June 15, 1965 K. A. G. ATTEBO ETAL 3,189,103

HYDRAULIC DRILL FEED CONTROL

Filed July 13, 1962 4 Sheets-Sheet 1

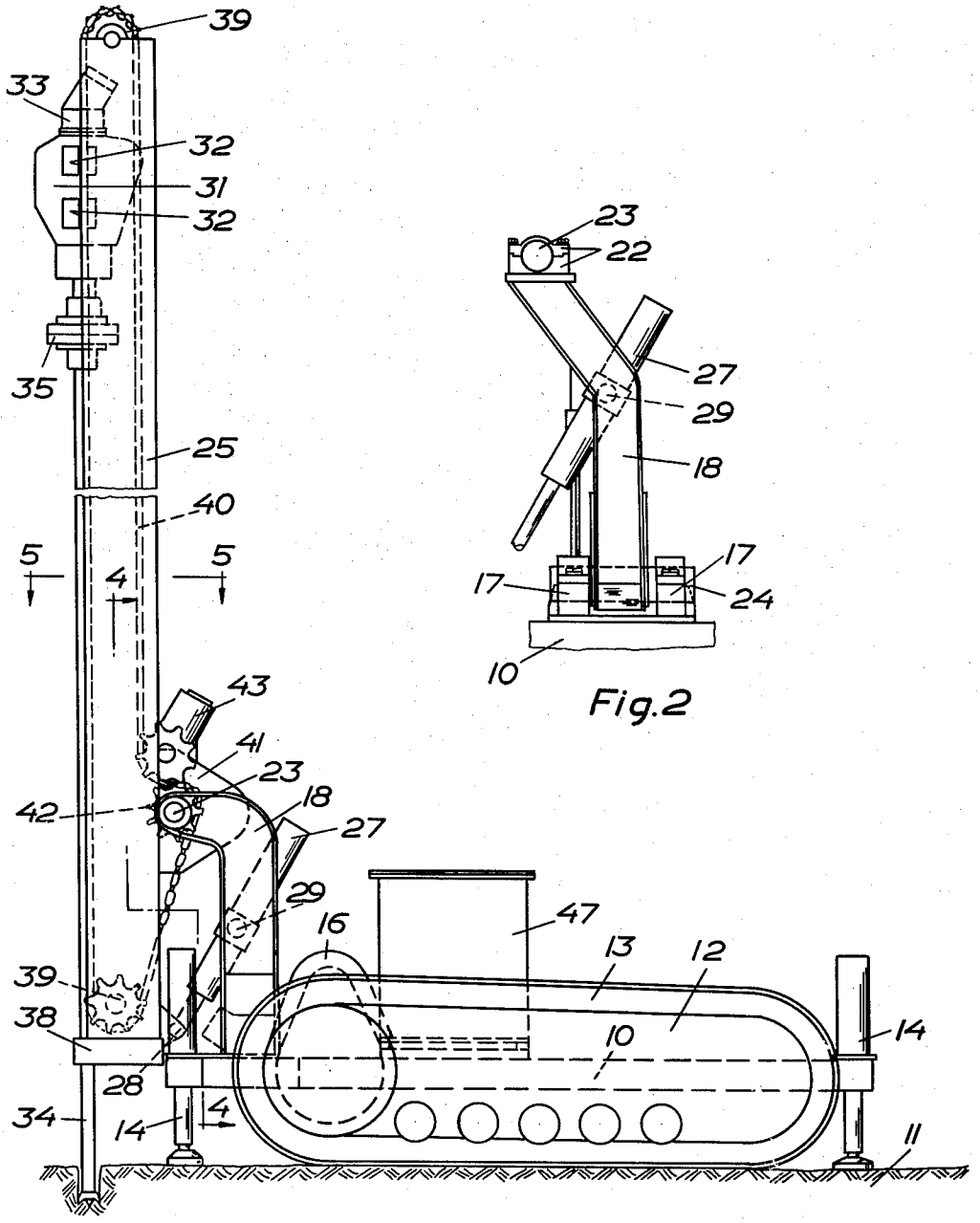

Fig. 1

Fig. 2

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HYDRAULIC DRILL FEED CONTROL

