United States Patent [19]

Case

[11] **3,856,093**

[45] **Dec. 24, 1974**

[54] **SPOIL EJECTOR FOR HORIZONTAL EARTH AUGERING MACHINE**

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[73] Assignee: **The Salem Tool Company,** Salem, Ohio

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[52] **U.S. Cl.** **173/152,** 175/88
[51] **Int. Cl.** **E21c 1/14**
[58] **Field of Search** 173/4, 31, 152; 175/88

[56] **References Cited**

UNITED STATES PATENTS

3,104,989	9/1963	Sedgwick et al.	175/88
3,366,186	1/1968	Young	173/31
3,395,940	8/1968	Young et al.	175/88
3,605,910	9/1971	Deeter et al.	173/4

Primary Examiner—James A. Leppink
Attorney, Agent, or Firm—Bosworth, Sessions & McCoy

[57] **ABSTRACT**

A spoil ejector for a horizontal earth augering machine such as a trench drill. The machine drives a helically vaned auger and cutting head operably connected to a traveling carriage that moves along a supporting frame to advance the cutting head into the earth. A length of pipe to be located in the hole is supported by the machine surrounding the auger and is fed with the auger into the hole by the carriage as the hole is deepened. The spoil dislodged by the cutting head is conveyed rearwardly by the helical vanes of the auger to the rearward end of the pipe. From the end of the pipe the spoil is deposited in a cylindrical housing from which it is ejected in a radial direction through a discharge chute to one side of the machine. The spoil is driven in a circumferential path through the chute by a plurality of radial paddles operatively connected by resilient means to the rotary drive for the auger cutting head for rotation in a circumferential path through the cylindrical housing. As the paddles approach the discharge chute they are flexed rearwardly relative to the direction of travel and then unflexed abruptly as they cross the discharge chute to fling the spoil radially outward to the side of the machine.

