April 29, 1958 J. R. FLETCHER ET AL 2,832,567

MOBILE ROOF DRILL

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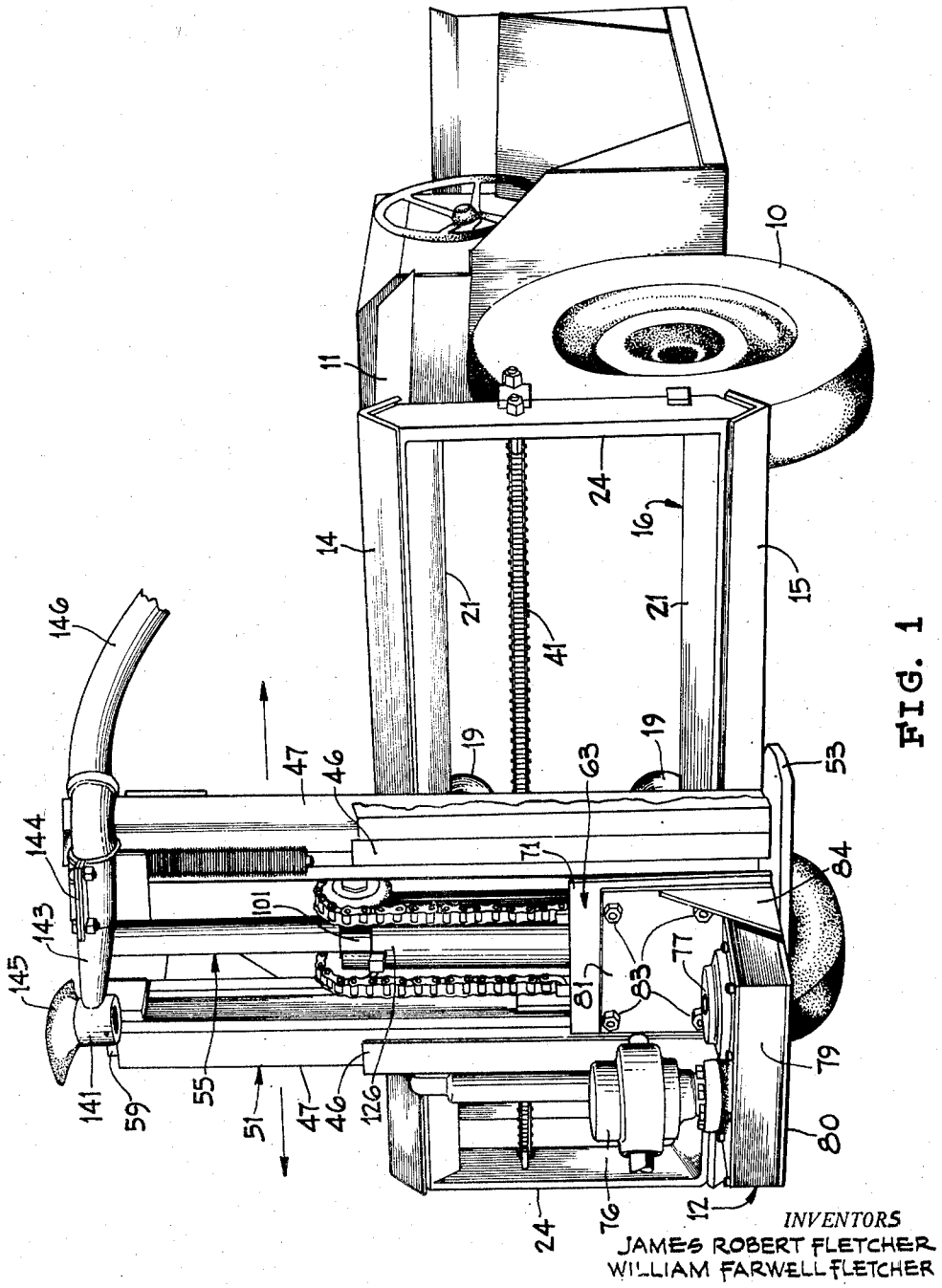


