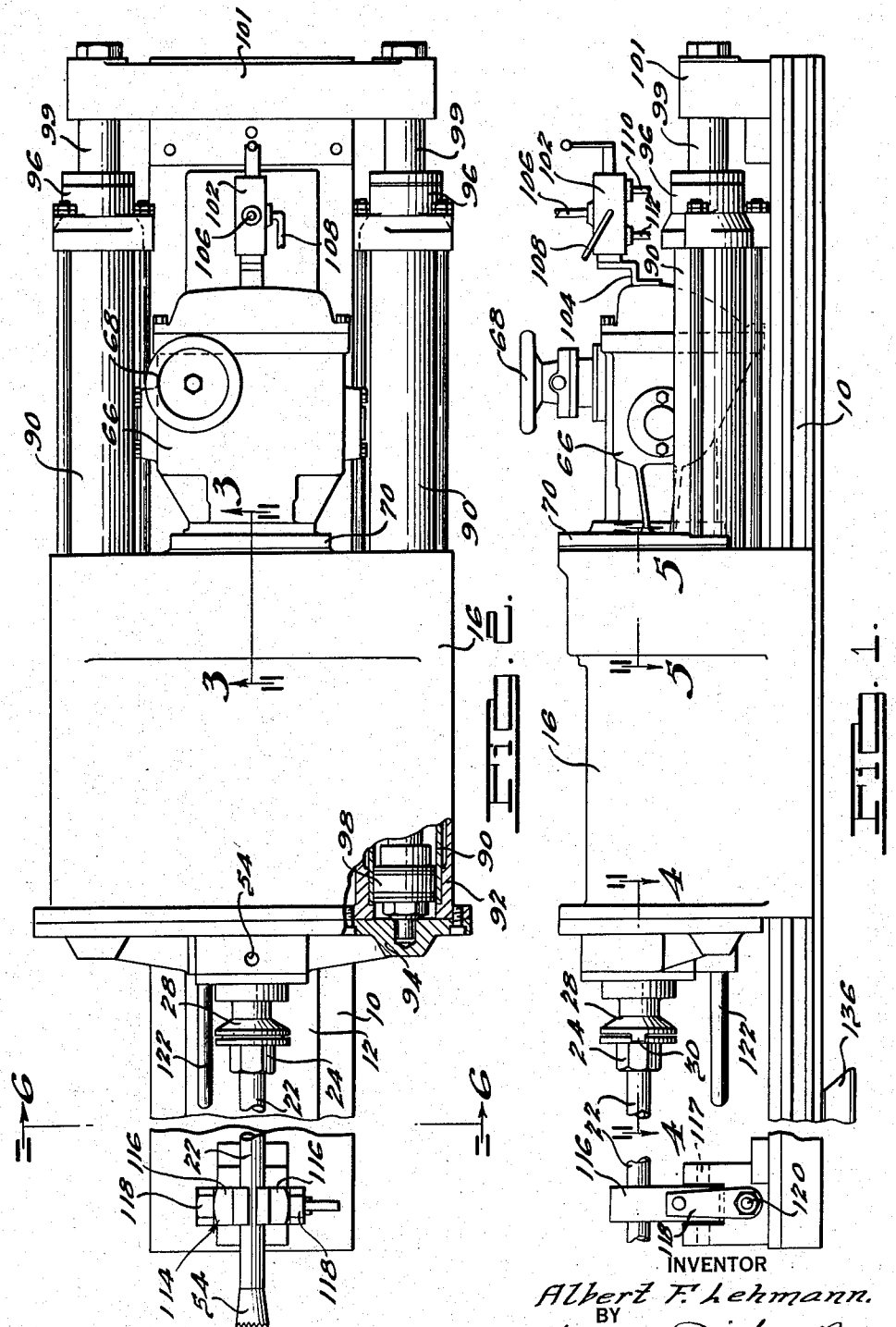
June 1, 1943. A. F. LEHMANN 2,320,874

MINING MACHINE

Filed Jan. 18, 1941 3 Sheets-Sheet 1



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MINING MACHINE

Filed Jan. 18, 1941 3 Sheets-Sheet 2

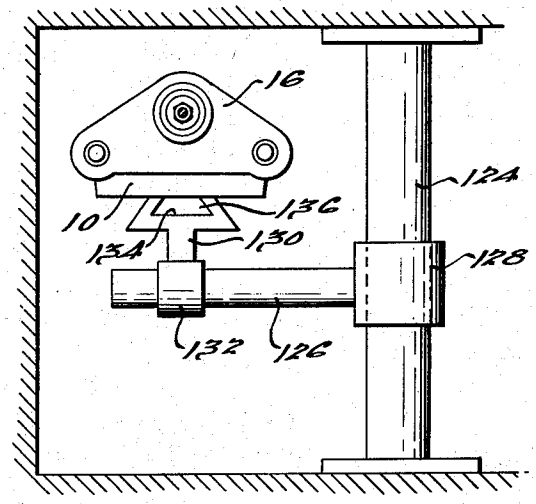


Fig. 7.