10 Claims, 4 Drawing Figures

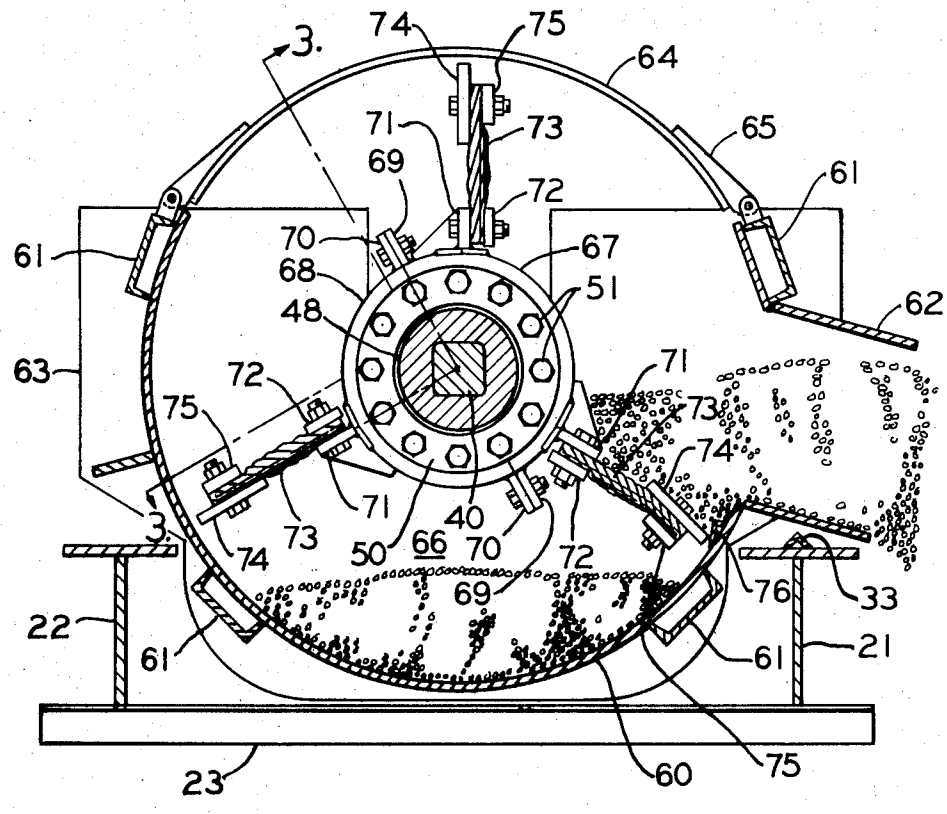
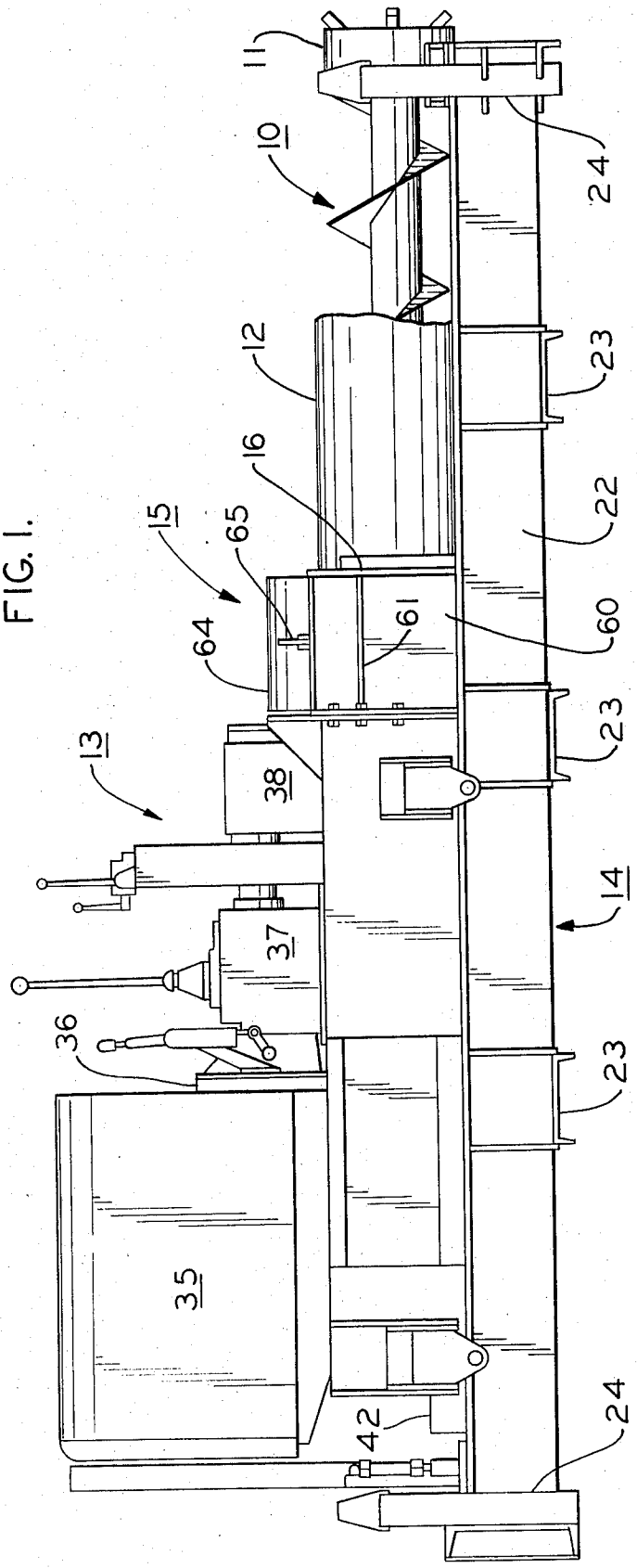


FIG. 1.



