April 2, 1968 H. G. PYLES ETAL 3,375,880

DUAL BOOM DRILL

Filed June 7, 1966 5 Sheets-Sheet 1

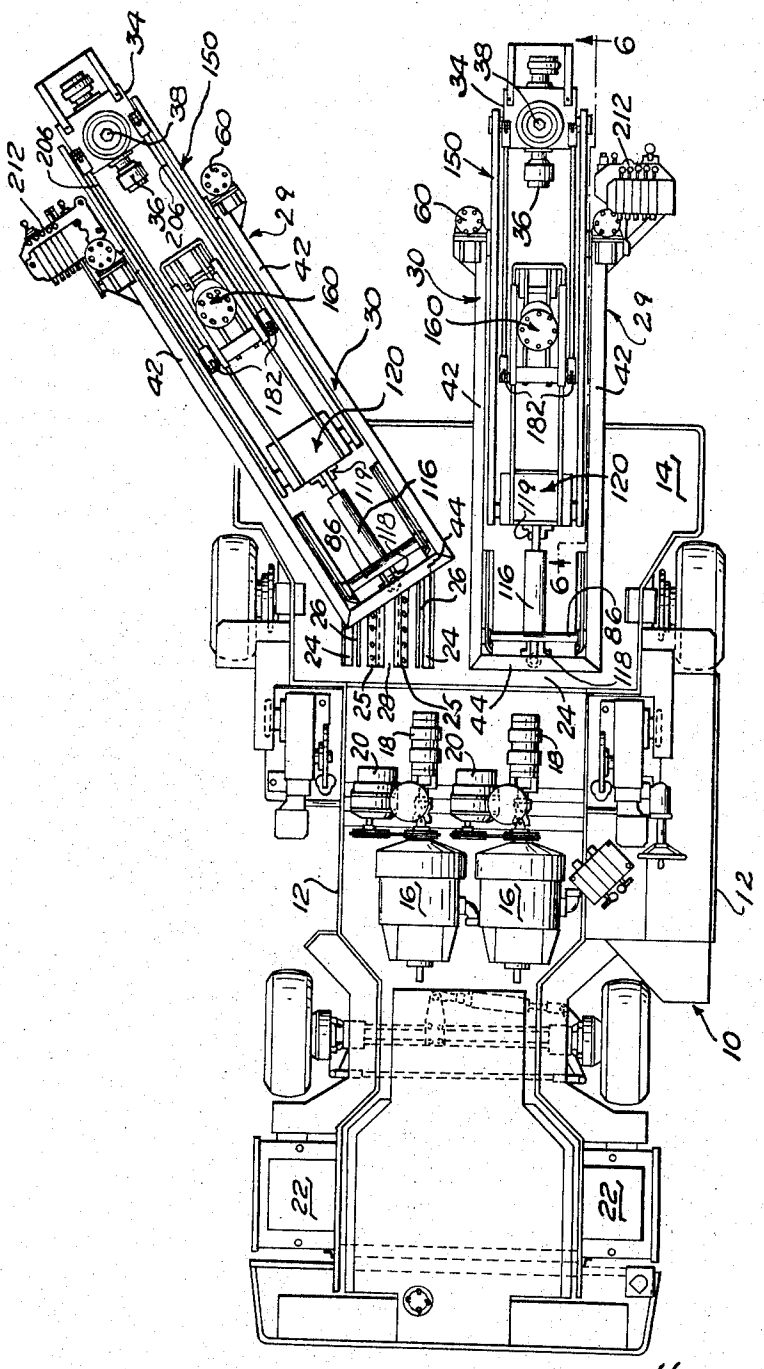


Fig. 1.

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DUAL BOOM DRILL

Filed June 7, 1966 5 Sheets-Sheet 2

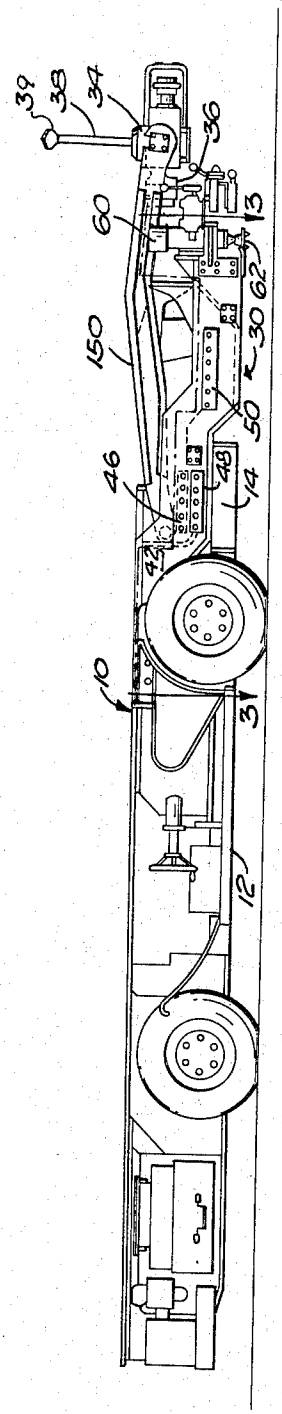


Fig. 2.

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DUAL BOOM DRILL

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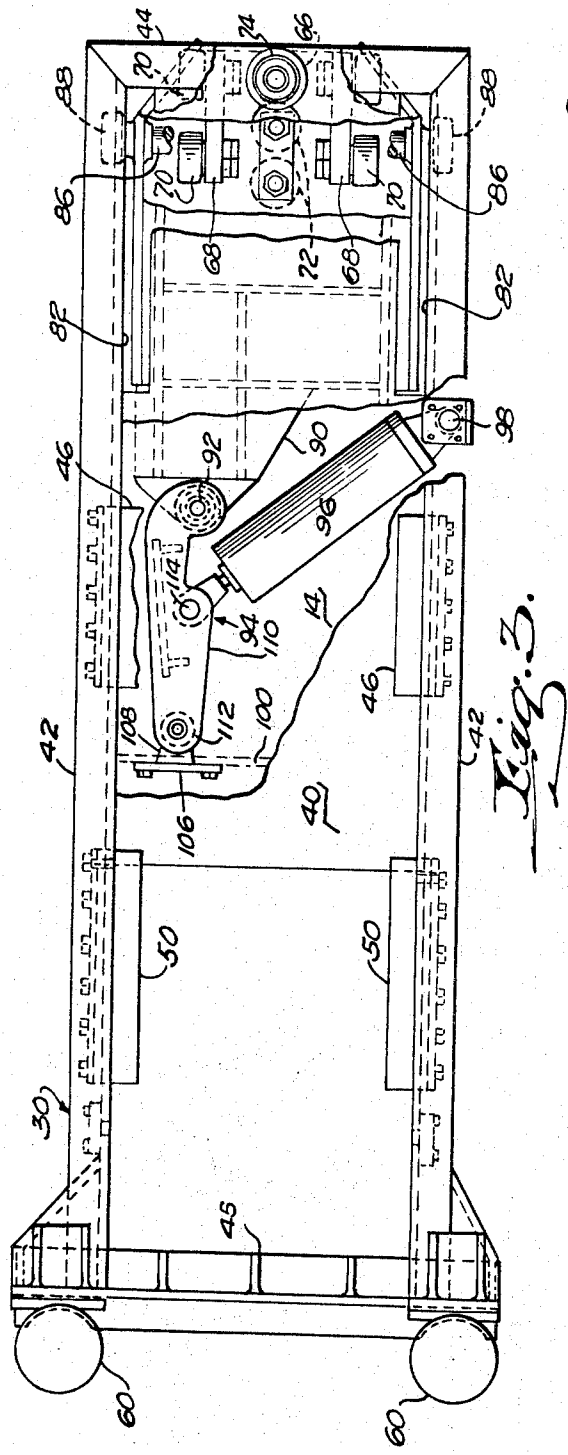


