Feb. 26, 1963 V. H. NIXON 3,078,932

DRILLING MACHINE

Filed Nov. 8, 1957 5 Sheets-Sheet 1

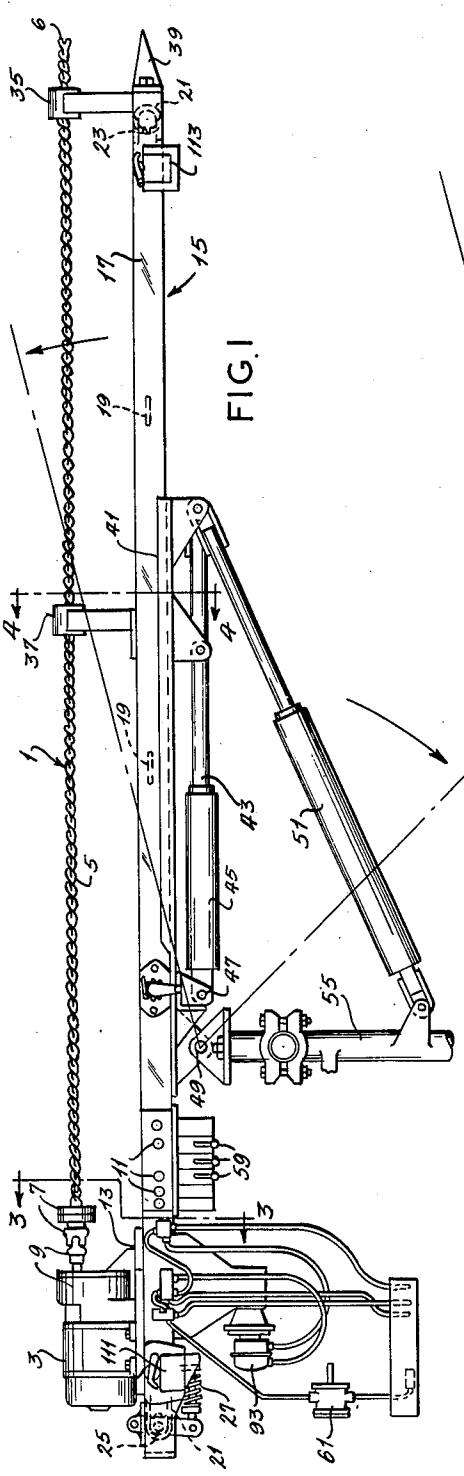

FIG. 1

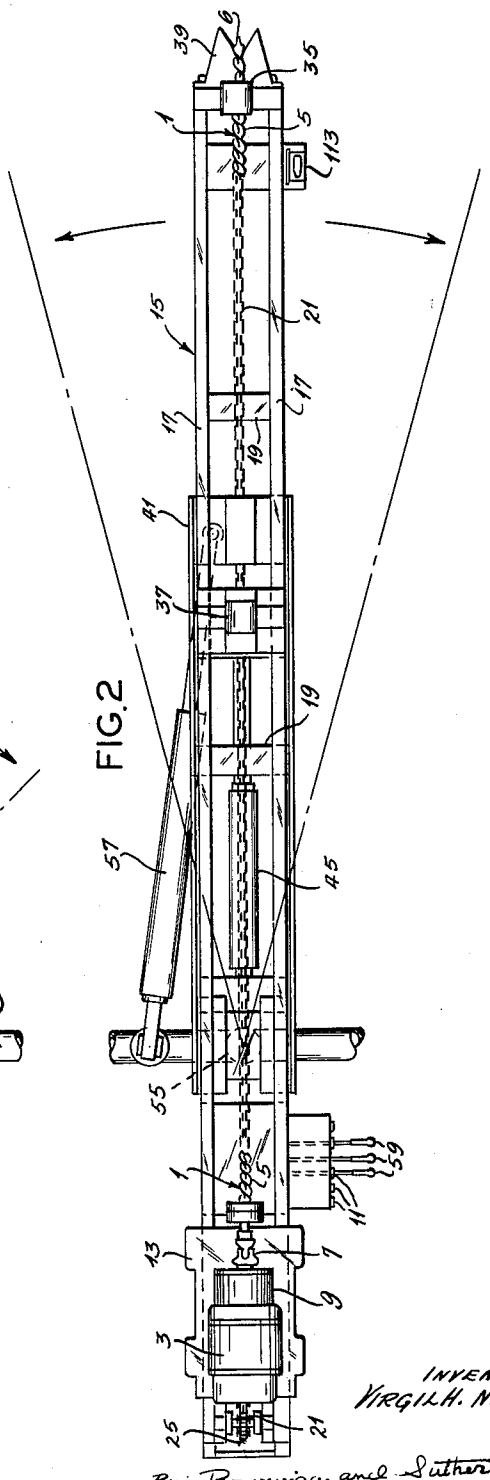

FIG. 2