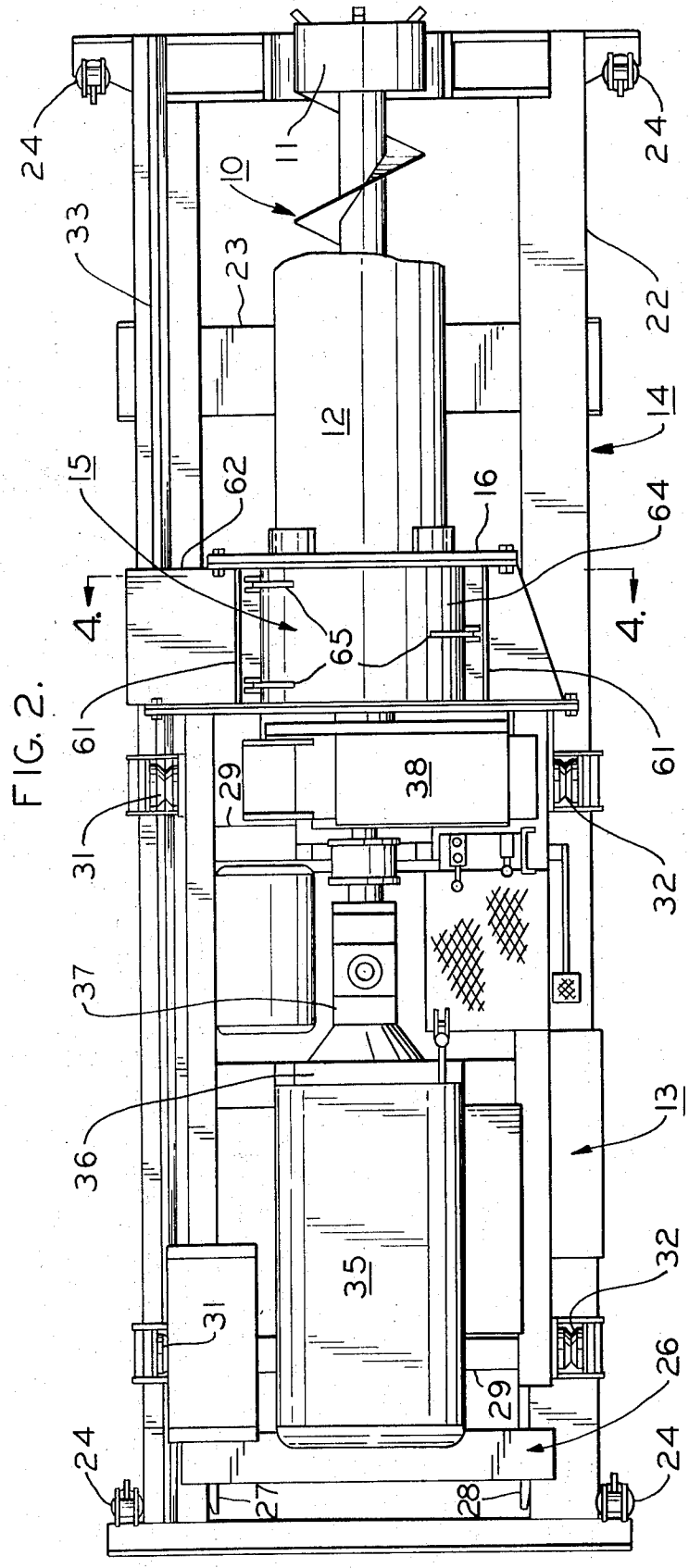

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FIG. 2.