Fig. 3.

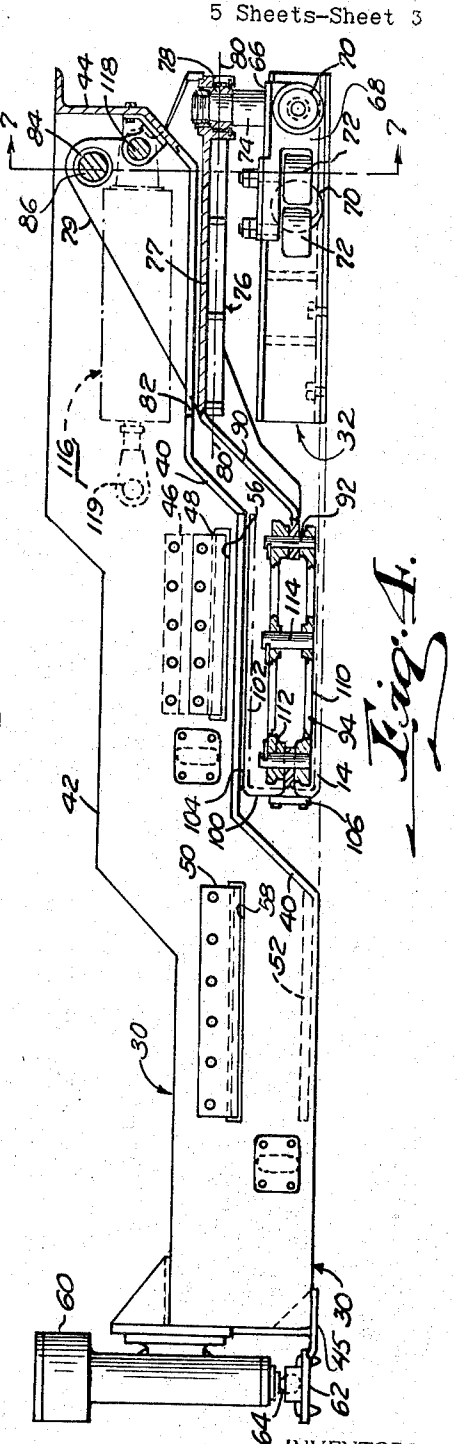


Fig. 4.

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DUAL BOOM DRILL

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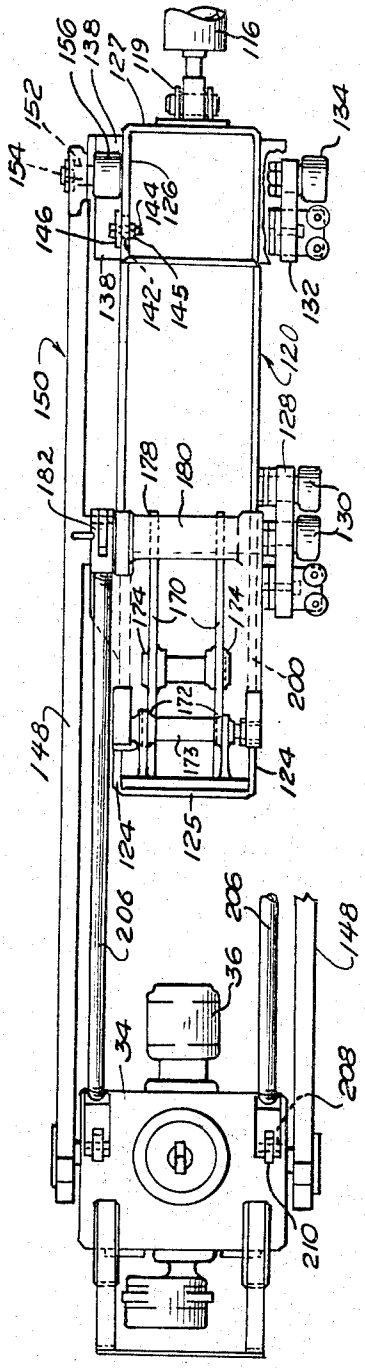


Fig. 5.

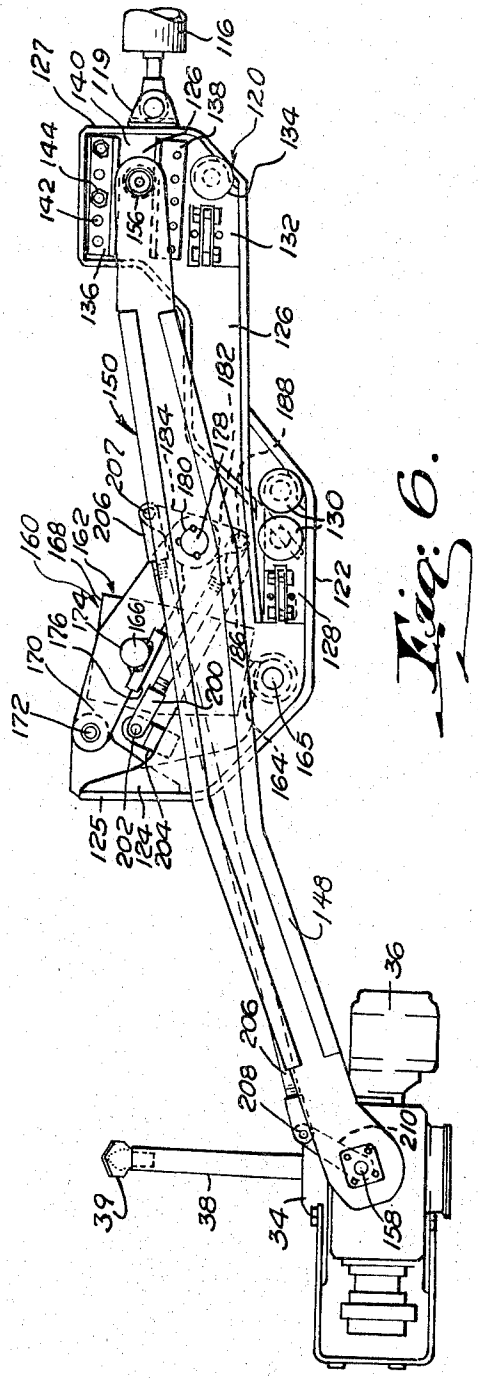


Fig. 6.