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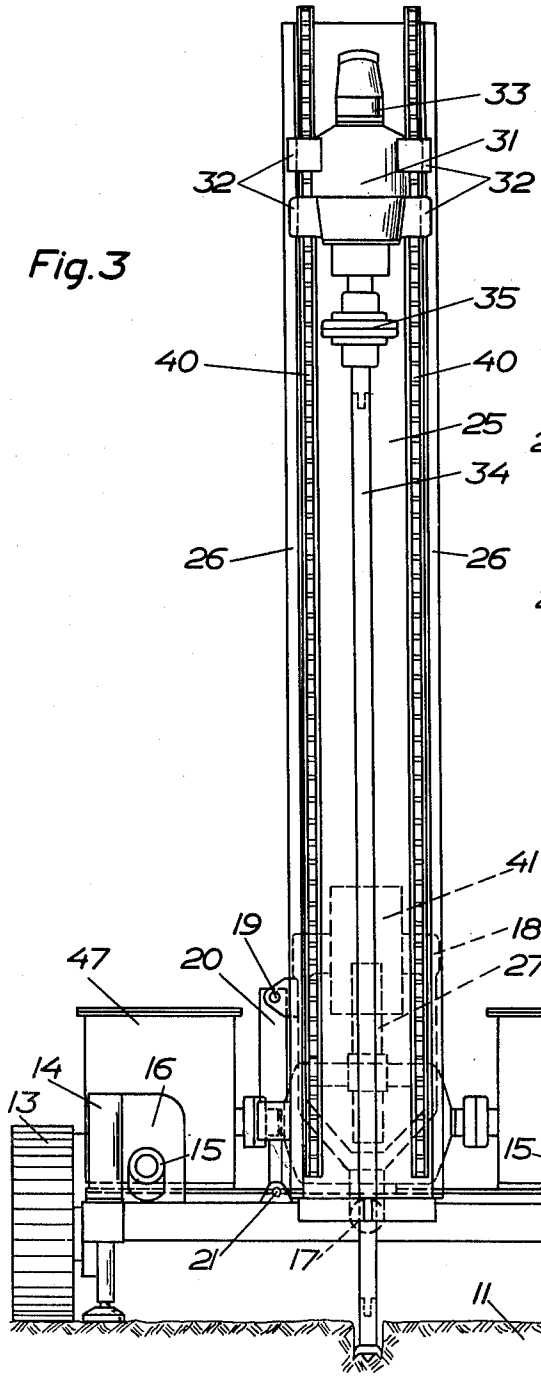
Fig. 3



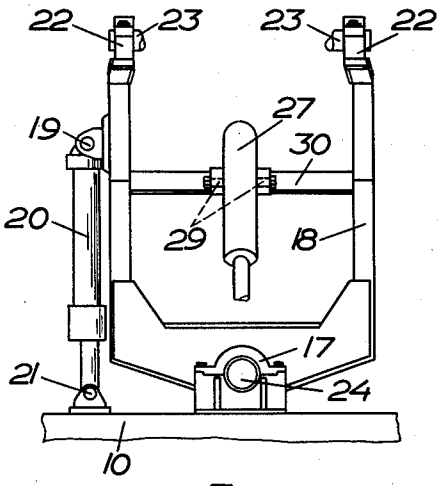


Fig. 4

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HYDRAULIC DRILL FEED CONTROL

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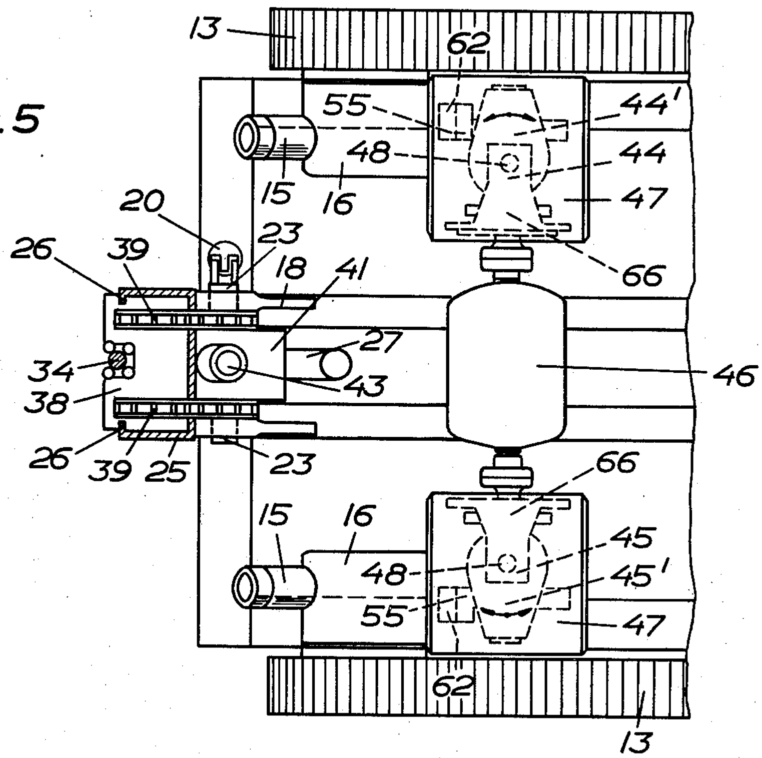