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DRILLING MACHINE

Filed Nov. 8, 1957 5 Sheets-Sheet 2

FIG. 3

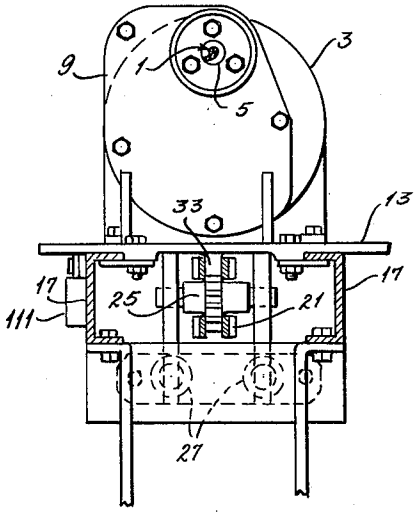


FIG. 4

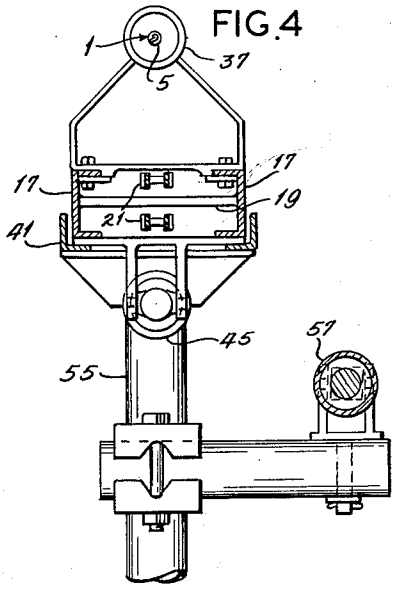
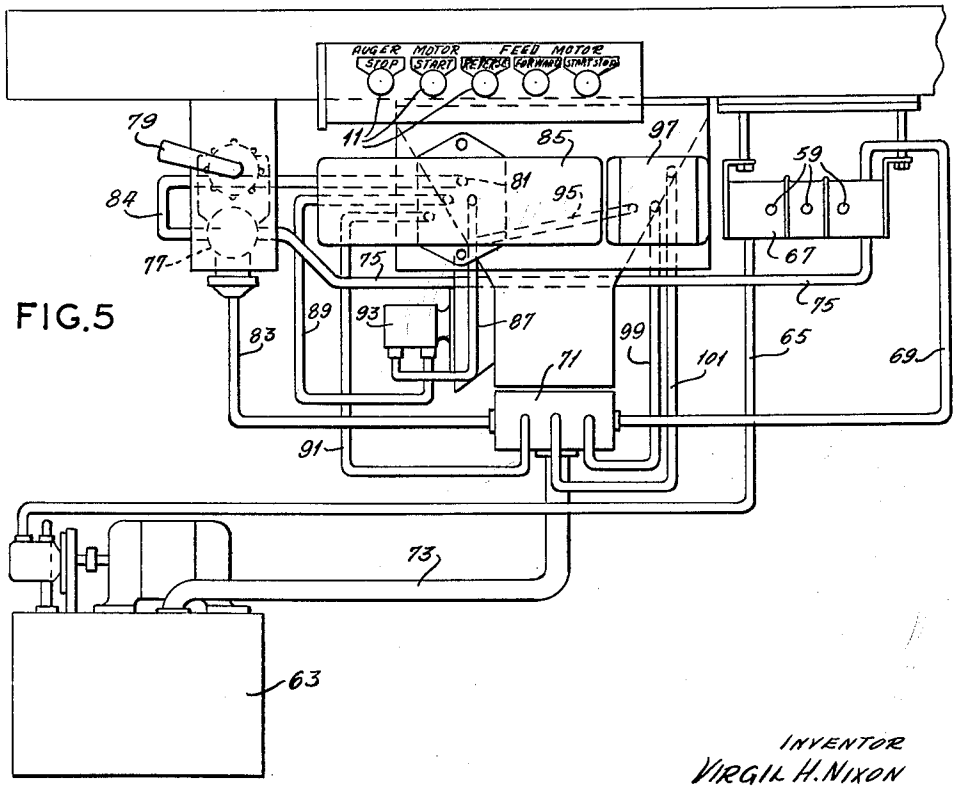


