

July 7, 1953

J. C. CURTIS ET AL
MOBILE DRILLING APPARATUS

2,644,669

Filed Jan. 20, 1950

4 Sheets-Sheet 1

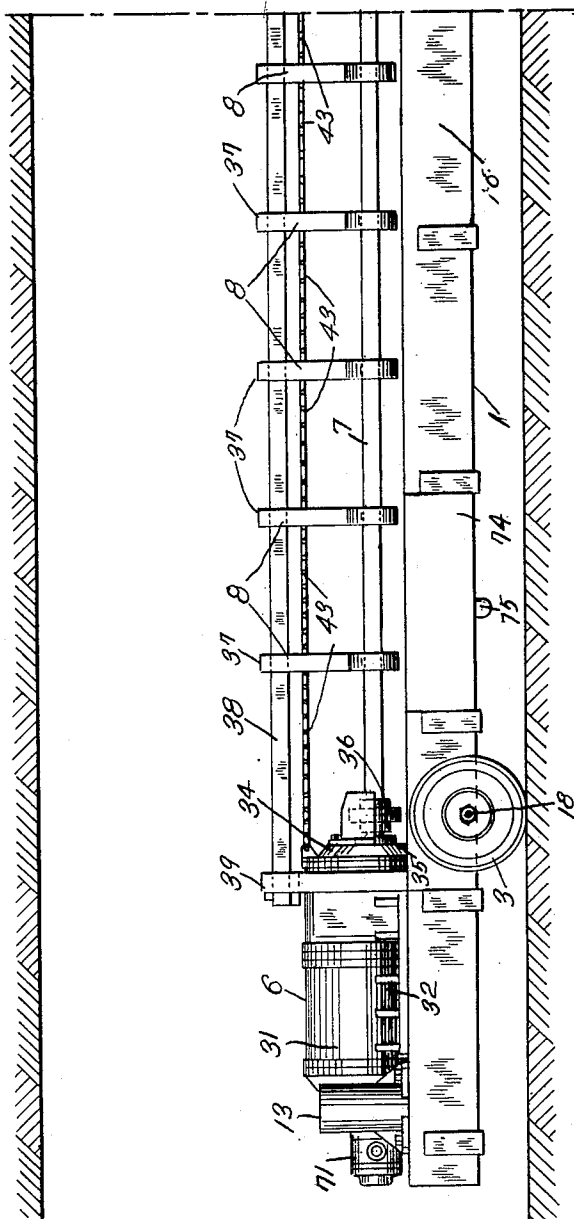


Fig. 1

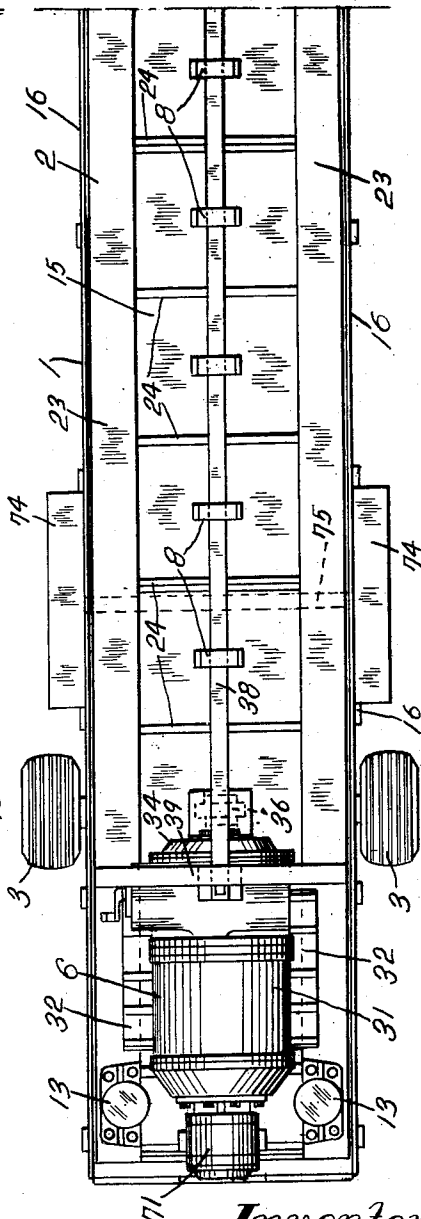


Fig. 2