Fig. 5

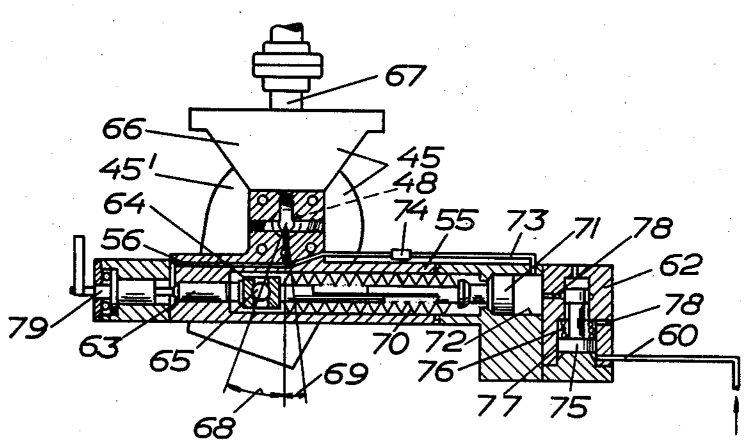

Fig. 6

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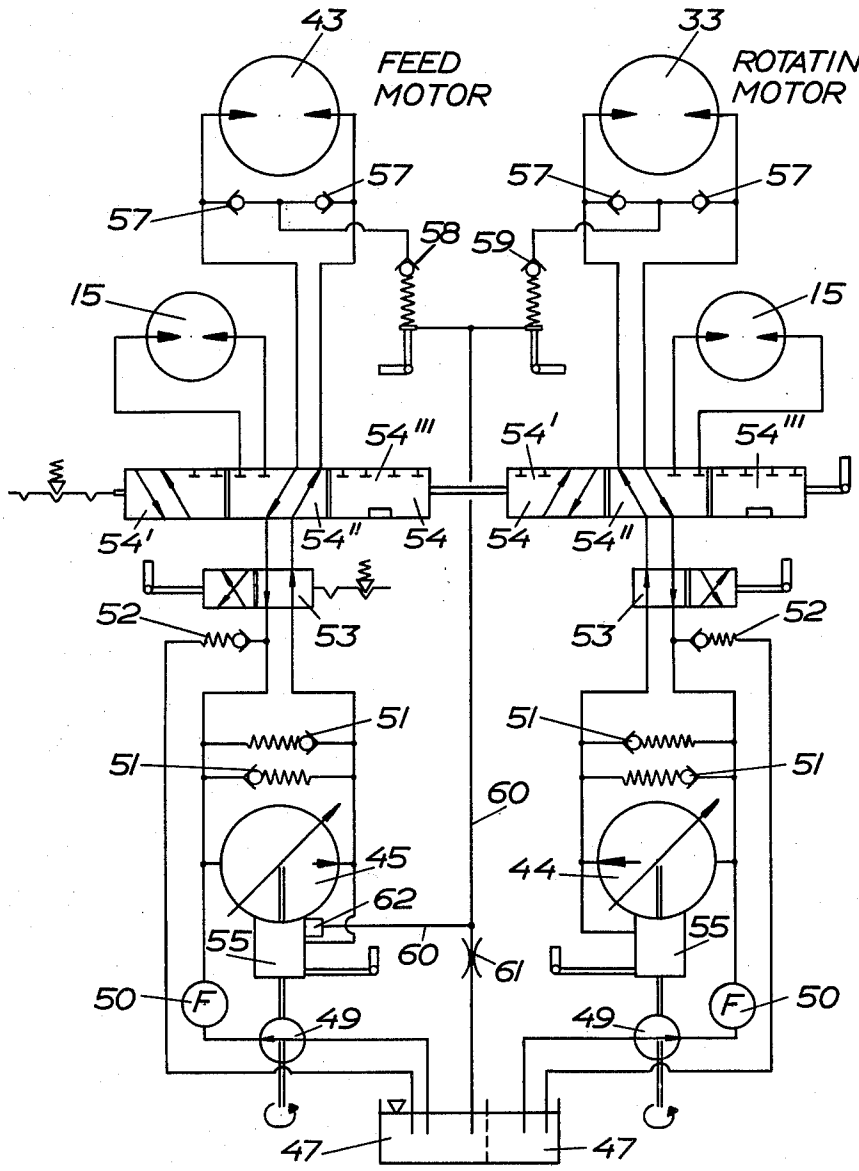

Fig.7

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HYDRAULIC DRILL FEED CONTROL

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Claims priority, application Sweden, July 20, 1961, 7,486/61
7 Claims. (Cl. 173—8)

This invention relates generally to the control of rock drills mounted on drill rigs and more specifically to a high pressure fluid or hydraulic drill feed control for such drills.