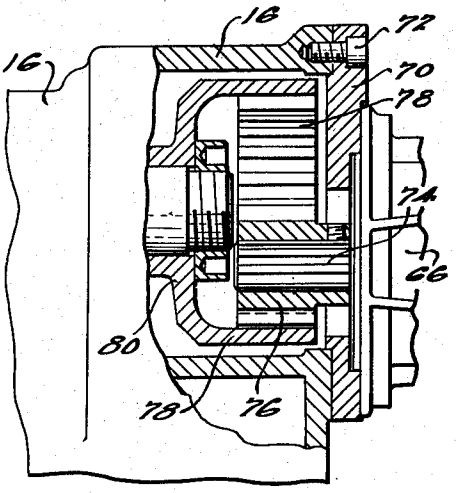


Fig. 3.

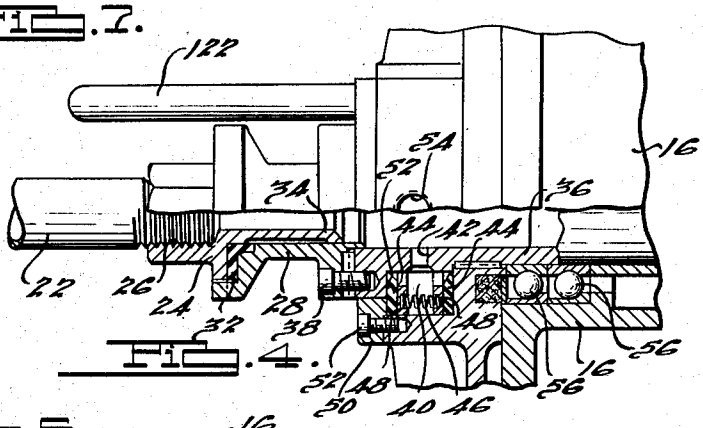
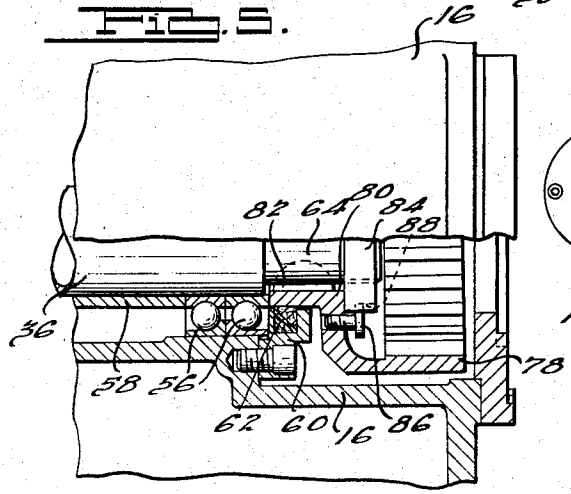


Fig. 4.

Fig. 5.



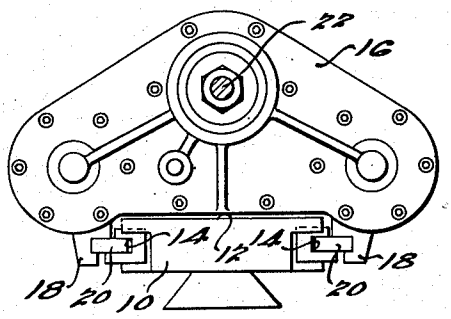


Fig. 6.

