United States Patent

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[54] **BACKHOE EXCAVATOR WITH ENDLESS BUCKET ATTACHMENT**
14 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **37/83,** 37/192, 175/90
[51] **Int. Cl.** **E02f 5/06**
[50] **Field of Search** 37/83–90, 191, 192; 214/138; 180/79.2; 74/250; 175/89, 90; 299/72

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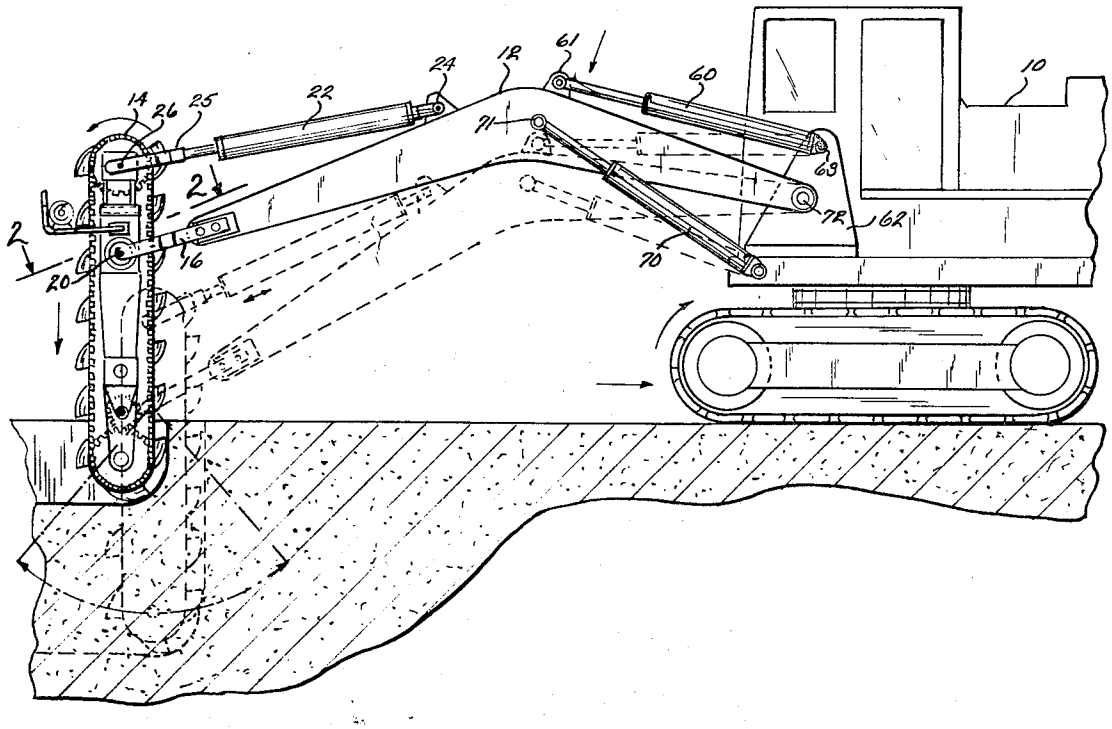
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ABSTRACT: A backhoe machine including a track laying or rubber tire tractor having a vertically adjustable boom (with the usual stick and bucket being removed) and having an endless bucket apparatus detachably secured intermediate its ends to the outer end of the boom. Longitudinal pitch is provided for the endless bucket apparatus by a piston-cylinder mechanism secured at one end to the top of the boom intermediate its ends and at its other end to a point near the top of the apparatus. Lateral pitch is provided by a reversible hydraulic rotator or hydraulic motor disposed between and connecting the end of the boom and the apparatus. The frame of the endless bucket apparatus may be formed of detachable sections to permit forming the apparatus into preselected lengths. An endless bucket gear chain or continuous linkage system on the apparatus may be driven by a reversible hydraulic gear chain motor through a set of meshed gears all preferably positioned at the bottom of the apparatus to provide more positive drive to the digging buckets. The endless gear chain or continuous linkage system may be reversed to release buckets stuck in dirt or material being excavated. Dirt or material may be carried away from the excavator by an auger and coacting tray disposed at the top of the apparatus or by an endless conveyor belt disposed at the top of the apparatus and movable laterally so that dirt may be dumped a substantial lateral distance from the apparatus. The auger or endless conveyor is provided on the apparatus for dumping material to the right or left side of the apparatus. The endless bucket apparatus may be circular, triangular, trapezoidal, or rectangular in longitudinal section for digging ditches of such respective shapes. A positive downward depressive force (crowd) may be applied to the endless bucket apparatus by a piston-cylinder mechanism rotatably secured to the top of the boom intermediate its ends, and its other end to the tractor at a point above where the boom is attached to the tractor.



