

July 11, 1939.

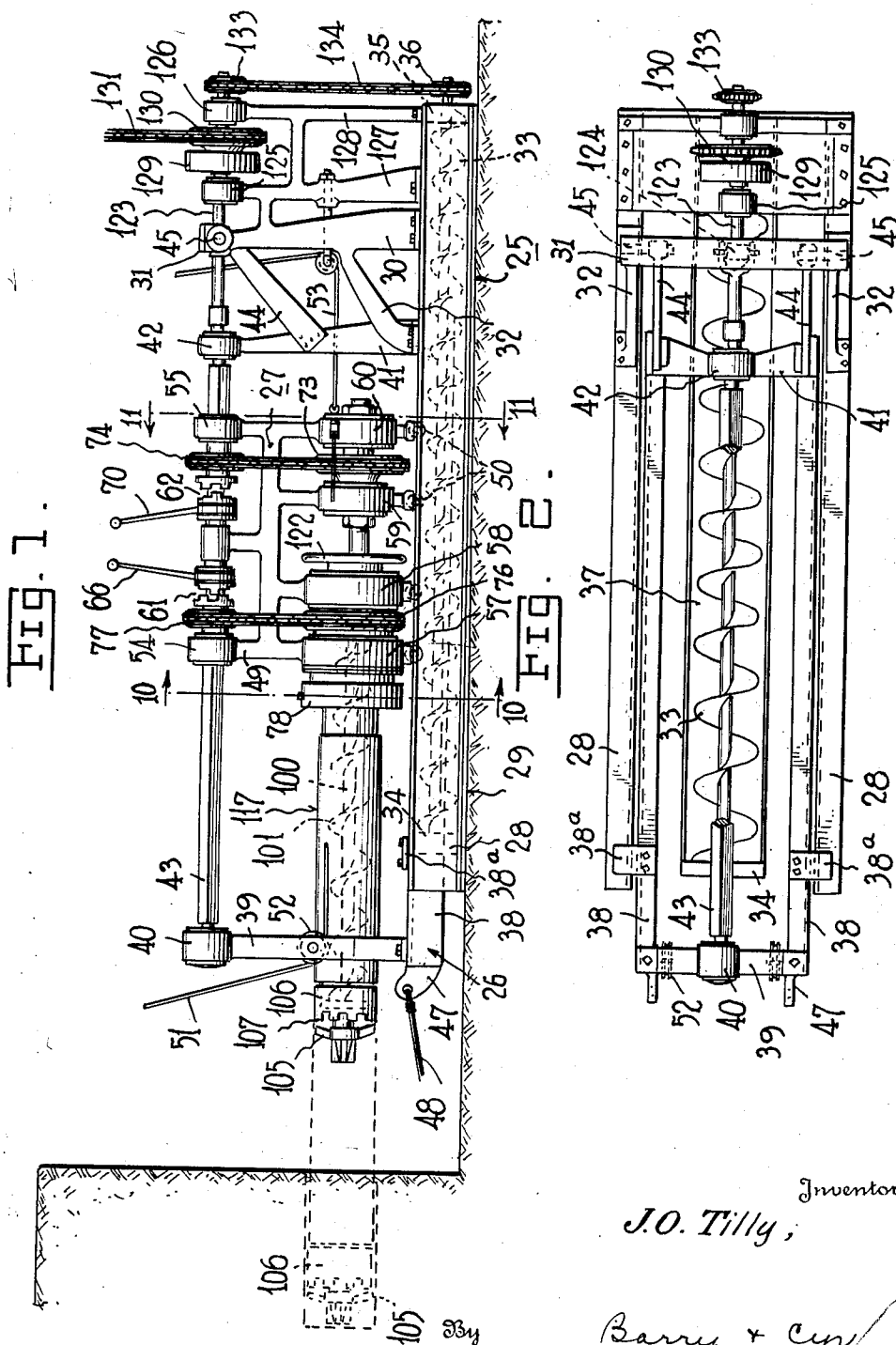
J. O. TILLY

2,165,666

HORIZONTAL DRILLING MACHINE

Filed June 24, 1937

7 Sheets-Sheet 1



July 11, 1939.

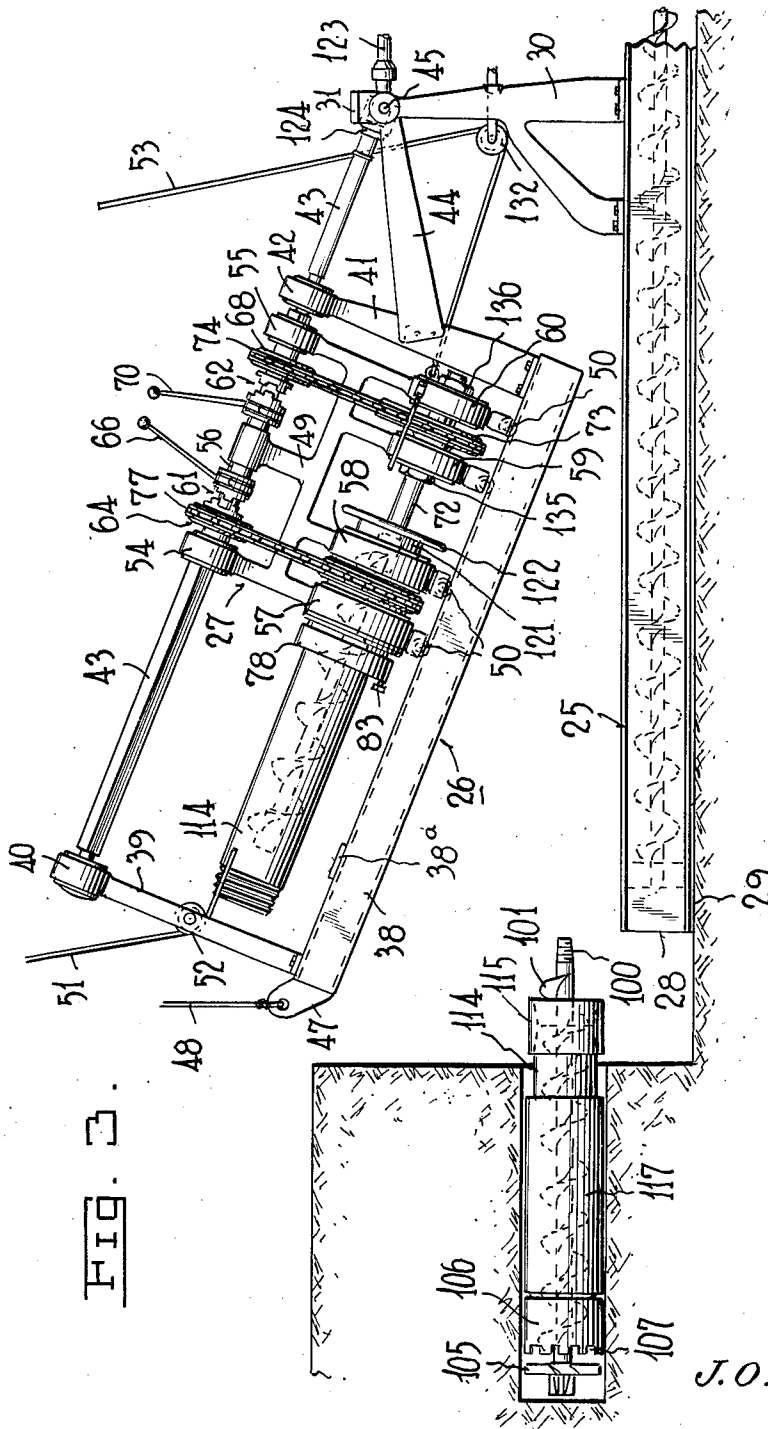
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HORIZONTAL DRILLING MACHINE

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HORIZONTAL DRILLING MACHINE

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Fig 6.

