

[54] **MINE NEUTRALIZATION DEVICE**

[75] Inventors: **Richard A. Sieg**, San Jose; **Charles D. De Palmo**, Campbell, both of Calif.

[73] Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, D.C.

[22] Filed: **May 1, 1972**

[21] Appl. No.: **249,376**

[52] U.S. Cl. **89/1 M**

[51] Int. Cl. **F41h 11/12**

[58] Field of Search **89/1, 1 A, 1 M; 102/1, 8, 19.2**

[56] **References Cited**

UNITED STATES PATENTS

2,425,357	8/1947	Walker	89/1 M
2,489,349	11/1949	White	89/1 M
3,040,658	6/1962	Maltby	102/19.2 X
2,455,636	12/1948	Woolson	89/1 M

3,075,461 1/1963 Ehlmann 102/1 R

FOREIGN PATENTS OR APPLICATIONS

718,880 3/1942 Germany 89/1 M

Primary Examiner—Samuel W. Engle

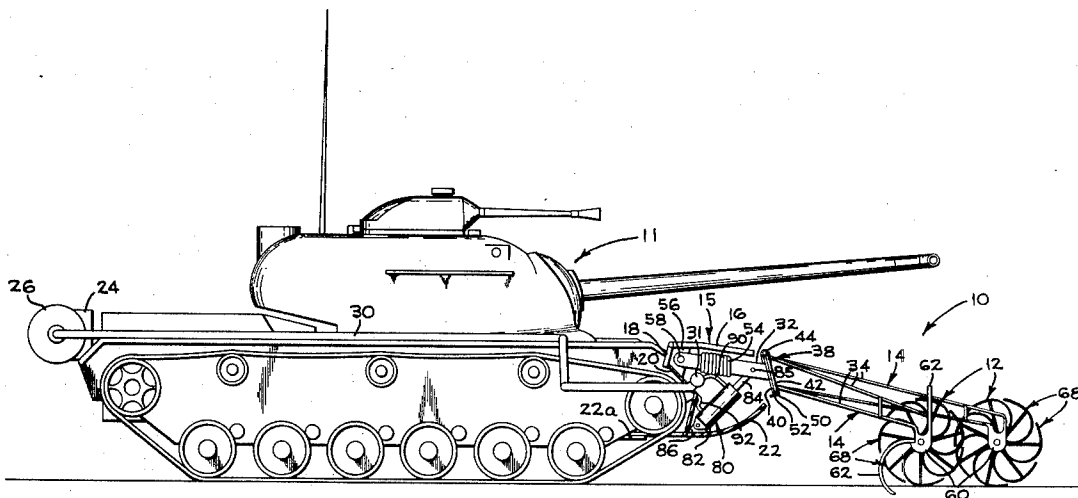
Attorney—Harry M. Saragovitz, Edward J. Kelly, Herbert Berl and Glenn S. Ovrevik

[57]

ABSTRACT

A tank mountable mine neutralization device including blast transparent wheels which are rotatably mounted upon the distal ends of blast transparent booms. A pneumatic actuator and energy absorption system is coupled to the booms to transfer a part of the tank weight onto the wheels and to dissipate any energy absorbed from the mine blast. The wheels are positioned on the ground at a safe distance ahead of the tank for the purpose of pressure actuating land mines over which the wheels roll when the tank advances.