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4 Sheets-Sheet 2

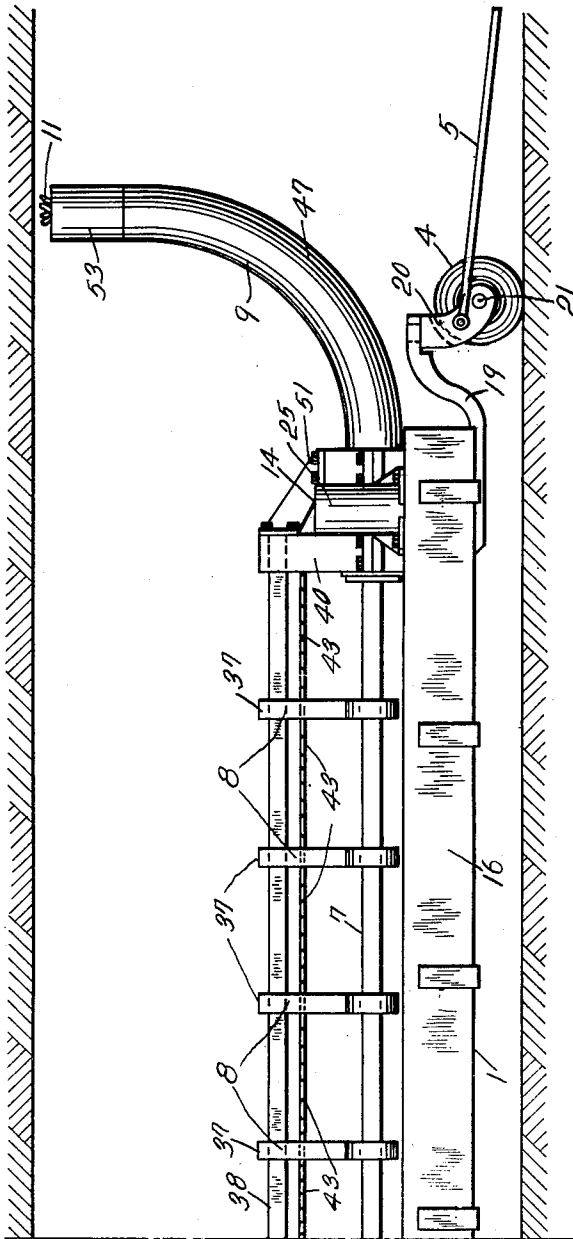


Fig. 1a.

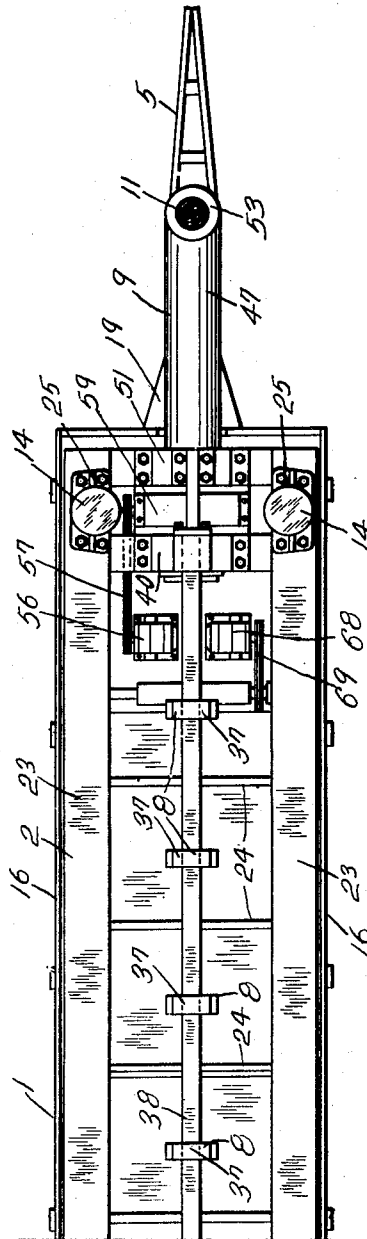


Fig. 2a.

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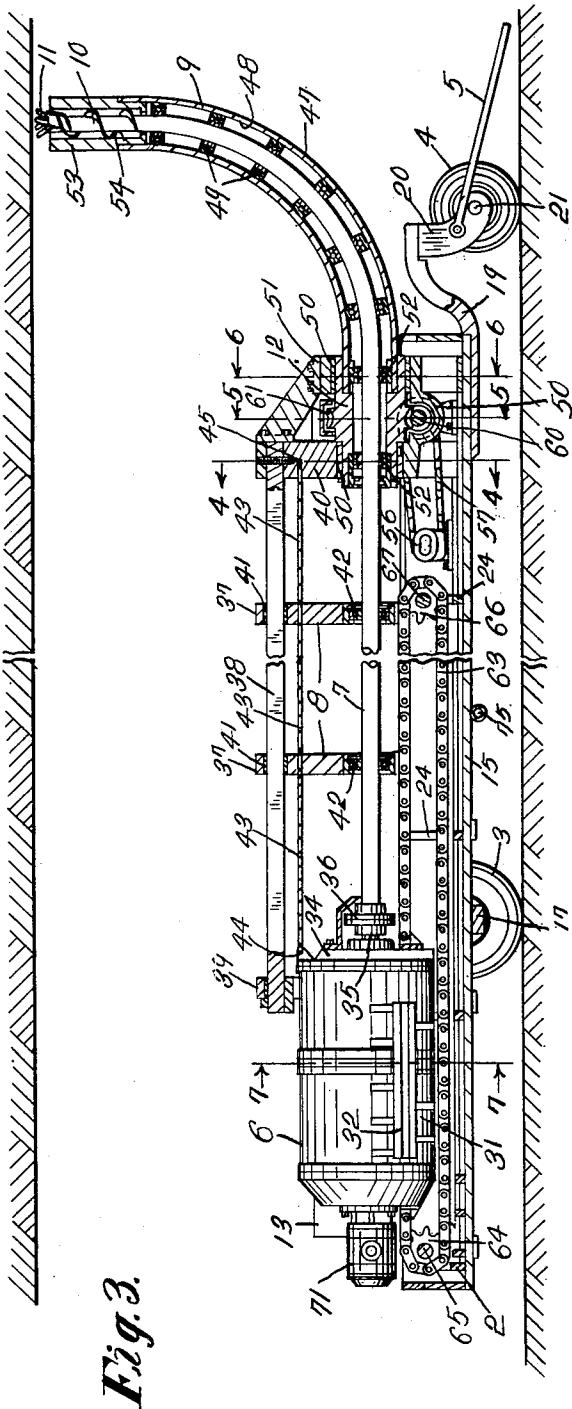


Fig. 3.

