March 20, 1928.

1,663,403

G. H. GILMAN

DRILLING MACHINE

Filed Feb. 24, 1920

4 Sheets-Sheet 1

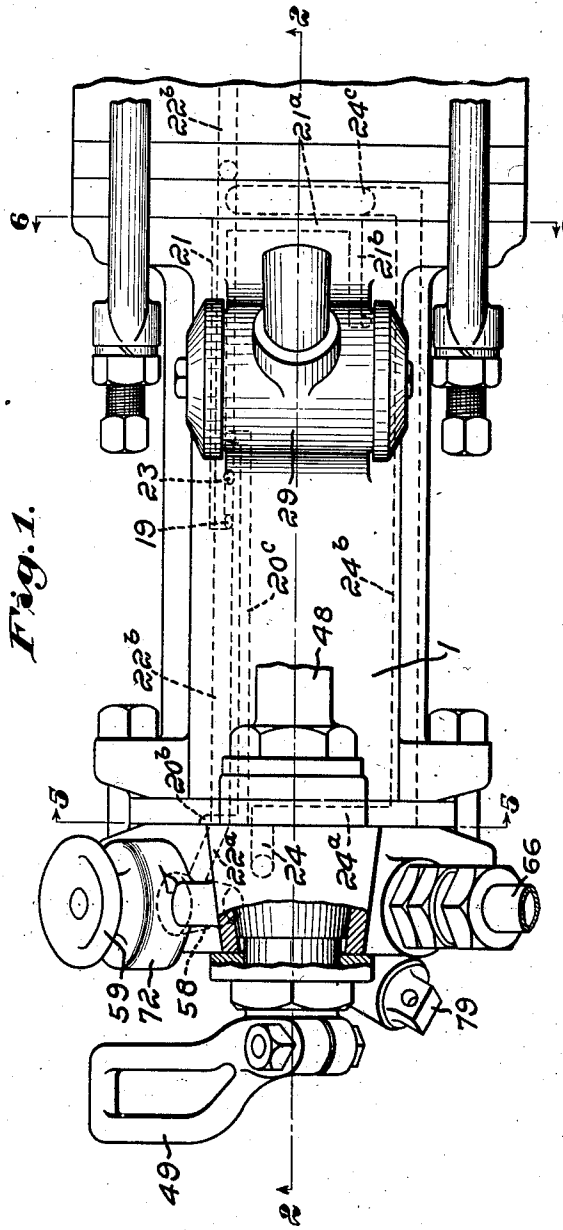

Fig. 1.

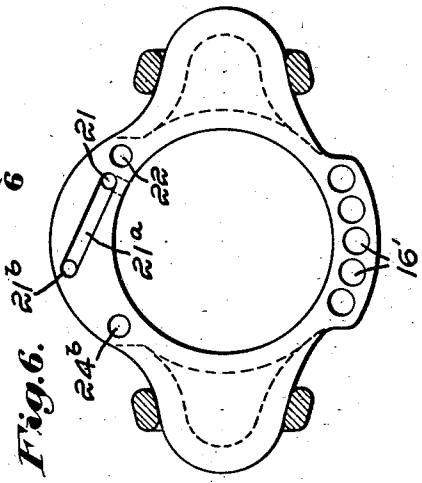

Fig. 6.

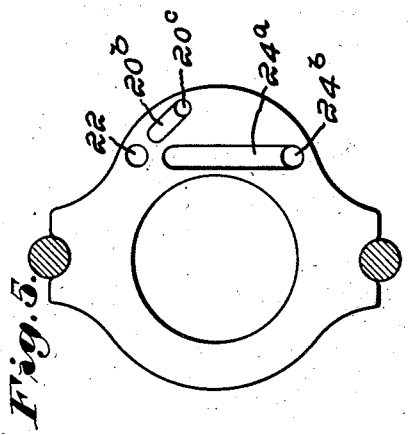

Fig. 5.