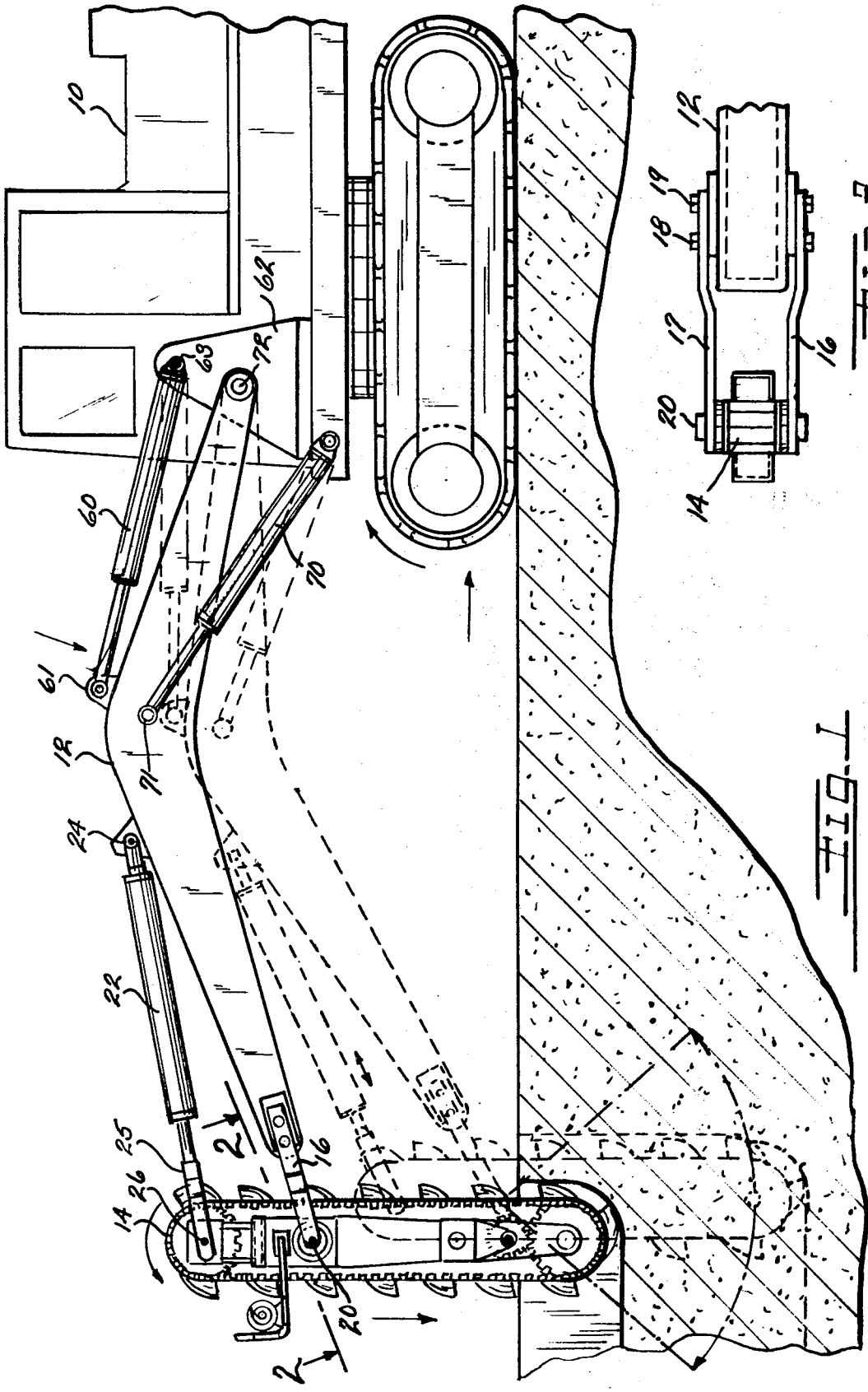


FIG. 1

FIG. 2

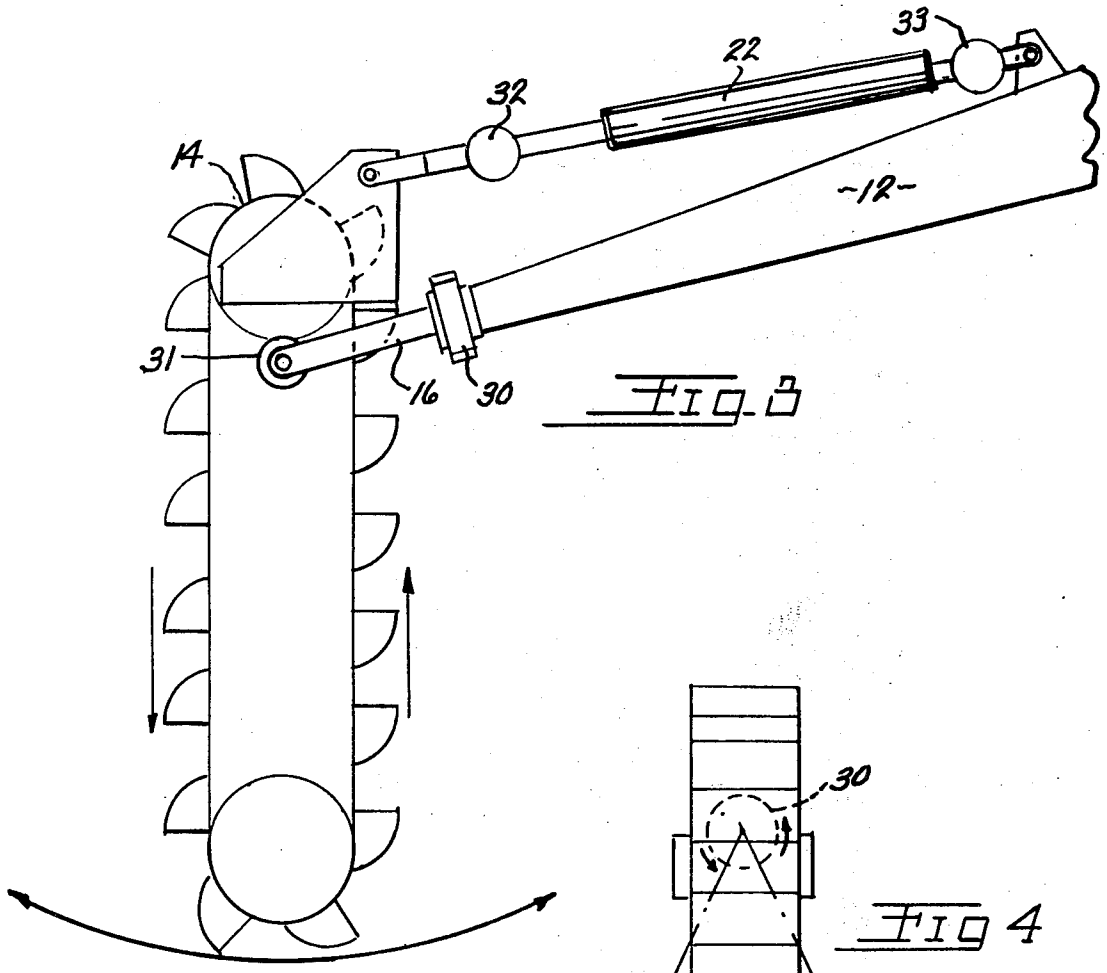


FIG. 3

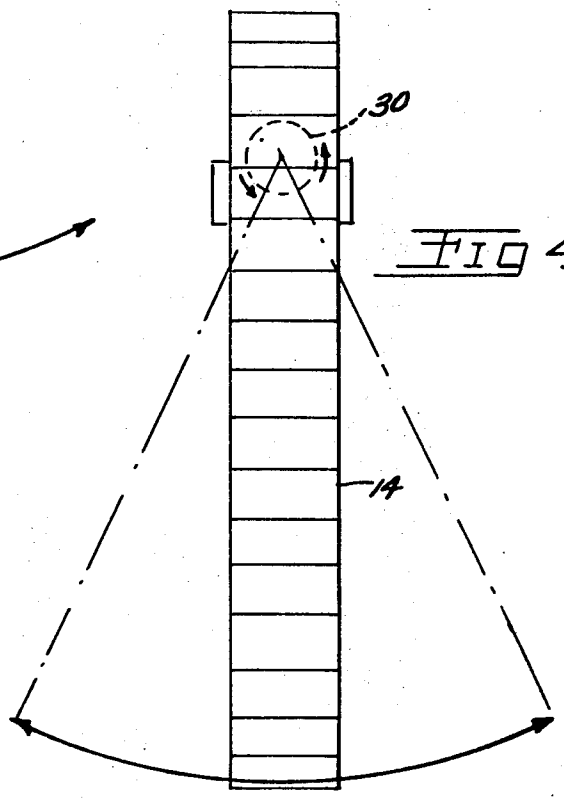


