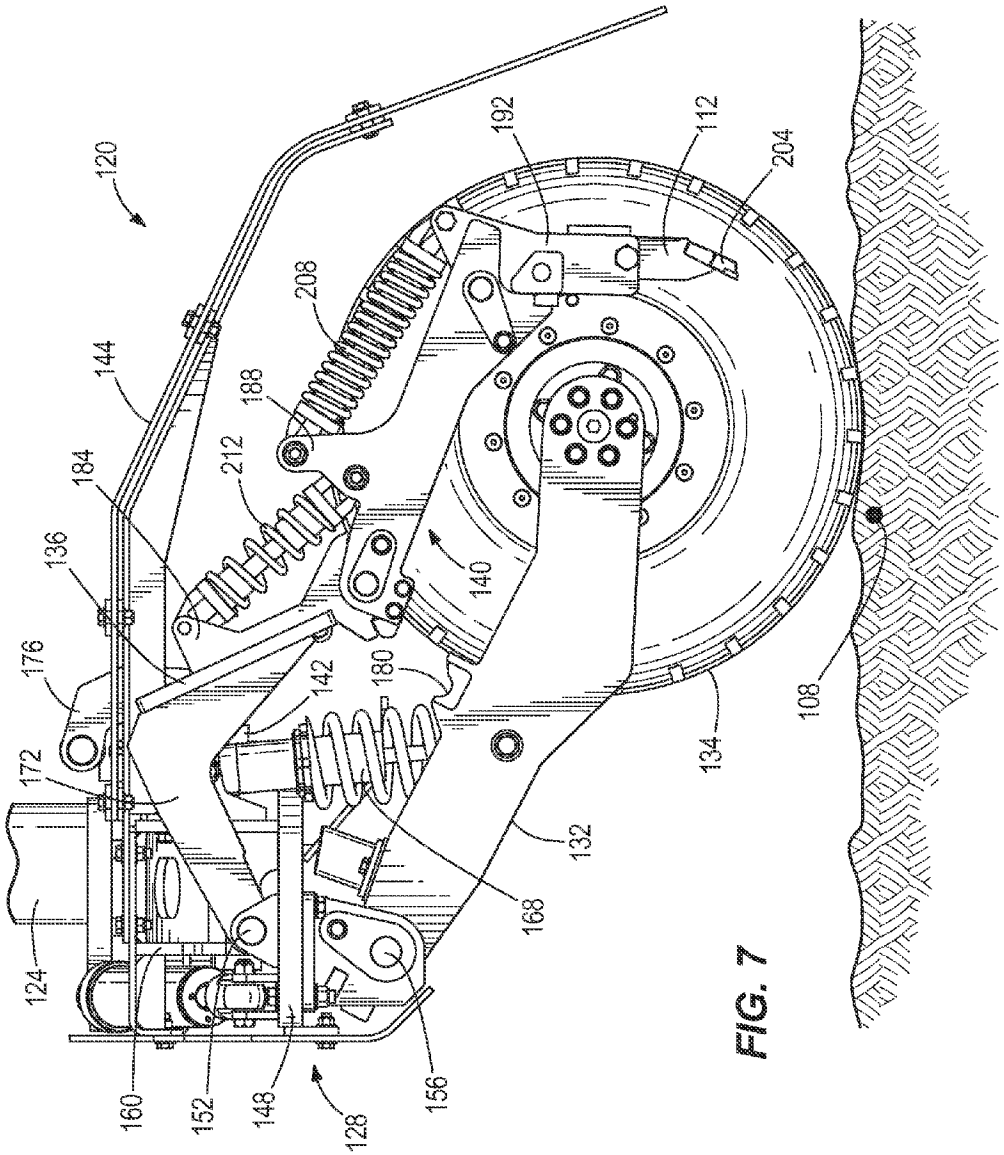
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FIG. 7