FIG. 5



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Filed Nov. 8, 1957 5 Sheets-Sheet 3

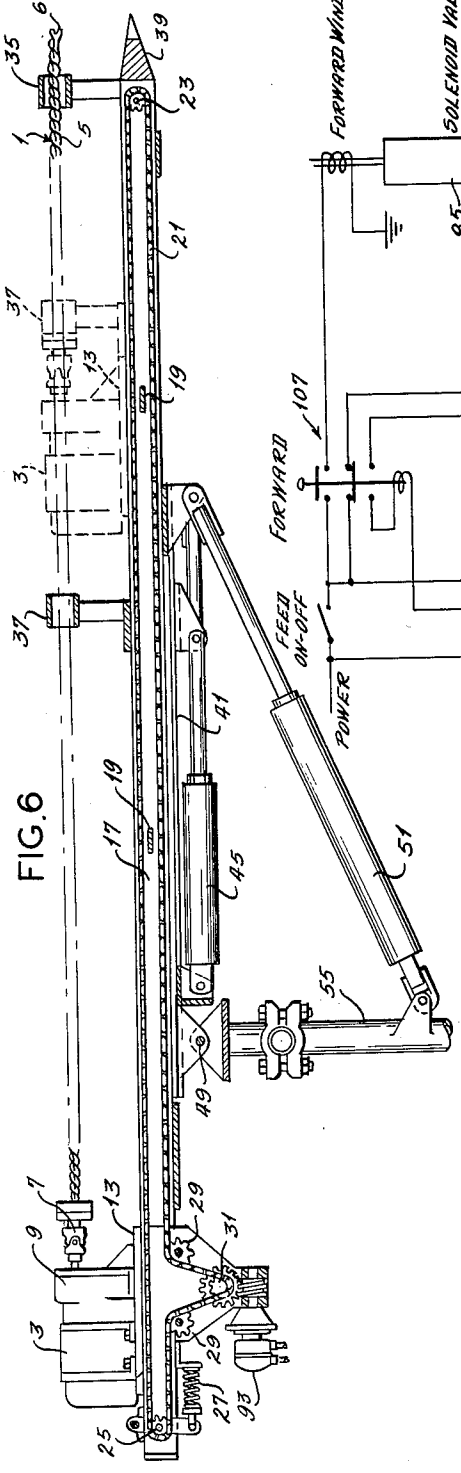

FIG.6

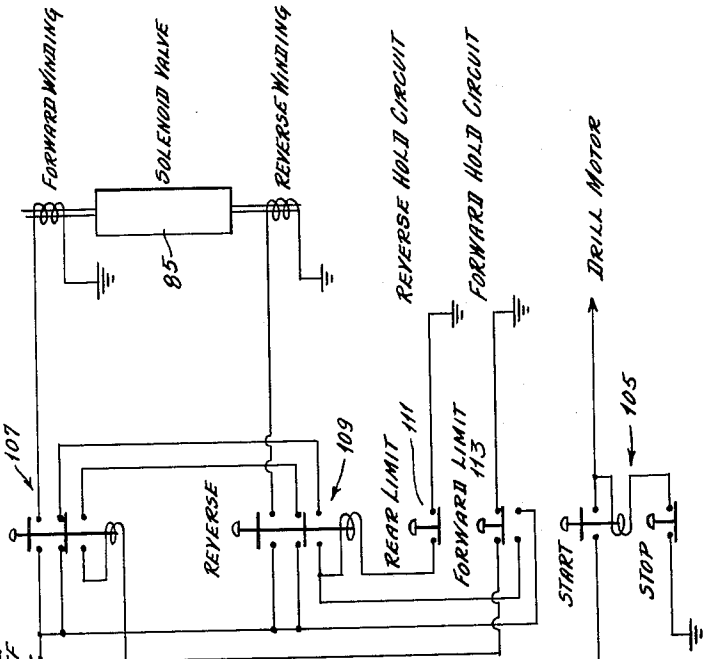

FIG.7

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Feb. 26, 1963 V. H. NIXON 3,078,932