FIG. 1

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MOBILE ROOF DRILL

Filed Feb. 8, 1956 5 Sheets-Sheet 2

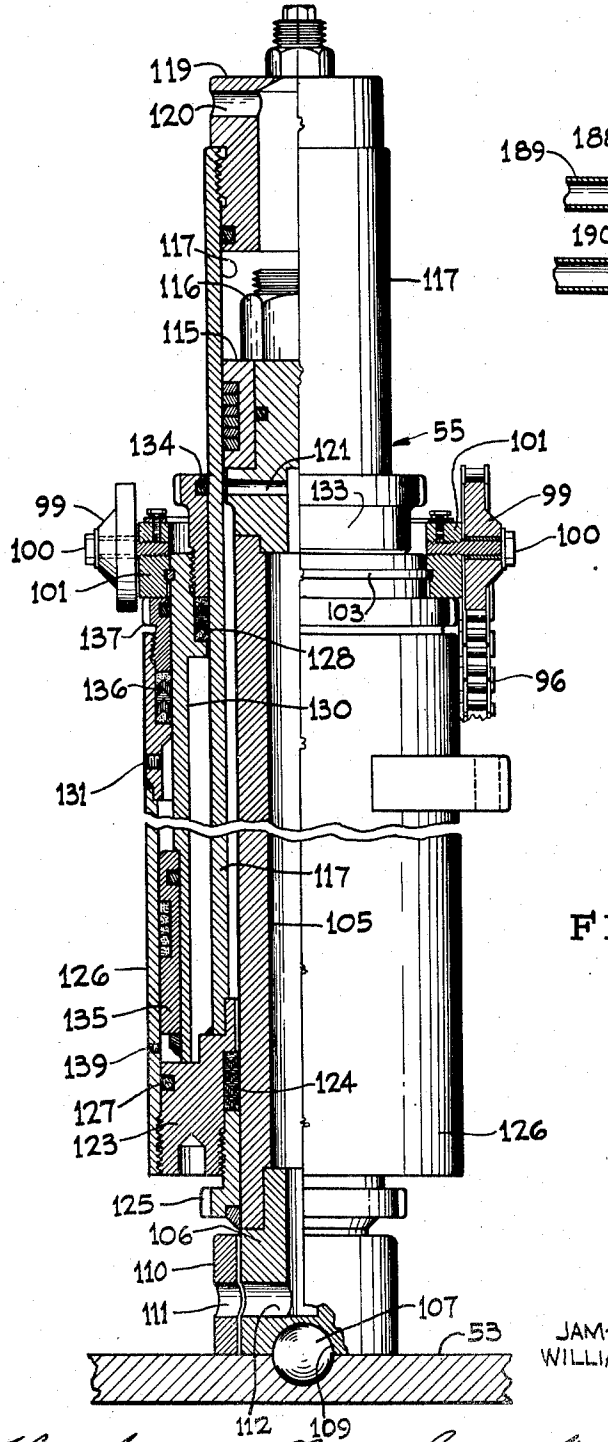


FIG. 3

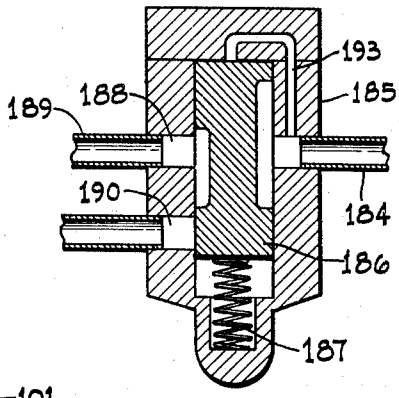


FIG. 8

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MOBILE ROOF DRILL

Filed Feb. 8, 1956 5 Sheets-Sheet 3

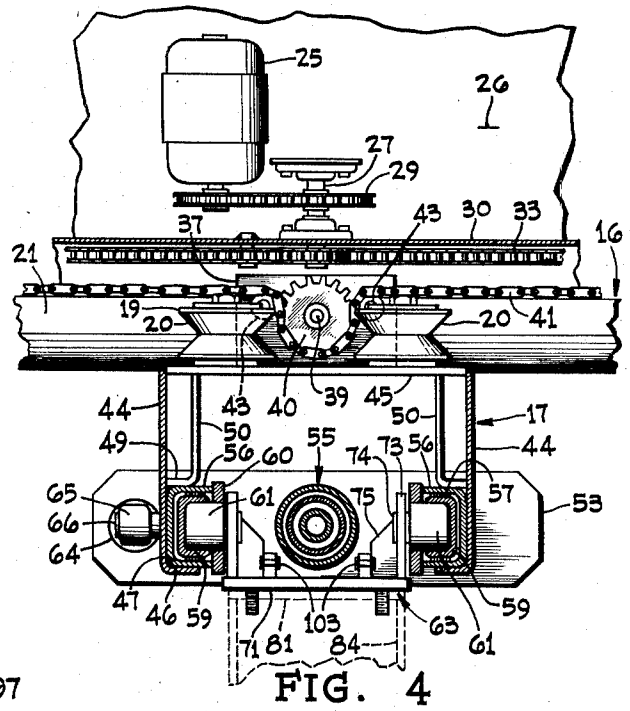


FIG. 4

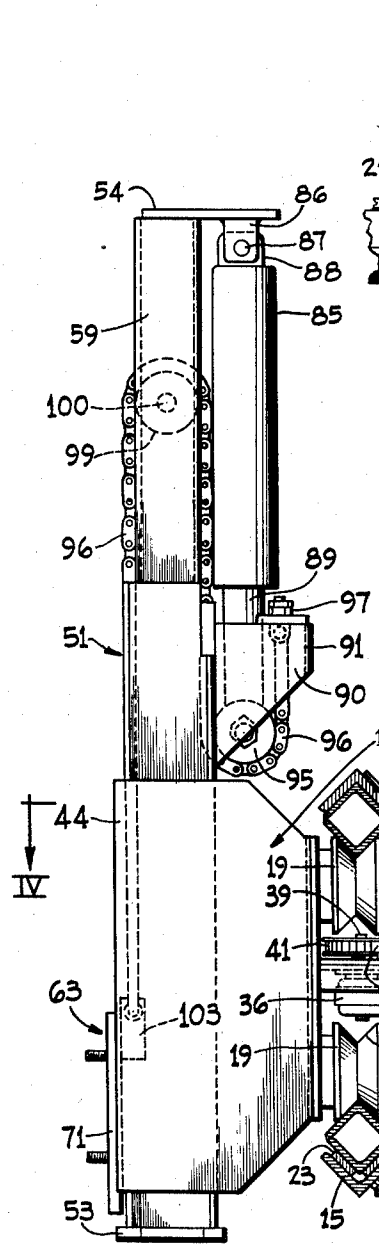


FIG. 5

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April 29, 1958 J. R. FLETCHER ET AL 2,832,567

MOBILE ROOF DRILL

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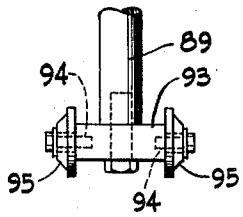