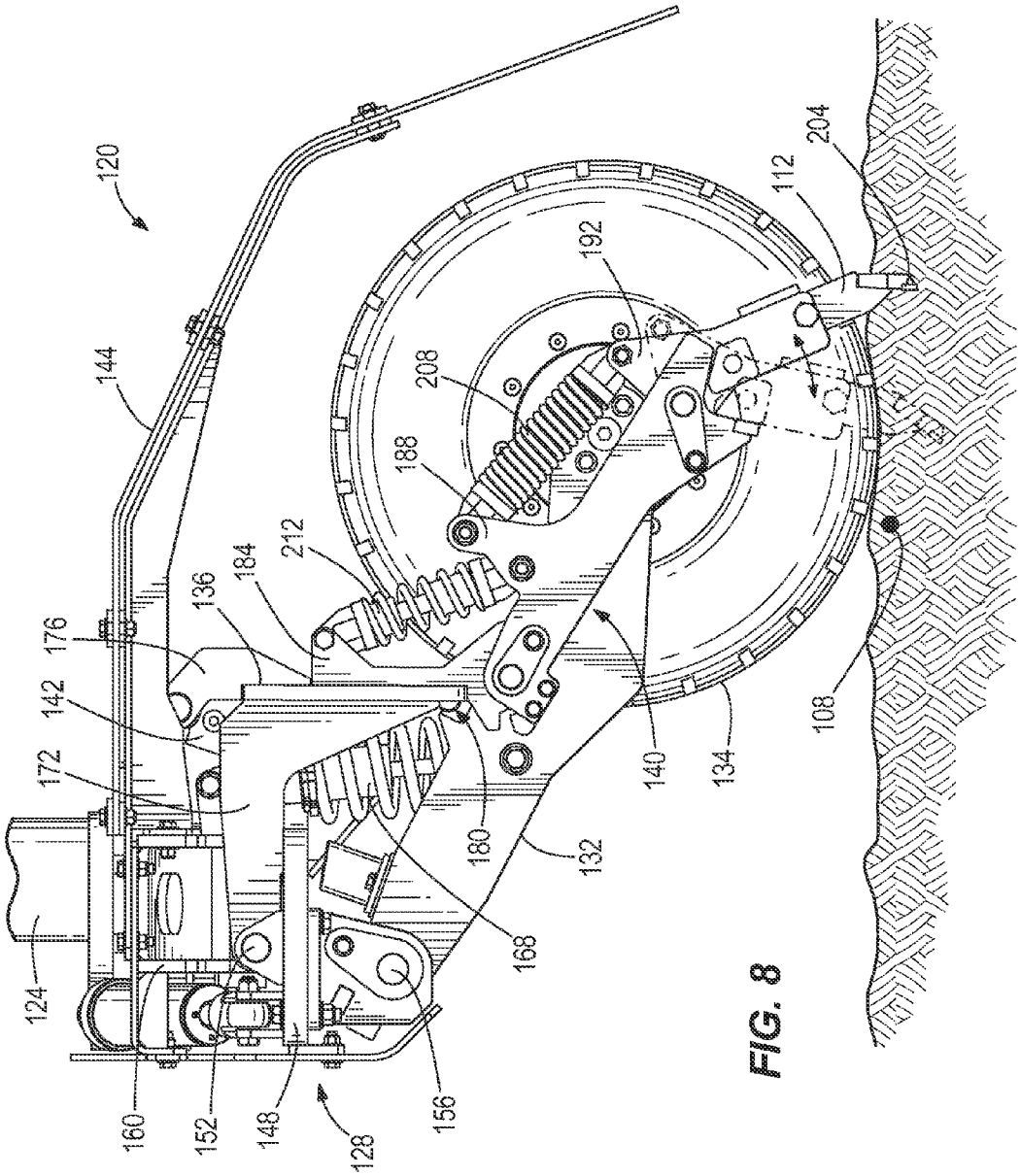
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FIG. 8