FIG 4

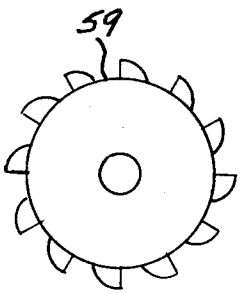


FIG. 1

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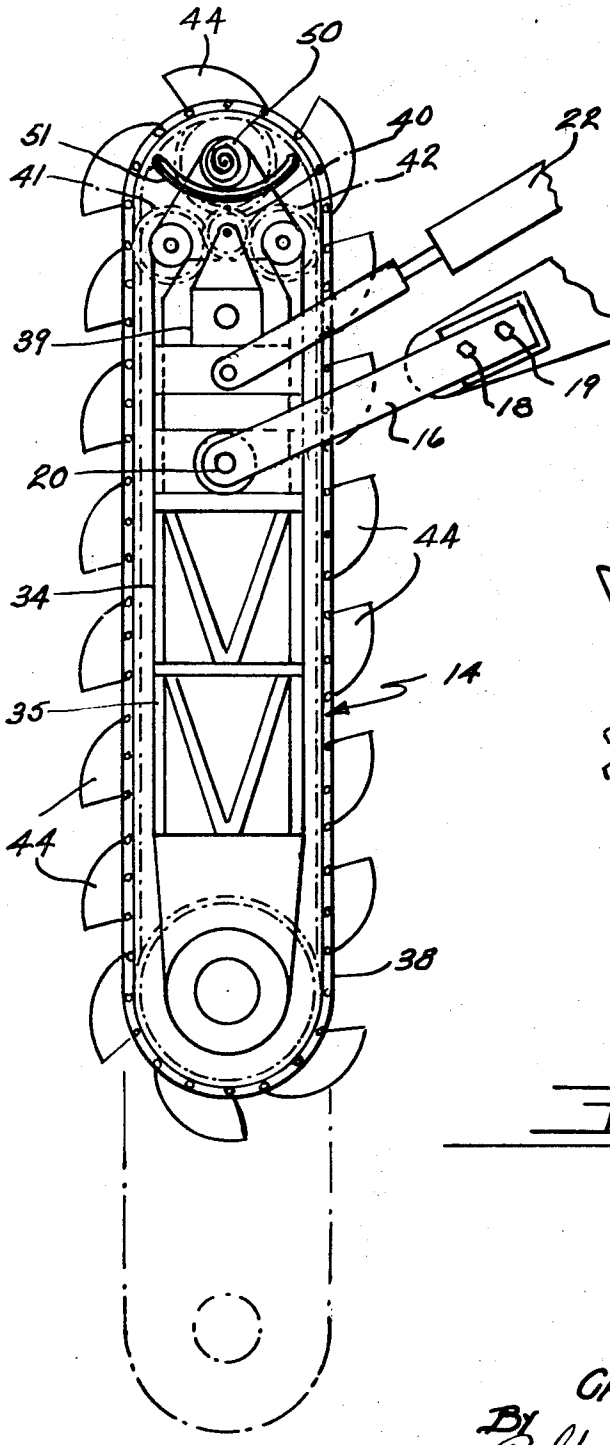


