ABSTRACT OF THE DISCLOSURE

Boom apparatus for supporting a rock drill which permits parallel holes to be drilled. There is a motor for rotating the boom 360° about the longitudinal axis of the boom. Thus, the motor also provides means for translating the drill parallel to the longitudinal axis of the boom. The motor is thus capable of positioning the drill parallel to the longitudinal axis of the boom. The motor may also be used for translating the drill parallel to the longitudinal axis of the boom. The motor may also be used for positioning the drill parallel to the longitudinal axis of the boom.

This application is a continuation-in-part of my prior copending U.S. patent application Ser. No. 469,783, now abandoned. This invention relates to boom construction and more particularly to booms for supporting and universally positioning drills and the like.

Booms of the present type are particularly adapted to drilling and/or mining machines as shown, described, and claimed in my copending U.S. patent applications, Ser. Nos. 385,666, now Patent No. 3,283,831, and 385,694, now abandoned, filed July 28, 1964, and assigned to the same assignee as is the present application.

In essence, machines of the type noted above are positioned in a working position for drilling a multiplicity of spaced holes in a working surface. Such holes when drilled in a vertical surface, in most instances, are perpendicular to the working surface or parallel to the longitudinal axis of the machine. Such surfaces when defining an end wall of a tunnel or excavation are cut from one side to the other, and from the roof to the floor of the excavation. Thus a drill must be positionable laterally and vertically. This vertical movement must be available below a normal horizontal position as well as above it. It is readily understandable that drilling a plurality of holes as hereinbefore discussed will be greatly facilitated if the drill or drills are positionable by their supporting booms and do not require repositioning of the drilling or mining machine during the drilling of one series of holes, especially when the machine is not of the self-propelled type.

Accordingly, an object of the present invention is to provide a boom for supporting and universally positioning a drill of a drilling machine for drilling a plurality of holes in a working surface.

Another object of the present invention is to provide the foregoing boom which is normally disposed along a longitudinal axis space laterally and vertically from the edges of the working surface to be drilled.

Another object of the present invention is to provide the foregoing movable in any direction from its normal longitudinal axis for displacing the drill it supports and for maintaining the axis of the displaced drill parallel to the longitudinal axis.

And, another object of the present invention is to provide the foregoing boom with means for moving the drill supported thereby out of parallelism with the longitudinal axis.
shown) engaging such axial and spiral splines is moved axially in motor 2 to rotate rotor 3.

An upper or main boom arm 6 extends along axis A-A and is pivotally connected to its rearward end to fit into 4 by a pivot or pivot pin 15, disposed parallel to arm 8 of fitting 4, by a pivot or pivot pin 13, disposed parallel to pivot 5. A lower or idler boom arm 6, is pivotally connected at its ends to the arm 8 and to the other end of link 15 by pivots or pivot pin 9 and 14, respectively, which are parallel to pivots 5 and 13. Thus, the main and idler boom arms 6 and 7 cooperate with arm 8 of fitting 4 and with idler link 13 to define a parallelogram.

An axial motor, comprising a cylinder 10 and a piston 11 movable axially relative to the cylinder, is pivotally connected at its ends to arm 8 by pivot 9 and to main boom arm 6 by a pivot or pivot pin 12. Axial movement of piston 11 relative to cylinder 10 causes main boom arm 6 to pivot on pin 5 and move in a normally vertical plane extending through axis A-A. It should be understood that when the boom assembly has been rotated from its normal undisplaced position with arm 7 spaced vertically below arm 6, the plane of movement of arm 6 is simultaneously rotated.

A secondary or extension boom arm 16 is pivotally connected at its rearward end to the arm 6 and link 15 by pivot 13, and extends along axis A-A. An axial motor comprising a cylinder 17, pivotally connected to arm 7 and link 15 by pivot 14, and a piston 18, movable axially relative to cylinder 17, is pivotally connected to arm 16 by a pivot or pivot pin 27 forwardly spaced from pivot 13. With piston 18 immovable relative to cylinder 17, arm 16 cooperates with link 15 and axial motor 17, 18 to define a structure of fixed triangular form which can be varied by varying the length of motor 17, 18.

A drill guide 21 is connected to arm 16 for axial movement parallel to axis A-A, and to provide a support for a drill rod 24 disposed parallel to axis A-A. A motor 26 is normally mounted on guide 21 for moving the drill 25 and its drill rod 24 axially along the guide 21 providing a path for such movement which is parallel to axis A-A. Drill guide 21 has a face portion 22 which is moved into engagement with the wall to be drilled before drilling commences.

