

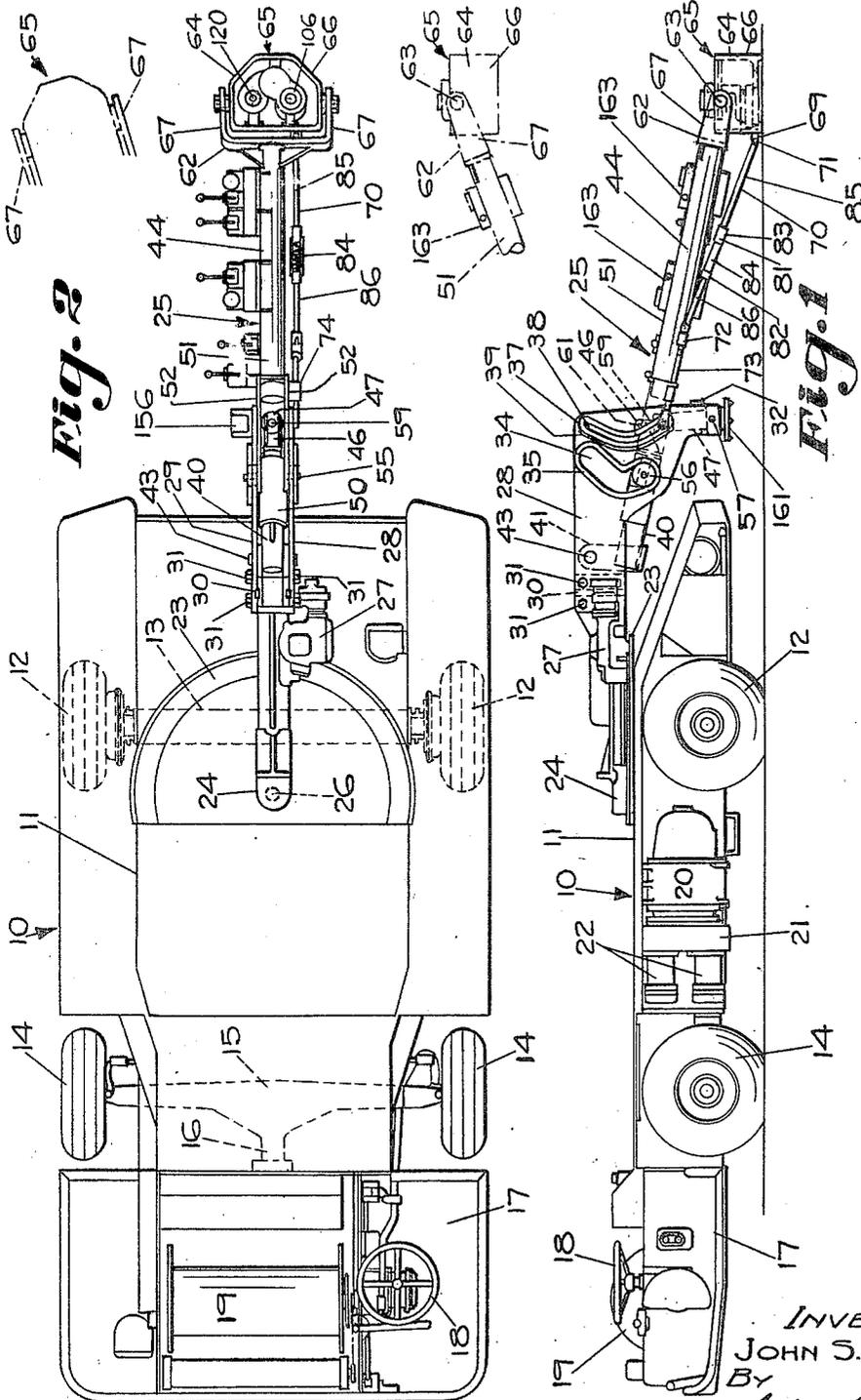
Dec. 3, 1957

J. S. BELTZ  
APPARATUS FOR CARRYING A DRILLING MECHANISM  
ALONG A DESIRED PATH