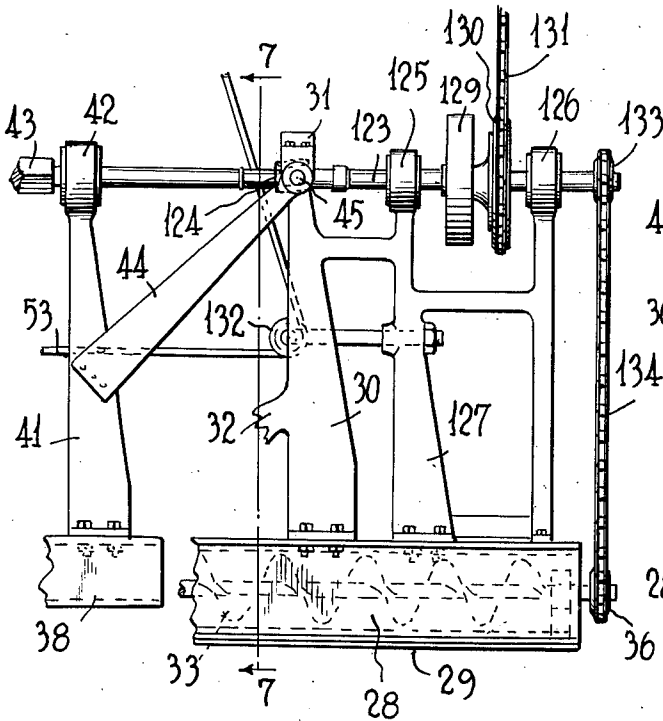


Fig. 7.

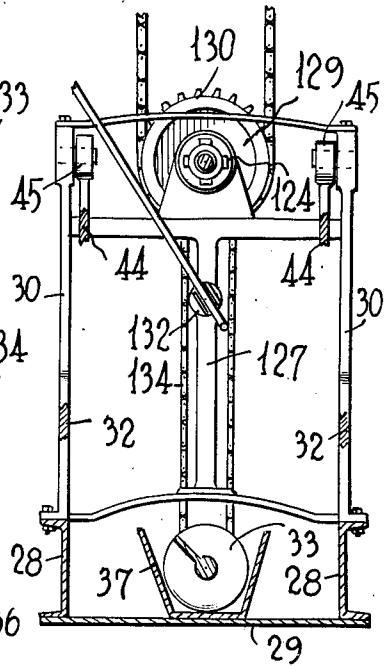


Fig. 16

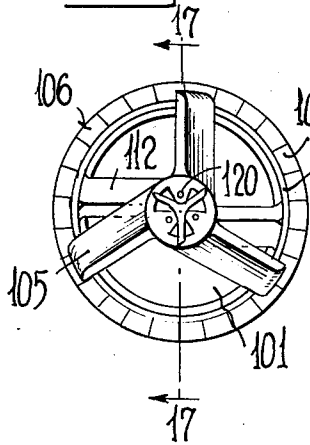
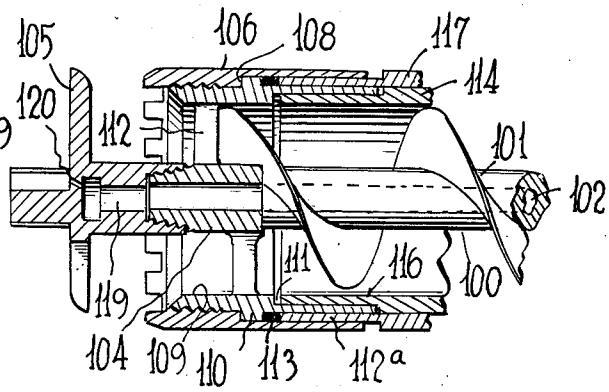


Fig. 17.



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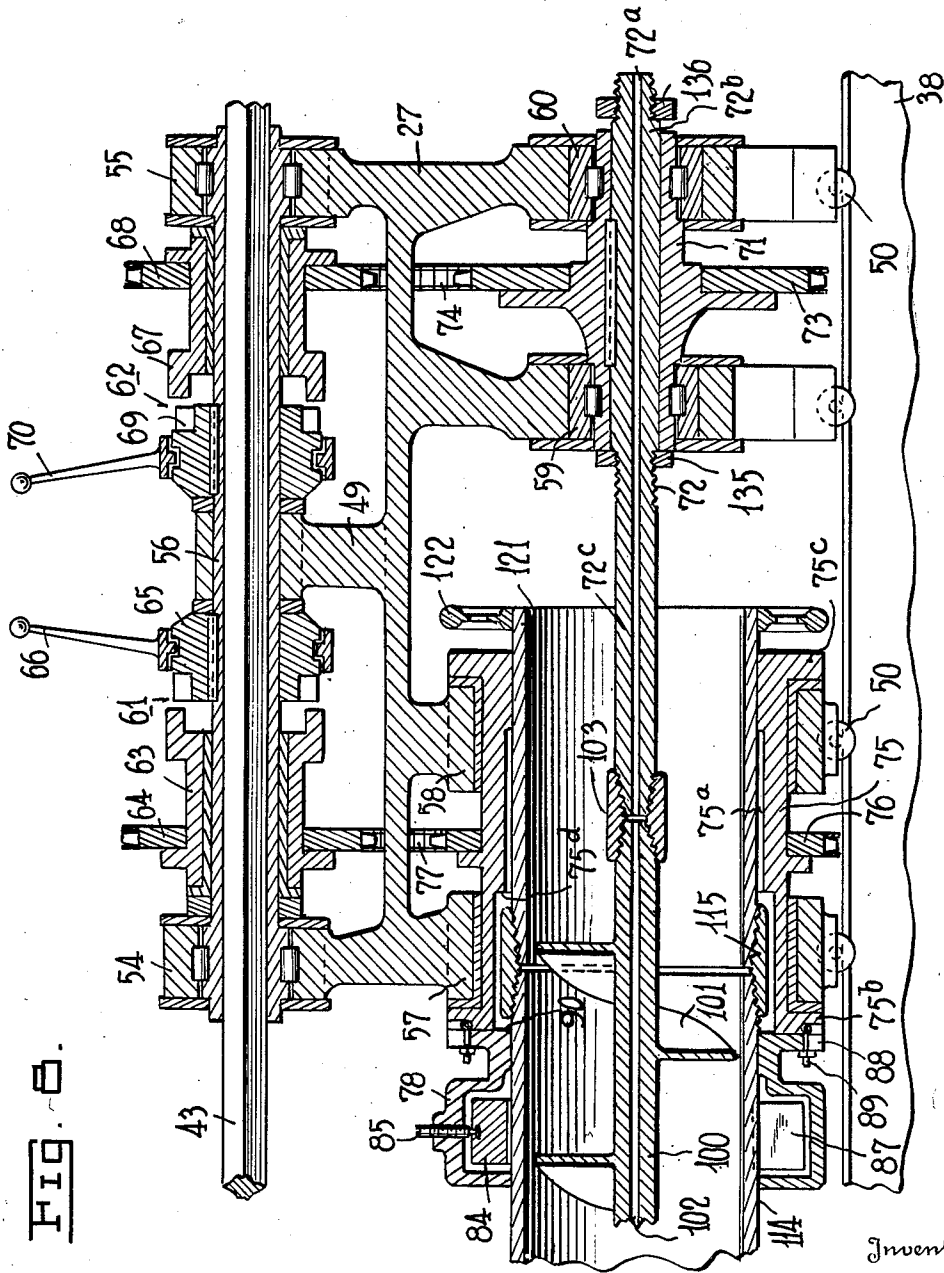