4 Claims, 9 Drawing Figures



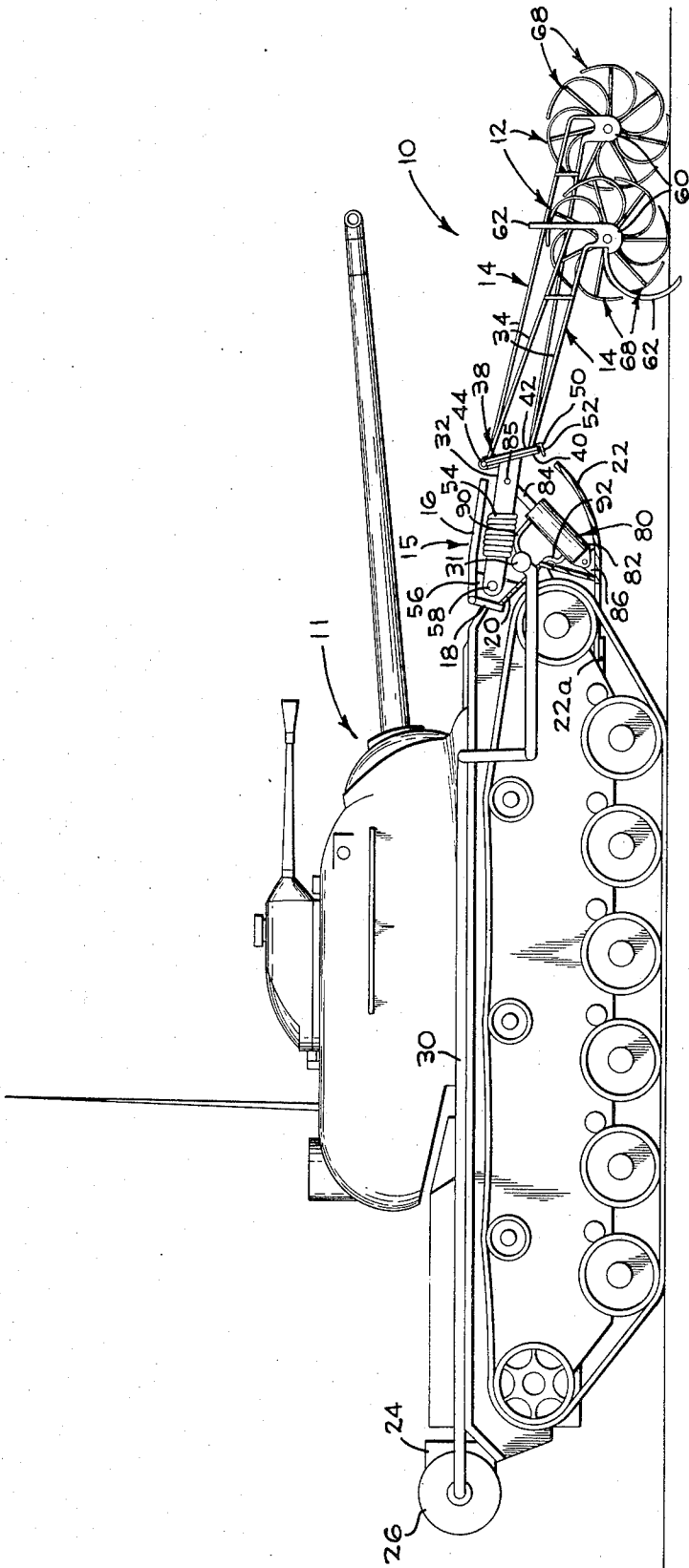


FIG. 1

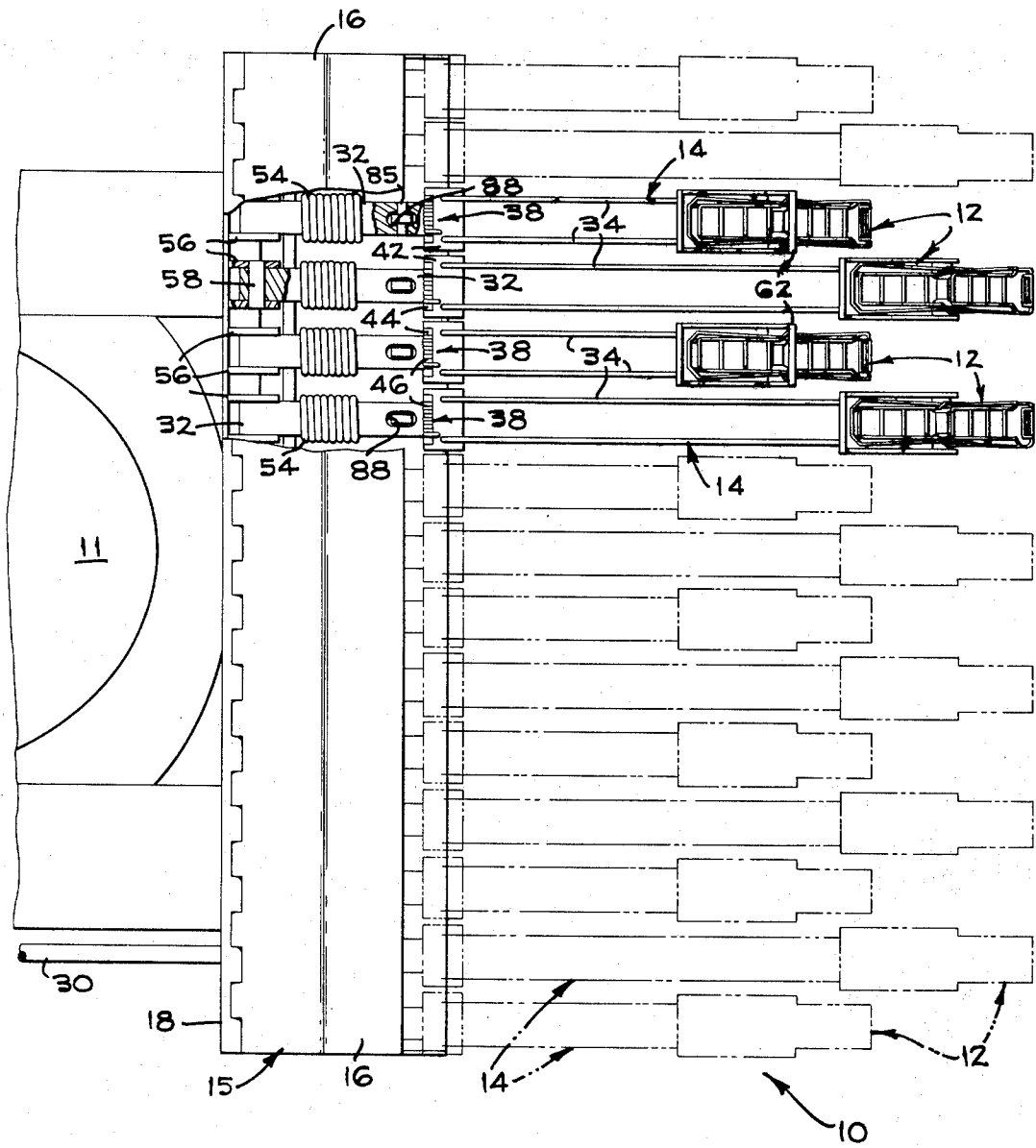


FIG. 2

FIG. 3

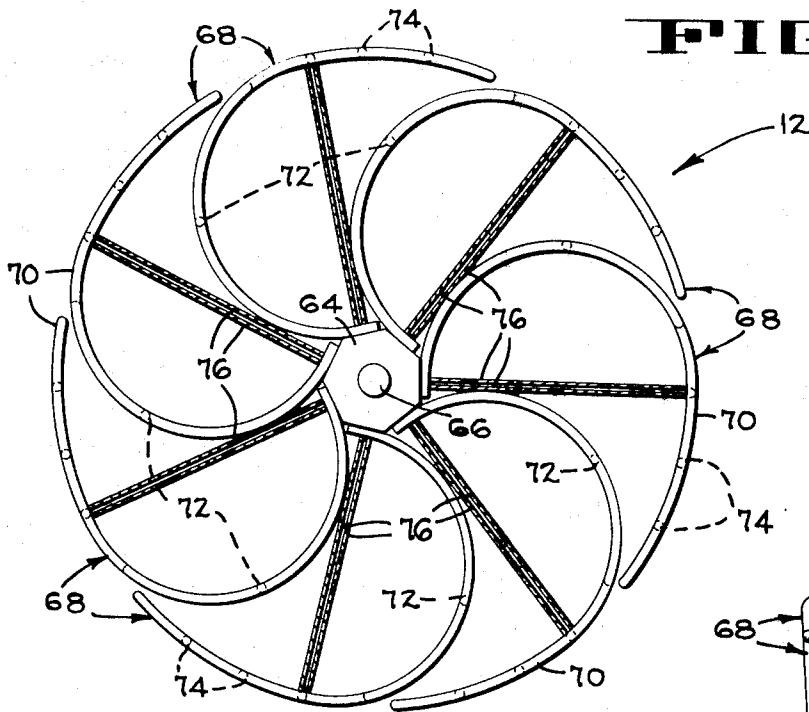


FIG. 4

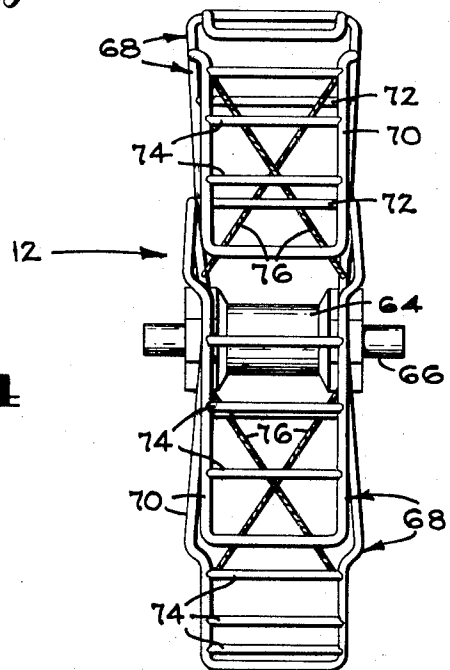
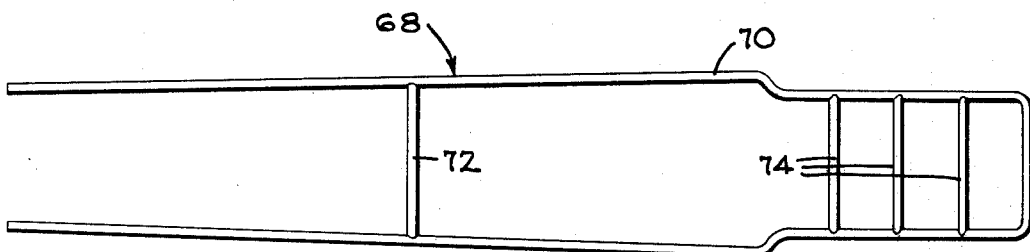