2,815,191

Filed May 10, 1950

6 Sheets-Sheet 1



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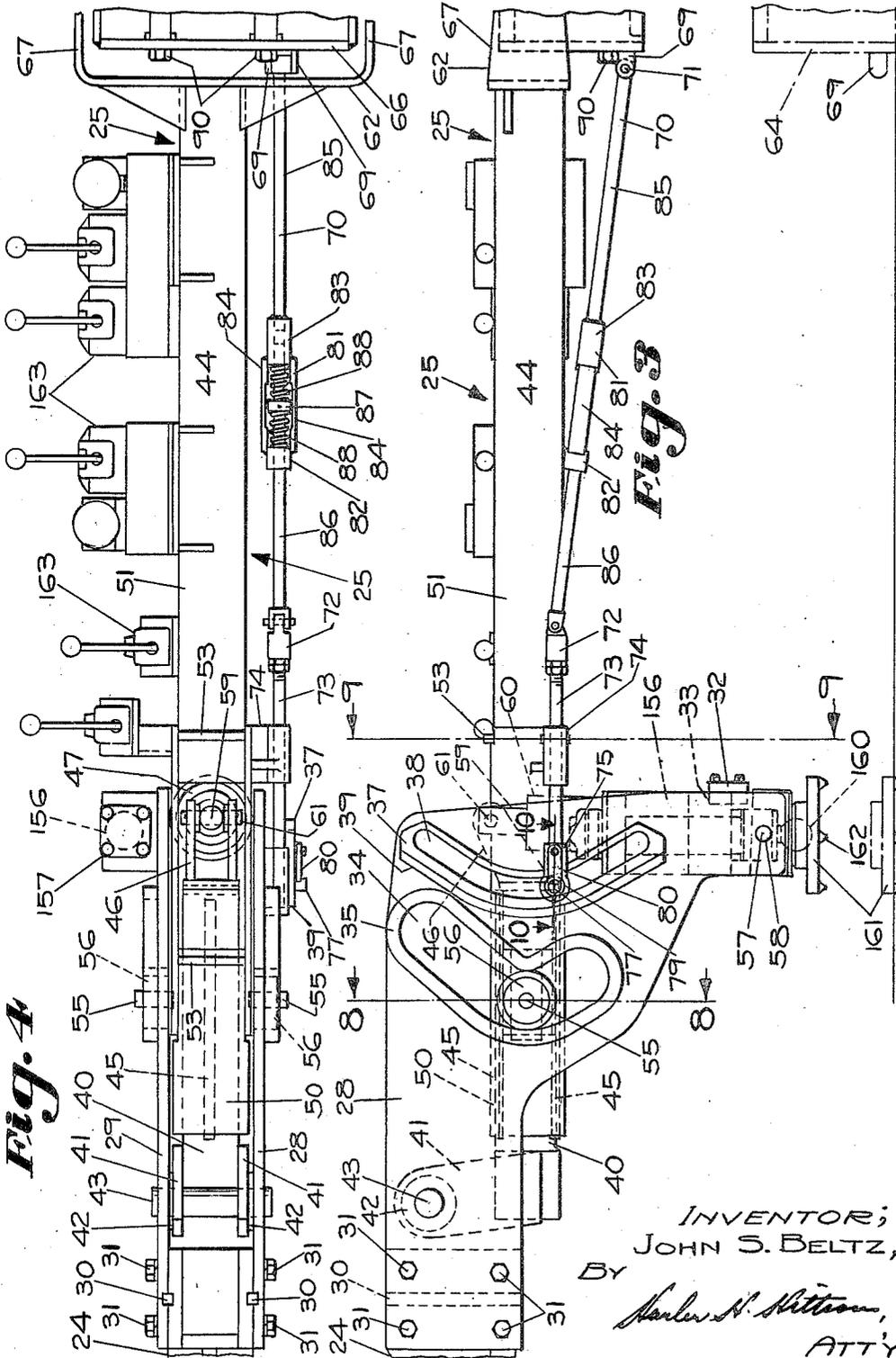