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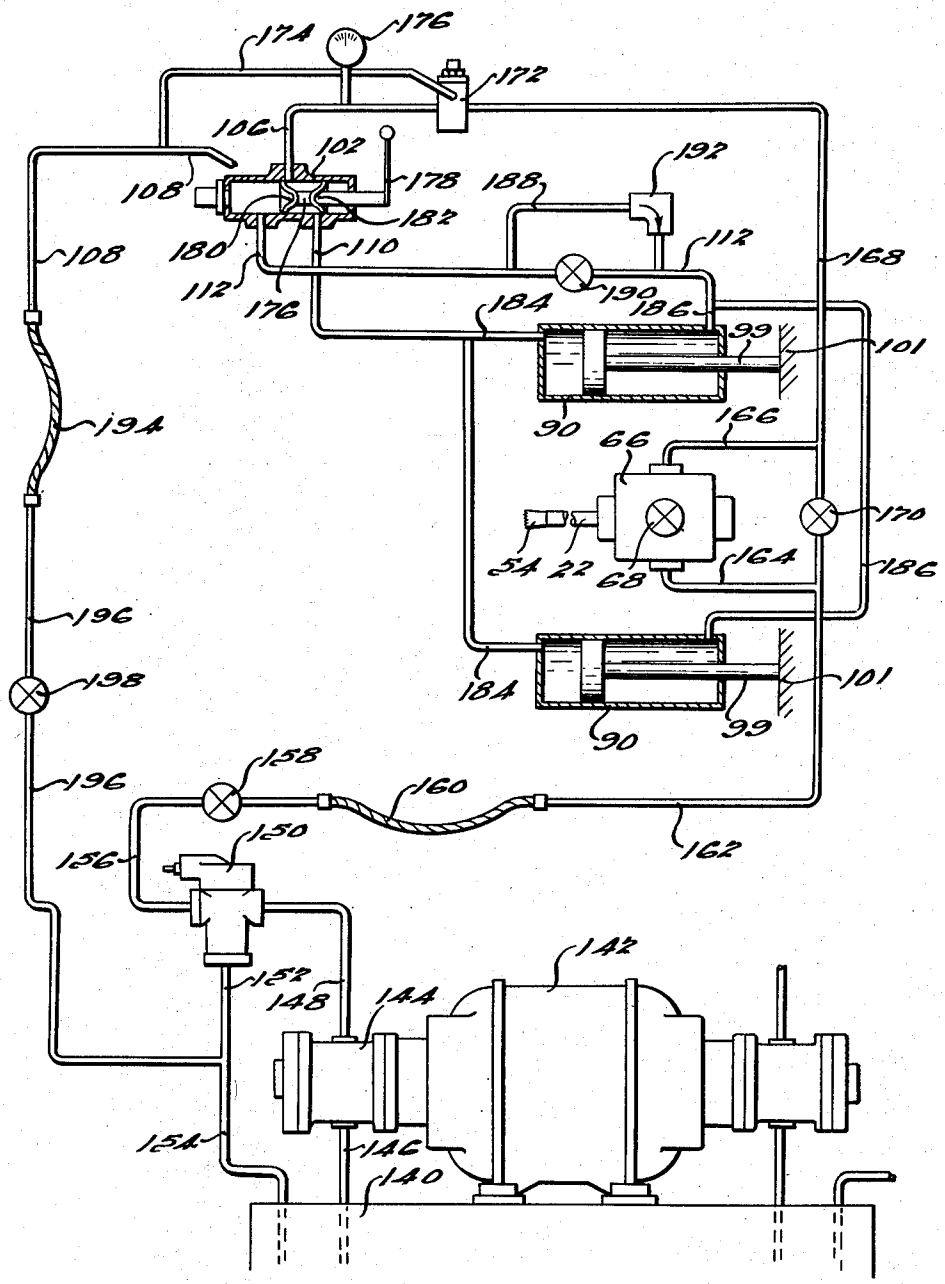


Fig. 8.

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UNITED STATES PATENT OFFICE

2,320,874

MINING MACHINE

Albert F. Lehmann, Detroit, Mich., assignor to Hydraulic Machinery, Inc., Detroit, Mich., a corporation of Michigan

Application January 18, 1941, Serial No. 374,987

6 Claims. (Cl. 255—45)

The present invention relates to mining machines and particularly relates to improvements in rotary drills for forming blast holes.

One of the primary objects of the present invention is to provide a machine of the type mentioned in which the blast holes may be more quickly formed than by the implements now in use.

Another object of the invention is to provide an hydraulically operated rotary mining drill which is functionally flexible so that it is readily accommodated to use on materials of different characteristics, such as hard or soft materials.

Another object of the invention is to provide a machine of the type mentioned which may automatically respond to variations in the hardness of the material worked upon so that when working on a soft spot the infeed of the drill is faster than when encountered by relatively hard material, when the infeed is slower.