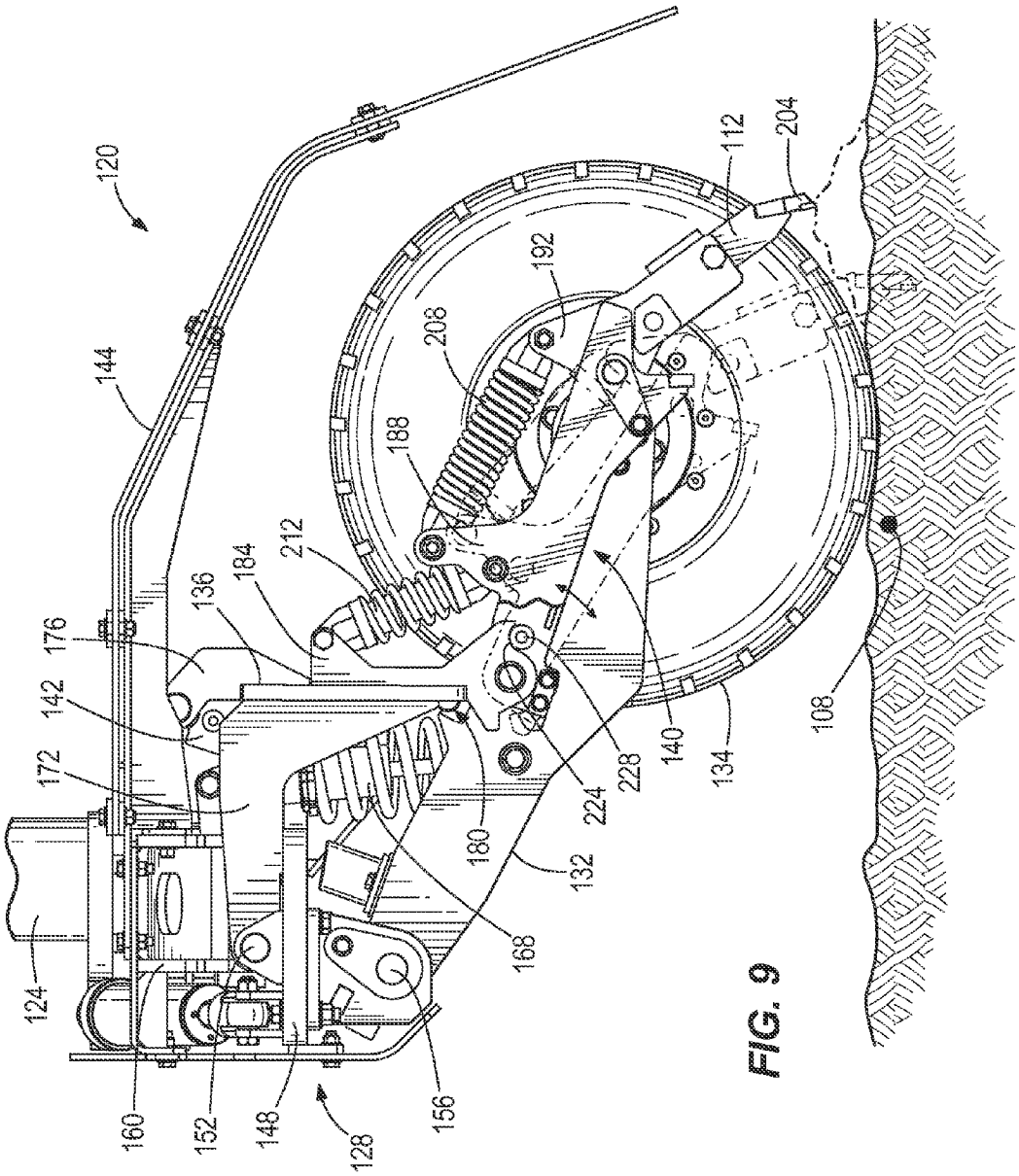
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FIG. 9

