United States Patent

Wilson

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[54] TRENCH CUTTER USING ENDLESS CUTTER CHAIN

[72] Inventor: **Leslie Peter Stuart Wilson,** Nassau, Bahamas

[73] Assignee: **Gimda Inc.,** Nassau, N.P., Bahamas

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[52] **U.S. Cl.** ..... **37/83,** 37/191 A, 175/90, 198/126

[51] **Int. Cl.** **E02f 5/06**

[58] **Field of Search** ..... 175/89, 90; 37/83–90, DIG. 20 AL, 191, 192; 198/126

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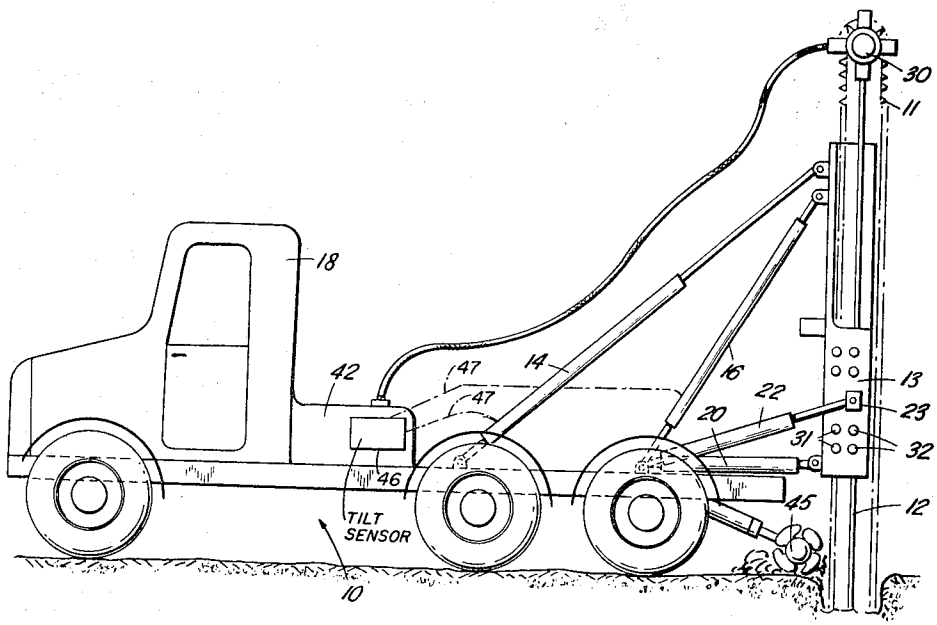
Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Clifford D. Crowder
Attorney—Cushman, Darby & Cushman

[57] **ABSTRACT**

Trench cutting apparatus particularly for cutting deep narrow trenches has a power-driven endless cutter chain on an elongated chain support which is linearly movable in a carrier mounted on a vehicle. In operation the carrier is vertical (or inclined to the vertical if a sloping trench is required) and is held in position by adjustable rams which permit the cutter to be positioned across the width of the vehicle as required and serve to maintain the carrier in the required plane.