Another object of the invention is to provide an improved drill of the type mentioned in which the rotary speed of the drill may be adjustably varied and in which the infeed of the drill may also be adjustably varied and may be set at a predetermined amount so that when the resistance to such infeed exceeds a certain amount, the infeed is stopped but the rotation of the drill continues.

A further object of the invention is to provide a drill of the type mentioned which may be operated so that the rate of infeed of the drill is adjustable and may be set so that the rate of infeed is constant regardless of the resistance on the drill bit, or may be set so that the rate of infeed automatically varies in direct response to the amount of resistance to infeed of the material being worked upon so that if less resistance is encountered, the rate of infeed increases, and if greater resistance is encountered, the rate of infeed decreases.

Another object of the invention is to provide a drill of the type mentioned in which a quick return of the drill to its outer position is accomplished regardless of the rate of infeed.

Another object of the invention is to provide a drill of the type mentioned which is so constructed that the life of the drill bit is relatively high.

Other objects of the invention will become apparent from the following specification, from the drawings relating thereto, and from the claims hereinafter set forth.

In the drawings, in which like numerals are used to designate like parts in the several views throughout:

Figure 1 is a broken, side elevational view of a rotary mining drill unit embodying features of the present invention;

Fig. 2 is a top plan view with a portion broken away and illustrating a portion in cross-section of the construction shown in Fig. 1;

Fig. 3 is an elevational and cross-sectional view taken substantially along the line 3—3 of Fig. 2;

Fig. 4 is an elevational and cross-sectional view taken substantially along the line 4—4 of Fig. 1;

Fig. 5 is an elevational and cross-sectional view taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is an end elevational view taken substantially along the line 6—6 of Fig. 2;

Fig. 7 is a diagrammatic view illustrating the drill unit of the present invention set up for use in a mine; and

Fig. 8 is a diagrammatic view illustrating the hydraulic circuit and the functional relationship of certain of the elements of the construction of the present invention.

In general, the present invention is directed to a rotating drill for drilling blast holes in mining operations. Such construction consists of an hydraulic power plant and an hydraulic drill unit. The power plant includes an oil reservoir, an electric motor, an hydraulic pump connected to the hydraulic motor, a safety valve for the pump and flexible pressure and return lines leading to and from the drill unit. The power plant may be mounted in a suitable location with the lines or conduits leading to the drill unit, which may be located in the mine where the drilling is to take place.

The drill unit is of a compact nature and may be suitably mounted on standards disposed within the mine so that the drill may be disposed to face the wall where the drilling is to take place. The drill unit includes an elongated standard, which is adjustable with respect to the wall and which has a rotating drill and spindle movably mounted thereon. The means for rotating the drill comprises an hydraulic motor and the drill is movable toward and from the wall during rotation by hydraulically actuated means in the form of a cylinder and piston construction. Controls are provided in the hydraulic circuit and the fluid motor is adjustable so that the drill is controllably fed into the work under controlled rotative speed.

The machine may be operated so that up to a predetermined pressure within the feed cylinders,

the rate of infeed may be constant regardless of the resistance on the bit, or, the operation may be such that the rate of infeed is automatically variable so that when the bit strikes a soft part the rate of infeed automatically increases, or when the bit strikes a hard spot the rate of infeed automatically decreases. Also, the circuit includes pressure regulating means of such a nature that when the pressure within the feed cylinders builds up beyond a predetermined amount, the fluid supplied such cylinders is diverted therefrom and is returned to the tank, so that the infeed is cut off while the drill bit continues to rotate.

Referring to the drawings for a detailed description of one illustrative embodiment of the present invention, and referring particularly to Figs. 1 through 6, in which the drilling unit is disclosed, such drilling unit includes an elongated base or standard 10, having a finished upper surface 12 and having ways 14 formed in the sides thereof. A housing 16 is slidably disposed on the finished surface 12 of the standard 10 for sliding movement therealong. Such housing 16 has depending side portions 18, each of which has rollers 20 mounted thereon. Such rollers 20 are so disposed that they are received within the ways 14 for guiding the housing and associated elements as they move along standard 10.