Fig. 4

Fig. 3

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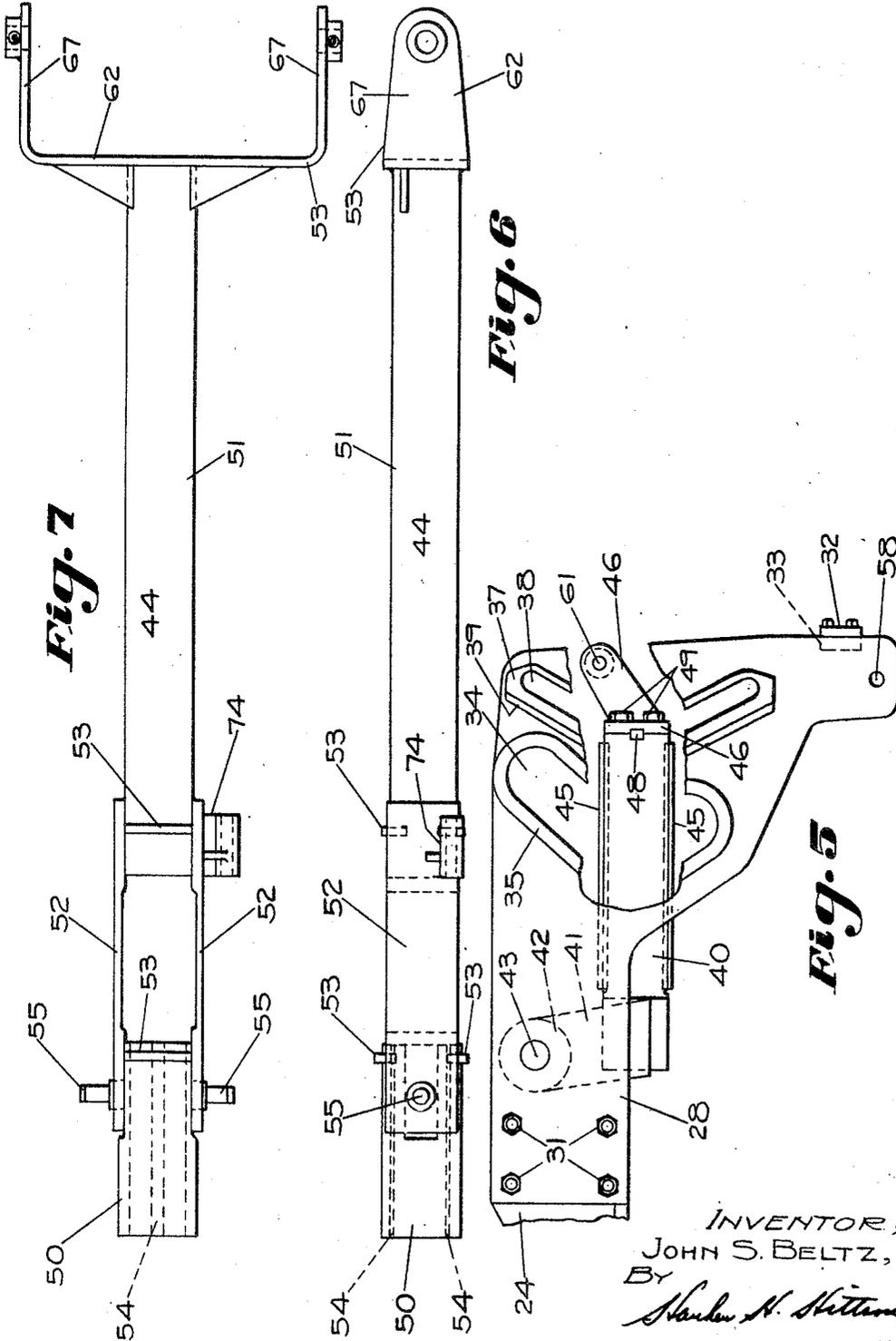
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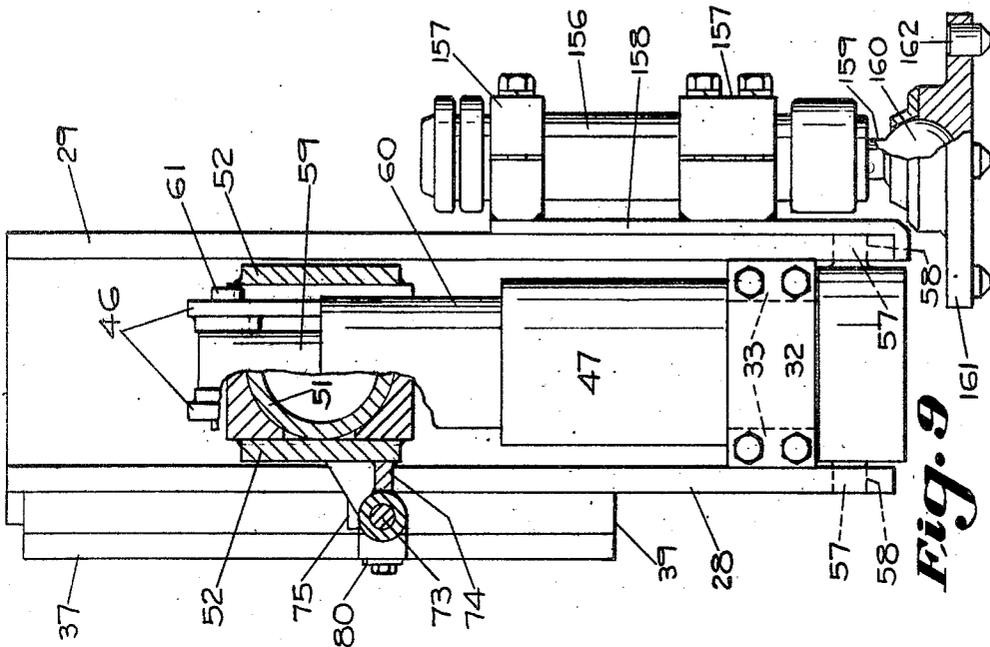
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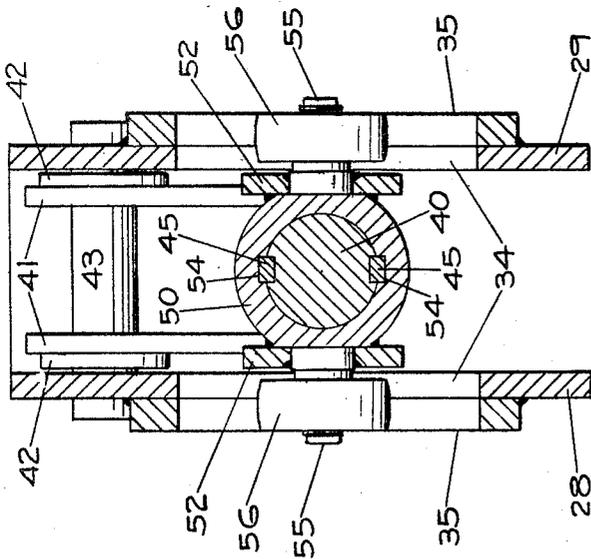
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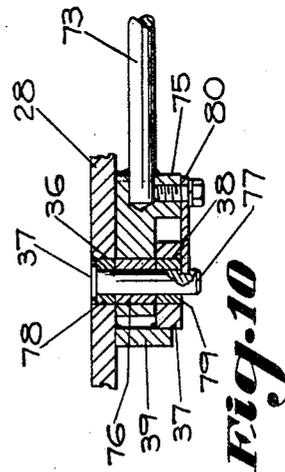
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*Fig. 9*