FIG. 5.

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HORIZONTAL DRILLING MACHINE

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Fig. 11.

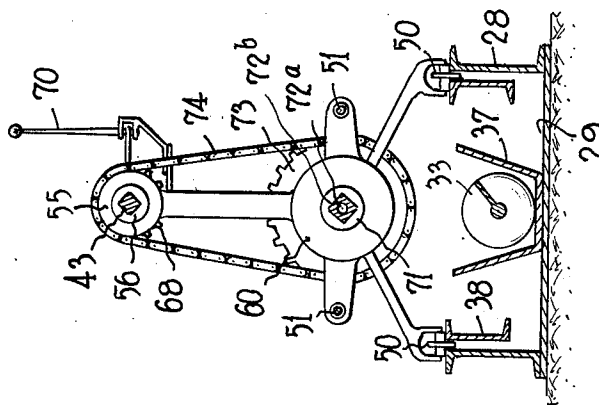
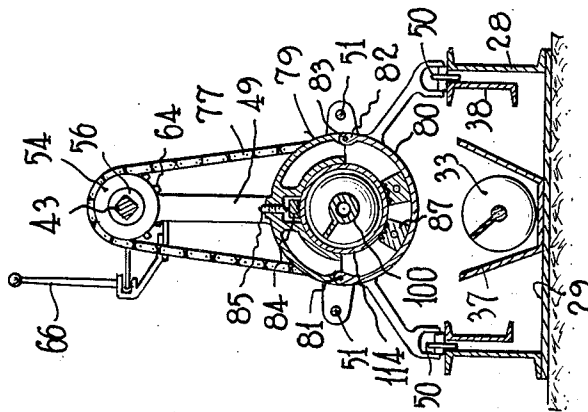
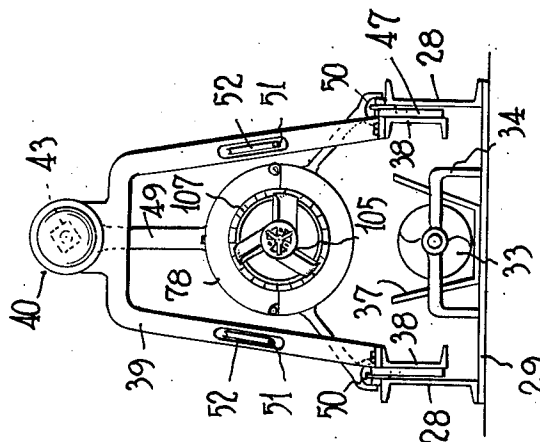


FIG. 10.



9. BIH



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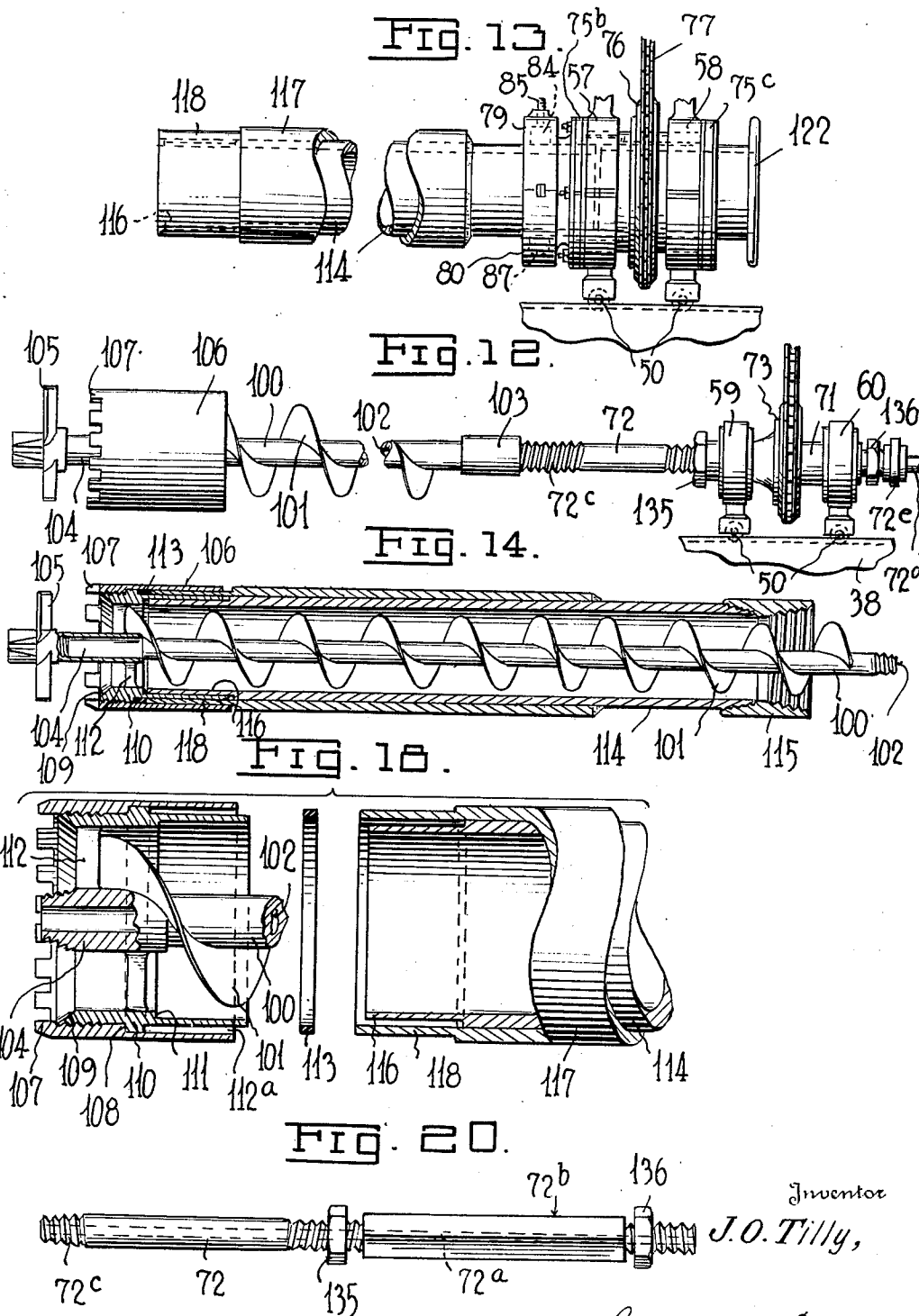
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HORIZONTAL DRILLING MACHINE