FIG. 5

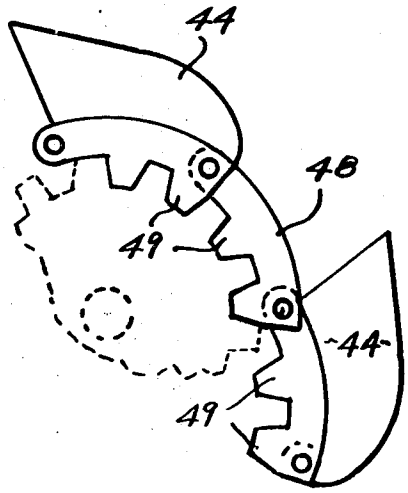


FIG. 6

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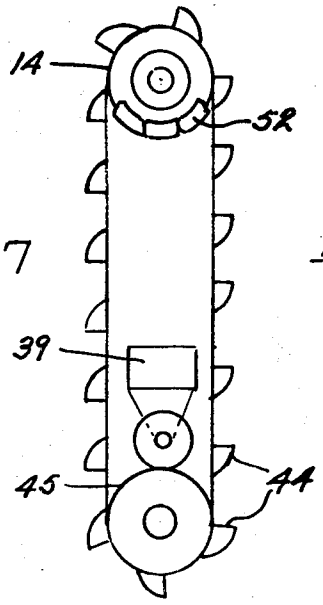