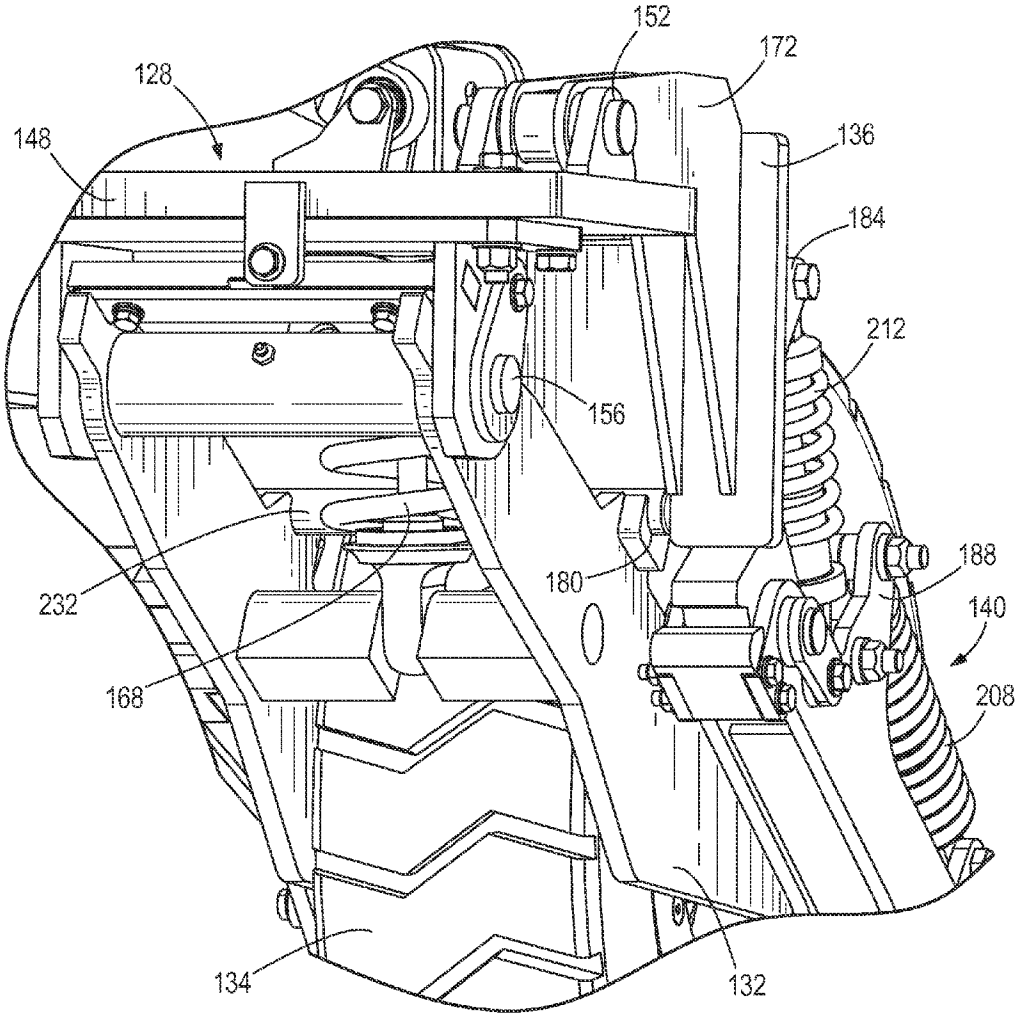

FIG. 10

WIRE NEUTRALIZATION SYSTEM

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with government support under contract number W56HZV-08-C-0525 awarded by the U.S. Army Tank Automotive Research, Development and Engineering Center. The United States government has certain rights in the invention.

BACKGROUND

The present invention relates to a wire neutralization system, and more specifically to a wire neutralization system for buried wires used to detonate explosive devices.

Military convoys occasionally travel through areas which may have explosive devices. These explosive devices may be triggered by a target presence sensor, a timer, or by a user controlled detonator. Examples of target presence sensors are trip wires, pressure plates, tilt sensors, and motion detectors, all of which infer the presence of a target from an input signal and automatically send a detonation signal, often through a control wire, to detonate the explosive device. Timers detonate an explosive device, usually by sending a detonation signal through a control wire, at a preselected time or within a preselected passage of time from a start time. User controlled detonators are operated by a human operator and may send the detonation signal via a control wire connected to the explosive device. The present invention is concerned with any type of explosive device that uses a buried wire of any kind to transmit a detonation signal or otherwise trigger the detonation of the explosive device. The buried wire may be buried in the terrain to mask the presence of the explosive device.

It would be useful to have a wire neutralization system that could neutralize buried wires. It would further be useful to be able to operate such a wire neutralization system while driving a vehicle designed to protect a driver from explosions. Such a vehicle could, for example, lead a military convoy to reduce the likelihood that the personnel and contents of the convoy will be harmed by an explosive device that uses a buried wire.

SUMMARY

In one aspect, the invention provides a wire neutralizing system for use with a vehicle, the wire neutralization system comprising: a frame adapted to be hitched to the vehicle; at least one wheel supporting the frame, a bottom of the wheel rolling over terrain having buried wires; and a blade movable between a stowed position in which the blade is above the bottom of the wheel and a deployed position in which the blade is below the bottom of the wheel; wherein the blade plows through the terrain to disable the buried wires when in the deployed position.

In some aspects of the invention, the wire neutralization system further comprises a wheel suspension unit permitting vertical travel of the wheel with respect to the frame in response to rough terrain. In some aspects of the invention, the wire neutralization system further comprises a suspension lockout feature that prevents relative vertical travel of the wheel with respect to the frame while the blade is deployed. In some aspects of the invention, the wire neutralization system further comprises a hydraulic system for moving the blade between the stowed and deployed positions. In some aspects of the invention, the blade comprises a plurality of blades; the wire neutralization system further comprising a hydraulic system for simultaneously moving the plurality of blades between the stowed and deployed positions. In some aspects of the invention, the wire neutralization system further comprises a blade trip biasing member biasing the blade toward the deployed position and accommodating movement of the blade toward a tripped position upon the blade meeting a tripping resistance while in the deployed position. In some aspects of the invention, the wire neutralization system further comprises a blade lift biasing member biasing the blade toward the deployed position and accommodating movement of the blade toward a lifted position upon the blade meeting a lifting resistance while in the deployed position.

In some aspects of the invention, the wire neutralization system further comprises a blade plate moveable mounted to the frame; and a blade station attached to the blade plate, the blade station including: a blade arm mounted to the blade plate; and a blade holder mounted to the blade arm and supporting the blade. In some aspects of the invention, the blade is movable between the stowed position and the deployed position by moving the blade plate with respect to the frame. In some aspects of the invention, the blade plate is pivotably interconnected to the frame and the blade arm is pivotably interconnected to the blade plate such that the blade moves between the stowed and deployed positions in response to the blade plate being pivoted relative to the frame. In some aspects of the invention, the blade plate further includes a blade station mounting tab to mount the blade station to the blade plate.

In another aspect, the invention provides a wire neutralizing system for use with a vehicle, the wire neutralization system comprising: a frame adapted to be hitched to the vehicle; at least one wheel supporting the frame, a bottom of the wheel rolling over terrain having buried wires; a blade plate movably mounted to the frame; and a blade station attached to the blade plate including: an blade arm mounted to the blade plate; a blade holder mounted to the blade arm; and a blade supported by the blade holder; wherein the blade is movable between a stowed position in which the blade is above the bottom of the wheel and a deployed position in which the blade is below the bottom of the wheel by moving the blade plate with respect to the frame; wherein the blade plows through the terrain to disable the buried wires when in the deployed position.