14 Claims, 6 Drawing Figures



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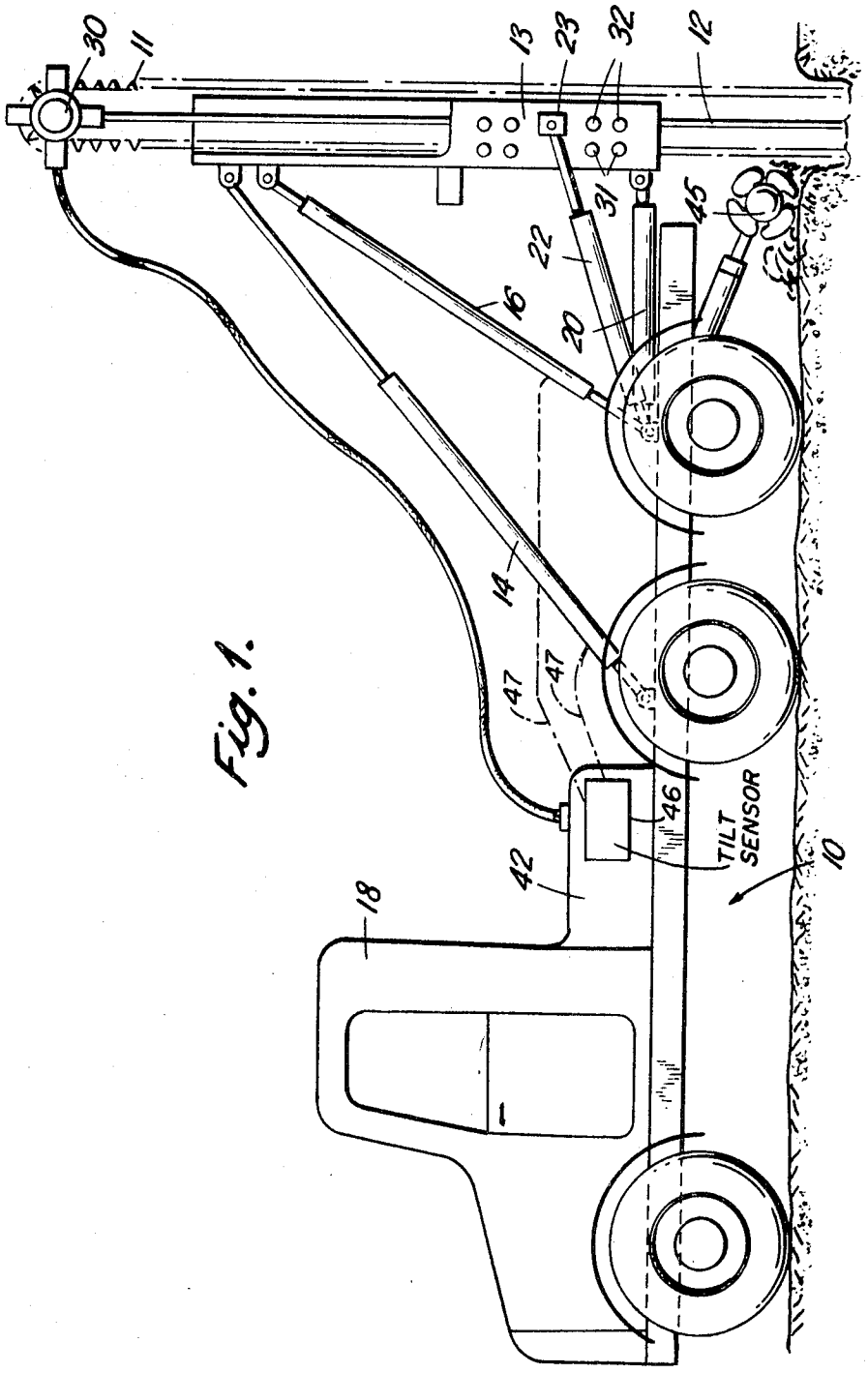


Fig. 1.