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4 Sheets-Sheet 2

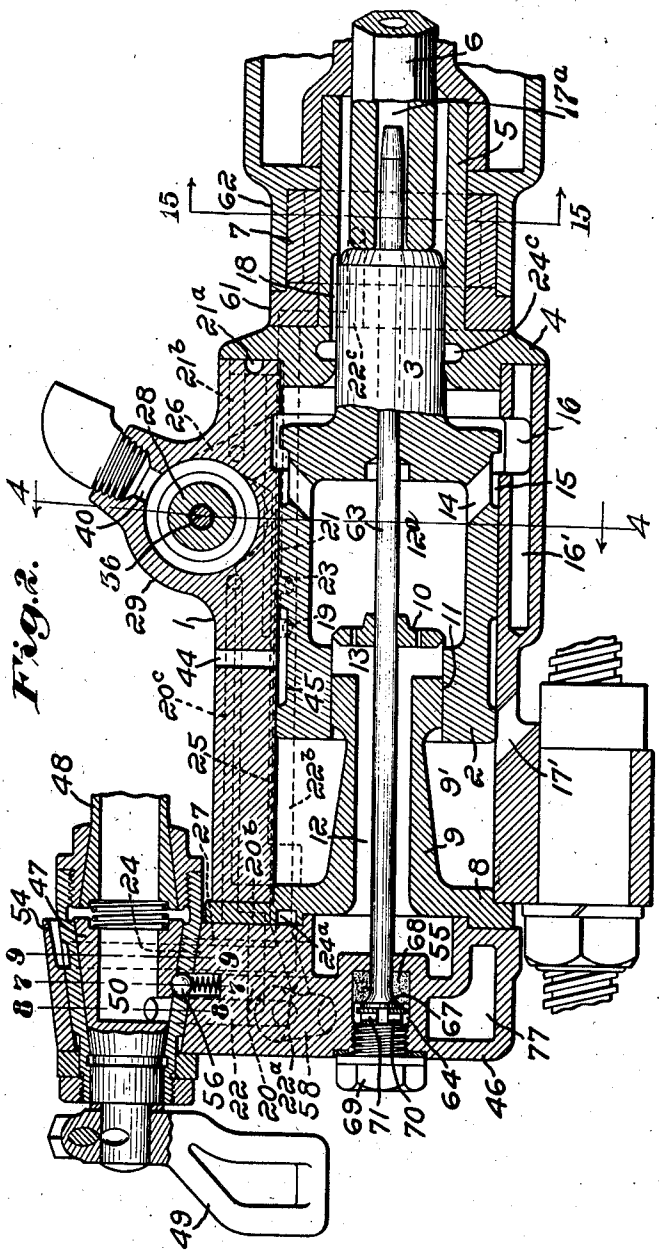

Fig. 2.

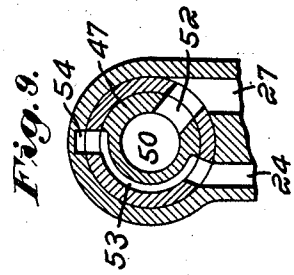

Fig. 9.

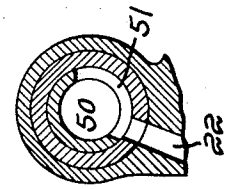

Fig. 8.

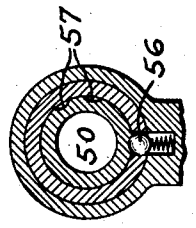

Fig. 7.

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G. H. GILMAN

DRILLING MACHINE

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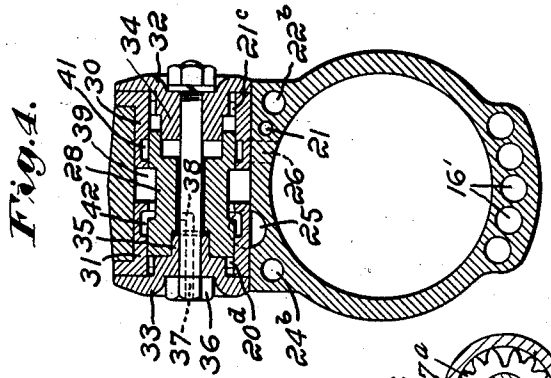

