United States Patent

[11] 3,577,664

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[21] Appl. No. 746,411
[22] Filed July 22, 1968
[45] Patented May 4, 1971

[73] Assignee Delta Diggers, Inc.

[54] EXCAVATION MACHINE HAVING IMPROVED DIGGING ELEMENTS
6 Claims, 18 Drawing Figs.

[52] U.S. Cl. 37/192, 37/141, 299/25, 198/99, 74/242.11, 180/26, 280/43.24, 280/5

[51] Int. Cl. E02f 3/14, E02f 5/20

[50] Field of Search ..... 37/(Digest), 191, 192, 141, 142, 83—90; 180/26, 19; 280/43, 34, 43.24, 43.17, 150.5, 5; 198/99, 101, 152; 254/86; 74/242.11, 242.14, 227; 299/25 (Cursory)

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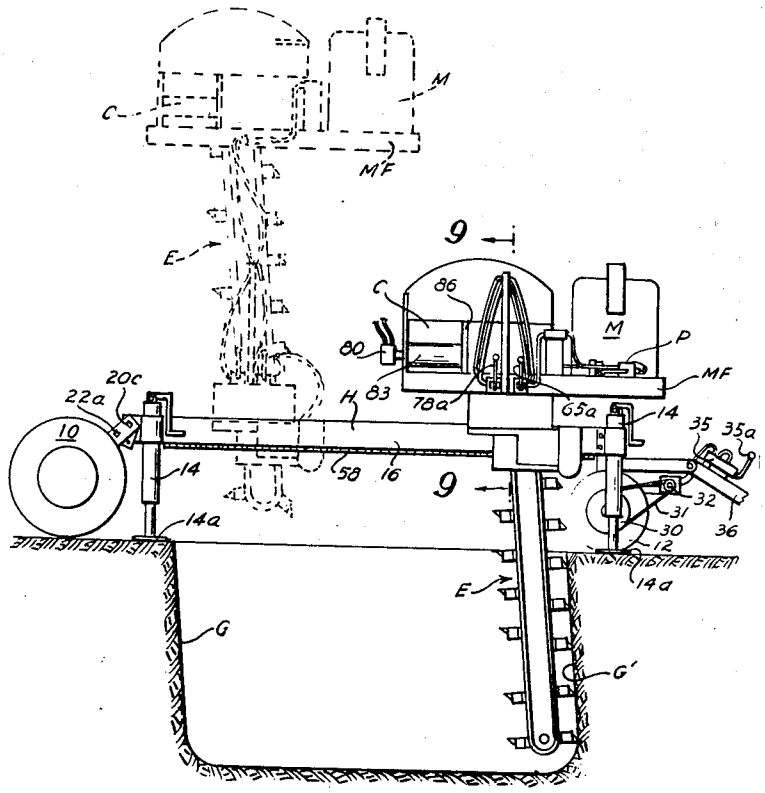
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Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Clifford D. Crowder
Attorney—Pravel, Wilson & Matthews

ABSTRACT: An excavation machine which is especially suitable for digging graves, wherein a mobile frame has an excavating assembly mounted thereon for movement substantially vertically and also horizontally relative to the frame for excavating the grave or other hole. The machine is compact, capable of being pulled on the highway, and is controlled hydraulically for the excavating operation. The excavation is effected with a plurality of scratching elements which scratch the dirt from the vertical wall and collect same in buckets on an endless conveyor, with such conveyor preferably being at a small angle with respect to vertical to obtain more effective, smooth excavating action so that the frame for the machine does not shift or move from its location during the excavating operation.



