United States Patent

[11] **3,575,006**

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[54] **UNDERGROUND CABLE-LAYING APPARATUS**
26 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **61/72.6,**
172/40, 172/710, 172/747, 172/763

[51] **Int. Cl.** **A01b 3/64,**
A01b 11/00, F16l 1/00

[50] **Field of Search** 61/72.6,
72.5, 72.1, 72.7; 172/40, 710, 747, 763; 37/193,
(Vibr. Digest)

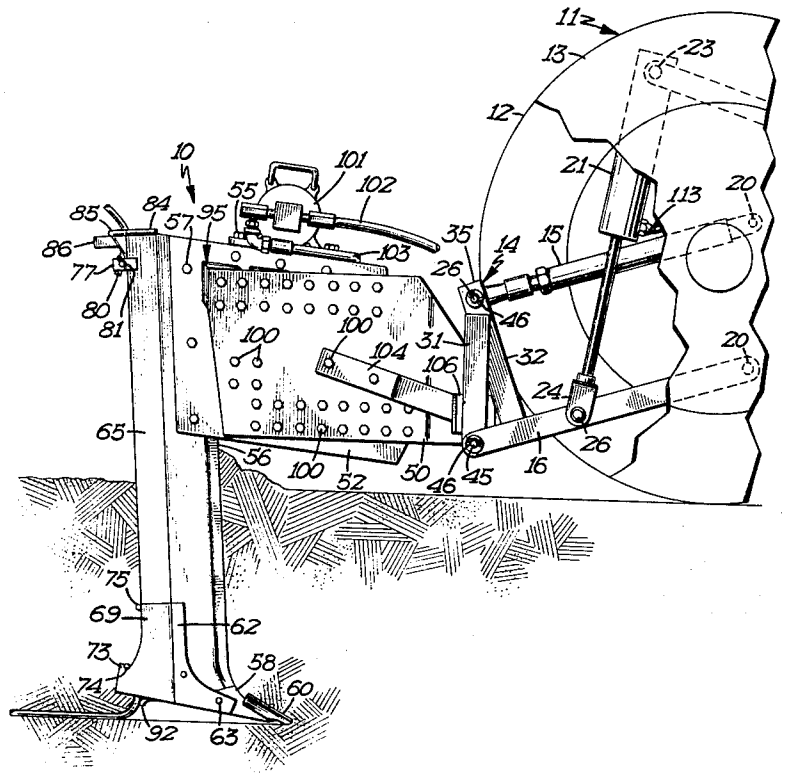
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ABSTRACT: The structure disclosed is directed to a vertical support mechanism which is generally driven and controlled through a three-point hitch of a prime mover, the mechanism being secured to a first pair of vertical plates that are pivotally secured to the vertical support mechanism at the front portions of the plates, the vertical plates being secured to a second pair of inwardly spaced plates through a plurality of elastomeric mounting and draft members and the inner vertical plates securing a blade member thereto at its upper end, the blade member being drawn through the earth at a depth sufficient to lay a cable therein after passing through a cable guide secured to the trailing edge of the blade member, the cable entering the guide from above the earth. A vibrator is secured to the blade member to substantially vibrate the blade member only, the remaining structure being isolated from the vibration through the elastomeric mountings which also serve as the draft coupling means coupling the mounting support to the blade member.