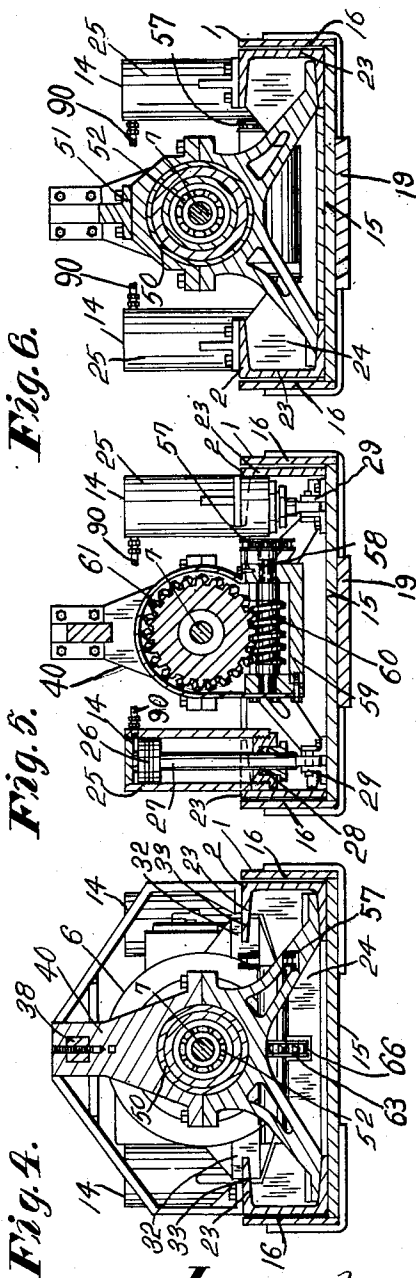


Fig. 6.

Fig. 5.

Fig. 4.

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Fig. 7.

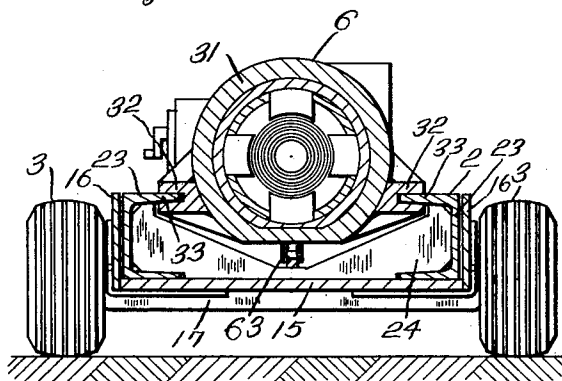


Fig. 8.

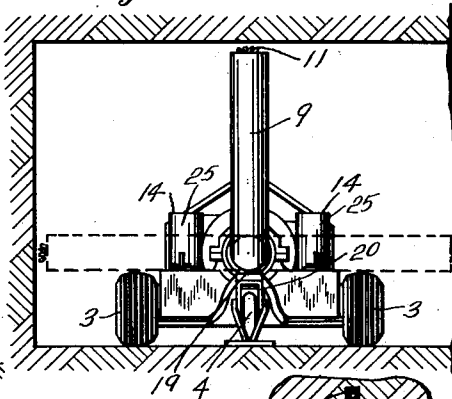


Fig. 9.

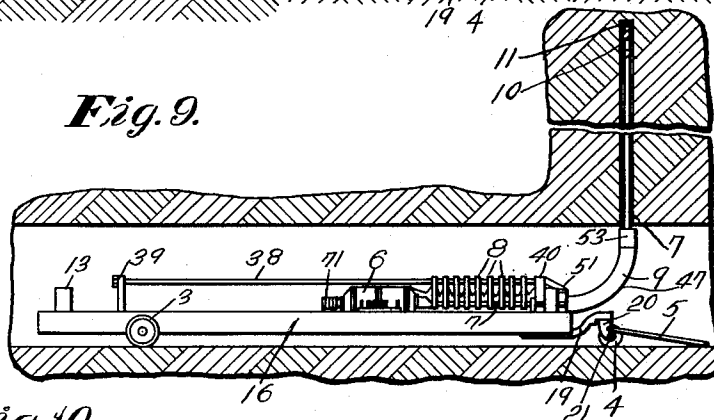


Fig. 10.

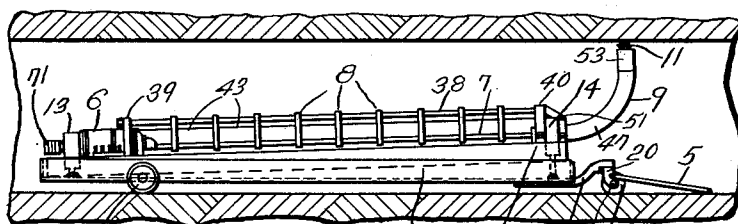
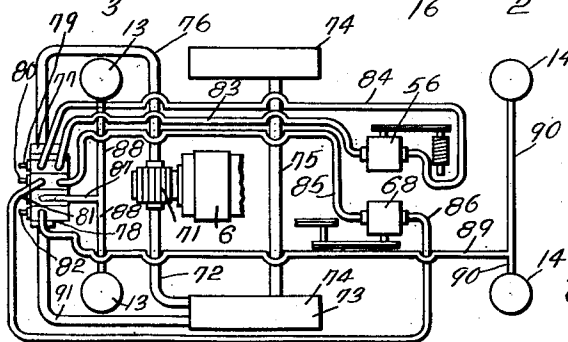


Fig. 11.



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UNITED STATES PATENT OFFICE

2,644,669

MOBILE DRILLING APPARATUS

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Application January 20, 1950, Serial No. 139,611

18 Claims. (Cl. 255—51)

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This invention relates to drilling apparatus and more particularly to a mobile drilling apparatus especially designed for use in drilling upright holes in the roof of an underground mine or tunnel, for receiving anchor bolts for internally supporting the roof.