PATENTED MAY 4 1971

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SHEET 1 OF 7

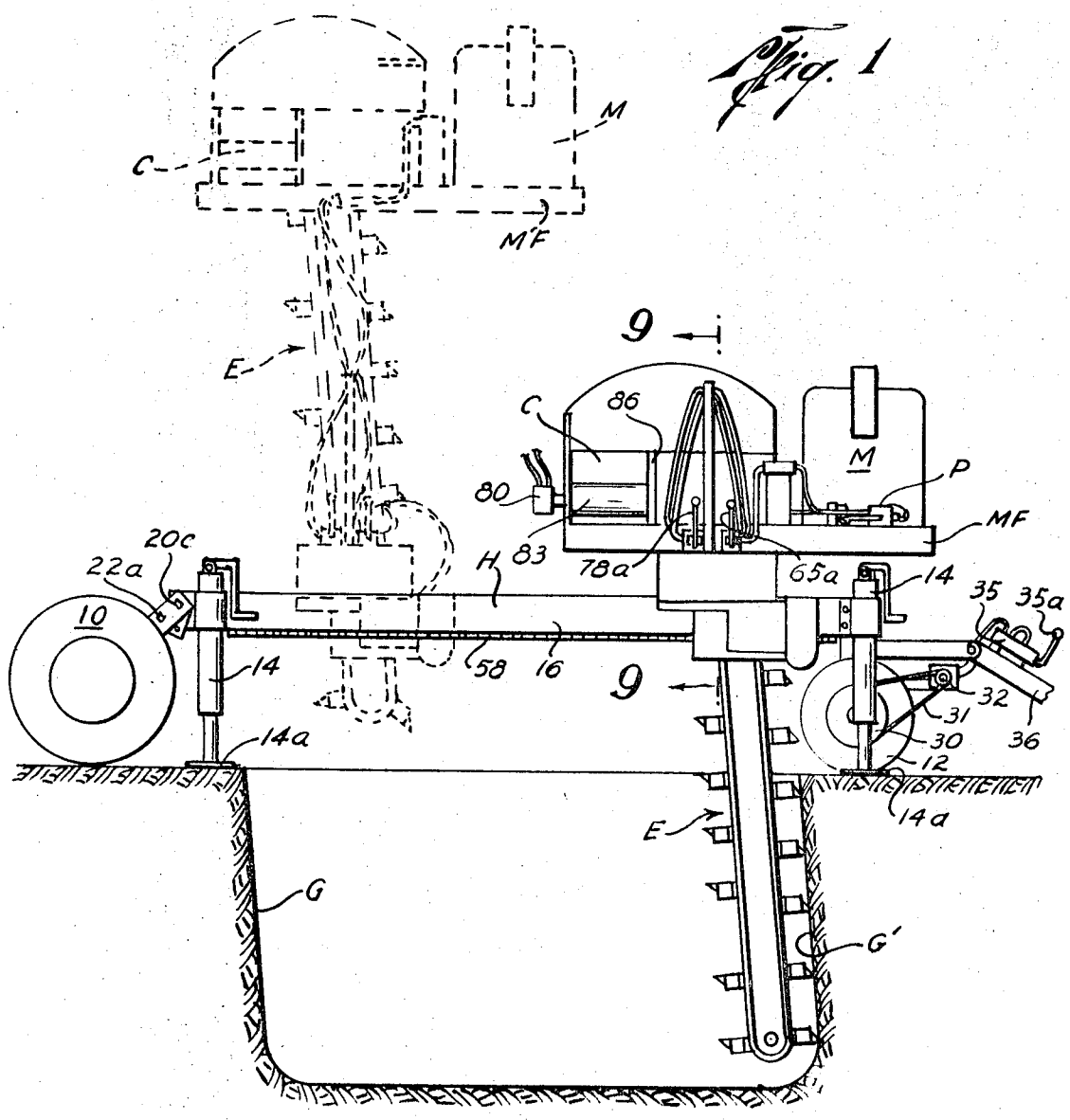


Fig. 1

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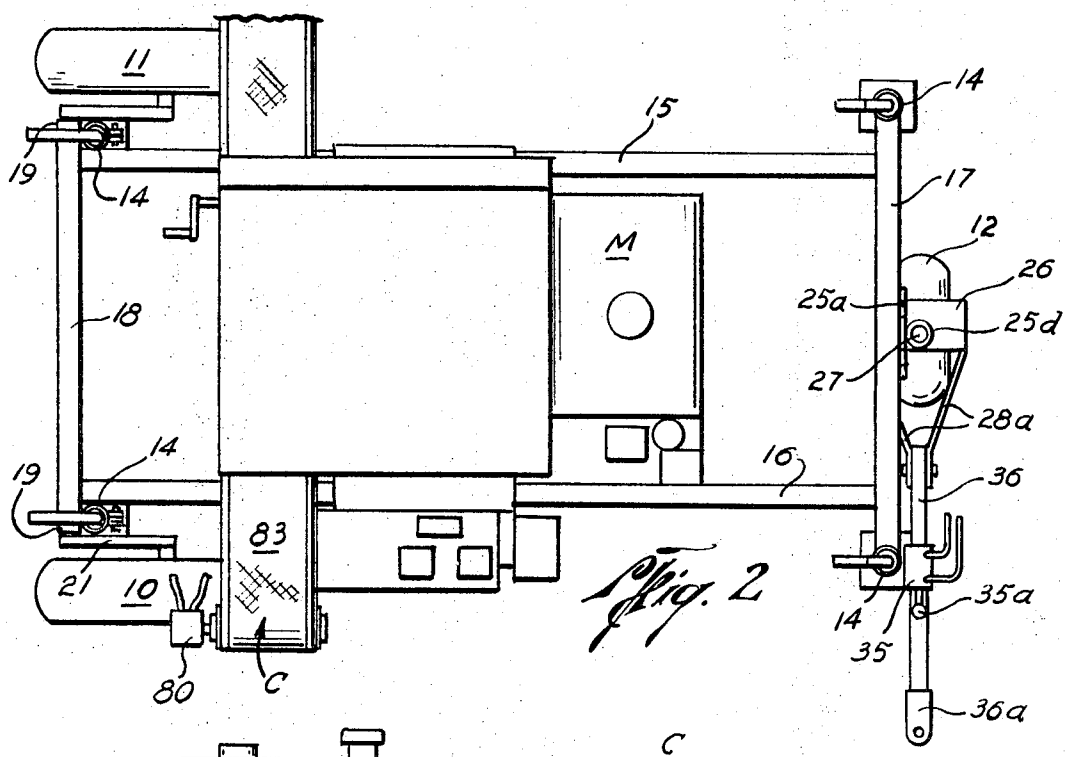


Fig. 2

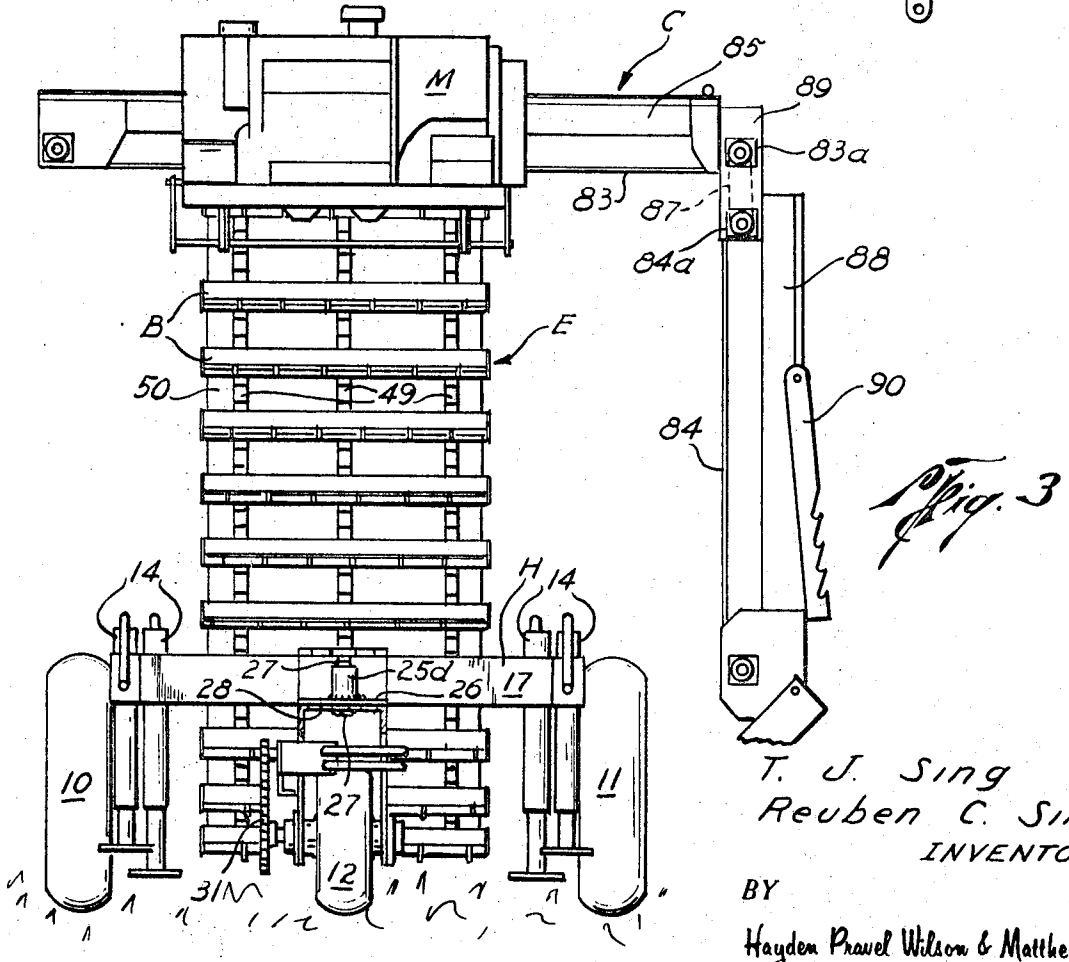


Fig. 3

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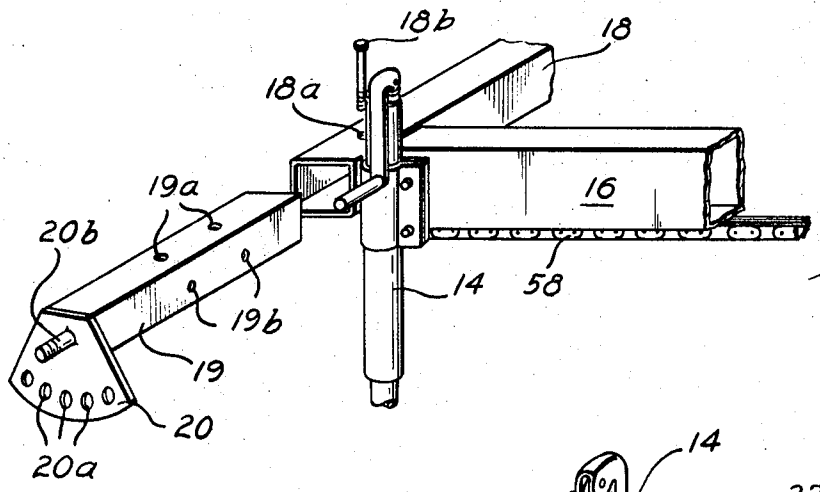