A primary object of the invention is to provide a high pressure fluid or hydraulic drill feed control for rock drills mounted on drill rigs which during work of the rock drill automatically will keep the feed or drill bit pressure, the drill torque, the number of revolutions of the drill, and the drill penetration rate at desired optimal values preset at will by the operator.

Another object of the invention is to provide a high pressure fluid or hydraulic drill feed control for rock drills mounted on drill rigs in which the risk of overloading the high pressure pumps and motors arranged on the drill rig for purposes of driving the rock drill is eliminated.

A further important object of the invention is to provide a high pressure fluid or hydraulic drill feed control for rock drill mounted on drill rigs in which there are included variable displacement pumps for driving the feed motor and drill rotating motor on the drill rig and said control is performed according to the requirements of the drilling performed and through the intermediary of varying means for varying the capacity or displacement of said pumps.

The above and other objects of the invention will become obvious from the following description and from the accompanying drawings in which an embodiment of the invention is illustrated by way of example. It should be understood that this embodiment is only illustrative of the invention and that various modifications may be made within the scope of the claims without departing from the scope of the invention.

In the drawings, wherein like numerals are employed to designate like parts,

FIG. 1 is a side view of a drill rig incorporating the present invention,

FIG. 2 is an enlarged fragmentary more exact side view of an upstanding forked frame indicated diagrammatically in FIG. 1,

FIG. 3 is a front view of the drill rig in FIG. 1,

FIG. 4 is an enlarged fragmentary view substantially on the line 4—4 in FIG. 1 of the forked frame with the feed superstructure removed,

FIG. 5 is a top view of the forward portion of the drill rig in FIG. 1 with the feed superstructure sectioned on the line 5—5 in FIG. 1,

FIG. 6 is an enlarged longitudinal sectional view of a constant horsepower control device indicated in FIG. 5, and

FIG. 7, finally, is a diagrammatic coupling diagram illustrating the high pressure fluid drive and control for the drill rig and the rock drill.

The drill rig according to the invention incorporates an underframe 10 supported on the ground 11 preferably by wheeled frames 12 carrying tracks 13. In the working position of the drill rig the underframe 10 is supported by hydraulic power jacks 14 extendable for contacting the ground 11 in order to relieve the frames 12 from excessive loads. For individual driving of each track 13 there are provided on the underframe 10 two hydraulic fixed displacement drive motors 15 preferably of axial piston type. The motors 15 are drive coupled to the tracks 13 over a suitable gearing 16. Forwardly on the underframe 10 and longitudinally thereof are arranged horizontal journals 17 for a shaft 24 on which an upstanding forked frame 18 is arranged to swing in a transverse plane with respect to the underframe 10. The forked frame 18 carries a side pivot 19 to which is coupled the cylinder end of a double acting hydraulic cylinder 20 the piston rod end of which is pivoted on a pivot 21 on the underframe 10. Through extension or contraction of the hydraulic cylinder 20 the forked frame 18 may be swung to the right or to the left in said transverse plane turning on the shaft 24 and the journals 17. The forked frame 18 is divided in fork shape in upward direction and carries at its upper ends bearings 22 for transverse trunnions 23 on a feed superstructure 25 which forms a pair of elongated guiding means or guides 26 extending in parallel relation and pivotally carried on the trunnions 23. The piston rod end of a double acting hydraulic cylinder 27 is at a pivot 28 pivotally connected to the front end of the feed superstructure, while the cylinder portion of the hydraulic cylinder 27 is pivoted on trunnions 29 supported pivotally on a transverse bar 30 on the forked frame 18. Through extension or contraction of the hydraulic cylinder 27 the feed superstructure 25 may be swung to the rear on the trunnions 23 to a dumped substantially horizontal position over the underframe 10 or may be elevated to vertical position or given a slight inclination in the forward direction past the vertical position.

A rock drill 31 is by means of two pairs of opposed guide members with guideways 32 thereon slidably arranged on and along the guides 26 and incorporates a rotating motor 33 for rotating an extension drill steel 34 or extension drill steel equipment connected to the forward end of the rock drill 31 via a coupling 35. In the example shown the rock drill 31 is a drill intended for rotary drilling, it being understood, however, that as an alternative there may be provided a percussive drill having a motor for rotating the drill steel. The rotating motor 33 shown is fixed at the rear of the rock drill 31 for driving the coupling 35 over a suitable gearing in the main housing of the rock drill 31. The rotating motor 33 is a hydraulic fixed displacement motor prefably of axial piston type conventionally provided with a driving plate, integral with and normal to the driving shaft of the motor and a cylinder barrel and piston assembly inclined relative to the driving plate, driving said plate and rotatable in unison therewith, these conventional elements being well known per se and therefore not shown in detail in the figures.

