

[54] **HYDRAULIC AND MECHANICAL NO-CUT EARTH WORKING MACHINE**

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[51] **Int. Cl.²** **B02J 5/06**

[58] **Field of Search** **37/1, DIG. 1, DIG. 19, 37/86, 117.5; 172/6; 340/419, 421; 214/761, 762, 138 R**

[56] **References Cited**

UNITED STATES PATENTS

1,850,412	3/1922	Pavlik	37/86
3,190,476	6/1965	Smith et al.	172/6 X
3,653,523	4/1972	Long	214/138 R

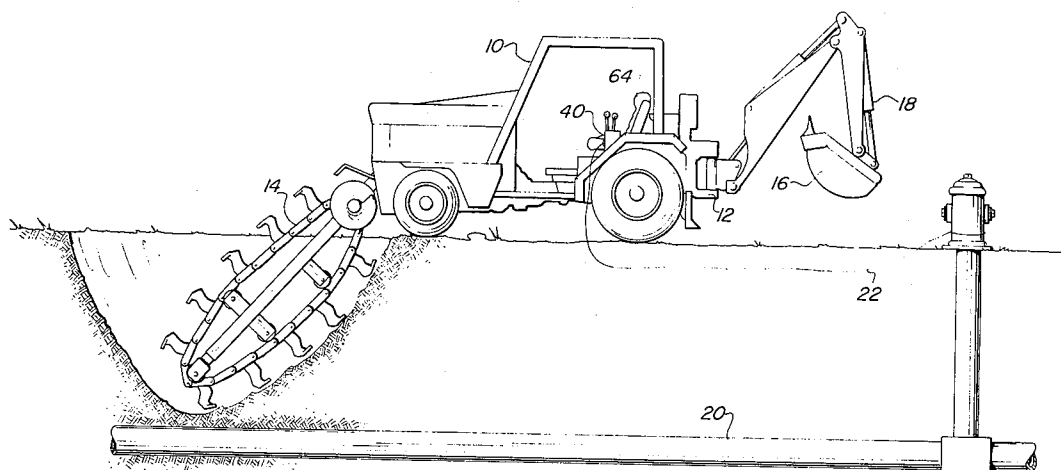
3,817,411 6/1974 Brown 214/138 R

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[57] **ABSTRACT**

An earth working machine having both mechanical and hydraulic controlled equipment is provided with an electronic circuit to prevent the earth working implements on the machine from cutting buried metal objects such as communication cables, water pipes, and the like. When the electronic equipment detects when the earth working implements are near or contacting the underground object, both the hydraulic system is immobilized and the mechanical drive clutch disengaged. Provision is made to prevent the probe from acting as a radio antenna and, also, a seat switch is provided to disable the equipment should the operator be thrown from his operating position.