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DUAL BOOM DRILL

Filed June 7, 1966 5 Sheets-Sheet 5

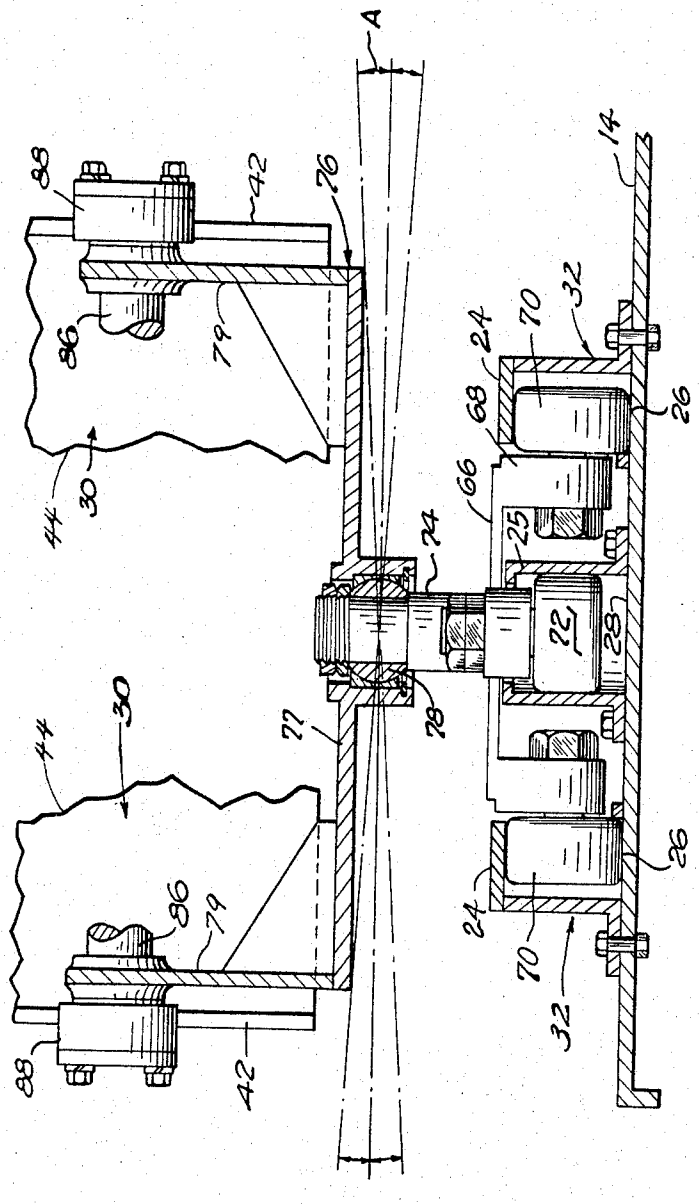


Fig. 7.

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United States Patent Office 3,375,880 Patented Apr. 2, 1968

3,375,880

DUAL BOOM DRILL

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Filed June 7, 1966, Ser. No. 555,738
10 Claims. (Cl. 173—37)

This invention relates to a mobile drilling machine and more particularly to a mobile drilling machine that includes means to adjust the axial position of the drill in the bore hole to maintain the drill axially aligned with the bore hole.

In underground mining, it is the present practice to support the roof of the excavated or mined areas with roof bolts and in certain instances with horizontal timbers or metallic tie members secured to the surface of the roof by a plurality of roof bolts that extend through predrilled holes in the timbers or tie members. It is believed that the roof bolts tie the overhead strata of different materials to each other and reduce horizontal shifting or sliding movement of the different strata relative to each other. With this type of roof support, it is now possible to mine and remove materials such as coal or the like according to a predetermined optimum plan.

Of greater import, however, is the improved safety afforded by supporting the overhead roof with roof bolts. The roof bolts support the rock strata forming the surface of the roof by tying exposed strata to a relatively hard and stable strata located thereabove so that the stable strata supports and holds the strata forming the exposed surface of the roof in place and minimizes the possibility of sections of the roof falling and injuring personnel working in the mine. The transverse timbers or metallic ties used under certain roof conditions are held in place adjacent the undersurface of the roof by a plurality of roof bolts extending through predrilled holes in the timbers or metallic tie members. The ties interconnect the roof bolts and provide additional bearing support for the roof. Under relatively stable roof conditions, the transverse ties or timbers may be omitted and roof bolts with rectangular bearing plates abutting the roof surface may be used to provide adequate and safe support for the roof.

In order to provide the desired roof support by bolting, it is necessary to first form bore holes or bolt holes to a given depth in the roof with a drill or boring tool. The depth of the bore hole may vary from several feet to ten feet or more, depending on the type of strata located above the roof. It is essential that the bore hole terminate in a strata that provides a good anchor for the expansion member on the roof bolt. Thus, the depth of the bore hole is controlled by the distance between suitable anchoring strata and the exposed roof surface.

It is often necessary to drill several bolt holes in a row transversely across the entry at given intervals to provide a standard bolt pattern. In patent application Ser. No. 254,544, entitled "Portable Drill Having Straight Line Motion," filed Jan. 23, 1963, now Patent No. 3,252,525 and assigned to the assignee of the present invention, there is described a mobile drilling machine that has a boom member extending forwardly therefrom. A horizontal linkage mechanism is provided to permit the drill head or drill pot maintained on the end of the boom to traverse a straight line perpendicular to the longitudinal axis of the drilling machine. Thus, if the drilling machine is positioned parallel to the entry, the boom, through the above-mentioned linkage, is movable linearly along a line transverse to the passageway or entry and is capable of drilling a plurality of bore holes along the line transverse

to the entry by moving the boom along and maintaining the body portion of the machine stationary.

The above-mentioned application also discloses a linkage mechanism for moving the drill mounted on the boom along a linear vertical path. With this arrangement, the bolt holes made by the drill are vertical and linear. There is also described in the above-mentioned application a means for mechanically varying the last named linkage mechanism to permit the drill mounted on the boom to move in a path at an angle and in a vertical plane. This provides a fore and aft angular adjustment for the drill steel. Thus, when the linkage mechanism is manually adjusted, it is possible with the drilling machine described in the above-mentioned patent to change the angular path of the drill from a straight line vertical path to a vertical fore or aft angular path relative to the mining machine and angular bolt holes may be drilled in the roof. The above-mentioned patent application therefore provides by means of the linkage described, an arrangement whereby a drill located at the end of a boom member may be moved in a preselected vertical plane. The drilling machine described in the above patent application is versatile and reduces substantially the time required to drill the holes in the roof bolts.