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,165,666

HORIZONTAL DRILLING MACHINE

James O. Tilly, Tulsa, Okla., assignor of sixty-five and two-tenths per cent to James Hailey, Tulsa, Okla., and two per cent to C. M. Martin, Tulsa, Okla., and one per cent to Frank R. Mofatt, Tulsa, Okla.

Application June 24, 1937, Serial No. 150,166

21 Claims. (Cl. 255—20)

This invention relates to drilling machines and particularly to machines which are adapted for the drilling of bore holes in the earth under streets and embankments, mines and tunnels and the like, to accommodate the laying therein of conduits for fluids, electric cables and the like.

This invention relates particularly to improvements in the Horizontal drilling machine, described and claimed in my former patent No. 1,835,191, dated December 8th, 1931.

A principal object is to provide a machine which will be labor saving to a maximum extent, safe in operation and relatively inexpensive in cost, operation and up-keep.

Another object is to provide a machine for boring holes more or less horizontally beneath the surface of the ground, whereby the digging of open ditches is avoided and the consequent inconvenience to traffic passing over the surface of the ground is eliminated.

Another object is to provide a construction which is easily portable.

An additional important object is to provide a machine which will simultaneously drill holes and lay casing for lining the holes.

A further object is to provide means for continuously removing cuttings from the bore hole and conveying them from the machine so as not to interfere with the operation of the machine.

A particular object is to provide a machine whereby drilling may be conducted at any desired angle from the horizontal.

A further object is to provide a machine which is in fixed position with regard to the face of the formation to be drilled, while permitting the drilling of holes of any desired length through the formation.

A special object is to provide means in conjunction with a drill and casing, for rotating these members independently of each other or together.

A further particular object is to provide means operable by the machine for adding lengths of drill shaft and casing to their respective strings as the drilling progresses and for disconnecting the sections of drill shaft and casing when necessary.

Numerous other objects and advantages will become apparent from a consideration of the following description taken in conjunction with the accompanying drawings illustrating an operative embodiment of this invention.

In the drawings:

Fig. 1 is a side elevation of the assembled machine of this invention.

Fig. 2 is a plan view of the supporting frames

showing the position of the main driving mechanism thereon.

Fig. 3 is a view similar to Fig. 1, showing the drilling mechanism tilted at an angle above the horizontal.

Fig. 4 is an elevation of the movable frame and the drill carriage frame rollable thereon and with the drill mechanism removed.

Fig. 5 is a vertical section of the movable frame and carriage taken along line 5—5 of Fig. 4.

Fig. 6 is a side elevation of the main drive mechanism shown in Fig. 3 in plan view and showing in somewhat greater detail the frame work supporting this mechanism.

Fig. 7 is a vertical section taken along line 7—7 of Fig. 6.

Fig. 8 is a vertical longitudinal section through the drill carriage showing in detail the arrangement of the various driving connections to the drill and casing rotating elements.

Fig. 9 is a front end elevation of the assembled machine.

Figs. 10 and 11 are sectional views of the machine taken along lines 10—10 and 11—11, respectively, of Fig. 1.

Fig. 12 shows the arrangement of the drive connections to the drilling mechanism.

Fig. 13 is a similar view of the mechanism utilized in rotating the casing.

Fig. 14 is a longitudinal section through the bit head and bit stem.

Fig. 15 is a perspective view partly in section of the casing driving sleeve and chuck.

Fig. 16 is an elevation of the drilling bit and adjacent parts.

Fig. 17 is a longitudinal sectional view partly in elevation of the same.

Fig. 18 is a longitudinal sectional view partly in elevation of parts arranged at the front end portion of the drill.

Fig. 19 is a perspective view of the thread protector nipple.

Fig. 20 is an elevation of a portion of the drill stem.

Referring specifically to the drawings wherein like reference characters designate like or similar parts, the machine of this invention includes primarily a main frame, indicated generally by the numeral 25, a secondary or movable frame 26, hingedly mounted at 45 on the main frame, 50 and a drill carriage, indicated at 27, movable longitudinally on the frame 26, and a drilling mechanism, all of which will be described in greater detail hereinafter.

Main frame 25 consists of a pair of parallel

beams 28 spaced apart and connected together at their lower edges by means of a plate 29 which extends under substantially the entire length of beams 28. Beams 28 and plate 29, in addition to forming a stationary base for the machine, serve also as a skid surface for moving the machine from place to place either on the ground or by loading on a truck or other vehicle. Near one end of beams 28 are fixedly attached a pair of oppositely disposed uprights 30, which are connected together at their free ends by a cross member 31. A pair of braces 32 helps connect uprights 30 rigidly to their respective beams 28. A helicoid conveyor 33 is journaled in bearings 34 and 35 which are supported on plate 29 at opposite ends of frame 25. Conveyor 33 is centered between beams 28 and extends the full length of frame 25. A sprocket 36 is mounted on the rear end of conveyor 33 and is adapted to be driven in a manner to be hereinafter described. A trough 37 encloses conveyor 33 on three sides thereof and throughout its length and is adapted to receive drill cuttings to be removed from the machine by conveyor 33.

Secondary frame 26 consists of a pair of parallel beams 38, which are spaced apart and are mounted between beams 28 at opposite sides of trough 37. A pair of uprights 39, rigidly mounted on one end of beams 38, join at their upper ends to support a bearing 40. A similar pair of uprights 41 (see Fig. 5), mounted on the opposite ends of beams 38, support a bearing 42. Journalled in bearings 40 and 42 is a driven shaft 43, preferably square in cross-section. Rigidly attached to uprights 41 are rearwardly and upwardly extending braces 44, the free ends of which are hingedly attached to the upper ends of uprights 30 by means of trunnions 45, which are journalled in openings in the upper ends of uprights 30. The secondary frame is provided with projecting lugs or plates 38a which rest on the beams 28 and support the forward end of the main frame. A pair of eye plates 47 are fixedly attached to the front ends of beams 38. Cables 48 are attached to the eye plates and by pulling upwardly on the cables, frame 26 pivots on main frame 25 in a vertical plane.