DRILLING MACHINE

Filed Nov. 8, 1957 5 Sheets-Sheet 4

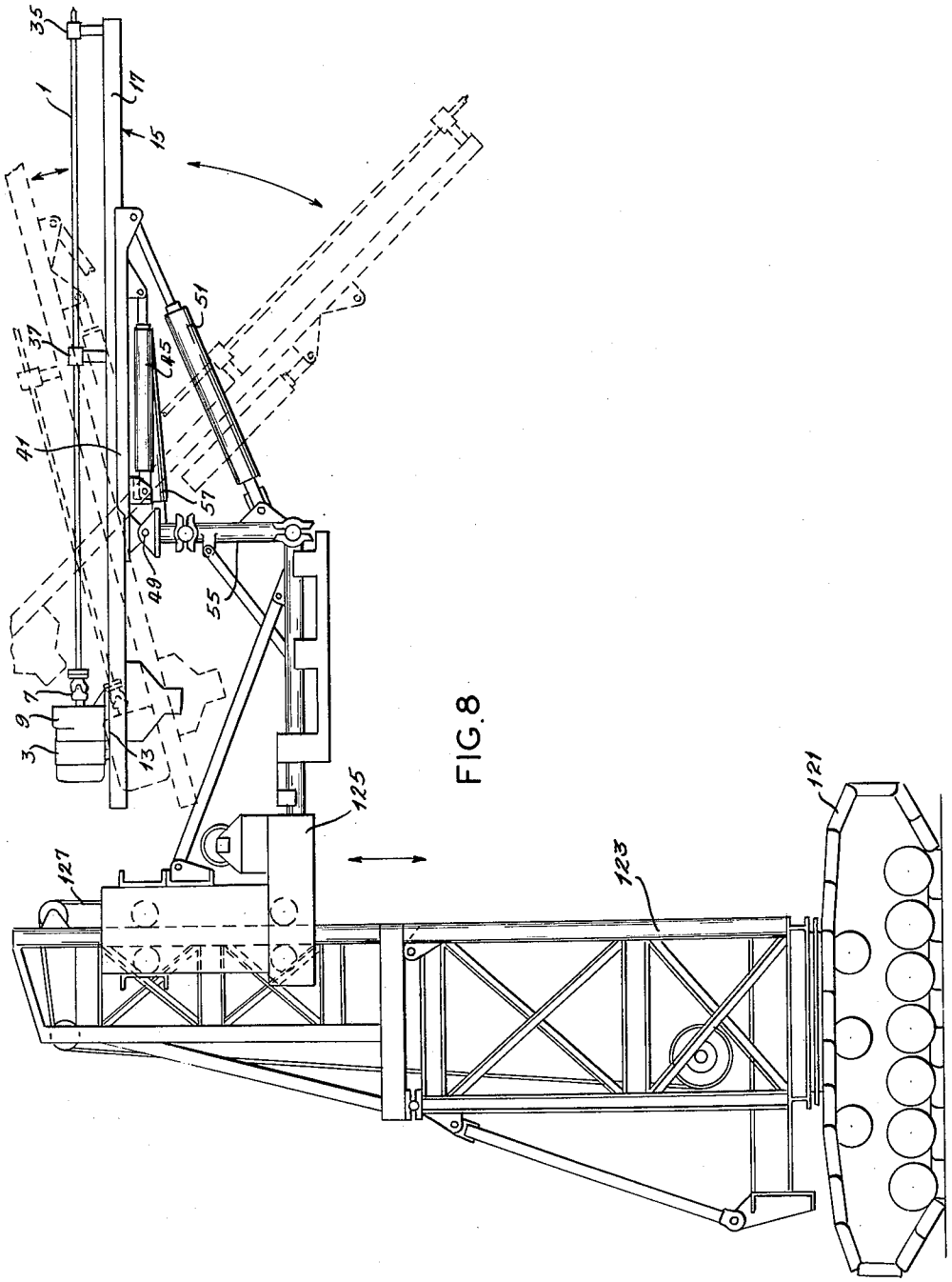

FIG. 8

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Feb. 26, 1963 V. H. NIXON 3,078,932