*Fig. 8*



*Fig. 10*

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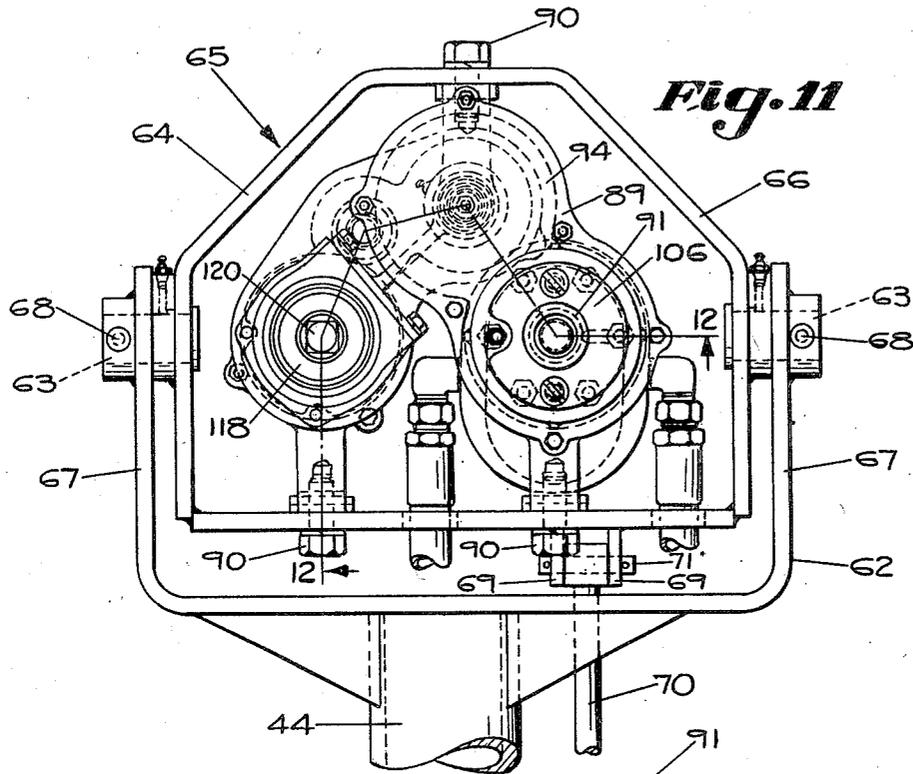
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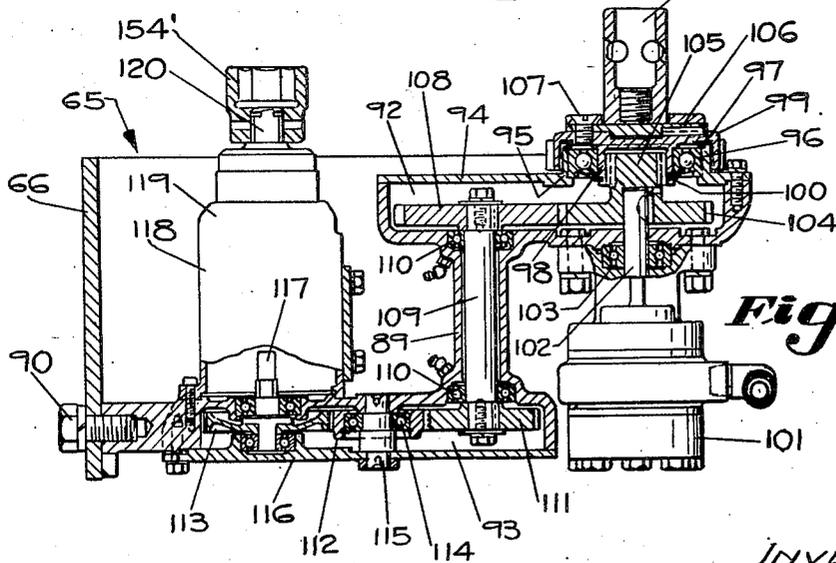
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*Fig. 11*



*Fig. 12*

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2,815,191

## APPARATUS FOR CARRYING A DRILLING MECHANISM ALONG A DESIRED PATH

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Application May 10, 1950, Serial No. 161,047

6 Claims. (Cl. 255—51)

This invention relates to apparatus for carrying a drilling mechanism along a desired path which is preferably, but not necessarily, a straight line path, while the mechanism is performing a drilling operation.

One object of the invention is to provide an improved apparatus of the type above set forth.

Another object of the invention is to provide improved apparatus of the type above set forth, in which a drilling mechanism is carried upon a swingable boom and said boom is caused to expand and contract or retract as it is swung to carry or move the drilling mechanism preferably, but not necessarily, along a straight line path.

In carrying out the foregoing object, it is another object of the invention to provide in the improved apparatus mechanism by which the boom may also be swung about axes lying substantially at right angles with respect to each other.

Another object of the invention is to provide an improved mining apparatus which is preferably, but not necessarily, in the form of a truck that carries a drill or drilling mechanism, and is capable of feeding the drill bit along a fixed rectilinear path by simultaneously swinging and rectilinearly feeding the drill or drilling mechanism.

Still another object of the invention is to provide improved apparatus as set forth in the foregoing object, wherein the drilling mechanism includes both a drill or drilling device and a torque wrench, the latter being adapted to drive threaded bars, rods or screws into openings formed by the drill or drilling device in a mine room roof or ceiling.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings:

Fig. 1 is a side view in elevation of a mining apparatus including a truck that embodies the features of the invention;

Fig. 2 is a view in plan of the apparatus seen in Fig. 1;

Fig. 3 is a view on a larger scale of a portion of the boom apparatus and associated mechanism of the apparatus seen in Fig. 1;

Fig. 4 is a view in plan of the mechanism seen in Fig. 3;

Fig. 5 is a side view in elevation, with a portion broken away, of a frame and an associated stub shaft that form parts of the boom mechanism of the apparatus;

Figs. 6 and 7 are a side elevational and a plan view, respectively, of another portion of the boom mechanism of the apparatus;

Figs. 8, 9 and 10 are sectional views, the views being taken substantially on lines 8—8, 9—9 and 10—10, respectively, of Fig. 3;

Fig. 11 is a view in plan of a drilling device and torque wrench unit carried by the machine as shown in Figs. 1 and 2;

Fig. 12 is a view in section, the section being taken on line 12—12 of Fig. 11;

Fig. 13 is a view in plan of a modified form of drilling device and torque wrench unit; and

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Fig. 14 is a view in section, the section being taken substantially on line 14—14 of Fig. 13.

In mining operations it is customary generally to provide in the mine rooms, passageways, etc., timbering or other structure for supporting the mine roof or ceiling to prevent it or a portion of it from falling. The installation of this timbering or other roof supporting structure which is costly and time consuming, is now being superseded by drilling long bores of relatively small diameter upwardly into the mine roof or ceiling and then by inserting in these bores long threaded bars, rods or screws that function to tie the lower strata of rock, shale, coal or other material immediately adjacent the top of the mine room or passage to the rock stratum thereabove, thereby preventing the lower strata from breaking and falling into the mine.