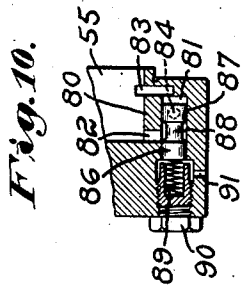

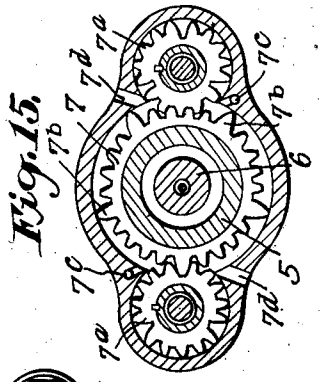

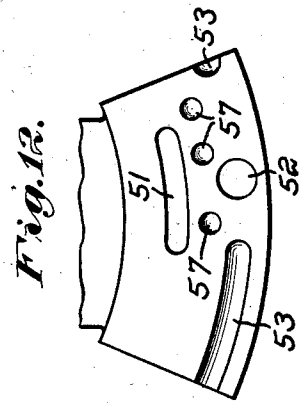

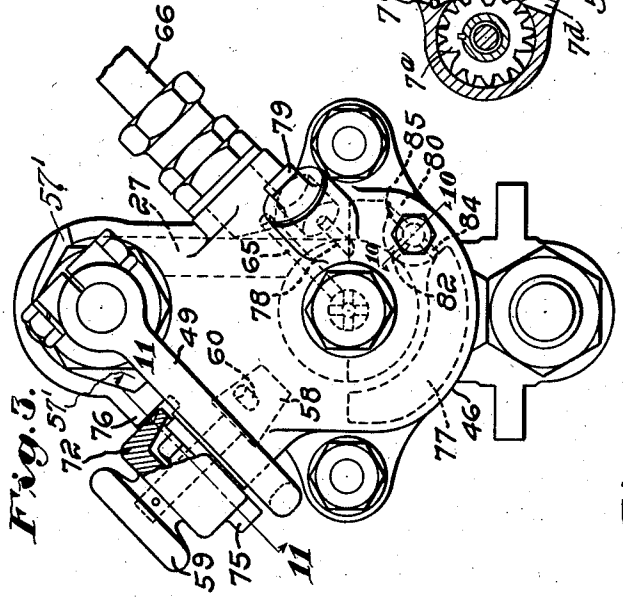

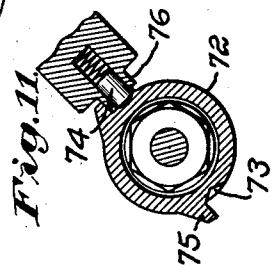

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1,663,403

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DRILLING MACHINE

Filed Feb. 24, 1920

4 Sheets-Sheet 4

Fig. 13.

