Nov. 17, 1964 E. H. KURT 3,157,237

ROCK DRILL

Filed April 18, 1962 2 Sheets-Sheet 1

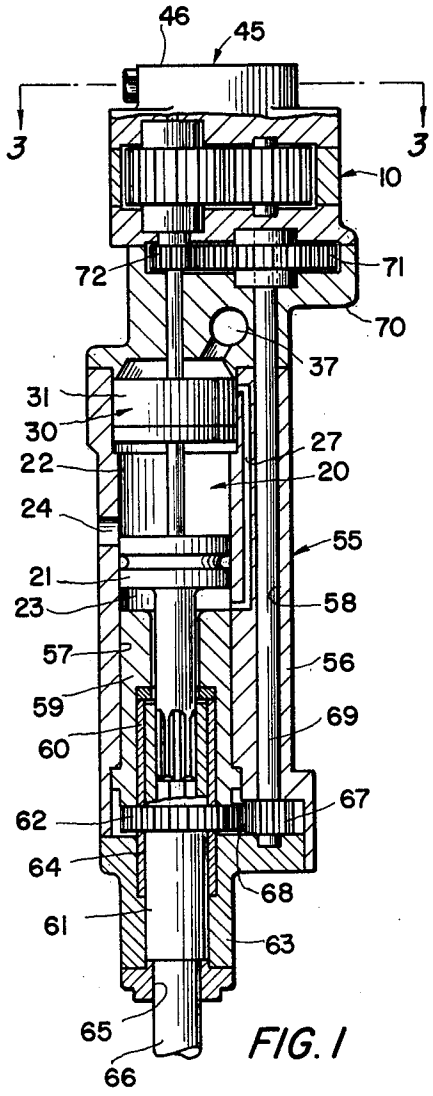



FIG. 1

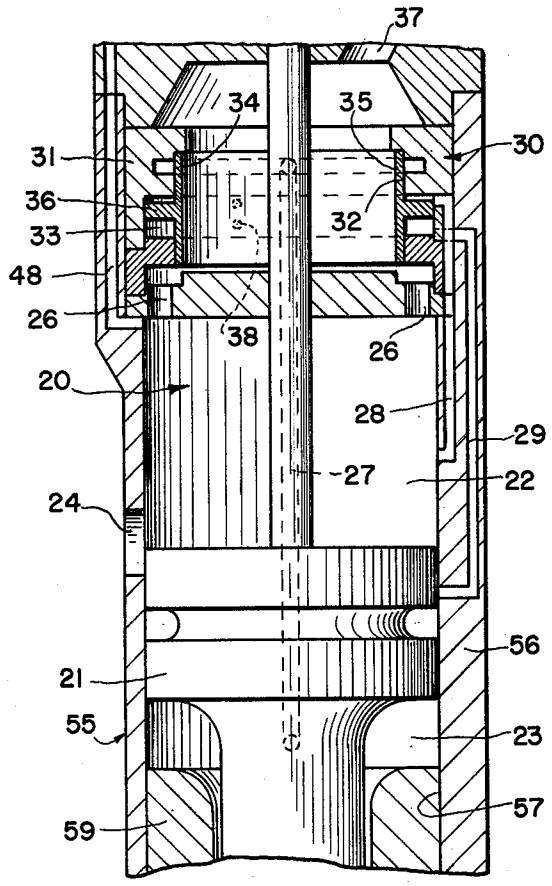



FIG. 2

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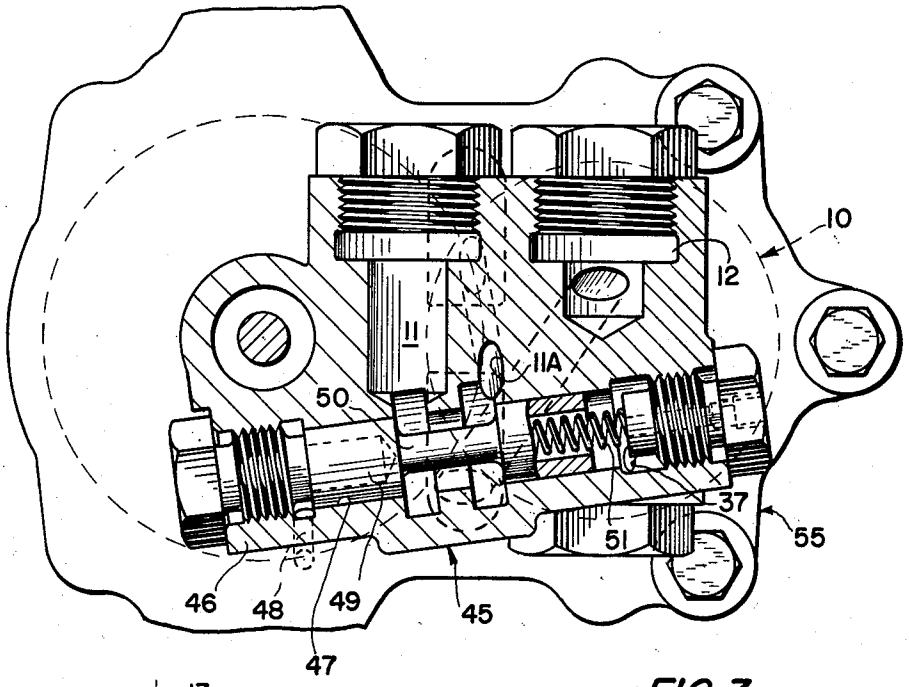



FIG. 3

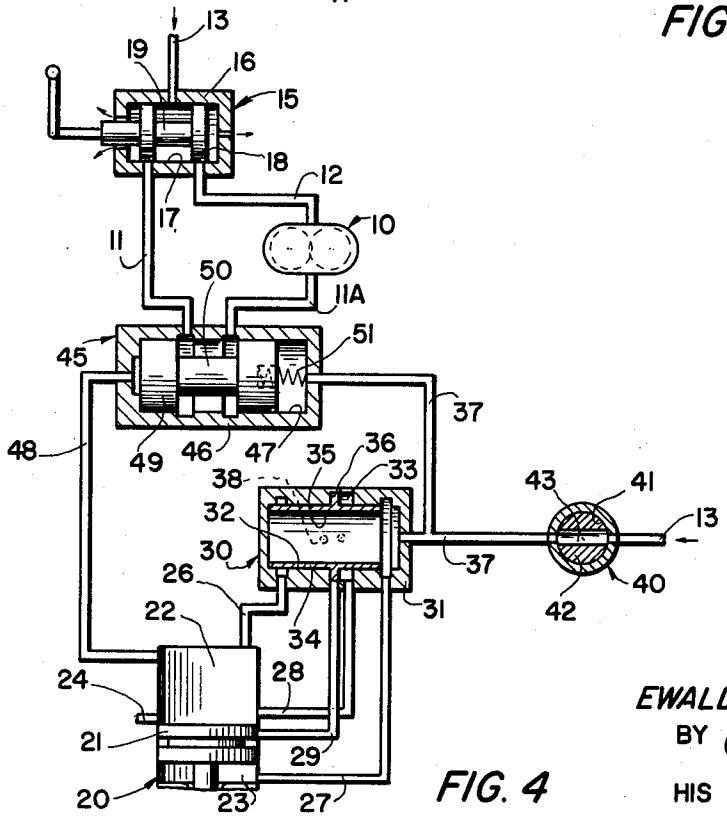



FIG. 4

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3,157,237

# ROCK DRILL

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7 Claims. (Cl. 173—105)

This invention relates generally to rock drills and more particularly to independent rotation of the steels of such drills.

Rock drills normally require two forces exerted on drill steels for effective operation, namely, axial and rotational. At the present time, a reciprocating axial motor having a hammer piston which impacts upon the rear end of the drill steel or steel adapter is provided to drive the steel axially into the material being drilled. This axial force causes the drill steel bit to bite into the material being drilled which is followed by rotation of the steel.

Two general arrangements are normally used to provide such axial and rotational force. U.S. Patent 2,108,989 issued February 22, 1938 to A. R. Mack, is representative of one such arrangement and provides intermittent motor means to drive a drill steel axially, and intermittently driven spline interlocks to provide rotational movement of the steel. However, it should be realized that such rotation is intermittent, and no individual control of the rotation of the steel is provided. Other representative arrangements similar to that of Patent 2,108,989 are provided by U.S. Patent 2,225,531 issued December 17, 1940 to C. L. Charles, and U.S. Patent 2,618,241 issued November 18, 1952 to J. A. Larsen et al. The other arrangement presently used has been to provide continuous rotation of the bit even during impact which has been found undesirable, causing rapid and excessive bit deterioration.