Fig. 4

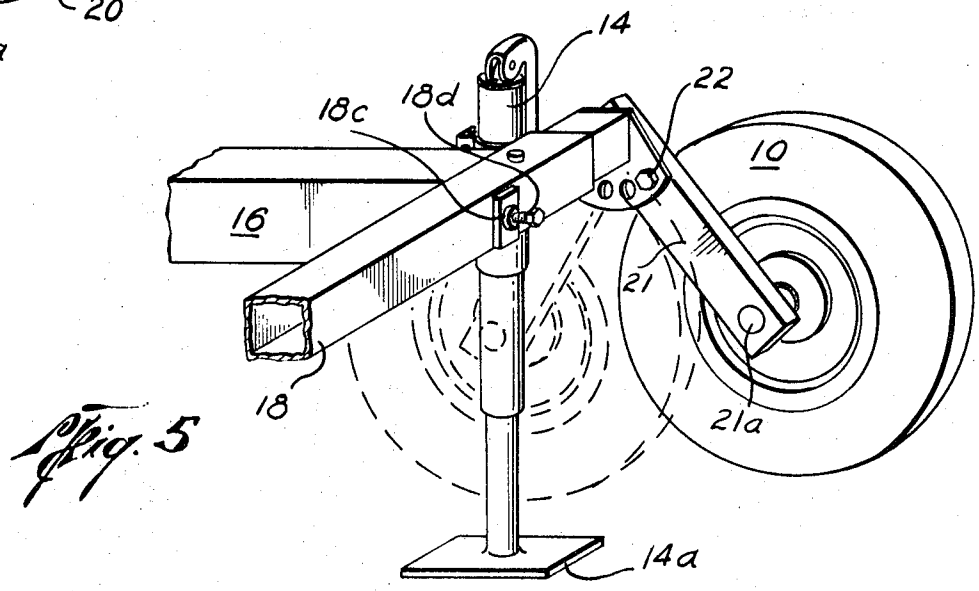


Fig. 5

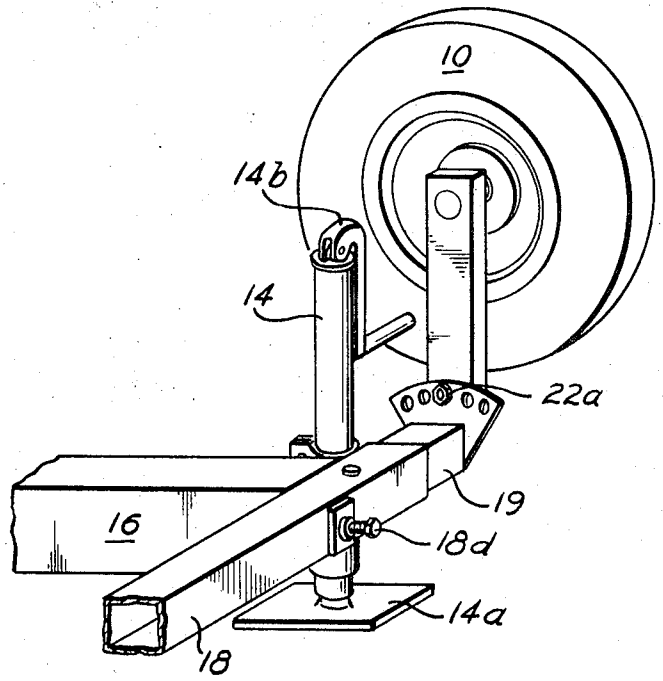


Fig. 6

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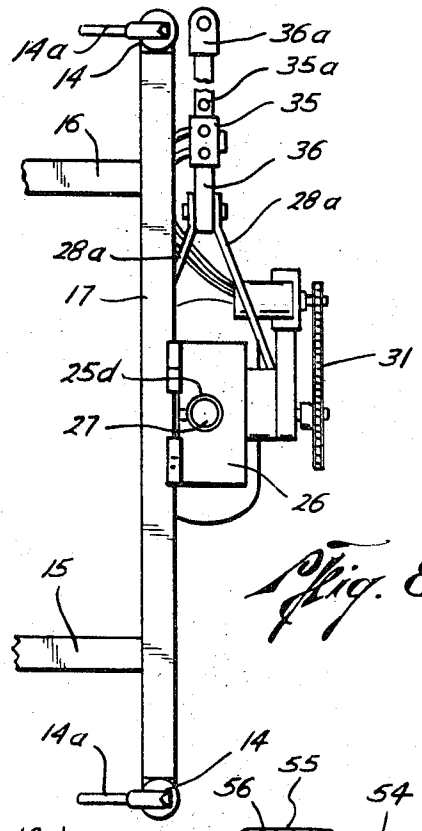


Fig. 8

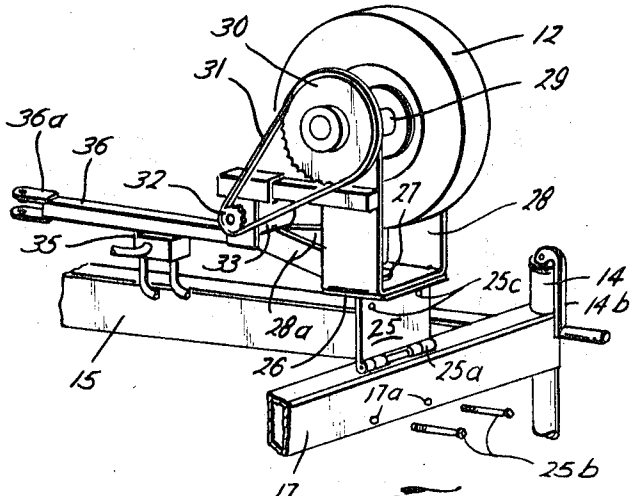


Fig. 7

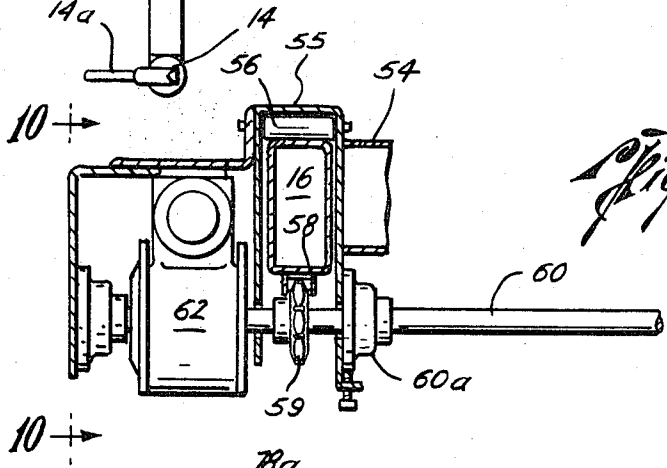
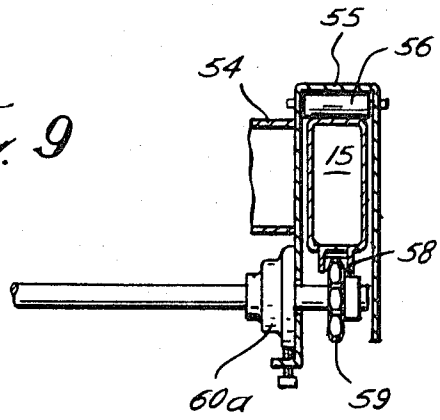


Fig. 9



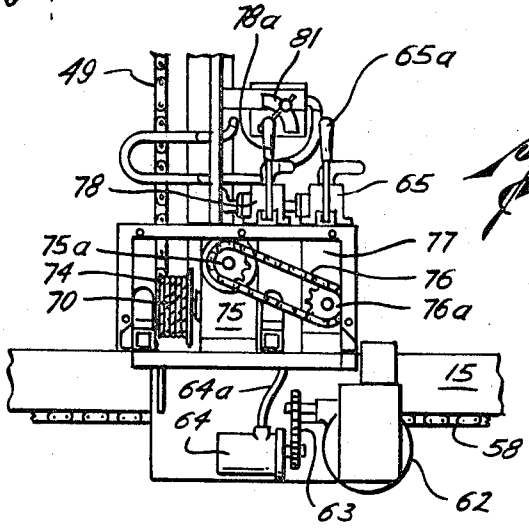


Fig. 10

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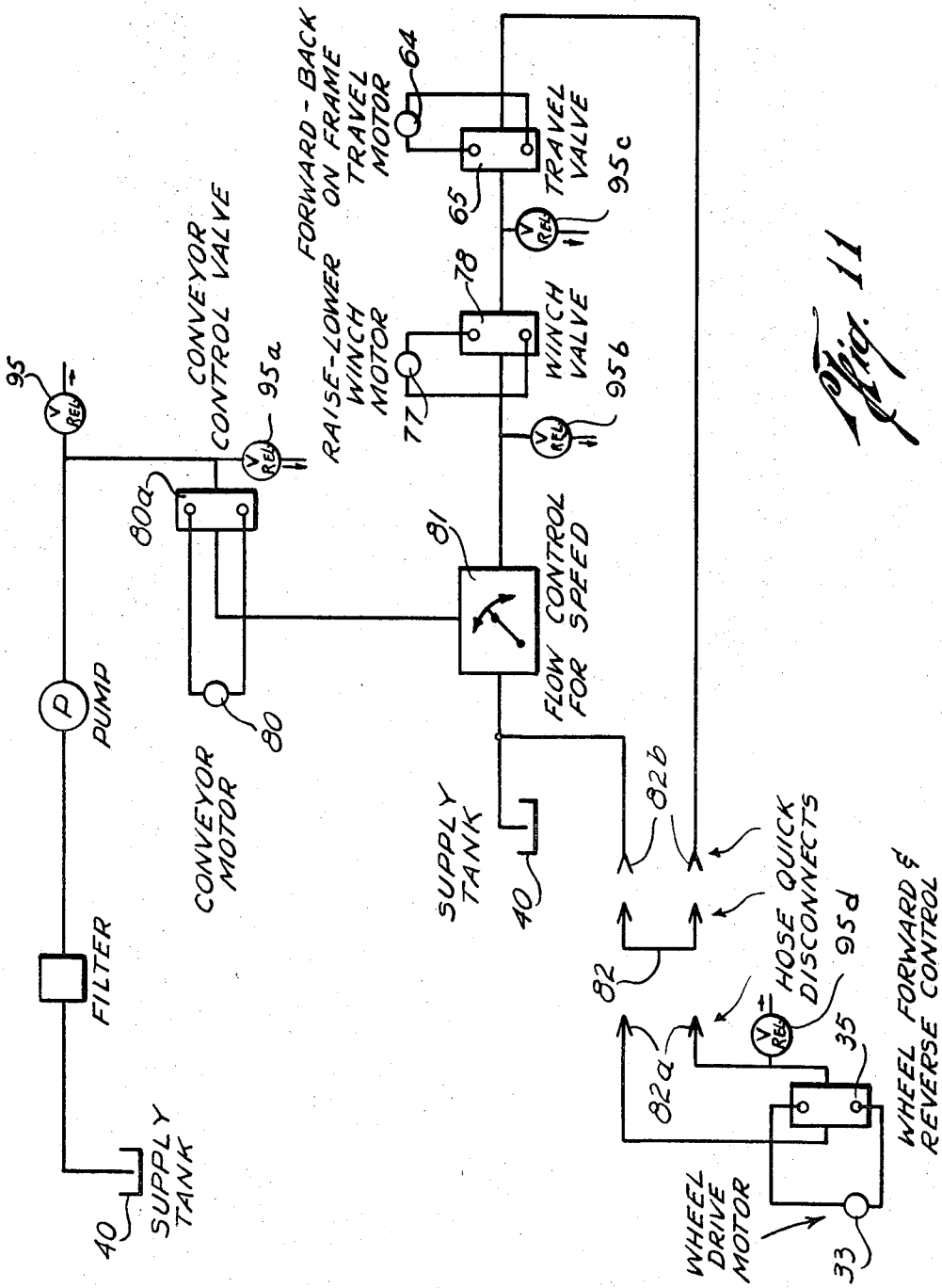