5 Claims, 2 Drawing Figures



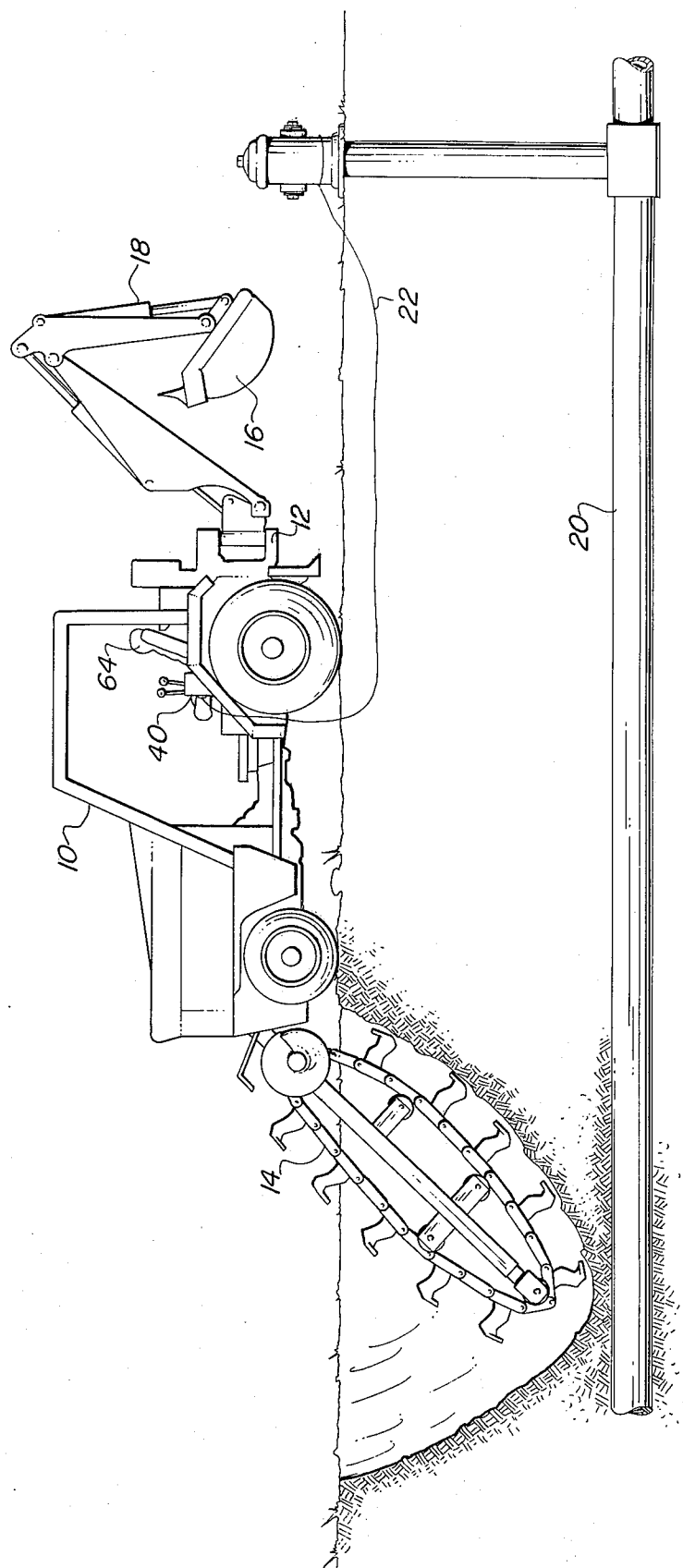


FIG. 1

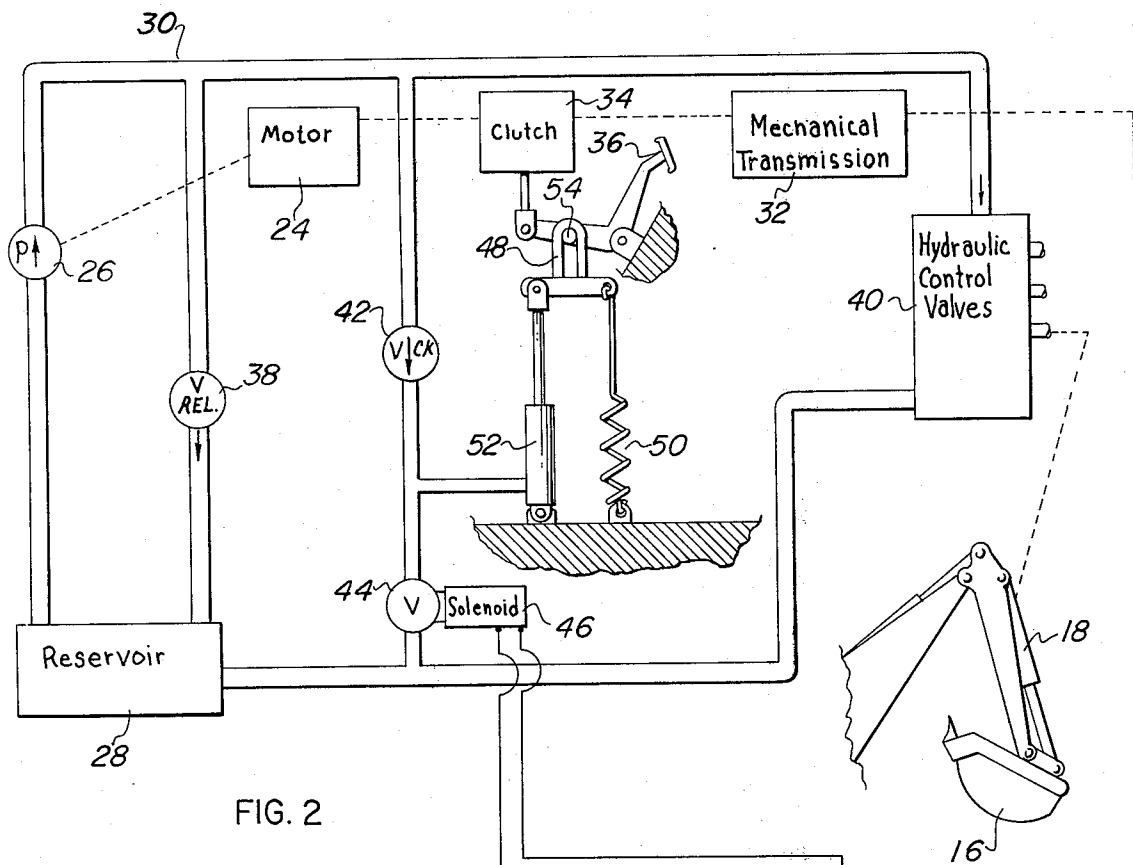
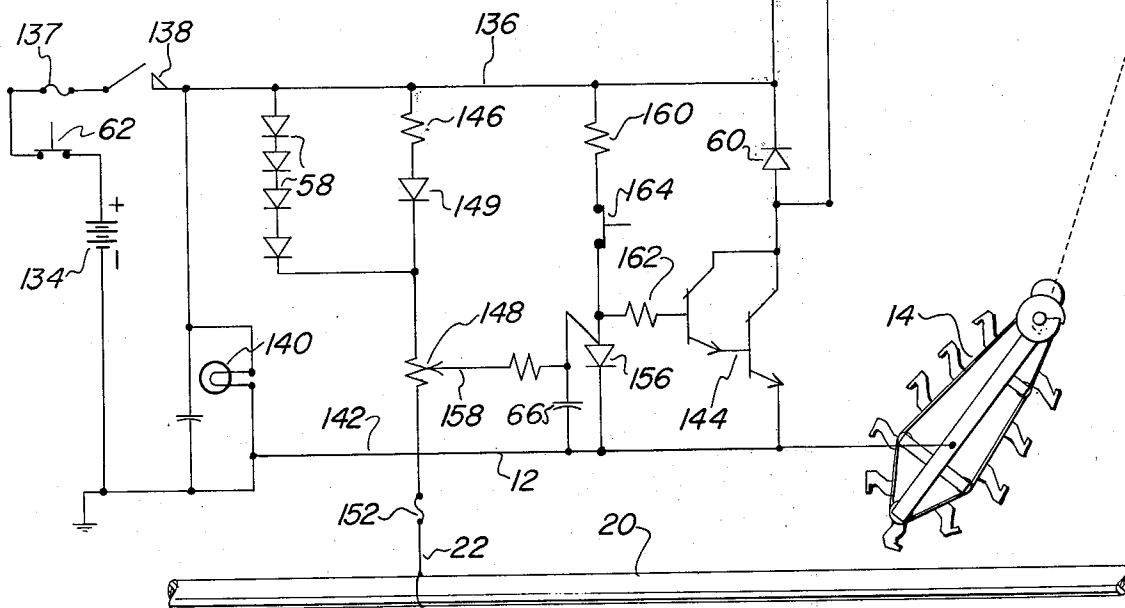


FIG. 2



HYDRAULIC AND MECHANICAL NO-CUT EARTH WORKING MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS:

This patent application is related to patent application Ser. No. 399,551, filed Sept. 21, 1973, by Johnny Lee Broyles. The two applications are owned by the same assignee. The title of the Broyles application is EARTH WORKING MACHINE PROTECTOR.