Where the bolt holes are being drilled in relatively hard materials substantial problems are encountered in aligning the drill steel with the axis of the bore hole during the drilling operation. Especially where the bolt holes are all a substantial depth. It has been found extremely difficult to maintain the drill steel aligned with the bore hole throughout the entire drilling operation. When one drills in hard material, frequently the drill steel will penetrate the hard material and be deflected slightly or tilt relative to the vertical axis. Continued vertical drilling when the drill steel is tilted or deflected and not aligned with the bore hole causes the drill steel to rub against the sides of the bore hole, especially at a location adjacent the roof surface which is called the collar of the hole. Under certain circumstances, the rubbing of the drill steel on the collar of the hole causes the drill steel through friction to overheat and break. As is well known, this frictional rubbing can also cause a fire hazard at the mine face in gaseous mines. The rubbing of the drill steel against the sides of the bore hole also absorbs a substantial amount of the thrust energy imparted to the drill and reduces the drilling efficiency. Another problem frequently encountered during drilling is through pre-drilled holes in tie members is the angular deflection of the predrilled holes relative to a vertical plane either because of the angular relation of the predrilled holes in the tie members or because the roof surface is not horizontally planar. There is a need, therefore, for a means to rapidly adjust the linear direction or path of the drill steel to thereby maintain the drill steel in alignment with the bore hole and eliminate the above-discussed rubbing of the drill steel against the side wall of the bore hole.

Briefly, our invention is directed to a mobile drilling apparatus that includes a swing frame connected to a deck of the mobile body. A boom member is pivotally connected at the rear end portion to the swing frame and has a drill pot secured to the boom front end portion. The swing frame has a linkage mechanism which permits the swing frame and boom member to pivot in a horizontal plane while the drill pot traverses a linear path perpendicular to the longitudinal axis of the drilling machine. A second linkage is included in the boom member to permit the drill pot to move along a linear path in a plane that includes the longitudinal axis of the boom member. The swing frame is universally connected to the mobile drilling machine and has support members connected to the front end thereof. The support members are operable

to rotate to a limited extent the swing frame about its longitudinal axis. To obtain a preselected angular relation of the swing frame transverse axis with the horizontal, the support members maintain the swing frame in this preselected angular relationship to the horizontal and permit the drill pot on the end of the boom to move upwardly in a plane at an angle to the vertical and thus advance the drill in the same angular plane. There is also provided in our drilling mechanism a means to adjust the linkage associated with the boom member by moving the boom member longitudinally relative to the swing frame to angularly adjust the drill steel forwardly or rearwardly in the same plane. Thus, with our invention, it is now possible to rapidly and accurately adjust the path of the drill steel in a plane including the longitudinal axis of the swing frame and in a plane transverse to the longitudinal axis of the swing frame. Our invention also includes a pair of drill assemblies each including a swing frame and boom member mounted on the front end of the mobile body and separately controlled to permit simultaneous drilling of a pair of bolt holes in the mine roof. The pair of swing frames are so connected to the mobile body that the drill pots secured to the front ends of the boom members mounted thereon move in substantially the same linear path perpendicular to the longitudinal axis of the drilling machine. With this arrangement, the pair of drilling assemblies are operable to simultaneously drill bolt holes along a line transverse to the longitudinal axis of the mining machine.

Accordingly, the principal object of this invention is to provide a mobile drilling machine that includes means to align the drill steel with the bore hole and to adjust the path of the drill steel to align the drill steel with the bore hole.

Another object of this invention is to provide a mobile drilling machine that includes a means to adjust the linkage mechanism in the boom member to pivot the drill pot and remotely adjust the angular relationship of the drill steel in a plane including the longitudinal axis of the swing frame.

A further object of this invention is to provide a mobile drilling machine that includes means to remotely adjust the transverse path of the drill steel.

A still further object of this invention is to provide a mobile drilling machine that includes a pair of drilling assemblies pivotally connected thereto and arranged to move the pair of drill pots in the same linear path that is perpendicular to the longitudinal axis of the drilling machine.

Other objects of this invention will become apparent from the following description of the practical embodiments thereof when considered in conjunction with the accompanying drawings.

In the drawings:

FIGURE 1 is a top plan view of a portable drilling machine embodying a pair of swing frames and boom members mounted thereon.

FIGURE 2 is a view in side elevation of the mobile drilling machine illustrated in FIGURE 1.

FIGURE 3 is an enlarged top plan view of the swing frame partially fragmented and taken along the line 3—3 in FIGURE 2 illustrating the linkage mechanism for moving the swing frame and the boom member mounted thereon in a horizontal direction. The linkage mechanism illustrated in FIGURE 3 and the means connecting the swing frame to the deck permits the drill pot positioned on the front end of the boom member to move in a linear path that is transverse to the longitudinal axis of the drilling machine.

FIGURE 4 is an enlarged view in side elevation and partially in cross-section of the swing frame and the means connecting the swing frame to the deck of the drilling machine body portion.

FIGURE 5 is an enlarged top plan view partially fragmented, of the drill boom member and the linkage mechanism associated therewith to move the drill pot vertically.

FIGURE 6 is an enlarged vertical section taken along the line 6—6 in FIGURE 1 illustrating the boom member and the linkage mechanism for raising and lowering the boom and for moving the boom member forwardly relative to the swing frame.

FIGURE 7 is a fragmentary view in section taken along the line 7—7 of FIGURE 4, illustrating the universal connecting means between the swing frame and the swing frame carriage.

Referring to the drawings and particularly to FIGURES 1 and 2, there is illustrated a drilling machine generally designated by the reference numeral **10** that includes a mobile body or wheeled car **12** having a flat deck **14** mounted on the front end thereof. A pair of motors **16** are mounted on the body **12** to furnish motive power for the car and to actuate a pair of hydraulic pumps **18** and a pair of vacuum pumps **20** that are suitably mounted on the body **12** behind the deck **14**. The hydraulic pumps **18** and the vacuum pumps **20** are suitably connected to the motors **16**. A pair of dust collectors **22** are mounted on the rear end of car **12** and are suitably connected to vacuum pumps **20** by flexible conduits (not shown).

A plurality of Z-shaped deck rails **24** and **25** are rigidly connected to the top surface of deck **14** extending from the rear end of deck **14** toward the front end thereof. Each of rails **24** and **25** is spaced from adjacent rails in parallel alignment with the longitudinal axis of the body **12**, thereby forming a pair of side deck channels **26** and a middle deck channel **28** (FIGURES 1 and 7).