Fig. 11

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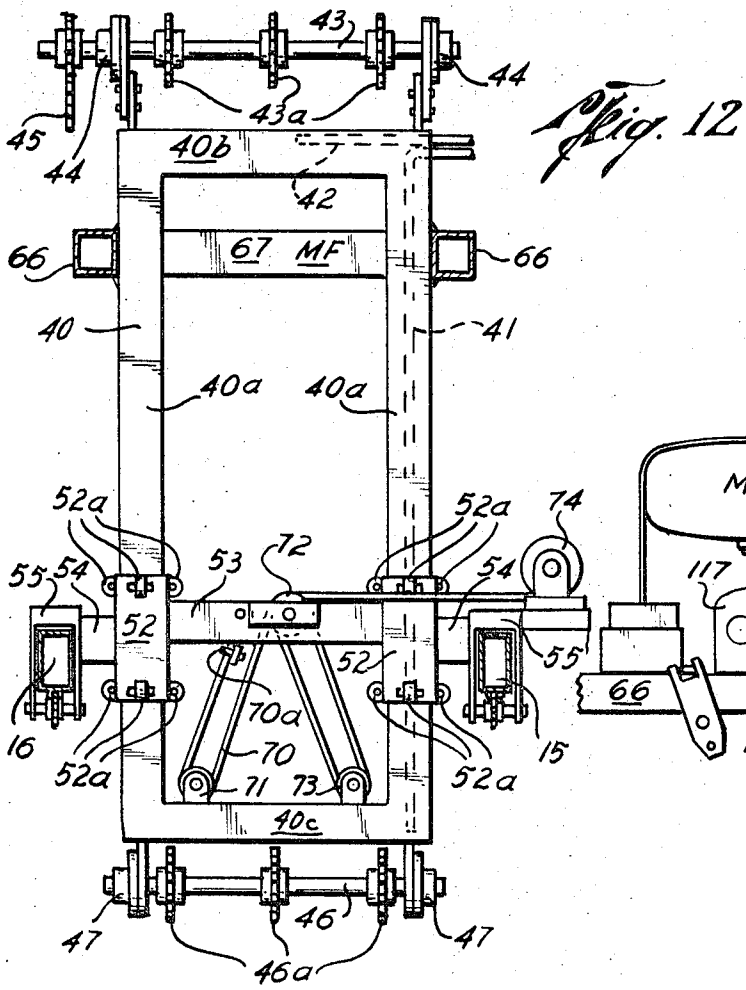


Fig. 12

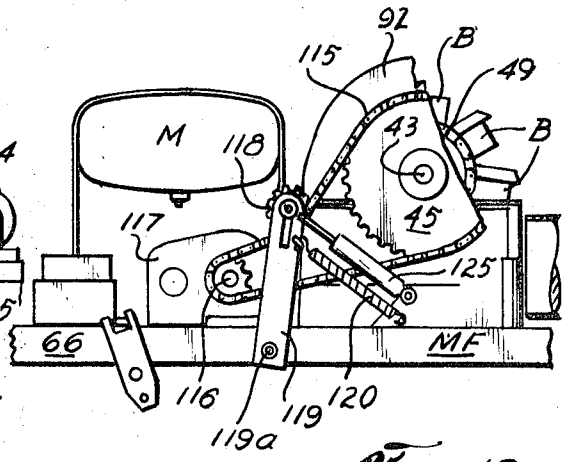


Fig. 13

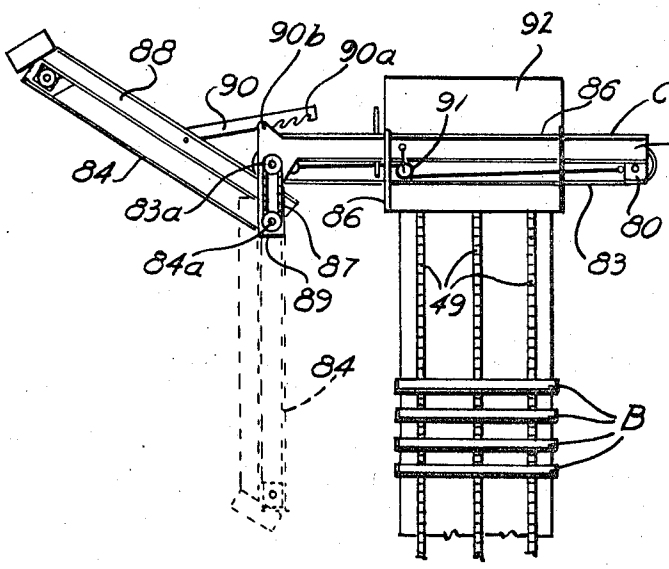


Fig. 14

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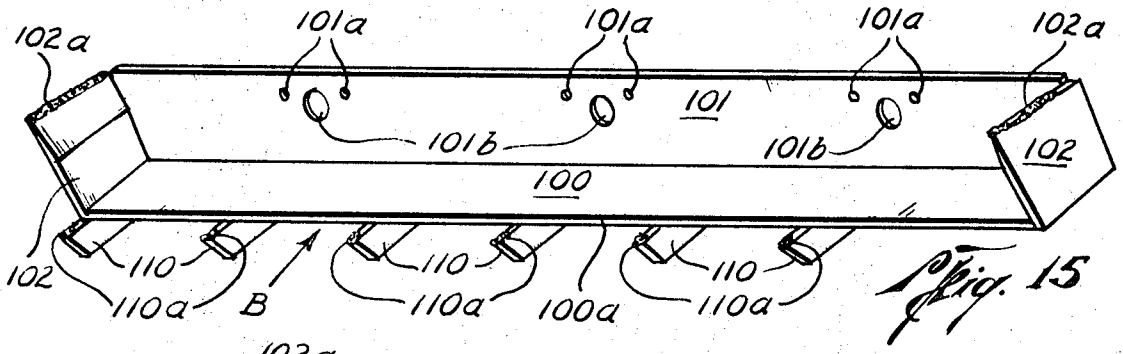