In underground mines or tunnels it is becoming common practice to drill upright holes in the roof strata for receiving anchor bolts whereby the roof rock may be internally supported without the use of conventional mine timbering. In mines or tunnels where the head room is relatively low it has been found difficult to drill upright holes in the roof of a depth substantially greater than the height of the mine passageway or tunnel with the conventional equipment available. The present invention contemplates improvements over known types of drilling equipment in that with an extremely low compact drill structure, upright holes of substantial depth may be drilled in the roof strata. The drilling apparatus of the present invention embodies a horizontal drill structure having novel guiding and directing means for a flexible driving element for the drill bit whereby the horizontal flexible element may be arcuately deflected to effect drilling of upright holes. By such a construction the upright drill holes may be drilled to a depth substantially greater than the height of the mine passageway or tunnel in which the drilling apparatus is located.

An object of the present invention is to provide an improved drilling apparatus having novel features of construction. Another object is to provide an improved mobile drilling apparatus especially designed for use in drilling upright holes in the roof strata of an underground mine or tunnel. Yet another object is to provide an improved drilling apparatus for drilling upright holes in the roof to a depth substantially greater than the height of the mine passageway or tunnel, with the holes located at strategic points for receiving roof anchor bolts whereby the roof rock may be firmly internally supported without the use of conventional mine timbering. A further object is to provide an improved mobile drilling apparatus of an extremely vertically compact structure and having a relatively long range of feed for the drill bit. A still further object is to provide an improved drilling apparatus embodying a flexible driving element for the drill bit and having novel guiding and deflecting means for the flexible element whereby the latter may be deflected from a horizontal position to a right angle vertical position. Another object is to pro-

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vide an improved drilling apparatus having an adjustable drilling element and improved means for adjusting and directing the drilling element whereby holes may be readily drilled at various angles. Still another object is to provide an improved drilling apparatus having novel features of construction and a novel arrangement of parts. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings:

Figs. 1 and 1a, when taken together, constitute a side elevational view of the improved drilling apparatus.

Figs. 2 and 2a, when taken together, constitute a plan view of the apparatus shown in Figs. 1 and 1a.

Fig. 3 is a central longitudinal vertical section taken through the drilling apparatus, with the intermediate portion of the apparatus broken away to facilitate illustration.

Figs. 4, 5 and 6 are enlarged cross sections taken respectively on lines 4—4, 5—5 and 6—6 of Fig. 3, illustrating structural details.

Fig. 7 is an enlarged cross section taken on line 7—7 of Fig. 3, showing the drill motor structure and its guide frame.

Fig. 8 is a front end view, taken on a reduced scale, of the drilling apparatus, with different angular positions of the drill bit shown in full and dotted lines.

Fig. 9 is a diagrammatic view showing the drilling apparatus in drilling position in a mine passageway or tunnel.

Fig. 10 is a diagrammatic view similar to Fig. 9 showing the drill guide frame in tilted position.

Fig. 11 is a diagrammatic view showing the hydraulic system.

The improved mobile drilling apparatus is of a low compact design especially adapted for use in mines or tunnels having low head room and generally comprises a mobile base 1 carrying a low compact horizontal guide frame 2 and mounted on a pair of rubber-tired rear wheels 3 and a rubber-tired front caster wheel 4, the latter being provided with a tow bar or handle 5. Slidably guided on the horizontal guide frame for longitudinal movement back and forth therealong is a horizontal motor 6, herein desirably an electric motor, which is adapted to drive a flexible drive shaft 7 having its horizontal portion guided by a series of movable

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guide members or "shuttle guides" 8 and at its outer portion passing through an arcuate deflecting guide member or curved deflecting tube 9. The outer end of the drive shaft carries a spirally vaned guide section 10 and a conventional rotary drill bit 11. The arcuate guide tube 9 is carried on a rotatable support 12 which is mounted on the front end of the guide frame to rotate about a horizontal longitudinal axis relative thereto whereby the drill bit 11 may be located in different angular positions. The base carries near its opposite ends pairs of elevating jacks 13 and 14 whereby the guide frame may be elevated and tilted in an endwise direction with respect to the base, for varying the height of the guide frame with respect to the floor surface and for effecting leveling of the guide frame when the base is supported by an uneven or inclined floor surface.

Now referring to the specific structure of the drilling apparatus it will be noted that the base 1 includes a bottom plate 15 and vertical side plates 16, the latter being rigidly secured as by welding to the bottom plate to provide a rigid unitary base structure. Extending horizontally beneath the bottom plate of the base frame near the rear end of the base is a drop axle 17 having axle portions 18 projecting laterally from the sides of the base and on which the rear wheels 3 are journaled. Attached to the bottom plate at the forward end of the base frame is a longitudinal bracket 19 on which a frame 20 is swiveled for rotation about an upright axis and this swivel frame carries a transverse axle 21 on which the front caster wheel 4 is journaled. The tow bar or handle 5 is pivotally connected to the swiveled caster frame. The horizontal guide frame 2 includes parallel side channel frame elements 23 suitably rigidly connected by cross frame sections 24, and the guide frame parts are rigidly secured together as by welding to provide a rigid unitary structure.

The front and rear jacks 13 and 14 are of the hydraulic type and include upright cylinders 25 rigidly secured to the side channel frames 23 and containing pistons 26 having their piston rods 27 extending downwardly through the packed bottom heads 28 of the cylinders. These piston rods are pivotally connected at their lower ends at 29 to the bottom plate 15 of the base frame to swing in longitudinal vertical planes about transverse axes. When liquid under pressure is suitably supplied to the jack cylinders the guide frame 2 may be elevated into different parallel horizontal positions with respect to the base and may be tilted in an endwise direction with respect to the horizontal as desired. By trapping liquid in the jack cylinders the guide frame may be firmly locked in adjusted position.