A drilling assembly, indicated generally by reference numeral **29**, is movably mounted on deck **14** by means which are described more fully below. The structural details on drilling assembly **29** are shown in detail in FIGURES 3 through 7, where there is shown drilling assembly **29** comprising a swing frame indicated generally by reference numeral **30**, a boom numbered **150**, a swing frame carriage referred to generally by reference numeral **32**, a boom carriage referred to generally by reference numeral **120**, a drill pot **34** mounted on the end of boom **150** and having a drill steel **38** rotatably steel mounted therein. A drill bit **39** is secured to the end of the drill steel **38**. A hydraulic motor **36** is connected to drill pot **34** and rotates the drill steel **38** and drill bit **39**. Drilling assembly **29** also includes reciprocating means **116** mounted on swing frame **30** and connected to boom carriage **120** to move the boom carriage longitudinally on the swing frame, elevating means indicated by reference numeral **160** mounted on boom carriage **120** to raise and lower boom **150** and drill pot **34**, swing means indicated generally by numeral **94** mounted on deck **14** and connected to connecting frame **76** and swing frame **30** to move swing frame **30** laterally so that the drill pot **34** moves perpendicular to the longitudinal axis of car **12**, and stabilizing jacks **60** mounted on the front of swing frame **30**.

FIGURES 3, 4 and 7 show in detail the construction of swing frame **30** and swing frame carriage **32**. Swing frame **30** comprises a bottom member **40**, a pair of spaced parallel side members **42** integral with and extending upwardly from bottom member **40**, and integral at one end with a back member **44** that is integral with and extends upwardly from bottom member **40**, and a front member **45** integral with the front ends of side members **42**. A first pair of vertically spaced inwardly extending guide rails **46** and **48** are connected to each side member **42** of swing frame **30** and extend inwardly therefrom, at a position approximately intermediate the front and back ends of side members **42**. A second pair of vertically spaced guide rails **50** and **52** are connected to each side member **42** and extend inwardly therefrom at a position between the front of side members **42** and the first pair of guide rails **46** and **48**. Guide rails **48** and **50** are removable from side member **42** and are adjustable in openings **56** and **58** extending through side member **42**

to permit assembly and adjustment of boom carriage **120** on swing frame **30**.

A pair of stabilizing jacks **60** are mounted on either end at the front of swing frame **30**. Stabilizing jack **60** can be actuated either mechanically or hydraulically and has a base plate **62** connected by a ball joint **64** to the lower end of stabilizing jack **60** to engage forcibly the floor of a mine. In conjunction with additional structural elements that are discussed in detail below, stabilizing jacks **60** can be employed to maintain swing frame **30** in a horizontal position regardless of the attitude of car **12** and regardless of the contour of the mine floor. In addition, jacks **60** can be employed to tilt and maintain swing frame **30** in a tilted position at an angle to a horizontal plane contaning the longitudinal axis of swing frame **30** regardless of the orientation of car **12** and the contour of the mine floor.

As is shown in FIGURES 3, 4 and 7, swing frame carriage **32** comprises a lower frame plate **66** having spaced parallel side members **68** depending downwardly therefrom. Each side member **68** of carriage **32** has rotatably connected thereto a pair of vertical support rollers **70**, adjacent the outer surface of side member **68**. A pair of horizontal guide rollers **72** are rotatably mounted on lower frame plate **66** and depend downwardly between side members **68**. Swing frame carriage **32** is constructed and arranged such that support rollers **70** traverse deck channels **26** and guide rollers **72** traverse deck channel **28**, thereby assuring that motion of swing frame carriage **32** is confined to a straight line parallel to the longitudinal axis of car **12**. The deck rails **24** have inwardly extending portions that provide an abutment means for the rollers **70** when the stabjacks **60** exert an upwardly lifting force on the swing frame **30**.

A pivot post **74** is rigidly connected to and extends vertically upwardly from, lower frame plate **66** of swing frame carriage **32**. A connecting frame **76**, having a base **77** with side members **79** extending upwardly therefrom is connected by means of a universal ball joint connection **78** to the upper end of pivot post **74** vertically spaced above lower frame plate **66**. As is shown in FIGURES 4 and 7, the universal ball joint connection **78** between pivot post **74** and connecting frame **76** is constructed and arranged so as to permit connecting frame **76** to pivot about pivot post **74** and to tilt or revolve at least to a limited extent about the longitudinal axis of the swing frame. FIGURE 7 clearly illustrates the manner in which the swing frame **30** is connected to the connecting frame **76** and how the connecting frame pivots about the pivot post **74** through universal connecting means **78**. The stabjacks **60** are individually operable so that the effective length of the stabjacks may be remotely controlled. The difference in linear dimension of the stabjacks controls the relative transverse angle of the swing frame as is illustrated by the letter A in FIGURE 7. As will be later explained, the universal ball joint connection **78** between the swing frame carriage **32** and the swing frame **30** permits adjustment of the drill steel in a plane transverse to the longitudinal axis of the swing frame **30** and transverse to the longitudinal axis of the boom **150**.

Referring again to FIGURES 3, 4, and 7, a pair of spaced parallel side members **79** extend upwardly from base **77** of connecting frame **76** through slots **82** formed in the bottom member **40** of swing frame **30**. Each side member **79** has a hole **84** extending through the upper end thereof and aligned with a similar hole in the opposite side member **79**. A shaft **86** extends through holes **84** in side members **79** of connecting frame **76** with the ends of shaft **86** connected at **88** to side members **42** of swing frame **30**.

Connecting frame **76** has a front member **90** extending downwardly from the front of base **77**. The lower end of front member **90** is connected by a universal type ball joint connection **92** to swing means indicated generally by reference numeral **94** connected to the upper surface of deck **14**. Ball joint connection **92** between front member **90** of connecting frame **76** and swing means **94** is similar in construction and operation to connection **78** between connecting frame **76** and pivot post **74** on swing frame carriage **32**. Thus, front member **90** on connecting frame **76** can both pivot about connection **92** and can be tilted at least to a limited extent about connection **92** while swing means **94** remains connected to and parallel with the upper surface of deck **14**. With the construction described above and shown in FIGURES 3 and 4 stabilizing jacks **60** can be operated independently to tilt swing frame **30** and connecting frame **76** as an integral structure relative to deck **14** while swing means **94** and lower frame plate **66** of swing frame carriage **32** remain mounted on deck **14** in parallel relation therewith.