DRILLING MACHINE

Filed Nov. 8, 1957 5 Sheets-Sheet 5

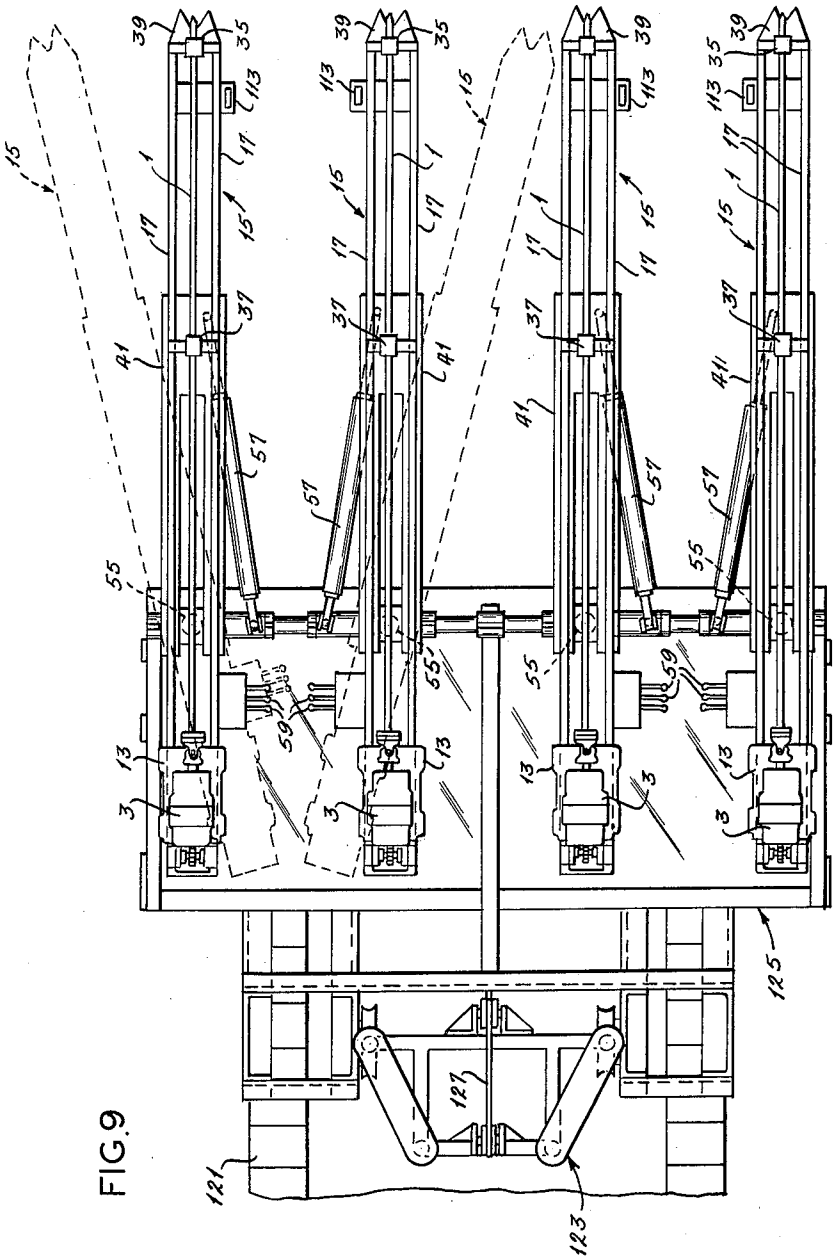

FIG. 9

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United States Patent Office 3,078,932 Patented Feb. 26, 1963

3,078,932

DRILLING MACHINE

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Filed Nov. 8, 1957, Ser. No. 695,252
2 Claims. (Cl. 175—51)

This invention relates to drilling machines, and more particularly to machines of the type used in drilling blast holes in mining operations.

It will be understood there is great interest in making more efficient use of labor and equipment in mining operations. While there have been various proposals for automatic drilling machines, it is felt there is room for significant improvement. Accordingly, a primary objective of the invention is to provide a machine whereby drilling may proceed with a minimum of supervision and at optimum conditions for the particular rock or ore. Another object of the invention is to provide for quick convenient location of the drill bit by means of simply operated positioning controls. A further object is to provide for convenient starting of a hole without disturbing the controls for drill pressure and rate of feed and without requiring the miner to even up the rock face by a pick, as has been customary. Still another object of the invention is to provide a conveniently adjusted means of controlling both the pressure of the bit on the rock and its rate of feed, it being understood that different types or hardness of rock are most efficiently drilled under different condition of bit pressure and bit rate of feed. Other objects of the invention include the provision of a machine which facilitates the drilling of uniform blast-hole patterns, especially as to hole depth, thereby economizing on blasting powder and achieving superior rock breakage as well as more efficient drilling.