Patented April 13, 1971 3,575,006

4 Sheets-Sheet 1

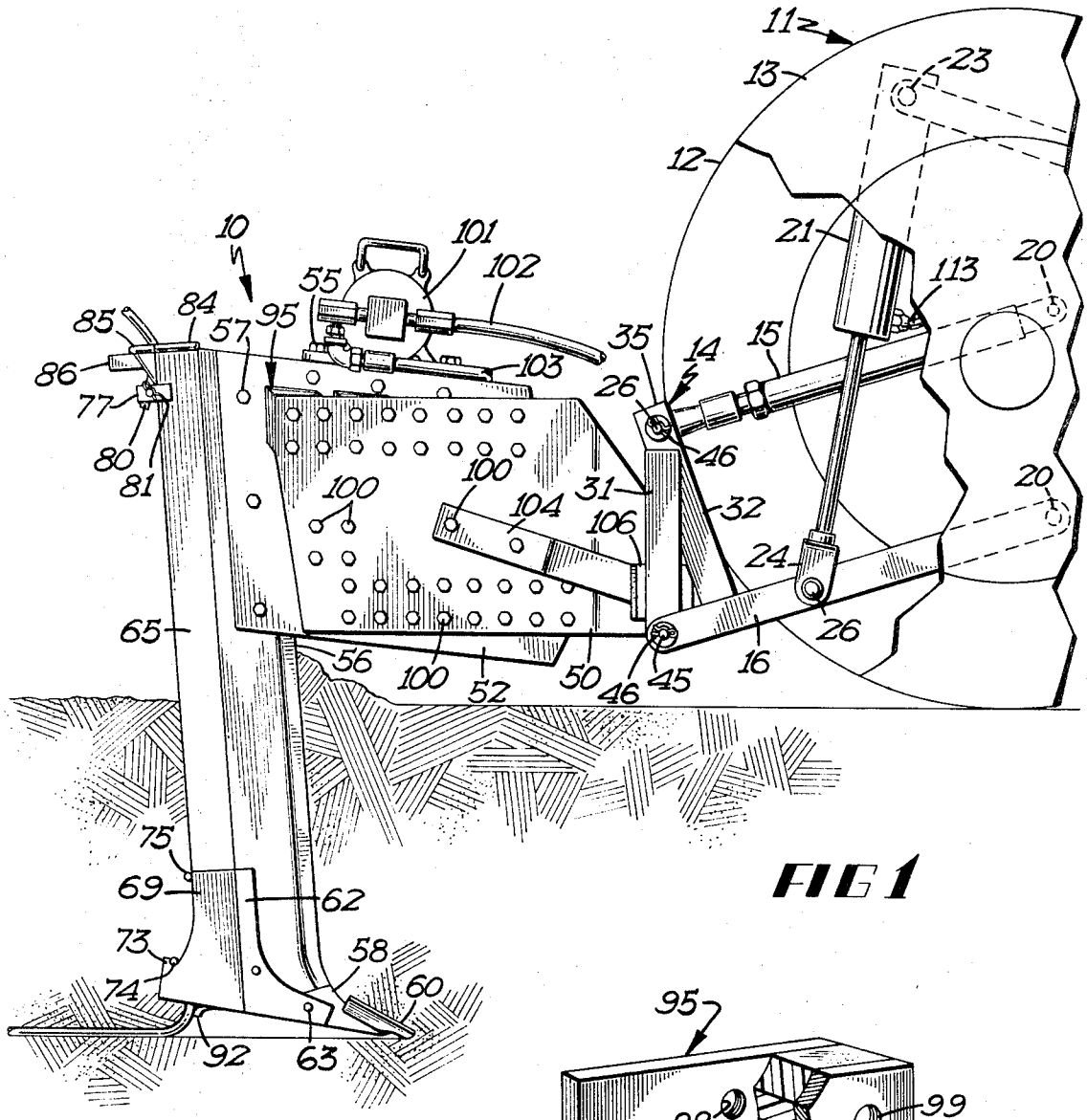


FIG 1

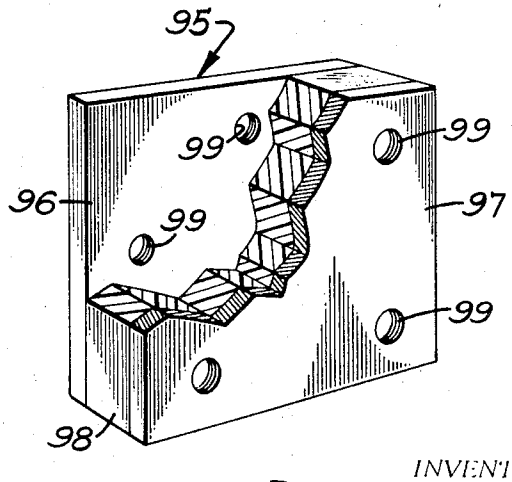


FIG 2

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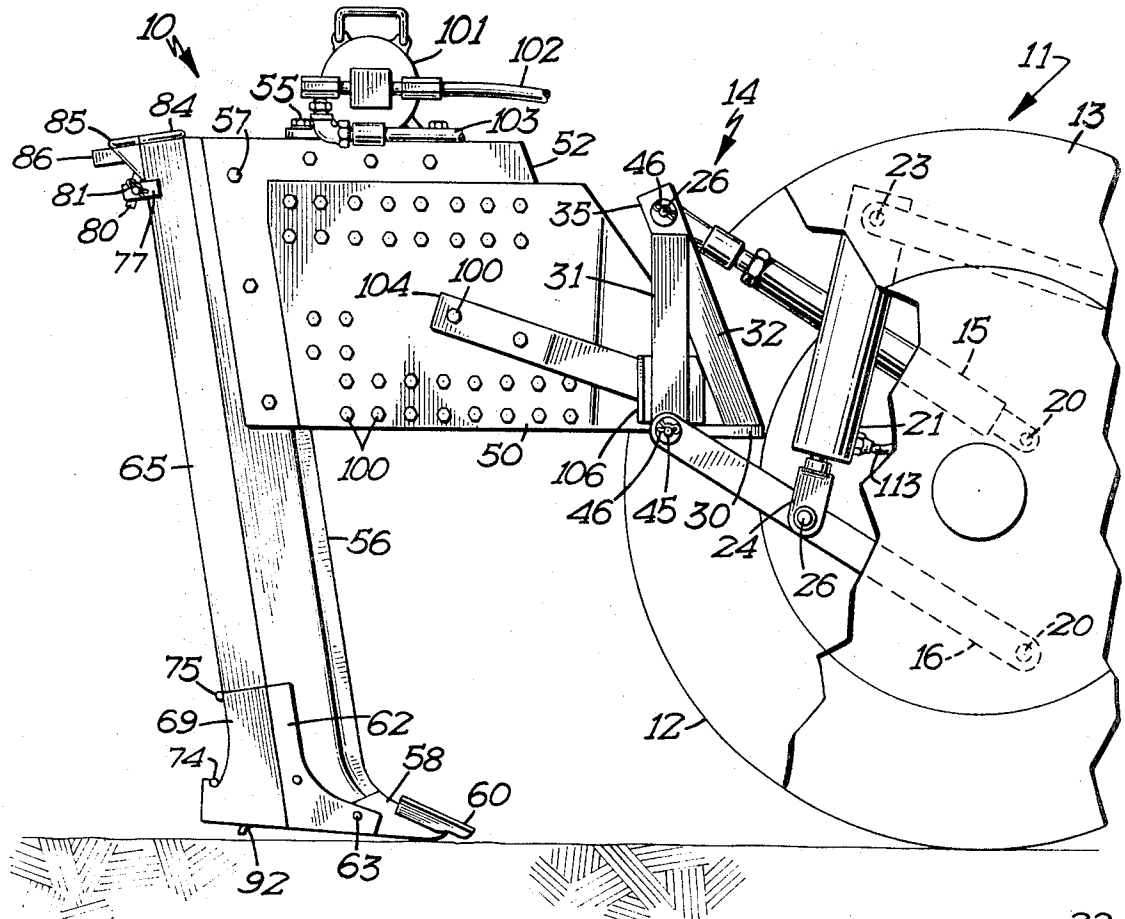