FIG. 5



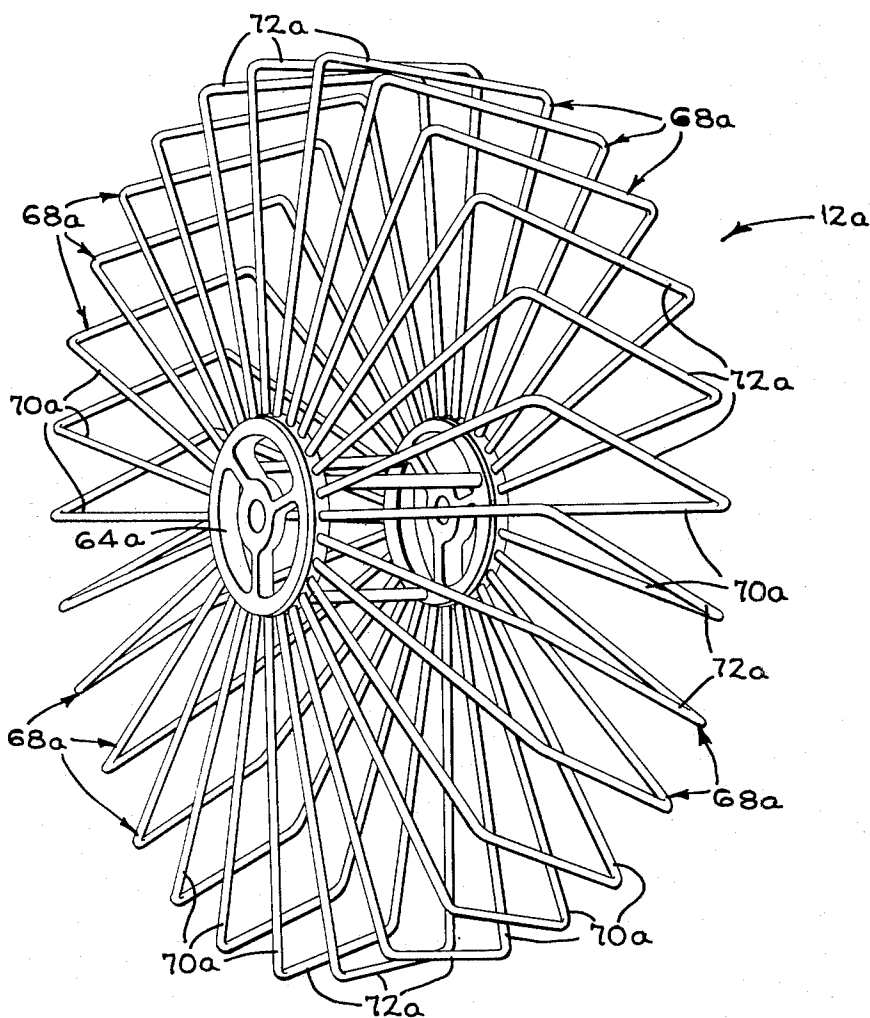


FIG. 6

FIG. 7

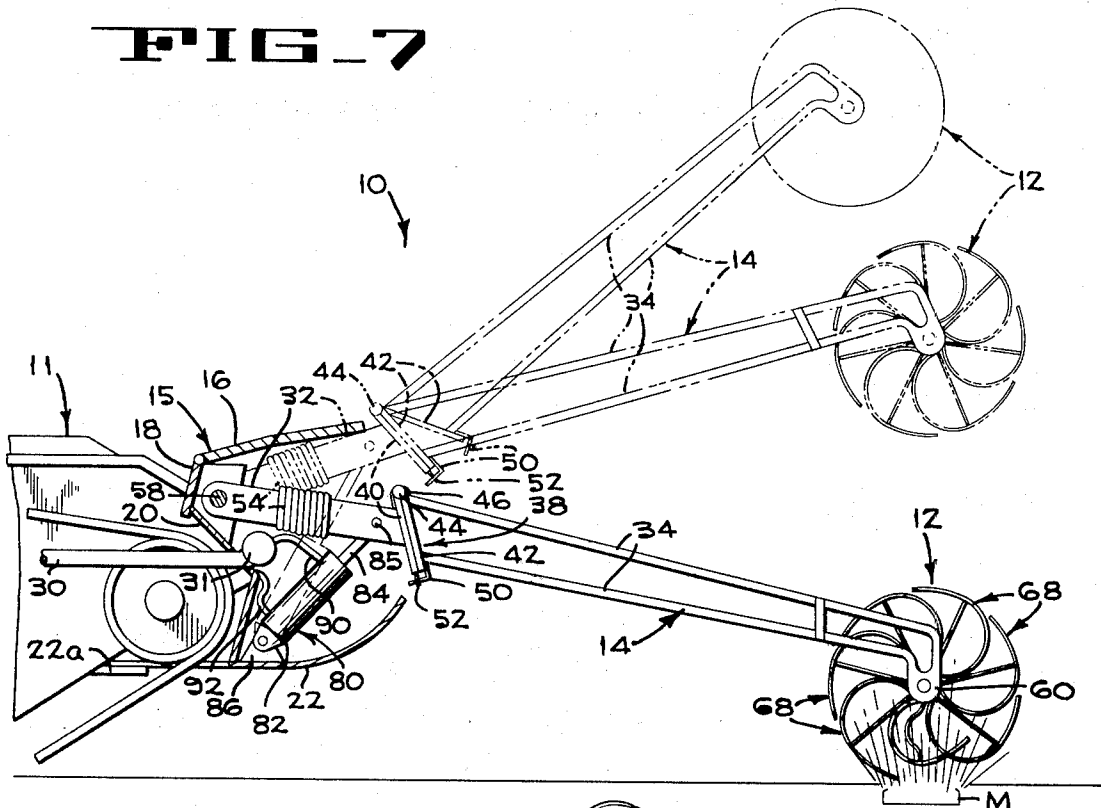
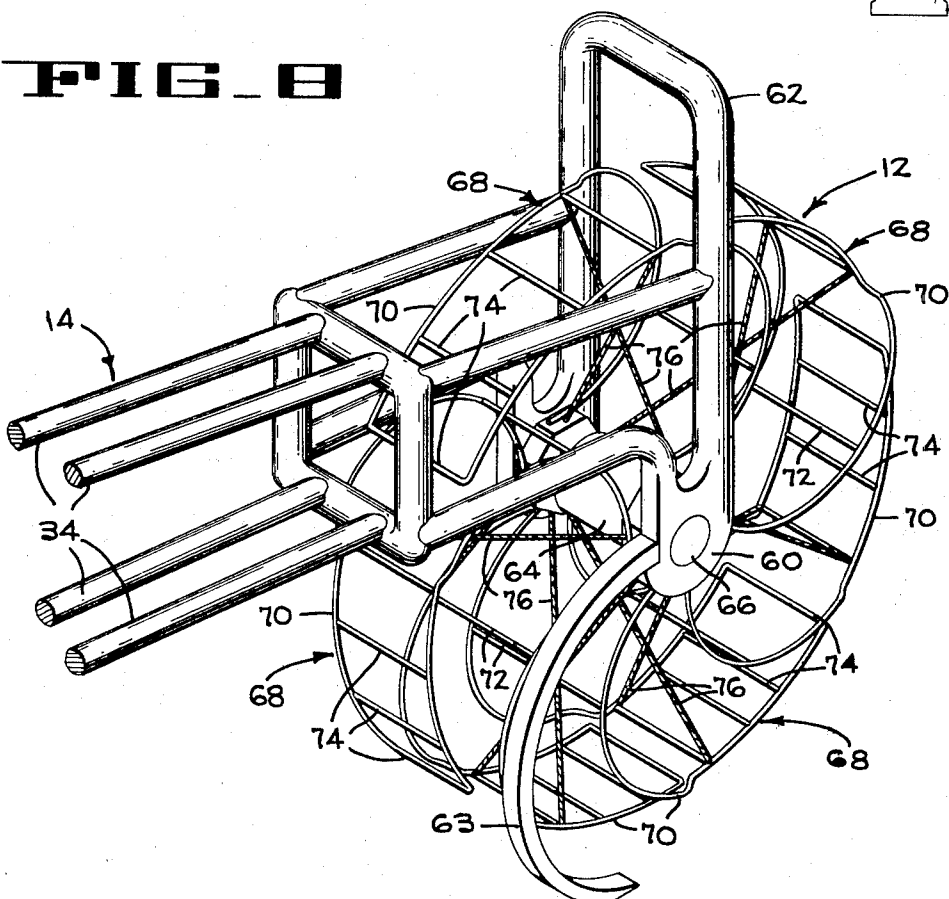