FIG. 7

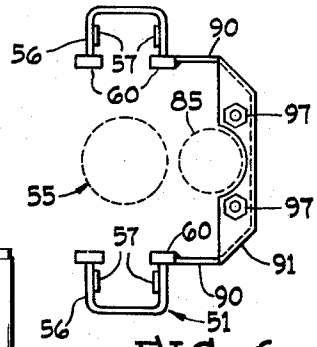


FIG. 6

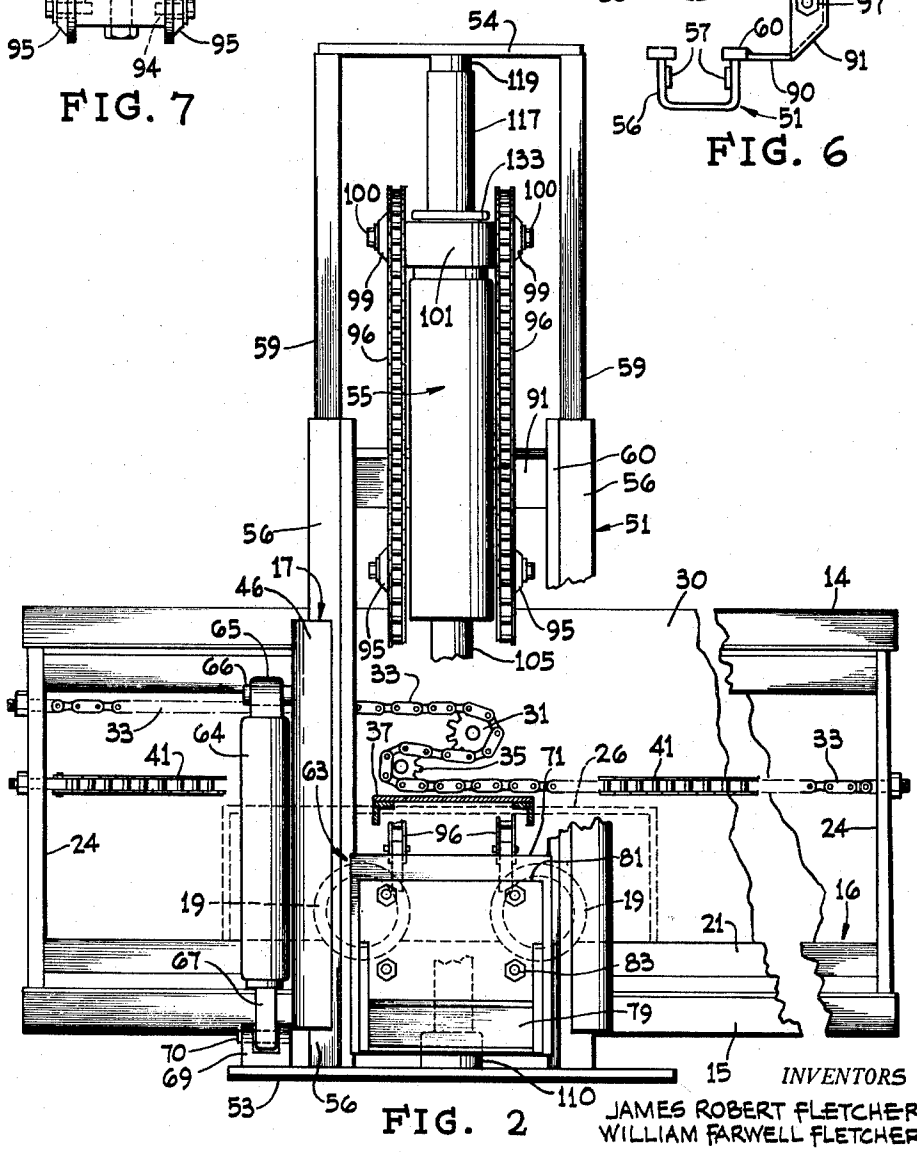


FIG. 2

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MOBILE ROOF DRILL

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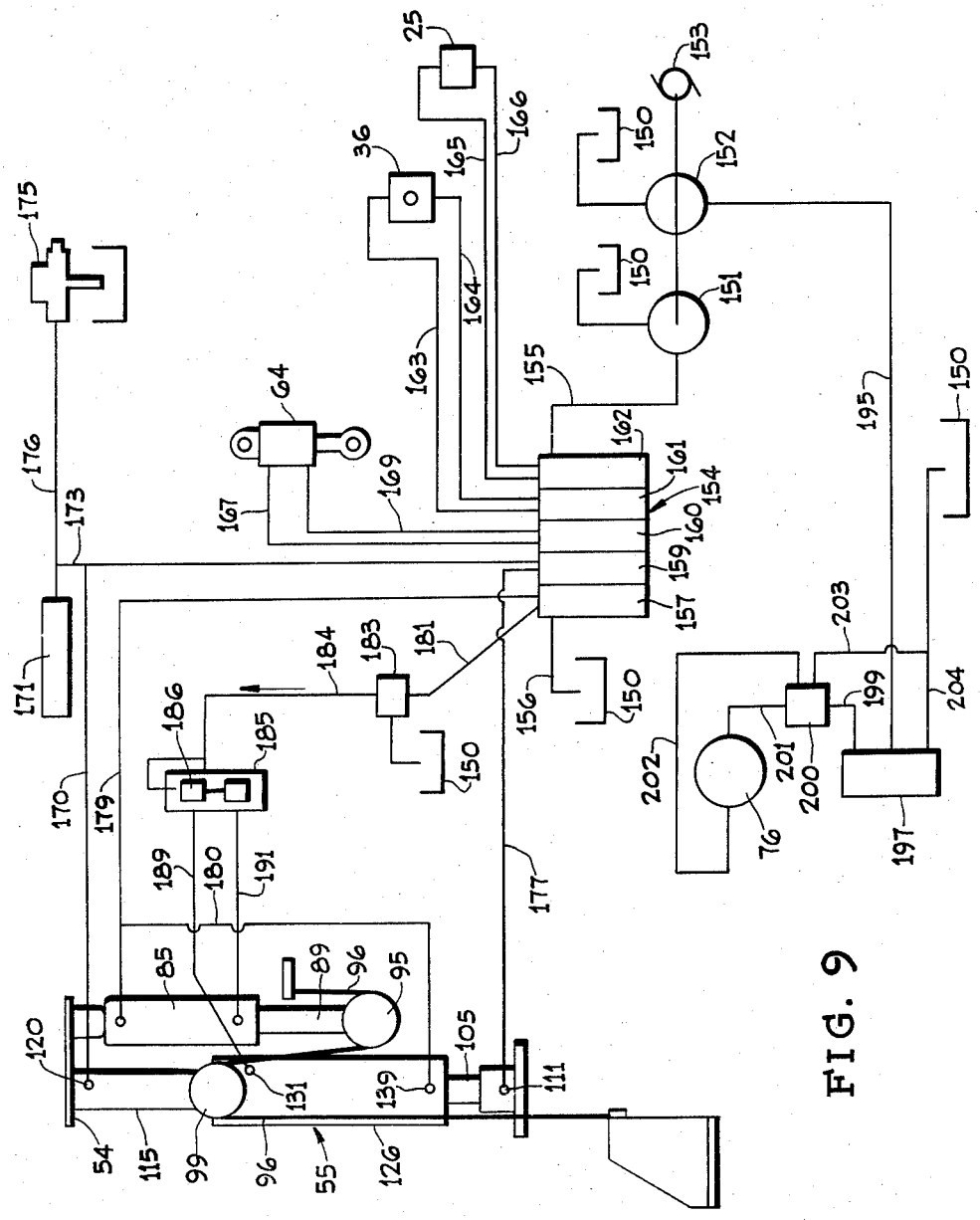


FIG. 9

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United States Patent Office 2,832,567 Patented Apr. 29, 1958

2,832,567

MOBILE ROOF DRILL

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Application February 8, 1956, Serial No. 564,287

17 Claims. (Cl. 255—51)

This invention relates to improvements in roof drills and more particularly relates to an improved form of mobile drill for drilling in mine roofs of varying consistencies and particularly hard rock roofs.

The principal object of the invention is to provide an improved form of drill for drilling in the roof of a mine so constructed and arranged as to assure a straight line travel of the drill and to prevent wandering of the drill bit in starting the hole.

Another object of the invention is to provide an improved form of drill for drilling in the roof of a mine in which the drill is vertically guided along a mast braced between the mine roof and floor.

A further object of the invention is to provide an improved form of drill particularly adapted for drilling in mine roofs in which the drill carriage is guided on a column or mast braced between the roof and floor, forming a straight line guide for the drill carriage and a safety jack for the protection of the operator of the drill.

A further object of the invention is to provide an improved form of mobile drill for drilling in the roof of a mine in which the drilling thrust is taken from the support truck for the drill and transmitted directly to the ground, so as to provide the necessary thrust for drilling in hard rock.

Still another object of the invention is to provide a roof drill having an extensible column or mast forming a guide for the drill carriage and wedged between the mine floor and roof and carrying a drill guide and dust collector adjacent the roof to prevent wandering of the drill and to collect the dust at the entrance of the hole being drilled.

Still another object of the invention is to provide a mobile roof drill in which the carriage for the drill is guided on an extensible mast wedged between the mine roof and floor by a hydraulic ram, and in which a means is provided to maintain pressure on the ram and to provide the necessary take-up for the mast, to take up for give in the mine roof and floor during the drilling operation.

Still another and more detailed object of the invention is to provide a simple and efficient form of drill particularly adapted for drilling in hard rock, in which the drill carriage is guided on an extensible column or mast wedged between the mine floor and roof, and in which a two stage hydraulic ram is provided to extend the column or mast and maintain the same in engagement with the mine roof, and a second hydraulic ram is provided to cooperate with the first hydraulic ram and through flexible draft devices trained about direction changing devices on said first and second rams, to feed the drill carriage along the mast, and wherein the hydraulic system for the rams is so arranged as to accommodate lowering of the drill carriage by gravity and to assure lowering of the first hydraulic ram to the full extent of its travel prior to operation of the second hydraulic ram, to prevent the formation of slack in the draft devices.

Still another object of the invention is to provide a novel and improved form of extensible mast or column having guide tracks therein for the carriage for the drill, so arranged as to provide a continuous guide for the carriage for the length of the mast in all positions of extensible and retractable movement of the mast.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

Figure 1 is a perspective view of a drill constructed in accordance with our invention with certain parts thereof broken away;

Figure 2 is a fragmentary front end view of the drill shown in Figure 1 with certain parts thereof broken away and certain other parts shown in section;

Figure 3 is a fragmentary partial sectional view taken through the hydraulic ram for wedging the mast for the drill carriage between the mine floor and roof and for feeding the drill carriage vertically for a portion of its length of travel;

Figure 4 is a fragmentary horizontal sectional view taken substantially along line IV—IV of Figure 5;

Figure 5 is a side view of the drill, with certain parts of the truck broken away and the transverse guide for the drilling mechanism shown in vertical section, and with the drill removed from the drill carriage;

Figure 6 is a fragmentary detail plan view of the lower section of the mast;

Figure 7 is a detail view showing certain details of the mounting of the sheaves on the piston of the secondary cylinder for elevating the drill.

Figure 8 is a diagrammatic sectional view of the shuttle valve used in the hydraulic system; and

Figure 9 is a schematic diagram showing the hydraulic diagram for effecting operation of the drill.

In the embodiment of the invention illustrated in the drawings, we have shown a portion of a wheel mounted self-propelled truck **10** including a frame **11** forming a support at its forward end for a vertical drilling device indicated generally by reference character **12**.

Extending across the front of the frame **11** and supported thereon are two vertically spaced slides **14** and **15** forming a slidable support and guide for a sliding frame **16**. The sliding frame **16** forms a slidable support for a carriage **17** for the drilling mechanism **12** on rollers **19**. The rollers **19** have generally V-shaped engaging faces **20** having rolling engagement with the inner faces of angular guide tracks **21** forming the upper and lower side frame members of the slide **16**. As shown in Figure 5, the lower slide **15** has bearing plates **23** extending therealong having slidable supporting engagement with the under faces of the angular guide track **21**. The guide tracks **21** are shown in Figure 5 as being rectangular in form with two of the corners of the rectangle intersecting a common vertical plane.

The guide tracks **21** of the slide **16** are connected together at their opposite ends by side frame members **24**, to form an open rectangular slidable frame movable along the slides **14** and **15** and forming a support and guide track for the carriage **17** on the rollers **19**, to accommodate positioning of the carriage **17** and the drilling mechanism **12** carried thereon in various positions with respect to the truck frame, including positions overhanging each end of the truck frame.

The slide **16** is moved laterally of the truck frame **11** along the slides **14** and **15** by means of a motor **25** mounted on a plate **26** of the frame **11** rearwardly of the slides **14** and driving a transverse shaft **27** by a chain and sprocket drive indicated generally by reference character **29**. The shaft **27** extends outwardly from an end plate **30** of the frame **11** and is suitably journaled thereon. A sprocket **31** on the outer end of the shaft **27** meshes

with a chain 33 connected at one end to an end frame member 24 of the slide 16 (see Figure 2). The chain 33 changes its direction about the sprocket 31 and extends toward the end frame member 24 to which it is connected, and about an idler sprocket 35, about which it changes its direction and extends to the opposite side frame member 24 of the slide 16, and is suitably connected thereto.

Thus, upon operation of the fluid motor 25 by the admission of fluid under pressure thereto the sprocket 31 will move the chain 33 therealong in one direction or another depending upon the direction of rotation of said sprocket, to laterally position the slide 16 along the slides 14 and 15, as desired.