For purposes of guiding the drill steel 34 a drill steel centralizer 38 is provided forwardly on the feed superstructure 25.

For positively feeding the rock drill 31 forwardly or

rearwardly along the guides 26 there are attached pairs of sprocket wheels 39 adjacent the guides 26 at the front and rear end of the feed superstructure 25. Two parallel chains 40 extend over the sprocket wheels 39. The rock drill with the rotation motor 33 and its gearing is connected to the chains 40 at one side of the plane through the axes of rotation of the sprocket wheels 39 while at the other side of said plane and coaxially with the trunnions 23 of the feed superstructure 25 there is arranged a gear case and gearing indicated at 41 which drivingly engages each of the chains 40 over a sprocket wheel 42. The gearing 41 is driven by means of a hydraulic rotary fixed displacement feed motor 43 preferably of axial piston type and analogous with the rotating motor 33.

The rotating motor 33 and the feed motor 43 are each incorporated in individual closed hydraulic drive circuits. To this end the inlets and outlets of the motors 33 and 43 are connected to the respective inlets and outlets of a pair of variable displacement hydraulic pumps 44 and 45 preferably of axial piston type and arranged on the underframe 10 one of said pumps, 44, being provided for driving the rotating motor 33 and the other, 45, for the feed motor 43. Each pump, being of axial piston type, is conventionally provided with a driving plate integral with and normal to the driven shaft of the pump and with a cylinder barrel and piston assembly inclined relative to the driving plate, and driven in a manner to be rotatable in unison therewith, these conventional elements being described in detail in U.S. Patent No. 2,298,849 and well known per se and therefore not shown in detail in the figures as their arrangement is obvious to those skilled in the art. Through adjustment of the inclination of the cylinder barrel with respect to the driving plate the displacement of the pump may be changed in a stepless manner from full flow in one direction to reversal of flow and for such angular adjustment the cylinder barrel housings 44^1, 45^1 of the pumps 44, 45 are pivotally journalled on trunnion bearings 48. The pumps 44 and 45 may be coupled directly to an electric drive motor 46 connectable to the line voltage. As an alternative there may be provided a common integral combustion engine for driving the pumps 44, 45 directly or with a suitable gear ratio. The pumps 44, 45 together with their regulating equipment to be described hereinafter are immersed in oil and mounted in tanks 47 on the underframe 10.

The conduits and bores between the pumps 44, 45 and the motors 33, 43 and the hydraulic circuitry for maneuvering the cylinders 27, 20 for elevating the feed superstructure, swinging of the forked frame 10, and for actuating the power jacks 14 have been omitted since they would make the drawings rather congested and since the arrangement of such structure is obvious to those skilled in the art.

The pump 45 for driving the feed motor 43, FIG. 7, is rotated together with a small pressure pump 49 which in wellknown manner sucks oil from the tank 47 of the pump 45 and over a filter 50 compensates oil losses in the closed circuit between the pump 45 and the feed meter 43. Additionally the pump 45 has a valve block incorporating a pair of oppositely directed overflow check valves 51 coupled in parallel with the pump 45, another overflow check valve 52 between the closed circuit and the tank 47 for venting excess circulation oil, and furthermore a two-position adjustable reversing valve 53 for reversing the direction of rotation of the feed motor 43 with respect to the direction of oil flow from the pump 45, which in the example shown constantly rotates in the same direction. In the circuit there is furthermore provided an adjustable switching valve 54 having three positions 54^1–54^{111} and 54^{11}. In the position 54^{11} occupied in FIG. 7 the valve 54 connects the pump 45 to the feed motor 43. The pump is also provided with a constant horsepower control device 55 shown more in detail in FIG. 6, incorporating varying means for the displacement or capacity of the pump, the task of said control device 55 being to keep the output of the pump 45 constant and to prevent the power of the feed motor 43 from being exceeded. The constant horsepower control device 55 senses the pressure in the closed hydraulic circuit at the outlet of the pump 45 via a conduit 56, FIG. 6, in communication with said circuit.