FIG. 8



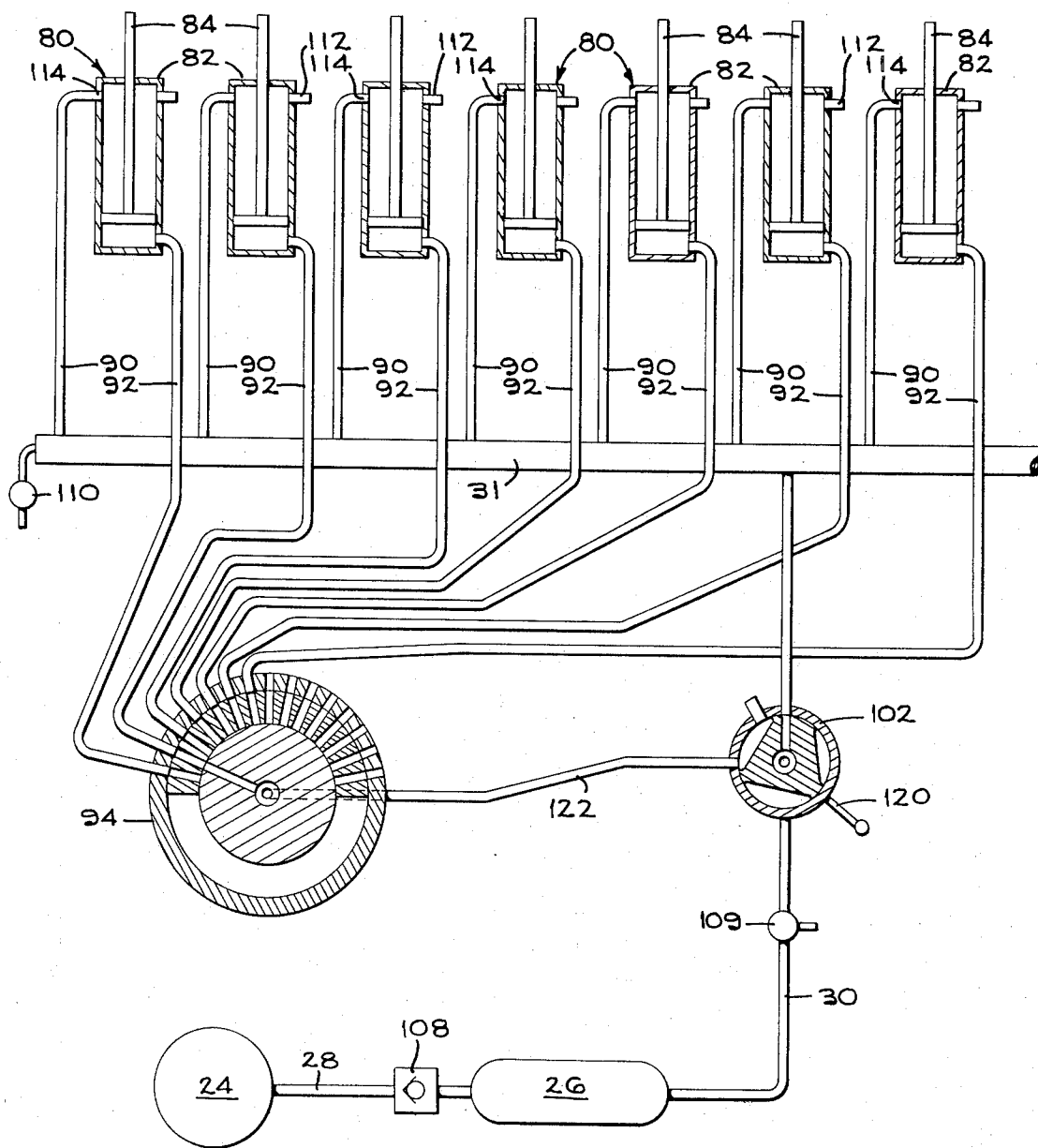


FIG. 9

MINE NEUTRALIZATION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an improved mine neutralization device for neutralizing land mines. The present invention relates more particularly to a mine neutralization device which is operable to detonate land mines in the path of travel of a vehicle.

2. Description of the Prior Art

Mine neutralization devices, of the kind to which the present invention relates, are mounted on a vehicle, such as a tank, and are utilized to neutralize, i.e., detonate, pressure actuated land mines buried in the ground in the vehicle path of travel. Such devices have included wheels which are rolled over the ground in front of the moving vehicle to thereby exert pressure on the ground and cause detonation of pressure actuated land mines over which the wheels are rolled.