FIG 2

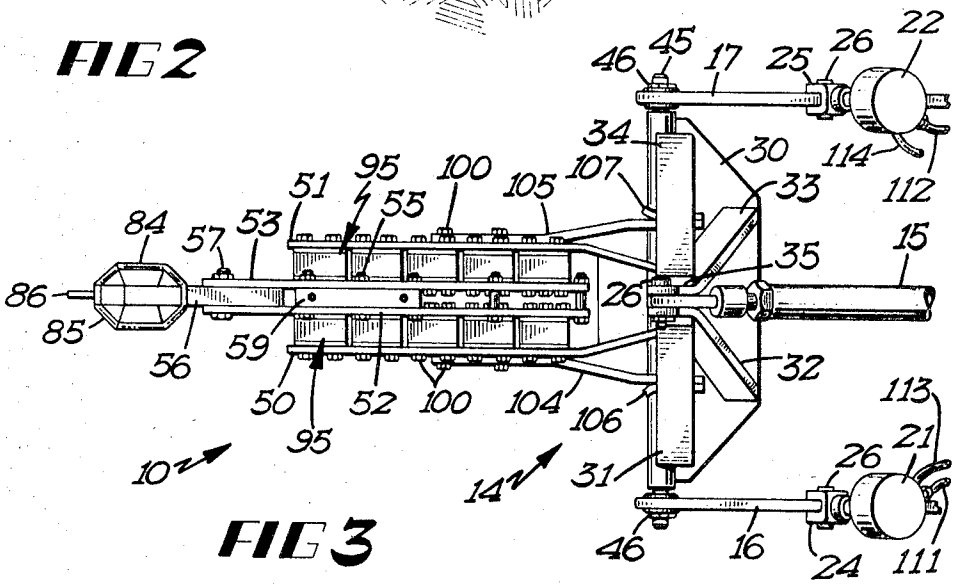


FIG 3

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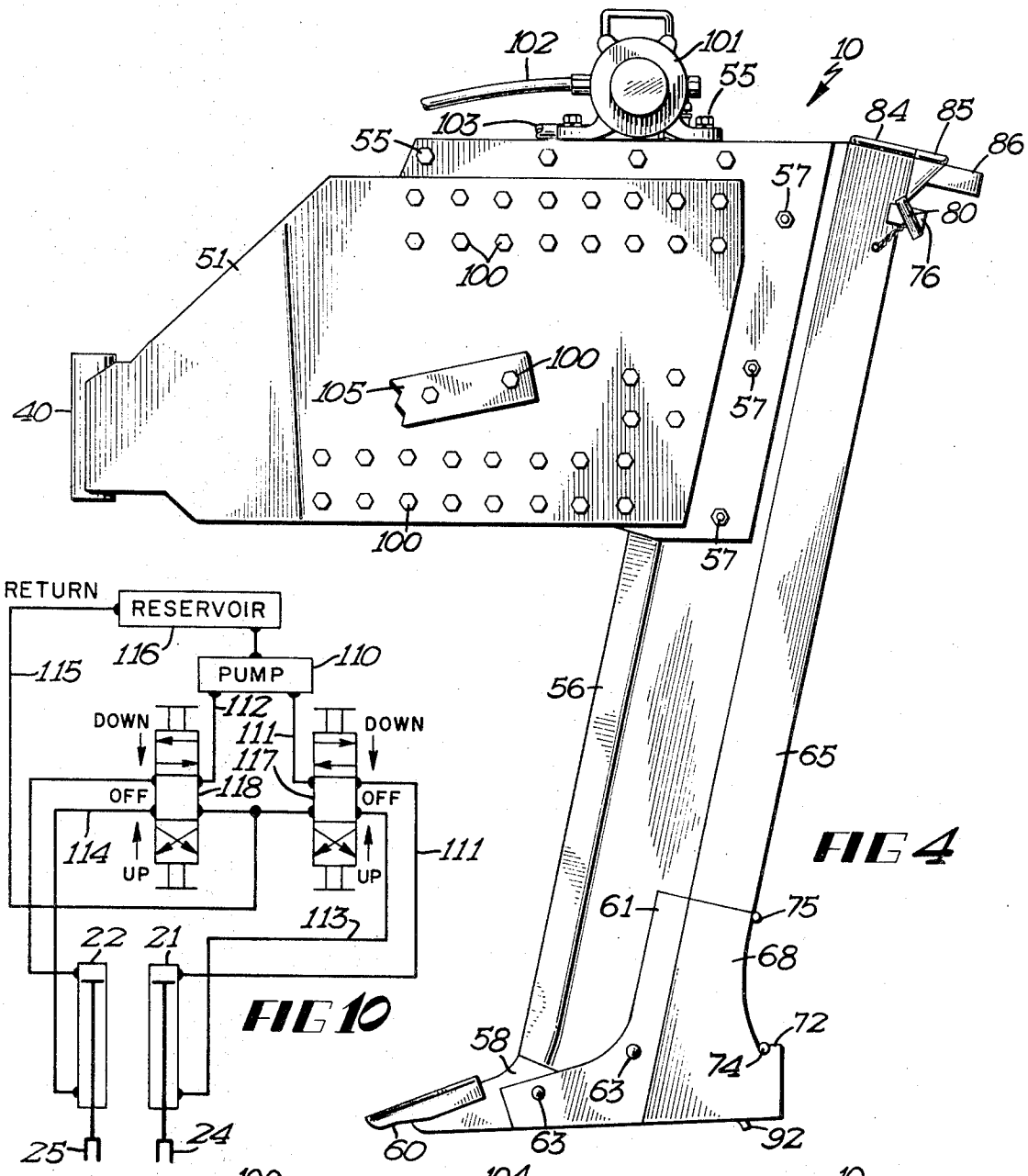


FIG 4

FIG 10

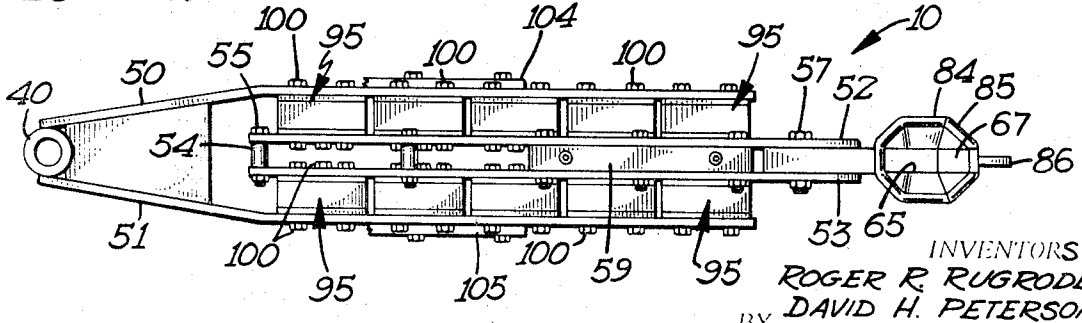


FIG 5

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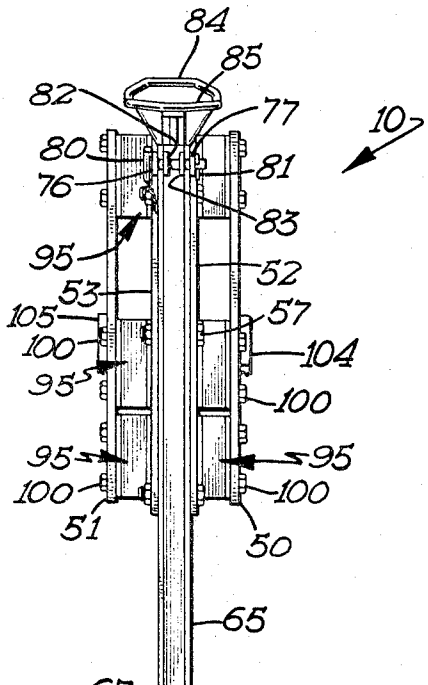