Fig. 15

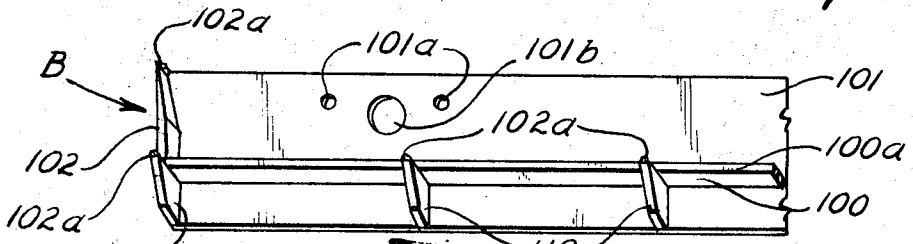


Fig. 16

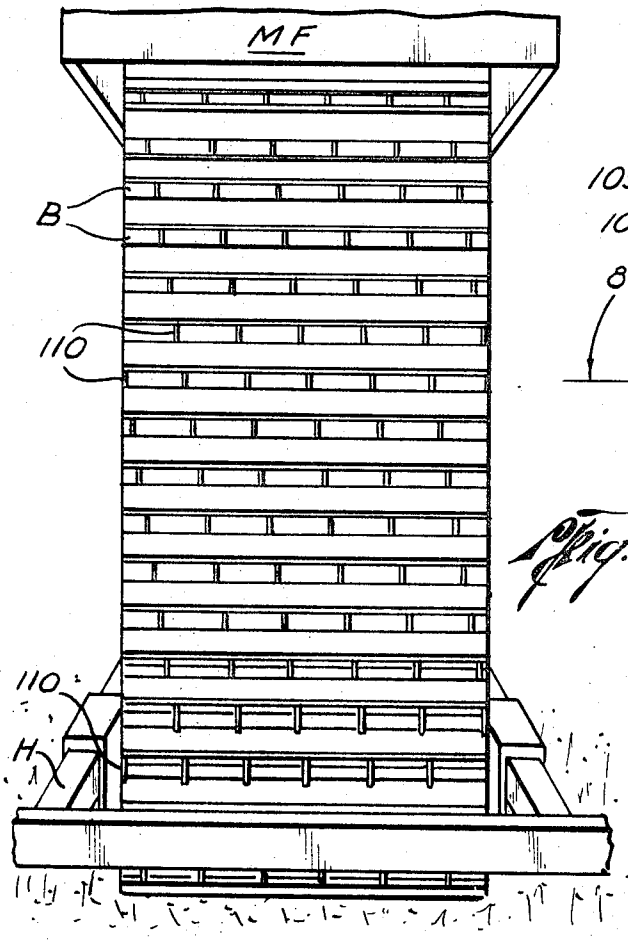


Fig. 17

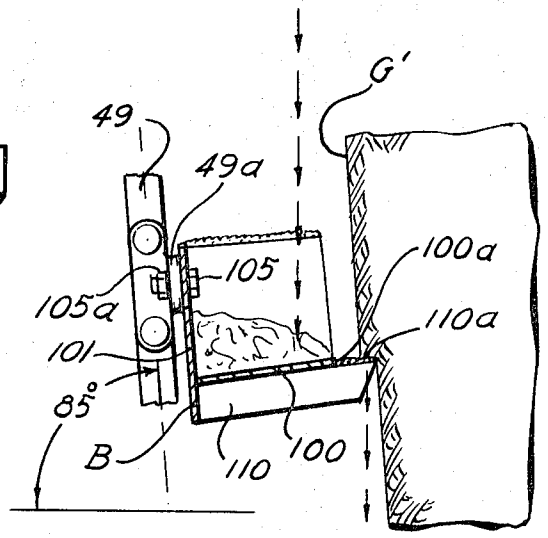


Fig. 18

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EXCAVATION MACHINE HAVING IMPROVED DIGGING ELEMENTS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is an improvement over copending U.S. Pat. application Ser. No. 570,509 filed Aug. 5, 1966 by Guy C. Pearson, now U.S. Pat. No. 3,474,551.

BACKGROUND OF THE INVENTION

The field of this invention is excavating machines for graves and the like.

A number of prior efforts have been made in the field of excavating apparatus for graves, examples of which are found in U.S. Pat. Nos. 2,501,083; 2,673,407; and 3,015,175. So far as is known, none of such prior art machines has ever been practical commercially, largely because their structures were either awkward to transport and use, or they were inefficient in digging and removal of dirt from the excavation. In the prior application of Guy C. Pearson, identified above, the general efficiency of transportation and use has been increased as compared to the prior art. For example, the engine for operating the excavation apparatus is mounted on the upper end of the digging assembly in the apparatus of the Pearson patent application to thereby impose the weight thereof on the digging fingers as the digging assembly is lowered.

SUMMARY OF THE INVENTION

The present invention constitutes an improvement over the apparatus of said Pearson patent application. Specifically, the present invention is compact, has a width and length so that it can be pulled on the highway or moved readily in a cemetery, has a scratching action which removes the dirt so that it falls into a plurality of buckets and is delivered as small particles above the ground. Such dirt is essentially pulverized, with the particle size being approximately that of beans, rice or small marbles, so that such dirt can be easily distributed over and around a casket in the grave after it is completed. Because of the simplified hydraulic control system used with the apparatus of this invention, the machine may be readily manipulated and operated by unskilled labor. The unit is capable of excavating a grave or hole even in frozen ground or concrete; this is important in cold climates where bodies are often stored for extended periods in the winter because of the difficulty and often inability of prior devices to dig out the frozen ground.

Other features and advantages of the invention will become apparent from the following description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevation partly in dotted lines, illustrating the excavation machine of the present invention in a typical operation for excavating a grave;

FIG. **2** is a plan view of the excavation machine of the present invention with some details thereof omitted for purposes of illustration;

FIG. **3** is a front elevational view of the excavation machine of the present invention, with certain portions thereof omitted for purposes of illustration;

FIG. **4** is a view illustrating one of the wheel support structures together with a portion of a jack at one portion of the frame;

FIG. **5** is a view of one portion of the frame of the excavation machine, illustrating one of the wheels therewith in two positions, one in dotted lines, and together with a jack for elevating and supporting such portion of the frame of the machine;

FIG. **6** is a view similar to FIG. **5**, but illustrating the wheel in another position;

FIG. **7** is a view illustrating a portion of the horizontal frame of the excavation machine with the front pivoted wheel in the raised or upwardly pivoted position;

FIG. **8** is a plan view of the forward portion of the horizontal frame of the excavation machine and the forward wheel therewith in a laterally extending position;

FIG. **9** is a view, partly in section and partly in elevation, taken on line **9–9** of FIG. **1**;

FIG. **10** is a view taken on line **10–10** of FIG. **9** and illustrating additional apparatus therewith;

FIG. **11** is a schematic diagram of the fluid actuated power and control means utilized with the excavation machine of the present invention; and

FIG. **12** is a view of the frame for the excavation assembly, with certain parts removed for purposes of illustration;

FIG. **13** is a view, partly in elevation and partly in section, illustrating parts of the engine and the drive means for operating the excavation assembly and other portions of the excavation machine of the invention;

FIG. **14** is a view illustrating the preferred arrangement of conveying dirt away from the machine to a point to one side of the excavation, and including an extension shown in both dotted lines and solid lines for increasing the extent of such removal of the dirt;

FIG. **15** is a isometric view illustrating in detail one of the excavation buckets and scratcher fingers therewith which are preferrably used with the assembly;

FIG. **16** is an elevation of the portion of one of the excavator buckets and scratcher elements therewith, corresponding to that shown in FIG. **15** and further illustrating same;

FIG. **17** is a front view illustrating the specific relationship of the scratcher elements on the buckets in the preferred form of the invention; and

FIG. **18** is a sectional view illustrating the angular relationship between the scratcher elements and the vertical wall of dirt being excavated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, the letter H designated generally the horizontal frame of the excavation machine of the present invention. The frame H has suitable ground engaging members, including wheels **10**, **11** and **12**, and also jacks **14** at each corner of the frame H (FIGS. **1** and **2**). An excavation assembly E, shown both in solid lines and dotted lines in FIG. **1**, is mounted on the horizontal frame H for movement therewith. Also, as will be explained, means are provided for mounting the excavation assembly E for movements substantially vertically and substantially horizontally relative to the frame H for the excavation operation. As will be explained in detail, power means with suitable controls are provided for operating the excavation assembly E to effect the excavating of the grave or hole G. Such power and control means include a motor or engine M which is disposed at the upper part of the assembly E for imposing its weight thereon.

Considering the invention more in detail, the substantially horizontal frame H is preferably generally rectangular in shape and is formed by substantially parallel tubular side frame members **15** and **16** which are welded or are otherwise secured to substantially parallel tubular front end member **17** and rear end member **18**. The rear frame member **18** is preferably hollow so that it can receive a frame extension **19** for attaching and supporting the wheel **10** to the frame number **18**, as best seen in FIGS. **4—6**. Thus, the extension **19** has a smaller external size than the internal dimensions of the tubular frame member **18** so that the extension **19** may slide internally of and relative to the frame member **18**. The extension **19** has a plurality of substantially vertical holes **19*a*** therein which are laterally spaced from each other and which are adapted to be separately aligned with an opening **18*a*** extending vertically through the frame member **18** so as to receive a retaining bolt or pin **18*b*** (FIG. **4**) therein to securely hold the extension **19** in a selected position with the outer end of the extension **19** at a desired distance from the rest of the frame H. It will be appreciated that more holes **19*a*** than illustrated in FIG. **4** may be provided to provide a greater selectivi-

ty as to positions and distances insofar as the extension 19 is concerned. Other holes 19*b* extending substantially horizontally through the extension 19 may be aligned with suitable openings such as the opening 18*c* having a locking bolt 18*d* therein to further secure the extension 19 to the frame member 18.

A bracket 20 is welded or otherwise secured to the outer end of the extension 19 and it is formed with a plurality of openings 20*a* and a pin or bolt 20*b*. The pin or bolt 20*b* extends through an opening in a wheel support arm 21 which has an axle 21*a* for the wheel 10. The arm 21 is pivotable on the bolt 20*b*, but is prevented from moving away from such plate 20 by a suitable retaining nut 20*c* on the end of the bolt 20*b* (FIG. 1). Also, the particular angle at which the arm 21 is disposed is determined by passing a retaining bolt or pin 22 (FIG. 5) through one of the openings 20*a* and another opening (not shown) in the arm 21. A nut 22*a* (FIG. 1) is secured on the bolt 22 when the arm 21 has been positioned at the desired angle. Because of the different positions of the opening or holes 20*a* in the plate 20, the wheel 10 may be positioned at the maximum rear wheel position shown in solid lines in FIG. 5 or at its maximum forward position shown in dotted lines in FIG. 5, or at any intermediate position therebetween. This permits the wheel 10 to be positioned so that it does not contact or roll over grave markers or similar things which might be in a cemetery. Also, in some instances it is desirable to invert the extension 19 as shown in FIG. 6 so as to position the wheel 10 upwardly to obtain a maximum lowering of the frame H with respect to the ground level when the jacks 14 are supporting the machine.