Drill carriage 27 includes a frame 49 mounted on rollers 50 and adapted to travel longitudinally on beams 38 of frame 26 between uprights 39 and 41. Frame 49 is moved forwardly on frame 26 by means of cables 51 which are attached to one of the members of frame 49 and extend forwardly thereof under pulleys 52, which are journalled in uprights 39. The carriage is pulled rearwardly on frame 26 by a cable 53 which is attached to the carriage frame and extends rearwardly therefrom. Mounted on the upper portion of carriage frame 49 and centered therein between beams 38, are a pair of longitudinally spaced bearings 54 and 55 in which is journalled a cylindrical sleeve 56 which slidably surrounds and rotates with shaft 43. Thus shaft 43 is additionally supported by bearings 54 and 55 and sleeve 56 while permitting the forward and backward movements of carriage 27 on frame 26. Mounted in carriage frame 49, below bearings 54 and 55, and supported from frame 26 by the rollers 50, are bearings 57, 58, 59 and 60 which are centered in frame 49 between beams 38 and are spaced apart longitudinally from each other.

Mounted on sleeve 56 (see Fig. 8), between bearings 54 and 55, are longitudinally spaced clutches 61 and 62. Clutch 61 includes a female sleeve member 63 loosely mounted on sleeve 56

and carrying a sprocket 64, and a male member 65, which is keyed to sleeve 56 and is adapted to be moved longitudinally thereon into engagement with member 63 by means of a lever 66. Clutch 62 is similar in construction and includes a floating female member 67 and sprocket 68 and a male member 69 operated by a lever 70.

Journalled in bearings 59 and 60 is drive sleeve 71 (Fig. 8), which surrounds head 72b of a drive shaft 72. Head 72b is preferably square in cross-section and the bore of drive sleeve 71 is of complementary shape so that rotation of the drive sleeve 71 will act to rotate drive shaft 72. The shank 72c of drive shaft 72 (Figs. 8, 12 and 20) extends forwardly of drive sleeve 71 and is cylindrical in shape and threaded externally at its forward end and for a distance forwardly of head 72b (see Fig. 12). A water supply pipe 72d is in communication with an axial bore 72a which extends through drive shaft 72, and is connected to head 72b by a swivel 72e. A sprocket 73 is fixedly mounted on drive sleeve 71 and is aligned with sprocket 68 of clutch 62. A chain 74 operatively connects the two sprockets 68 and 73.

Drive sleeve 71, bearings 59 and 60, sprockets 73 and drive shaft 72 constitute a drill head for the machine, and by virtue of the method of mounting on carriage 27, the drill head is movable longitudinally on secondary frame 26 (Fig. 12).

Journalled in bearings 57 and 58 is a casing sleeve or cylinder 75 (Figs. 8, 13 and 15) having an internal bore 75a and annular end flanges 75b and 75c abutting against the outer sides respectively of bearings 57 and 58. Internal bore 75a is counterbored for a short distance rearwardly from flange 75b (Figs. 8 and 15) to provide an inner shoulder 75d. A sprocket 76 is fixedly mounted on cylinder 75 between bearings 57 and 58 and is in alignment with sprocket 64 of clutch 61, and a chain 77 operatively connects the two sprockets 64 and 76. Attached to flange 75b by means of bolts 89 is a circular chuck 78 which comprises an annular frame formed by semi-circular sections 79 and 80 (see Figs. 10 and 13) which are hinged together at one side by means of a hinge 81 and which are detachably connected together at the opposite side by means of registering apertured ears 82 through which a pin 83 is removably inserted. A toothed jaw 84 is adjustably mounted in frame section 79 and is adjustable toward and away from the transverse axis of the chuck by means of a set screw 85. Jaws 86 and 87 are adjustably mounted in frame section 80 and together with jaw 84 are adapted to grip a casing 114 to rotate same either clockwise or counter-clockwise as will be more fully brought out hereinafter. Chuck 78 is provided with an annular flange 88, consisting of two sections to conform with frame sections 79 and 80, and the frame sections are hingedly attached to flange 75b of cylinder 75 by means of bolts 89. Thus either one of sections 79 or 80 can be swung on hinge 81 after pulling pin 83 and loosening certain of the bolts 89 while the other section, by means of the remaining bolts 89, is still attached to flange 75b. Flange 88 has an internal diameter less than that of the counterbored section of cylinder bore 75a, and thus provides a shoulder 90, opposite shoulder 75d. The purpose to which these shoulders are put will be described more fully in connection with the description of the operation of the machine.

A drill shaft 100, having spiral convolutions about the exterior thereof forming a cuttings conveyor 101 and having an axial bore 102, is 75

connected to shank 72c of drive shaft 72 by means of a collar 103 and extends horizontally from the central portion of cylinder 75 toward the front end of secondary frame 26. Bore 102 of the drill shaft registers with bore 72a of the drive shaft forming a continuous passageway through these members. On the forward end of drill shaft 100 is a threaded nipple 104 (see Fig. 14) into which is threadedly connected a bit head 105. A protection collar 106, having serrations 107 in its forward edge, is mounted concentrically about drill shaft 100 just behind bit head 105. Protection collar 106 (Figs. 12, 13, 16, 17 and 18) is threaded internally in its forward end and counterbored rearwardly of the threads to provide an internal shoulder 108. A liner 109, threaded externally at its forward end and having an external annular flange 110, is inserted in protection collar 106 and threadedly engaged therewith until flange 110 abuts against shoulder 108. Liner 109 is also counterbored to provide an annular recess 111 therein.

Protection collar 106 and liner 109 are rigidly mounted concentrically about drill shaft 100 and nipple 104 by means of spacing bars 112 and the interior diameter of liner 109 is such as to freely receive the forward end of conveyor 101, which is thus placed in cuttings receiving proximity to bit head 105. By the counterboring of protection collar 106, an annular recess 112a is provided between the inner wall of collar 106 and the outer surface of liner 109. Seated in recess 112a against flange 110 is a ring bushing 113.