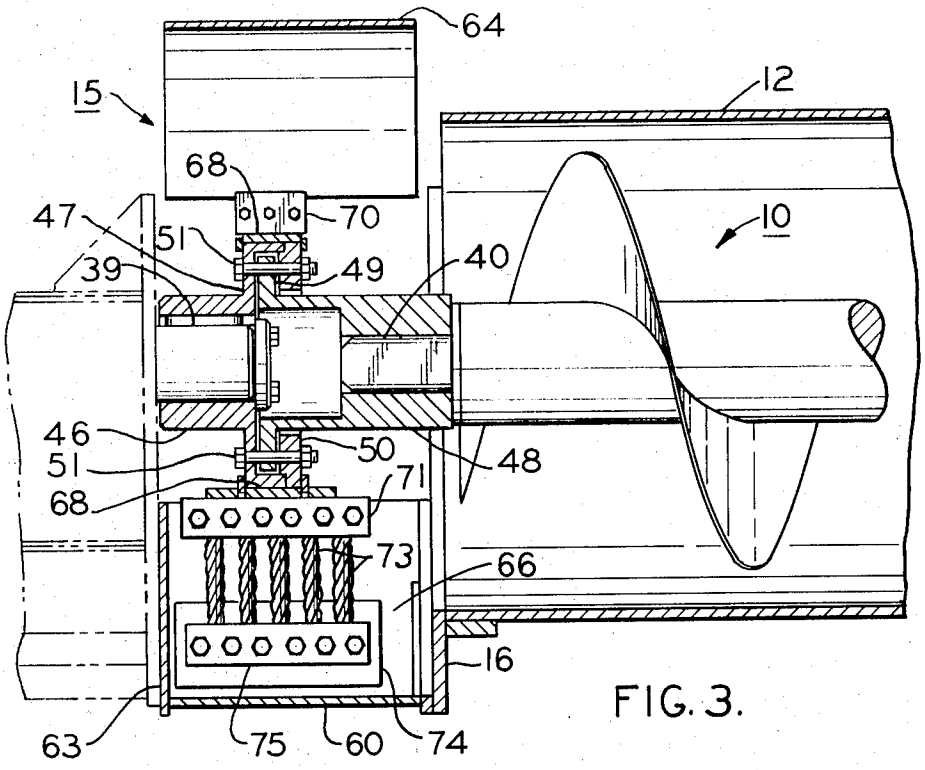

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FIG. 3.

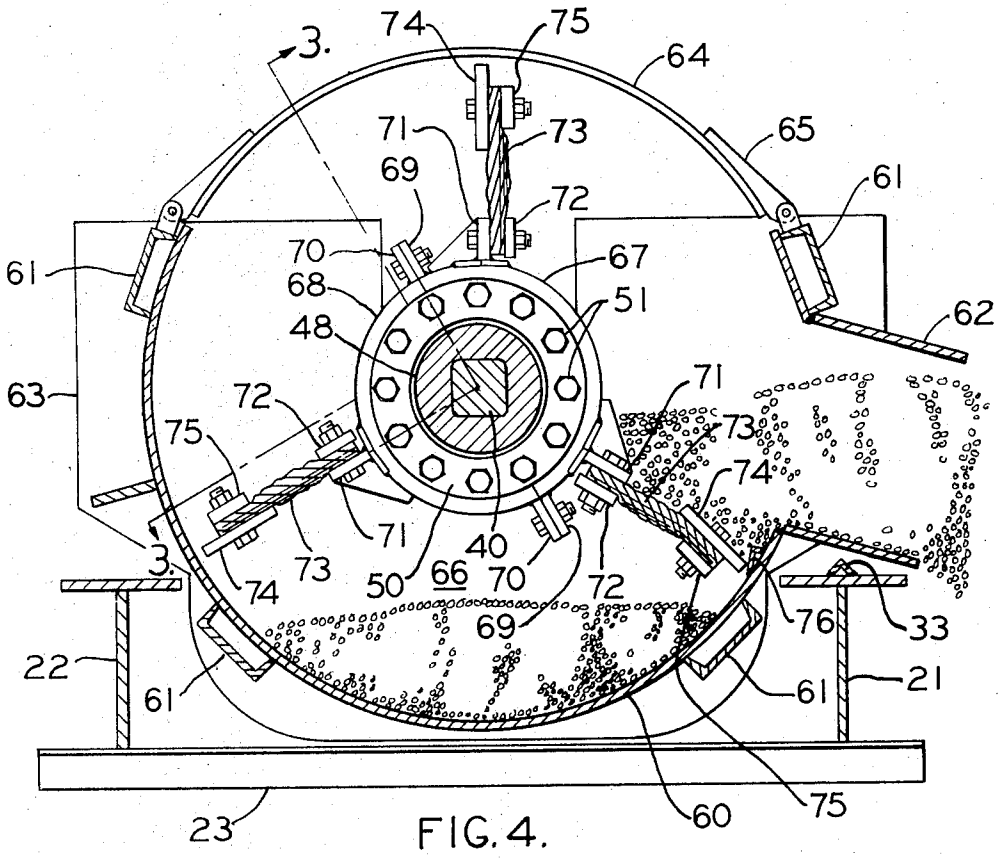

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FIG. 4.

SPOIL EJECTOR FOR HORIZONTAL EARTH AUGERING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to earth augering machines for drilling horizontal underground holes such as in the installation of underground pipes or conduit and the like. The invention has particular utility as employed in association with auger machines called trench drills that are positioned in an excavation or trench for drilling horizontal holes under streets, roadways, railroads and the like while simultaneously feeding a pipe or other conduit into the hole being drilled.

The augering or drilling of horizontal holes under streets, highways, railroads and the like for pipe or conduit is conventionally usually accomplished by first digging trenches or excavations of the required size and depth at opposite ends of the length span of the pipe or conduit to be placed. An augering machine or trench drill of well known design such as the type described in U.S. Pat. Nos. 3,366,186 and/or 3,605,910 is then positioned in one of the trenches or excavations for drilling laterally into the end wall of the trench and through to the other excavation.