Each of the jacks 14 is of a conventional construction and preferably they are connected or formed integrally with the frame H although they may be separate and merely positioned under the frame H when needed for the digging operation. The jacks 14 are each provided with a baseplate 14*a* which rests upon the ground to form a broad base at substantially each of the corners of the frame H with the wheels 10, 11 and 12 off of the ground. The jacks 14 are each provided with a conventional handle 14*b* for an internal screw (not shown) which is utilized for raising and lowering the jacks 14 to thereby raise and lower the frame H relative to the ground.

It should also be pointed out that the wheel 11 is mounted on an extension 19 (FIG. 2) corresponding to the extension 19 of FIGS. 4—6 for the wheel 10, but since the details for the extension 19 connecting the wheel 11 to the frame H are preferably the same as described heretofore in connection with the wheel 10, reference is simply made to the previous description.

The front wheel 12 is mounted so that it may pivot from a position substantially parallel to the wheels 10 and 11 (FIGS. 1 and 3) to a position 90° on either side thereof (FIGS. 2 and 8). Also, the front wheel 12 is hinged so that it may be swung upwardly from a position on the ground to a raised position (FIG. 7) when the front jacks 14 are supporting the forward part of the frame H. Although the details of the mounting for such front wheel 12 may be varied, as will be understood by those skilled in the art, the form illustrated in the drawings, particularly in FIGS. 2, 3, 7 and 8 includes a hinged bracket 25 which is connected to the front frame members 17 by any suitable hinge such as hinge 25*a* (FIG. 7). The hinge plate 25 may be secured to the front member 17 by means of retaining bolts 25*b* which are adapted to extend through holes 17*a* in the front member 17 and also holes 25*c* in the plate or bracket 25.

The plate or bracket 25 has a tubular sleeve or pipe 25*d* welded thereto and to a lower bracket 26 which is substantially perpendicular to the hinged bracket 25 and is welded or is otherwise secured thereto. There is an opening through the plates at 26 in communication with the opening in the pipe 25*d* for receiving a pivot bar or rod 27 (FIGS. 2 and 8), which pivot pin or rod 27 is, was or otherwise secured to a substantially U-shaped axle support 28 so that such axle support 28 may pivot relative to the hinge plate 25 and the plate 26 therewith. The support 28 carries an axle 29 extending through the wheel 12 and to which is connected a drive sprocket 30 which has a chain 31 operably mounted thereon. The chain 31 also connects with a sprocket 32 on a hydraulic or fluid-actuated motor 33 which is supplied with fluid from any suitable source, but preferably from the fluid system of the machine of this invention, as will be more evident hereinafter. A control valve 35 of conventional construction with a handle 35*a* for controlling the direction of fluid flow to the motor 33 is mounted on a tongue 36 which extends forwardly and is connected to a pair of straps 28*a* which are welded or otherwise secured to the support 28. The forward end of the tongue 38 is provided with a pin hitch 36*a* or any other suitable trailer-type hitch for connecting the tongue 36 to a trailer if so desired. The tongue 36 also serves as a means for changing the position of the wheel 12 for thereby moving the entire machine by the operation of the wheel 12 since the wheel 12 is driven with the motor 33. Such movement of the machine using the powered wheel 12 is utilized when in relatively close quarters such as adjacent the site to be excavated for a grave in a cemetery. The machine is normally brought to the area with a tractor or other vehicle and then is detached and the final movements are made by controlling the power to the wheel 12. However, no pulling vehicle is necessary to move the machine in a cemetery since the traveling speeds for the machine from a brisk walk to a creeping movement can be readily selected. Reference is made in particular to FIG. 12 of the drawing wherein a substantially rectangular hollow frame 40 of the assembly E is shown with some of the external parts removed for purposes of illustration, as will appear from the description hereinafter. Such frame 40 is preferably made of hollow square-shaped tubular pipe which is interconnected so as to form a continuous inner chamber. The substantially vertical frame 40 has substantially vertical side members 40*a* which are connected with an upper member 40*b* and a lower member 40*c*. For the purpose of using the frame 40 as the hydraulic reservoir in connection with the fluid system of the machine, a section of pipe 41 extends downwardly to a point near the bottom of the frame 40 as indicated in FIG. 12 and an inlet pipe 42 extends into the interior of the frame 40 near the upper portion thereof for supplying hydraulic fluid and for returning same thereto with respect to the fluid system, as will be more fully explained.

At the upper end of the frame 40, a shaft 43 is mounted which is provided with a plurality of sprockets 43*a* which are rotatable with the shaft 43. The shaft 43 is mounted in suitable bearing supports 44 which are secured to the upper end of the frame 40. A drive sprocket 45 is secured to one external end of the shaft 43, and such sprocket 45 has a chain drive assembly which extends to the motor or engine M (FIG. 13) so that such sprocket 45 is driven to thereby drive the sprockets 43*a*. The details of such chain sprocket drive assembly are described hereinafter.

At the lower end of the frame 40, a plurality of idler sprockets 46*a* are mounted on a rotatable shaft 46, with the shaft 46 being supported by suitable bearing supports 47 at each end thereof. The sprockets 46*a* are aligned vertically with the sprocket 43*a* and an endless chain 49 (FIG. 14) extends over each pair of sprockets 43*a* and 46*a* so that when the sprockets 43*a* are driven by the driving of the drive sprocket 45, the endless chains 49 are moved in an endless path on the sprockets 43*a* and 46*a*. Each of the chains 49 has a plurality of buckets B extending laterally and secured to all three of the chains 49 for movement therewith. Only a portion of each of the buckets B is illustrated in FIG. 14 so that the chains 49 can be more easily seen, but the general arrangement of the buckets B and the specific preferred construction thereof are illustrated in particular in FIGS. 15—18, details of which will be described hereinafter. A steel backup plate 50 (FIGS. 3 and 14) is secured to the frame 40 and is disposed inwardly of the endless chains at 49, such plate 50 being secured to the frame 45 by welding or any other suitable means. As will be more evident hereinafter, the plate 50 prevents the dirt which

is being scratched and removed during the excavating operation from falling behind the excavator E during the excavating operation.

The frame **40**, and therefore the entire excavator assembly E, is guided in its vertical movement and is caused to move horizontally by a coaction between guide sleeves **52** and the substantially vertical frame members **40***a*. Antifriction means such as rollers **52***a* are preferably carried by the guide sleeves **52** for engaging the four external surfaces of each of the frame members **40***a* (FIG. **12**). Each of the guide sleeves **52** is preferably in the form of a square tube having a slightly larger internal size than the external size of the frame members **40***a*. It will be appreciated of course, that the frame members **40***a* and the guides **52** may be round or any other suitable shape. In any event, the guides **52** are connected by a brace **53** which is welded or otherwise secured thereto and extends therebetween (FIG. **12**). The outer extremities of each of the guide sleeves **52** is welded or is otherwise secured to a connecting section **54** (FIGS. **9** and **12**), each of which in turn is welded or otherwise secured to bearing housing and guide members **55**, each of which has a plurality of roller bearings **56** or similar antifriction means in engagement with the frame members **15** and **16** of the horizontal frame H (FIGS. **9** and **12**). A track is formed in each of the horizontal frame members **15** and **16** by a chain **58** or the like which is suitably secured thereto for engagement by sprockets **59** (FIGS. **9** and **10**). The sprockets **59** are attached to a rotatable shaft **60** which is supported in bearings **60***a* which are suitably suspended from the bearing frame members **55** (FIG. **9**). A conventional worm gear drive assembly **62** is connected to one end of the shaft **60** for rotating the same when suitable power is applied thereto through a chain and sprocket drive **63** (FIG. **10**) which is supplied with power from a fluid-actuated or hydraulic motor **64**. The fluid power system will be described hereinafter more in detail in connection with the schematic diagram illustrated in FIG. **11**, but briefly, the motor M operates a pump P (FIG. **1**) which pumps the hydraulic fluid from the reservoir provided in the frame **40** and then hydraulic fluid is controlled by a three-position valve **65** (FIG. **10**) having a handle **65***a* therewith for controlling the direction of the fluid flow to the motor **64** through a fluid hose or line **64***a*. Thus, by controlling the position of the valve **65**, the motor **64** may be operated in either a forward or reverse direction, or placed in neutral. In this manner, the direction of movement of the shaft **60** and thus the sprockets **59** may be either in a direction towards the front frame member **17** or towards the rear member **18** depending upon the particular position selected by the handle **65***a* on the valve **65**.