The apparatus shown in the drawings was particularly devised for drilling the aforementioned holes or bores in the mine roof or ceiling and then for screwing or driving the aforementioned along bars, rods or screws into the previously drilled holes. This apparatus includes a truck 10 having a main frame or body 11. Truck 10 is provided adjacent its front end with a pair of traction wheels 12 carried upon the ends of an axle 13. Adjacent its rear end the truck 10 is provided with a pair of steering wheels 14 carried upon the ends of an axle 15 that is pivotally mounted at 16 to main frame 11.

At one side of the truck 10 and rearwardly of the rear axle 15 and one of the wheels 14 there is an operator's platform or station 17 at which is positioned a steering wheel 18 and other control mechanisms, by which an operator may control the operation of the truck 10. It may be mentioned that the operator may seat himself upon platform 17 so that he may face in that direction in which he desires to drive the truck 10. Adjacent the operator's platform 17 there is a cable reel mechanism 19 that carries an electric cable, not shown, through which electric current is supplied to the electrical apparatus of the truck.

Truck 10 also includes a main electric motor 20 at one side of the main frame 11 and between one of the wheels 12 and 14. Electric motor 20 drives through reduction gearing contained in a housing 21 a pair of hydraulic pumps 22. Pumps 22 are the main hydraulic pumps of the apparatus and are employed to drive the traction wheels, etc., of the truck, as well as to operate other hydraulic motors hereinafter described.

Adjacent its front end the main frame 11 of truck 10 carries and preferably includes a turntable or platform 23 that supports the rear end member or frame 24 of an expansible and contractable or retractable boom assembly 25. Boom assembly 25 is carried in cantilever in a conventional manner upon the platform 23 by the rear end frame member 24 thereof which is pivoted at 26 to swing upon the platform 23 about an upright axis, whereby the boom may be swung laterally or from side to side by a reversible hydraulic motor and reduction gear unit 27 carried by the member 24. The frame or member 24 of boom assembly 25 at its front end is substantially square in cross-section and at two of its opposite sides it carries spaced side plates 28 and 29 (see particularly Figs. 3, 4 and 5). Plates 28 and 29 are interlocked with and secured to the front end of member 24 by square keys 30 and cap screws 31. Plates 28 and 29 are generally L-shaped and their forward portions or legs extend downwardly. Adjacent their bottoms these forward downwardly extending portions or legs are interconnected by a cross-plate or bar 32 bolted at its ends to lugs 33, one of which is welded to each plate 28 and 29.

Plates 28 and 29 each includes a substantially L-shaped opening or cam slot 34 which slots 34 are aligned with

each other and provide cam surfaces for a linkage mechanism described hereinafter. The cam surfaces provided by each opening 34 is reinforced by a shoulder member 35 welded to each of the plates 28, 29. Plate 28 includes a second opening or cam slot 36 (see Fig. 10) 5 positioned forwardly of the first cam slot 34. Spaced laterally outwardly of the plate 28 is a cam plate 37 that includes a cam slot 38 that corresponds in shape and is in alignment with cam slot 36 in plate 28. Cam plate 37 is carried by a curved plate 39 welded to both 10 it and the plate 28.

Spaced side plates 28 and 29 carry between them a forwardly extending arm 40 that has welded to its rear end a pair of spaced upwardly extending legs 41. Adjacent its top each of the legs 41 is provided with a spacer abutment 42 that abuts one of the spaced side plates 28 or 29 to limit sidewise movement of the arm 40 between them upon a pivot pin 43. Pivot pin 43 extends through aligned openings in the spaced side plates 28, 29, the spacer abutments 42 and legs 41. It 20 will be seen that the arm 40 is free to swing pivotally about the horizontal axis of pivot pin 43 and between the spaced side plates 28 and 29.

Arm 40 is adapted to fit and telescope into the rear end of a boom member 44 and for this purpose its front portion is circular in cross-section and carries two diametrically oppositely spaced longitudinally extending keys 45 (see particularly Figs. 5 and 8). At its front end arm member 40 carries a removable bracket 46 adapted to receive the piston rod of a double acting hydraulic motor or jack 47 (see Fig. 9). Bracket 46 is secured to the front end of arm 40 by a key 48 and cap screws 49. (See Fig. 5.) 25

The member 44 of boom assembly 25 includes a rear tubular portion 50, a front tubular portion 51 and a pair of side bars or straps 52 welded at their ends to the portions 50 and 51 and gussets 53 thereon for spacing the portions 50 and 51 apart. Rear portion 50 of member 44 is bored to fit over arm 40 and it is provided with two keyways 54 that receive the keys 45 on arm 40. 30 The keys 45 and keyways 54 prevent relative rotation of arm 40 and rear portion 50 while permitting the latter and consequently the member 44 to slide longitudinally or rectilinearly upon the arm 40.

Each of the bars or side straps 52 of boom member 44 has adjacent its rear end an outwardly projecting stub shaft 55 welded thereto that carries a roller 56. Stub shafts 55 lie upon a common axis and project into the aligned cam slots 34 in side plates 28 and 29 so that rollers or cams 56 engage and are guided by the walls 35 of the slots as the boom, including portions 40, 50, 52 and 51, is swung about the pivot pin 43. The cam rollers 56 and cam slots 34 cooperate in forming a linkage between the rear portion, main frame or mounting means of the boom assembly including the member or portion 24 and the spaced side plates 28 and 29. As the member 44 of boom assembly 25 is swung about the pivot pin 43 the linkage, including the cam slots 34 and cam rollers 56, cam or move the member 44 longitudinally or rectilinearly along the arm 40, whereby the front end of boom portion 51 follows along or describes a vertical straight line path. 40

The member 44 of boom assembly 25 is swung about the horizontal axis of pivot pin 43 by the hydraulic piston motor or jack 47. Jack 47 is carried between the spaced side plates 28, 29 of the frame of the boom assembly 25 by a pair of trunnions 57 that project from the body of the jack into aligned openings 58 in the side plates 28 and 29. Hydraulic jack 47 has a telescoping piston that includes a piston rod 59 and a piston sleeve 45 60 that telescope with each other and with the body of the jack 47. Piston rod 59 extends upwardly between the two arms of bracket 46 on arm 40 and is pivotally connected thereto by a pin 61.