The augering machine or trench drill generally comprises an elongated frame with suitable ways and a carriage supporting a helically vaned auger and cutting head, adapted for guided travel along the ways toward and away from the hole to be drilled. A prime mover is usually supported on the carriage for turning the auger and a feed drive (hydraulic cylinder, rack and pinion mechanism, cable mechanism, or the like) is provided for moving the carriage forward along the ways to advance the auger and bit into the earth. The pipe to be placed is initially positioned around the auger vanes with its forward end somewhat to the rear of the cutting head and with its rearward end bearing against a pusher member on the carriage.

As the auger and pipe advance into the earth, spoil dislodged by the cutting head is conveyed rearwardly through the pipe by the auger vanes and deposited in the excavation just ahead of the carriage. As the carriage advances, it must pass through or over the pile of accummulated spoil and thus the spoil must periodically be shoveled away or otherwise removed. If the removal of spoil is not properly attended to it could interfere with the travel of the carriage and also interfere with the operation of equipment located on the carriage. In most operations sufficient spoil is removed that a large part of it must be taken out of the excavation during the drilling operation.

Various types of mechanisms for diverting the spoil to another part of the excavation such as along the side of the machine have been considered but those previously considered are either too cumbersome and costly or are inadequate to handle the type of spoil involved.

A critical problem encountered in handling spoil is the nature of the geological material that might be expected in various locations. It is possible that the spoil will include rocks etc. that would jam a mechanical device and place excessive loads on the drive mechanism. Moreover, for efficient operation the spoil must be dislodged so it does not interfere with the drilling apparatus or operation, particularly when large diameter drills are used which develop substantial amounts of spoil.

The spoil ejector mechanism of the present invention, however, resolves the difficulties indicated above and affords other features and advantages heretofore not obtainable.

SUMMARY OF THE INVENTION

It is among the objects of the invention to convey spoil produced by a horizontal earth augering machine or trench drill from the rearward end of the auger that conveys the spoil out of the horizontal hole being drilled to a location clear of the machine rotates and advances the auger and cutting head.

Another object is to provide a mechanism for ejecting spoil conveyed by the auger vanes of an earth auger machine to a position laterally of the auger axis, which mechanism occupies a minimum of space and does not require a separate drive mechanism.

Still another object is to improve the speed and efficiency of horizontal earth augering machines by keeping the space ahead of the advancing drive carriage for the machine free of spoil being removed from the horizontal hole being drilled by the auger cutting head.

These and other objects and advantages are achieved by the unique spoil ejector construction of the invention, which is adapted for use in association with the same rotary drive used to turn the cutting head and auger sections for conveying spoil rearwardly out of the horizontal hole being drilled. As conventional elements the augering machine or trench drill comprises an auger with a cutting head on the forward end and helical auger vanes formed thereon for conveying spoil rearwardly from the horizontal hole. A cylindrical pipe or conduit is positioned around the auger vanes with one end against a pusher member on the carriage and progressively fed into the hole as the auger and bit are advanced by the carriage.

According to the improvement of the invention a generally cylindrical spoil ejector housing coaxial with the auger is located at the rearward end of the pipe or conduit for receiving spoil therefrom. The housing has a lateral discharge chute formed therein at one side and adapted to direct spoil in a radial direction to the side of the machine clear of the carriage. A plurality of spoil ejector paddles are operatively connected to the rotary drive for the auger by resilient connecting means and are adapted to be revolved through a circular path defined by the generally cylindrical interior wall and end walls of the spoil ejector housing. The resilient means connecting the paddles to the rotary drive are capable of limited flexing movement and the paddles are flexed in a rearward direction relative to their direction of rotation by suitable means as they approach the discharge chute. The paddles unflex abruptly as they near the discharge chute to fling spoil being pushed thereby in a radially outward direction through the chute to the side of the machine.