BACKGROUND OF THE INVENTION:

1. Field of the Invention.

This invention relates to earth working equipment having hydraulically controlled elements as well as mechanically driven elements and more particularly to electronic devices to prevent such equipment from cutting buried pipes or cables.

2. Description of the Prior Art.

Before my invention, various pipe or cable locators were well known. They were used to locate the position of underground pipes and one common system generated a 20cps (cycle per second) alternating electrical signal and applied the signal to the pipe. A detector was used to search for this signal and thus the pipe. Other systems were to attach wire to the pipe and then check for electrical continuity when a probe or earth working tool touched the pipe. Also before my invention, it was known that when an underground pipe was detected by an earth working tool, an alarm could be given or a hydraulic system of the earth working machine could be blocked. By blocked, I mean that a valve in the high pressure line could cutoff the high pressure line. The following examples of the prior art were known to me before filing this patent application:

Pavlik	1,850,412
Maust	2,131,291
Maddox	2,243,876
Sheehan et al	2,409,397
Stryker	2,561,152
E. Smith et al	3,190,476
Albrecht	2,615,969
Winters	2,789,282
Popelier	3,170,579
Strenger, Jr., et al	3,296,494
Hansenbaig	3,407,895
Humphreys, Jr.	3,418,572
Long-Short	3,653,523
Kelly	3,648,282
Fuzzell	3,659,734

In addition to the above, I am familiar with the commercial embodiment of the Broyles invention identified above. This invention, of course, used a key switch to the electronic circuits so that without the key for the electronic circuits, the machinery could not be moved. In addition, that equipment used the fail-safe valve so in the event of loss of electrical power, the equipment would shut down.

SUMMARY OF THE INVENTION:

1. New and Different Function.

Certain types of earth working machines, such as chain ditchers, have portions of them mechanically driven while other portions are hydraulically driven. Also, many types have a demand only hydraulic system. A demand only hydraulic system is one using a control valve wherein if there is no movement of a particular piece of equipment, the hydraulic pump is bypassed so

there is no high pressure on the hydraulic lines. I.e., there is high pressure on the hydraulic lines only when hydraulic pressure is needed.

My invention provides a portion of the system wherein hydraulic pressure is captured to hold a clutch in an operative position.

Explaining further, a spring is attached to bias a mechanical clutch into the disengaged or inoperative position. The clutch is permitted to be in the engaged position only if there is hydraulic pressure. Thus, any failure of the equipment will cause a disengagement of the clutch. However, with a demand only hydraulic system, it is necessary that a certain amount of the pressure be captured and held at all times so the spring can be held in a tension position, permitting the clutch to remain operative.

It is important that the equipment be quickly stopped upon contact with the pipe. Additional movement of a few millimeters will injure the pipe or cable.

In addition to this, it is desirable for safety to have the machine inoperative in the event the operator is thrown from his seat. I.e., if some attempt is made to operate the machine while the operator is not in the seat, it is disengaged. This is provided by a pressure switch in the seat so the operator must be seated in the seat before the machine will operate.

2. Objects of this Invention.

An object of this invention is to protect underground metal objects such as cables or pipes from being cut by earth working machines.

Further objects are to achieve the above with a device that is sturdy, compact, durable, lightweight, simple, safe, efficient, versatile, and reliable, yet inexpensive and easy to manufacture, install, adjust, operate, and maintain.

Other objects are to achieve the above with a method that is versatile, rapid, efficient, and inexpensive, and does not require skilled people to install, adjust, operate, and maintain.

The specific nature of the invention, as well as other objects, uses, and advantages thereof, will clearly appear from the following description and from the accompanying drawing, the different views of which are not necessarily to the same scale.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. 1 is a side elevational view of an earth working machine with an embodiment of this invention shown thereon schematically.