The motor 6 has a horizontal casing 31 provided with lateral guide portions 32 having guideways for slidably receiving the upper guide flanges 33 of the side channels 23 of the guide frame. Thus, the motor may slide back and forth longitudinally of the guide frame. The front head 34 of the motor may contain a conventional speed changing gearing whereby drive may be effected at different speeds, and the terminal drive shaft 35 is connected by a coupling 36 to the flexible drive shaft 7 which may be in the form of a wire rope, or any other suitable construction which is capable of limited bending without detrimental distortion. The horizontal rearward portion of the flexible drive shaft extends lengthwise of the guide frame and

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is guided by the movable guide members 8, and the latter includes vertically disposed sliding frames or supports 37 guided for movement longitudinally of the guide frame along a horizontal guide bar 38 arranged parallel with and above the guide frame as clearly shown in Fig. 3. This guide bar is supported at its rear end in a cross support 39 mounted at the top of the guide frame and at its front end within the top of a vertical support 40 carried by the guide frame. This guide bar is desirably square in cross section and the sliding supports have square openings for receiving bearing elements 41 for slidably engaging the guide bar. These sliding supports also carry anti-friction bearings 42 in which the horizontal portion of the flexible drive shaft is journaled and within which the drive shaft has axial sliding movement, as later explained. The sliding bearing supports 37 are connected together by flexible chain or cable sections 43 which are attached at 44 rearwardly of the guides to the front motor head and at 45 forwardly of the guides to the upright support 40. These chain sections extend between and are connected to the guide members so that when the drilling motor is fed forwardly along the guide frame the guide members are free to move together and when the drilling motor is retracted along the guide frame the guide members are moved apart a predetermined distance by the chain sections. Thus, as the motor 6 slides forwardly along the guide frame it effects progressive movement of the bearing supports forwardly along the guide bar, and when the motor is in its foremost position the guide supports are collapsed with the cable sections folded together as shown in Fig. 9, and when the motor is retracted the connecting chain sections effect spreading of the guide supports apart into a predetermined spaced relation as shown in Figs. 1 and 1a. Thus, a sliding, collapsible bearing mounting structure is provided for the horizontal portion of the flexible drive shaft 7.

The curved guide 9 has a curved tubular section 47 having a bore 48 in which a series of anti-friction bearings 49 are arranged and the flexible drive shaft 7 extends through the tube section and is rotatably and slidably mounted within these bearings. The tube section at its rear end is secured to the rotatable support 12 and the latter is suitably journaled within bearings 50 supported within the vertical support 40 and a forwardly located bearing bracket 51. The rotatable support 12 has mounted therein an anti-friction bearing 52 and the horizontal portion of the flexible drive shaft is journaled and slidably mounted within this bearing as it extends from the shuttle guides into the rotatable support as shown in Fig. 3. Secured within the outer end of the curved tube section 47 is a cylindrical guide member 53 having a bore 54 for receiving the spirally vaned guide section 10 when the drill bit is in retracted position. The spiral vanes of this guide section are adapted to engage the bore walls and serve to guide the drill bit during starting of a hole and also, to some extent, function to convey the cuttings from the hole in certain positions of the drill bit.

The rotatable tube supporting frame 12 may be rotated in its bearing mounting to change the angular position of the guide tube by means of a conventional reversible hydraulic motor 56 mounted on the guide frame 2 and the motor power shaft is connected through a chain and sprocket drive 57 to a transverse horizontal

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shaft 58 suitably journaled within a gear housing 59 supported by the guide frame between the rear support 40 and the front bearing bracket 51. Fixed to the shaft 58 is a worm 60 meshing with a worm wheel 61 secured to the rotatable tube support 12. Thus, when liquid under pressure is suitably supplied to the motor 56 the frame 12 may be rotated to change the angular position of the guide tube. The drilling motor 6 may be slid back and forth along the guides of the guide frame 2 by means of a feed chain 63 having its ends attached to the opposite ends of the motor casing 31 and passing around a guide sprocket 64 fixed to a horizontal transverse shaft 65 suitably journaled at the rear end of the guide frame. The chain extends longitudinally of the guide frame and passes around a front drive sprocket 66 fixed to a horizontal transverse shaft 67 likewise suitably journaled on the guide frame. A conventional reversible hydraulic motor 68 is connected by a chain and sprocket drive 69 to the shaft 67. Thus, by suitably operating the motor 68 the feed chain 63 may be actuated to effect feeding of the drilling motor 6, together with the flexible drive shaft, in a direction longitudinally of the guide frame thereby to feed the drill bit 11 toward or from the work.

Now referring to the hydraulic system shown in Fig. 11 it will be observed that driven by the motor 6 and mounted at the rear end of the motor casing 31 (See also Fig. 3) is a hydraulic pump 71 having its suction side connected by a conduit 72 to a liquid reservoir 73. This reservoir consists of a pair of tanks 74 mounted at the sides of the base frame and connected together by a cross pipe 75. The pressure side of the pump is connected by conduit 76 to the pressure passage of a conventional slide valve mechanism 77. This valve mechanism includes a valve box 78 having parallel horizontal bores for respectively receiving slide valves 79, 80, 81 and 82 of the balanced spool type, having suitable operating handles. The bore containing the slide valve 79 is connected by conduits 83 and 84 to the reversible motor 56 for rotating the guide tube 9 about the longitudinal axis of the rotatable support 12, and the bore containing the slide valve 80 is connected by conduits 85 and 86 to the reversible feed motor 68. The bore containing the slide valve 81 is connected by a conduit 87 and branch conduits 88 to the rear elevating jacks 13 while the bore containing the slide valve 82 is conducted by conduit 89 and branch conduits 90 to the front jacks 14. The discharge passage of the valve box is connected by a conduit 91 back to the reservoir.