A section of casing 114, having an internally threaded casing collar 115 mounted on the rearward end thereof, encloses drill shaft 100 and conveyor 101 and the rearward end of drill shaft 100 and conveyor 101 extends beyond collar 115 (Figs. 8 and 14). The end of casing 114 bearing collar 115 extends into cylinder 75 where collar 115 is received in the counterbored section of cylinder bore 75a between shoulder 90 of the chuck frame and shoulder 75d of the cylinder. Casing 114 has an external diameter substantially equal to that of liner 109 and the forward end of casing 114 is reduced to form a cylindrical tip 116 which is slidably engaged in recess 111 of liner 109. A direction sleeve 117 surrounds casing 114 and is rigidly united therewith either by welding or by shrinking same on the casing. The forward end of direction sleeve 117 is reduced forming a cylindrical tip 118 parallel to tip 116 and concentric therewith. Tip 118 is adapted to be slidably received in recess 112a and into bearing contact therein with bushing 113, at the same time that tip 116 is received in recess 111. The described construction of the rearward ends of protection collar 106 and liner 109 and of the forward ends of casing 114 and direction sleeve 117, as illustrated particularly in Figs. 17 and 18, provides a double cylindrical tongue-and-groove joint between these several members, which is adapted to permit casing 114 and drill shaft 100, with its attached bit head 105 and collar 106, to rotate freely and independently of each other, while remaining in close contact with each other. Direction sleeve 117 has an external diameter substantially equal to that of protection collar 106 as well as that of casing collar 115.

Bit head 105, the section of drill shaft 100 to which it is connected, protection collar 106, casing section 114, direction sleeve 117 and the other elements united with these members, together form a drill bit having independently rotatable members, and wherein the flush arrangement of

collar 106 and sleeve 117 provide an elongated bearing surface for the drilling of the bore hole, which is highly advantageous in aiding the bit head to drill a straight bore hole through the formation to be drilled.

Bit head 105 has a hollow chamber 119 in the interior thereof, (Fig. 17) which communicates with bore 102 of drill shaft 100, and a series of ports 120 lead from chamber 119, through the walls thereof, to the front of the bit head and between the wings of the bit head.

A thread protector nipple 121 (Fig. 8), externally threaded on end, extends into bore 75a of cylinder 75 and engages the threads of casing collar 115 for the purpose of protecting these threads from damage or clogging by cuttings which will be discharged by conveyor 101 through casing 114. The rearward end of protector nipple 121 has a circular handle 122 fixedly mounted thereon to assist the rotative insertion and withdrawal of nipple 121 from collar 115.

A thrust nut 135 is threadedly mounted on shank 72c of drive shaft 72 and can be moved toward and away from bearing 59 to accommodate the thrust of drill shaft 100 during the drilling operation. A second thrust nut 136 threadedly engages the opposite end of drive shaft 72 to limit and control the slippage of drive shaft 72 in sleeve 71.

Shaft 43 (Fig. 6) extends through bearing 42 rearwardly between uprights 30 and is connected to a stub shaft 123 by means of a universal joint 124 centering substantially in the horizontal axis of trunnions 45. By this arrangement, a flexible joint is provided in shaft 43 which will permit the pivotal movement of shaft 43 in accordance with the pivotal movement of frame 26 in trunnions 45. Stub shaft 123 is journaled in spaced bearings 125 and 126, which are fixedly supported on beams 28 of the main frame 25 by upright supports 127 and 128, respectively. Mounted on stub shaft 123, between bearings 125 and 126, is a fly wheel 129, which tends to absorb any whip which might occur in an elongated shaft, such as shaft 43. A main drive sprocket 130 is rigidly mounted on stub shaft 123 and a chain 131 operatively connects sprocket 130 to a suitable source of power for driving the mechanism of the machine. Such a source of power, which is not shown, may be any sort of prime mover commonly used for driving machinery and may be an internal combustion engine, electric motor or steam engine, which is equipped with a reversing connection to sprocket chain 131. Supported by upright support 127 is a sheave 132, which is adapted to swivel in its support means, and cable 53, which is utilized to draw carriage 27 rearwardly on frame 26, is passed through sheave 132 and led to a power means suitable for moving the carriage on the frame. On the rearward end of stub shaft 123, is mounted a sprocket 133, which is in alignment with sprocket 36 on conveyor 33 and a chain 134 operatively connects sprockets 36 and 133.

The machine above-described is operated in the following manner: If a horizontal bore hole is to be made beneath a street or other surface which is on the same level as the surrounding area, an excavation slightly longer and wider than the over-all dimensions of the machine is dug to receive the machine and is made sufficiently deep, so that when the machine is in position in the excavation, the drilling mechanism is at the level at which the bore hole is to be drilled. If a bore hole is to be drilled through an em-

bankment, the machine is simply moved into position at the proper level against the face of the embankment and is ready to begin operation.

A pressure water supply line is connected to pipe 72d, chain 131 is operatively connected to a suitable prime mover and cables 51 and 53 connected to suitable means, such as a power winch which, by pulling on cables 51 and 53 will move the carriage 27 and its drilling mechanism toward or away from the formation to be drilled.

Power from the prime mover is now applied through chain 131 and sprocket 130 to stub shaft 123 and thence to driven shaft 43 and shaft 43 is placed in driving engagement with the sleeve 71 rotating drill shaft 100 in a clockwise direction to drive bit head 105 into the formation to be drilled. Bit head 105 is continuously held against the face of the formation by continuous pull applied to cable 51 by the power winch (not shown).

When the drill is started, water under high pressure is forced through bore 102 of the drill shaft, entering through bore 72a of the drive shaft 72, and is ejected through ports 120 in the bit head. The jetting of the high pressure water assists in the boring and also washes the cuttings from the bore hole, the cuttings being caught by the convolutions of conveyor 101, which conveys them through casing 114 and discharges them through the open end of protector nipple 121, from which the cuttings fall into trough 37 to be moved by conveyor 33 which discharges them rearwardly from frame 25, to be removed manually or otherwise from the vicinity of the machine. Conveyor 33 is in operation at this time due to its connection by means of chain 134 to stub shaft 123.

Normally, as the drilling proceeds, clutch 61 is left in dis-engaged position and casing 114 is, therefore, not rotated. Nevertheless, because of the method of mounting in the carriage 27, casing 114 will follow the bit head into the bore hole as the drilling proceeds. Should it be found desirable to rotate casing 114 and direction sleeve 117, as for example, to loosen the drill when some obstruction, such as a rock, lodges between the bore hole and sleeve 117, clutch 61 may then be engaged and the casing and its sleeve rotated by means of the connection formed by chain 77 between sprockets 64 and 76, until the obstruction has been dis-lodged and the drill freed. At the same time, rotation of the drill shaft 100 may be continued or clutch 62 may be dis-engaged and only the casing rotated.