In some aspects of the invention, the wire neutralization system further comprises a wheel suspension unit permitting vertical travel of the wheel with respect to the frame in response to rough terrain; and a suspension lockout feature that prevents relative vertical travel of the wheel with respect to the frame while the blade is deployed. In some aspects of the invention, the suspension lockout feature includes a lockout engagement groove, the lockout engagement groove engageable by the blade plate such that a force pathway is created between the wheel and the frame through the blade plate. In some aspects of the invention, the blade plate is movable relative to the frame via a hydraulic system. In some aspects of the invention, the blade plate is pivotably interconnected to the frame and the blade arm is pivotably interconnected to the blade plate such that the blade moves between the stowed and deployed positions in response to the blade plate being pivoted relative to the frame.

In some aspects of the invention, the blade plate includes a blade station mounting tab to mount the blade station to the blade plate. In some aspects of the invention, the wire neutralization system further comprises a blade lift biasing member connected to the blade station mounting tab and the

blade arm to bias the blade toward the deployed position and accommodating movement of the blade toward a lifted position upon the blade meeting a lifting resistance while in the deployed position. In some aspects of the invention, the blade arm includes a stop member that engages a portion of the blade station mounting tab to prevent further movement of the blade while in the lifted position.

In some aspects of the invention, the wire neutralization system further comprises a blade trip biasing member connected to the blade holder and the blade arm to bias the blade toward the deployed position and accommodating movement of the blade toward a tripped position upon the blade meeting a tripping resistance while in the deployed position.

Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a wire neutralization system of the present invention attached to a military vehicle.

FIG. **2** is a rear perspective view of a bank assembly from the wire neutralization system of FIG. **1**.

FIG. **3** is a front perspective view of the bank assembly of FIG. **2**.

FIG. **4** is a rear view of the bank assembly of FIG. **2** without a cover plate.

FIG. **5** is a perspective view of a portion of the bank assembly of FIG. **2** illustrating the trailing arms.

FIG. **6** is a perspective view of a blade station from the bank assembly of FIG. **2**

FIG. **7** is a side view of the bank assembly of FIG. **2** with the blade in a stowed position.

FIG. **8** is a side view of the bank assembly of FIG. **2** with the blade in a deployed position.

FIG. **9** is a side view of the bank assembly of FIG. **2** with the blade in a lifted position.

FIG. **10** is a perspective view of a portion of the bank assembly of FIG. **2** illustrating an engagement bar in a lockout groove.

DETAILED DESCRIPTION

Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

FIG. **1** illustrates a wire neutralization system **100** configured to be attached to a vehicle **104**. Generally, the wire neutralization system **100** is configured to roll over rough terrain that may contain buried wires **108** (FIG. **7**) attaching one or more explosive devices to a respective detonator. The term "wire" refers to any wire of any kind that can transmit a detonation signal or otherwise trigger the detonation of the explosive device. The system **100** is attached to the front of the vehicle **104**, such that as the vehicle **104** is driven over the terrain, the system **100** is pushed along the terrain in front of the vehicle **104**. Alternative, the system **100** may be pulled along the terrain by the vehicle **104** (e.g., towed behind the vehicle **104**). The wire neutralization system **100** includes one or more blades **112** that may be deployed into the ground to plow through the terrain and neutralize the buried wires **108**. The term "neutralize" and its variants will be used herein to mean uprooting, cutting, or otherwise deactivating or rendering inoperable a wire for its intended purpose, and to mean exposing a wire or a portion of a wire to make the wire more easily detectable. In the illustrated embodiment, the vehicle **104** is a military vehicle **104** designed to protect a user or driver from harm in the event that a close proximity explosion is triggered while neutralizing the wires **108** coupled to any explosive devices. Alternatively, other vehicles **104** that are sufficient for a desired application may be used in conjunction with the wire neutralization system **100**.

The wire neutralization system **100** includes an attachment base **116** that hitches one or more bank assemblies **120** to the front of the vehicle **104**. Each of the bank assemblies **120** attaches to the base **116** via a caster pin **124**. The bank assemblies **120** are able to freely rotate about the caster pins **124** with respect to the base **116**, such that bank assemblies **120** are able to pivot in the desired direction when the vehicle **104** turns or the landscape slopes. Additionally, the attachment base **116** and the bank assemblies **120** each have a rolling degree of freedom that allows for rotation about a horizontal axis. The rolling degree of freedom allows the system **100** to balance or adjust to laterally undulating terrain.