The general mode of use of the improved drilling apparatus is as follows: The apparatus may be hauled or towed about the mine or tunnel in any suitable manner and when the apparatus is suitably positioned in the mine passageway or tunnel as shown in Fig. 8 and it is desired to drill an upright hole in the overlying roof strata, the guide tube 9 may be located in a vertical position as shown. The drilling motor 6 may then be started to effect rotation of the drill bit 11 through the flexible drive shaft 7, and the slide valve 80 may then be positioned to supply liquid under pressure to the feed motor 68 to effect feed of the drilling motor 6 forwardly along the guide frame thereby to move the flexible drive shaft 7 axially to feed the drill bit toward the work to effect drilling of a vertical hole. The spirally vaned guide 10 serves to guide the

drill bit during starting of the hole and as the drill bit is fed forwardly the guide 10 leaves the guide tube 53 and enters the hole formed by the drill bit. The sliding bearing supports or "shuttle guides" 8 serve to guide the horizontal portion of the flexible drive shaft and as the drilling motor 6 is fed forwardly the guides 8 move together so that when the drilling motor is fully advanced the guides are collapsed as shown in Fig. 9. When the hole is completed the feed motor 68 may be reversed under the control of the slide valve 80 thereby to move the drilling motor rearwardly along the guide frame to retract the drill bit from the hole, and as the motor moves rearwardly the guide supports 8 move apart by means of the chain sections 43 into the predetermined spaced relation shown in Fig. 10. When desired the motor 56 may be operated under the control of the slide valve 79 to rotate the tube frame 12 to locate the guide tube 9 into different angular positions inclined with respect to the vertical. A range of lateral swing of the guiding tube of substantially 180° is provided as shown in Fig. 8. It is therefore possible to drill holes at different inclinations in the roof strata and to drill horizontal or inclined holes in the side walls or ribs as may be desired. When the drilling apparatus is supported on the uneven or inclined floor surface the slide valves 81 and 82 may be suitably positioned to effect supply of liquid under pressure to the jacks 13 and 14 to effect leveling of the guide frame and under certain conditions the jacks may be concurrently operated to elevate the guide frame into different parallel positions with respect to the base. Thus, the guide tube 9 may be tilted in longitudinal planes as well as in transverse planes to vary the location of the drill bit. Due to the location of the caster wheel 4 directly beneath the guide tube 9 it is possible to locate the drill bit close to the face and to the ribs and in the corners. When the drilling of the holes is completed an adaptor may be substituted for the drill bit 11, and, when the drive shaft 7 is rotating at a relatively low speed, the adaptor may engage the nuts of the roof bolts, to effect tightening of the latter in the holes, in a well-known manner.

As a result of this invention an improved mobile drilling apparatus is provided whereby holes may be drilled at various locations in a mine passageway or tunnel and the apparatus of the present invention is especially adapted to drill upright holes in the roof strata for the reception of roof supporting anchors. By the provision of the novel guiding means and the flexible drive shaft arrangement upright holes may be drilled in the roof to a depth substantially greater than the height of the mine passageway or tunnel. The drilling apparatus due to its mobile mounting and its vertically compact structure may be readily transported from place to place through the relatively restricted passageways of an underground mine or tunnel. Other uses and advantages of the invention will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent is:

1. In a drilling apparatus for drilling holes in the roof, floor or sidewalls of a subterranean passageway, a mobile base movable over the floor, a horizontal guide frame carried by said base, fluid operated jack means arranged between said guide frame and said base for elevating and tilting said guide frame with respect to the floor surface, a drilling motor mounted on said guide frame for movement back and forth therealong, fluid operated means for moving said motor along said guide frame, a flexible shaft movable axially with and driven by said motor for rotating a drill bit, guiding means for said shaft as the latter moves axially including a curved front guide tube mounted on the forward end of said guide frame and through which said shaft extends for deflecting the outer portion of said shaft in a lateral direction, means for mounting said guide tube for rotation about a longitudinal axis relative to said guide frame to change the angular position of said drill bit, and fluid operated means for rotating said guide tube on its mounting.

2. In a drilling apparatus for drilling holes in the roof, floor or sidewalls of a subterranean passageway, a mobile base movable over the floor, a horizontal guide frame carried by said base, fluid operated jack means arranged between said guide frame and said base for elevating and tilting said guide frame with respect to the floor surface, a drilling motor mounted on said guide frame for movement back and forth therealong, fluid operated means for moving said motor along said guide frame, a flexible shaft movable axially with and driven by said motor for rotating a drill bit, guiding means for said shaft as the latter moves axially including a curved front guide tube mounted on the forward portion of said guide frame and through which said shaft extends for deflecting the outer portion of said shaft in a lateral direction, means for mounting said guide tube for rotation about a longitudinal axis relative to said guide frame, fluid operated means for rotating said guide tube on its mounting to change the angular position of said drill bit, and a pump driven by said motor for supplying fluid under pressure to said several fluid operated means.

3. In a drilling apparatus, a base, a horizontal guide frame carried by said base, a drilling tool guided on said frame for movement back and forth therealong and having an axially movable flexible drive shaft for a drill bit, guiding means for said flexible shaft for guiding the latter as it moves axially including a guide bar arranged parallel with said guide frame, a series of aligned relatively movable guide members mounted for movement along said guide bar and each carrying a bearing in which said shaft is journaled and is axially slidable, and a curved front guide mounted on the front end of said guide frame and through which said flexible shaft extends for deflecting the outer portion of said shaft in a lateral right angle direction with respect to the path of movement of said drilling tool along said guide frame.