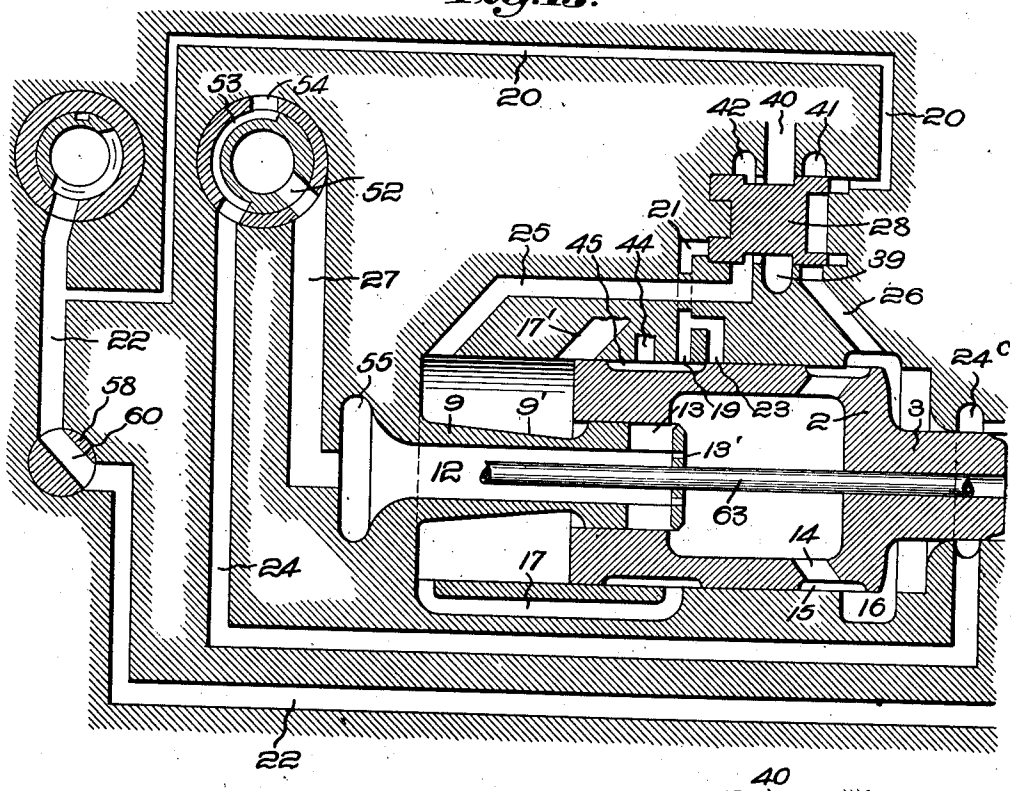
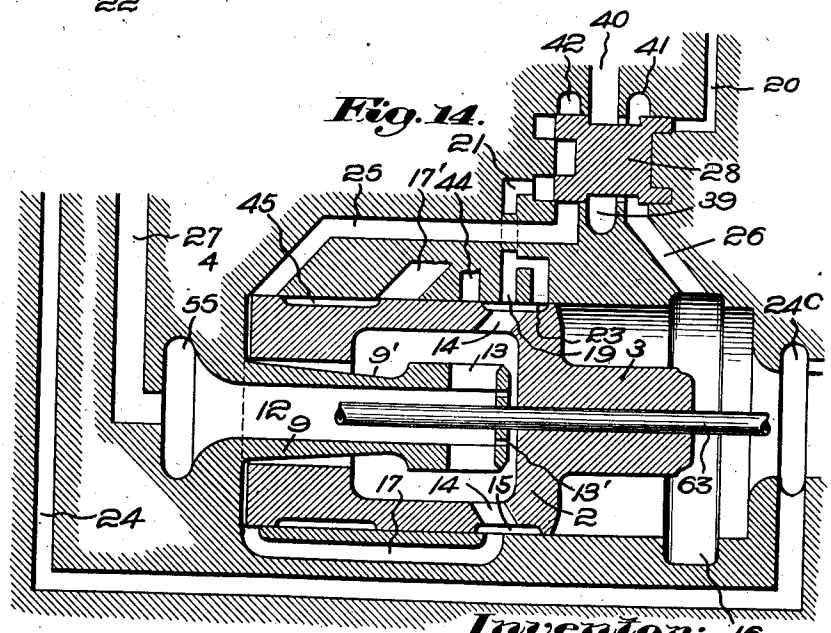


Fig. 14.



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Patented Mar. 20, 1928. 1,663,403

UNITED STATES PATENT OFFICE.

GEORGE H. GILMAN, OF BOSTON, MASSACHUSETTS.

DRILLING MACHINE.

Application filed February 24, 1920. Serial No. 360,619.

My invention relates generally to drilling machines and particularly, but not exclusively, to those for drilling rock and like formations and in this respect comprehends among other things a fluid pressure motor of the expansible chamber type of general application and means for controlling in a convenient and expeditious manner the various instrumentalities of the drilling machine.

My invention will be best understood from the following description and accompanying drawings of a specific embodiment of my invention, the scope of which will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 shows a plan of the drilling machine embodying my invention;

Fig. 2 shows a section on the line 2—2 of Fig. 1;

Fig. 3 shows an end elevation of Fig. 1;

Fig. 4 shows a section on the line 4—4 of Fig. 2 with the piston omitted;

Figs. 5 and 6 respectively show sections on the lines 5—5 and 6—6 of Fig. 1;

Figs. 7, 8 and 9 respectively show sections through the throttle valve on the lines 7—7, 8—8 and 9—9 of Fig. 2;

Fig. 10 shows a section on the line 10—10 of Fig. 3;

Fig. 11 shows a section on the line 11—11 of Fig. 3;

Fig. 12 is a development of the exterior surface of the throttle valve;

Figs. 13 and 14 represent diagrammatically the arrangement of ports and passages in the submitted embodiment of my invention, Fig. 13 showing the piston at the front end of the cylinder and Fig. 14 showing the piston at the rear end of the cylinder; and

Fig. 15 is a section on the line 15—15 of Fig. 2.