A hollow spindle 22 is rotatably mounted on housing 16 by means including a spindle nose element 24, having a tapped central opening 26 which threadably receives therein the threaded end of spindle 22. The mounting member 24 is connected to a complementary mounting element 28 for rotation therewith by means of tongue and groove connections 30, as shown in Fig. 1. Vulcanized rubber 32 is disposed between the facing surfaces of members 24 and 28 and is vulcanized to such surfaces so as to provide a cushion for the spindle nose. The member 24 also has an inwardly directed tubular portion 34 which engages the inner surface of member 28, so that a rugged spindle nose is provided.

The member 28 is secured to a tubular drive shaft 36, which is disposed within the bore of housing 16, by means of screws 38 or the like. The front closure plate of housing 16 is formed with an annular chamber 40 adjacent the spindle nose, which communicates with the interior of the tubular shaft 36 through a plurality of annular spaced radially disposed openings 42, and which in turn communicates with the interior of the hollow spindle 22 through the hollow member 24. Annular, rubber sealing elements 44 are disposed within the chamber 40 and are urged against the opposite walls thereof by means of compression springs 46, which have their ends disposed within metal cup elements 48, which in turn bear against the seals 44. An annular closure ring 50 is fixed to the front face of the closure plate by means of screws 52 or the like, and bears against one surface of the outermost sealing element 44. The inner edge of sealing element 44 bears against a radial shoulder 62 formed on the drive shaft 36. Water from a suitable source is conducted into the chamber 40 through an opening 54' formed in the front closure plate of the housing and flows through the spindle 22 and out through the drill bit 54, which is removably secured to the forwardmost end of the spindle 22, so that the water is directed against the material being worked upon through the hollow bit 54. The bit 54 is formed of suitable material such as carborundum or the like. The pressure of the water within chamber 40 serves to force the seals 44 against their adjacent walls to further aid in the sealing.

The drive shaft 36 extends longitudinally of the housing 16 and is rotatably mounted thereon by means of ball bearing assemblies 56 disposed adjacent the forward and rear ends of such drive shaft. A spacer sleeve 58 embraces the drive shaft 36 and abuts against the ends of the inner racers of the facing bearing assemblies 56 to retain such bearing assemblies in place. An annular member 60 (Fig. 5) is fixedly secured to the housing 16 and has a shoulder portion which bears against the outer race of the outer bearing assembly 56 to hold such assemblies against longitudinal displacement. A suitable annular seal 62 may be held in place by a radially inwardly projecting shoulder of member 60.

The inner end of the drive shaft 36 may be closed and may be of slightly reduced diameter as indicated at 64 in Fig. 5, for connection to the drive means which will be described in detail hereinafter.

The drive means for the shaft 36 and, therefore, for the spindle 22 and drill bit 54, comprises a standard fluid or hydraulic motor 66 which is here illustrated as being of the piston type, but which may also be of the vane, gear or rotor types. Such piston motor 66 includes the usual hand wheel 68 which is operatively connected to the piston elements of the motor for varying the angular positions thereof in order to control the angular relation of the piston motor elements. In such motors, the greater the angular relationship, the greater the displacement and the less the speed, and, conversely, the less the angular relationship, the less the displacement and the greater the speed. As the speed decreases, the torque increases. The motor 66 is, of course, provided with the usual inlet and outlet ports and the relationship of such ports will be described in connection with the description of Fig. 8.

The housing of motor 66 is secured to a plate member 70, see Figs. 3 and 5, which in turn is secured to the rear face of housing 16 by suitable means, such as screws 72.

The motor 66 has the usual drive shaft 74 associated therewith to which a pinion 76 is fixed for rotation therewith. Such pinion 76 is constructed and arranged to mesh with the teeth of an internal gear 78, so that upon rotation of the pinion 76 the gear 78 is correspondingly driven. The gear 78 has an integral hub portion 80 which embraces the inner reduced end 64 of drive shaft 36 and is keyed thereto by means of a suitable key 82. A threaded end element 84 is threadably received over the inwardly projecting threaded end of reduced portion 64. Such member 84 projects radially outwardly so that it bears against the inner face of hub portion 80, and may be fixed against rotation by means of a suitable set screw 86, which is so arranged that a portion of the head of such screw is received within a slot 88 formed in member 84. It will thus be seen that the shaft 36 is rotatably mounted within housing 16 and is secured to the internal gear 78 for rotation therewith. It will further be appreciated that as fluid under pressure is supplied to the fluid motor 66, the drill bit 54 is rotated through the connections of spindle 22 with the driving pinion 76, above described.