4. In a drilling apparatus, a frame, motor operated drilling means including a flexible drive shaft for rotating the drill bit, said shaft having a horizontal portion extending lengthwise of said frame, means for rotating and axially moving said drive shaft relative to said frame, guiding means on said frame for guiding said hori-

zontal shaft portion and including spaced bearing supports, means for guiding said supports for relative movement into close adjacency and means including flexible elements for flexibly connecting said supports together whereby when said shaft is moved forwardly in an axial direction said flexible elements permit said bearing supports to approach one another and when said shaft is axially retracted said flexible elements cause said bearing supports to move apart a predetermined distance, a curved guide mounted at one end of said frame and with which said shaft engages for deflecting the outer portion of said shaft to locate the drill bit in a right angle position with respect to said horizontal shaft portion, and spaced guiding means carried by said curved guide and engaging the deflected outer portion of said shaft at longitudinally spaced points, and said deflected shaft portion having axial sliding movement with respect to said spaced guiding means.

5. In a mobile drilling apparatus for drilling holes in a bounding surface of a horizontal tunnel or other subterranean passageway comprising, in combination, a mobile support adapted to travel over the floor and having an elongated horizontal frame disposable in different positions generally lengthwise of the tunnel or passageway, an elongated horizontal guide frame overlying said support and extending lengthwise of said support frame along a substantial portion of the length of the latter, a drilling tool mounted on said guide frame for movement longitudinally therealong and including a rearward motor and a forwardly extending flexible drive shaft movable axially with and driven by said motor and carrying a drill bit at its outer end, a front curved guide mounted at the forward end of said guide frame and through which said flexible drive shaft passes for deflecting said shaft laterally to locate the bit axis at substantially right angles to the longitudinal axis of said guide frame, collapsible guiding means carried by said guide frame and engaging said flexible shaft along its longitudinal straight portion intermediate said motor and said front curved guide and collapsible as said motor is advanced along said guide frame during feeding of the drill bit toward the work, and means for feeding said motor forwardly along said guide frame.

6. A drilling apparatus as set forth in claim 5, wherein said collapsible guiding means comprises a series of aligned relatively movable guide members having bearing means engaging said flexible shaft at longitudinally spaced points along said straight shaft portion and a longitudinal guide bar carried by said guide frame and along which said guide members are movable for guiding said guide members during movement of the latter toward their collapsed positions.

7. A drilling apparatus as set forth in claim 6, wherein means connected to said guide members is provided for moving the latter into spaced apart relation when said drilling motor is retracted, said connecting means being flexible and folding up between said guide members as the latter are moved into collapsed relation as said motor is fed forwardly into its forward position on said guide frame.

8. A drilling apparatus as set forth in claim 5, wherein vertical jack means are provided for elevating and tilting said guide frame relative to said mobile support.

9. In a drilling apparatus, a mobile base movable over the floor of a mine passageway, a lon-

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gitudinally extending horizontal guide frame carried by said mobile base, a motor guided on said frame for longitudinal movement back and forth therealong, a flexible drive shaft movable axially with and driven by said motor for rotating a drill bit, guiding means including guiding elements carried by said guide frame for guiding said flexible drive shaft as the latter moves axially with said motor, said guiding means also including a curved front guide tube mounted at the forward end of said base and guide frame and through which said drive shaft extends for deflecting the latter in a direction at a substantial angle outwardly beyond the lateral boundaries of said base and guide frame toward the surface to be drilled, and means comprising a rotatable support for mounting said guide tube for adjustment about a horizontal axis relative to said guide frame to change the angular relation of said tube relative to said base thereby to vary the drilling position of said drill bit.

10. In a drilling apparatus, a portable base movable over the ground, a guide frame arranged in a horizontal position on said base and extending lengthwise of the latter, a motor guided on said frame for movement back and forth therealong, means for feeding said motor along said guide frame, a flexible drive shaft movable axially with and driven by said motor for rotating a drill bit, and guiding means for said drive shaft as the latter moves axially including a series of relatively movable guide members arranged in alignment and engaging said shaft at longitudinally spaced points, means for mounting said guide members for bodily and relative movements longitudinally of said guide frame whereby said guide members may move toward one another as said motor is advanced toward its foremost position on said frame and may move apart as said motor is retracted, and means connected to said guide members for limiting the movement apart of said members.

11. In a drilling apparatus, a portable base movable over the ground, a guide frame arranged in a horizontal position on said base and extending lengthwise of the latter, a motor guided on said frame for movement back and forth therealong, means for feeding said motor along said guide frame, a flexible drive shaft movable axially with and driven by said motor for rotating a drill bit, and guiding means for said drive shaft as the latter moves axially including a series of relatively movable aligned guide members engaging said shaft at longitudinally spaced points, means for mounting said guide members for bodily and relative movements longitudinally of said guide frame whereby said guide members may move toward one another as said motor is advanced toward its foremost position on said frame and may move apart as said motor is retracted, each of said guide members carrying a bearing in which said shaft is journaled and relative to which said shaft has axial sliding movement as said motor is fed, and means connected to said guide members for limiting their movement apart during retraction of said motor.

12. In a drilling apparatus, a portable base movable over the ground, a horizontal guide frame carried by said base, a drilling tool guided on said frame for movement back and forth therealong and having an axially movable flexible drive shaft for a drill bit, means for feeding said tool back and forth along said guide frame, guiding means for said flexible shaft for guiding the latter as it moves axially including a guide bar

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arranged parallel with said guide frame, a series of aligned guide members mounted for relative movement toward and from one another and for bodily longitudinal movement along said guide frame and each carrying a bearing in which said shaft is journaled and is axially slidable, said guide members moving toward one another as said tool is advanced toward its foremost position and moving apart as said tool is retracted, and connecting means extending between and connected to said guide members for limiting their movement apart during retraction of said tool.