INVENTON
LESLIE PETER STUART WILSON

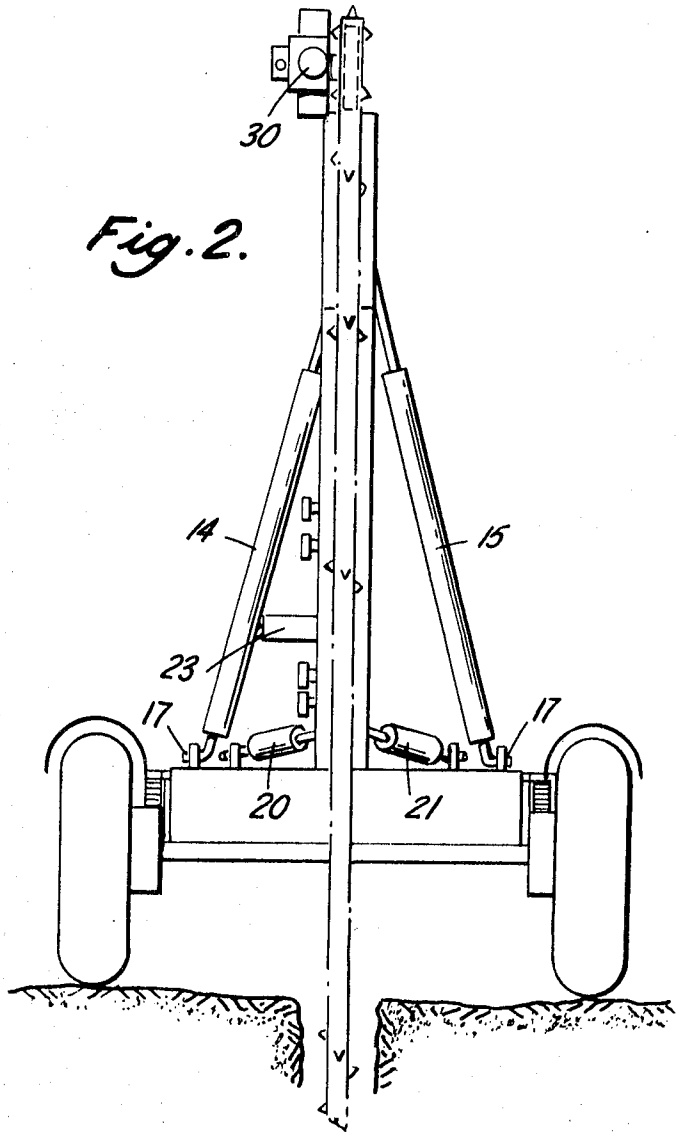
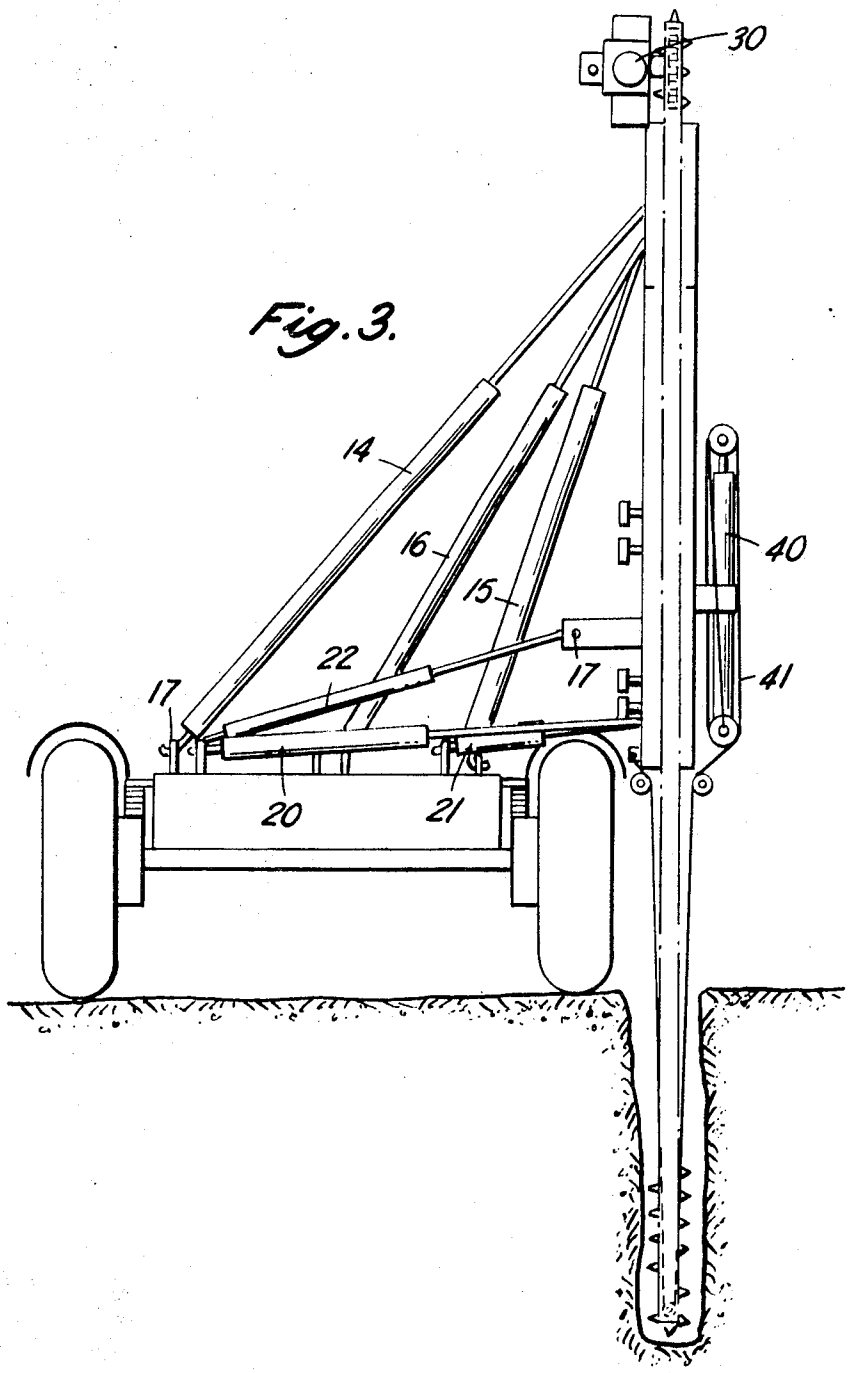


Fig. 2.