The carriage 17 is moved along the slide 16 on the rollers 19 by means of a motor 36 mounted on and depending from a shelf 37 extending inwardly from the carriage 17 toward the end wall 30 of the frame 11 between the rollers 19. The motor 36 has a motor shaft 39 extending upwardly of the plate or shelf 37 and has a sprocket 40 thereon, meshing with a chain 41 suitably secured at its opposite ends to the side frame members 24 of the slide 16. The chain 41 is maintained in mesh with the sprocket 40 by tension idlers 43, rotatably mounted on the plate or shelf 37 on opposite sides of the sprocket 40. Thus upon the admission of fluid under pressure to the motor 36 to operate the same the carriage 17 will be laterally moved along the chain 41 and slide 16 to position the drilling mechanism in a desired drilling position.

Referring now to Figures 4 and 5, the carriage 17 has parallel spaced vertically extending side plates 44 extending forwardly of a back plate 45 thereof. The side plates 44 have inturned outer ends 46, the inner margins of which define one face of channeled guides 47. The opposite faces of the channeled guides 47 are formed by legs 49 of bracing members 50, extending parallel to the side plates 44 and welded or otherwise secured to the back plate 45 at their inner ends and to the side plates 44 at the ends of the legs 49 thereof.

The channeled guides 47 form a slidable guide for an extensible column or mast 51 having a base plate 53 engageable with the ground and a roof plate 54 engageable with the roof, and forced into engagement with the roof by a two stage hydraulic ram 55.

The extensible mast 51 includes facing channeled guide members 56 welded or otherwise secured to the base plate 53 and extending upwardly therefrom and guided for vertical movement along the channeled guides 47. The channeled guide members 56 are generally U-shaped in form and have bearing plates 57 extending along the insides of the legs thereof having bearing engagement with the outer sides of the legs of channeled guide members 59, forming the inner or upper section of the mast 51.

The legs of the channeled guide members 56 are shown as having bearing strips 60 extending along the outer ends thereof and welded or otherwise secured thereto. As herein shown, the bearing strips 60 are relatively wide and extend inwardly of the legs of the channeled guide members 56 over the ends of the legs of the inner or upper channeled guide members 59, and form retainers therefor and also form guides for guide rollers 61 extending laterally from opposite sides of a drill carriage 63 for guiding said carriage for vertical movement along the mast 51. Two guide rollers are provided for each side of the drill carriage 63 for maintaining said drill carriage parallel to the mast 51 during travel therealong for the entire length thereof.

It may be seen from Figure 4 that the rollers 61 extend inwardly of the bearing strips 60 along the inner margins thereof within the channeled guides formed between the legs of the inner or upper guide member 59 of the mast and that said bearing strips and channeled guides form guides for the rollers 61, during movement along the outer guide members of the mast for substantially the

length thereof. It should be further understood that the channeled guides formed between the legs of the inner guide members of the mast form guides for the rollers 61 as the drill carriage 63 moves upwardly therealong beyond the bearing strips 60 and the lower or outer guide members therefor.

The mast 51 is moved downwardly as a unit along the guides 57 to engage the bearing plate 53 with the ground by operation of a hydraulic ram including a cylinder 64 having an ear 65 extending upwardly from the head end thereof and carried on a pivot pin 66 extending outwardly from one side plate 44 of the carriage 17, which is shown in Figure 2 as being the left hand side plate thereof. A piston rod 67 is extensible from the lower end of the cylinder 64 and extends within a connector 69 extending upwardly from the base plate 53, and is pivotally connected thereto as by a pivot pin 70. The admission of fluid under pressure to the head end of the cylinder 64 will thus move the mast 51 downwardly to engage the base plate 53 with the ground. The admission of fluid under pressure to the piston rod end of said cylinder will lift and hold said base plate above the ground.

The drill carriage 63 includes a vertical transversely extending plate 71 extending in advance of the outer guides 56 of the extensible mast 51 and having parallel spaced plates 73 extending inwardly from the plates 71 along the guides formed between the inner margins of bearing members 60 and the legs of the channels of the inner guide member 59. Each of the plates 73 has two aligned vertically spaced rollers 61 mounted thereon on pivot pins 74 extending outwardly from said side plates, and positioning said rollers to have guiding engagement between the bearing plates 60 and within the channels formed by the inner guide members 59. Gusset plates 75 are provided to brace the side plates 73 to the front plate 71.

The drill carriage 63 forms a support for a drill motor 76 and chuck 77, and a speed reducer (not shown) contained within a housing 79, for driving the chuck 77 from the motor 76. The housing 79 is carried on a bottom plate 80 extending forwardly of a back plate 81 abutting the plate 71 and secured thereto as by studs and nuts 83. Gusset plates 84 are provided to brace the bottom plate 80 to the back plate 81. The drill motor 76 may be a well known form of fluid operated motor suitably secured to the top of the housing 79 for driving the reduction gearing (not shown) carried within said housing and driving the chuck 77 journaled within said housing. The motor 76, chuck 77 and reduction gearing with the housing 79 may be of any well known form and are no part of our present invention so need not herein be shown or described further.

The means for vertically feeding the drill carriage 63 along the mast 51 includes the two-stage ram 55 and a secondary ram or cylinder and piston 85 depending from the roof plate 54 and pivotally connected between spaced ears 86, depending from said roof plate, on a pivot pin 87 extending through said ears and through a lug 88 extending upwardly from the head end of the cylinder 85. The cylinder 85 is shown as having a piston rod 89 extensible from the lower end thereof and extending between opposite side walls 90 of a yoke 91, welded or otherwise secured to the inner sides of the inner bearing strips 60 and extending rearwardly therefrom. The piston rod 89 is shown as having a block 93 bolted or otherwise secured to its lower end, having aligned shafts 94 extending laterally from opposite sides thereof. Guide rollers 95, rotatably journaled thereon said shafts form guide rollers for flexible draft devices in the form of chains 96, for elevating the carriage along the mast 51 and accommodating lowering movement thereof by gravity as will hereinafter more clearly appear as this specification proceeds. The chains 96 are shown as being secured at their inner ends to attachments 97 on the yoke

91. From said attachments the chains 96 are trained downwardly therefrom around the sheaves or rollers 95 and upwardly therefrom around sheaves or rollers 99 carried on shafts 100 extending outwardly from a crosshead 101 carried on an extensible cylinder 130 of the ram 55. A snap ring 105 is provided to retain the crosshead 101 to the cylinder 130. From the sheaves 99 the endless chains extend downwardly between the bearing strips 60 and are secured to the inside of the plate 71 on attachments 103.

The two-stage ram 55 for wedging the mast 51 between the mine floor and roof and also effecting vertical feeding movement of the drill carriage 63 along the mast 51 in cooperation with the ram 85, is shown in Figure 3 as including a hollow piston rod 105 secured to and extending upwardly from a fitting 106 at its lower end, rockingly mounted on the base plate 53 on a ball 107 partially recessed within said base plate and having bearing engagement with a socket 109 in the bottom of the fitting 106. The fitting 106 extends within a retainer and gland 110 mounted on the base plate 53 and extending upwardly therefrom. A passageway 111 for fluid under pressure leads through the wall of the retainer and gland 110 and has communication with a passageway or port 112 leading into the fitting 106 and extending upwardly therefrom and having communication with the hollow interior of the piston rod 105.

The piston rod 105 is shown as having a piston 115 on its upper end and secured to said piston rod as by a nut 116 threaded on a threaded upper end portion of said piston rod. The piston 115 is sealed to and movable along a cylinder 117 closed at its upper end by an end cap 119 having a port 120 leading thereinto in communication with the inside of the cylinder 117. Fluid under pressure entering the port 120 will thus raise the cylinder 117 upwardly along the piston 115 and piston rod 105 to engage the roof plate 54 with the mine roof. A port 121 is shown as leading from the hollow interior of the piston rod 105 to the inside of the cylinder 117 on the piston rod side thereof to admit fluid under pressure thereto to effect upward movement of the cylinder 117 along the piston rod 105. The lower end of the cylinder 105 is shown as being welded or otherwise secured to a gland 123 sealed to the piston rod 105 as by seal 124 and a gland nut 125. The gland 123 is shown as being threaded for a part of the length thereof and as having an outer cylinder 126 threaded thereon and sealed thereto as by an O-ring 127. The outer cylinder 126 extends upwardly along the inner cylinder 130, and is sealed thereto adjacent the upper end of the inner cylinder 130 by packing 128 and a gland nut 133 sealed to the wall of the cylinder 117 as by an O-ring 134. A seal 135 is shown as being interposed between the outer wall of the inner cylinder 130 and the inner wall of the outer cylinder or shell 136 adjacent the lower end of the outer cylinder 126 to seal said inner cylinder to the wall of said outer cylinder. The upper end of the outer cylinder 126 is shown as being sealed to the wall of the outer cylinder 126 is by packing 136 and a gland nut 137.