FIGS. **2-4** illustrate one bank assembly **120** according to an embodiment of the present invention. The illustrated bank assembly **120** includes a bank frame **128**, a plurality of trailing arms **132** supporting one or more wheels **134**, a blade plate **136**, and one more blade stations **140** attached to the blade plate **136**. The bank assembly **120** also includes a plurality of bank roll shocks **122**, which may stabilize bank flutter at high speeds (e.g., speed greater than 20 mph). In the illustrated embodiment, the bank assembly **120** includes two trailing arms **132** and two wheels **134**, but in alternative constructions the bank assembly **120** may include more or fewer than two trailing arms **132** and wheels **134**. The blade plate **136** is moved relative to the bank frame **128** by hydraulically moving or operating a hydraulic actuator **142** (i.e., extending and retracting the actuator's piston relative to its cylinder) attached to both the blade plate **136** and the bank frame **128**. As a result, the blade stations **140** are also moved relative to the bank frame **128** when the hydraulic actuator **142** is moved. The bank assembly **120** also includes a cover **144** (FIG. **1**) attached to the bank frame **128** that prevents dirt and debris being kicked-up from the wheels **134** from obscuring the view of the vehicle operator. Additionally, the cover **144** (FIG. **1**) may also be formed of a material that helps protect the driver from harm in the event of a triggered explosion.

The bank frame **128** of the bank assembly **120** includes a substantially planar bank plate **148** supporting a plurality of blade plate pivot mounts **152** (FIGS. **2** and **3**) on a top surface and a plurality of trailing arm mounts **156** (FIGS. **2** and **3**) on a bottom surface. As mentioned earlier, the bank frame **128** is attached to the base **116** via the caster pin **124**, which hitches the bank frame **128** to the vehicle **104**. Specifically, the caster pin **124** is attached to the plate **148** via gussets **160**. The gussets **160** also support a plurality of suspension mounts **164**. Further, a cylinder mount **166** (FIG. **5**) extends from the bottom surface of the plate **148** for attachment to the hydraulic actuator **142**.

FIGS. **3** and **5** illustrate the trailing arms **132** of the bank assembly **120**. The trailing arms **132** have a first end supporting the attached wheels **134** for rotational movement and a second end that is pivotally attached to the bank frame **128** at the trailing arm mounts **156**. The trailing arms **132**, including the wheels **134**, are also connected to the bank

frame **128** through multiple suspension units **168** to further support the bank frame **128** and for permitting vertical travel of the wheels **134** with respect to the bank frame **128** in response to rough terrain. As the bank assembly **120** encounters rough terrain, the trailing arms **132** are able to pivot relative to the bank frame **128** about the mounts **156** when a force exerted on the wheels **134** overcomes the biasing force of the suspension units **168**. The suspension units **168** include various energy absorbing features (e.g., a spring, viscous fluid, etc.) that enable the suspension units **168** to help dissipate the force exerted on the wheels **134** as a result of the rough terrain.

In reference to FIG. **2**, the blade plate **136** includes a plurality of attachment arms **172** extending toward the bank frame **128**. The attachment arms **172** pivotally connect the blade plate **136** to the blade plate pivot mounts **152** of the bank frame **128**. The blade plate **136** is then connected to the hydraulic actuator **142** by a pair of mounting tabs **176** so that the blade plate **136** is raised when the hydraulic actuator **142** is extended and the blade plate **136** is lowered when the hydraulic actuator **142** is refracted. The hydraulic actuator **142** is fluidly coupled to the remainder of a hydraulic system by hydraulic lines and actuated by a control panel mounted within the vehicle **104** for manipulation by a user. In reference to FIG. **10**, when the hydraulic actuator **142** is fully retracted, and the blade plate **136** is fully lowered or deployed, an engagement bar or portion **232** of the blade plate **136** engages a suspension lockout feature or groove **180** (FIGS. **5** and **10**) formed in the trailing arms **132**. The engagement of the blade plate **136** with the lockout groove **180** prevents substantially vertical travel of the wheels **134** relative to the bank frame **128**. When the blade plate **136** is engaged with the lockout groove **180**, a force pathway is created between the wheel **134** and bank frame **128** that is primarily directed through the blade plate **136**, and not the suspension units **168**. The alternative force pathway prevents the suspension units **168** from compressing, thereby assisting in the wire neutralizing capabilities of the system **100**, as will be described below. Although the lockout feature **180** is illustrated as a groove **180**, it is to be understood that the lockout feature **180** could be any other structure or feature that is capable of preventing the full use of the suspension units **168**. The blade plate **136** additionally includes a plurality of blade station mounting tabs **184**, which are used to attach the blade stations **140**.