Inventor
Leslie Peter Stuart Wilson
By Cushman, Darby & Cushman
Attorneys

Fig. 3.



Inventor
Leslie Peter Stuart Wilson
By Cushman, Darby & Cushman
Attorneys

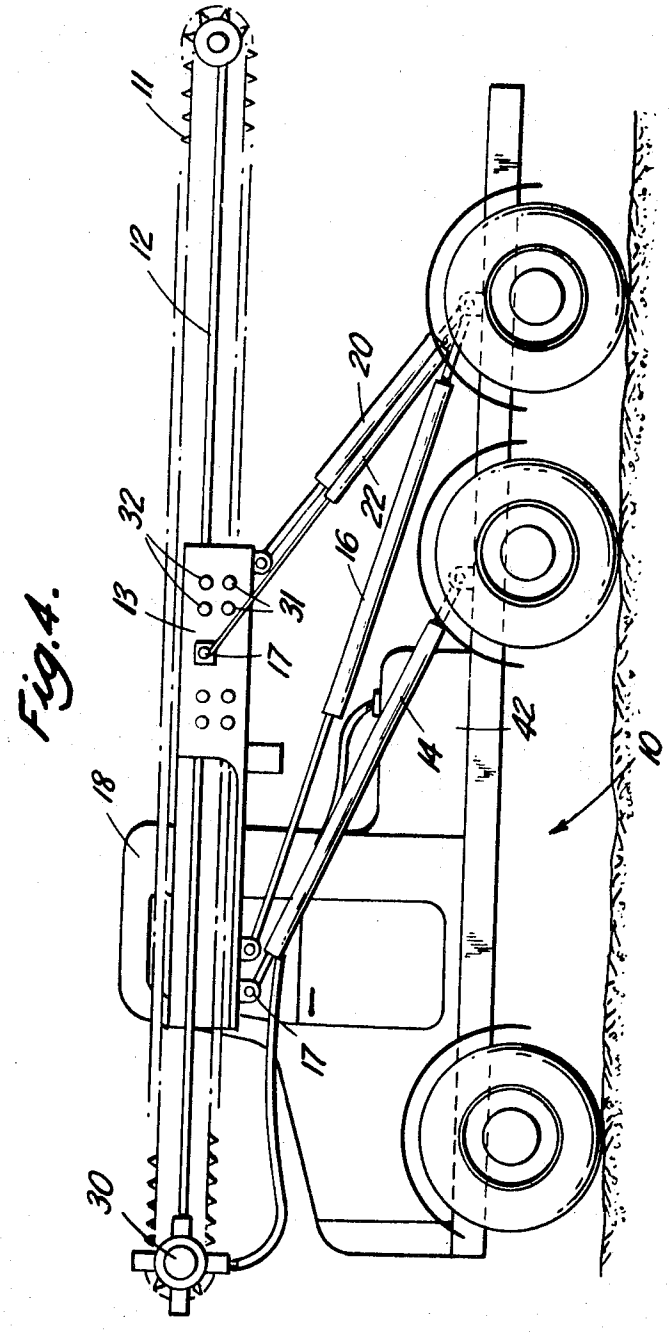


Fig. 4.

Inventor
Leslie Peter Stuart Wilson
By Cushman, Darby & Cushman
Attorneys

Fig. 5.