Briefly, the drilling machine includes at least one and preferably two drilling units per operator, which units may be elevated or shifted laterally on the machine by power controls. Each drilling unit has a long auger type drill bit coupled to a drill motor. The drill motor is mounted on a carriage, which is adapted for movement along a frame. The frame may be tilted and swung in order to control the angle of the hole, and it may be advanced independently of the drill motor carriage in order to facilitate starting of a hole. Hydraulic cylinders preferably are utilized in advancing, tilting and swinging the frame. The machine further includes a hydraulic system for advancing the drill carriage on its frame, which system is under control of adjustable pressure-relief and flow control valves, so as to predetermine the maximum rate of feed (in soft rock) and maximum bit pressure (in hard rock). An adjustable control may be provided for automatically reversing the feed motor and retracting the drill bit when the proper hole depth is reached.

In operation, elevating and lateral movement controls together with the tilt and swing controls are adjusted to locate the bit at the proper position on the rock face and at the proper angle. The drill motor is started, and the thrust or frame-advance control can be manipulated by the operator to start the hole, whereupon the hydraulic feed system is actuated to take over control. This feed system permits the drilling to continue without operator supervision until the hole is completed and the bit automatically retracted, whereupon the operator repositions the drilling unit and associated bit for the next hole.

Other features of the invention will be in part apparent from and in part pointed out in the following detail description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation of a single bit unit such as might be used in a multiple bit machine, the bit being fully retracted;

FIG. 2 is a top plan view of the drilling unit shown in FIG. 1;

FIG. 3 is a cross section taken on the line 3—3 of FIG. 1;

FIG. 4 is a cross section taken on the line 4—4 of FIG. 1;

FIG. 5 is a diagram of the hydraulic circuit used in control of this machine;

FIG. 6 is a vertical longitudinal section of the frame showing the feed mechanism of the drill;

FIG. 7 is an electric circuit diagram;

FIG. 8 is a diagrammatic side elevation of a multiple-bit drilling machine; and

FIG. 9 is a diagrammatic top plan view of the multiple-bit machine shown in FIG. 7.

Referring to the drawings, it is contemplated that a drilling machine will be built with two or four drilling units of the type shown in FIG. 1, and that two such units can be conveniently handled by an operator. Each unit has an auger or other type of drill 1, the auger type having spiral flights 5 for conveying the cuttings from the bit 6. The drill bit is rotated by means of an electric or other type of motor 3, and the drill preferably is coupled to the motor through a universal joint 7 and a reducing unit 9, which includes a thrust bearing and changeable gears (not shown). The gears are changed for different drilling conditions, a good selection of bit speeds being 780, 640, 520, 420, 350 and 280 r.p.m. Push button switches 11 are mounted at the operator's station to start and stop the motor. A hydraulic drill motor could have hydraulic speed controls.

The drill motor 3 is mounted upon a carriage 13, which is adapted for movement along a frame 15 forming part of the bit feed-control assembly. This frame may be made up from a pair of heavy channel sections 17, joined together in spaced relationship by cross ties 19. A chain 21 extends substantially the length of the frame in the space between the channel members 17, there being a front sprocket 23 and a rear sprocket 25 about which the chain is trained. The rear sprocket may be spring mounted to take up slack and tension the chain, as indicated at 27. As will be more apparent in FIG. 6, the chain 21 is also guided about idler sprockets 29 to a drive sprocket 31, which is driven by a hydraulic motor system to be described. Necessarily, the drill-motor carriage 13 is fastened at 33 to the chain, hence is advanced and retracted by the hydraulic motor unit.

It may further be noted the frame carries a fixed forward bit support 35 and a travelling bit support 37. The intermediate support 37 necessarily should be able to advance in front of the carriage as drilling progresses beyond the mid point and should return to the center position as the carirage is retracted. The details of such travelling bit supports are understood in the art, hence in the interests of simplifying the disclosure are not described or claimed as part of this invention.

Next, it will be observed the forward end of the frame has points 39, which are adapted to dig into the rock face and steady the bit. The frame 15 itself is slidably mounted in angle members 41 and is pinned to a piston 43 of a hydraulic thrust cylinder 45, which is otherwise fastened at 47 to the angle members 41. The thrust cylinder is adapted to advance and retract the frame 15, and thereby the drill bit within limits, but independently of the normal bit feed. This feature of operation is especially desirable in starting a hole. Heretofore, it has often been necessary for the operator to even up the rock face where a hole is to be drilled, a somewhat tedious manual operation involving the use of a pick. Applicant's thrust

cylinder affords close operator control over initial movement of the bit, thereby permitting the hole to be started more conveniently while not disturbing the settings for the normal rate of feed or bit pressure.