When the full length of the section of casing 114 has been drilled, the carriage 27 with its supported mechanism will be at the forward end of frame 26. At this time, protector nipple 121 is backed out of collar 115, drill shaft 100 disconnected from drive shaft 72, chuck 78 is opened to clear collar 115, whereupon carriage 27 with its supported mechanism is drawn backward along frame 26 by pull applied to cable 53, leaving casing 114 in the bore hole, as shown in Fig. 3. The front end of secondary frame 26 is then lifted by an upward pull applied to cables 48, frame 26 pivoting on trunnions 45, until the front end of this frame is clear of the excavation in which the machine is placed. This position of frame 26 is also shown in Fig. 2. A new section of drill shaft 100 is then extended through cylinder 75 and connected to drive shaft 72 and a new section of casing 114 is slipped over the drill shaft and into cylinder 75. Chuck frame 78 is then locked about the casing and the chuck jaws brought into engagement therewith by adjustment of set screw 85. In the view showing in Fig. 3, new sections

of casing and drill shaft have been inserted in cylinder 75. Frame 26 is then lowered back into normal position and the ends of new sections of casing and drill shaft brought into alignment with the corresponding ends of the sections of casing and drill shaft in position in the bore hole. Clutches 61 and 62 are thrown into engagement, and drive shaft 72 and cylinder 75 rotated in the clockwise direction to make up the new sections of casing and drill shaft into their respective strings, and protector nipple 121 is again screwed into the casing collar. Clutch 61 is then disengaged but rotations of drill shaft continued, thereby continuing the drilling operation until the new sections have drilled their full length into the formation. The adding of new joints of drill shaft and casing is repeated as the drilling continues until drilling of the bore hole is completed. At this time, not only will the bore hole have been drilled, but will be completely lined with casing which may be left in the hole by disconnecting the bit head and stem from the casing and drill shaft protruding from the forward end of the bore hole, disconnecting the driving mechanism from the casing and drill shaft at the machine end of the bore hole, and with drawing the drill shaft from the casing.

If it is desired to withdraw the casing from the bore hole, the machine may also be utilized for this purpose. The bit head and bit stem is disconnected from the forward end of the casing and drill shaft and carriage 27 is drawn backward on frame 26. In carrying out this movement chuck 78 is left in closed position about the casing and the backward movement of the carriage and cylinder will pull shoulder 90 of the chuck frame against the casing collar and thus provide a means, in addition to the chuck jaws themselves, for gripping the casing and pulling the entire string backwardly from the bore hole. The drill shaft being connected to drive shaft 72, which is locked against withdrawal from sleeve 71 by thrust nut 136, will also be pulled back at the same time. When a full section of casing has been pulled from the bore hole, tongs are applied to the next following section of casing, clutch 61 is thrown into engagement and the rotation of drive shaft 43 reversed, causing the withdrawn section of casing to be unscrewed from the following section. Clutch 62 is then thrown into engagement reversing the drill shaft rotation and hold back means applied to the following section of drill shaft and the first drill shaft section is then unscrewed from the drilling string. With both the casing and drill shaft sections free, the front end of frame 26 is lifted until it is clear of the excavation, and the casing and drill shaft sections removed from the machine. This operation is then repeated until all of the casing and drill shaft have been removed from the bore hole.

With the machine of this invention, bore holes may be drilled horizontally or at an angle above the horizontal without changing the position of stationary frame 25. Holes may be drilled at an angle below the horizontal by proper positioning frame 25. Holes of any desired length and diameter may be drilled thereby, and the machine may be constructed to utilize casing and drill shaft sections of any desired length. Commercial machines designed in accordance with this invention are designed for the boring of holes having diameters ranging from three inches up to twenty-eight inches and up to several hundred feet in length. The machines are preferably con-

structed in various sizes, each size to drill bore holes having a limited range of diameters, as for example from twelve to twenty-eight inches or from three to eight inches, and to accommodate five or ten foot sections of casing and drill shaft.

Numerous other modifications may be made in size, form and arrangement of parts without departing from the scope of the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A machine of the class described, comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a carriage movable longitudinally of said secondary frame, a drill supported by said carriage, a casing surrounding said drill and also supported by the carriage, means for simultaneously moving the carriage, drill and casing longitudinally of the secondary frame, means for rotating the drill, and means for rotating the casing independently of the drill.

2. A machine of the class described, comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a carriage movable longitudinally of said secondary frame, a drill supported by said carriage, a casing surrounding said drill and also supported by the carriage, means for simultaneously moving the carriage, drill and casing longitudinally of the secondary frame, means for rotating the drill, means for rotating the casing independently of the drill, and a spiral conveyor surrounding the drill and positioned between the drill and said casing.

3. A machine of the class described, comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a carriage movable longitudinally of said secondary frame, a drill detachably connected to and supported by the carriage, a casing detachably connected to the carriage and surrounding said drill, means for simultaneously moving the carriage, drill and casing longitudinally of the secondary frame, and means for rotating the drill and casing while they are moving with the carriage longitudinally of the secondary frame.

4. A machine of the class described comprising, a stationary frame, a normally horizontal secondary frame pivotal on said stationary frame for movement about a horizontal axis, a drill longitudinally and horizontally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, driving means for rotating said casing and separate driving means for rotating said drill independently of said casing, both of said driving means being longitudinally movable on said secondary frame in accordance with the longitudinal movements of the drill and casing, and a conveyor arranged between the drill and casing.

5. A machine of the class described comprising a stationary frame, a secondary frame pivotal on said stationary frame, a drill longitudinally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, a driven shaft journaled in said secondary frame, a driving connection from said driven shaft to said casing for rotating same, a separate driving connection from said driven shaft to said drill for rotating said drill independently of said casing, both of said driving connections being slidable on said driven shaft in accordance with the longitudinal movement of said drill and casing and means for driving said driven shaft.

6. A machine of the class described comprising, a stationary frame, a secondary frame pivotal on said stationary frame, a drill longitudinally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, a cylinder surrounding said casing, chuck means attached to said cylinder and releasably engaging said casing, means for rotating said cylinder and separate means for rotating said drill independently of said cylinder, both of said latter means being movable on said secondary frame in accordance with the movement of said drill and cylinder.

7. A machine of the class described, comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a rotatable driven shaft mounted on and arranged parallel to the secondary frame, a carriage movable longitudinally of said secondary frame and slidably engaging said shaft, a drill carried by said carriage, a casing surrounding said drill and also carried by said carriage, means for simultaneously moving the carriage, drill and casing longitudinally of the secondary frame, and means operatively connecting the shaft and drill for rotating said drill.

8. A machine of the class described, comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a rotatable driven shaft mounted on and arranged parallel to the secondary frame, a carriage movable longitudinally of said secondary frame and slidably engaging said shaft, a drill carried by said carriage, a casing surrounding said drill and also carried by said carriage, means for simultaneously moving the carriage, drill and casing longitudinally of the secondary frame, means operatively connecting the shaft and drill for rotating said drill, and other means operatively connecting said shaft and casing for rotating said casing.

9. A machine of the class described comprising, a stationary frame, a secondary frame pivotal on said stationary frame, a drill longitudinally movable on said secondary frame, means for rotating said drill in cutting relationship to a formation to be drilled, first conveying means operated by said drill for conveying drill cuttings toward the rear of the drill, second conveying means journaled in said stationary frame below said first conveying means for receiving said cuttings

therefrom and for continuing the rearward movement of said cuttings and a driving connection from said drill rotating means to said second conveying means.