According to the preferred embodiment the resilient means connecting the paddles to the rotary drive comprises two or more relatively short lengths of stiff steel cable extending radially from the rotary drive axis to each of the paddles. This construction permits the paddles to flex to avoid jamming that could be caused by rocks or other obstructive material in the housing, and thus prevents excessive loads on the prime mover, and also provides beneficial flinging action of the dislodged spoil.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation with parts broken away, illustrating a horizontal earth augering machine embodying the invention;

FIG. 2 is a plan view of the horizontal earth augering machine of FIG. 1;

FIG. 3 is a fragmentary sectional view on an enlarged scale taken on the line 3—3 of FIG. 4; and

FIG. 4 is a transverse sectional view drawn to the same scale as FIG. 3 and taken on the line 4—4 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings and initially to FIGS. 1 and 2 there is shown a horizontal earth augering machine embodying the invention and adapted to be positioned in an excavation or trench at one end of a hole to be drilled. The machine includes an auger broadly indicated by the numeral **10**, with a cutting head **11** mounted on the forward end. A pipe **12** to be advanced into the hole simultaneously with the cutting head **11** is coaxially positioned around the auger **10** and has an outer diameter approximately the same as the diameter of the hole to be drilled. The machine illustrated and described herein is adapted to place a pipe of a diameter up to 48 inches in holes up to 200 ft. in length.

The auger **10** and pipe **12** are advanced or fed by a carriage **13** adapted for travel along a main frame **14**. The carriage **13** has a spoil ejector assembly **15** embodying the invention for throwing spoil conveyed from the hole by the auger **10** through the pipe **12**, to a position at the side of the machine. The carriage **15** also has a pusher ring **16** at its forward end that engages an end of the pipe **12** for advancing it into the hole.

While the invention resides in the construction and operation of the spoil ejector assembly **15** the general construction of the horizontal earth augering machine will be described briefly for the purpose of illustrating the invention as used in association with a machine of typical construction.

The main frame **14** of the machine includes a pair of spaced longitudinally extending parallel beams **21** and **22** joined by cross members **23**. Four vertical hydraulic jacks **24** of known construction, which may be similar to those disclosed in U.S. Pat. No. 3,605,910, are located at the corners of the main frame **14** for leveling it in the trench. Additional frame sections may be attached to the forward end of the main frame **14** to lengthen it as required.

The carriage **13** is positioned on the main frame **14** for guided movement longitudinally on the parallel beams **21** and **22** between a fully retracted position shown in FIGS. **1** and **2** to a forward limit position wherein the cutting head **11** has been advanced approximately to the full length of the auger **10**. Thus the carriage **13** can be moved forward on the main frame **14** for feeding the auger **10** and pipe **12** into the hole and can then be retracted to permit the insertion of additional auger sections and pipe sections depending on the total length of the hole to be drilled. A typical length of carriage travel is about 8 ft. and a typical overall length for the machine is about 17 ft.

The carriage **13** comprises a rigid frame **26** formed of longitudinally extending members **27** and **28** and cross members **29**. A pair of wheels **31** and **32** located at each end of the carriage **13** ride on the parallel beams **21** and **22**, the wheels on the beam **21** having circumferential grooves that engage a guide rail **33** on the beam **21**.

A prime mover **35** such as a diesel engine is mounted on the carriage **13** to provide the drive for both turning the auger **10** and cutting **11** and advancing the carriage. The output shaft of the prime mover **35** drives through a conventional mechanical clutch **36** a conventional mutli-speed transmission **37** and a reduction gear unit **38** with an output shaft **39** (FIG. **3**) that is coupled to a shank **40** of square cross section forming parts of the auger. While for convenience the illustrated auger **10** constitutes a single section having the shank **40** at one end and cutting head **11** at the other end, the auger usually includes several helically vaned auger sections connected end to end in known manner in a string of sections as the depth of the drilled hole increases; in such case, the shank **40** is on the auger section nearest the machine and the cutting head is on the auger section furtherest from the machine. The coupling between the shaft **39** and the shank **40** is located within the spoil ejector assembly **15** and serves to drive working parts of the assembly **15**.

The carriage **13** is advanced and retracted by a known hydraulic crowd cylinder **42** (FIG. **1**) connected at one end to the main frame **14** and having its piston rod (not shown) connected to the rigid frame **26** at the forward end of the crowd cylinder of the carriage **13**, being powered by known hydraulic means such as that disclosed in U.S. Pat. No. 3,605,910.