A port 139 leads through the wall of the cylinder 126 beneath the seal 135 to supply fluid under pressure to move the inner cylinder 130 vertically along the outer cylinder 126 and the cylinder 117. A port 131 leads through the wall of the outer cylinder 126 above the seal 135, to supply fluid under pressure thereto, to move the cylinder 130 downwardly along the outer cylinder 126 to the position shown in Figure 3.

It may here be seen that upon the admission of fluid under pressure to the port 120 and head end of the cylinder 117, that the cylinder 117, the outer cylinder 126 and the inner cylinder 130 will move vertically as a unit until the roof plate 54 is engaged with the mine roof. At the same time the ram 85 will move upwardly as a unit with the block 93 and sheaves 95, the sheaves 99 moving upwardly with the cylinder 130, the sheaves 95 and 99 moving upwardly together. The carriage 63 will remain stationary at the lower ends of the guides formed between the bearing strips 60 during the operation of engaging the roof plate 54 with the roof.

When the roof plate 54 is in engagement with the roof, wedging the mast between the mine roof and mine floor and providing a rigid roof supporting column and guide for the carriage 63, fluid under pressure may then be admitted to the head end of the cylinder 85 and may also be admitted through the port 139. This will lower the piston rod 89 and sheaves 95 and will raise the inner cylinder 130 upwardly along the cylinder 117, together with the sheaves 99 carried thereby. Upward movement of the sheaves 99 and downward movement of the sheaves 95 will thus effect vertical movement of the drill carriage 63 along the mast 51.

When it is desired to lower the carriage 63, fluid under pressure may first be admitted through the port 131 to lower the cylinder 130 within the cylinder 126 to the full extent of travel thereof and may then be admitted to the piston rod end of the cylinder 85 under the control of a sequence valve 185, as will hereinafter more clearly appear as this specification proceeds. The entire mast may be lowered by the admission of fluid under pressure to the underside of the piston 115 through the port 112, the hollow interior of the piston rod 105 and the port 121.

Mounted on the roof plate 54 is a collar 141 extending from a pipe or conduit 143 clamped to the plate 54 as by a clamp 144 (see Figure 1). The collar 141 is in axial alignment with center of the chuck 77 and the drill carried therein and forms a guide for the drill, guiding the drill as it initially enters the roof and preventing wandering thereof. Secured to and extending outwardly from the upper end portion of the collar 141 is a funnel-like collector 145 engageable with the mine roof during the drilling operation and forming a dust collector for the cuttings. As herein shown, the pipe 143 has communication with the inside of the collar 141 and is connected with a source of vacuum (not shown) on the truck 10 through a hose 146, for collecting and removing the cuttings during drilling.

Referring now in particular to Figures 8 and 9 and the fluid connections for effecting operation of the drill, a tank 150 for hydraulic fluid, such as oil, is shown as supplying fluid to two connected pumps 151 and 152 driven from a motor 153. The pumps 151 and 152 may be dual pumps contained within a single housing. The pump 151 may have a lesser capacity than the capacity of the pump 152 and supplies fluid under pressure to operate the rams 55, 85, 64, and the side feed motors 25 and 36. The pump 152 supplies the necessary volume of fluid under pressure to operate the drill motor 76 and effect drilling in hard rock as well as in softer top conditions.

The pump 151 is connected with a valve bank 154 through a pressure line 155 for supplying fluid under pressure thereto. A return line 156 is shown as leading from the valve bank 154 to the tank 150, to return hydraulic fluid thereto. The valve bank 154 includes valves 157, 159, 160, 161, and 162 suitably connected with the pressure line 155 and return line 156. Said valves may be of a well known construction so need not herein be shown or described in detail. The valve 161 is connected with opposite ends of the motor 36 to supply fluid under pressure to operate said motor in reverse directions, as selected, through a pressure line 163, supplying pressure to rotate said motor in one direction when the valve 161 is in one position, and through a pressure line 164 supplying pressure to said motor to rotate said motor in an opposite direction and thus reversely move the carriage 17 and drilling mechanism 12 along the slides or guide tracks 21.

The valve 162 is connected with the motor 25 through a pressure line 165 supplying pressure to rotate said motor in one direction when said valve is in one position,

and through a pressure line 166 supplying pressure to reverse the direction of rotation of said motor when said valve is in a second position and move the slide 16 along the slides 14 and 15 to position the slide 16 in the desired lateral position with respect to the truck 10.

It should here be understood that when the slide 16 and drilling mechanism 12 overhangs one end or the other of the truck 10, that the overhanging load is taken off the truck and the mast 51 and slide 16 are maintained in position in aligned relation with respect to the ground and the roof, by the base plate 53 engaging the ground and the roof plate 54 engaging the roof. The mast 51 and ram 55 thus take the weight of drilling from the truck 10 and relieve the overhung weight and drilling reactions from said truck and take the drilling reactions directly against the ground.

The valve 160 is provided to supply fluid under pressure to the head end of the ram 64 through a pressure line 167 when the valve 160 is in one position, to engage the base plate 53 with the ground and to supply fluid under pressure to the piston rod end of the ram 64 through a pressure line 169, when the valve 160 is in another position, to raise the base plate 53 and mast 51 above the ground and to maintain said base plate and mast in spaced relation with respect to the ground.

The valve 159 is provided to supply fluid under pressure to the port 120 of the ram 55 through a pressure line 170, to effect raising of the piston 115 and the entire ram assembly along the piston rod 105, and to engage the roof plate 54 with the mine roof and maintain said roof plate in engagement therewith. As herein shown, an accumulator 171 is connected in the pressure line 170 through a pressure line 173, to supply pressure to maintain the roof plate 54 in engagement with the roof in cases where the roof may give upwardly or the bottom may sink, to assure a rigid support between the mine bottom and roof under conditions where either the roof or bottom may give, due to the pressure exerted thereagainst. The accumulator 171 may be of any well known form so need only be diagrammatically shown herein. A relief valve 175 is shown as being connected with the pressure line 173 through a pressure line 176. The relief valve may be set to control the pressure of the roof plate 54 on the roof and to relieve this pressure when it exceeds a predetermined safe value.

The valve 159 also has connection with the port 111 through a pressure line 177 to supply fluid under pressure to said pressure line when the valve 159 is in a second position to effect lowering of the ram 55 along the piston rod 105, to disengage the roof plate 54 from the mine roof at the termination of a drilling operation, and when it is desired to move the drilling mechanism laterally to start the next succeeding hole.

The valve 157 has connection with the head end of the cylinder 85 through a pressure line 179 to supply fluid under pressure to the head end of said cylinder to extensibly move the piston rod 89 with respect to the cylinder 85, when the valve 157 is in one position. A pressure line 180 is connected from the pressure line 179 to the port 139 to supply fluid under pressure thereto to effect vertical movement of the inner cylinder 130 along the cylinder 117 and raise the sheaves 99 as the sheaves 95 are moving downwardly, and thus effect travel of the carriage 63 upwardly along the mast 51 to feed the chuck 77 and drill vertically into the mine roof, for drilling a hole therein.

The valve 157 also has a pressure line 181 leading therefrom having a relief valve 183 therein. A pressure line 184 connects the relief valve 183 with the sequence valve 185. The sequence valve 185 is diagrammatically shown in Figure 8 and may be of a well known form having a valve piston 186 therein, biased by a spring 187 to admit fluid to a port 188, connected with the port 131 through a pressure line 189, for supplying fluid under pressure to effect lowering movement of the inner

cylinder 130 along the cylinder 117. The sequence valve 185 also has a port 190 therein connected with the piston rod end of the cylinder 85 through a pressure line 191. The port 190 is normally closed by the valve piston 186. A pressure line 193 leads from the pressure line 184 through the body of the valve 185, to supply fluid under pressure to the opposite end of the valve piston 186 from the spring 187, and to move the valve piston against the bias of the spring 187 in position to admit fluid under pressure through the port 190 to the piston rod end of the cylinder 85 and effect elevation of the sheaves 95.