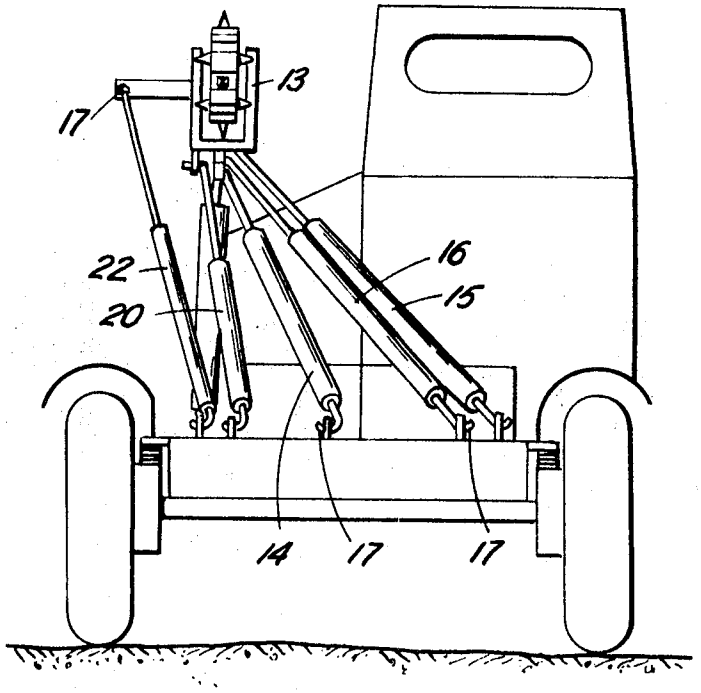
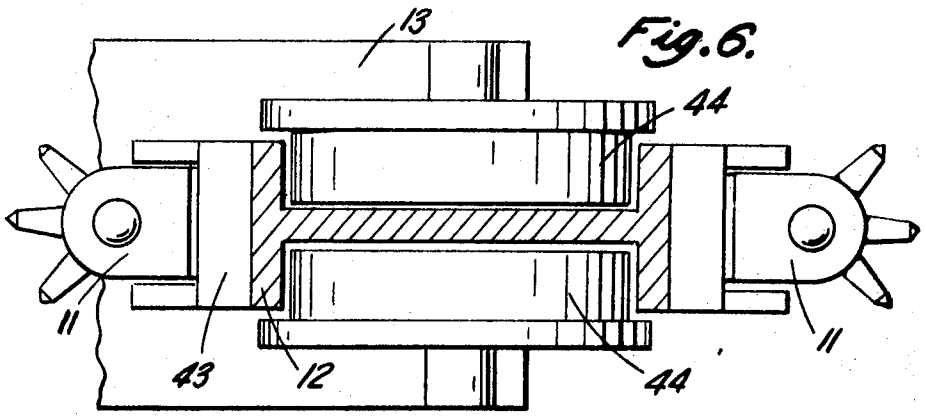


Fig. 6.



Inventor
Leslie Peter Stuart Wilson
By Cushman, Darby & Cushman
Attorneys

TRENCH CUTTER USING ENDLESS CUTTER CHAIN

BACKGROUND OF THE INVENTION

This invention relates to apparatus for cutting trenches and is particularly, but not exclusively directed to apparatus for cutting quite narrow trenches.

As a typical example, the apparatus may be used for cutting a trench say 4 inches width which may be as much as 20 feet or more deep. Narrow trenches are required for many purposes. For example shallow trenches are often required for the laying of cables and like. Deep narrow trenches are required inter alia, for the insertion of impermeable sheets into the ground for forming water storage reservoirs in which rain water collects above a saline ground water table. Provided the impermeable barrier extends below the normal level of the saline ground water table, rain water collects on top of the saline ground water which it may displace downwards as far as or below the barrier. As another example, deep trenches may be required to extend down through a porous layer of ground into a lower permeable layer to form an enclosed volume of ground from which water may be pumped out to provide dry ground for building etc. Also, as a converse case, a water storage reservoir may be formed by deep trenches with impermeable barriers extending down through a porous layer of soil down into a lower impervious layer.

SUMMARY OF THE INVENTION

According to this invention, trench cutting apparatus comprises a vehicle, an endless chain cutter on an elongated chain support, a carrier on the vehicle in which the chain support is linearly movable for lowering into the ground, and power means for driving the cutter chain and for moving the chain support in the carrier. With this apparatus, the chain cutter is lowered into the ground or used to cut its way into the ground by lowering the chain support in the carrier; the vehicle is then moved forward with the cutter chain operating in order to cut the trench. The speed of forward motion would be suited to the grade of hardness or resistance of the ground formation encountered. The speed may be controlled by an automatic device or devices sensing the pressure and therefore the load on the cutter drive, e.g., the pressure in the hydraulic drive circuit if a hydraulic drive is employed and reducing or stopping, e.g., by hydraulic control, the speed of traction.

Adjustable means may be provided for supporting the carrier on the vehicle at points spaced along the length of the carrier. These adjustable means may comprise power-operated means to maintain the carrier in a required angular position.

Usually the chain support and chain carrier are maintained vertical during operation. Since the vehicle when moving forward over the ground may lurch or tilt, and since the cutter chain may be in a deep trench, there may be provided sensing means sensing tilting of the vehicle about its longitudinal axis operative automatically to control said power operated means to maintain the carrier in a vertical longitudinal plane. The carrier would also normally be maintained vertically upright in this plane when cutting a trench. The chain support and chain carrier may be movable to an alternative position for example, horizontal for transit.

However, where the trench is required to be other than in the vertical plane, or other than at right angles to the ground surface, the power operated means may be automatically controlled to keep the cutter chain in the desired plane.