The coupling between the output shaft **39** of the reduction gear unit **38** is coupled to the shank **40** by an assembly including a hub **46** secured to the end of the shaft **39** and having a radial flange **47**. A drive chuck **48** with a square socket to receive the end of the shank **40** has a cooperating radial flange **49** that seats against the flange **47**. A retainer plate **50** that telescopes over the drive chuck **48** is positioned adjacent the flange **49** and the flanges **47**, and **49** and retainer plate **50** are all bolted together with machine bolts **51**. The hub **46** and drive chuck **48** are located within the spoil ejector assembly **15** as indicated in FIGS. **3** and **4** and are used to drive the spoil ejector assembly as will be described in more detail below. The spoil ejector assembly comprises a generally cylindrical housing **60** located coaxially around the hub **46** and drive chuck **48** and having a diameter greater than the diameter of the pipe **12**. The housing **60** defines about 240° of a cylindrical surface and the remaining 120° span faces upward as most clearly indicated in FIG. **4**. The housing **60** is supported by braces **61** in the form of U-shaped lengths of channel stock that extend between the pusher plate **16** and a portion of the rigid frame **26** of the carriage **13**.

At the right hand side of the housing **60** as viewed in FIG. **4** is a discharge chute **62** of rectangular cross sectional form adapted to guide spoil from the interior of the housing **60** to the side of the machine adjacent the parallel beam **21**. The forward end of the chamber within the housing **60** is defined by the pusher member **16** and such as the rearward end by a rear plate **63**. The top of the housing is closed by a cover **64** clamped in position by clamps **65**. The cylindrical spoil ejector chamber **66** within the housing **60** receives spoil from the pipe **12** as the spoil is conveyed rearwardly by the helical flights of the auger **10**.

The operating mechanism of the spoil ejector assembly **15** is operatively connected to the hub **46** and retainer plate **50** by a pair of matching semi-cylindrical clamping bands **67** and **68** that fit around the flange **47** of the hub **46.** The bands **67** and **68** are clamped in place by means of brackets **69** and **70** respectively at each end thereof which are bolted to one another. Three paddle brackets **71** are welded to the clamp sections **67** and **68** as best illustrated in FIG. **4.** The paddle brackets **71** each have a cooperating clamping bar **72** for clamping five short lengths **73** of stranded steel cable therebetween using machine bolts. The cable lengths **73** are all of essentially equal length and all are sufficiently resilient to permit limited flexing. The opposite ends of the cable lengths **73** are clamped between paddles **74** and clamping bars **75** using a plurality of machine bolts. The paddles **74** accordingly are carried by the hub **46** through a circular path of travel closely spaced from the interior wall of the cylindrical housing **60** and serve to push spoil deposited in the spoil ejector chamber **66** in a counterclockwise direction as viewed in FIG. **4** to a position where the spoil may exit through the discharge chute **62.**

Welded to the interior surface of the cylindrical housing **60** just adjacent the discharge chute **62** is a flexing member **76** in the form of an angle bar positioned in the path of the paddles **74.** The flexing member **76** is engaged by each paddle **74** and it interrupts the revolving movement of the respective paddle **74** to cause its respective cable lengths **73** to flex. The flexing continues until the respective paddle **74** and its respective cable lengths are flexed rearwardly relative the direction of rotation a sufficient amount to permit the paddle to clear the flexing member **76.** At this point the cable lengths unflex abruptly and the paddle correspondingly springs forward sharply to fling spoil ahead of it through the discharge chute **62.** The abrupt movement of the paddle **74** causes the spoil to be propelled forcibly through the discharge chute **62** and assures that effective ejection of spoil is achieved.

The cable lengths **73** serve an additional function in that they permit resilient movement of the paddles to accommodate (e.g., bypass) rocks and other obstructions in the chamber **66** that would otherwise jam the paddles and place an undesirable load on the gear reduction unit **38** and prime mover **35.**

It will be apparent that while cable lengths **73** are utilized in the embodiment illustrated and described herein, other resilient flexing members such as spring steel strips can be used to achieve the desired results. The resilient connection between the paddles **74** and the rotary drive should be such that the flexing is sufficient and the flexing members stiff enough to achieve the desired propelling of spoil through the chute **62** and also to accommodate obstructions that could jam the paddles and put excessive loads on the reduction gear unit **38** and prime mover **35.**

While the invention has been shown and described with respect to preferred embodiments thereof, this is for the purpose of illustration rather than limitation and other variations and modifications of the embodiments herein shown and described will be apparent to those skilled in the art. Accordingly, the patent is not to be limited to the specific embodiments of the invention herein shown and described nor in any other way that is inconsistent with the extent to which the progress in the art has been advanced by the invention.