The wheels of such mine neutralization devices are subjected to mine blasts which may damage a wheel so that the device is immobilized and the wheel must be replaced after it has encountered the mine blast. In view of this situation the conventional approach has been to utilize wheels made of high strength materials and massive enough to survive the damaging effects of a mine blast. The large mass of such wheels presents large projected areas to mine blasts so that much of the blast energy is coupled to the structure of the device. The high energy coupling effect necessitates wheel supporting structures of large mass adequate to resist the effects of the coupled blast energy. Consequently, these mine neutralization devices, due to the construction of the wheels and wheel supporting structure, have been heavyweight devices which, because of their high weight, substantially reduce the mobility of the vehicles on which they are mounted.

SUMMARY OF THE INVENTION

The goal of the present invention is to provide a mine neutralization device designed to avoid limitations which are inherent in the structure and operation of the mine neutralization devices of the prior art. The goal of the present invention is achieved by providing a lightweight, blast transparent mine neutralization device wherein the device includes wheels mounted on booms that function to transfer part of the weight of the vehicle on which the device is mounted onto the wheels to increase the pressure load applied to the ground by the wheels.

In order to accomplish the goal of the present invention, the wheels and booms of the mine neutralization device are constructed of streamlined elements of small cross section that are difficult to destroy when subjected to the effects of mine blasts. The wheels and booms are "blast transparent" because they are designed so that only a minor proportion of the energy of a mine blast is coupled thereto. The streamlining and small diameter of the wheel and boom elements, used to achieve blast transparency, is done in such a way that the wheels and booms present small projected areas to the mine blasts so that small amounts, rather than large amounts, of blast energy are coupled to the structure of the device. The blast transparent wheels appear massive to the fuses of pressure actuated land mines because the connecting booms are utilized to

transfer part of the weight of the vehicle, on which the device is mounted, onto the wheels.

The mine neutralization device of the present invention includes, in its preferred form, a pneumatic system coupled to the booms for accomplishing weight transfer from the vehicle onto the wheels. The mine neutralization device of the present invention also includes an energy absorption system for absorbing that amount of any blast energy that is coupled into the wheels and booms so as to increase the blast survivability of the device.

Accordingly, a major object of the present invention is to provide a lightweight, blast transparent mine neutralization device. Another object of the invention is to provide a blast transparent mine neutralization device having power controlled wheel supporting booms and having energy absorption means for absorbing blast energy coupled into the wheels. These and other objects of the invention will become apparent hereinafter.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the mine neutralization device of the present invention mounted upon a tank.

FIG. 2 is an enlarged diagrammatic plan of the mine neutralization device shown in FIG. 1.

FIG. 3 is an enlarged side elevation of one of the blast transparent wheels of the mine neutralization device of the present invention.

FIG. 4 is an end elevation of the wheel shown in FIG. 3.

FIG. 5 is a view of a wheel spoke which is utilized in the wheel of FIGS. 3 and 4, the spoke being shown in a flattened condition prior to its being bent into the curved condition in which it is mounted on the wheel as shown in FIG. 3.

FIG. 6 is a perspective view of an alternate form of blast transparent wheel for use in the mine neutralization device of the present invention.

FIG. 7 is a side elevation of a boom utilized with the mine neutralization device of the present invention and illustrates, by means of sequentially activated positions of the boom, the energy dissipation cycle that may occur when a land mine is detonated by a boom mounted wheel.

FIG. 8 is a perspective view showing the arrangement wherein a wheel is mounted on the front end of a boom.

FIG. 9 is a diagrammatic representation of the pneumatic system utilized for operating the device of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIGS. 1 and 2, the numeral 10 identifies a mine neutralization device, embodying the present invention, that is mounted on a tank 11 in the manner illustrated in FIG. 1. The device is suited for neutralizing, i.e., detonating, land mines buried in the ground and situated in the path of travel of the tank. The device 10, as best shown in FIG. 2, includes two parallel rows of wheels 12 mounted on booms 14. The booms are connected to the tank structure and are arranged to place the wheels on the ground in front of the tank in two transversely extending rows with the wheels in one row being longitudinally aligned with the gaps in the other row so that all, or substantially all, of the ground surface between the outermost set of wheels

will be subjected to a mine detonation force prior to the entry of the tank thereon.

The mine neutralization device 10 includes a metal frame 15 suitably mounted on the forward portion of the tank 11 which frame is comprised of plates of armor that provide a compartment in which certain operative components of the device are disposed. The frame generally includes a top plate 16 hinged at one edge thereof to the top edge of a plate 18 which is secured to the forward and upper body of the tank. The plate 18 is also secured to the top edge of plate 20 that is secured to the lower body of the tank. The frame further includes a curved armor base plate 22 that is secured directly to the tank at the center portion thereof wherein it is rigidly supported upon a mounting plate 22a (FIG. 1). The compartment formed by the frame is open at the front so that booms 14 may project forwardly of the tank, as shown in FIGS. 1 and 2.

The mine neutralization device 10 further includes an air compressor 24 and an air accumulator 26 which are mounted on the rear of the tank as shown in FIG. 1. The compressor 24 and the accumulator 26 are interconnected by a length of conduit 28 (FIG. 9). The outlet of the accumulator 26 is connected to a length of conduit 30 which extends along one side of the tank (FIG. 1) and into the aforescribed frame compartment 15 where it is connected to an air manifold 31.

Each boom 14 includes an arm 32 that is pivotally anchored inside frame 15 and a plurality of struts 34 that are connected to the free end of the arm so as to project from the front of the frame. The struts 34 and the arm 32 of each boom are connected by a suitable hinge-latch device 38 which includes a metal plate 40 secured to the free end of arm 32 and a metal hinge plate 42 secured to the ends of the struts 34. The hinge-latch device 38 serves to releasably latch the struts 34 to the arm 32 so that when the device 38 is latched the struts 34 and arm 32 are rigidly interconnected. As will be explained, when the hinge-latch device 38 becomes unlatched, the struts 34 can pivot upwardly relative to the arm 32. The plate 42 is hinged to the plate 40 by a hinge pin 44 located at the top edges of the respective plates. A torsion spring 46 (FIG. 2) is wound about each hinge pin 44. Each torsion spring 46 includes a first end resting against the top face of the outer plate 42 and a second end resting against the rear face of the inner plate 40. When the outer plate 42 is caused to move away from the plate 40 (due to the effects of a blast to be described hereinafter) the torsion spring is torsioned and upward rotation of the plate 42 about the hinge pin is opposed by this torsioning of the spring. Each spring-latch device 38 further includes a latch member 50 secured to the lower end of plate 42 and a catch member 52 secured to the lower end of plate 40. The latch member 50 latches to the catch member 52 to latch the plate 42 to the plate 40. When sufficient upward force is exerted on the plate 42 by the effects of a blast transmitted through struts 34, the latch member 50 releases (unlatches) from the catch member 52 to permit upward rotation of the plate 42 as is shown in FIG. 7.