The sequence valve thus normally supplies fluid under pressure to lower the cylinder 130 along the cylinder 117 until the cylinder 130 reaches the lower end of its travel. The increased pressure caused by bottoming of the cylinder 130 will then pass through the pressure line 193 and move the valve piston 186 against its spring bias into position to admit fluid under pressure to the piston rod end of the cylinder 85 and retractibly move the piston rod 89 within the piston 85 and elevate the sheaves 95, accommodating the drill carriage 63 to move downwardly along the mast 51 by gravity.

Since the drill carriage 63 moves downwardly along the mast 51 by gravity, the sequence valve 185 serves to assure that the cylinder 130 and sheaves 99 move downwardly to their full extent of travel prior to upward movement of the sheaves 95 with respect to the cylinder 85. The cylinder 130 thus moving downwardly prior to upward movement of the sheaves 95 assures the absence of slack in the chain 96 which may be caused by retarding of the drill carriage 63 in its guides and too rapid relative movement between the sheaves 99 and 95 with respect to each other. The relief valve 183 connecting the pressure line 181 with the pressure line 184 is provided to relieve pressure from said pressure lines when the cylinder 130 is bottomed and the piston rod 89 is in its fully retracted position.

The fluid pressure connection from the pump 152 to the drill motor 76 includes a pressure line 195 connected from the pump 152 to a speed control valve 197, which may be of any well known form so need not herein be shown or described in detail. A pressure line 199 connects the valve 197 with a control valve 200 controlling the direction of operation of the drill motor 96. A pressure line 201 leads from the valve 200 to one end of the fluid motor 76 to effect rotation of said motor in one direction when the valve 200 is in one position. A pressure line 202 is connected from the valve 200 to the motor 176 to supply fluid under pressure thereto to reverse the direction of rotation of the motor 76 when the valve 200 is in a second position, it being understood that the pressure lines 201 and 202 serve as return lines, as well as pressure lines, depending upon the direction of rotation of the motor 76. A return line 203 leads from the valve 200 to the tank 150. A second return line 204 leads from the speed control valve 197 to the return line 203, to return fluid to the tank 150.

It should here be understood that when the drilling is soft, the bit should be rotated as rapidly as possible and the thrust of drilling must be limited to prevent the bit from plunging into the hole with a resultant clogging of the cuttings. In soft cutting, therefore, a relatively high pressure must be supplied for rotating the drill at the high rate of speed, enabling the bit to clear itself and to prevent plunging of the bit.

When the cutting is hard, as where the mine roof may be hard rock, the bit chips the cuttings from the roof with the result that the rotational force required to drive the drill is relatively low and the rotational demand stays the same during the entire operation of drilling in hard rock. The force required to rectilinearly feed the drill, however, increases to provide the maximum thrust necessary to chip the cuttings from the roof.

It should further be noted that with the drilling apparatus of our invention, since the mast 51 is solidly

wedged between the mine floor and mine roof and since the drill carriage is guided in the mast for movement therealong to effect the drilling operation, that drilling may be effected with very little attention from the operator and that the drill of my invention readily lends itself to automatic control of the drilling operation.

It should further be understood that the wedge mast takes the entire thrust of drilling from the truck therefor, and may readily be positioned beyond opposite sides of the truck without tipping the truck or straining the same, the entire thrust for drilling being taken directly on the ground and the mast automatically takes up to compensate for a sagging bottom or give in the roof, maintaining the mast wedged between the roof and floor for various operating conditions.

It may still further be seen that the guide 141 for the drill is positioned adjacent the mine roof to prevent wandering of the drill in the starting of a drilling operation, and that the dust collector is also at the roof and is a part of the drill guide making it necessary to have the dust collector in place before starting a drilling operation.

It may still further be seen that the parallel control circuit to the two raising and lowering cylinders with the sequence control valve in the circuit assures that the cylinder 130 will go down to the full length of its stroke before the piston 89 is elevated within its cylinder 85 and thus prevents the formation of slack in the chain connected to the carriage which may otherwise occur due to the fact that the carriage goes down by gravity and may be retarded in its downward travel.

It should also be understood that the mast 55 provides a continuous guide for the carriage rollers when in its collapsed and fully extended positions, forming a straight line guide for the carriage and drill carried thereby for the entire length of vertical travel of the carriage along the mast.

While we have herein shown and described one form in which our invention may be embodied, it should be understood that we do not wish to limit ourselves to the specific form shown, but that various variations and modifications in the invention may be effected without departing from the spirit and scope of the novel concepts thereof.

We claim as our invention:

1. In a drilling mechanism having an extensible mast and a drill carriage guided for movement therealong, a two-stage ram including a piston rod mounted on the lower end portion of said mast, a cylinder movable along said piston rod and connected with the upper end portion of said mast and having an outer cylinder movable along said first mentioned cylinder, a second ram supported on said mast adjacent the upper end thereof and having a depending piston rod, a sheave on said depending piston rod, a second sheave on said outer cylinder for movement therewith, a draft device fixed at one end from vertical movement and reeved about said sheaves and connected with said carriage at its opposite end for vertically moving said carriage along said mast upon the supply of fluid under pressure to elevate said outer cylinder and lower said depending piston rod, said drill carriage moving downwardly along said mast by gravity upon lowering of said outer cylinder and upward movement of said depending piston rod, and means assuring the lowering of said outer cylinder and the sheave thereon prior to raising said depending piston rod to maintain said draft device taut upon lowering of said drill carriage by gravity comprising a parallel fluid connection to said outer cylinder and the piston rod end of said second cylinder and a sequence valve in said parallel fluid connection normally open to supply fluid under pressure to lower said outer cylinder and operating upon the increase in pressure caused by bottoming of said outer cylinder to supply fluid under pressure to said second cylinder to raise said piston rod.

2. In a drilling mechanism having an extensible mast and a drill carriage guided for movement therealong, a two-stage ram including a piston rod mounted on the lower end portion of said mast, a cylinder movable along said piston rod and connected with the upper end portion of said mast and having an outer cylinder movable along said first mentioned cylinder, a second ram supported on said mast adjacent the upper end thereof and having a depending piston rod, a sheave on said depending piston rod, a second sheave on said outer cylinder for movement therewith, a draft device fixed at one end from vertical movement and reeved about said sheaves and connected with said carriage at its opposite end for vertically moving said carriage along said mast upon the supply of fluid under pressure to elevate said outer cylinder and lower said depending piston rod, said drill carriage moving downwardly along said mast by gravity upon lowering of said outer cylinder and upward movement of said depending piston rod, and means assuring the lowering of said outer cylinder and the sheave thereon prior to raising of said depending piston rod and the sheave thereon, to maintain said draft device taut upon lowering of said drill carriage by gravity comprising a parallel fluid connection to said outer cylinder and the piston rod end of said second cylinder and a sequence valve in said parallel fluid connection normally open to supply fluid under pressure to lower said outer cylinder and operating upon the increase in pressure caused by bottoming of said outer cylinder to supply fluid under pressure to said second cylinder to raise said piston rod, and an accumulator supplying pressure to said first cylinder of said two-stage ram to maintain said mast in engagement with the mine roof and floor and to automatically extend said mast to accommodate for give in the mine roof and floor.

3. In a drilling apparatus, a drill carriage, guide rollers mounted on said drill carriage and extending from opposite sides thereof, and a telescopic guide for said carriage guiding said carriage for vertical movement with respect to the ground including two facing outer channeled members engageable with the ground, two facing inner channeled members guided within said outer channeled members for movement therealong, the inner of said channeled members having parallel spaced walls forming a guide for said guide rollers and the outer of said channeled members having parallel spaced guide strips extending vertically therealong and terminating at their inner sides in alignment with the parallel spaced walls of the inner of said channeled members, whereby said parallel spaced guide strips form a vertical continuation of the guide formed by said parallel spaced walls and coact with said rollers to form a continuous guide for said rollers of the same width for the length of said telescopic guide when in its fully extended position.

4. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending extensible mast carried at the front of said frame for relative movement with respect thereto and including a lower guide section having a base plate thereon, hydraulic means connected between said frame and lower guide section for engaging said base plate with the ground, an upper guide section telescopically movable with respect to said lower guide section and having a roof plate thereon, second hydraulic means mounted on said base plate and having operative connection with said upper guide section for engaging said roof plate with the roof to provide a rigid column and guide between the roof and floor, a drill carriage guided in said guide for vertical movement therealong, a third hydraulic means supported on said upper guide section and depending therefrom, and a flexible draft device fixed at one end, connected with said drill carriage at its opposite end and operatively associated with said third and second hydraulic means, for vertically moving said drill carriage upon relative movement of said third and second hydraulic means with respect to each other.

5. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending extensible mast carried at the front of said frame for relative movement with respect thereto and including a lower guide section having a base plate thereon, hydraulic means connected between said frame and lower guide section for engaging said base plate with the ground, an upper guide section telescopically movable with respect to said lower guide section and having a roof plate thereon, second hydraulic means mounted on said base plate and having operative connection with said upper guide section for engaging said roof plate with the roof to provide a rigid column and guide between the roof and floor, a drill carriage guided in said guide for vertical movement therealong, a third hydraulic means supported on said upper guide section adjacent the upper end thereof and depending with respect to its supporting connection thereto and having a piston rod extensible from the lower end thereof, a sheave carried on said piston rod, a second sheave carried by said second hydraulic means, and a flexible draft device connected with the lower of said guide sections adjacent the upper end thereof and trained downwardly therefrom around said first sheave upwardly around said second sheave and downwardly to said drill carriage, and having connection therewith for vertically moving said drill carriage upon movement of at least one of said sheaves with respect to the other.

6. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending extensible mast carried at the front of said frame for relative movement with respect thereto and including a lower guide section engageable with the ground and an upper guide section telescopically movable with respect to said lower guide section for engagement with the roof, each guide section having facing channeled members guided for telescopic movement with respect to each other, the inner of said channeled members having parallel spaced walls extending the length thereof and the outer of said channeled members having guide strips extending vertically therealong over the ends of the walls of the inner of said channeled members and terminating in alignment therewith, to form a continuous guide of the same width throughout the length of said guide when in its extreme extended position, and a drill carriage having rollers extending therefrom of sufficient length to have guiding engagement with said parallel walls and said guide strips, and to be guided by said strips for a portion of vertical travel of said carriage, said strips and walls for an additional portion of vertical travel of said carriage and said walls for the remainder of vertical travel of said carriage and guiding said rollers beyond the ends of the inner of said channeled members along the outer of said channeled members.

7. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending extensible mast carried at the front of said frame for relative movement with respect thereto and including a lower guide section engageable with the ground and an upper guide section telescopically movable with respect to said lower guide section for engagement with the roof, hydraulic means connected between said frame and lower guide section for engaging said lower guide section with the ground, other hydraulic means connected between said lower guide section and upper guide section for engaging said upper guide section with the roof, to provide a continuous rigid column between the roof and ground taking the drilling reactions on the ground, each guide section including facing channeled members guided for telescopic movement with respect to each other, the inner of said channeled members having parallel spaced walls extending the length thereof and the outer of said channeled members having guide strips extending vertically therealong over the ends of the walls of the inner of said channeled members and terminating in alignment therewith to form a continuous guide of the same width throughout the length of said mast when in its extreme extended positions, a drill carriage having rollers of sufficient length to have guiding engagement with said walls and strips, a third hydraulic means, a flexible draft means operated by said third hydraulic means and connected between the upper end of said lower guide section and said carriage and operated by said third hydraulic means for vertically moving said carriage along said mast.

8. In a drilling apparatus particularly adapted for drilling in a mine roof, a mobile frame, a vertically extending guide at the forward end of said frame spaced vertically with respect to the ground, a vertically extending extensible mast guided in said guide for vertical movement therealong and including a lower guide section engageable with the ground, an upper guide section guided for telescopic movement with respect to said lower guide section, said upper and lower guide sections being arranged to provide continuous facing channeled guides in the various positions of extension and retraction of said guides with respect to each other, a hydraulic cylinder having a piston rod extensible therefrom connected between said vertically extending guide and said lower guide section for vertically moving said mast with respect to the ground and engaging said lower guide section with the ground, a second hydraulic cylinder having a piston rod extensible therefrom connected between said lower guide section and said upper guide section for engaging said upper guide section with the roof and maintaining said guide sections in engagement with the roof and ground, a drill carriage guided for movement along said guide sections for substantially the length thereof, a third hydraulic cylinder having a piston rod extensible therefrom carried on said upper guide section, a flexible draft device connected between the upper of said guide sections and said carriage and cooperating with said third hydraulic cylinder, and an operative connection between the piston rod of said third cylinder and said flexible draft device for vertically moving said drill carriage upon extensible movement of the piston rod from said third cylinder.

9. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, spaced vertically with respect to the ground, a telescopic mast guided in said guide for vertical movement therealong and including a lower guide section guided in said guide for vertical movement therealong, an upper guide section guided for telescopic movement with respect to said lower guide section, said guide sections being so constructed and arranged as to provide continuous facing channeled guides throughout the length of said mast in the various positions of adjustment thereof, a bearing plate on the lower end of said lower guide section, a hydraulic cylinder having a piston rod extensible therefrom connected between said vertically extending guide and bearing plate for engaging said bearing plate with the ground and holding said bearing plate in spaced relation with respect to the ground, a roof plate on the upper end of the upper of said guide sections, a second hydraulic cylinder having a piston rod extensible therefrom carried on said bearing plate and having engagement with said roof plate for maintaining said bearing plate in engagement with the ground and engaging said roof plate with a mine roof, a source of supply of hydraulic fluid under pressure including a valve and a pressure line connected from said valve to said second hydraulic cylinder for supplying fluid under pressure thereto to maintain said bearing and roof plates in engagement with the ground and roof, an accumulator having fluid connection with said pressure line to maintain said bearing plates in engagement with ground and roof and providing pressure to continue extensible movement of said piston with respect to said cylinder to compensate for give in the mine floor and roof, and means

limiting the pressure of said roof plate against the mine roof.

10. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, spaced vertically with respect to the ground, a telescopic mast guided in said guide for vertical movement therealong and including a lower guide section guided in said guide for vertical movement therealong, an upper guide section guided for telescopic movement with respect to said lower guide section, said guide sections being so constructed and arranged as to provide continuous facing channeled guides throughout the length of said mast in the various positions of adjustment thereof, a bearing plate on the lower end of said lower guide section, a hydraulic cylinder having a piston rod extensible therefrom connected between said vertically extending guide and bearing plate for engaging said bearing plate with the ground and holding said bearing plate in spaced relation with respect to the ground, a roof plate on the upper end of the upper of said guide sections, a second hydraulic cylinder having a piston rod extensible therefrom carried on said bearing plate and having engagement with said roof plate for maintaining said bearing plate in engagement with the ground and engaging said roof plate with a mine roof, a source of supply of hydraulic fluid under pressure including a valve and a pressure line connected from said valve to said second hydraulic cylinder for suppiying fluid under pressure thereto to maintain said bearing and roof plates in engagement with the ground and roof, and fluid pressure means having connection with said pressure line to maintain said bearing plates in engagement with ground and roof and providing pressure to continue extensible movement of said piston with respect to said cylinder to compensate for give in the mine floor and roof comprising an accumulator connected in said pressure line and charged by pressure in said pressure line, to supply pressure to said second hydraulic cylinder.

11. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, spaced vertically with respect to the ground, a telescopic mast guided in said guide for vertical movement therealong and including a lower guide section guided in said guide for vertical movement therealong, an upper guide section guided for telescopic movement with respect to said lower guide section, said guide sections being so constructed and arranged as to provide continuous facing channeled guides throughout the length of said mast in the various positions of adjustment thereof, a bearing plate on the lower end of said lower guide section, a hydraulic cylinder having a piston rod extensible therefrom connected between said vertically extending guide and bearing plate for engaging said bearing plate with the ground and holding said bearing plate in spaced relation with respect to the ground, a roof plate on the upper end of the upper of said guide sections, a second hydraulic cylinder having a piston rod extensible therefrom carried on said bearing plate and having engagement with said roof plate for maintaining said bearing plate in engagement with the ground and engaging said roof plate with a mine roof, a source of supply of hydraulic fluid under pressure including a valve and a pressure line connected from said valve to said second hydraulic cylinder for supplying fluid under pressure thereto to maintain said bearing and roof plates in engagement with the ground and roof, and fluid pressure means having connection with said pressure line to maintain said bearing plates in engagement with ground and roof and providing pressure to continue extensible movement of said piston with respect to said cylinder to compensate for give in the mine floor and roof, and an adjustable relief valve connected in said pressure line and limiting the pressure of said roof plate against the mine roof.