Accordingly, an object of this invention is to provide a rock drill with independently controlled drill steel rotation.

Another object of this invention is to provide a rock drill having independently controlled continuous drill steel rotation, and independently controlled intermittent axial impacting of the drill steel.

Another object of this invention is to provide a rock drill having independently controlled continuous drill steel rotation, independently controlled intermittent axial impacting of the drill steel, and sequencing means for stopping the rotation of the drill steel at the time of impact.

This invention contemplates a rock drill having a casing with a rotatable adapter for receiving a drill steel, a ring gear encircling and attached to the steel adapter, a drill steel fitted into the adapter, an axial motor in the casing having a reciprocating piston for impacting the drill steel to drive it axially into material to be drilled, a reversing valve having an inlet to receive pressure fluid and a pair of discharge passages connected to the axial motor each in communication with the area on one side of the piston to provide pressure fluid for reciprocation of the piston, pilot passages connecting the axial motor on both sides of the piston to a motoring chamber of the reversing valve to pilot operate the valve for alternately connecting fluid to one side of the piston and then to the other, a drive motor connected to the casing for continuously rotating the drill steel, a gear train connecting the rotation drive motor to the ring gear, valve means connected to the rotation drive motor for providing pressure fluid to drive the motor in either direction, a sequencing valve connecting the valve means to the motor for rotating the drill steel and having motoring inlets one being connected to receive pressure fluid at the inlet of the reversing valve and the other to the chamber of the axial motor receiving pressure fluid to drive the piston toward the drill steel for pilot operation to control fluid flow to the motor for



stopping rotation of the drill steel when the piston impacts the steel.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration purposes only and are not to be construed as defining the limits of the invention.

FIGURE 1 is a sectional elevational view of a rock drill made in accordance with the invention,

FIGURE 2 is an enlarged sectional view illustrating a portion of the axial motor and a reversing valve therefor of the novel drill of FIGURE 1,

FIGURE 3 is an enlarged sectional view taken on line 3—3 of FIGURE 1 illustrating a sequencing valve which controls the steel rotating motor in response to the axial motor, and

FIGURE 4 is a diagrammatic view of the axial and rotational motors and the control systems therefor.

Referring now to the drawings, the motors and controls therefor are shown diagrammatically in FIGURE 4. A motor 10, such as a gear motor, is provided to continuously rotate a drill steel 66 and has two pressure or motor lines 11A and 12 for receiving and/or discharging pressure fluid received from a pressure source indicated by a pressure supply line 13 and controlled by a valve 15. Control valve 15 may be of conventional spool design providing a closed center or blocked neutral position, and connects one motor line to inlet and the other motor line to exhaust when moved in one direction. Valve 15 reversely connects the motor lines when moved in the opposite direction from center.

As shown in the drawings, valve 15 has a body 16 with a bore 17. A spool 18 is slidably disposed in the bore 17 and has a necked portion 19. When the spool 18 is in the closed center position, the lands at the ends of the necked portion 19 block pressure fluid in line 13 from motor lines 11 and 12. When the spool 18 is moved to the right, with reference to the drawings, necked portion 19 laps lines 12 and 13 providing pressure fluid to the motor 10 which is exhausted through line 11 into the bore 17 and escapes through valve body 16 around the spool 18. When the spool 18 is moved in the opposite direction, necked portion 19 laps lines 11 and 13 driving the motor 10 in the opposite direction. Exhaust fluid from motor 10 then passes through line 12 into the bore 17 of the valve 15 and escapes through a port indicated in the end wall of the body 16.

An axial motor 20 provides intermittent impacts to drill steel 66 by a hammer piston 21 which divides the motor area into a driving chamber 22 and a return chamber 23. The motor 20 has a discharge 24 which alternately communicates with chambers 22 and 23 as determined by the position of the piston 21. Motor inlet lines 26 and 27 communicate with the ends of the chambers 22 and 23, respectively, providing pressure fluid alternately to the chambers for reciprocating hammer piston 21.