As shown in FIG. 2, each boom arm 32 has a winding 54 of insulated electrical wire wrapped around it. Each winding is connected to suitable electrical power source (not shown) that energizes the winding to establish an electromagnetic field thereabout. The arm and struts of the booms 14, the hinged plates 40 and 42, and

the other elements of the device are made of ferric metal and form a magnetic flux path for the magnetic flux created by the windings 54. The magnetic flux created at the front ends of the booms by the energized windings 54 sets up an electro-magnetic field in the vicinity of the wheels 12 particularly at ground elevation. These electromagnetic fields are effective to detonate land mines having magnetically actuated fuses, and the field pattern is such that magnetic influence fuses can be actuated well ahead of the tank.

The rear end of each boom arm 32 is situated between a pair of corresponding anchor plates 56 secured to the frame plate 18. Each anchor plate includes an opening which is adapted to mate with an opening in the end of each arm 32, and a pin 58 is utilized to pivotally anchor each arm to the corresponding pair of anchor plates (FIG. 2).

The struts 34 of each boom 14 are each connected to wheel supporting yokes 60 in the manner shown in FIG. 8. As shown in FIG. 2, the struts 34 of the booms are not all of equal length, the longer booms including struts that are longer than the struts of the shorter booms. The yokes connected to the booms having the shorter struts differ slightly from the yokes connected to the booms having the longer struts. The yokes at the front ends of the shorter booms 14 are constructed, as shown in FIG. 8, to include a U-shaped strap 62. The straps 62 of the yokes that are attached to the shorter booms provide physical isolation between adjacent wheels and booms so as to safeguard against entanglement of adjacent wheels and booms should lateral deflection of a boom occur as a result of the detonation of a land mine. In FIG. 8, the yoke includes a wire snagging tine 63 which is attached to the outboard sides of only the two outermost booms for the purpose of snagging mine actuating trip wires strung on the ground.

The wheels 12 of the mine neutralization device 10 may be constructed generally as shown in FIGS. 3 and 4. The wheel includes a central hub 64 journaled on a shaft 66 and includes curved metal spokes 68 secured to the hub 64 and extending radially therefrom. Each spoke 68 (FIG. 5) is comprised of a U-shaped leg 70 bent into an arcuate shape as shown in FIG. 3. The inner ends of the spokes 68 are fastened to the hub 64. Metal reinforcing rods 74 are welded to the leg 70 to provide a uniform ground contact pattern. Steel cables 76 are attached to the legs 70 as shown in FIGS. 3 and 4. The cables 76 are arranged in criss-cross relationship (FIG. 4) to each other and tie the outer ends of the spoke to the inner end thereof to reinforce the spokes against deformation. A single spoke 68 is shown in flat projection in FIG. 5 to further illustrate the configuration of the wheel spokes and the way in which the rods 74 are secured to the U-shaped leg 70. The projection ends of the central shaft 66 (FIG. 4) of each wheel are adapted to be rigidly secured within the lower end of the supporting yoke 60 so as to mount the wheel for free rotary movement.

Thus, each wheel 12 is a lightweight structure including a lattice of flexible spokes 68 that are designed to yield radially inward to survive the effects of a mine detonation occurring beneath the wheel. The spokes 68 of the wheel are arranged to form two generally continuous, circular load application surfaces that are defined by the arcuate spoke portions at the periphery of the wheel lattice. The metal rods 74 interconnecting the arcuate spoke portions of each spoke near the wheel

periphery form a load application surface pattern. When a mine is detonated under a wheel the spokes are the only elements of the device that are directly exposed to the hypervelocity shock wave that occurs close to the explosive.

The wheel of FIGS. 3 and 4 includes spokes with arcuate legs 70 with the spokes being arranged so that the outer end of each spoke overlaps the arcuate legs of an adjacent spoke. This overlapping enables a blast deflected spoke to engage a deflection limiting bar 72 attached across the leg 70 of the adjacent spoke. In this way, a blast deflected spoke may be supported by the adjacent spoke while sustaining a blast force and prevented from undergoing treatment deformation.

The wheel of FIGS. 3 and 4 is well suited for its purpose insofar as the spokes 68 are flexible elements that can flex radially toward the hub 64 when the wheel experiences an upward acting blast force. An alternate form of wheel which may be satisfactory for the purpose at hand is shown in FIG. 6. The modified form of wheel 12a of FIG. 6 includes a metal hub 64a and generally radially oriented metal spokes 68a. The spokes 68a are U-shaped members which include radially extending end portions 70a and intermediate connecting portions 72a which latter portions are not in parallel relationship with the wheel axis. The wheels 12a can be utilized in a mine neutralization device similar to that described hereinbefore.

In the mine neutralization device 10, a plurality of pneumatic devices 80 are disposed in the compartment formed by the frame 15 in the manner indicated in FIG. 1. Each pneumatic device 80 is disposed beneath a respective boom arm 32 and includes a cylinder 82 and a piston rod 84 which is connected to a piston head received within the cylinder. The lower end of each cylinder is pivotally anchored by means of a pin coupled to a respective anchor block 86 secured to the base plate 22. Each piston rod 84 projects from the free end of its associated cylinder into a vertical opening 88 (see FIG. 2) within the overlying boom arm 32. Each piston rod 84 is connected to the overlying boom arm by means of a pin 85 which is fixed within the boom arm and rotatably secured within the upper end of the piston rod to couple the piston rod to the boom arm in the manner illustrated in FIG. 2. Each cylinder 82 is double acting and has a restriction orifice 114 near the top end of the cylinder. The orifice near the top end of each cylinder is connected to an air hose 90 that is, in turn, connected to the air manifold 31. The lower end of each cylinder is connected by means of an air hose 92 to a selector valve 94 (shown only in FIG. 9).

FIG. 9 is a diagrammatic illustration of the pneumatic system which is incorporated in the mine neutralization device 10 particularly illustrating the way in which the various system components are arranged. As shown in FIG. 9, the pneumatic system includes the aforesaid air compressor 24, the accumulator 26, the pneumatic devices 80 (only a portion of the devices 80 are represented in FIG. 9 for the purposes of illustration), and the air manifold 31. The pneumatic system also includes a control valve 102 and the aforementioned selector valve 94, both of which will be described in more detail hereinafter.

The air compressor 24 is a gasoline engine driven unit which provides a continuous flow of compressed air. The accumulator 26 has an inlet connected to the compressor 24 by the conduit 28 and has an outlet con-

nected to the manifold 31 by the conduit 30. A check valve 108 is interposed between the compressor 24 and accumulator 26 to permit one-way flow of compressed air from the compressor into the accumulator. A regulator valve 109 is interposed between the accumulator 26 and the manifold 31 to control the system pressure. A normally closed relief valve 110 is connected to the manifold 31 to limit the air pressure in the manifold to a predetermined maximum greater than the level of air pressure established in the manifold during normal system operation. During normal operation the level of air pressure in the manifold is about 100 p.s.i. The relief valve may be set to open up when the manifold air pressure reaches a pre-set value above the system pressure, e.g., 120 p.s.i., to vent compressed air from the manifold and to limit the maximum load imposed upon the wheels. This relief valve may be actuated, for example, when all or most of the wheels rise simultaneously due to a terrain feature.