In one convenient arrangement, adjustable supports are provided on said vehicle supporting the carrier at points spaced along its length so that the carrier is held in an adjustable position with respect to the vehicle. The carrier for example may be supported at or near its upper end by three double-acting hydraulic rams mounted on the vehicle. These rams, form in effect, an adjustable tripod providing a fixed support (adjustable in position) with respect to the vehicle for the upper end of the carrier. The carrier may be supported at or near its lower end by a pair of double-acting hydraulic rams mounted on the vehicle. Alternatively the carrier may be

mounted at or near its lower end on a member traversable across the width of the vehicle, for example on a lead screw.

Preferably the carrier is mounted at one end of the vehicle, for example the rear end, and is movable transversely across the vehicle, for example, by means of the aforementioned rams which position the upper and lower ends of the carrier. It is desirable for example in cutting a trench adjacent the boundary of the site to be able to position the cutter chain outside the wheel base or track of the vehicle so that the vehicle can be driven around the site within the boundary with the cutter located at or close to the boundary.

If rams are provided for supporting the carrier, preferably they are arranged so that the carrier can be positioned horizontally or substantially horizontally for transit and can be held vertical or substantially vertical for operations.

The aforementioned means for driving the cutter chain conveniently comprises a hydraulic motor mounted on the chain support. For inserting the cutter chain into the ground, a further motor or winch or ram device may be provided. In one convenient arrangement however the cutter motor is employed for this purpose, means being provided for locking the cutter chain relatively to the carrier so that operation of the cutter motor drive to the cutter chain causes the chain support to be moved in the carrier. Such locking may be effective by passing bolts through the cutter chain and carrier. In some cases, the same or similar bolts may be employed, when the cutter support is at the right depth, to lock the support with respect to the carrier leaving the cutter chain free to move relatively to the support and carrier. It is commonly required however that the bottom of a trench should be at a predetermined depth with respect to a datum, irrespective of local variation in the surface level of the ground. For making deep trenches for water storage, for example, it is usually desired that the bottom of the trench should be at a constant height relative to the ground water table; thus the bottom of the trench should follow a constant height contour irrespective of the surface level of the ground. For this reason, power operated means may be provided for controlling the position of the chain support in the carrier. These means may comprise a double-acting hydraulic ram or rams on the carrier for moving the chain support through a multi-fold block and tackle. Such power operated means for controlling the position of the chain support may be controlled by means of a level sensing system, for example a taut wire alongside the route of the vehicle marking a datum level with sensing means on the vehicle sensing the level of the vehicle with respect to the wire.

Preferably the carrier is pivotally carried on the vehicle to permit limited angular movement about an axis parallel to the longitudinal axis of the chain support. A hydraulic ram may be provided for adjusting the angular position of the carrier about this axis. The pivoting of the carrier for rotating about this axis when it is in operation enables the carrier to follow along the line of the trench, changing direction as the vehicle changes direction. The movement may be controlled by a hydraulic or other mechanism, for example a double-acting ram acting on a lever arm extending outwardly from the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side elevation of a vehicle showing a cutter chain in position for operation;

FIG. 2 is a rear elevation of the cutter assembly and part of the vehicle of FIG. 1 showing the cutter chain in one position;

FIG. 3 is a view similar to FIG. 2 but showing the cutter chain in another position;

FIG. 4 is a side elevation of the vehicle of FIG. 1 showing the cutter chain in a stowed position for travel;

FIG. 5 is a rear elevation of the vehicle of FIG. 4; and

FIG. 6 is a diagrammatic section through a cutter chain support and chain carrier along the lines 6—6 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings there is shown diagrammatically a vehicle **10** on the rear end of which is mounted a cutter chain assembly. The vehicle may be a wheeled vehicle as shown in the drawings or track vehicle. It is preferably a self propelled vehicle as illustrated although, when cutting the trench, it may in some cases be preferable to use a winch on the vehicle or at a fixed point for hauling the vehicle.

The cutter chain assembly comprises a cutter chain **11** carried on an elongated chain support **12** in the form of a rigid beam which is slidable in a cutter carrier **13**. The upper end of the carrier **13** is supported by means of three hydraulic double-acting rams **14, 15** and **16**. These rams, at their lower ends, are pivotally mounted at spaced points on the chassis of the vehicle and, at their upper ends, are attached to the carrier **13** near the top end thereof, the attachment to the carrier providing limited rotational freedom of movement in any direction. This may be achieved for example by the use of the eye connections. These three rams **14, 15, 16** form, in effect, an adjustable tripod which enables the top end of the carrier to be located in any convenient position. FIG. **2** illustrates this carrier held on the center line of the vehicle while FIG. **3** shows it held to one side of the vehicle. FIG. **4** shows the cutter chain and carrier assembly horizontal in the stowed position with the top end of the carrier **13** located at one end of the center line of the vehicle adjacent the driver's cab **18**.