10. A machine of the class described comprising a stationary frame, a secondary frame pivotal on said stationary frame, a drill longitudinally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, a first conveyor cooperating with said drill and rotatable in said casing for conveying drill cuttings from the head of said drill and discharging same rearwardly through said casing, a second conveyor journaled in said stationary frame and adapted to receive the cuttings discharged from said casing, means for rotating said drill and driving said first conveyor and a driving connection from said drill rotating means to said second conveyor.

11. In a machine of the class described, a frame, a carriage longitudinally movable on said frame, a driven shaft journaled in said frame parallel to the path of movement of said carriage, an elongated drill shaft rotatably journaled in said carriage and longitudinally movable therewith, a boring bit attached to the forward end of said drill shaft, a collar fixedly mounted on said drill shaft rearwardly of said bit, a casing surrounding said drill shaft rearwardly of said collar and rotatable independently of said drill shaft and collar, a cylinder surrounding said casing and rotatably journaled in said carriage and longitudinally movable therewith, chuck means carried by said cylinder releasably engaging said sleeve, independent driving connections from said driven shaft to said drill shaft and said cylinder, said independent driving connections being slidable on said driven shaft in accordance with the longitudinal movement of said drill shaft and cylinder, power operated means for driving said driven shaft, and means for moving said carriage longitudinally on said frame.

12. A machine of the class described, comprising a stationary frame, a normally horizontal second frame pivotal on said stationary frame for movement about a horizontal axis, a drill longitudinally and horizontally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, driving means for rotating said casing, separate driving means for rotating said drill independently of said casing, both said driving means being longitudinally movable on said secondary frame in accordance with the longitudinal movement of the drill and casing, means for connecting both said driving means together whereby the drill and casing may be rotated together, and a conveyor arranged between the drill and casing.

13. A machine of the class described comprising a stationary frame, a secondary frame pivotal on said stationary frame, a drill longitudinally movable on said secondary frame, a casing surrounding said drill and movable longitudinally therewith, a driven shaft journaled in said secondary frame, a driving connection from said driven shaft to said casing for rotating same, a separate driving connection from said driven shaft to said drill for rotating said drill independently of said casing, both of said driving connections being slidable on said driven shaft in accordance with the longitudinal movement of said drill and casing, clutch means carried by said driving connections whereby said drill and casing may be driven together, a power shaft rotatably journaled in said stationary frame, a

flexible driving connection between said power shaft and said driven shaft, and a connection for supplying power to said power shaft.

14. A machine of the class described comprising, a frame, a drill head longitudinally movable on said frame, an elongated drill shaft rotatably connected to said drill head, a boring bit attached to the forward end of said drill shaft, a collar surrounding said drill shaft rearwardly of said bit and rotatable with said drill shaft, a casing surrounding said drill shaft rearwardly of said collar and rotatable independently thereof, said casing being smaller in external diameter than said collar, a sleeve surrounding said casing and fixedly attached thereto, said sleeve having an external diameter equal to that of said collar, and a cylindrical tongue and groove joint between said collar and said casing and sleeve, whereby said collar and said casing and sleeve may rotate independently of each other while in contact with each other.

15. A machine of the class described comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a drill movable longitudinally of said secondary frame, a casing surrounding said drill and movable longitudinally of the secondary frame, means for simultaneously moving the drill and casing longitudinally of the secondary frame, and means for rotating the drill or casing while they are moving longitudinally of the secondary frame.

16. A machine of the class described comprising, a frame, a carriage movable longitudinally on said frame, a driven shaft journaled in said frame parallel to the path of movement of said carriage, a drill head mounted on said carriage, a drill shaft rotatably connected to said drill head and extending forwardly of said frame, a cylinder journaled in said carriage and surrounding said drill shaft forwardly of said drill head, a casing surrounding said drill shaft forwardly of said cylinder and extending into said cylinder, chuck means carried by said cylinder and releasably engaging said casing, driving connections from said driven shaft to drill head and said cylinder and means for reversibly driving said driven shaft.

17. A machine of the class described comprising an elongated substantially horizontally disposed primary frame, a secondary frame arranged substantially parallel to and resting on the primary frame and having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis arranged crosswise of the primary frame, a drill movable longitudinally of said secondary frame, a casing surrounding said drill and movable longitudinally of the secondary frame, means for simultaneously moving the drill and casing longitudinally of the secondary frame, means for rotating the drill or casing while they are moving longitudinally of the secondary frame, and a spiral conveyor surrounding the drill and positioned between the drill and said casing.

18. A machine for making substantially horizontal conduits under roadways or the like, comprising a primary supporting frame, a secondary frame movably connected to the primary frame to permit the front end portion of the secondary frame to be moved upwardly from a lower sub-

stantially horizontal position into an upper position and vice versa, one of said frames being provided with planar guide means which are normally substantially horizontally arranged, a carriage supported by the secondary frame and movable along said guide means, a drill stem movable with the carriage along the guide means and having a bit at its outer end, a casing movable with the carriage along said guide means and surrounding the drill stem, a conveyor positioned within the casing, and means for rotating the drill stem while it is moving with the carriage along said guide means.

19. A machine for making substantially horizontal conduits under roadways or the like, comprising a primary supporting frame, a secondary frame movably connected to the primary frame to permit the front end portion of the secondary frame to be moved upwardly from a lower substantially horizontal position into an upper position and vice versa, one of said frames being provided with planar guide means which are normally substantially horizontally arranged, a carriage supported by the secondary frame and movable along said guide means, a drill stem movable with the carriage along the guide means and having a bit at its outer end, a casing movable with the carriage along said guide means and surrounding the drill stem, a conveyor positioned within the casing, and means for rotating the drill stem and casing while they are moving with the carriage along said guide means.

20. In an apparatus of the character described, a driving shaft, a carriage movable longitudinally of the shaft, a drill stem having a portion journaled in the carriage and arranged parallel to the driving shaft, means including a clutch having a

portion splined to the driving shaft for driving said portion of the drill stem from the driving shaft, a sleeve of relatively large diameter in comparison with said portion of the drill stem journaled in said carriage and arranged co-axially with the drill stem, means including a clutch having a portion splined to the driving shaft for driving the sleeve independently of said portion of the drill stem, a chuck operatively connected with said sleeve, a section of casing surrounded by the chuck and locked to the sleeve, a coupling arranged substantially within the sleeve and having threaded engagement with one end of the section of casing, and a tubular thread protector extending into the sleeve and having threaded engagement with said coupling.

21. A machine for making conduits under roadways or the like comprising a primary supporting frame, a secondary frame having one of its end portions pivotally connected to the primary frame for movement about a horizontal axis to permit the other end portion of the secondary frame to be swung upwardly from a substantially horizontal position into an inclined position and vice versa, one of said frames being provided with planar guide means normally substantially horizontally disposed, a carriage swingable with the secondary frame and movable along said guide means, a drill stem movable with the carriage along the guide means and having a bit at its outer end, a casing movable with the carriage along said guide means and surrounding the drill stem, a conveyor positioned between the drill stem and casing, and means for independently rotating the drill stem or casing while they are moving with the carriage along said guide means.

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