A pilot operated, reciprocation control or reversing valve 30 provides pressure fluid alternately to lines 26 and 27 and is pilot operated by pressure fluid from motor 20 alternately provided by pilot lines 28 and 29. Valve 30 has a body 31 with a bore 32 and an annular groove forming a motor chamber 33. A tubular spool 34 with a bore 35 is slidably disposed in the bore 32 of the body 31 and has an annular flange 36 disposed in the motor chamber 33. A pressure fluid inlet 37 is connected to the end of the valve body 31 and in communication with bore 35 of spool 34. As pressure fluid is alternately fed back from chambers 22 and 23 of axial motor 20 to motor chamber 33 of valve 30 through pilot lines 28 and 29,

respectively, pressure in the chamber 33 acts on the annular flange 36 to reciprocate the spool 34 for alternately connecting pressure inlet line 37 to the motor inlet lines 26 and 27. Motor chamber 33 has a pair of spaced vents or orifices 38 each at one end thereof and cooperating with one of the pilot lines 28 and 29 to restrict pilot pressure fluid momentarily in chamber 33 to shift the spool 34 and to relieve the chamber prior to receiving pilot pressure fluid from the other pilot line.

A valve and motor combination similar to valve 30 and motor 20 is shown and described in U.S. Patent 2,886,064, issued May 19, 1959 to W. A. Morrison, and assigned to the assignee of this application.

To control the supply of pressure fluid to the valve 30, a conventional "on-off" control or throttling valve 40 is provided to connect the pressure fluid supply line 13 to the inlet line 37 of valve 30. The control valve 40 is conventionally illustrated as having a hollow body 41 in which is disposed a rotary spool 42 having a passage therethrough. By rotating the spool 42 the passage 43 is alined to connect lines 13 and 37 to provide fluid flow to valve 30, or misalined to block flow of pressure fluid. It should be understood that while pressure fluid is provided to valves 15 and 40 from a common supply line 13, independent supplies can be provided if desired.

Thus it should be readily seen that the drill steel 66 may be independently rotated by motor 10 controlled by valve 15, and may be independently driven axially by intermittent impacts provided by reciprocation of hammer piston 21 of motor 20 controlled by valve 40 when throttling valve 40 passes pressure fluid.

Intermittent impacts to drive the bit (not shown) of drill steel 66 into the material to be drilled and rotation of the drill steel 66 only after such impact is accomplished by providing a sequencing valve 45. The valve 45 has a body 46 with an axial bore 47 communicating at one end with the valve end of the driving chamber 22 of motor 20 through a line 48, and receiving constant pressure fluid from inlet line 37 at its other end.

Valve 45 is connected in motor line 11 and has two spaced ports intermediate the ends of the bore 47. Thus, bore 47 is connected by one portion of line 11 to the control valve 15, and to motor 10 by the other portion 11A.

A spool 49 is slidably disposed in the bore 47 and is normally biased by a spring 51 in the bore end receiving constant pressure fluid from line 37 toward the connection of line 48. When throttling valve 40 is open pressure fluid from line 37 cooperates with spring 51 to bias spool 49. Spool 49 has a necked portion 50 which laps the two spaced connections of line 11–11A to permit flow between the valve 15 and the motor 10 when in the biased position.

On the return stroke of piston 21, exhaust port 24 is closed, and pressure and pilot lines 27 and 29 are connected by motor chamber 23 so pressure fluid from pilot line 29 enters valve motor chamber 33 to shift valve member 34 for connecting inlet line 37 to the driving chamber 22. Pressure fluid entering chamber 22 acted on by the returning piston 21 provides high pressure fluid to bore 47 through line 48 to kick spool 49 against its bias to block communication of lines 11 and 11A and stop motor 10 momentarily. As piston 21 commences its impact stroke, passages 26 and 28 are connected by motor chamber 22 to provide pilot pressure fluid to the other end of valve motor chamber 33 for reversely shifting spool 34 which connects line 37 to chamber 23. Piston 21 also uncovers exhaust 24 which vents motor chamber 22 and line 48 and the end of bore 47 to which it is attached. The spool 34 and piston 21 reciprocate at high speed so the slight systemic delay provides correct timing for reciprocation of piston 21.

The motors 10 and 20 with valves 30 and 45 form parts of the novel rock drill 55 as shown in FIGURES 1 to 3 while the control valves 15 and 40 are preferably mounted on a drill tower or similar adjacent structure



readily accessible for manual operation, but not limited thereto.