Swing means **94** comprises a hydraulically actuated swing jack **96** pivotally connected at one end **98** to deck **14** near the central longitudinal axis through bed **14** and adjacent the other drilling assembly **29**. A flange **100** is integral with and extends vertically upwardly from deck **14** (FIGURES 3 and 4). A lower slide plate **102** is integral with the upper end of vertical flange **100** and extends rearwardly therefrom in vertically spaced parallel relation with the upper surface of deck **14**. An upper slide plate **104** is rigidly secured to the lower surface of bottom member **40** of swing frame **30**, in abutting slidable relationship with lower slide plate **102**. The slidable contact between slide plates **102** and **104** permits lateral swinging motion of swing frame **30** relative to deck **14** while providing continuous support for swing frame **30**.

A swing lever mounting plate **106** is rigidly secured to flange **100** and has a tongue **108** extending through flange **100** into the space between lower slide plate **102** and deck **14**. A swing lever **110** is pivotally connected at one end **112** to tongue **108** of mounting plate **106**. Swing lever **110** projects rearwardly from its connection to mounting plate **106** in a direction opposite to the direction of forward motion of swing frame carriage **32** and swing frame **30**. The opposite end of swing lever **110** is connected to front portion **90** of connecting frame **76**, as explained above. Swing jack **96** extends from its pivotal connection **98** to deck **14** under swing frame **30** to a pivotal connection **114** with swing lever **110** intermediate the ends of swing lever **110**.

When swing jack **96** is actuated, swing lever **110** pivots about its fixed end **112** with the opposite end of swing lever **110** traversing an arcuate path that is concave toward the front of swing frame **30**. The swinging motion of end **92** of swing lever **110** is imparted through connecting frame **76** to swing frame **30**. Simultaneously with imparting a swinging motion to connecting frame **76** and swing frame **30**, the moving end of swing lever **110** imparts to the lower frame plate **66** of swing frame carriage **32** a straight linear movement parallel to the longitudinal axis of car **12**, which straight linear motion is also imparted to the rear end of swing frame **30** at a point immediately above the center of pivot post **74** on swing frame carriage **32**. The combination of the swinging motion of swing frame **30** and connecting frame **76** with the linear motion of swing frame **30** and swing frame carriage **32** results in movement of the front end of swing frame **30** along a straight line laterally with relation to drilling machine **10** and perpendicular to the longitudinal axis thereof.

As illustrated in FIGURES 1 and 4 the reciprocating means **116**, such as a hydraulic jack, is connected at **118** to rear member **44** of swing frame **30** and is connected at **119** to a boom carriage, indicated generally by reference numeral **120** and illustrated in detail in FIGURES 5 and 6. Boom carriage **120** is illustrated in detail in FIGURES 5 and 6 and includes a base **122**, spaced parallel front side walls **124** extending upwardly from base **122** and connected by a front end plate **125** and spaced parallel rear side walls **126** extending upwardly from base **122** and connected by a rear end plate **127** to which the reciprocating

means 116 is pivotally connected at 119. A pair of roller connecting plates 128 are rigidly secured one on either side of base 122 between the front side walls 124 and rear side walls 126. A pair of front rollers 130 are rotatably mounted on each roller connecting plate 128 at the side thereof remote from base 122 of boom carriage 120. A rear roller connecting plate 132 is rigidly secured to and spaced from the outer surface of each rear side wall 126 of boom carriage 120, and a rear roller 134 is rotatably secured to each of rear roller mounting plates 132 adjacent the side thereof remote from the rear side wall 126.

FIGURES 3 and 4 illustrate the swing frame 30 and FIGURES 5 and 6 illustrate the boom carriage 120. The boom carriage 120 is maintained in the swing frame 30 and the rear end of boom carriage 120 is connected at 119 to reciprocating means 116, front rollers 130 on boom carriage 120 engage and traverse a path between front side rails 50 and 52 on swing frame 30, and rear rollers 134 on boom carriage 120 engage and traverse a path between side rails 46 and 48 on swing frame 30. As was indicated above, side rails 48 and 50 are removable from side members 42 of swing frame 30 to enable assembly and adjustment of boom carriage 120 on swing frame 30. Reciprocating means 116 can be actuated to move boom carriage 120 longitudinally along swing frame 30, thereby increasing the available drilling area obtainable with the use of this invention and permitting greater flexibility in aligning the drill with the desired location of bolt holes and with predrilled holes in the rigid tunnel support members.

Upper and lower boom rails 136 and 138, respectively, are connected, as shown in FIGURE 6 on boom carriage 120 to the outer surface of rear side wall 126 and extend outwardly therefrom in spaced parallel relation with each other to define therebetween a slide path 140. A plurality of bolt holes 142 extend through rear side wall 126 and boom rails 136 and 138 are connected to rear side wall 126 by bolts 144 through holes 142, or other suitable fastening means constructed and arranged to permit adjustment of the rails to provide a slide path 140 that can be either horizontal or can be inclined at an angle to the horizontal. For example, hole 142 can have a diameter substantially larger than the shaft of bolt 144 which is secured by a lock nut 145, as shown in FIGURE 5, and a lock washer 146 or other suitable means, can be interposed between the head of bolt 144 and the outer surface of rail 136 or 138 to provide secure rigid mounting of the rails on rear side wall 126 with the rails oriented in any desired horizontal or inclined position. The function, in combination with other structural elements of the apparatus of this invention, of structure providing either a horizontal or inclined slide path 140 is explained more fully below.

FIGURE 5 illustrates one-half of the mounting arrangement for the boom 150 in the boom carriage 120. It should be understood, however, both boom arms 148 are similarly secured to the rear of boom carriage 120. The boom 150 has a pair of parallel arms 148 movably mounted in one end thereof between the pairs of boom rails 136 and 138 on boom carriage 120. The arms 148 have a pair of holes 152 extending transversely through the rear end thereof with shafts 154 secured to the boom and extending through holes 152 with boom arms 148 rotatable about shafts 154. Boom rollers 156 are rotatably mounted on shafts 154 between boom arms 148 and boom carriage rear side wall 126 in engagement with the respective boom rails 136 and 138 for traversing slide path 140. Drill pot 34 is pivotally connected at 158 at the opposite end of and between boom arms 148 remote from boom carriage 120.

Elevating means, indicated in FIGURE 6 generally by reference numeral 160, constructed and arranged to raise and lower boom 150 is mounted on boom carriage 120 adjacent front side walls 124. Elevating means 160 comprises a hydraulically actuated elevating jack 162 having a piston rod 164 pivotally connected at 165 to lower side wall 124 of boom carriage 120. The jack 162 is pivotally connected to the elevating links 170 by trunnions 166 on opposite sides of the jack cylinder 168.

The pair of elevating links 170 are pivotally connected at 172 to a shaft 173 extending between front side walls 124 of boom carriage 120 for vertical swinging movement of elevating link 170. A recessed portion 174 is cut in elevating links 170 intermediate the ends thereof to engage trunnions 166 extending outwardly from the side of cylinder 168. Elevating link 170 is secured at 174 on trunnion 166 by retaining bar 176. The end of elevating link 170 remote from pivotal connection 172 to shaft 173 is pivotally connected at 178 to a shaft 180 extending transversely across boom carriage 120 with each end of shaft 180 rigidly secured to one of the pair of parallel boom arms 148.