The lower end of the carrier **13** is held in the operating position by means of two hydraulic double-acting rams **20, 21** which are pivotally mounted on the vehicle at points spaced transversely across the width of the vehicle and extend to a common point on the carrier near the lower end thereof, the connection to the carrier permitting limited relative angular movement in any plane. It will be seen that if the three rams **14, 15, 16** are set to hold the top end of the carrier in any given position, then the rams **20, 21** enable the lower end of the carrier **13** to be fixed so locating the carrier both in a fore and aft plane and in a transverse plane. A further ram **22** extends between the vehicle and a lever arm **23** extending transversely from the carrier **13**. This ram **22** enables the carrier **13** to be rotated through a small angle about a vertical axis (assuming the carrier is vertical) and thus enables the direction of cut to be changed.

The cutter chain **11** is driven by a hydraulic motor **30** which may also be used for raising and lowering the cutter support when initially starting operation. For this purpose bolts **31** are provided for enabling the cutter chain to be locked to the carrier **13** so that operation of the motor **30** causes the chain support to be raised or lowered. When the chain support is at the appropriate depth, the bolts can be put at **32** to lock the support to the carrier and unlocking the chain so enabling it to be driven freely with respect to the chain support and carrier. However for many purposes it is required to adjust the depth of the trench in accordance with a datum irrespective of variations of the surface of the ground and for this reason, there is provided an additional ram **40** operating through a four-fold purchase **41** to raise or lower the chain support in the carrier automatically. This ram may be controlled in any convenient way. In some cases it may be controlled manually, or alternatively there may be a taut wire stretched alongside the path of the vehicle and sensing means on the vehicle sensing the level of the vehicle with respect to the wire and automatically controlling the ram. The ram **40** may be used for lifting the cutter support, using gravity for downward movement or provision may be made for powered raising and lowering of the cutter.

Hydraulic fluid for operating the rams is supplied from a unit **42** which contains an auxiliary motor, tank and pump and also a control unit. Rams are used rather than jacks since it is possible to interconnect two rams to permit some degree of freedom of movement. Such interconnection permits the hydraulic fluid to pass from the cylinder of one ram to the cylinder of another if the pressure in one cylinder rises due to excessive mechanical loading, thereby permitting some movement of the rams. This is desirable since, if the vehicle passes over uneven ground so that one side of the vehicle may rise relative to the other side, it is important that the cutter chain should remain in substantially the same plane. This may be achieved, in the arrangement having five rams shown in the drawings by interconnecting any of the three rams **14, 15** and **16** forming the adjustable tripod or alternatively or in conjunction with rams **20, 21** to permit exchange of oil between the rams on one side of the pistons, the other side of the pistons being connected by suitable compensating lines to a reservoir in the unit **42**.

It may be desired to cut a trench which is not vertical but which slopes in a plane at right angles to the fore-and-aft line of the vehicle.

Tilt Sensor means **46** (FIG. **1**), e.g., a pendulum or gyroscope are provided in the unit **42** for sensing tilting of the vehicle about a longitudinal axis and these means **46** as indicated diagrammatically at **47** are arranged to control the rams **14, 15** and **16** so as to maintain the cutter vertical or at the required inclination to the vertical. The rams **14, 15, 16, 20** and **21** may thus be used for holding the carrier at the appropriate angle. The rams are connected to the carrier so as to allow of the necessary movement. The carrier and cutter chain may be set by the rams at any angle in a fore-and-aft plane of the vehicle. For example, if the cutter is mounted on the rear of the vehicle as shown in the drawing, the lower end may extend forwardly to cut in part beneath the vehicle if so desired. When set to one side of the vehicle, the cut likewise can be at an angle so that it extends underneath the vehicle. The cutter chain assembly may be tilted and adjusted to one side or the other of the vehicle for cutting outwardly to undercut the foundations of a building. The control unit also provides correction to be made for yawing of the vehicle. The chain support is controllable in the steering or yawing plane to correct for any yaw of the vehicle or to correct any deviation of the cutter from the planned path of cutting.