13. In a self-contained, unitary drilling apparatus for drilling upright holes in the roof of an underground passageway comprising a mobile base movable over the floor of the passageway, a horizontal guide frame carried by said base, motor operated drilling means guided on said guide frame for movement therealong and including an axially movable flexible shaft for rotating a drill bit, said shaft having a horizontal rearward portion extending lengthwise of said guide frame when said drilling means is in retracted position, guiding means for said shaft for guiding the latter as it moves axially including a curved front guide tube mounted at the front end of said base and guide frame and through which said shaft extends, said tube at its outer portion extending vertically above said base and frame toward the roof surface for deflecting the outer portion of said shaft in a right angle vertical direction toward said roof, and means for mounting said guide tube for adjustment about a horizontal axis relative to said guide frame whereby said tube may be adjusted into different angular positions inclined with respect to the vertical to change the angular relation of said tube relative to said base to vary the drilling position of said drill bit with respect to said base.

14. In a drilling apparatus adapted to travel over the ground, a horizontal guide frame, a motor mounted on said guide frame for movement therealong, means for feeding said motor back and forth along said guide frame, a flexible drive shaft driven by said motor for rotating a drill bit, a series of relatively movable aligned guide members separately mounted for movement longitudinally of said guide frame for guiding the horizontal rearward portion of said shaft as the latter moves axially, said guide members moving toward one another as said motor is advanced toward its foremost position and moving apart as said motor is retracted, means connected between said guide members for limiting their movement apart during retraction of said motor, and a curved front deflector tube mounted at the front end of said guide frame and through which said shaft passes for deflecting the outer portion of said shaft, said tube projecting outwardly beyond the lateral boundaries of said base and guide frame, to locate said bit in a right angle position with respect to said horizontal rearward shaft portion and to direct the bit toward the surface to be drilled.

15. A drilling apparatus adapted to travel over the ground, a horizontal guide frame, a motor mounted on said guide frame for movement therealong, means for feeding said motor back and forth along said guide frame, a flexible drive shaft driven by said motor for rotating a drill bit, a series of relatively movable aligned guide members separately mounted for movement longitudinally of said guide frame for guiding the horizontal rearward portion of said shaft, as the latter moves axially, said guide members

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moving toward one another as said motor is advanced toward its foremost position and moving apart as said motor is retracted, means connected between said guide members for limiting their movement apart during retraction of said motor, a curved deflector tube mounted at the front end of said guide frame and through which said shaft passes, said tube projecting outwardly beyond the lateral boundaries of said base and guide frame for deflecting the outer portion of said shaft into a right angle position with respect to said horizontal rearward shaft portion and for directing said drill bit toward the surface to be drilled, and a guide rotatable with said drill bit and engaging the bore of the outer portion of said deflector tube for guiding the drill bit during starting of a hole, said guide moving out of said tube-bore as said drill bit is advanced toward the work during drilling.

16. In a drilling apparatus adapted to travel over the ground, a horizontal guide frame, a motor mounted on said guide frame for movement therealong, means for feeding said motor along said guide frame, a flexible drive shaft driven by said motor for rotating a drill bit, a series of relatively movable aligned guide members separately mounted for movement longitudinally of said guide frame for guiding the horizontal rearward portion of said shaft, said guide members moving toward one another as said motor is fed forwardly and moving apart when said motor is retracted, means connected between said guide members for limiting their movement apart during retraction of said motor, a curved front deflector tube mounted at the front end of said guide frame and through which said shaft passes for deflecting the outer portion of said shaft into a right angle position with respect to said horizontal rearward shaft portion, and a guide rotatable with said drill bit rearwardly of and in adjacency to the latter and engaging the bore of the outer portion of said deflector tube for guiding the drill bit during starting of a hole and movable out of said bore as the bit is advanced, said rotatable guide having spiral vanes which serve as guides when located in said guide-bore and which act as a screw conveyor when displaced from said bore for moving the cuttings outwardly from the drill hole in certain positions of the drill bit.

17. In a drilling apparatus, a mobile base, a horizontal guide frame carried by said base, a drilling tool guided on said frame for movement therealong and including a motor driven flexible drive shaft for a rotary drill bit, guiding means for the horizontal rearward portion of said flexible shaft including a series of relatively movable guide members in which said shaft is journaled, guiding means for said guide members whereby the latter may move relative to said frame and

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flexible elements for connecting said guide members together and for limiting their movement apart, said flexible elements folding up to permit movement of said guide members close together with respect to said guiding means as said drilling tool is moved forwardly along said guide frame and said flexible elements effecting movement of said guide members apart with respect to said guiding means when said tool is moved rearwardly along said guide frame, and a curved guide element carried at the front end of said guide frame and within which said flexible shaft extends, said guide element projecting outwardly beyond the lateral boundaries of said base and frame for deflecting the outer portion of said shaft into an angular position with respect to the rearward portion of said shaft, said guide members and said curved guide element carrying bearings for slidably receiving said shaft and in which said shaft is journaled.

18. In a unitary, mobile drilling apparatus for drilling holes in a bounding surface of a subterranean passageway, a mobile base adapted to travel over the floor of the passageway, a motor mounted on said base, a flexible drive shaft driven by said motor and when retracted having its major portion extending horizontally lengthwise of said base, a drilling bit secured to the outer end of said shaft and driven thereby, front curved guiding means mounted at the front end of said base and projecting outwardly beyond the lateral boundaries of said base, said guiding means engaging said flexible drive shaft for laterally deflecting the outer portion of said shaft to locate said drill bit in an angular position with respect to the rearward horizontal portion of said shaft, and means for varying the inclination of the outer portion of said curved guiding means relative to said base to locate the bit axis in different angular positions with respect to the vertical.

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