At this point it should be noted for clarity that the complete structure of the boom 150 includes a pair of boom arms 148 that are maintained in spaced parallel relation by shaft 180, drill pot 34, and the connection between boom arms 148 and rear side wall 126 of boom carriage 120. Similarly, elevating means 160 includes a pair of elevating levers 170 that are maintained in spaced parallel relation by the intermediate portion of shaft 180, trunnions 166 and cylinder 168, and the intermediate portion of shaft 173. Detailed description of such plurality of structural elements in the apparatus of this invention has been omitted, where possible, to simplify the description presented herein.

A pair of pivot levers 182 (only one of which is shown in FIGURES 5 and 6) are rotatably mounted on shaft 180 between elevating lever 170 and boom 150. The pivot levers 182 each have oppositely projecting lever arms 184 and 186. One end of each connecting rod 200 is pivotally connected at 188 to lever arm 186 of pivot lever 182, and the other end of connecting rod 200 is pivotally connected at 202 to a connecting bracket 204 extending inwardly from front side wall 124 of boom carriage 120. Connecting rod 200 and mounting bracket 204 are constructed and arranged such that pivotal connection 202 is adjacent and vertically spaced from pivotal connection 172 between elevating lever 170 and shaft 173. A second pair of connecting rods 206 are pivotally connected at 207 to the other lever arms 184 of pivot levers 182, and the other ends of connecting rods 206 are pivotally connected at 208 to one end of a drill pot link 210. The other end of drill pot link 210 is rigidly connected to drill pot 34 at 158 in a common connection with the pivotal connection between boom 150 and drill pot 34.

The above described linkage among elevating means 160, boom 150, and drill pot 34 is constructed and arranged such that a first parallelogram is formed by elevating levers 170, lever arms 182 between pivotal connections 178 and pivotal connections 188, connecting rods 200, and the vertical distance between pivotal connections 202 and pivotal connections 172. A second parallelogram is formed by lever arms 184 between pivotal connections 178 and pivotal connections 207, connecting rods 206, drill pot links 210, and the portion of boom arms 148 between pivotal connections 158 and pivotal connections 178. The linkage functions in combination with the pivotal and longitudinally movable connection at the rear end of boom arms 148 to shafts 154 to move drill pot 34 along a straight path. As elevating jack 162 is actuated, pivotal connections 178 between elevating links 170 and boom arms 148 transverses an arcuate path that is concave toward the front end of boom 150. The arcuate forward motion employed to raise and lower boom 150 is combined with the longitudinal motion of boom arms 148 on rollers 156 along slide path 140 to provide a resultant straight line motion to the front end of boom 150 and drill pot 34. The straight line of travel of drill steel 38 in drill pot 34 thus lies in a plane perpendicular to the longitudinal axis through slide path 140.

Thus, if boom guide rails **136** and **138** are adjusted such that the longitudinal axis of slide path **140** is inclined to the horizontal, the motion of drill pot **34** will follow a straight line making an angle with the vertical along a path perpendicular to the longitudinal axis of slide path **140**.

In order to tilt drill pot **34** to align the drill with the new angular path of movement, it is necessary to change the linkage relationship between elevating means **160** and boom **150**. This is done by providing a new location for pivotal connection **202** between connecting rod **200** and connecting bracket **204** secured to boom carriage **120**. The now location of pivotal connection **202** is on one side of the vertical line projected downwardly from pivotal connection **172**. The new location of pivotal connection **202** is displaced to an extent that the line between connection **202** and pivotal connection **172** is at an angle to the vertical equal to the angle at which drill pot **34** will operate when the boom traverses the desired path inclined to the vertical. The adjustability of connection **202** can be attained by making mounting bracket **204** adjustable on front side wall **124** or by providing a plurality of available locations for connection **202** on mounting bracket **204**.

The adjustability or tilt of the drill pot to align the drill in a new angular path either fore or aft may also be attained after the drill steel **38** and drill bit **39** are in the bolt hole. This is accomplished by moving the boom carriage **120** longitudinally in the swing frame to thus move the pivotal connection **202** longitudinally relative to pivotal connection **172**. This movement of carriage **120** on swing frame **30** is accomplished by remotely actuating the reciprocating means **116**.

Operation

The drilling machine **10** is moved into position with the pair of drilling assemblies **29** extending forwardly from the mobile body **12**. The drilling assemblies **29** are positioned with the drill steel **38** adjacent the desired line of drilling. The stabjacks **60** are actuated to move the base plates **62** into abutting relation with the mine floor and stabilize the swing frame **30**. The drilling assemblies **29** are then separately controlled to pivot the boom assemblies **150** and move the drill bit **39** upwardly adjacent the roof. Where minor fore or aft adjustments are required, the reciprocating means **116** may be actuated to move the boom **150** and boom carriage **120** longitudinally on the swing frame **30** while the drill bit **39** is spaced from the roof. The linkage for boom **150** is then actuated to move the drill steel **38** in an upward vertical direction and the motor **36** is actuated to rotate the drill bit. Where desired, a percussive member may also be associated with the drill pot to apply percussive forces to the drill bit as it is rotatably driven by the motor **36**. During the drilling operation, that is as the drill steel **38** is advanced upwardly into the roof, minor angular adjustments can be made to the drill steel to minimize or eliminate rubbing of the drill steel against the bore hole.

Assuming, for example, that the drill bit **39** strikes a hard material during initial penetration and is deflected laterally relative to the longitudinal axis of the boom **150**. Continued penetration of the drill bit would cause the drill steel **38** to rub on a lateral edge of the bolt hole. To eliminate the rubbing the lateral angularity of the drill steel **38** can be adjusted remotely by actuating the individually operable stabjacks **60** to rotate the swing frame **30** about its longitudinal axis as is illustrated in FIGURE 7. The angular deflection of the drill steel **38** is the same as the angular rotation of the swing frame **30** about its longitudinal axis, as for example, the angle A illustrated in FIGURE 7. With this arrangement, the drill steel **38** is deflected laterally until it is aligned with the angular hole being formed in the mine roof.

If the angular deflection from the vertical is fore or aft relative to the longitudinal axis of the boom **150**, the angularity of the drill steel **38** can be adjusted by remotely actuating the reciprocating mechanism **116** to change the fore or aft angularity of the drill steel **38** after the bit has penetrated the roof. The bit penetration in the roof holds the front end of the boom in a fixed position and fore or aft movement of the boom in the swing carriage changes the relative location of the pivots in elevating means **160** and changes the fore or aft angle of the drill steel **38**.