For cutting a wide trench, two or more cutter chains may be mounted parallel to one another on one or more carriers to operate in planes spaced in a direction transverse to the longitudinal axis of the vehicle. Alternatively side cutters may be provided on a single chain to give a wider trench.

The carrier, chain support and chain are shown in FIG. **6** from which it will be seen that the cutter chain **11** runs in a chain guide **43** in the chain support **12**. Rollers **44** permit linear movement of the chain support in the carrier **13** while firmly supporting the chain support. It will be noted that the chain support is narrower than the width of the trench being cut. The chain carrier may be shaped so as, in conjunction with the chain support, at least substantially to enclose the upwardly moving portion of the cutter chain as it moves through the carrier whereby spoil is carried upwardly through the carrier. In this case deflector plates may be provided, possibly in conjunction with a side blast of exhaust or other gases or of water, for discharging sideways of the vehicle spoil carried upwardly through or towards the carrier. Typically the discharge would be into a spoil carrying truck which is driven alongside the trench cutting apparatus as the trench is cut. In the particular arrangement illustrated a spiral spoil remover **45** is provided near the ground surface to heap the spoil alongside the trench for subsequent back filling.

I claim:

1. Trench cutting apparatus comprising a vehicle, three double-acting rams pivotally mounted at spaced points on said vehicle to form an adjustable tripod, an elongated carrier pivotally secured near one end to said rams to be supported thereby, adjustable means on the vehicle for adjustably supporting the carrier near its other end whereby the carrier may be held substantially vertical but is adjustable in position and angular inclination, an endless cutter chain on an elongated chain support, said chain support being mounted in said carrier for linear movement along the length thereof, said chain support and cutter chain being substantially longer than said carrier and a hydraulic drive motor on said chain support for driving said cutter chain.

2. Trench cutting apparatus comprising a vehicle having a longitudinal axis, a transverse axis and an upright axis, said longitudinal and transverse axes being mutually perpendicular and lying in a common plane, said upright axis extending perpendicularly to said common plane, an elongated chain support, an endless cutter chain carried on said chain support, an elongated carrier, said chain support being carried on said elongated carrier, means for linearly moving the chain support in the carrier for lowering the chain and chain support into the ground, means for driving the cutter chain, mounting means for mounting the carrier on said vehicle, said mounting means supporting said carrier at two points spaced along the length of said carrier, said mounting means including adjustable positioning means for moving the carrier about said transverse axis of said vehicle, said mounting means further permitting angular adjustment of said carrier with respect to the vehicle about at least said longitudinal and said upright axes of said vehicle.

3. Trench cutting apparatus as claimed in claim 2 wherein said mounting means permit angular adjustment of the carrier with respect to the vehicle about three axes.

4. Trench cutting apparatus as claimed in claim 2 wherein said mounting means comprise extensible supports on the vehicle supporting said carrier at points spaced along the length of the carrier.

5. Trench cutting apparatus as claimed in claim 2 wherein said mounting means comprise rams operable to maintain the carrier in a required angular position.

6. Trench cutting apparatus as claimed in claim 2 wherein said mounting means for supporting the carrier comprise three double-acting hydraulic rams mounted on the vehicle for supporting the carrier at or near its upper end.

7. Trench cutting apparatus as claimed in claim 6 wherein the carrier is supported at or near its lower end by a pair of double-acting hydraulic rams mounted on the vehicle.

8. Trench cutting apparatus as claimed in claim 2 wherein the carrier is mounted at one end of the vehicle and is movable transversely of the vehicle.

9. Trench cutting apparatus as claimed in claim 8 wherein the carrier is movable to a position beyond the side of the vehicle on one or each side thereof.

10. Trench cutting apparatus as claimed in claim 2 wherein means are provided for locking the cutter chain to the carrier whereby the cutter chain drive may be used for moving the chain support in the carrier.

11. Trench cutting apparatus as claimed in claim 2 wherein means are provided for locking the chain support in the carrier.

12. Trench cutting apparatus as claimed in claim 2 wherein power operated means are provided for controlling the position of the chain support in the carrier.

13. Trench cutting apparatus as claimed in claim 12 wherein said power operated means for controlling the position of the chain support in the carrier comprise at least one double-acting hydraulic ram on the carrier for moving the chain support through a multi-fold block and tackle.

14. Trench cutting apparatus as claimed in claim 2 wherein said carrier is pivotally carried on the vehicle to permit limited angular movement about an axis parallel to the longitudinal axis of the chain support and wherein a hydraulic ram is provided for adjusting the angular position of the carrier about said axis.

* * * * *