As previously mentioned, the motor M and the drive assembly for the endless chains **49** are mounted at the top of the excavator assembly E (FIG. **1**) so as to impose the weight of the motor M and the related structure on the entire excavator assembly E to thereby eliminate any chain or cable pull down devices and to also provide a direct drive from the motor M to the excavator assembly chains **49**. The motor M may be mounted on the upper end of the frame **40** in any suitable manner but preferably a frame MF (FIGS. **12** and **13**) is provided which is rectangular in shape and has two parallel side frame members **66** and front and rear frame members **67**. The side frame members **66** are welded, bolted or otherwise secured to the vertical frame members **40***a* of the excavator assembly frame **40** (FIG. **12**). Only portions of the frame MF are shown in FIG. **12** for purposes of illustration, but the relationship of such frame MF to the motor M can be seen in FIG. **13**.

For lifting the excavator assembly E from an excavation or grave and for controlling the rate of lowering of the assembly E, a cable **70** is connected at one end **70***a* to the connecting beam or brace **53**; such cable **70** is then run through a first pulley **71** secured on the frame section **40***c* and then over one section of a pulley **72** which is mounted on the connecting beam **53**, and then the cable **70** passes over a second pulley **73** on the frame member **40***c*, and then it passes over another portion of the pulley **72** and then to a winch **74**.

The operation of the winch **74** may be controlled in any suitable manner, but preferably the arrangement illustrated in FIG. **10** is utilized wherein a worm gear drive **75** is driven by a chain **76** which extends from a sprocket **75***a* to a drive gear **76***a* which is driven by a fluid or hydraulic motor **77** secured thereto. The operation of such motor **77** is controlled by a valve **78** which has a handle control **78***a* therewith so that the valve **78** may be put in any one of three positions to either raise the excavator assembly E, lower the assembly E, or lock the assembly E.

The fluid system which is connected to the valve **78** is the same system as is utilized in connection with the valve **65** and is schematically illustrated in FIG. **11**. As illustrated therein, the supply tank is actually the reservoir provided by the internal chamber with the frame **40**, and although the supply tank is shown as being in two parts in FIG. **11**, it will be understood that such supply tank is the single frame **40** in the preferred form of the invention. The fluid is drawn from the supply tank through a filter by means of a pump P (FIGS. **1** and **11**). The motor M is connected to the pump P in any conventional manner for operating same. For operating a conveyor C which is used for removing the cuttings or dirt from the buckets B to a point remote from the grave G or other excavation, as will be more fully explained, a conveyor motor **80** is connected in the fluid system as shown at FIG. **11**. Thus conveyor motor **80** has a suitable control valve **80***a* to control the flow of the hydraulic fluid from the pump P to the conveyor motor **80** for controlling the operation of the conveyor C, as will be more fully explained hereinafter. The fluid in the system flows through a flow control or regulator **81** which determines the amount of hydraulic fluid supplied to the motors **64** and **77** when the valves **65** and **78**, respectively, are in the operating position. As previously explained, the valve **65** controls the flow of the hydraulic fluid to the motor **64** which thereby controls the forward and backward movement of the excavator assembly E on the frame H. The valve **65** is a three-position valve, having a forward, backward and neutral position, with the neutral position serving as a lock to hold the excavator assembly in the desired position during running or other use. The valve **78** controls the winch motor **77** which is used for operating the winch **74** to either raise or lower same. The valve **78** is also a three-position valve so that it has a neutral position for locking the winch **74** and thereby locking the endless assembly E in a selected position in elevation. The system also includes a means to connect and disconnect the wheel drive motor at **33** for driving the front wheel **12**, as previously explained. The control valve for such motor **33** is indicated at **35** and it is also in the fluid system.

When the portion of the fluid system including the motor **30** and the valve **35** are disconnected, the system is nevertheless completed by a short section of hose **82** illustrated schematically in FIG. **11**. The short section of hose **82** is removed and then the connections **82***a* are connected with connections **82***b* when it is desired to operate the motor **33**. It should be noted that pressure relief valves of conventional design may be incorporated at suitable points in the fluid system as indicated schematically at **95**, **95***a*, **95***b*, **95***c* and **95***d*.

The conveyor C previously referred to is preferably made in two sections which includes a first endless belt **83** on a first section and a second endless belt **84** on a second section or conveyor extension. The endless belt **83** is mounted on a slidable channel member or frame **85** and is powered by the hydraulic or fluid motor **80** with suitable controls therewith as indicated in FIG. **11**. The channel member **85** is slidable laterally and is supported in a pair of upright steel plates **86** which has suitable openings therein for the passage of the channel member or frame member **85**. The length of the conveyor **83** and also the length of the channel **85** supporting the motor **80** and the rollers for the conveyor at each end thereof is greater than the width of the rest of the assembly so that the outer end of the conveyor **83** is adapted to discharge dirt therefrom at a point remote from the excavation or grave G.

The extension conveyor **84** is supported in any conventional manner and includes a drive means with sprockets, one of

which is indicated at 84*a* as connected by a chain 87 to a sprocket 83*a* so that the rotation of the endless conveyor 83 is transmitted to the conveyor 84 to also drive the same through the same motor 80. The conveyor 84 is supported on a suitable pair of steel plates or channel members 88 which are together pivoted to a downwardly extending plate or plates 89 which form a part of and extend downwardly from the member or members 85. The particular angle at which the conveyor 84 is disposed may be selected by an adjustable locking arm 90 which has a plurality of notches 90*a* therein which may be engaged with a suitable locking pin 90*b* on the member or members 85. Thus, the extension conveyor 84 may be dropped to a substantially vertical position as illustrated in FIG. 14 for transportation over the highways, or it may be raised to an elevated position for providing an extension of the conveyor 83 so as to convey the dirt to a point a greater distance from the excavator assembly E than is possible with just the conveyor belt 83, for the purpose of loading the dirt in a truck or at some more remote location. It will be appreciated that the extension 84 is not essential but it does provide the additional advantages enumerated above. The conveyor C may be shifted relative to the frame members 86 which support same and this may be done either manually or through a suitable winch control 91 which is indicated schematically in FIG. 14. Above the conveyor C and the upper buckets B is a dirt deflector 92 which serves to deflect dirt as it is discharged from the bucket B when they go over the top sprockets 43*a* and dump dirt onto the conveyor C.

Reference is now made to FIGS. 1 and 15—18 in particular wherein details of the buckets B are illustrated. First of all, it should be noted that the excavator assembly E is shown in an angled or inclined position in FIG. 1 and a detailed illustration with respect to one of the buckets B is also shown at such an angle in FIG. 18. This particular angle is exaggerated in the drawings for the purposes of emphasis, but in any event, the purpose of such angle of inclination will be described hereinafter.

As previously noted, the excavator assembly E has a plurality of the buckets B secured to the endless chains 49. A typical construction for each bucket B is shown in particular in FIGS. 15 and 16 wherein the bucket B has a lower or bottom plate 100, a rear plate 101 and side plate 102, leaving the front and top thereof open. It is to be noted that the upper edges of the side plates 102 indicated at 102*a* are tapered to form a knife edge which provides for trimming the sidewalls of the grave G during the excavation. The rear plate 101 has a pair of bolt holes 101*a* for receiving bolts 105 (FIG. 18) which extend through attachment dogs 49*a* on each of the endless chains 49. The bolts 105 are secured by nuts 105*a* so that each of the buckets B is held to each of the three endless chains 49 by a pair of the bolts 105 and nuts 105*a* therewith. Each bucket B also has a relatively large hole 101*b* between each of the bolt holes 101*a* through which the teeth on the sprockets 43*a* and 46*a* may extend for pushing loose dirt through the chain link instead of letting the dirt pack, thereby relieving any tendency to cause stress on the chain from the packed dirt. The bottom plate 100 is set at an angle of about 80° with respect to the backplate 101 so that the dirt which falls into the bucket onto the plate 100 is caused to move toward the backplate 101.

A plurality of scratcher fingers or elements 110 are welded or otherwise secured as to the bottom of the bottom plates 100 with the forward tip 110*a* extending outwardly from the leading edge 100*a* of the bottom plate 100 so that the scratching elements 110 do all of the contacting with the vertical edge G' of the excavation or grave G (FIG. 18). Preferably the tips 110*a* are hard surfaced with tungsten carbide or similar hard surfacing material.