Otherwise, the angle members 41 are pivoted at 49 for movement in the vertical direction under control of a hydraulic tilt cylinder 51. The pivotal support 49, in turn, is mounted upon a column 55 for movement in the horizontal direction under control of a hydraulic swing cylinder 57. Accordingly, the drill bit may be readily adjusted to any desired angle, vertical and horizontal, this being desirable because blast holes are angled in order to maintain a uniform width and height at the working face of the mine. Separate control valves 59 located at the operators station are connected to the several hydraulic cylinders 45, 51 and 57 so as to permit control over each cylinder.

Referring now to FIG. 5, there is a main hydraulic pump 61 supplied by an associated reservoir 63. The pump outlet is connected at 65 to a housing 67 for the control valves 59, which control the aforementioned thrust, tilt and swing cylinders. It will be understood, the housing includes an inlet passage to which pressure pipe 65 is connected and from which branch passages lead to the three separate cylinder-control valves 59. The hydraulic cylinders 45, 51 and 57 are of the double-action type, hence their control valves 59 are manual four-way valves, preferably operated by joy sticks. When the joy stick is moved in one direction, pressure is supplied to one end of the associated cylinder and its other end is drained to an outlet passage in the valve housing 67. This outlet passage is connected through a drain pipe 69 to a return manifold 71, which in turn empties through a connection 73 to the pump reservoir 63.

The pressure side of the system is continued from the inlet passage of the valve housing 67 by a conduit 75 to the inlet port of an adjustable relief valve 77. Control unit 77 is adapted to release hydraulic fluid through a drain 83 to the return manifold when the pressure in the outlet port or pipe 84 exceeds a predetermined value. An adjusting handle 79 is provided to vary the outlet pressure in accordance with the drilling conditions, as will be explained, and the pressure outlet from the relief valve is connected at 84 to the inlet 81 of a three-position four way solenoid valve 85. Valve 85 has a pair of outlet conduits 87 and 89, and the valve is actuated by solenoid means from a closed position to either of two open positions. In one open position, the conduit 87 is fed from the inlet 81 and the conduit 89 drains through connection 91 to the return manifold 71, but this relationship is reversed when the solenoid valve is actuated to its other open position.

Conduit 87 is connected to what is termed the "forward" side of a reversible hydraulic motor 93, whereas the other conduit 89 is connected to the so-called "reverse" side of the motor. Accordingly, the solenoid valve starts and stops the motor and also determines its direction of rotation, the arrangement being such that the drill is advanced when pressure is supplied through "forward" conduit 87 and the drill is retracted when the input 81 is placed in communication with "reverse" conduit 89.

The connection 87 to the "forward" side of the motor is connected at 95 to an adjustable flow control valve 97, which is adjusted to bleed off a predetermined quantity of hydraulic fluid through a drain pipe 99 and a discharge pipe 101 to the return manifold. It will be understood that the main hydraulic pump 61 has a predetermined capacity or rate of flow, and that the speed of the hydraulic motor 93 or rate of bit advance is determined by the amount of fluid bypassed through the flow control. In other words, the rate of bit advance is limited, the limit rate being determined by the setting or quantity of hydraulic fluid bypassed through the flow control valve 97. Such a limit on the rate of advance is especially desirable in drilling soft materials in order to insure that the cuttings are removed by the spiral flights of the drill. If the advance is too great in relation to the rotational speed, the cuttings will accumulate within the hole. It may also be noted that the control over the rate of feed applies only to the advance or "forward" side of the motor. In normal operation, there will be some drain off through the flow control 97 so that the rate of advance is somewhat less than that obtainable from the hydraulic pump. On the other hand, there is no drain off on the "reverse" side of the motor unit, hence retraction will be at a maximum rate and the drilling operation thereby speeded up.

The adjustable relief valve 77 is especially desirable in drilling hard materials. It should be understood that this valve is responsive to the pressure on the inlet side of the feed motor 93. Should the bit encounter an unusually hard material or difficult drilling condition, the pressure relief valve 77 will function to limit the thrust force applied of the drill to a predetermined value, thereby protecting the bit against breakage.