FIG. **6** illustrates a single blade station **140** according to an embodiment of the present invention with portions removed to illustrate various enclosed features. The blade station **140** includes a blade arm **188** pivotally connected to the blade station mounting tab **184** and a blade holder **192** pivotally connected to the blade arm **188**. The blade holder **192** supports a blade **112**, which extends past the blade holder **192** to expose a cutting edge **204** for insertion into the terrain to neutralize the buried wires **108**. The blade station **140** also includes an overload trip biasing member **208** coupled to both the blade holder **192** and the blade arm **188**. Additionally, the blade station **140** includes an overload lift biasing member **212** coupled to both the blade arm **188** and the blade station mounting tab **184**. The purpose of the biasing members **208**, **212** will be described in detail below.

In continued reference to FIG. **6**, the blade **112** includes two sets of cutting edges **204** (i.e., first and second cutting edges **204** at opposite ends of the blade **112**) such that the blade **112** can be oriented in two positions. The double-edged blade **112** allows the user to change the orientation of the blade **112** between first and second orientations. In the first orientation, the first cutting edge **204** is use while the second cutting edge **204** is in reserve within the blade holder **192**. The operator may switch to the second orientation of the blade **112** when the first cutting edge **204** becomes dull or damaged. In the second orientation, the second cutting edge is placed into use and the first cutting edge is in reserve. The cutting edge **204** that is in use extends beyond the blade holder **192** so it can engage and cut through the terrain. While in either the first or second orientation, the position of the blade **112** is fixed relative to the blade holder **192**. Specifically, the blade **112** is attached to the blade holder **192** by a mount or fastener **216** while two blocks **220** prevent rotation of the blade **112** about the fastener **216**. Further, the cutting edges **204** are made from a carbide material to help prevent excessive wear of the cutting edges **204** and extend the lifetime of the blade **112**. Alternatively, or in addition, other types of blades **112** not illustrated (e.g., singled-edged blades, etc.) may be used with the wire neutralization system **100**.

FIG. **7** illustrates the wire neutralization system **100** with the blade **112** in a retracted or stowed position. To move the blade **112** into the stowed position, the hydraulic actuator **142** is extended, causing the blade plate **136** and the blade station **140** to be lifted relative to the bank frame **128** so that the blade **112** is above the bottom of the wheel **134**. FIG. **8** illustrates the wire neutralization system **100** with the blade **112** in the deployed position. The blade **112** is moved from the stowed position (FIG. **7**) into the deployed position (FIG. **8**) by retracting the hydraulic actuator **142**, which lowers the blade plate **136** and the blade station **140** relative to the bank frame **128**. The illustrated wire neutralization system **100** fails into the deployed position because if hydraulic fluid is lost the hydraulic actuator **142** will retract under the weight of the assembly it supports. In other configurations, the wire neutralization system **100** can be made to fail into the stowed position as a matter of design preference.

When the blade station **140** is lowered, a portion of the blade **112**, including the cutting edge **204**, is inserted into the ground. In the illustrated embodiment, the blade **112** extends below the bottom of the wheel **134** by approximately two inches while in the deployed position. In other embodiment, the blade **112** may extend more or less than two inches below the bottom of the wheel **134**. While the blade **112** is extended into the ground and the vehicle **104** is moving, the blade **112** is subjected to drag loads.

As illustrated in FIG. **8**, the drag loads cause the blade **112** to pivot relative to the blade arm **188** into an operating position (shown with solid lines) from a non-operating position (shown with phantom lines). During typical operation, the blade **112** and blade holder **192** are pushed back to a position in a range from 90 degrees to 135 degrees in relation to the blade arm **188**, depending on the drag load exerted on the blade **112** by the terrain or ground. This may result in a forward sweeping motion of the blade **112** toward the non-operating position when the blade **112** transitions from hard terrain to soft terrain or a hole.

Additionally, the blade **112** may encounter hard objects (e.g., rocks) while it is extended into the ground that may exert a large impact force or resistance on the blade **112**. A large impact force may cause damage to the blades **112**. Therefore, the plurality of overload biasing members **208**, **212** are provided to allow controlled movement of the blade **112** relative to the bank frame **128** during such an impact force. The impact force may have a horizontal force component, or tripping resistance, that causes the blade **112** and blade holder **192** to rotate relative to the blade arm **188** into a tripped position (rotated further than the operating position) causing the overload trip biasing member **208** to

compress and absorb some of the impact. After impact, the biasing force of the trip biasing member **208** forces the blade **112** back into the typical deployed or operating position.

Similarly, the impact force caused by a hard or dense objet may have an upward force component, or lifting resistance, on the blade **112**. The upward force causes the blade arm **188** to rotate relative to the blade station mounting tab **184** into a lifted position (FIG. **9**) causing the overload lift biasing member **212** to compress and absorb some of the impact. The blade arm **188** includes a stop member or cylindrical stop **224** that engages with an arcuate groove **228** formed in the blade station mounting tab **184** to prevent further vertical movement of the blade **112** past the lifted position. After the impact, the biasing force of the lift biasing member **212** forces the blade **112** back into the deployed or operating position. The impact force acting on the blade **112** may also cause both the biasing members **208**, **212** to be compressed, allowing the blade **112** to move vertically and horizontally in relation to the bank frame **128**.