The rock drill 55 has a casing 56 with a relative large axial bore 57 and a smaller axial bore 58 parallel to bore 57. Bore 57 in part provides the chamber area for the axial motor 20 and receives a tubular member 59 in front or drill end thereof. A bearing 60 is disposed in the member 59 and supports the rear portion of a drill steel adapter 61. A ring gear 62 encircles and is attached to adapter 61 and is spaced from its ends. A casing cap 63 is connected to the casing 56 and has an axial bore 65 that is counterbored to house a bearing 64 to support the front portion of the drill steel adapter 61 that is disposed on the side of gear 62 remote from the bearing 60. The axial bore 65 provides a passage for drill steel 66 held in the adapter 61.

The reciprocation control valve 30 is disposed in the other or rear end of the bore 57, and is held fixed therein by a casing cap portion 70 which houses a pair of meshing gears 71 and 72. A shaft 69 is fixed at one end to gear 71, extends through the bore 58, and has a drive gear 67 fixed at its other end which meshes with an idler gear 68 in mesh with the ring gear 62. The gear pump 10 is connected to the cap portion 70 and has one of its gears connected to the gear 72 to complete the gear train from the motor 10 to the adapter 61.

The body 46 of the sequencing valve 45 is then connected to the pump 10. While the various passages interconnecting the valves to the motors are shown or shown in part in the preferred form as being provided in the rock drill 55, such passages may be provided by external hoses or tubes connected to ports provided therefor in the drill structure.

Thus, with throttling valve closed, spring 51 biases spool 49 to its open position and actuation of valve 15 connects pressure fluid from line 13 to line 11 or 12 to drive motor 10 which continuously rotates steel 66. With control valve 15 in its closed neutral position, motor 10 does not operate. Operation of throttle valve 40 provides pressure fluid to valve 45 for biasing plunger 49 and to valve 30. Valve 30 provides pressure fluid alternately to motor chambers 22 and 23 through lines 28 and 29 to reciprocate piston 21 of axial motor 20 which impacts steel 66 to provide an axial driving force for the drill. Although not shown, the hammer piston 21 and drill steel adapter 61 may be modified so the piston impacts the adapter to impact axial driving force to the drill steel 66. With throttling valve 40 open, actuation of control valve 15 will start motor 10 to rotate steel 66 in addition to being driven axially. However, pressure fluid from motor chamber 22 is connected to sequencing valve 45 and kicks spool to the closed position to block pressure fluid flow through motor 10. Motor 10 is then momentarily stopped to prevent rotation of steel 66 at the moment of impact by piston 21.

Accordingly, a rock drill made in accordance with the invention has an independently controlled reciprocating motor for intermittently impacting a drill steel for driving the steel axially, an independently controlled motor for continuously rotating the steel, and sequencing means interconnecting both motors to stop rotation of the drill steel upon impact by the piston of the axial motor.

Although but a single embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may also 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. A power system for a rock drill having a drill steel, comprising a rotary fluid motor drivingly connected to the drill steel, valve means connected to the rotary fluid motor having an inlet to receive pressure fluid to drive said fluid motor for rotating the drill steel, means bias-

ing the valve means to an open position for continuously rotating the steel, a drill motor having a reciprocally driven hammer piston to intermittently impart axial driving forces to the drill steel, said drill motor having inlet means to receive pressure fluid and passage means connecting the drill motor to the valve means to provide pressure fluid for closing the valve means against the biasing means as the hammer piston moves away from the drill steel to block the pressure fluid driving the rotary fluid motor and momentarily stop rotation of the drill steel when the drill motor imparts axial forces thereto.

2. The power system for a rock drill in accordance with claim 1, and a throttling valve having an inlet to receive pressure fluid and being connected to the valve means and drill motor to simultaneously provide pressure fluid to bias said valve means and to operate said drill motor.

3. The power system for a rock drill in accordance with claim 1, in which said valve means includes a directional control valve having a normally closed position to block the pressure fluid that drives the rotary fluid motor and two operative positions to drive the rotary fluid motor in one direction when in one of said operative positions and in the reverse direction when in the other operative positions.