FIG 6

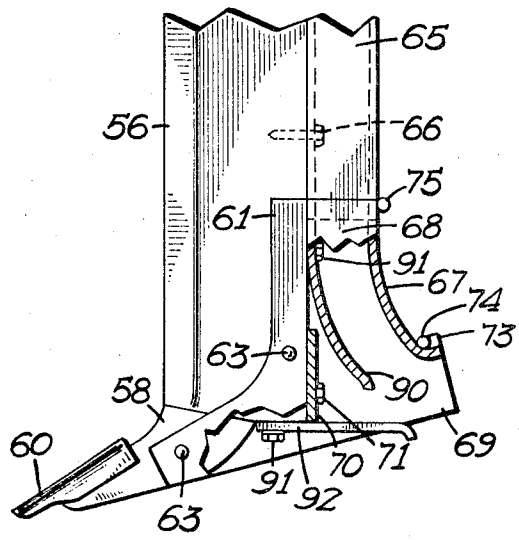


FIG 7

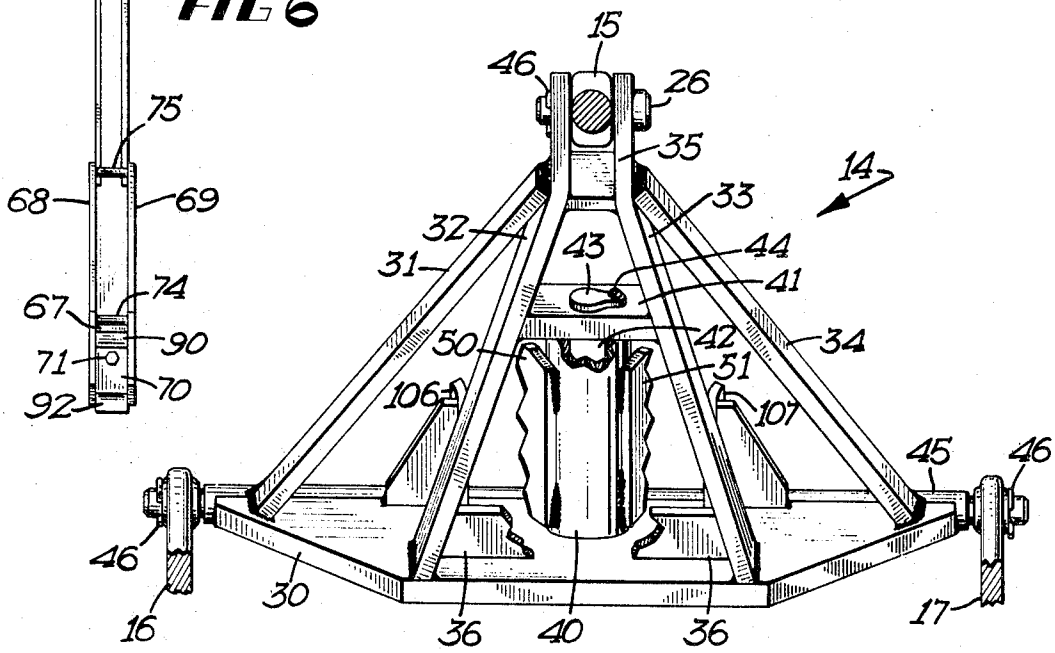


FIG 8

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UNDERGROUND CABLE-LAYING APPARATUS

This invention relates to the field of cable-laying equipment and more particularly to cable-laying equipment in which the cable is directed into the mechanism from above the ground.

Numerous devices have been constructed for laying underground cable of the communication type in which it is desirable to place the cable in the ground at least 30 to 40 inches below the ground surface and systematically bring the cable to the surface to a junction box or service point. A number of the prior art devices are designed to pull the cable through the ground after having first lowered the cable to the level at which it is to be maintained in the ground and a mole-type blade is drawn through the ground, the mole member pulling the cable through the ground behind it. This type of structure places strain on the cable and if it is desirable to pull the cable through the earth for any distance, the cable is subject to breaking or cracking some of the metal sheaths that are contained within the cables. It has been found that this particular means of laying the cable in the ground possesses a number of disadvantages.

Another type of cable-laying mechanism is the one which draws the cable through the ground by directing the cable from above the earth and the cable-laying mechanism is drawn through the ground with "brute force" by merely connecting several tread-type tractors in tandem. This generally requires an inefficient use of prime mover equipment and quite often results in damage to or breakage of equipment when an obstruction is encountered.

Another form of cable-laying equipment makes use of an eccentric mounting for the blade member or an oscillatory motion is created in the blade member, generally through an auxiliary power source wherein a shaft passes through a mounting mechanism and an eccentric is used to create an orbital or oscillatory motion in the blade itself. In other words, there is a direct metal-to-metal contact through the bearings or journals of the shaft and the vibratory motion is not only imparted to the blade member but to the entire machine and the result is that a great deal of vibration is encountered by the machine leading to breakage and fatigue of various parts of the machine. Other attempts to provide an oscillatory motion to the blade member has been through the use of a vibrator or oscillatory mechanism connected to the blade itself, where the blade is pivotally connected to its mounting means through a shaft which is journaled in some form of bearings. The blade is then allowed to move through a limited movement about the pivot axis. Again, in this type of structure, the vibratory or oscillatory motion is transmitted through the metal-to-metal contact and eventually results in the metal mounting structure carried by the prime mover absorbing part of the oscillation or vibratory motion that is intended to be applied to the blade member.

The present invention makes use of an elastomeric mounting and the same mounting is also used to support the blade member in a draft-bearing arrangement so that the blade is pulled through the earth by the elastomeric mountings. The present invention makes use of a vibrator which is connected directly to the blade and through the use of the elastomeric mountings, the blade is effectively isolated from the mounting mechanism which supports the blade and thus the vibrations are substantially contained within the blade member rather than being transferred to the mounting mechanism itself. Thus, the mounting mechanism and support mechanism for the blade is not subjected to the vibration produced by the vibrator.

There are numerous advantages in the present construction and arrangement and particularly with respect to the combination of the vibrator and elastomeric mountings. For example, it has been found that in the present structure, there is no need to employ a coulter to break the ground ahead of the blade member and because of the vibration and elastomeric mounting, the area immediately ahead of the blade is kept clean and the earth forms a very good backfill behind the blade after it passes through the earth. It has also been found that through the use of the elastomeric mounting

means and in mounting the blade member secured to a number of forwardly extending plates, the blade may be laterally deflected some 8 to 10 inches at the lower portion of the blade. Obviously, this is not possible with the types of construction in which the entire mechanism is rigidly fastened together through metal-to-metal construction. It has also been found that the blade may be turned through a rather short radius through the combination of the vibrator, the elastomeric mounting means, and the pivot member. In fact, it has been found that where a four-wheeled tractor has been used for a prime mover, the cable may be layed on a 6-foot radius.

While the blade is being drawn through the earth, the elastomeric blocks are twisted in a shear plane lying parallel to the supporting plates supporting the blade member and it has been found that an optimum operation is obtained when the blade forms approximately a 9° angle with respect to a true vertical. Through the use of the elastomeric mounting means and vibrator, it has also been found that the blade life has been greatly extended whereas it has been determined that without the mechanism just described the blades are easily damaged or broken and that when the blade encounters a submerged object, the shock of hitting the submerged object is absorbed through the elastomeric blocks or the blade member may be allowed to rise vertically or deflect laterally to overcome the obstruction without damage to the cable. By effectively isolating the blade from the rest of the mounting mechanism, and through the use of an open or recessed portion at the rear of the cable guide, certain vertical movements of the blade are facilitated without damage to the cable when an obstruction is encountered. In fact, through the use of the elastomeric mounting mechanisms, most obstructions are easily averted without having to withdraw the blade from within the earth and the cable-laying operation may be continued without interruption.