From the description thus far given, it will be seen 75

that when jack 47 is expanded the member 44 of boom assembly 25 will be swung upwardly about the horizontal axis of pivot pin 43, and that when jack 47 is contracted the member 44 of boom assembly 25 will be swung in a reverse or downward direction about said horizontal axis of pin 43. It will also be seen that when the member 44 of boom assembly 25 is swung either upwardly or downwardly it will be moved by the linkage including cam slots 34 and cam rollers 56 longitudinally or rectilinearly along the arm 40, whereby the front end of the boom assembly 25 will follow or describe a straight line path.

At its front end the front tubular portion 51 of boom assembly 25 includes a yoke 62 welded to the end of tubular portion 51 through gussets. Yoke 62 carries for pivotal movement through aligned trunnion pins 63 (see Fig. 11) the frame 64 of a combined drill bit driving mechanism and torque wrench 65. Trunnion pins 63 provide a pivotal connection between the yoke 62 and the combined drilling mechanism and torque wrench 65 on a transverse horizontal axis. Frame 64 of drill or drill bit driving mechanism and torque wrench 65 includes an outer frame member 66 and this outer frame member 66 is pivoted for swinging movement to the yoke 62 by the pins 63 which extend through it and into the forwardly extending spaced arms 67 of yoke 62. Pins 63 are locked in the arms 67 by set screws 68.

As best seen in Figs. 3, 4 and 11, the rear member of outer frame 66 carries a pair of spaced rearwardly extending lugs or ears 69 that receive through a pivot pin 71 the front end of a rod or link 70 of a second linkage mechanism. Rod or link 70 extends rearwardly from the outer frame 66 along one side of boom member 44, and its rear end is pivotally connected through a pivot connector 72 to the front end of a rod 73. Rod 73 is carried for longitudinal movement through a bracket 74 welded to the front end of one of the side bars or straps 52 of member 44 (see Figs. 6, 7 and 9), and upon its rear end (see Fig. 10) there is welded a block 75. Block 75 forms a tongue that extends between the side plate 28 of boom assembly 25 and the cam plate 37 and it carries through a bushing 76 a pin 77, upon the ends of which there are cam rollers 78 and 79. Cam roller 78 operates in the cam slot 36 in side plate 28 and cam roller 79 operates in the cam slot 38 in cam plate 37. Pin 77 is slotted or notched at its outer end to receive the end of a fastening plate 80 bolted at one side of the block 75 and extending over the cam plate 37. 40

It will be seen that when the front boom member 44 is swung by the hydraulic jack 47 the second linkage, including the cam slots 36, 38, cam rollers 78, 79, and rods or links 73 and 70, will shift or swing the outer frame 66 and the combined drill and torque wrench 65 on the trunnion pins 63. The shape of cam slots 36, 38 is such that a vertically extending drill bit carried by the combined drill and torque wrench 65 will remain in a vertical position when the boom member 44 is swung about the axis of pin 43. Rod or link 70 of the second linkage mechanism includes a connecting device 81 that permits the combined drill and torque wrench 65 to pivot to a limited extent upon the trunnion pins 63 against compression springs. Connecting device 81 is comprised of a pair of spaced tubular end members 82 and 83 spaced apart by a pair of straps 84. End member 83 is welded upon the rear end of the forward member 85 of rod 70, and end member 82 slidably receives the forward end of the rear member 86 of rod 70. The forward end of rod member 86 extends between the straps 84 and into the end member 83 welded to rod member 85. Rod 86 carries a collar 87 locked thereto between the straps 84. Springs 88 are interposed between abutment collar 87 and the end members 82 and 83. It will be seen that the connecting device 81 causes the rod or link 70 to be resiliently expandable and contractable. 45

The frame of the combined drill and torque wrench 65

includes a housing casting 89 carried by the outer frame 66 through three cap screws 90. Housing or body casting 89 together with suitable closure plates that cooperate with it forms a housing structure that includes an upper gear box 92 and a lower gear box 93. Top cover plate 94 includes an upstanding bearing receiving collar 95 in which there is an anti-friction bearing 96. Bearing 96 at its bottom abuts a shoulder on the plate 94 and is retained within the collar 95 by a snap ring 97. The inner race of bearing 96 receives the boss 98 of a hub 99, the boss being secured within the race by a snap ring 100. Hub 99 is flanged at its outer periphery to form a collar that extends downwardly over and cooperates with the upstanding bearing receiving collar 95 to form a lubricant and dirt seal for the upper gear box 92.

Body casting 89 carries a rotary hydraulic motor 101, the shaft 102 of which extends into the upper gear box 92 and is axially aligned with the hub 99. Shaft 102 is supported by an anti-friction bearing 103 and its end projects into and drives a gear 104. Gear 104 includes a central upwardly extending splined boss 105 that extends into and engages the boss 98 of hub 99 to drive the latter. Hub 99 is provided upon its top surface with a threaded stud plate 106 fastened thereto by a plurality of screws 107. The threaded stud of stud plate 106 is adapted to receive a drill bit receiving socket 91.