FIG. 2 is a schematic representation of the hydraulic and electronic systems of the machine according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

Referring specifically to FIG. 1, there may be seen represented vehicle 10, having frame 12. Endless chain ditcher 14 is attached to the frame 12 of the vehicle 10. On the forward end of the vehicle, backhoe 16 is attached to the frame. The backhoe 16 has various hydraulic cylinders or hydraulic motors 18 connected thereto to operate same as is well known in the art.

The structure as described to this point is old and well known to the art and is commercially available on the market.

To prevent the earth working implements, either the backhoe 16 or the chain ditcher 14, from injuring a metal object underground, such as a buried pipe 20, an electrical probe 22 extends from the vehicle and is attached electrically to the underground pipe 20. The probe 22 is attached to an electronically controlled device which will be described later so that if either of the earth working implements were to touch the pipe or become proximate thereto, corrective measures are taken to prevent further advancement of the vehicle which would cause the implement to injure the pipe 20.

It will, of course, be understood that the vehicle has motor 24, such as a gasoline internal combustion engine, thereon. This is schematically shown in FIG. 2, and it will be understood, of course, that it is present in FIG. 1, the motor being connected to frame 12. The motor 24 is connected to hydraulic pump 26, which pumps hydraulic fluid from hydraulic reservoir 28 to high pressure line 30. The motor also is connected to mechanical transmission elements 32 by clutch 34. The clutch is normally controlled by clutch pedal 36 through conventional lever mechanisms. Relief valve 38 extends from the output high pressure line 30 of the pump 26. Also, hydraulic control valves 40 are attached from the outlet of the pump through the high pressure line 30 to the hydraulic reservoir 28. Of course, at least one of the hydraulic valves is attached to the hydraulic motor 18 upon the backhoe. The drive for the chain ditcher 14 may be either mechanically driven through the mechanical transmission 32 (as illustrated) or it may be provided with a hydraulic motor and be hydraulically driven through the hydraulic control valves.

It will be recognized that the elements identified by numerals from 24 through 40 are conventional and well known to the art and commercially available on the market in the combination as described.

In addition to the above, check valve 42 is connected to the output of pump 26. It is connected so fluid can flow freely through the check from the high pressure line 30 back toward the hydraulic reservoir 28. However, the flow through the check valve 42 is prohibited in normal operation because the outlet from the check valve 42 connects into solenoid valve 44. If the solenoid valve 44 is closed, there can be no fluid flow through this path back to the hydraulic reservoir.

The check valve 44 is a normally open valve, i.e., if there is no electrical voltage attached to the solenoid portion 46, the valve will be open. The entire hydraulic mechanism of the vehicle will be inoperative unless electricity is provided to the solenoid 46 from the valve 44.

Slotted bar 48 is attached to the frame of the vehicle through hydraulic cylinder 52. Spring 50 extends from the slotted bar also to the frame. Pin 54 extends through the slot of the slotted bar and the pin 54 is attached to the clutch pedal levers. If there is no hydraulic pressure within the cylinder 52, the spring 50 will pull the slotted bar which will pull the pin to disengage the vehicle clutch. However, the hydraulic cylinder 52 is connected so that if there is hydraulic pressure upon it, it will push against the spring 50 to permit the vehicle clutch to be engaged. The pin is free to work in the slot of the bar 48 so that the clutch may be disengaged by operation of the pedal 36. Therefore, if the pressure on the hydraulic system falls because of the opening of the valve 44, the vehicle clutch 34 will be disengaged.

If the hydraulic output in line 30 is reduced to nil or almost nil because of the operation of the hydraulic control valves 40, the vehicle clutch 34 will not be disengaged because the pressure is captured or trapped between the check valve 42 and the solenoid valve 44. However, once the solenoid valve 44 open, there will no longer be any hydraulic pressure within the output line 30.

The electronic control which provides current to the solenoid 46 in normal condition and cuts it off in the event of proximity of the earth working implement to the metal object or pipe 20 is quite similar to that disclosed in the patent application Ser. No. 399,551 by Johnny Lee Broyles which is owned by the same assignee of this application. This electronic circuit description follows.