It is therefore a general object of the present invention to provide a blade member which is drawn through the earth by an elastomeric mounting and draft member.

It is still another object of this invention to provide improved cable-laying apparatus which substantially isolates vibrations of the blade member from the remainder of the structure.

It is yet another object of this invention to provide a blade member for forming a passage in the earth to accommodate a cable in which the blade is suspended from the mounting mechanism by elastomeric mounting means.

It is yet another object of this invention to provide a vibrated blade member drawn through the earth by an elastomeric mounting and draft member.

It is another object of the present invention to provide an improved cable-guide mechanism which is used with a cable-laying mechanism.

It is still a further object of this invention to provide an improved earth subsoil working mechanism adapted to be connected to a prime mover.

These and other objects and advantages of the invention will more fully appear from the following description, made in connection with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views, and in which:

FIG. 1 is a side elevation of the invention shown in working position in the earth;

FIG. 2 is a side elevation of the invention shown withdrawn from the earth in a transporting position;

FIG. 3 is a top plan view of the structure as found in FIG. 2;

FIG. 4 is an elevation of a portion of the equipment including the mounting for the elastomeric means;

FIG. 5 is a plan view of the equipment as seen from above in FIG. 4 excluding the vibrator;

FIG. 6 is a rear elevation of the blade member, cable guide, and mounting for the elastomeric means;

FIG. 7 is a partial section view of the foot member and lower portion of the cable guide;

FIG. 8 is a perspective of the supporting mechanism adapted to be connected to a prime mover;

FIG. 9 is a perspective of one of the elastomeric blocks used as a mounting and draft member; and

FIG. 10 is a hydraulic schematic of the cable-laying lift structure.

The cable-laying apparatus 10 is constructed and arranged to be drawn by a tractor of tread construction, or more preferably a tractor having wheels thereon such as indicated by numeral 11. Tractor 11 has a first rear wheel 12 and a second wheel 13 shown broken away to expose a portion of the connection mechanism. A support mounting 14 is shown connected to a conventional three-point hitch of the tractor in which mounting 14 is connected to an upper adjustable arm 15 and through a pair of lower arms 16 and 17. Arms 16 and 17 are pivotally connected to tractor 11 by suitable means such as pins 20 as is arm 15. Arms 16 and 17 are connected to the tractor mount through a pair of hydraulic cylinder and piston members 21 and 22 respectively. It will be understood that cylinders 21 and 22 have hydraulic fluid supplied thereto for causing the vertical movement of members 15, 16, and 17, and mounting support 14 carried therewith. Hydraulic piston and cylinder mechanisms 21 and 22 are secured pivotally to a fixed arm at the upper ends thereof by suitable means such as a pivot pin 23, the mountings being fixedly secured to the tractor. The ends of the piston arms are connected to arms 16 and 17 through suitable means such as a clevis 24 and 25 respectively and pin members 26. Adjustable arm 15 is held to the upper portion of support mounting 14 by suitable means such as pin 26.

Mounting support 14 is shown in more detail in FIG. 8 in which a base plate 30 has four vertically oriented brace members 31 through 34 weldably connected thereto and extended upwardly to form a clevis member 35 which has pin 26 secured therein. Situated behind another brace member 36 which is weldably secured to base 30 and brace arms 32 and 33, is a swivel member 40. Situated above swivel member 40 is a gusset member 41 which is formed parallel to plate 30 and a pin 42 passes through a pair of bores in plate 30 and gusset 41 through the central bore of swivel member 40 to provide a substantially vertically oriented swivel member. Pin 42 has an end cap 43 secured thereto with a machine screw 44 fastened through the end cap into a mating set of screw threads formed in gusset 41 to hold end cap 43 in place. The swivel member 40 is approximately 8 inches in length, 2¾ inches in diameter, and receives a pin which is approximately 1½ inches in diameter. The plates, braces, and swivel members and pins are all formed of steel. A shaft member 45 is weldably secured to the rearwardly or trailing edge of base member 30 and extends horizontally and transversely to the direction of the extension of arms 15 through 17. Shaft 45 has arms 16 and 17 secured thereto by a suitable means such as a pair of pin members 46. For the most past, the support mounting is formed from ¾-inch steel stock, and the shaft 45 just described is formed from 1½-inch diameter stock.

A pair of outside plates (FIGS. 3 through 6) 50 and 51 are weldably secured to swivel member 40 and taper outwardly to a portion where they are approximately 6½ inches apart and are then directed rearwardly in parallel fashion to each other. The plates are formed from ½-inch-thick steel and are approximately 40 inches long and 21 inches high. Another pair of plates 52 and 53 are disposed inwardly of plates 50 and 51 and are secured at the front edge thereof by a suitable means such as a spacer 54 and machine bolt 55. Additional spacers are formed between plates 52 and 53 and a vibrator mounting bar 59 is also secured between plates 52 and 53. A blade member 56 is secured to plates 52 and 53 by suitable means such as machine bolts 57. Blade member 56 is approximately 5 feet long, 8 inches wide, and 1¼ inches thick, the leading edge of the blade having a radius of approximately one-sixteenth inch. A foot member 58 is secured to the lower portion of blade member 56 by suitable means such as machine bolts and a toe member 60 is secured to the front portion of foot member 58. The foot portion extends downwardly and forwardly from blade member 56 and has a pair of plate members 61 and 62 secured thereto by suitable means such as bolts or cap screws 63. Plates 61 and 62 are formed with an upwardly extending portion which is secured to blade member 56 by machine screws or cap screws 63. The plate member is approximately ⅜ inch thick and has its lower edge cut at an angle in the same manner as foot 58 so that the members are relieved by an angle of approximately 15° when measured normal to the trailing edge of blade member 56.