Gear 104 meshes with and drives a gear 108 carried on the upper end of a shaft 109 that extends through a tubular portion of the body casting 89 and into the lower gear box 93. Shaft 109 is carried on spaced anti-friction bearings 110. The lower end of shaft 109 carries a gear 111 that meshes with a reach gear 112 that meshes with a gear 113. Reach gear 112 is carried by an anti-friction bearing 114 mounted upon a stationary shaft 115, one end of which is carried by the body casting 89, and the other end of which is carried by the cover plate 116 for the lower gear box 93. Gear 113 drives an upstanding shaft 117 also carried upon anti-friction bearings, one in the body casting 89 and the other in a cup formed on the cover plate 116. Shaft 117 drives a torque wrench 118 that may be of any standard construction. The body 119 of torque wrench 118 is secured to the body casting 89 by a plurality of cap screws. Torque wrench 118 includes a driving shaft 120 that receives a socket 154' (see Fig. 12) adapted to receive the ends of the previously mentioned rods, bolts or screws that are to be threaded into the holes drilled in the mine roof.

In Figs. 13 and 14 there is shown a modified form of combined drill and torque wrench 121. In this embodiment the combined drill and torque wrench is trunnioned directly to the yoke 62 by suitable pivot pins 124 (see Fig. 14) that fit into sockets 123 formed in the body casting 126. Body casting 126 cooperates with a cover plate 127 on the bottom thereof to form a gear housing 128 and it carries a rotary hydraulic motor 129, the drive shaft 130 of which extends downwardly into the gear housing 128 and is supported therein by an anti-friction bearing 131 clamped between the main body casting 126 and the housing of motor 129 by the latter. Drive shaft 130 carries within the gear housing 128 a gear 132 that meshes with a gear 133 and a gear 134. Gear 133 is carried by the end of an upright shaft 135 mounted at its lower end in a tapered roller bearing 136 carried by the casting 126. The upper end of shaft 135 is carried by a roller bearing 137 received in a cap 138 fastened to the body casting 126 by a plurality of cap screws 139. Cap 138 includes a shoulder portion 140 that extends into the body casting 126 and abuts a lubricant retainer 141. Retainer 141 is in the form of a collar that fits the shaft 135 closely to retain lubricant about roller bearing 137.

The top of shaft 135 fits into and drives an internally threaded hollow tapered member 142. Tapered member 142 includes a peripheral downwardly extending flange

portion 143 that fits over and cooperates with an upstanding collar 144 on cap 138 to provide a top dirt and lubricant seal for the bearing 137. The tapered member 142 is secured to shaft 135 by a cap screw 145 threaded into the upper end of shaft 135. The central bore of the tapered member 142 is internally threaded and it receives a locking or jam screw 146 that abuts the cap screw 145. Locking screw 146 receives a socket 147 that is adapted to receive a drill bit.

The gear 134 drives a shaft 148 that is carried by two anti-friction bearings, one in the body casting 126 and the other in a cup formed on the cover plate 127. Shaft 148 drives a torque wrench 149. Torque wrench 149, like torque wrench 118, may be of any suitable construction and in the embodiment shown it includes a main body 150 that is driven by the shaft 148 and includes lugs 151 that cooperate with a lug 152 on the bottom of the driven shaft member 153 of the torque wrench. Shaft 153 receives a socket 154 adapted to receive the heads of the aforementioned rods, screws or bolts. The housing of torque wrench 149 is formed as an integral part of main body casting 126 and is closed at the top by a collar or cap 155. Body casting 126 is provided with a lug 125 (Fig. 13) that receives the front end of rod or link 70. However, with this embodiment of the torque wrench the front end of rod 70 will be bifurcated to fit over the lug 125.

Referring now particularly to Fig. 9 of the drawings, the side plate 29 carries a double acting hydraulic piston motor or jack 156 that is secured to it by suitable bracket structure including clamps 157 welded to a plate 158 which in turn is welded to the side plate 29. The piston rod 159 of jack 156 is formed at its lower end as a ball 160 and it carries a foot or base plate 161 provided with a plurality of downwardly extending studs or pins 162. Jack 156 is used as a supplemental support for supporting the rear portion or frame of the boom assembly 25 while the drill is being fed upwardly to bore a hole in the mine roof or ceiling by extending its piston rod 159 so that the foot or base plate 161 rests upon the ground, as indicated in Fig. 3 of the drawings.

Front boom member 44 carries a plurality of hydraulic valves 163 that may be actuated by an operator standing adjacent them to control the supply of hydraulic fluid from the pumps 22 to the rotary hydraulic motor 101 or 129, the motor 47 and the jack 156 and other hydraulic motors of the mining apparatus.

In the operation of the apparatus the truck is driven to adjacent the location where it is desired to drill a hole upwardly into the mine roof or ceiling. With the boom lowered, as seen in Fig. 1, and the combined torque wrench and drill resting upon or adjacent the mine room floor, a drill bit, not shown, is placed in the socket 91. The motor 101 is then started to drive the drill bit, and jack 47 is operated to elevate the member 44 of boom assembly 25. As the boom is elevated, of course, the drill bit will enter and bore an opening upwardly into the mine roof or ceiling. Because of the linkage, including the cam elements 34 and 56, the front end of front tubular portion 51, and the axis of the trunnion pins 63, and consequently the combined drill and torque wrench, will move vertically upwardly; that is, they will move along a straight or rectilinear path, thereby to feed the drill bit directly into the mine room ceiling without bending it. As the boom is elevated the second linkage, including the cam elements 36 and 38 and the rollers 78 and 79, will cause the frame of the combined drill and torque wrench to swing upon the mounting pins 63 to maintain the axis of the drill bit vertical.