Fig. 7

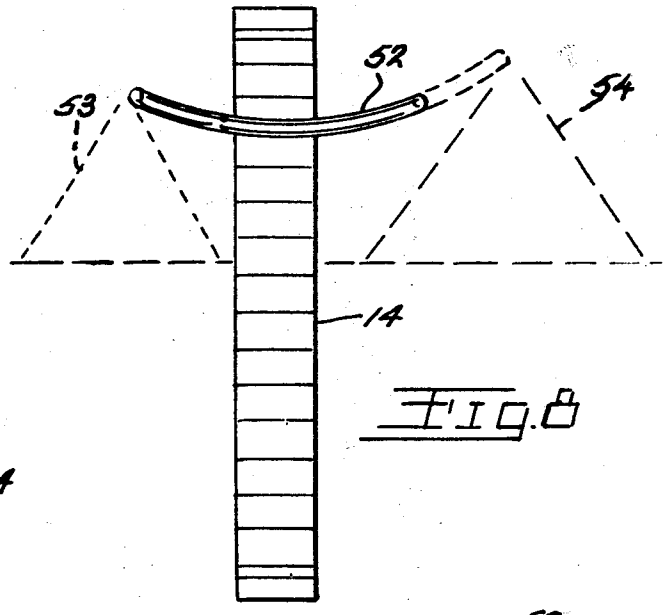


Fig. 8

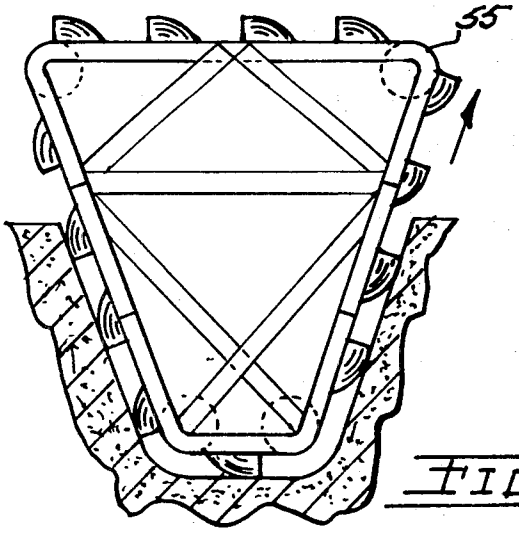


Fig. 9

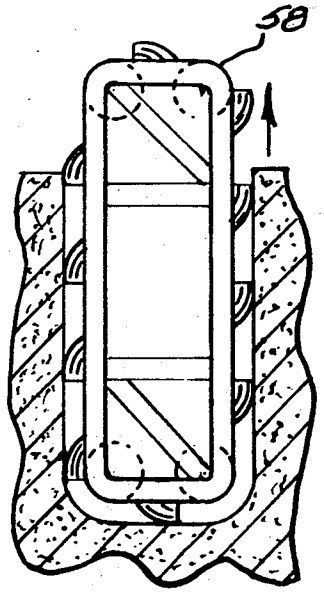


Fig. 12

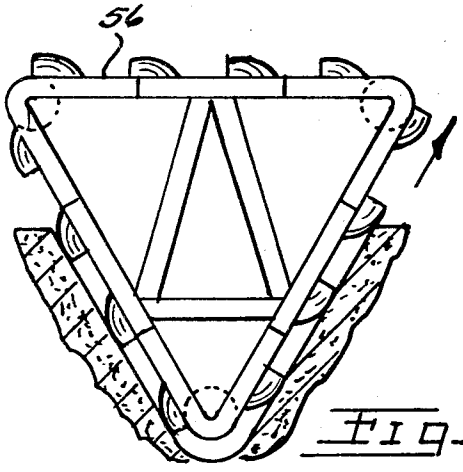


Fig. 10

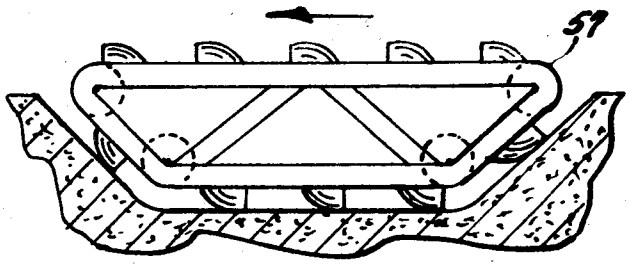


Fig. 11

BACKHOE EXCAVATOR WITH ENDLESS BUCKET ATTACHMENT

This invention relates to excavators and more particularly to backhoe type excavating machines.

Backhoe machines are inherently limited in digging speed, capacity, depth and trench forming configuration. There has long been a need for a backhoe-endless bucket combination to overcome such limitations.

It is an object of the invention to provide a backhoe-endless bucket combination for substantially increasing trench digging speed, capacity, and depth.

A further object of the invention is to provide a backhoe-endless bucket combination effecting both longitudinal and lateral pitch to the endless bucket apparatus and effecting a positive depressive force (crowd) to such apparatus.

A further object of the invention is to provide a machine of the above type having means for conveying excavated material to the right or left of the excavator. A further object of the invention is to provide a machine of the above type having circular, triangular, trapezoidal, or rectangular shaped endless bucket apparatus for digging trenches of such respective configurations.

A further object of the invention is to provide a machine of the above type wherein material may be conveyed from the buckets and laterally away from the apparatus a preselected distance.

A further object of the invention is to provide a machine of the above type that is simple in construction, inexpensive to manufacture, and highly effective in operation.

Briefly, the foregoing objects are accomplished by a conventional backhoe machine including a track laying or rubber tire tractor having a vertically adjustable boom with the usual stick and bucket being removed from the outer end of the boom. An elongated endless bucket excavating apparatus is detachably secured intermediate its ends to the outer end of the boom by a pair of spaced parallel brackets rigidly secured at their inner ends to the boom and with such apparatus rotatably secured to the outer ends of the brackets to permit such apparatus to rotate in a substantially vertical plane. Longitudinal pitch is provided for the endless bucket apparatus by a hydraulic piston-cylinder mechanism secured at one end near the top of the boom intermediate its ends and at its other end near the top of the apparatus. Such piston-cylinder mechanism also functions to keep the apparatus upright when desired. Lateral pitch is provided by a reversible hydraulic rotator or hydraulic motor disposed between and connecting the end of the boom and the apparatus intermediate the ends thereof. The frame of the endless bucket apparatus may be formed of detachable structural sections to permit forming the apparatus into preselected lengths for digging trenches of preselected depths. An endless bucket gear chain or linkages is provided on the apparatus and may be driven by a suitable drive means such as, for example, a reversible hydraulic gear chain motor through a set of meshed gears all preferably positioned at the bottom of the apparatus to provide more positive drive to the digging buckets, although it will be understood that such gears and motor may be positioned in the middle or at the top of the apparatus. Such gear chain motor may be reversed to release buckets stuck in dirt or material being excavated. Dirt may be carried away from the excavator by a dirt removal auger and coacting dirt removal tray disposed at the top of the apparatus and movable laterally of the apparatus so that dirt may be dumped a substantial lateral distance to the right or left of the apparatus if required. The endless bucket apparatus may be circular, triangular, trapezoidal, or rectangular in longitudinal section for digging ditches of such respective shapes. A positive downward depressive force (crowd) may be applied to the endless bucket apparatus by a piston-cylinder mechanism rotatably secured to or adjacent the top of the boom intermediate its ends and at its other end to the tractor at a point above where the boom is attached to the tractor.