Secured to the rear edge of blade member 56 is a cable guide 65 which is secured to the blade by suitable means such as cap screws 66 (FIG. 7). A cable guide 65 is formed of a U-shaped channel member of 10-gauge metal material and has a backplate 67 which encloses the channel member. Another pair of backplates 68 and 69 are weldably secured to the lower end portions of channel member 65 in abutting relationship with the trailing edge of plate members 61 and 62, plate members 68 and 69 maintaining the same angular relationship with the bottom portion of plates 61 and 62 as well as foot member 58. As shown in FIG. 7, plate members 68 and 69 are weldably secured to a crossbar 70 which fits against the trailing edge of blade member 56 and is held in place against blade member 56 by suitable means such as a machine screw or bolt 71. The rear portion of plates 68 and 69 are curved downwardly and rearwardly and terminate in an upturned portion 72 and 73 respectively which are adapted to engage a crossbolt 74 which is weldably secured to backplate 67. Disposed above crossbar 74 and above the curved portion of backplate 67 is another crossbar 75 that engages the outer edge of channel member 65. At the top of channel member 65 are a pair of rearwardly extending lugs 76 and 77 which have a pin 80 passing therethrough that is held in place by another pin 81. Secured to the back portion of backplate 67 are a pair of tabs 82 and 83 which mate respectively with tabs 76 and 77. In other words, pin 80 holds backplate 67 in place at the top of the channel member 67 and also secures backplate 67 against movement through the use of crossbar 74. At the upper end of channel member 65 is a flared portion 84 and another flared portion 85 is secured on the upper edge of backplate 67. A handle member 86 is also secured to the upper portion of backplate 67 to aid in removing the plate from the channel member which may be accomplished while the blade member is in the earth by drawing the backplate upwardly. The lower portion of channel member 65 is extended through the use of a curved plate member 90 which is secured to the trailing edge of blade member 56 through suitable means such as a machine screw 91. Secured flush with the bottom edge of blade member 56 is a sole plate 92 which is also secured in place through suitable means such as machine screw 91. Sole plate 92 extends rearwardly to form a partial covering of a lower opening behind the blade member. In other words, the cable may extend downwardly through channel member 65 and when extended rearwardly through the opening formed by curved plate 90 and backplate 67, there will be a recessed portion at the bottom of the opening between plates 68 and 69 so that in the event the blade member and cable guide are moved upwardly, the cable member is free to move through the opening without producing any shearing effect on the cable.

Inside mounting plates 52 and 53 which are disposed centrally with respect to outer plates 50 and 51, are held in place by a plurality of elastomeric blocks 95 (FIG. 9). As will be seen, elastomeric blocks 95 form an elastomeric mounting means and means for supporting blade 56 so that it may be drawn through the earth. The elastomeric block is formed from a pair of steel plates 96 and 97 which have an elastomeric member 98 sandwiched therebetween. Plate 97 has a plurality of screw threads 99 formed therein in what might be described as a square pattern, and plate 96 has screw threads 99 formed therein in a diamond shaped pattern. In other words, the threaded holes formed in plate 96 are rotated approximately 45° from those formed in plate 97. The

elastomeric member 98 is bonded to the two steel plates 96 and 97 so that any force or torque applied to one plate is transferred or coupled to the other plate through the elastomeric member 98. It has been found that a suitable structure forming the elastomeric member is one manufactured by the Lord Manufacturing Company of Erie, Pennsylvania, which is described as a "sandwich mounting" and has a spring constant of approximately 1,400 pounds per inch. The elastomeric mounting 95 is approximately 4 inches square and the holes are spaced about 2½ inches apart.

Each of the elastomeric mounting blocks 95 is secured to mounting plates 50 and 51 by a plurality of machine bolts 100. For this particular embodiment, it has been found that good results have been obtained by aligning four of the elastomeric mounting blocks 95 in a row which is parallel with the upper portion of plates 51 and 50 and another row of four blocks is formed along the lower edge of plates 50 and 51. Additionally, a pair of single elastomeric mounting blocks 95 are secured near the rear central portion of plates 50 and 51. Another plurality of machine bolts 100 secure inner plates 52 and 53 to the plurality of elastomeric mounting blocks 95 so that plates 52 and 53 are coupled to plates 50 and 51 respectively through the mounting blocks 95. Accordingly, blade member 56 is also coupled to outer plates 50 and 51 through the elastomeric mounting means. It will be seen that as blade member 56 is drawn through the earth, the elastomeric mounting blocks also serve as the draft coupling means. That is, the force required to move blade member 56, foot 58, toe 60, the accompanying plates and cable guide through the earth is applied to swivel member 40 and plates 50 and 51 and transferred to plates 52 and 53 through the elastomeric mounting blocks which form an equal and opposite force against that required to move the blade member through the ground. The action of the blade member and foot will be discussed more fully later.

A vibrator 101 is secured to the top of bar 59 by suitable means such as bolts 55 which anchor the vibrator to inner plates 52 and 53 and the blade member 56 and its appendages and the cable guide attached thereto. Vibrator 101 is hydraulically operated and has a pair of hydraulic lines 102 and 103 connected thereto which are interconnected to the hydraulic system of the prime mover 11. Vibrator 101 is the type of vibrator employing the epicyclic principle in which a mass or weight is driven through an orbit concentric with the input or drive. Vibrators of this type are manufactured by the Martin Engineering Company, Neponset, Illinois, two of which are described in U.S. Pat. Nos. 2,999,393, and 3,036,471, the inventor being Edwin F. Peterson. Vibrators of this type generally are operated at a speed of approximately 3,400—3,600 r.p.m.

When the blade member 56 is above the ground, it will be noted that it is free to pivot about pin 42 without any lateral restrictions and thus in order to prevent the blade and mounting mechanism from swaying from one side to another, a pair of sway control bars 104 and 105 are secured to plates 50 and 51 respectively by suitable means such as machine bolts 100. Sway control bars 104 and 105 extend forwardly and upwardly from plates 50 and 51 and encounter a pair of stop members 106 and 107 respectively. Stop members 106 and 107 are weldably secured to base plate 30 on the mounting support, the sway control bars extending inwardly of the stop mechanisms 106 and 107.

It is desirable that the hydraulic control system be constructed and arranged so that hydraulic piston and cylinder assemblies 21 and 22 may be controlled individually. As will be shown later, there are advantages in providing dual controls. A pump 110 provides hydraulic fluid under pressure and may be part of the hydraulic system of the prime mover, but in any event, it is generally driven by the prime mover. Pump 110 has a pair of hydraulic output lines 111 and 112 which are connected to the upper ends of cylinders 21 and 22 respectively. Another pair of conduits or hydraulic lines 113 and 114 are connected to the lower ends of cylinders 21 and 22 respectively and are interconnected with a return line 115 which is connected to a reservoir 116, reservoir 116 being connected to pump 110. A four-way directional control valve 117 is interconnected in hydraulic lines 111 and 113 and another four-way directional control valve 118 is interconnected in hydraulic lines 112 and 114. The four-way control valves 117 and 118 have a "center-off" position, and when the valve is moved to one position, such as marked "down," hydraulic fluid from pump 110 is directed through valves 117 and 118 to supply fluid to the upper end of cylinders 21 and 22, thus moving the pistons therein downwardly. The fluid which may be contained in the lower part of cylinders 21 and 22 passes back to reservoir 116 through the two control valves and return line 115. In order to direct the fluid under pressure against the lower portion of the piston, control valves 117 and 118 are set in the other position such as "up" and the hydraulic fluid from pump 110 is then directed to cylinders 21 and 22 through lines 111, 113, and 112, and 114. It will also be recognized that valves 117 and 118 may be ganged or may be operated individually. That is, one valve such as control valve 117 may be operated without resort to operating valve 118 and thus fluid pressure may be applied to cylinder 21 without affecting the other cylinder 22. This form of control is especially helpful where the tractor or prime mover is tilted to one side and it is desirable to cant blade 56. It is also desirable in some instances to cant blade 56 where the tractor or prime mover is on a level surface and it is desirable to place the cable under the edge of a hard surface, such as a roadway or sidewalk.