In the preferred form of the invention, the endless conveyors or chains 49 are set at an angle of about 85° with respect to vertical so as the increase the angle of the scratcher elements or fingers 110 with respect to the wall G' so that dirt which is cut or scratched from the wall G' falls downwardly therefrom into the buckets B therebelow. If the endless chains 49 are vertical or if they angle in a direction with the upper ends more toward the wall G' than the lower ends, the dirt falls away from the buckets B and is accumulated at the bottom so that then the buckets B must pick the dirt from the bottom which interferes with subsequent cutting action. It has therefore been found that the relationship wherein the lower ends of the endless chains 49 are disposed closer to the wall G'may than the upper ends as indicated in FIG. 18 is highly advantageous for this produces efficient cutting and removal of the dirt from the end wall G'.

The entire excavator assembly E preferably includes 48 buckets B made may six sets of eight buckets per set. The teeth of the consecutive buckets in each set are staggered in such a manner that as the set of eight buckets passes through any given point or line on the wall G', a full width of the bucket has been cut by the fingers or teeth 110, with no overlap of such teeth or fingers 110. Thus, for one revolution of the 48 buckets B, each point of contact has been cut six times with a total of 288 scratcher teeth 110 cutting into the wall G' during each revolution. It is to be noted that the leading edge 100*a* of the bucket B never comes into contact with the wall G' being cut with the scratcher elements 110 whereby the dirt or soil of the wall G' is ripped or scratched from the wall instead of digging it. This makes it possible to cut frozen ground, concrete, solidified caliche and sand stone, as well as other hard surfaces or substances.

In FIG. 17, the staggered arrangement of the scratcher teeth 110 is illustrated schematically, showing the set of buckets B from the first to the eighth set with different positions of the scratcher teeth 110 as explained above. It will be understood of course that such arrangement is the preferred arrangement and the invention is not limited thereto. However, it has been found that with the large number of buckets B such as 48 buckets, the scratching action is accentuated to such an extent that there is substantially no vibration of the apparatus during the cutting or scratching of dirt from the wall G'. It also prevents any shifting of the apparatus on its jacks 14 during the excavation operation and minimizes wear and other factors in connection with the machine itself.

Because the cutting surface of each tooth 110 is narrow and the portion of each tooth coming into contact with the wall of dirt G' is small, the dirt which is scratched or cut loose is in small particles or pulverized. Also, low horsepower is required compared to prior devices which depend upon a digging action as distinguished from the scratching action of this invention.

The chain drive assembly illustrated in FIG. 13 for driving the buckets B may be utilized with other chain drive structures. As illustrated in FIG. 13, the idler chain assembly includes a chain 115 which extends over the sprockets 45 and over a sprocket 116 on a transmission or gearbox 117 from the motor M. An idler sprocket 118 is mounted on a pivoted lever 119 which is pivotally connected at 119*a* to the horizontally extending frame member 66. A spring 120 is connected from the lever 119 to the frame member 66 to urge the sprocket 118 into constant engagement with the external surface of the chain 115 to maintain it tightly in engagement with both of the sprockets 45 and 116. A shock absorber 125 is likewise connected to the pivot lever 119 and to some part of the frame or the motor M. The shock absorber 125 permits the sprocket 118 to move in a counterclockwise direction from that illustrated in the FIG. 13 when there is shock loading on the sprocket 45 and therefore on the chain 115 due to shock loads on the teeth 110 or the buckets B. For example, during the initial cutting or scratching action with the excavator assembly E, a relatively sever shock load may be imposed on the transmission 117 but the shock absorber 125 permits a relaxing of such load and thereby prevents damaging shock loads on the transmission 117 and the rest of such drive apparatus.

The operation or use of the excavation machine of this invention is believed evident from the foregoing description. As illustrated in FIG. 1, the apparatus is initially moved into position for the digging of the grave G or other hole at any desired

location. The wheel 12 is operated as previously described to move the assembly into position and then the jacks 14 are lowered so that the horizontal frame H is then supported on the feet or base members 14*a* of each of the four jacks 14. The jacks 14 are used to level the frame H at this time. During such positioning of the machine, the excavator assembly E is in the dotted line position of FIG. 1. Then the conveyor motor 80 is started to operate the conveyor C and the handle 78*a* is shifted to permit the winch 74 to release some of its cable 70 so that the weight of the motor M and the parts therewith are imposed on the assembly E to force the buckets B with their scratcher elements 110 downwardly to make an initial cut substantially vertically downwardly into the ground to the depth desired. After the depth of the hole has been reached with the initial cut, the valve handle 78*a* is shifted to the neutral position to lock the assembly at that particular elevation or at that particular depth. Thereafter, the valve handle 65*a* is shifted to cause the excavator assembly E to move forwardly on the frame H. The endless chains 49 are of course moving in their endless paths and the buckets B with the scratcher teeth 110 are also moving in their endless paths for continuously cutting against the front or end wall G' as the assembly E moves forwardly. The excavator assembly E may move forwardly for the full length of the frame E to point such as indicated in solid lines in FIG. 1 at which time the length, width and depth of the grave G are completed. Thereafter, the forward movement of the excavator assembly E is stopped by shifting the valve handle 65*a* to the neutral position, or the valve handle 65*a* may be shifted so as to cause the excavator assembly E to move rearwardly to some intermediate position or to the rear position. The valve 78 is then actuated with the handle 78*a* to cause the winch 74 to wind the cable 70 thereon to lift the excavator assembly E upwardly so that its bottom portion is above the ground level and so that it assumes substantially the dotted line position of FIG. 1. The entire machine may then be moved to a different location for subsequent excavation operations.

It should be noted that during the excavating action, the dirt which is scratched or cut is lifted with the buckets B and is dumped when the buckets B pass over the upper sprockets 43*a* so that such dirt is dumped onto the conveyor 83 which conveys the dirt to the extension 84 if it is being utilized and then the conveyor 84 carries it to a point for dumping away from the grave G. Because the scratcher elements 110 cut the dirt into relatively fine particles which are of the size of rice, beans or small marbles, and usually less than one-half of an inch, such dirt may be readily put back into the grave to cover the casket and fill around the sides thereof.

The entire machine may be attached to a tractor, truck or automobile and may be pulled over a highway for many miles to any point to which the machine is to be used because the width of the machine is less than the normal width for highway travel and it therefore complies with highway regulations for transportation over the highways.

We claim:

1. An excavation machine, comprising:
   a. a substantially horizontal frame;
   b. ground-engaging members secured to the frame for supporting same;
   c. an excavator assembly disposed substantially vertically and having therewith an endless conveyor of scratcher elements for scratching dirt and the like loose and buckets therewith for removing the loose dirt to form the excavation;
   d. means mounting said excavator assembly on said frame for movements in the substantially horizontal and substantially vertical directions to form a grave of predetermined dimensions;
   e. power and control means therewith for moving said endless conveyor in its endless path and for also moving said excavator assembly including said endless conveyor substantially horizontally during the excavation with said scratcher elements;
   f. said power and control means including an engine mounted on the upper end of said excavator assembly for imparting weight to said excavator assembly to lower same for the initial excavation cut into the ground; and
   g. said excavator assembly including:
      1. a plurality of laterally extending buckets mounted on said endless conveyor and having a base, rear wall and ends;
      2. each of said buckets having a plurality of laterally spaced scratcher fingers secured along substantially the entire lower surface of said base and projecting outwardly therefrom beyond the forward edge of said base and substantially perpendicular to said rear wall; and
      3. means for disposing said excavator assembly at an angle with the lower portion of the endless conveyor forwardly of the upper portion thereof so that dirt scratched loose by said fingers falls into one of said buckets therebelow as said buckets move upwardly for the excavation.

2. The structure set forth in claim 1, wherein: said scratcher fingers on said buckets are laterally offset with respect to the scratcher fingers on the other buckets so that each of said scratcher fingers essentially cuts a separate groove in the dirt.

3. The structure set forth in claim 2, wherein: the total number of said scratcher fingers is sufficient to produce cuttings of the dirt of a size at least as small as 1 inch in diameter.

4. The structure set forth in claim 1, wherein each of said buckets includes: only said base, rear wall, and ends so as to leave an open front and top with said scratcher fingers projecting outwardly from said base adjacent its open front when said buckets are moving upwardly for substantially the full height of said endless conveyor.

5. The structure set forth in claim 4, wherein: each of said ends of said bucket is formed with an upper beveled edge for trimming the sidewalls of the grave being excavated.

6. The structure set forth in claim 1, wherein:
   a. said endless conveyor includes a pair of endless chains and sprockets upon which said chains are mounted; and
   b. each of said buckets has a rear wall with a plurality of holes therein longitudinally aligned with the sprockets for each of said chains and through which the sprocket teeth extend for forcing any dirt from said chain to prevent packing of dirt therein.