The feed motor 93 is controlled through its solenoid valve 85 by a start-stop switch 105, a "forward" switch 107 and a "reverse" switch 109. These switches are electrically connected to the solenoid valve windings so that the direction of bit feed may be controlled independently of the start-stop condition. In other words, the solenoid valve may be moved from a closed position wherein the drill motor is entirely cut off from input pressure to positions in which the feed motor is either driven in the forward or reverse direction. In addition, the machine includes limit switches mounted on the frame 15 and adapted for actuation by the drill-motor carriage 13. A first limit switch 111 is fixed at the back of the frame and is connected to the solenoid valve so as to stop the feed motor. The forward limit switch 13 may be adjustably positioned along the frame so as to control the depth of the drill hole, and this switch, in turn, is connected in a way so as to reverse the feed motor, thereby automatically retracting the bit upon completion of the hole. The details of the electric circuits are conventional and will be readily understood by those skilled in the art. One system is diagrammed, however, in FIG. 7.

Referring now to FIGS. 8 and 9, a multiple-drill machine is shown to have an endless-track chassis 121 with a vertical tower 123 on which a platform 125 is mounted for vertical movement. The platform may be elevated and lowered by means of cables 127 or in some other fashion not pertinent to this invention. The platform 125 in turn carried a plurality of drilling units and their operators. For example, there may be four drilling units of the type described heretofore and two operators. For further convenience in locating the bits, the tower 123 may be adapted for rotation about a vertical axis on its chassis 121, and the platform 125 might be adapted for sidewise movement, within limits.

In operation, the chassis 121 is moved into position opposite the mining face and the platform 125 is elevated to a position for drilling a first row of four holes, but before the platform is elevated out of reach, it would be desirable to set the positions of the forward limit switches for the desired hole depth. The operator may then manipulate the manual valves which control the tilt and swing of hydraulic cylinders for each drilling unit to set the drills at proper angles with respect to the face. If there is a hole-starting problem, the operator may further manipulate the thrust cylinder control while the hole is started, the thrust cylinder otherwise being actuated to drive the frame 15 against the rock face so as to steady the drilling unit. The drill motor is started and the feed motor is also started in the forward direction. At the beginning of a drilling operation, it may be necessary to vary the adjustments for the rate of feed and bit pressure, but normally these particular settings need not be disturbed except on rare occasions. Also, the hole depth setting would not be changed, except on rare occasions.

Accordingly, the actual drilling of a hole is substan-

tially automatic, the feed motor being reversed and the bit retracted when the proper depth is reached. The operator's task is reduced largely to that of locating the drills in accordance with the desired blasting pattern after completion of one set of holes. Since the relative locations of the four drills, the angles and depths of the holes drilled are all maintained by the machine, a more uniform drilling pattern is assured. In this respect, it will be understood that a row of four holes would be drilled at one level, the platform then elevated to drill a similar row of holes, etc. to the top of the mine face. If the mine face is wider than that required for four drills, then the entire machine may be moved on its chassis to another position and the process repeated.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a rock-drilling machine having a frame, a drill carried by the frame for travel therealong, a fluid-actuated reversible feed motor having "forward" and "reverse" lines and adapted to move the drill along the frame, and a constant-flow pump having supply and return lines; the improvement that comprises a three-position main control valve connected to the supply and return lines of the pump, said feed motor having its "forward" and "reverse" lines connected to the main control valve, the main control valve being movable from a stop position wherein the pump supply line is disconnected from both the "forward" and "reverse" lines of the motor to a forward position wherein the supply line of the pump is connected to the "forward" line of the motor and the "reverse" line of the motor is connected to the return line of the pump thereby to advance the drill, the main control valve also being movable from the stop position to a reverse position wherein the motor connections are reversed, thereby to retract the drill, and an adjustable by-pass valve connected only between the forward line of the motor and the return line of the pump, thereby to bleed off a predetermined selected quantity of the constant pump flow, whereby control of the rate of drill advance is reduced to a pre-set value when the main control valve is in the forward position without limiting the rate of drill retraction when the main control valve is in the reverse position.

2. A rock-drilling machine as set forth in claim 1 further including a solenoid means for actuating the main control valve between its positions, forward, stop and reverse switches connected for actuating the solenoid means and thereby the valve to its respective positions, a limit switch on the forward end of the frame for engagement by the drill and connected to actuate the solenoid means and valve from the forward to the reverse position, and a second switch at the back of the frame connected to actuate the solenoid and valve from the reverse to the stop position.

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