Through the use of two control valves such as valves 117 and 118, it is also possible to correct one cylinder for any leakage which may occur. Such a feature is highly desirable in the event leakage occurs in both cylinders and the leakage is not the same for each cylinder.

Various types of prime movers may be used for drawing the cable-laying mechanism through the ground and one such prime mover which has performed well is the Model 1950-T Oliver tractor, manufactured by the Oliver Corporation.

OPERATION

The cable-laying apparatus, before being inserted into the earth, is disposed as found in FIG. 2. A cable is inserted into the cable guide and after passing outwardly at the bottom of the guide, the cable is drawn upwardly so that it may extend above the earth. A hole is dug in the earth approximately 3½ to 4 feet deep to accommodate the blade member and the lower appendages secured thereto, at which time hydraulic fluid is applied to cylinders 21 and 22 through control valves 117 and 118. Control valves 117 and 118 are placed in the "down" position causing arms 15, 16, and 17 to be lowered and place the blade member and cable guide in the earth. The depth of the blade member, foot 58, and toe 60 may be regulated by a vertical movement of mounting support 14 and is controllable through valves 117 and 118. As pointed out previously, it may be desirable to cant blade 56 and this can be achieved by lifting arm 16 or 17 an appropriate amount to properly orient blade member 56. As the prime mover or tractor 11 moves forwardly, torque is applied to foot member 58, toe 60, and blade 56 so that a twisting action is applied to the members just described as well as the inner plates 52 and 53 which assume a position where the bottom edges of the plates are substantially parallel to the surface over which they are drawn. In other words, a couple or torque is applied which is resisted by the elastomeric mounting means 95 and it has been found that blade 56 assumes a slanting position approximately 3° forward of a vertical line extending into the earth. This is shown in FIG. 1 where it will be evident that plates 52 and 53 have rotated with respect to plates 50 and 51. It will also be seen that the corner block shown in FIG. 1 indicates a distortion of the block from the configuration seen in FIG. 9. During this period of operation, vibrator 101 is set in motion and is allowed to vibrate at a speed of approximately

3,400—3,600 r.p.m. The cable emerges through the opening formed by the lower portion of backplate **67** and guide member **90** and is protected by sole plate **92** as the blade member, foot, and associated structure moves through the earth. Should toe member **60** encounter an obstruction, if blade member **56** is lifted upwardly, it will be seen that the entire structure may be lifted upwardly without producing a shearing effect upon the cable because sole plate **92** is terminated short of extending rearwardly to the back portion of plates **68** and **69**. Blade member **56** may also be forced laterally to the side of an obstruction and through the use of the elastomeric blocks **95** and pivot member **40**, flexibility is provided for blade **56** in such a manner that blade member **56** will usually clear an obstruction without a great deal of difficulty. As the cable is laid in the ground, it has been found that there is a very small slit made in the earth and that results are quite satisfactory without rolling the earth behind the blade. Due to the elastomeric action of blocks **95** and vibrator **101**, it has also been found that very little earth is piled in front of blade member **56** and that a coulter is not required to break the earth in front of blade member **56**. Due to pivot member **40** and pin **42**, along with elastomeric blocks **95**, it has been found that a radius of approximately 6 feet may be turned in changing the direction of orientation of the cable. When it is desirable to again bring the cable above the earth, hydraulic fluid is applied to cylinders **21** and **22** and support mounting **14** is raised to bring blade **56** and cable guide **65** to the surface. By selecting elastomeric blocks **95** to have the proper modulus of elasticity characteristics, it is possible and highly desirable to facilitate a draft movement of the prime mover before the blade member **56** starts to move, thus greatly reducing or eliminating the slippage of the driving members of the prime mover. In other words, the elastomeric elements **98** of blocks **95** are elastically deformed below their elastic limits when the driving wheels of the prime mover turn through a small arc from a position of rest, at which time blade member **56** starts its movement of being drawn through the earth.

As explained earlier, the sway control bars **104** and **105** prevent the mounting plates and blade member from swaying laterally although the sway control bars are disengaged from stops **106** and **107** when the blade member and cable guide are in the earth in their normal operative position.

The present invention may also be used in the application of conditioning agricultural soil by fluidizing, aerating and reconstituting the physical nature and characteristics of the soil and thus increase its porosity, especially at a subsoil level.

In working the earth at a subsoil level, cable guide **65** may be detached and a different toe member or plow member secured to foot **58** if so desired. The equipment is then operated in the same manner as described above without putting a cable in the soil.

Thus it will be apparent that a new and unobvious means has been disclosed for drawing a blade member through the soil in such a manner that the elastomeric mounting means not only serves as a means for mounting the blade member, but also serves as a "draft" member by transferring the power required to move the blade through the soil from the prime mover. Additionally, the elastomeric blocks isolate the vibrations of the vibrator **101** from mounting plates **51** and **52** in such a manner that the vibrations are effectively dampened and not transferred to the mounting plates or the support mounting or lift mechanism on the prime mover. With such isolation, the operators have not experienced any vibrations imparted to those metal portions just described and fatigue of the metal appears to be eliminated. The blade life has been greatly extended and even though blade member **56** may become worn, its life expectancy is several times that of a member which is mounted rigidly to the mounting support.

It will, of course, be understood that various changes may be made in the form, details, arrangement, and proportions of the parts without departing from the scope of invention which consists of the matter shown and described herein and set forth in the appended claims.

We claim:

1. Underground cable-laying apparatus comprising:
a. a prime mover;
b. elastomeric mounting means connected to said prime mover and supported thereby, said mounting means including a rigid mounting plate having attached thereto over at least a portion of the surface of said plate an elastomeric material;
c. a vertically extending blade member resiliently mounted to said prime mover by means of said elastomeric material and in position to be drawn through the earth; and
d. cable guide means carried by said blade member in trailing relation and guiding the cable from above and into the earth directly behind said blade member as it is moved through the earth by said prime mover.

2. The structure as set forth in claim **1** including: vibratory means connected to said blade member in vibrating relation to facilitate the movement of said blade member through the earth by said prime mover.

3. The structure as set forth in claim **1** including: pivotal means having a substantially vertically oriented axis securing said elastomeric mounting means to said prime mover facilitating a pivotal movement of said blade member about said pivotal means.