To accomplish this, an axial motor is provided having a cylinder 19, fixedly connected to arm 16, and a piston 23. A drill guide a bracket 20 on guide 21, movable axially relative to the cylinder to move guide 21 axially on arm 16.

It should now be understood that varying the length of axial motor 10, 11 causes arm 6 to pivot on pin 5 at one end to radially displace its other end, arm 16, guide 21 and drill 25 with rod 24 from axis A-A. The boom structure forming a parallelogram provides a pantograph-type displacing means, thus guide 21 and drill 25 with its drill rod 24 remain parallel to axis A-A when radially displaced therefrom. By rotating motor 3 of motor 2, guide 21 and drill 25 with its rod 24 is arcuately displaced inwardly along a circular path around axis A-A. Finally, to move guide 21 and drill 25 with its rod 24 out of parallelism with axis A-A, the length of axial motor 17, 18 is varied to pivot arm 16 on pin 13, and move guide 21 and drill 25 with its rod 24 accordingly. Axially mechanical coupled means comprising arm 7, link 15 and motor 17, 18 is provided to maintain guide 21 and drill 25 with its rod 24 parallel to axis A-A when radially displaced by pivoting boom arm 6, this could be accomplished with a fluid couple, in accordance with the present invention, which probably would be the generally preferred form of couple for an assembly having a main boom or boom arm of variable length, as shown in FIGURE 2. In such an arrangement a boom has one end pivotally connected to a mounting. A drill support is pivotally connected to the other end of the boom, and a first motor means pivots the boom around the mounting.

A second motor means pivots the drill support relative to the boom. Control means responsive to the pivotal movement of the boom actuates the second motor means to pivot the drill support in unison with the pivoting of the boom on the mounting.

Referring now specifically to FIGURE 2, a boom or boom arm 30 of adjustable length normally extends, in its undisplaced position along axis A-A. Boom 30 is comprised of a cylinder 31 pivotally connected at its rearward end to fitting 4 by pivot or pivot pin 5, and a piston 32 extending forwardly from the cylinder 31 and pivoting with a head fitting 33 at its free end. Piston 32 is movable axially relative to cylinder 31 to vary the length of boom 30 or the axial spaced relation between pivot 5 and head fitting 33. Although boom 30 is shown and described as a cylinder and piston arrangement, it could be a telescopic cylinder or of any other applicable construction. Accordingly, there is no intent to define the limits of the present invention thereby, but rather, merely to facilitate description thereof.

In this instance, one end of idler link 15 and cylinder 17 are pivotally connected to each other and to fitting 33 by a pivot or pivot pin 35, while the other end of link 15 is pivotally connected to the rearward end of arm 16 by a pivot or pivot pin 34. As before, piston 18 is pivotally connected to arm 16 by a pivot or pivot pin 27. Thus, as in the boom assembly of FIGURE 1, link 15, arm 16 and motor 17, 18 cooperate to form a triangular support structure.

As in the boom assembly of FIGURE 1, motor 2 is provided to rotate boom 30, when in its undisplaced position, on axis A-A. Axial motor 10, 11, pivotally connected to arm 8 by pivot 9, now is pivotally connected to boom 30 by pivot 12 to cause boom 30 to pivot on pin 5 and radially displace guide 21 and drill 25 with its rod 24 in the plane that extends through axis A-A.

To maintain guide 21 and drill 25 with its rod 24 parallel to axis A-A or to angularly offset the triangular support structure from the axis of boom 30 an amount equal to its arcuate movement relative to axis A-A when boom 30 is pivoted, a servo or follow-up system having a pair of appropriately flow connected fluid motors 36 and 37 are provided. As shown, balance motor 36 is connected at its ends to boom 30 and arm 8, and when boom 30 pivots on pin 5 creates a flow of fluid to follow-up motor 37, connected at its ends to fitting 33 and to link 15 and arm 16, to pivot the structure equally and oppositely on pivot 35 to boom 30.

The flow connected motors 36 and 37 may, in accordance with the present invention, be in an independent closed pressure fluid system operating as described above; however, it is preferable to provide positive operation of motor 37 simultaneously with motor 10, 11.