Means are provided for sliding the housing 16 along the standard 10 so that the drill 54 is fed inwardly of and away from the work. Such means includes a pair of cylinders 90 having their for-

ward ends received within cylindrical portions 92 formed in the housing 16 at opposite sides thereof. The forwardmost ends of the cylinders are closed by the housing end plate 94, and the rear ends have caps 96 secured thereto. A piston 98 is disposed within each of such cylinders and has a piston rod 99 associated therewith which projects through the cap 96 of each of the cylinders. The rearmost ends of the piston rods 99 are fixed to the standard 10 by means of a transversely extending member 101. Such member 101 is secured to the standard 10 and the piston rods 99 are secured to such member 101 so that when fluid under pressure is supplied the forwardmost end of the cylinders 90, the housing 16 is caused to slide forwardly of the standard 10 to feed the drill inwardly. When fluid is supplied the opposite ends of cylinders 90, the housing 16, together with the drill, is backed off to move the drill outwardly from the work. While the inlet and outlet ports of such cylinders are not shown here, they are, however, shown in Fig. 8, and will be described in connection therewith.

A four-way valve 102 is mounted on the housing of the fluid motor 66 by means of a bracket 104. Such four-way valve has an inlet conduit 106 which communicates with a central opening in the valve housing and also has a return conduit 108 which communicates with the interior of the valve through a central opening disposed substantially at a right angle to the opening for the conduit 106. A conduit 110 leads to the forward ends of cylinders 90 for feeding the drill inwardly, and a conduit 112 leads to and communicates with the rear ends of the cylinders 90 for backing the drill outwardly from the work. The details of the hydraulic circuit will be described later, in connection with the description of Fig. 8.

The spindle 22 is of substantial length so that a hole of considerable depth may be drilled. In order to support the forward end of the spindle at the beginning of the drilling operation, a steady rest generally indicated at 114 is mounted on the forward end of the standard 10. Such steady rest may be of suitable construction, and is here illustrated as being of separable half sections 116 which, when upright, provide an aperture for slidably receiving therein the spindle 22. The sections 116 are pivotally mounted upon a suitable pivot pin 117 and, while such sections may fall apart to free the spindle 22 of any support, they are releasably held together by means of a pair of upstanding arms 118 which are secured to a transversely extending pivot pin 120. When the arms are in their upper position, as shown, the sections 116 are held together, while when the arms 118 are pivoted to drop away from engagement with the sections 116, such sections 116 may pivot to release the spindle 22. This will permit the maximum infeed, since the steady rest is out of the way and will not interfere with the spindle nose sections 24 and 28 as it approaches the wall of the mine.

In order to automatically move the steady rest out of the way, a forwardly projecting rod 122 is secured to the end plate 94 of the housing 16, and such rod is so positioned that as the housing 16 moves forward, the forward end of the rod abuts against one of the upstanding arms 118 to pivot both of the arms 118 out of engagement with sections 116 so that such sections fall away from the spindle. Suitable spring means may be provided for separating the sections when they are released from engagement with the arms 118, if desired.

Referring to Fig. 7, the drill unit is diagrammatically illustrated in position within a mine, and such unit may be mounted to an upright post 124, which is disposed within the mine, by means of a laterally extending arm 126 having a clamping portion 128 which embraces the post 124 and may be adjustably fixed thereto at the desired height. Another upstanding mounting arm 130 is mounted on the arm 126 by means of a slidable clamp 132 so that the arm 130 may be adjustably fixed with respect to the arm 126. The arm 130 is provided with a guideway 134, having upwardly tapered side walls, which receives therein a complementary member 136. Such member 136 is secured to the under side of the standard 10, and may be elongated in form in order to provide for rough adjustments of the standard 10 along the supporting bracket 130.

It will thus be seen that the drill unit may be conveniently mounted upon the arm 130 and roughly positioned within the mine at the desired location. Thereafter, the drill may be rotated and reciprocated to provide the in and out feeds for drilling the blast holes.

Referring to Fig. 8, the hydraulic power plant and hydraulic drill unit are diagrammatically illustrated together with the hydraulic circuit therefor. The power plant includes an oil tank or reservoir 140, which may be mounted on skids for movement within the mine. A double end electric motor 142 is mounted on the tank 140, and has oppositely directed drive shafts extending therefrom, each of such drive shafts being adapted to be connected to an hydraulic pump 144. The arrangement for only one end of the shaft is illustrated, but it is to be understood that a similar arrangement may be provided on the opposite end of the motor shaft for operating another drill unit, if desired. The motor 142 may be suitably connected to the power lines in the usual way.