4. A power system for a rock drill having a drill steel, comprising a drill casing having an axial drill motor chamber and an adapter for the drill steel, a hammer piston reciprocal in the drill motor chamber for intermittently imparting axial driving forces to the drill steel, a reversing valve disposed in the casing having an inlet to receive pressure fluid and a pair of outlets connected to the ends of the drill motor chamber alternately providing pressure fluid to reciprocate the hammer piston, a fluid motor drivingly connected to the adatper to continuously rotate the drill steel, a directional control valve for the fluid motor having an inlet to receive pressure fluid and two motor passages each connected to one side of the fluid motor providing a flow path for the pressure fluid to drive said motor, a sequencing valve connected in one of the motor passages having a valve member normally biased to a valve open position, and a passage connecting the drill motor chamber to the sequencing valve to provide pressure fluid to kick the valve member to a valve closed position blocking pressure fluid flow through the fluid motor to momentarily stop rotation of the drill steel at the instant the drill motor imparts axial driving force.

5. A power system for a rock drill having a drill steel, comprising a drill casing having an axial drill motor chamber and an adapter for the drill steel, a hammer piston reciprocal in the drill motor chamber for intermittently imparting axial driving forces to the drill steel, a reversing valve disposed in the casing having an inlet to receive pressure fluid and a pair of outlets connected to the ends of the drill motor chamber alternately providing pressure fluid to reciprocate the hammer piston, a fluid motor drivingly connected to the adapter to continuously rotate the drill steel, a directional control valve for the fluid motor having an inlet to receive pressure fluid and two motor passages each connected to one side of the fluid motor providing a flow path for the pressure fluid to drive said motor, a sequencing valve connected in one of the motor passages having a valve member normally biased to a valve open position, and a passage connecting the drill motor chamber to the sequencing valve to provide pressure fluid to kick the valve member to a valve closed position blocking pressure fluid flow through the fluid motor to momentarily stop rotation of the drill steel at the instant the drill motor imparts axial driving force.

6. A power system for a rock drill having a drill steel, comprising a drill casing having an axial drill motor chamber and an adapter for the drill steel, a hammer piston reciprocal in the drill motor chamber for intermittently imparting axial driving forces to the drill steel, a reversing valve disposed in the casing having an inlet to receive pressure fluid and a pair of outlets connected to the ends of the drill motor chamber alternately providing pressure fluid to reciprocate the hammer piston, a throttling valve having an inlet to receive pressure fluid and being connected to the inlet of the reversing valve to control the flow of pressure fluid thereto, a fluid motor drivingly connected to the adapter to continuously rotate the drill steel, a directional control valve having an inlet to receive pressure fluid and two motor passages each connected to one side of the fluid motor providing a flow path for the pressure fluid to drive said motor, a sequencing valve connected in one of the motor passages having a valve member normally biased to a valve open position, a passage connecting the throttling valve to the sequencing valve to provide pressure fluid for biasing the valve member when pressure fluid is provided to the reversing valve, and a passage connecting the drill motor chamber to the sequencing valve to provide pressure fluid to kick the valve member to a valve closed position blocking pressure fluid flow through the fluid motor to momentarily stop rotation of the drill steel at the instant the drill motor imparts axial driving force.

7. A power system for a rock drill having a drill steel, comprising a drill casing having an axial drill motor chamber and an adapter for the drill steel, a hammer piston reciprocal in the drill motor chamber for intermittently imparting axial driving forces to the drill steel, a reversing valve disposed in the casing having an inlet to receive pressure fluid and a pair of outlets connected to the ends of the drill motor chamber alternately providing pressure fluid to reciprocate the hammer piston, a throttling valve having an inlet to receive pressure fluid and being connected to the inlet of the reversing valve to control the flow of pressure fluid thereto, a fluid motor drivingly connected to the adapter to continuously rotate the drill steel, a directional control valve having an inlet to receive pressure fluid and two motor passages each connected to one side of the fluid motor providing pressure fluid to drive said motor, a sequencing valve connected in one of the motor passages, a valve member in the valve, spring means biasing the valve member during continuous rotation of the drill steel, a passage connecting the throttling valve to the sequencing valve to provide pressure fluid for biasing with said spring means the valve member during drill motor operation, and a passage connecting the drill motor chamber to the sequencing valve to provide pressure fluid to kick the valve member to a valve closed position blocking pressure fluid flow through the fluid motor to momentarily stop rotation of the drill steel at the instant the drill motor imparts axial driving force.

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