The buckets may be powered by one or more hydraulic motors that can be mounted on the endless bucket framework at any position thereon so as to afford maximum power when and where required. The principal hydraulic power for the hydraulic motors driving the continuous or endless bucket system is supplied by a pump on the prime power source of the backhoe machine.

The principal uses of the invention will be for ditching, excavating, trenching, grading and cleanup work. It is to be particularly understood that the principal prime power source is an all hydraulic backhoe excavator with the appendage known as the "stick and bucket" being removed and with the normal appendage known as the boom being attached at its outer end to the frame of the endless bucket apparatus. The hydraulic cylinder that controlled the (removed) backhoe bucket is now used to power the endless bucket excavator apparatus. The power formerly used for the hydraulic cylinder that controlled the bucket is the power available for the invention. This system of continuous excavators can be applied to any of the varieties of conventional hydraulic backhoes, either crawler or wheel mounted, with or without a revolving turntable, including farm tractor type backhoes.

The system of modular frameworks aforedescribed can be so constructed that when the plane of rotation of the buckets is perpendicular to the longitudinal line of the trench being dug, a variety of cross-sectional contours of the trench can be effected. The truncations of the trench and the pitch of the sides will create no problem to the contractor as has been the case in the past. The floor of the excavated trench may be flat or curved.

Through the use of hydraulics, a variety of line speeds of the buckets, and feed of the crowd actions will allow for adjustment for the varying conditions of simple to difficult excavation.

The material that is excavated through the use of the endless bucket system will be conveyed upward and to an area where the buckets will empty onto the aforementioned auger or belt conveyor that will also be hydraulically powered, such system transporting the excavated material onto a spoil area adjacent and parallel to the excavation. Another advantage of such system of buckets attached to the hydraulic backhoe boom would be the various contours and curves available around objects facilitated through the swinging motion of the rotating excavator in an excavation plane parallel to the line of excavation.

A big advantage in using a hydraulic motor to drive the endless or continuous buckets would be the ability to reverse the motor when areas hard to dig or excavate are encountered that normally would either stall the direct mechanical drive and/or shear and break mechanical connections such as, for example, shear pins. Through the use of hydraulics and a simple overload relief or bypass valve installed in the line, when excessive hydraulic pressures build up, the bypass valve will take effect.

Feed and speeds of the endless bucket apparatus attachment have a variable range as required by digging conditions encountered through the use of what is normally known as a feathering spool or similar device in the backhoe valve controls. All controls of depth, feed, speed and crowding action of the endless bucket apparatus are capable of being controlled without major modifications in the standard hydraulic backhoe excavator. Additionally, all standard hand and foot controls would perform the near identical function when the machine was properly equipped as a backhoe, eliminating special operator instruction and fatigue.

Considering the power plants and horsepower rating of engines of existing continuous wheel or ladder type trenchers and the function of excavation which can be considered width X depth (cross section measured in square feet) x speed in feet per minute, there is much more power available size for size in the present backhoe-endless bucket apparatus along with the advantage of maximum digging depth facilitated through the power boom arrangement.

The trenching and digging efficiency of the present invention can be considered theoretically as 100 percent efficient because of its continuous nature versus a simple backhoe which only digs and excavates to a theoretical efficiency factor of approximately 50 percent. A backhoe deadheads approximately 50 percent of its total operating cycle.

The basic hydraulic backhoe boom can also be equipped with a circular wheel-type endless bucket excavator that can be used as a loading tool into trucks or haul bodies when applied to either an excavation or material handling project. Rotation of the wheel is in a plane parallel to the bank or spoil area to effect a cutting action in the course of excavation similar to a facing or end-mill operation on a machine tool.

The utility of the present backhoe-endless bucket machine is the marked reduction in capital investment required by a contractor who, heretofore, has invested not only in a backhoe, but also in a continuous trencher to do two specific types of jobs. With the present invention, the contractor will only have one major investment in the form of the backhoe, with a relatively lesser investment in the continuous or endless bucket elevator attachment.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the drawings wherein:

FIG. 1 is a side elevational view of a backhoe machine constructed in accordance with the invention;

FIG. 2 is an enlarged view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged side elevational view of the endless bucket apparatus shown in FIG. 1, and showing a modification thereof;

FIG. 4 is an end elevational view of the apparatus shown in FIG. 3;

FIG. 5 is a side elevational view of a modified type of endless bucket apparatus of the invention;

FIG. 6 is a side elevational view of modified chain links which may be used on the apparatus of FIG. 5;

FIG. 7 is a side elevational view of another modification of the endless bucket apparatus of the invention;

FIG. 8 is an end elevational view of the apparatus shown in FIG. 7;

FIG. 9 is a side elevational view of an elongated trapezoidal configured endless bucket apparatus;

FIG. 10 illustrates a modification of the apparatus shown in FIG. 9;

FIG. 11 illustrates a further modification of the apparatus shown in FIG. 9;

FIG. 12 is a side elevational view of a rectangular configured endless bucket apparatus; and

FIG. 13 is a side elevational view of a circular configured endless bucket apparatus.