The pump 144 is of standard construction and may be of the gear, vane, or other suitable type, as will be appreciated by those skilled in the art. An inlet conduit 146 communicates with the oil in tank 140 and also communicates with the inlet of the pump 144. An outlet conduit 148 leads from the discharge side of the pump 144 and communicates with a safety relief valve 150, which is of conventional construction. A return line 152 leads from the relief valve back to conduit 154, which returns to the tank so that the pump 144 may be continuously operated when the drill unit is shut off and the oil recirculated back into the tank. A conduit 156 leads from the relief valve 150 and has a shut-off valve 158 interposed therein. A flexible conduit 160 is connected to the conduit 156 and leads to the hydraulic drill unit. Such conduit 160 communicates with a rigid conduit 162 mounted on the drill unit.

An inlet conduit 164 communicates with conduit 162 and leads to the inlet of the fluid motor 66. An outlet conduit 166 communicates with the discharge of the motor 66 and communicates with another conduit 168. Such conduit 168 may be placed in communication with the conduit 162 or may be shut off from such communication by means of a shut-off valve 170. When such valve is shut off, the fluid under pressure passing through conduit 162 passes through the motor 66, causing rotation of the

spindle 22, and then passes into the conduit 168 through conduit 166. When the valve 170 is open, the fluid passes directly from conduit 162 into conduit 168.

Conduit 168 communicates with the inlet of a conventional pressure regulating valve 172, and one of the outlets of such valve communicates with the inlet conduit 106 of four-way valve 102. Another of the outlets of the valve 172 communicates with a return conduit 174 which, in turn, communicates with the return line 108 of the four-way valve 102. A pressure gauge 176 is interposed between the valve 172 and the four-way valve 102 to indicate the pressure in the inlet line 106.

As stated, the pressure regulating valve 172 is of conventional construction and is adjustable so that it is responsive to variable pressures, depending upon the adjustment of the valve. In operation, there is free flow of fluid from conduit 168 to conduit 106, but in the event that the pressure builds up in conduit 106, the plunger of valve 172 is actuated to open the port leading to conduit 174 so that fluid is diverted from flow into conduit 106 and is returned through conduit 174 to the return line 108, around four-way valve 102.

The four-way valve 102 has an operating plunger or spool 176 mounted therein which is operated by a handle 178 so that the valve may be positioned to communicate the inlet 106 with the conduit 110, in the position shown in Fig. 8. The conduit 112 is then in communication with the return line 108 through the inset portion 180 of the spool 176. The opposite end of the spool has a similar inset portion 182, so that when the valve is shifted to such a position that the conduit 106 is in communication with conduit 112, the conduit 110 then returns the fluid through the inset portion 182 into line 108.

With the valve in the position shown, the fluid under pressure enters the forward ends of cylinders 90 which communicate directly with conduit 110. The cylinders 90 are then caused to move forwardly, moving therewith the spindle 22 and drill bit 54 to cause the infeed of the drill.

The rear ends of the cylinders 90 communicate through branch conduits 186 with conduit 112. The conduit 112 has a by-pass conduit 188 communicating therewith, and an adjustable needle valve 190 is interposed in such conduit 112 between the points at which the conduit 188 communicates therewith. A check valve 192 of conventional construction is interposed in the conduit 188 and permits free flow through such conduit in the direction of the arrow, but prevents flow in the opposite direction.

The return line 108 is in communication with a flexible return conduit 194, which, in turn, communicates with a rigid conduit 196 mounted on the power plant. A shut-off valve 198 is interposed in the conduit 196. A return conduit 196 communicates with conduit 154 for return to the tank.

It will thus be seen that with the valves 158 and 198 shut off, there is no flow of the fluid under pressure to the drill unit and the flexible conduits 160 and 194 may be disconnected, if desired. However, with the valves 158 and 198 open and the valve 170 closed, fluid under pressure passes through the hydraulic motor 66 to drive the same and to rotate the spindle 22. The speed of the spindle 22 and drill bit 54 may be controlled by adjusting the hand wheel 68. With the valve 102 in the position shown, the drill bit 54 is fed inwardly, as mentioned above. With the valve 190 fully open, the flow of the fluid from the back ends of cylinders 90 is unrestricted, so that the fluid returns directly to the tank through conduits 108, 194, 196 and 154. With this setting, the rate of the infeed automatically varies in that in the event that the drill strikes a soft spot the resistance to its infeed decreases and its rate of infeed increases. Conversely, when a hard spot is struck, the rate of infeed will decrease. By adjusting the needle valve 190 to restrict the flow through conduit 112, the rate of infeed will be constant for a particular setting in that the restricted discharge from the cylinders 90 will determine such rate of infeed.