Voltage is provided between the main line 136 and ground line 142 by a source of electrical energy such as the vehicle battery 134. One side of the electrical solenoid connection 46 is connected to the main line 136. Fuse 137 connects between the source of electrical energy or battery 134 and the main line 136 for conventional protection. Also, the connection between the source of electrical energy main line is through key switch 138. Therefore, the earth working implements upon the vehicle 10 are completely inoperative if the switch 138 is not closed by the use of a key. Indicator light 140 from the main line 136 to ground line 142 indicates electrical power is furnished to the control circuit. The ground line 142 is, in fact, the frame 12 of the vehicle 10 and, therefore, the earth working implement, such as chain ditcher 14, is part of or electrically connected to the ground line 142. As illustrated, the solenoid 46 is connected between the main line 136 and the ground line 142 through transistors 144. Therefore, if the key switch 138 is closed and the transistors 144 are conducting, the solenoid 46 will be energized, thereby closing the valve 44 and making the machine operative. However, if the transistors 144 are not conducting, the solenoid 46 will not be energized just the same as though the fuse 137 or the key switch 138 were open.

The main line 136 is connected through low value resistor 146, light emitting diode 149 and low value rheostat 148 and fuse 152 to the probe or clamp 22 and, thus, to the metal object 20 itself. Unijunction transistor 156 is connected on tap 158 on the rheostat 148.

It will be understood by those skilled in the electronic art that when the earth working implement 14 touches or is proximate the pipe 20, this change in voltage upon the unijunction transistor 156 will cause it to conduct through normally closed reset switch 164. The transistor 156 is connected to a center point between high value resistors 160 and 162. This, of course, changes the voltage upon the transistors 144 and causes them to become non-conductive and which results in de-energization of solenoid 46. The sensitivity of the controls may be controlled by the setting of the rheostat 148.

The series of four diodes 58 between the main line 136 and the rheostat 148 cause the light emitting diode 149 to be operative and to glow when good contact is made between the probe 22 and the pipe 20. The probe 22 might be several feet in length and, therefore, it would act as a radio antenna. Certain difficulties have been experienced with this probe picking up radio frequency energy (as from spark ignition systems or radio

transmitters) and triggering the device, thus, inactivating the vehicle because of this reason rather than the proximity of the earth working implement to the pipe. I have found that capacitor 66 parallel to unijunction transistor 156 is effective to prevent this. Diode 60 connected parallel to the solenoid 46 protects transistors 144 from damage when they become non-conductive. The inductance of solenoid 46 will produce a "kick" upon disconnection.

After the transistor 156 is fired to cause the transistors 144 to be non-conductive, it is necessary to open the circuit by opening the reset switch 164 so the control circuit is again ready to operate after the contact of the earth working implement 14 with the pipe 20. Again, those skilled in the art will understand that when the reset switch 164 is opened, this in itself will also energize the solenoid 46 which will close the valve 44; therefore, permitting the equipment to be operated to move the earth working implement 14 away from the pipe 20. Those skilled in the art will understand the necessity of being able to operate the equipment, otherwise a great deal of difficulty would be encountered in moving the implement 14 away from the obstruction or pipe 20. This could be achieved by temporarily disconnecting the probe 22 from the pipe 20 or by removing the fuse 152. However, to get the unijunction transistor back in proper operation, the reset switch 164 is desirable.

Pressure switch 62 is connected in series with the fuse 137 and key switch 138. It will be understood that the seat pressure switch is physically located within the vehicle seat 64 connected to frame 12 of the vehicle 10 as seen in FIG. 1. It will be readily apparent that if the operator is not in the seat enclosing the switch 62, no electrical energy will be provided to the solenoid 46; thus, disabling the equipment just as surely as though the key switch 138 were open or the earth working implement were to contact the underground metal object 20. Those skilled in the art will recognize that certain delays could be used upon the seat switch 62, these delay mechanisms could either be mechanical type delays or electrical delays. Therefore, if the pressure was not on the seat switch for a period of two seconds, the equipment would not be shut down, but for any longer period of time, it would be shut down. Delay switches are well known to the art, both physical and electronic; therefore, they will not be discussed here.