In operation, the blades **112** of the bank assemblies **120** are positioned in the deployed position. While the blades **112** are in the deployed position, the blade plate **136** engages with the lockout groove **180** (i.e., the engagement bar **232** is received by the lockout groove **180**) to provide constant engagement of the blades **112** with the ground or terrain, as illustrated in FIG. **10**. As such, the suspension units **168** are prohibited from compressing such that wheel **134** will not move vertically relative to the bank frame **128** and the blades **112**, keeping the blade **112** deployed at the intended depth, which may be approximately two inches. Once the blades **112** are deployed, the vehicle **104** may drive along a desired route to neutralize wires **108** attached to explosive devices that are buried in the ground. While driving, the blades **112** are able to move relative to the bank frame **128** in response to varied terrain density or in reaction to hard objects, as described above. Once the vehicle **104** has arrived at its destination, and the plowing of terrain is no longer necessary, the blades **112** are lifted into the stowed position, the engagement bar **232** is removed from the lockout groove **180**, and the suspension units **168** are operational. While the blades **112** are in the stowed position, the vehicle **104** may drive on any type of road (e.g., paved, gravel, etc.) without causing damage to the road as a result of the blades **112**. It is to be understood that the wire neutralization system **100** of the present invention is capable of being pushed, pulled, or moved at high speeds while attached to the vehicle **104**. In some embodiment, the wire neutralization system **100** may be driven at a speed in excess of 20 mph (miles per hour). In other embodiments, the system **100** may be driven at a speed in excess of 45 mph. In yet another embodiment, the system **100** may be driven at a speed in excess of 60 mph.

Various features and advantages of the invention are set forth in the following claims.

What is claimed is:

1. A wire neutralizing system for use with a vehicle, the wire neutralization system comprising:

a frame adapted to be hitched to the vehicle;

at least one wheel supporting the frame, a bottom of the wheel rolling over terrain having buried wires;

a blade plate movably mounted to the frame;

a blade station attached to the blade plate including:

a blade arm mounted to the blade plate;

a blade holder mounted to the blade arm; and

a blade supported by the blade holder;

wherein the blade is movable between a stowed position in which the blade is above the bottom of the wheel and a deployed position in which the blade is below the bottom of the wheel by moving the blade plate with respect to the frame;

a wheel suspension unit permitting vertical travel of the wheel with respect to the frame in response to rough terrain while the blade is in the stowed position; and

a suspension lockout feature that prevents relative vertical travel of the wheel with respect to the frame while the blade is in the deployed position;

wherein the blade plows through the terrain to disable the buried wires when in the deployed position, and wherein the wheel is engaged with the terrain while the blade plows through the terrain in the deployed position.

2. The wire neutralization system of claim **1**, wherein the suspension lockout feature includes a lockout engagement groove, the lockout engagement groove engageable by the blade plate such that a force pathway is created between the wheel and the frame through the blade plate.

3. The wire neutralization system of claim **2**, wherein the wheel is supported by a trailing arm, wherein the lockout engagement groove is disposed on the trailing arm, and wherein the force pathway is created between the wheel and the frame through the blade plate when the blade is in the deployed position.

4. The wire neutralization system of claim **3**, wherein the blade plate includes an engagement bar, and wherein the engagement bar is received in the lockout engagement groove when the blade is in the deployed position.

5. The wire neutralization system of claim **1**, wherein the blade plate is movable relative to the frame via a hydraulic system.

6. The wire neutralization system of claim **1**, wherein the blade plate is pivotably interconnected to the frame and the blade arm is pivotably interconnected to the blade plate such that the blade moves between the stowed and deployed positions in response to the blade plate being pivoted relative to the frame.

7. The wire neutralization system of claim **1**, wherein the blade plate includes a blade station mounting tab to mount the blade station to the blade plate.

8. The wire neutralization system of claim **7**, further comprising a blade lift biasing member connected to the blade station mounting tab and the blade arm to bias the blade toward the deployed position and accommodating movement of the blade toward a lifted position upon the blade meeting a lifting resistance while in the deployed position.

9. The wire neutralization system of claim **8**, wherein the blade arm includes a stop member that engages a portion of the blade station mounting tab to prevent further movement of the blade while in the lifted position.

10. The wire neutralization system of claim **1**, further comprising a blade trip biasing member connected to the blade holder and the blade arm to bias the blade toward the deployed position and accommodating movement of the blade toward a tripped position upon the blade meeting a tripping resistance while in the deployed position.

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