The closed hydraulic circuit between the pump 44 and the rotating motor 33 is analogous with the above described circuit and consequently likewise incorporates a pressure pump 49, a filter 50, overflow check valves 51, 52, a reversing valve 53, a three-position switching valve 54 connecting in the position 54^{11} the pump 44 to the feed motor 33, and a constant horsepower control device 55. The adjustable three-position switching valves 54 of the two circuits are mechanically interconnected and arranged to switch in the alternative position 54^1 each pump 45, 44 over to one of the drive motors 15. The third position 54^{111} is an idle position.

Over check valves 57 and adjustable spring loaded overflow valves 58 and 59 having manually adjustable spring load, the inlets and outlets of the motors 43 and 33 are connected to a conduit 60 which via a throttle valve 61 is exhaustable into one of the tanks 47 of the pumps 44, 45. In addition the conduit 60 is connected to a pressure cut-off device 62, FIG. 6, arranged together with the control device 55.

The constant horsepower control device 55, FIG. 6, in principle consists of a slidable piston 63 in a cylinder chamber in said device one face of which piston 63 is spring loaded while the other face senses the pressure in the conduit 56 in communication with the outlet of the pump 45. A slide 64 connects an extension on the spring loaded face of the piston 63 directly to an adjusting pivot 65 on the cylinder barrel housing 45^1 of the axial piston pump 45. Through sidewise displacement of the pivot 65 the housing 45^1 can be turned on the trunnion bearings 48 and its angle adjusted and varied with respect to a fixed pump housing section 66, which latter incorporates the driven shaft 67 of the pump 45 integral with the driving plate, not shown. Through the angular displacement of the pump housing 45^1 the displacement of the pump 45 may be varied in continuous manner from fuel flow in one direction as indicated by the angle 68 to reversal of flow indicated by the angle 69. A spring package 70 is interposed between the slide 64 and a large area piston 71 reciprocable in a cylinder 72 in the control device 55. At the rear face of the piston 71 the cylinder 72 communicates over a conduit 73 incorporating a throttle valve 74 directly with the conduit 56. The cylinder 72 may be exhausted to the tank 47 of the pump 45 via the pressure cut-off device 62. In the cut-off device is slidably arranged a spring loaded piston valve 75 in a cylinder 77 connected to the conduit 60, FIG. 7. The spring load is provided by a spring 76. Against the action of the spring 76 the piston valve 75 may be displaced axially as soon as sufficient pressure arises in the conduit 60, and such displacement opens exhaust passages 78 to the tank 47 whereby the cylinder 72 of the constant horsepower control device 55 is exhausted and the pressure acting on the piston 71 therein relieved.

Identical constant horsepower control devices 55 are arranged on each of the pumps 44 and 45. In the example shown the pressure cut-off device 62 of the pump 44 is left idle. For setting the base value of the control devices 55 there is arranged a manually adjustable screw member 79 on each of them by which the pre-compression of the spring package 70, which is an assembly of a number of springs having different characteristics, may be regulated. Every pressure change in the circuit controlled is sensed by the piston 63 of the respective control devices 55 via the conduit 56 and results in a change of the compression of the spring package 70. Such change effects displacement of the slide 64 and angular displacement of the pivot 65 whereby the displacement of the pump 45^1 is varied. In known manner the spring characteristics are chosen

in a manner to give a resultant characteristic closely following the theoretical pump output curve represented by the product between pump pressure and pump displacement and such close following is directly transmitted via the slide 64 to the pump housing 45 which obviously results in a regulation with substantially constant horsepower output. In addition to such control the pressure cut-off device 62 of the pump 45 is active and senses via the spring loaded valves 58, 59 excessive pressure peaks before the rotating motor 33 as well as before the feed motor 43. As soon as the pressure in the circuits at one of these points, as a result of the drilling conditions and for example caused by the drill steel being stuck exceeds the adjustable manually preset spring load value on any of the valves 58, 59, high pressure fluid will flow past the respective valves 58, 59 into the conduit 60. The pressure will rapidly rise in the conduit 60 owing to the action of the throttle valve 61 and will subsequently move the piston valve 75 in the cut-off device 62 to open the exhaust passages 78 of the cylinder 72. This relieves the pressure acting on the piston 71 in the control device 55 and the entire assembly therein consisting of the piston 63, the slide 64, the spring package 70, and the piston 71 is displaced by the remaining pressure acting on the piston 63 to the right in FIG. 6. During this movement the slide 64 turns the housing 45^1 of the pump in a direction toward or past zero displacement. This adjustment is performed under practically constant peak pressure in the circuit controlled. The decrease or reversal of flow from the pump 45 will rapidly cure the drilling conditions through a decrease in the feed or bit pressure or a reversal of the feeding direction and as soon as the circuit pressure returns to a value below the value necessary for opening the spring loaded valves 58, 59, the conduit 60 will be rapidly exhausted via the throttle valve 61 to the tank 47, the piston valve 75 will close the exhaust passages 78 and the position of FIG. 6 of the control device 55 will subsequently be restored by the pressure again acting on the large area piston 71 after pressure equalization at the opposite ends of the pistons 63 and 71.