The embodiment shown and described above is only exemplary. I do not claim to have invented all the parts, elements or steps described. Various modifications can be made in the construction, material, arrangement, and operation, and still be within the scope of my invention. The limits of the invention and the bounds of the patent protection are measured by and defined in the following claims. The restrictive description and drawing of the specific example above do not point out what an infringement of this patent would be, but are to enable the reader to make and use the invention.

I claim as my invention:

1. In an earth working machine having
 - a. a motor attached to a frame,
 - b. a hydraulic earth working implement attached to the frame,
 - c. a hydraulic pump driven by the motor,
 - d. at least one hydraulic control valve attached to the frame,
 - e. said control valve forming means for

- i. providing hydraulic pressure from the pump to the earth working implement in one position and
 - ii. releasing the pressure of the pump in another position,
 - f. said hydraulic control valve interconnecting said pump and said earth working implement,
 - g. mechanical transmission elements mounted on the frame for selective activation of a second earth working implement attached to the frame and
 - h. a pedal operated clutch interconnecting the motor and said mechanical transmission elements,
 - i. the improved structure for preventing any earth working implement attached to the frame of the vehicle from damaging buried metal objects comprising:
 - j. means for detecting if any earth working implement attached to the frame is proximate the metal object,
 - k. a check valve attached to the outlet of said pump,
 - l. said check valve being means for permitting fluid flow only from the outlet of said pump to a fluid reservoir at the inlet of said pump,
 - m. a solenoid controlled valve connected to the outlet of said check valve,
 - n. said solenoid valve controlled by said means for detecting, so that said solenoid valve is open responsive to the earth working implement being proximate said metal object, and
 - o. a hydraulic clutch cylinder,
 - p. said hydraulic clutch cylinder fluidly connected between said check valve and said solenoid valve,
 - q. said hydraulic clutch cylinder being structurally connected to said clutch, whereby
 - r. opening of said solenoid valve releases the pressure upon said hydraulic clutch cylinder, thereby
 - s. disengaging said clutch to cease movement of said earth working implements.
2. The invention as defined in claim 1 with additional limitations of
- a. an operator seat on the frame,
 - b. a switch in said operator's seat,
 - c. said switch also being means for opening said solenoid valve responsive to lack of an operator upon the seat.
3. The invention as defined in claim 1 with additional limitations of
- a. a strap with an elongated slot therein attached to said clutch cylinder,
 - b. a spring attached to said strap to urge the clutch in a disengaged position, and
 - c. a pin on the clutch through the slot whereby the clutch can be disengaged by the pedal at anytime, and
 - d. loss of hydraulic pressure to the clutch cylinder causes the clutch to be disengaged by said spring.
4. The invention as defined in claim 3 with additional limitations of
- a. an operator seat on the frame,
 - b. a switch in said operator's seat,
 - c. said switch also being means for opening said solenoid valve responsive to lack of an operator upon the seat.
5. In an earth working machine having
- a. a motor attached to a frame,
 - b. a hydraulic earth working implement attached to the frame,
 - c. a hydraulic pump driven by the motor,

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- d. at least one hydraulic control valve attached to the frame,
- e. said control valve forming means for
 - i. providing hydraulic pressure from the pump to the earth working implement in one position and
 - ii. releasing the pressure of the pump in another position,
- f. said hydraulic control valve interconnecting said pump and said earth working implement,
- g. mechanical transmission elements mounted on the frame for selective activation of a second earth working implement attached to the frame, and

- h. a pedal operated clutch interconnecting the motor and said mechanical transmission elements,
- i. the method of protecting underground buried objects comprising:
- j. detecting if any earth working implement is proximate the metal object,
- k. releasing all hydraulic pressure responsive to said detection, and
- l. disengaging the clutch responsive to said detection, thereby ceasing operation of any earth working implement.

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