4. The blade member as set forth in claim **1** including: a wedge-shaped foot member secured to the lower leading edge of said blade member in a forwardly and downwardly oriented direction.

5. The cable guide means as set forth in claim **1** including: an enclosed channel member having a flared opening at the upper end and a lower portion curved rearwardly and opening to the rear, said opening including a recessed bottom portion facilitating an upward movement of said blade and channel members with respect to the cable without stressing the cable.

6. The blade member as set forth in claim **1** including: vertically and forwardly extending plate means connecting said blade member to said elastomeric mounting means in an inverted L-shape, said elastomeric mounting means being arranged in a plurality of positions along said plate means.

7. The structure as set forth in claim **6** including: second vertically extending plate means connected between said prime mover and said elastomeric mounting means, said elastomeric mounting means defining a shear plane therein parallel to said second plate means.

8. Underground cable-laying apparatus comprising:
a. a prime mover;
b. vertically movable support means mounted upon said prime mover;
c. control means carried by said prime mover for controllably moving said support means vertically;
d. a pair of horizontally spaced rigid mounting plates extending parallel to each other in vertical planes, said plates being secured to said support means for movement therewith;
e. elastomeric mounting and draft means secured to adjacent faces of each of said mounting plates;
f. a vertically extending blade member secured between and to the said elastomeric mounting and draft means in supported relation for movement therewith;
g. a foot member carried by said blade member adjacent its lower forwardly facing end and adapted to be drawn through the earth thereby; and
h. cable guiding means secured along the trailing edge of said blade member and guiding the cable from above and into the earth directly therebehind as said blade member is drawn through the earth.

9. The structure defined in claim **8** including: vibratory means connected to said blade member and vibrating the same and said foot member as the latter is drawn through the earth by said elastomeric mounting and draft means and said prime mover.

10. The structure as set forth in claim **8** including: pivotal means having a substantially vertically oriented axis securing said pair of mounting plates to said vertically movable support

means facilitating a pivotal movement of said blade member about said pivotal means.

11. The structure as set forth in claim 8 including: a pair of sway control bars secured to said pair of mounting plates and extending forwardly and laterally to cooperatively engage said vertically movable support means upon a predetermined pivotal movement of said mounting plates.

12. The structure as set forth in claim 8 including: another pair of plates connecting said blade member to said elastomeric mounting and draft means, said other pair of plates disposed between said mounting plates and having said elastomeric mounting and draft means arranged in a plurality of rows between said pairs of plates.

13. The cable guiding means as set forth in claim 8 including: an elongated channel member of U-shaped cross section having a flared portion at the upper end and a lower portion curved rearwardly and opening to the rear behind said foot member, said channel member including a recessed bottom portion facilitating an upward movement of said blade and channel members with respect to the cable without stressing the cable;

a channel cover closing said open portion of said channel member and conforming to the trailing edge thereof;

a releasable securing means releasably securing said channel cover to said U-shaped channel member facilitating removal of said channel cover while said blade and channel members are in an earth embedded relationship.

14. Underground cable laying apparatus comprising:

a. vertically movable support means constructed and arranged to be connected to a prime mover and adapted to be controlled by means for controllably moving said support means vertically;

b. a pair of horizontally spaced mounting plates extending parallel to each other in vertical planes, said plates being secured to said support means for movement therewith;

c. vertically extending blade means adapted to be drawn through the earth in cutting relationship;

d. elastomeric mounting and draft means secured between said pair of horizontally spaced mounting plates and the upper end of said blade means in torque and draft resisting relationship, said elastomeric means defining a pair of shear planes extending substantially parallel to said pair of mounting plates; and

e. cable guiding means secured along the trailing edge of said blade means and guiding the cable from above and into the earth directly therebehind as said blade means is drawn through the earth.

15. The structure as set forth in claim 14 including:

another pair of horizontally spaced mounting plates extending parallel to each other in vertical planes and disposed between said elastomeric mounting means;

releasable securing means securing the upper end of said blade means to said other pair of mounting plates.

16. The structure as set forth in claim 15 including:

vibration means connected to said blade means and vibrating the same as the latter is drawn through the earth.

17. In underground subsoil working apparatus, the combination comprising:

a. vertically movable support means adapted to be mounted upon a prime mover including a control means carried by the prime mover for controllably moving said support means vertically;

b. a pair of horizontally spaced mounting plates extending parallel to each other in vertical planes, said plates being secured to said support means for movement therewith;

c. elastomeric mounting and draft means secured to adjacent faces of each of said mounting plates; and

d. a vertically extending blade member secured between and to the said elastomeric mounting and draft means in supported relation for movement therewith to be drawn through the earth thereby.

18. The structure defined in claim 17 including: vibratory means connected to said blade member and vibrating the same as the latter is drawn through the earth by said elastomeric mounting and draft means.

19. The structure defined in claim 17 including: another pair of plates connecting said blade member to said elastomeric mounting and draft means, said other pair of plates disposed between said mounting plates and having said elastomeric mounting and draft means disposed between said pairs of plates.

20. The structure of claim 1 wherein the modulus of elasticity of said elastomeric mounting means is sufficient to facilitate a draft movement of said prime mover before said blade member is set in motion and drawn through the earth.

21. The structure as set forth in claim 1 including: blade member canting means constructed and arranged to be operably connected to said prime mover and said elastomeric mounting means facilitating canting of said blade member.

22. The structure as set forth in claim 8 including: blade canting means operably connected to said prime mover and said vertically movable support means facilitating canting of said blade member.

23. The control means as set forth in claim 8 including:

a pair of hydraulic actuators transversely disposed with respect to said prime mover, each of which have one end secured to said prime mover and the other end secured to said support means in vertically movable relationship; and

a pair of control valves operably connected to said pair of hydraulic actuators facilitating individual control thereof.

24. The control means as set forth in claim 8 including:

a pair of hydraulic actuators, each of which have one end secured to said prime mover and the other end secured to said support means in vertical moving relationship, said actuators each having a pair of hydraulic ports;

a hydraulic pump and return reservoir operably connected to the input thereof;

first conduit means connected between said pump and corresponding ports on said pair of actuators;

second conduit means connected between said reservoir and corresponding ports on said pair of actuators; and

a pair of four-way valves interconnected in said first and second conduit means, one of said valves controlling the hydraulic flow through one of said pair of actuators, and the other of said valves controlling the hydraulic flow through the other of said actuators.

25. The structure of claim 8 wherein said prime mover has at least a pair of driving wheels operably engaging the surface over which said prime mover is drawn, said elastomeric mounting and draft means being elastically deformed upon movement of said prime mover wheels facilitating a delayed movement of said blade member.

26. The structure as set forth in claim 14 including: blade canting means constructed and arranged to be operably connected to a prime mover and said vertically movable support means facilitating canting of said blade means.