Prior to drilling the operator adjusts the spring load on the valves 58, 59 to a value corresponding to the maximum drilling torque and maximum bit pressure or feed motor torque, respectively, allowed by the rock and the drilling equipment. By means of the screw member 79 on the constant horsepower control device 55 of the pump 44 the operator thereupon adjusts and sets the maximum permissible number of revolutions of the rotating motor 33 for drilling. By means of the screw member 79 on the constant horsepower control device 55 of the pump 45 the operator thereupon firstly in a purely manual manner regulates the starting and collaring of the drill hole, whereupon he by means of the same member 79 adjusts and sets the maximum permissible number of revolutions of the feed motor, which is equivalent with the maximum permissible drill penetration rate for the work in question. With these operations accomplished the drilling aggregate will operate independently and thanks to the presetting of the valves 58, 59 and the screw members 79 will constantly keep the feed pressure, the drill torque, the number of revolutions of the drill, and the drill penetration at the most effective values. By means the cut-off devices 62 on the pump 45 overloading of the rotating motor and feed motor will be prevented.

The embodiment of the invention above described and illustrated in the drawings should only be considered as an example and the invention may be modified in several different ways within the scope of the following claims.

What we claim is:

1. A high pressure fluid drill feed control comprising a movable drill rig, elongated guiding means on said drill rig, a rock drill reciprocable on said guiding means, a drill steel carried by said rock drill, means connected to said rock drill and adjacent said guiding means for positively feeding said dock drill forwardly or rearwardly along said guiding means, said feeding means comprising a high pressure fluid driven fixed displacement rotary feed motor of axial piston type, a first high pressure fluid variable displacement pump of axial piston type in flow communication with said feed motor to form therewith a first closed pressure fluid circuit, a high pressure fluid driven fixed displacement rotating motor of axial piston type on said rock drill for rotating said drill steel, a second high pressure fluid variable displacement pump of axial piston type in flow communication with said rotating motor to form therewith a second closed pressure fluid circuit, a driven shaft on said first and second pump, a piston barrel housing on each said pump, connected to said shaft and angularly adjustable thereto for varying in a continuous manner the displacement of said first and second pump, respectively, power means connected to said pumps for driving said shafts, preadjustable automatic constant horsepower control valve means connected to said piston barrel housing for controlling the angle thereof with respect to said shafts of each said pump, and pressure fluid actuated means connected to said control valve means and in flow communication and responsive to a selectively preset pressure in said first and second circuit before said feed motor and said rotating motor, respectively, for automatically reducing the displacement of said first pump by reducing the angle of its respective piston barrel housing thereto to a value according to the torque requirements of said drill steel.

2. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled and having a rock drill with a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor and second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit, and means for driving said pumps, the combination which comprises first adjusting means connected to said first pump for controlling the displacement of said pump and the torque of said drill motor in response to fluid pressure and including means for sensing fluid pressure in said first circuit for actuation of said first adjusting means, second adjusting means connected to said second pump for controlling the displacement of said second pump and the torque of said feed motor in response to pressure and including means for sensing fluid pressure in said second circuit for actuation of said second adjusting means, and control means connected to said second adjusting means and in flow communication with said first and second circuits and responsive to a predetermined maximum pressure in either of said circuits for actuating said second adjusting means to reduce the displacement of said second pump when said predetermined maximum pressure is reached.

3. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled and having a rock drill with a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor and a second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit, and means for driving said pumps, the combination which comprises a first pressure fluid operated adjusting means connected to said first pump and having a large cross-sectional face on one side thereof, a smaller cross-sectional face on the other side thereof with a spring for balancing said smaller cross-sectional face against said larger cross-sectional face, said first adjusting means being in flow communication with said first circuit for sensing fluid pressure therein for adjusting the displacement of said pump and the torque of said drill motor in response to said fluid pressure, a sec-

ond pressure fluid operated adjusting means connected to said second pump and having a large cross-sectional face on one side thereof, a small cross-sectional face on the other side thereof with a spring for balancing said smaller cross-sectional face against said larger cross-sectional face, said second adjusting means being in flow communication with said second circuit for sensing fluid pressure therein for adjusting the displacement of said second pump and the torque of said feed motor in response to said fluid pressure, and control means connected to said larger cross-sectional face of said second adjusting means and in flow communication with said first and second circuits for sensing a predetermined maximum pressure in either of said circuits for exhausting said second adjusting means on the larger face thereof whereby said spring means is relieved and pressure on said smaller cross-sectional face actuates said adjusting means to reduce the displacement of said second pump when said predetermined maximum pressure is reached.

4. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled and having a rock drill with a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor and a second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit and means for driving said pumps, the combination which comprises first adjusting means connected to said first pump for controlling the displacement of said pump and the torque of said drill motor in response to fluid pressure and including means for sensing fluid pressure in said first circuit for actuation of said adjusting means, second adjusting means connected to said pump for controlling the displacement of said second pump and the torque of said feed motor in response to fluid pressure and including means for sensing fluid pressure in said second circuit for actuation of said adjusting means, and automatic control means connected to said second adjusting means and in flow communication with said first and second circuits, said automatic means comprising adjustable spring-loaded overflow valves in said first and second circuits and an exhaust valve between said overflow valves and said second adjusting means whereby when a predetermined maximum pressure has been reached in said first or second circuits as determined by the setting of said overflow valves, said exhaust valve actuates said second adjusting means to reduce the displacement of said second pump.

5. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled and having a rock drill with a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor and a second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit, and means for driving said pumps, the combination which comprises a first pressure fluid operated adjusting means connected to said first pump and having a large cross-sectional face on one side thereof, a smaller cross-sectional face on the other side thereof with a spring for balancing said smaller cross-sectional face against said larger cross-sectional face, said first adjusting means being in flow communication with said first circuit for sensing fluid pressure therein for adjusting the displacement of said pump and the torque of said drill motor in response to said fluid pressure, a second pressure fluid operated adjusting means connected to said second pump and having a large cross-sectional face on one side thereof, a smaller cross-sectional face on the other side thereof with a spring for balancing said smaller cross-sectional face against said larger cross-sectional face, said second adjusting means being in flow communication with said second circuit for sensing fluid pressure therein for adjusting the displacement of said second pump and the torque of said feed motor in response to said fluid pressure, and automatic control means connected to said second adjusting means and in flow communication with said first and second circuits, said automatic means comprising adjustable spring-loaded overflow valves in said first and second circuits and an exhaust valve between said overflow valves and said second adjusting means whereby when a predetermined maximum pressure has been reached in said first or second circuit as determined by the setting of said overflow valves, said exhaust valve exhausts the large cross-sectional face of said second adjusting means thereby relieving the spring of said second adjusting means to permit the reduced pressure on the smaller cross-sectional face thereof actuating said second adjusting means to reduce the displacement of said second pump.

6. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled and having a rock drill with a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor and a second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit, and means for driving said pumps, the combination which comprises first adjusting means connected to said first pump for controlling the displacement of said pump and the torque of said drill motor in response to fluid pressure and including means for sensing fluid pressure in said first circuit for actuation of said adjusting means, second adjusting means connected to said second pump for controlling the displacement of said second pump and the torque of said feed motor in response to fluid pressure and including means for sensing fluid pressure in said second circuit for actuation of said adjusting means, and control means connected to said second adjusting means and in flow communication with said first circuit and responsive to a predetermined maximum pressure in said first circuit for actuating said second adjusting means to reduce the displacement of said second pump when said predetermined maximum pressure is reached.

7. In apparatus of the character described for fluid pressure control of the feed of a rock drill toward a surface to be drilled, the combiantion which comprises a movable drill rig, elongated guiding means on said drill rig, a rock drill reciprocable on said guiding means, a drill steel carried by said rock drill, said rock drill having a fluid pressure driven rotary drill motor and a first high-pressure fluid variable displacement pump in flow communication with said drill motor and forming therewith a first pressure fluid circuit, a fluid pressure driven rotary feed motor on said guiding means for reciprocating said rock drill thereon and having a second high-pressure fluid variable displacement pump in flow communication with said feed motor and forming therewith a second pressure fluid circuit, power means for driving said pumps, first adjusting means connected to said first pump for controlling the displacement of said first pump and the torque of said drill motor in response to fluid pressure and including means for sensing fluid pressure in said first circuit for actuation of said adjusting means, second valve means connected to said second pump for controlling the displacement of said second pump and the torque of said feed motor in response to fluid pressure and including means for sensing fluid pressure in said second circuit for actuation of said adjusting means, and automatic control means connected to said second adjusting means and in flow communica-

tion with said first circuit, said automatic control means comprising an adjustable spring-loaded overflow valve in said first circuit and an exhaust valve in flow communication with said overflow valve and connected to said second adjusting means whereby when a predetermined maximum pressure has been reached in said first circuit as determined by the setting of said overflow valve said exhaust valve operates said second adjusting means for actuating said second pump for reducing the displacement thereof.

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