12. In a drilling apparatus particularly adapted for drilling in a mine roof, a mobile frame, a vertically extending guide at the forward end of said frame, a telescopic mast guided in said guide and including a lower guide section having a bearing plate on the lower end thereof, a first hydraulic cylinder having a piston rod extensible therefrom connected between said guide and the lower of said guides for engaging said bearing plate with the ground, an upper guide section guided for vertical movement along said lower guide section, a bearing plate on the upper end of said upper guide section for engagement with the roof, a second hydraulic cylinder having a piston rod extensible therefrom carried on said first mentioned bearing plate and connected with said second mentioned bearing plate, for engaging said second mentioned bearing plate with the mine roof, a source of supply of fluid under pressure including a pump, a plurality of valves, a pressure line leading from one of said valves to said first hydraulic cylinder, a pressure line leading from the other of said valves to said second hydraulic cylinder to effect engagement of said bearing plates with the ground and roof, and an accumulator in said pressure line maintaining fluid under pressure therein to maintain said bearing plates in engagement with the floor and roof and to take up for give in the floor and roof.

13. In a drilling apparatus particularly adapted for drilling in a mine roof, a mobile frame, a vertically extending guide at the forward end of said frame, a telescopic mast guided in said guide and including a lower guide section having a bearing plate on the lower end thereof, a first hydraulic cylinder having a piston rod extensible therefrom connected between said guide and the lower of said guides for engaging said bearing plate with the ground, an upper guide section guided for vertical movement along said lower guide section, a bearing plate on the upper end of said upper guide section for engagement with the roof, a second hydraulic cylinder having a piston rod extensible therefrom carried on said first mentioned bearing plate and connected with said second mentioned bearing plate, for engaging said second mentioned bearing plate with the mine roof, a source of supply of fluid under pressure including a pump, a plurality of valves, a pressure line leading from one of said valves to said first hydraulic cylinder, a pressure line leading from the other of said valves to said second hydraulic cylinder to effect engagement of said bearing plates with the ground and roof, and an accumulator in said pressure line maintaining fluid under pressure therein to maintain said bearing plates in engagement with the floor and roof and to take up for give in the floor and roof, a drill carriage guided for movement along said lower and upper guide sections, and a third hydraulic cylinder having a piston rod extensible therefrom, said third hydraulic cylinder having connection with the upper of said guides and depending therefrom, a flexible draft device connected between the lower of said guide sections and said drill carriage, and an operative connection between said piston rod of said third cylinder and said flexible draft device, for operating the same to vertically move said drill carriage along said guides.

14. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, a telescopic mast guided in said guide and including a lower guide section guided in said guide for vertical movement therealong and an upper guide section guided in said lower guide section for movement therealong, a bearing plate on the lower end of said lower guide section, a first hydraulic cylinder having a piston rod extensible therefrom connected between said guide and lower guide section, for vertically moving said bearing plate and mast with respect to the ground, a roof plate on the upper end of said upper guide section, a two-stage hydraulic cylinder and piston unit having a piston rod supported on the lower of said bearing plates, a cylinder movable along said

piston rod and having operative connection with said roof plate and a second cylinder movable along said first cylinder, a drill carriage guided in said lower and upper guide sections for movement along said mast, a third hydraulic cylinder depending from said roof plate and having a piston rod extensible from the lower end thereof, a guide sheave on the end of said last mentioned piston rod, a guide sheave on said second cylinder of said two-stage hydraulic cylinder and piston unit, and a flexible draft device connected from the lower of said guide sections, adjacent the upper end thereof and trained around said sheaves and having connection with said carriage for vertically moving said carriage along said lower and upper guides upon relative movement of said sheaves with respect to each other.

15. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, a telescopic mast guided in said guide and including a lower guide section guided in said guide for vertical movement therealong and an upper guide section guided in said lower guide section for movement therealong, a bearing plate on the lower end of said lower guide section, a first hydraulic cylinder having a piston rod extensible therefrom connected between said guide and lower guide section, for vertically moving said bearing plate and mast with respect to the ground, a roof plate on the upper end of said upper guide section, a two-stage hydraulic cylinder and piston unit having a piston rod supported on the lower of said bearing plates, a cylinder movable along said piston rod and having operative connection with said roof plate and a second cylinder movable along said first cylinder, a drill carriage guided in said lower and upper guide sections for movement along said mast, a third hydraulic cylinder depending from said roof plate and having a piston rod extensible from the lower end thereof, a guide sheave on the end of said last mentioned piston rod, a guide sheave on said second cylinder of said two-stage hydraulic cylinder and piston unit, and a flexible draft device connected from the lower of said guide sections, adjacent the upper end thereof and trained around said sheaves and having connection with said carriage for vertically moving said carriage along said lower and upper guides upon relative movement of said sheaves with respect to each other, a source of supply of fluid under pressure to said cylinders under manual selection and including a valve, a pressure line leading from said valve to said first mentioned cylinder of said two-stage hydraulic cylinder and piston unit, and an accumulator connected in said pressure line for maintaining pressure thereon and supplying sufficient pressure to said first mentioned cylinder of said two-stage hydraulic cylinder and piston unit to compensate for give in the mine floor and roof.

16. In a drilling apparatus particularly adapted for drilling in a mine roof, a frame, a vertically extending guide at the forward end of said frame, a telescopic mast guided in said guide for vertical movement therealong and including a lower guide section slidably guided in said guide, an upper guide section guided for telescopic movement with respect to said lower guide section, said guide sections being arranged to provide continuous facing channeled guides throughout the length of said mast, a drill carriage guided for movement along said guides, a bearing plate on the lower end of the outer of said guide sections, a first hydraulic cylinder having a piston rod extensible therefrom connected between said guide and bearing plate for engaging said bearing plate with the ground, a roof plate on the upper end of said upper guide section, a two stage ram having an inner cylinder with a piston rod extensible therefrom and carried on said bearing plate, said cylinder engaging said roof plate, said two-stage hydraulic ram also having an outer cylinder movable along said inner cylinder, a third hydraulic cylinder mounted on the inner of said guides adjacent the upper end thereof and depending therefrom, a piston rod extensible from the lower end of said cylinder, a sheave on said piston rod, a second sheave on said outer cylinder of said two-stage cylinder and piston, a flexible draft device connected with the lower of said guides adjacent the upper end thereof and reeved about said sheaves and having connection with said drill carriage for vertically moving said drill carriage upon relative movement of said sheaves with respect to each other, a source of supply of fluid under pressure, selectively operable valve means for supplying fluid pressure to said inner cylinder of said ram to engage said roof plate with a mine roof, a second valve, fluid pressure connections from said second valve to the outer cylinder of said ram and to the piston rod end of said third cylinder, to effect lowering of said outer cylinder and retractible movement of said piston rod with respect to said third cylinder, and a sequence valve in said fluid pressure connection to said last mentioned cylinders operable to assure lowering movement of said outer cylinder of said ram to the full length of its stroke prior to elevation of the sheaves operated by retractible movement of said piston rod of said third cylinder within said third cylinder.

17. In a drilling apparatus particularly adapted for drilling in a mine roof, a vertically extending extensible mast including a lower guide section having a bearing plate on the lower end thereof engageable with the ground, an upper guide section telescopically movable with respect to said lower guide section and having a roof plate on the upper end thereof for engagement with the roof, hydraulic cylinder and piston means mounted on said bearing plate for maintaining said bearing plate in engagement with the ground and having operative connection with said roof plate for moving said roof plate into engagement with the roof to provide a rigid column and continuous guide between the mine roof and floor, a drill carriage guided in said guide for vertical movement therealong, means for feeding said drill carriage vertically along said guide, a source of supply of fluid under pressure and valve means controlling the supply of fluid under pressure to said hydraulic cylinder and piston means to operate said hydraulic cylinder and piston means to engage said bearing plate with the ground and said roof plate with the mine roof, an accumulator charged from said source of supply of fluid under pressure and having fluid connection with said hydraulic cylinder and piston means for maintaining said bearing plate in engagement with the ground and said roof plate in engagement with the roof and taking up for give in the roof and floor, and relief valve means connected with said accumulator for limiting the pressure of said roof plate against the mine roof to a predetermined safe pressure.

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