Although the invention is shown and described herein with reference to backhoe machines of the track laying or rubber-tired type, it will be understood that it may be applied to any type of excavating machine.

The terms and expressions which have been used are used as terms of description, and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

The term "tractor," as used herein, includes track-laying tractors, rubber-tire tractors, farm tractor-type backhoes, and any excavating tractor having a boom thereon.

Referring to the drawings, there is shown a conventional backhoe machine including a tractor **10** having a vertically adjustable backhoe boom **12** operatively secured thereto, with the usual backhoe stick and bucket being removed from the outer end of the boom. An upright elongated endless bucket excavating apparatus or excavator **14** is detachably secured intermediate its ends to the outer end of the boom **12** in operative position thereon, by suitable attaching means such as, for example, a pair of spaced parallel brackets **16** and **17** rigidly secured at their inner ends to the boom by the bolts **18** and **19** and with such apparatus **14** rotatably secured by the bolt **20** to the outer ends of the brackets **16**, **17** to permit such apparatus to rotate in a substantially vertical plane.

Longitudinal pitch in the positioning of the apparatus **14** with respect to the boom **12**, as indicated by the broken arrow in FIG. **1**, is provided by a hydraulic piston-cylinder mechanism **22** rotatably secured at one end to the bracket **24** on the top surface of the outer portion of the boom **12**, intermediate its ends, and at its other end to the top of the apparatus **14** by means of the bracket **25** and the bolt **26**. Such piston-cylinder mechanism **22** also functions to keep the apparatus **14** upright when desired. Thus, the apparatus **14** may be selectively positioned at an angle to the vertical in the longitudinal plane of the boom **12**.

Lateral pitch, as indicated by the bottom arrows in FIG. **4**, is provided by a suitable rotating means in the form of a reversible hydraulic rotator or hydraulic motor **30** (FIGS. **3** and **4**) disposed between and connecting the end of the boom **12** and the apparatus **14** intermediate the ends thereof. Thus, the apparatus **14** may be positioned at an angle to the vertical in a plane at right angles to the longitudinal plane of the boom **14**. Sets of spherical bearings **31**, **32** and **33** may be provided as shown, to permit free movement of the respective parts when lateral pitch is effected.

Referring now to FIG. **5**, the frame of the endless bucket apparatus **14** may be formed of detachable, modular, structural sections **34** and **35**, for example, to permit forming the apparatus **14** into preselected lengths for digging trenches of preselected depths. A continuous linkage system such as, for example, an endless bucket gear chain **38** is provided on the apparatus **14** and may be driven by a reversible hydraulic gear chain motor **39** through a set of meshed coacting gears **40**, **41**, and **42**. In FIG. **5** such motor and gears are shown positioned at the top of the apparatus **14**. In Flg. **7** such motor and associated gears are all preferably positioned at the bottom of the apparatus to provide more positive drive to the digging or excavating buckets **44** disposed in spaced relation on the chain **38**. Such gear chain motor **39** may be reversed to release buckets stuck in dirt or material being excavated. In FIG. **7**, the coacting gears include a drive gear **45**.

Dirt or material may be carried away from the excavator or apparatus **14** by a dirt feed or dirt removal auger **50** (FIG. **5**) and coacting dirt removal tray **51** disposed at the top of the apparatus **14**. In FIGS. **7** and **8**, dirt is dumped from the buckets **44** onto an endless conveyor belt assembly **52** movable laterally to the left or right of the apparatus, as shown in FIG. **8**, so that dirt may be dumped directly adjacent the apparatus in a pile **53**, or in a pile **54** a substantial lateral distance from the apparatus **14**, if required. FIG. **6** illustrates a modified bucket endless gear chain formed of arced or partially curved links **48** of equal size, each having gear teeth **49**. Each link **48** has a pitch diameter and pressure angle the same as the drive gear. The buckets are preferably disposed on every other link of the gear chain.

Referring now to FIGS. **9** through **13**, the endless bucket apparatus **14** may be triangular, trapezoidal or rectangular in longitudinal section for digging ditches of such respective shapes in transverse configuration. FIG. **9** shows a vertically elongated trapezoidal configuration **55**. FIG. **10** shows a triangular configuration **56**. FIG. **11** shows a horizontally elongated trapezoidal configuration **57**. FIG. **12** shows a rectangular configuration **58**. FIG. **13** shows a circular configuration **59**. In this instance, the ditch is dug by disposing the apparatus in a plane at right angles to the plane of the boom and then digging to a selected depth, after which the apparatus is raised to the top of the ground and moved longitudinally of the ditch a distance equal to the width of the buckets, and again digging to the selected depth.

A positive downward depressive force (crowd) may be applied to the endless bucket apparatus **14** by a piston-cylinder mechanism **60** (FIG. **1**) rotatably secured to the bracket **61** on the top of the boom **12**, intermediate its ends, and at its other

end to the bracket **62** on the tractor **10** at a point **63** above where the boom **12** is attached to the tractor. There is further included a hydraulic piston-cylinder mechanism **70** rotatably secured at one end at the point **71** on the boom **12** intermediate the ends thereof and at the other end to the tractor **10** below the point **72** where the boom is attached to the tractor, such mechanism **70** being used for raising and lowering the boom. The coacting piston-cylinder mechanism **60** along with the piston cylinder mechanism **70** provide selective positive downward depressive force or crowd on the boom. The piston-cylinder mechanisms **60** and **70** are hydraulically interlocked to coact with each other in applying such depressive force to the boom.