In the event that the resistance to the infeed increases to a predetermined amount, depending upon the setting of valve 172, such valve 172 will act to by-pass a portion of, or all of, the fluid from conduit 106 into conduit 174, and return such fluid to the tank, so that the infeed is either reduced or entirely cut off.

By shifting the spool 176 so that the conduit 106 communicates with conduit 112, and conduit 110 communicates with conduit 108, the drill is backed out or returned to its outward position. A quick return is provided regardless of the restriction imposed by the setting of needle valve 190 in that the one-way valve 192 permits unrestricted flow through conduit 188 in the direction of the arrow of such valve. The return of the fluid from cylinders 90 is through conduits 110 and 108.

It will thus be appreciated that by setting the various valves described above in desired positions, that the construction of the present invention provides a functionally flexible apparatus. Such apparatus is, therefore, adapted to meet the different conditions that are found in mining operations so that best results may be obtained.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. A rotary drilling machine comprising a drill, a first hydraulically actuated means for rotating said drill, a second hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulical circuit for supplying fluid under pressure to both of said first and second means, means interposed in said circuit between said first and second means to regulate the flow of fluid to said second means depending upon the pressure within said second means, a reversing valve to control the flow of fluid to said second means, and restricting means interposed in said circuit for controlling the flow of fluid through said second named means.

2. A rotary drilling machine comprising a drill, a first hydraulically actuated means for rotating said drill, a second hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulical circuit for supplying fluid under pressure to both of said first and second means, means interposed in said circuit between said first and second means to regulate the flow of fluid to said second means depending upon the pressure within said second means, a reversing valve to control the flow of liquid to said second means, and restrict-

ing means interposed in said circuit on the discharge side of said second means for controlling the flow of fluid through said circuit to regulate the rate of infeed of said second means.

3. A rotary drilling machine comprising a drill, a first hydraulically actuated means for rotating said drill, a second hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulical circuit for supplying fluid under pressure to both of said first and second means, means interposed in said circuit between said first and second means to regulate the flow of fluid to said second means depending upon the pressure within said second means, a reversing valve to control the flow of fluid to said second means, and restricting means interposed in said circuit on the discharge side of said second means for controlling the volume of fluid discharged therefrom to thereby regulate the rate of infeed of said second means.

4. A rotary drilling machine comprising a drill, a variable speed hydraulically actuated means for rotating said drill, an hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulic circuit for supplying fluid under pressure to both of said first and second named means, means interposed in said circuit on the inlet side of said second named means to divert the flow of fluid therefrom when the pressure of said second named means reaches a predetermined value, a reversing valve to control the flow of fluid to said second means, and adjustable restricting means interposed in said circuit on the discharge side of said second named means for regulating the rate of infeed of said second named means.

5. A rotary drilling machine comprising a drill, a first hydraulically actuated means for rotating said drill at variable speeds, a second hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulic circuit for supplying fluid under pressure to both of said first and second means in series, means interposed in said circuit between said first and second means to regulate the flow of fluid to said second means depending only upon the pressure within the said second means, a reversing valve to control the flow of fluid to said second means and restricting means interposed in said circuit for controlling the flow of fluid through said second named means.

6. A rotary drilling machine comprising a drill, a first hydraulically actuated means for rotating said drill at variable speeds, a second hydraulically actuated means for feeding said drill inwardly and outwardly, common means forming an hydraulic circuit for supplying fluid under pressure to both of said first and second means in series, means interposed in said circuit to regulate the flow of fluid to said second means depending upon the pressure within said second means and independent of the speed of rotation of said drill, a reversing valve to control the flow of fluid to said second means, and restricting means interposed in said circuit for controlling the flow of fluid through said second named means.

ALBERT F. LEHMANN.

CERTIFICATE OF CORRECTION.

Patent No. 2,320,874. June 1, 1943.

ALBERT F. LEHMANN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 75, claim 2, for "liquid" read --fluid--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of July, A. D. 1943.

Henry Van Arsdale,

(Seal) Acting Commissioner of Patents.