Such simultaneous motor control can be accomplished by a system, such as shown in FIGURE 3, wherein a valve 40, having an inlet line 41 to receive pressure fluid and a discharge line 42 for such fluid, is connected to two motor lines 43 and 44. Motors 10, 11 and 37 connected in the boom assembly as shown in FIGURE 2 are flow connected in series. Accordingly line 43 is connected to the head end of cylinder 10 to provide flow for extending piston 11 and line 44 is connected through valve means 46 to the rod end of cylinder of motor 37 to provide flow for retraction. A line 50 connects through valve means 46, the head end of the cylinder of motor 37 and the rod end of cylinder 10.

Valve means 46 provides check valves 47 and 48 in lines 44 and 50 respectively, each passing flow into and blocking flow out of motor 37. Valve means 46 also has pilot operated means responsive to increased pressure or flow in one of the lines 44 or 50 to motor 37 to open the check valve 47 or 48 in the other of the lines 44 or 50.
to permit flow out of motor 37. Thus valve means 46 isolates motor 37 when it is not positively operated and provides simultaneous positive operation of motors 10, 11 and 37. With the system of FIGURE 3, motor 36 is not required. However motors 10, 11 and 37 with their connections to the boom assembly structure must be so proportioned to cause angular displacement of arm 16 relative to boom 30 by motor 37 that is equal and opposite to the angular displacement of boom 30 relative to axis A—A by motor 10, 11.

To eliminate separate motors 36 and 37 of FIGURE 2, as shown in FIGURE 4, cylinder 10 and piston 11 are provided with sensing portions 10a and 11a respectively. Cylinder 17 is no longer connected to boom head 33 and has a follow-up portion 17a with a follow-up piston 18a extending axially therefrom and connected to the boom head. Arm 16 is now pivotally connected to the end of boom 30 by pivot 35 and the ends of the cylinder sensing portion 18a are flow connected to the ends of the cylinder follow-up portion 17a by lines 51 and 52.

Axial movement of piston 11 to pivot boom 30 moves the piston sensing portion 11a in cylinder sensing portion 10a. The resulting fluid discharge from cylinder portion 10a is transmitted by one of the lines 51 or 52 to cylinder portion 17a causing cylinder 17 and piston 18 to move in unison relative to piston 18a and pivot arm 16 relative to boom 30. The fluid discharge from cylinder portion 17a returns to the opposite side of cylinder portion 10a through the other of the lines 51 or 52.

Although axial motors 10, 11; 10a, 11a; 17, 18; 17a, 18a; 19, 23; 36 and 37 are shown and described as fluid actuated piston and cylinder assemblies, they could be electrically or hydraulically driven axial screw-type motors.

Although several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited there-to. Various changes may be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

I claim:

1. Drilling apparatus comprising:
   a mounting;
   a boom having one end pivotally connected to said mounting;
   a drill support pivotally connected to the other end of said boom;
   first motor means for pivoting said boom about said mounting;
   second motor means for pivoting said drill support relative to said boom; and
   control means responsive to the pivotal movement of said boom for actuating said second motor means to pivot said drill support in unison with the pivoting of said boom on said mounting.

2. The drilling apparatus of claim 1 wherein the control means includes third motor means for sensing the pivotal movement of said boom; said third motor means being flow connected to said second motor means.

3. The drilling apparatus of claim 1 wherein said second motor means are flow connected in series with said first motor to provide said control means.

4. The drilling apparatus of claim 1 wherein said control means includes a follow-up motor responsive to said first motor means for actuating said second motor means.

5. Boom apparatus for supporting and universally positioning a drill comprising:
   a rotary means adapted to be mounted on supporting structure;
   a main boom having one end pivotally connected to said rotary means and adapted to be rotated about its longitudinal axis by said rotary means;
   a second boom pivotally connected to the other end of said main boom for supporting a drill guide;
   first motor means for displacing said main boom about the pivotal connection between said main boom and said rotary means; and
   follow-up means responsive to pivotal movement of the main boom for pivoting said second boom about the pivotal connection between said second boom and said main boom equally and oppositely to the pivotal movement of said main boom.

6. The boom of claim 5 wherein said second boom is extensible with respect to said main boom.

7. The boom of claim 6 wherein said main boom is variable in length.

8. The boom of claim 7 further comprising means independent of said first motor means for pivoting said second boom relative to said first boom.

9. The boom in accordance with claim 8 wherein:
   the follow-up means includes a pair of flow connected motors, one for sensing pivotation of the main boom and the other for pivoting the second boom arm.

10. The boom in accordance with claim 8, wherein:
    the follow-up means is a motor flow connected in series with the motor for pivoting the main boom.

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