Upon the completion of the drilling of one or more holes in the mine roof or ceiling by the drill bit, the forward portion 44 of boom assembly 25 will be lowered and the drill bit removed therefrom. The operator will then start into each of the drilled openings in the mine roof or ceiling a threaded rod or screw and he will then

shift the forward portion of the boom 44 so as to cause the socket 154' on the shaft 121 of the torque wrench to engage the head of this rod or screw. With the head of the rod or screw in driving relation with the torque wrench 118, the hydraulic motor 101 is operated to cause the torque wrench to swing or drive the rod or screw upwardly into the mine roof or ceiling. It will, of course, be seen that when the rod or screw is threaded into the mine room ceiling to such an extent that its head or a washer on the screw engages the mine room ceiling, the torque wrench will slip to prevent stripping of the threaded relation between the screw or rod and the rock strata of the mine roof or ceiling.

When particularly hard drilling is encountered the jack 156 may be employed to assist in supporting the rear frame portion of the boom assembly 25 to prevent downward swinging or tilting of it.

From the foregoing description it will be seen that there is provided a drilling apparatus particularly adapted to drill holes in a mine room roof or ceiling and then to drive into the drilled holes threaded rods or bars that serve to tie the strata that forms the roof of the mine together to prevent cave-ins and the like. It will also be seen that the boom mechanism which carries the combination drill and torque wrench may be swung laterally about the vertical axis of the pivot 26 as indicated in Fig. 2 of the drawings, that its forward portion may be swung about the horizontal axis of the pivot pin 43, and that when the forward portion 44 is so swung the forward end of it moves to describe a straight line path.

While in the embodiment of the invention shown the truck and boom carry a combination drill and torque wrench, it is obvious that any mining mechanism may be substituted for the combination drill and torque wrench 65 or 122.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and applicant therefore wishes not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of the invention, what is desired to secure by Letters Patent of the United States is:

1. Drilling apparatus including in combination a frame, an extensible and retractable boom, a drilling mechanism, pivotal mounting means mounting said drilling mechanism on one end of said boom for pivotal movement about an axis, mounting means mounting the other end of said boom on said frame for swinging movement, means for swinging and extending and retracting said boom for causing said drilling mechanism to follow a straight line path when said boom is swung, and adjusting mechanism including a link and cooperating cam elements connecting said drilling mechanism and frame for adjusting said drilling mechanism about said axis as the boom is swung.

2. A mine roof drilling apparatus including in combination a truck having a main frame, a turntable on said truck main frame, a boom supporting frame on said turntable, motor means for rotating said boom supporting frame, an extensible boom, mounting means mounting the inner end of said boom on said boom frame for swinging movement about a horizontal axis, motor means for swinging said boom as aforesaid, a drill mechanism including a drill frame, a yoke on the outer end of said boom, pivotal mounting means mounting said drill frame in said yoke for pivotal movement on a horizontal axis, adjusting mechanism including cooperating cam elements interconnecting said boom frame and the outer end of said boom for adjusting the latter longitudinally when said boom is swung about said first-named horizontal axis, adjusting mechanism for swinging said drill frame in said yoke with respect to said outer end of said boom as the boom is swung about said first-named

horizontal axis, said adjusting mechanism including a linkage having cooperating cam elements connecting said drill frame and said boom supporting frame, and a jack means adapted to aid in supporting said boom supporting frame.

3. A mine drill apparatus including in combination a truck having a main frame, a turntable on said main frame, a boom supporting frame on said turntable, a drill bit driving mechanism, pivotal mounting means mounting said drill bit driving mechanism on the outer end of said boom for pivotal movement, mounting means mounting the inner end of said boom on said frame for swinging movement, adjusting mechanism interconnecting said boom supporting frame and the outer end of said boom for adjusting said outer end of said boom rectilinearly as it is swung, said adjusting mechanism including cooperating cam and link elements interconnecting said boom and boom supporting frame, and adjusting mechanism for swinging said drill bit driving mechanism with respect to said boom including a link and cooperating cam elements connecting said drill bit driving mechanism and said boom supporting frame for adjusting said drill bit driving mechanism with respect to said boom as the latter is swung.

4. A drilling machine including a frame, an extensible boom pivotally mounted at one end on a transverse horizontal axis and carried by said frame, drill mechanism pivotally carried by the other end of said boom on a transverse horizontal axis and movable upwardly and downwardly as said boom swings on said first named horizontal axis, means for extending and retracting said boom as it swings to direct the movement of said drill mechanism along a straight vertical line, and cam and linkage mechanism interconnecting said drill mechanism and said frame to swing said drill mechanism on its horizontal axis as said boom swings.

5. A drilling machine including a frame, an extensible boom pivotally mounted at one end on a transverse horizontal axis and carried by said frame, drill mechanism pivotally carried by the other end of said boom on a transverse horizontal axis and movable upwardly and downwardly as said boom swings on said first named horizontal axis, means for extending and retracting said boom as it swings to direct the movement of said drill mechanism along a straight vertical line, and linkage mechanism interconnecting said drill mechanism and said frame including means holding said drill along a fixed axis as said boom swings.

6. A mine drill apparatus including in combination a supporting frame, an extensible boom, a drill bit driving mechanism, pivot means mounting said drill bit driving mechanism on the outer end of said boom, mounting mechanism mounting the inner end of said boom on said frame for swinging movement including a carrying element, a boom carrying arm, pivot means connecting said arm to said carrying element, mechanism including cooperating cam and link means interconnecting said carrying element and said frame for adjusting said boom rectilinearly as it is swung, and adjusting mechanism for swinging said drill bit driving mechanism on the outer end of said boom as the boom is swung, said adjusting mechanism including a resilient linkage having cooperating cam elements connecting said drill bit driving mechanism and said boom for swinging the drill bit driving mechanism as aforesaid.

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