I claim:

1. In an augering machine for drilling horizontal holes in the earth and for simultaneously placing lengths of pipe therein, said machine including an auger and cutting head, rotary drive means for said auger and cutting head and a traveling carriage for advancing said auger and cutting head and a length of pipe positioned coaxially around said auger, simultaneously into the hole whereby spoil dislodged by said cutting head is conveyed rearwardly through said pipe by said auger, the improvement which comprises:

means defining a spoil ejector chamber adapted to receive spoil for said pipe,

a plurality of rotary paddles located in said chamber and adapted to engage and propel spoil deposited in said chamber,

resilient means connecting said paddles to said rotary drive means for rotation with said auger, and

stationary unflexing means located in said chamber for abruptly releasing paddles, the flexing means of which are flexed, as the paddles reach a predetermined angular position in said chamber,

whereby when each paddle passes said unflexing means its respective resilient means unflexes abruptedly and said paddle springs forward to fling spoil in a direction laterally of said carriage.

2. The apparatus of claim **1** in which said unflexing means comprises a projection in said chamber that engages each of said paddles and flexes its flexing means and then abruptly releases said paddle to so fling said spoil material.

3. A machine as defined in claim **1** wherein said resilient connecting means comprises, for each of said paddles, a plurality of lengths of stranded steel cable connected at one end to said rotary drive means and at their other end to the respective paddle.

4. A machine as defined in claim **3** wherein said lengths of steel cable for each of said paddles are located in a common radial plane relative to the axis of rotation of said paddles.

5. A machine as defined in claim **2** wherein said stationary means comprises a bar element extending parallel to the axis of rotation of said paddles and spaced laterally therefrom, said bar element being adapted to engage the outer edge portion of each of said paddles whereby said resilient means must flex to permit said paddles to bend inwardly and rearwardly relative to the direction of rotation in order to pass said bar element.

6. A machine as defined in claim **1** wherein said spoil ejector chamber has a generally cylindrical form.

7. A machine as defined in claim **1** wherein said cylindrical spoil ejector chamber is coaxial with said pipe and has a diameter greater than the outer diameter of said pipe.

8. A machine as defined in claim **1** including a lateral discharge chute communicating with said spoil ejector chamber and adapted to receive and convey to a position laterally of said carriage, spoil being flung by said paddles as they spring forward following engagement with said stationary means.

9. In combination,

an augering machine for drilling horizontal holes in the earth and for simultaneously placing lengths of pipe therein, said machine comprising:

an auger and cutting head,

rotary drive means for said auger and cutting head, and

a traveling carriage for advancing said auger and cutting head and a length of pipe positioned coaxially around said auger, simultaneously into the hole whereby spoil dislodged by said cutting head is conveyed rearwardly through said pipe by said auger, and a spoil ejector assembly located on said carriage, said assembly comprising:

means defining a spoil ejector chamber adapted to receive spoil from said pipe,

a plurality of rotary paddles located in said chamber and adapted to engage and propel spoil deposited in said chamber,

resilient means connecting said paddles to said rotary drive means for rotation with said auger, and

stationary unflexing means located in said chamber for abruptly releasing paddles, the flexing means of which are flexed, as the paddles reach a predetermined angular position in said chamber

whereby when each paddle passes said stationary means its respective resilient means unflexes abruptedly and said paddle springs forward to fling spoil in a direction laterally of said carriage.

10. A spoil ejector assembly for propelling spoil deposited therein by a power earth auger, to a position, laterally of the auger axis, comprising:

means defining a spoil ejector chamber adapted to receive spoil from a hole being drilled by said auger,

at least one rotary paddle located in said chamber and adapted to engage and propel spoil deposited in said chamber,

rotary drive means for said paddle,

resilient means connecting said paddle to said rotary drive means, and

stationary unflexing means located in said chamber for abruptly releasing paddles, the flexing means of which are flexed, as the paddles reach a predetermined angular position in said chamber

whereby when said paddle passes said stationary means its resilient means unflexes abruptedly and said paddle springs forward to fling spoil in a direction laterally of said auger axis.

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