As aforementioned, the buckets **44** (FIG. **5**) through their endless bucket chain **38** may be powered by one or more hydraulic motors **39** that can be mounted on the endless bucket apparatus framework at any suitable position thereon so as to afford maximum power when and where required. The principal hydraulic power for the hydraulic motors driving the continuous or endless bucket system is supplied by a conventional pump on the prime power source of the backhoe machine **10**.

I claim:

1. In a backhoe machine of the type including a tractor having a vertically adjustable boom operatively secured thereto; the combination thereof including an endless bucket excavating apparatus disposed intermediate its ends on the boom, attaching means for detachably securing the apparatus to the boom in operative position thereon, said means including a pair of spaced parallel brackets rigidly secured at their inner ends to the boom, the endless bucket apparatus being rotatively secured to the outer ends of the brackets to permit the apparatus to rotate in a vertical plane, a hydraulic piston-cylinder mechanism operatively disposed on the upper surface of the outer portion of said boom in substantially parallel relation thereon with the inner end of such mechanism being secured to the boom, said endless bucket apparatus being elongated and carried by said boom in substantially upright operative position, the outer end of the piston-cylinder mechanism being secured to the end of the endless bucket apparatus to provide longitudinal pitch in the positioning of the apparatus with respect to the boom whereby the apparatus may be selectively positioned at an angle to the vertical in the longitudinal plane of the boom, rotating means disposed between and connecting the brackets and the end of the boom to permit lateral pitch in the positioning of the elongated endless bucket apparatus whereby the apparatus may be positioned at an angle to the vertical in a plane at right angles to the longitudinal plane of the boom, said rotating means being a reversible rotary-type hydraulic motor, and further including two sets of spherical bearings operatively secured to the outer end of the brackets to allow free lateral swing of the endless bucket apparatus.

2. The structure of claim **1** wherein said endless bucket apparatus includes a frame formed of detachable modular sections to permit forming such elongated apparatus into preselected lengths for forming trenches of preselected depths.

3. The structure of claim **1** wherein said endless bucket apparatus includes an elongated frame, an endless gear chain operatively disposed on said frame for rotation thereabout, excavating buckets operatively disposed on said chain in spaced relation thereon for excavating, a set of coacting gears including a drive gear disposed on said frame and meshed with said chain to drive the same, and a reversible hydraulic motor disposed on said frame and meshed with said gears to drive the same whereby the chain may be rotated in one direction on the frame for excavating and may be reversed in direction to release the buckets if they become stuck in the material being excavated.

4. The structure of claim **3** wherein the reversible hydraulic motor gears and hydraulic motor are disposed at the bottom of the upright endless bucket apparatus to give more positive drive to the digging buckets adjacent thereto.

5. The structure of claim **3** and further including a reversible endless conveyor belt assembly operatively disposed on the endless bucket apparatus so as to receive dirt from the buckets as they pass over the top of the frame and carry and dump the dirt laterally of the apparatus, said belt assembly being laterally movable with respect to the apparatus thereby enabling the belt assembly to be disposed in a preselected lateral position with respect to the endless bucket apparatus whereby dirt may be dumped laterally to the left or right of and directly adjacent the apparatus or at a substantial lateral distance from the apparatus.

6. The structure of claim **3** and further including a dirt-feed auger and coacting dirt-removal tray operatively disposed on the apparatus to receive dirt from the buckets as they pass over the top of the frame and carry and dump the dirt laterally to the left or right of the apparatus.

7. The structure of claim **3**, wherein said endless gear chain is formed of arced gear links of equal size each having gear teeth, each of said links having a pitch diameter and pressure angle the same as said drive gear.

8. The structure of claim **7** wherein a bucket is disposed on every other link of said gear chain.

9. The structure of claim **1** wherein said endless bucket apparatus is of trapezoidal configuration in longitudinal section for digging ditches of trapezoidal shape in transverse configuration.

10. The structure of claim **1** wherein said endless bucket is of rectangular configuration in longitudinal section for digging ditches of rectangular shape in transverse configuration.

11. The structure of claim **1** wherein said endless bucket is of triangular configuration in longitudinal section for digging ditches of triangular shape in transverse configuration.

12. The structure of claim **1** wherein said endless bucket apparatus is of circular configuration in longitudinal section for digging ditches of substantially circular shape in transverse configuration.

13. The structure of claim **1** and further including a hydraulic piston-cylinder mechanism rotatably secured at one end to the boom intermediate the ends thereof and at the other end to the tractor below the point where the boom is attached to the tractor for raising and lowering the boom, and a coacting second piston-cylinder mechanism rotatably secured at one end to the boom intermediate the ends thereof and at the other end to the tractor above the point where the boom is attached to the tractor for providing positive downward depressive force on the boom.

14. The structure of claim **1** wherein the piston-cylinder mechanisms are hydraulically interlocked to coact with each other in applying a positive downward depressive force to the boom.