Each cylinder 82 includes a relief valve 112 near the top of the cylinder which relief valve is set to open to vent compressed air from the cylinder when the air pressure therein exceeds a level several times that of the normal system air pressure. For example, each valve 112 typically can be set to open when the cylinder air pressure builds up to about 350 p.s.i. The build up of pressure in a cylinder to 350 p.s.i. can only occur, if at all, when a land mine is detonated and the piston rod 84 moves rapidly upwardly in the cylinder due to upward pivoting of the boom under the force of the blast.

Each cylinder 82 includes an orifice 114, mentioned previously, connected to the manifold 31 by the air hose 90. The orifice serves to restrict the flow of compressed air from the cylinder during rapid forced movement of the piston rod 84, as occurs when the particular boom 14 that is coupled to the piston rod is pivoted upward by blast forces. This restricted discharge of air from the cylinder accomplishes air cushioning of the piston rod 84 and restricts its travel rate.

The manually actuated control valve 102 is included in the system to control the position of the booms. For simplicity, the valve actuator is shown in FIG. 9 in the form of a rotatable lever 120 which lever can be operated between three positions corresponding to three different valve conditions. The lever 120 can be placed in a first position to fully close the valve 102 and to operatively disconnect from the air supply and vent both the manifold 31 and the selector valve 94. The lever 120 can be placed in a second position wherein the valve 102 is open to operatively connect the manifold 31 to the accumulator 26 and to vent the selector valve 94. Finally, the lever can be placed in a third position wherein the valve 102 is open to operatively connect the selector valve 94 to the accumulator and to vent the manifold.

The selector valve 94 is designed to selectively connect the air supply through an inlet line 122 to one or all of the conduits 92 leading to the lower end of the pneumatic cylinders 82. The valve 94 can be actuated into any of 16 different valve positions, as, for example, by manual actuation of a lever (not shown) coupled to the valve to connect all of the cylinders 82 to the accumulator 26 or to selectively connect any one particular cylinder to the accumulator. When the selector valve 94 is in a first position it connects a selected hose 92 to the conduit 122 that connects the valve 94 to the

valve 102. If the valve 102 is positioned to connect the accumulator 26 to the valve 94, the particular cylinder 82 connected to the selected hose 92 is supplied compressed air. When the selector valve 94 is in a second position it connects a second selected hose 92 to the conduit 122. If the valve 102 is still positioned to connect the accumulator to the valve 94, the particular cylinder 82 connected to the second selected hose will be supplied compressed air. In this manner, any particular cylinder can be supplied compressed air from the accumulator 26. When the valve 94 is in its 16th position, it connects all fifteen lines 92 to the accumulator 26 and all cylinders are activated.

During the operation of the aforescribed system, the air compressor 24 operates to supply compressed air through the check valve 108 to the accumulator 26. The job performed by the system at any particular time depends upon the condition of the valves 102 and 94. If it is desired to rest the wheels 12 on the ground without applying a pressure load to the wheels, the valve 102 is positioned so that the manifold 31 and valve 94 are both operatively disconnected from the accumulator 26 and vented. Such operative disconnection cuts off the flow of compressed air from the accumulator to the manifold and to the valve 94. Forward movement of the tank causes the wheels 12 to roll over the terrain without having to bear any portion of the tank weight.

When it is desired to perform a mine neutralizing or detonating function, the valve 102 is operated to operatively connect the accumulator 26 to the manifold 31. Compressed air, at about 100 p.s.i., flows from the accumulator 26 into the manifold 31 and into all of the cylinders via the restricted inlet orifices 114. The compressed air flowing into the cylinders forces the piston head downwardly. The booms 14, being coupled to the piston rods 84, are all urged downward about their pivoted ends to press the wheels 12 against the ground. Movement of the tank over the terrain rolls the wheels over the ground as part of the tank weight is transferred to the wheels by the forces imposed upon the booms.

When it is desired to lift all of the wheels 12 off the ground, the valve 102 is operated to operatively disconnect the manifold 31 from the accumulator 26 and to operatively connect the accumulator to the valve 94. The valve 94 is operated to operatively connect each cylinder 82, via the hoses 92 and the conduit 122, to the valve 102. When this has been done, compressed air flows from the accumulator 26 through the valves 102 and 94 into the cylinders 82 via the cylinder inlets near the bottom ends of the cylinders. The compressed air flowing into the cylinders 82 forces the piston rods 84 upwardly in the cylinders thereby raising the front ends of the booms 14 to lift the wheels 12 off the ground. When the piston rods are fully extended from the top ends of the cylinders, the wheels may be held about 4 feet above the ground so as to permit normal travel of the tank 11 or other vehicle which is designed to carry the mine neutralization device of the present invention.

When it is desired to lift a particular wheel 12 off the ground while keeping the other wheels on the ground for the purpose of maintenance or wheel replacement, the control valve 102 is operated to operatively connect the accumulator to the selector valve 94, and the selector valve 94 is operated to operatively connect a particular cylinder 82, coupled to the boom 14 supporting the wheel 12 to be lifted, to the accumulator

26. Compressed air flows from the accumulator 26 through the valves 102 and 94 and into the particular cylinder 82 via the cylinder opening near the bottom end of the cylinder.

FIG. 7 illustrates the way in which the energy dissipation cycle of a wheel and boom unit occurs during a mine detonation. More particularly, FIG. 7 illustrates the way in which a wheel 12 which has detonated a pressure activated land mine M can be pivoted upward in order to accomplish dissipation of blast energy. In the following discussion it will be assumed, for ease of explanation, that the wheel 12 and the struts 34 of the boom 14 are subjected to a blast force of large magnitude when the land mine M is detonated. When the mine explodes, the blast force accompanying the explosion acts with greatest impact on the wheel spokes 68 which are nearest to the ground. These spokes 68 flex, in response to the blast force, toward the center of the wheel. The ends of the flexed spokes are moved by the blast force between portions of the arcuate legs 70 of the adjacent spokes and engage the limiting bars 72 thereof. The front end of the boom 14 is pushed upward by the blast force causing the boom to pivot upward about its pivotally mounted end. The upwardly pivoting boom moves the associated piston rod 84 until it is fully extended from its cylinder 82. The top plate 16 of the frame compartment 15 can be lifted upward about its hinge connection to back plate 18 by the upward movement of arm 32. The fully extended piston rod 84 arrests the upward pivoting movement of the arm 32 and prevents further movement thereof. The struts 34 at the outer end of the boom may continue to move, however, to dissipate the blast forces. The struts 34 act on the hinge-latch device 38 to urge the plate 42 out of latching relation with the plate 40. When sufficient force is exerted to unlatch the latch member 50 from the catch member 52, the outer end of the boom will be free to move, and the struts will then pivot upward about the axis of the hinge pin 44 to swing the plate 42 away from the plate 40 while lifting the wheel 12 further off of the ground. The torsion spring 46 acts to oppose upward swinging of the plate 42 and thereby acts to slow the rate of upward movement of the end of the boom. When the end of the boom eventually ceases its upward movement it will fall back until the plate 42 swings into engagement with the plate 40 and the latch member 50 latches with the catch member 52. A hydraulic damper may be provided to slow this return. The arm 32 will pivot downwardly about its pivotal mounting as the wheel 12 is carried back onto the ground. System pressure is thereafter reestablished in the cylinder 82 and the boom again presses the wheel 12 into pressure contact with the ground.