To drill a series of bolt holes along a line transverse to the longitudinal axis of the drilling machine, the swing frame **30** of the respective drilling assemblies **29** is actuated to move the drill pot in the desired line transverse to the longitudinal axis of the drilling machine. The angular adjustments previously described may be accomplished in any position of the drilling assemblies **29** by the previously described remote actuating means.

It will be apparent that the combination of longitudinal and lateral movement of the drill steel **38** provides rapid and accurate alignment of the drill steel with a desired location over a large area without repositioning the drilling machine.

Each of the drilling assemblies **29** is separately operated from separate control panels **212** mounted on the front of the drilling assemblies **29**. Each of the hydraulically actuated elements is connected by a suitable conduit to the pumps **18**. In addition, there may be incorporated with the apparatus of this invention the additional improvements described in application Ser. No. 254,544 comprising the hollow drill steel and suitable collecting conduits connected with vacuum pumps **20** and dust receiver **22** to provide for continuous collection and removal of dust from the drilling area. The adjustment and linkages associated with the swing frame **30** and boom **150** may also be incorporated in a drilling machine having only one drilling assembly.

According to the provisions of the patent statutes, we have explained the principle, preferred construction, and mode of operation of our invention and have illustrated and described what we now consider to represent its best embodiments. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. In a mobile drilling machine the combination comprising,

a mobile body having a horizontal deck portion,

a swing frame assembly pivotally secured to said horizontal deck portion,

a boom assembly having a front end portion and a rear end portion, said boom assembly rear end portion pivotally connected to said swing frame assembly for vertical pivotal movement of said boom assembly front end portion relative to said swing frame assembly,

means to pivot said boom assembly adjacent said rear end portion relative to said swing frame assembly so that said boom assembly front end portion moves in a vertical linear path,

means to pivot said swing frame assembly in a plane parallel to said horizontal deck portion and move said boom assembly front end portion in a linear path transverse to the longitudinal axis of said mobile body,

said swing frame assembly including universal means to permit limited rotation of said swing frame assembly about the longitudinal axis of said swing frame assembly and relative to said horizontal deck portion, and

actuating means connected to said swing frame assembly to rotate said swing frame assembly about the longitudinal axis thereof and relative to said horizontal deck portion to preselected positions wherein said boom front end portion moves in a plane at an

angle to a vertical plane and in a plane parallel to the transverse axis of said mobile body.

2. A mobile drilling machine as set forth in claim 1 which includes,

a drill pot pivotally connected to the front end portion of said boom assembly and having a drill member extending upwardly therefrom,

said boom assembly including linkage means to move said drill member in a linear vertical path, and

means to move said boom assembly relative to said swing frame assembly to adjust said linkage means so that said drill member moves in a plane at an angle to the vertical and in a plane parallel to the longitudinal axis of said mobile body as said boom assembly pivots relative to said swing frame assembly.

3. A mobile drilling machine as set forth in claim 1 in which said swing frame assembly includes,

a swing frame carriage posiitoned on said horizontal deck portion,

a swing frame having a front end portion and a rear end portion, and

universal connecting means connecting said swing frame rear end portion to said swing frame carriage, said universal connecting means operable to permit limited rotation of said swing frame about the longitudinal axis of said swing frame relative to said swing frame carriage to thereby permit said boom front end portion to move in a plane at an angle to a vertical plane and in a plane parallel to the transverse axis of said mobile body.

4. A mobile drilling machine as set forth in claim 1 in which said actuating means includes,

ground engaging jacks connected to the front end of said swing frame and arranged to rotate said swing frame about the longitudinal axis thereof relative to said swing frame carriage so that said boom front end portion moves in a plane at an angle to a vertical plane and in a plane parallel to the transverse axis of said mobile body.

5. A mobile drilling machine as set forth in claim 2 in which said means to move said boom assembly relative to said swing frame assembly includes guide means on said swing frame assembly and power actuated means to move said boom assembly longitudinally relative to said swing frame assembly.

6. In a mobile drilling machine the combination comprising,

a mobile body having a horizontal deck portion,

longitudinal guide means on said deck portion,

a drilling assembly including a swing frame carriage positioned in said guide means and movable longitudinally along an axis parallel to the longitudinal axis of said mobile body,

a swing frame having a front end portion and a rear end portion,

universal connecting means connecting said swing frame rear end portion of said swing frame carriage so that said swing frame is operable to pivot in a horizontal plane relative to said horizontal deck portion about said universal connecting means,

a linkage mechanism connected to said deck portion and said swing frame intermediate said end portions, said linkage mechanism including actuator means operable to pivot said swing frame in a horizontal plane and move said swing frame front end portion along a substantially linear path transverse to the longitudinal axis of said mobile body,

support means connected to said swing frame front end portion and arranged to support the front end of said swing frame and to maintain said swing frame transverse axis in a preselected angular relation to a horizontal plane,

a boom member having a front end portion and a rear end portion, said boom member rear end portion pivotally connected to said swing frame rear end portion for vertical pivotal movement of said boom member front end portion relative to said swing frame,

a drill pot pivotally connected to the front end portion of said boom member and having a drill member extending upwardly therefrom,

said boom member having a second linkage mechanism connected to said drill pot with a second actuator means operable to move said drill member along a linear path in a plane that includes the longitudinal axis of said boom member, and

said support means including means to permit limited rotation of said swing frame about the longitudinal axis of said swing frame and thereby permit the drill member to move in a plane at an angle to a vertical plane and in a plane parallel to the transverse axis of said mobile body.

7. A mobile drilling machine as set forth in claim 6 which includes,

power actuated means connecting said boom member rear end portion to said swing frame,

said power actuated means operable to move said boom member longitudinally relative to said swing frame and move the relative location of the pivot connections in said linkage mechanism to thereby change the angle of said drill member so that said drill member moves in a plane at an angle to the vertical and in a plane parallel to the longitudinal axis of said mobile body.

8. A mobile drilling machine as set forth in claim 6 which includes,

a pair of drilling assemblies arranged in side by side relation on said horizontal deck portions with said boom members extending forwardly therefrom, and

separate linkage mechanisms connected to said deck portion and arranged to pivot the front ends of said drilling assemblies toward and away from each other in a horizontal plane so that said drill members move in the same linear path transverse to the longitudinal axis of said mobile body.

9. A mobile drilling machine as set forth in claim 6 in which said support means includes,

a pair of ground engaging jack members connected to said swing frame front end portion on opposite sides of the longitudinal axis of said swing frame, and

said jack members including power actuated means operable to extend and retract said jack members and thereby rotate said swing frame about the longitudinal axis thereof.

10. A mobile drilling machine as set forth in claim 9 which includes,

control means for said power actuated means operable to extend and retract said jack members and for said power actuated means operable to move said boom member longitudinally relative to said swing frame, and

said control means operable to adjust the angular relation of said drill member relative to said mobile body during the drilling operation to thereby align the drill member in the drill hole.

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