In the case just described the blast force is of large magnitude because a land mine with a high explosive charge has been detonated. In other instances where the blast force is of moderate magnitude the device 38 may not become unlatched because the undissipated blast force may be too little to accomplish unlatching of the device once the arm 32 has reached its highest pivot position. In an instance where the blast force is of low magnitude the arm 32 may not reach its highest pivotable position.

The spoke assemblies of the wheel 12 are designed so that the loss of a spoke assembly by explosion damage will not appreciably affect the rolling capability of the wheel. A mine detonation directly under a wheel 12

may cause the loss of one or more reinforcing rods 74 with only a small decrease in the overall effectiveness of the wheel 12.

In light of the foregoing description it is now convenient to discuss various aspects of the disclosed device which may promote a better understanding of the present invention.

As may now be apparent, the open-type lattice of spokes utilized in the wheels 12 allows most of the blast energy to pass through the wheels without effect. The cylindrical shape and small diameter of the wheel spokes also acts to allow only minimum coupling of the blast energy to the wheels, and the flexibility of the wheel spokes minimize coupling of blast energy to the wheels. The booms 14 are comprised of cylindrical struts 34 at wide spacings whose configuration imparts a desired low energy coupling characteristic to the booms and makes the booms blast transparent in both the vertical and horizontal directions.

The pneumatic system for controlling the booms permits the application, regulation, and removal at will of wheel-to-ground pressure loads. The system permits the booms to pivot up and down with respect to each other when clearing land mines located in uneven terrain and also permits application of constant force application by the wheels to the ground, regardless of substantial variations in ground elevation, because of the steady air pressure supplied to each of the pneumatic cylinders 82. As any boom 14 rises, due to terrain variations, air is displaced from the associated cylinder 82 and forced into the manifold 31. This action causes the system pressure to raise in proportion to the height of boom travel and in proportion to the number of booms raising. The increase in system pressure results in a greater pressure load being transmitted by the booms to all of the wheels 12.

The entire mine neutralization device 10, with the exception of the compressor 24, the accumulator 26 and the conduit 30, can be attached to the front of the tank so as to be readily jettisoned from the tank. To this end, the components of the pneumatic system, with the exception of the components 24, 26 and 30, can be located in the frame compartment and the main air pressure lines can be equipped with automatic disconnect and self sealing provisions.

The pneumatic system has an operating pressure of about 100 p.s.i. If all of the booms 14 rise simultaneously, the pressure relief valve 110 in the manifold 31 limits the maximum system pressure. The cylinders 82 are provided with restricted orifices 114 which discharge air from the cylinders during this upward movement of the booms so that when a sudden large movement of any boom occurs, such as will happen with a large mine detonation, the pressure in the associated cylinder will raise to several times the operating pressure. The associated cylinder relief valve 112 will then open to prevent damage to the cylinder. The increasing pressure in the cylinder thereby aids in absorbing the shock energy of the mine blast.

The ability of the mine neutralization device 10 to accomplish controlled blast energy dissipation is a significant characteristic of its operation. Since it is not possible to avoid coupling of some blast energy into the wheels 12 and their supporting structure, means are provided for dissipating the coupled energy without damaging any portion of the device. The described device is designed so that the coupled energy is controlled

and dissipated over an appropriate time span whereby the resulting stress forces acting on the structure of the device can be held below the yield point of the material of which the device is comprised.

Three levels of blast energy dissipation are provided. The first level of energy dissipation is that which may be absorbed in the resiliency of the wheel spokes 68. Blast energy is accepted and dissipated through the spring action of the spokes 68. Whenever the energy accepting spokes 68 of a wheel 12 are resiliently deflected enough to cause the various wheel spokes to act as stops for each other, energy is transmitted to the wheel hub 64. The second level of energy dissipation then occurs as the upward force of the blast is resisted by the pneumatic device 80 attached to the associated boom 14. The third energy dissipation level permits activation of the hinge-latch device 38. When the upward force exerted on boom exceeds a predetermined magnitude, the device 38 releases thereby allowing the wheel 12 to arc high in the air about the hinge axis of the device 38. This movement is resisted by the torsion spring means of the device 38. Return motion of the booms to the latch-up mode may be controlled by a hydraulic device (not shown) to increase the time span of energy dissipation.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

We claim:

1. In a mine neutralization device, adapted to be secured to a vehicle for use in detonating land mines located beneath the ground surface over which the vehicle travels, the combination comprising;
 - a frame which is securable to a vehicle, the frame including a boom support structure;
 - a plurality of booms projecting from said frame, each boom in said plurality thereof comprising a forward arm portion, a rearward arm portion and a latch device which is adapted to provide a releasable latched pivotal interconnection between said forward arm portion and said rearward arm portion;
 - a plurality of blast transparent wheels, each wheel in said plurality thereof rotatably connected to and supported by said forward end portion of its respective boom;
 - each boom being pivoted adjacent its rearward end by means of a pivotal connection between said rearward end portion of said boom and said boom supported structure;
 - a plurality of boom actuators, each boom actuator in said plurality thereof being connected to said rearward end portion of its respective boom and being operative to transmit a mechanical load onto the wheel supported on its respective boom to thereby pivot its respective boom downward about said pivotal connection between said rearward portion of its respective boom and said boom support structure and to dispose the respective wheel supported by said boom into pressure contact with the ground surface.

2. The combination set forth in claim 1 wherein each latch device is normally latched so that said arm portions of said booms are pivotally moveable as a unit about the respective pivotal connection of each boom with said boom structure.

11

3. A mine neutralization device comprising;
an array of individually pivoted booms each mounted
so as to be pivotable in a vertical plane, each boom
including a first portion and a second portion;
a plurality of wheels, each wheel being rotatably supported at one end of said second portion of a particular one of said booms, means associated with said first portion for pivotally urging each boom in a downward direction;
and means for mounting said mine neutralization device on a vehicle so that the booms project forwardly from the vehicle to dispose the wheels on the ground in front of the vehicle;
each wheel having a generally circular wheel periph-

12

ery and being comprised of an open frame construction so as to be blast transparent;
plus means for pivotally connecting the second portion of each boom to the first portion thereof, said last named means including a latch for normally maintaining said boom portions in a rigidly coupled relationship.

4. The apparatus set forth in claim 3 wherein each of said latches are arranged to be unlatched when subjected to blast forces of a high magnitude to permit the second portion of the associated boom to pivot vertically upward relative to the first portion of the boom.

* * * * *

15

20

25

30

35

40

45

50

55

60

65