Referring particularly to Fig. 2, the embodiment of my invention herein submitted comprises a cylinder member 1 in which is mounted a piston having a head portion 2 and a projecting stem or hammer bar 3. This piston is mounted for reciprocation, and in the embodiment of my invention submitted is what is termed in the art a "floating" piston, that is, one which is not restrained in respect to its angular motion to follow a fixed path, as would be the case if, for example, it were splined to the cylinder by means of grooves or similar cam structures.

The front end of the cylinder is closed by a front head 4 provided with an extension 5 for receiving the hammer bar. Mounted in front of the hammer bar in position to be struck thereby is a drill steel 6, said drill steel being carried by a chuck which may be rotated by an independent rotation motor comprising the rotor 7 carried by the extension 5. The chuck and independent rotation motor just referred to may be of any suitable type, as for example that shown in United States Letters Patent No. 1,605,712, granted to me November 2, 1926, wherein the rotor 7 is in the form of a ring gear (Fig. 15) journalled on the extension 5 and meshing with the gears 7^a, the latter serving as rotary abutments for the elongated teeth or pistons 7^b of the rotor 7. Herein the rotor is provided with the inlet ports 7^c adapted to be supplied with motive fluid, as hereinafter described, and with exhaust ports 7^d leading to the atmosphere.

Herein the rear end of the cylinder is closed by a rear cylinder head 8 which has integrally formed therewith a distributing plug 9 having a head portion 10 which fits the reduced interior bore 11 of the chamber 12^a formed in the piston. The plug as shown is provided with a passage 12 for conveying motive fluid to the internal piston chamber, the fluid being discharged from the passage 12 through laterally directed passages 13 which may be controlled by means of the reduced bore 11.

The piston illustrated is provided adjacent the front end of the internal chamber with passages 14 for conveying fluid from said chamber to the distributing passage 15 which herein takes the form of an annular groove formed on the exterior wall of the piston, this groove and the groove 16 formed in the interior wall of the cylinder being adapted to convey fluid from the internal chamber to the front end of the cylinder when the piston is near the forward end of its stroke. Herein, when the piston is adjacent the rear end of stroke, as shown diagrammatically by Fig. 14, the distributing passage 15 communicates with a passage 17 leading from the intermediate to the rearward end of the cylinder in order that fluid may be conducted from the interior piston chamber to the rearward end of the cylinder.

Rearwardly of the head 10 the distributing plug is shown as formed with a tapered annular groove, as indicated in Fig. 2 at 9′.

This groove serves to increase the volume of the rear cylinder chamber and also serves when the rearward edge of the head passes into the internal piston chamber on the rearward stroke of the piston to admit fluid from said internal chamber to the rearward portion of the cylinder. This event preferably is caused to occur before the distributing groove 15 is brought into communication with the passage 17 in order to admit a small volume of air to the rear of the cylinder to cushion the same. The point at which this cushioning fluid is admitted may be regulated by suitably proportioning the length of the groove 9′ or by substituting different distributing plugs for different conditions of work, the said different distributing plugs having grooves of different length.

This fluid of course, is available for operating the piston on the forward stroke. Obviously, the cushioning fluid may be admitted through the passage 17 and the main supply of air through the groove 9′, which may be done by suitably locating them with relation to the part of the piston which uncovers them to admit fluid by way of them to the rear of the cylinder.

Preferably the passages 13 are so located that they are partially closed when the piston is at the end of its forward stroke. This will reduce the flow to the internal piston chamber by throttling action and thereby reduce the pressure of the fluid transferred from the internal chamber to the front end of the cylinder. In order that the piston may strike a powerful blow it is desirable that no more pressure should exist in front of the piston at any time than is necessary to distribute the fluid to cause the piston to operate and only enough air need be admitted to the front end of the cylinder as is necessary to return the piston without doing any other work. Obviously the passages for supplying the front end of the cylinder must open before the piston reaches the end of its forward stroke but by throttling the flow before or at the time air is transferred from the internal chamber to the front of the piston, the air admitted to the front end of the cylinder is at reduced pressure and in consequence thereof, does not unnecessarily check the blow of the piston. The return stroke is initiated as a result of the difference in the total pressures exerted by the motive fluid on the larger front face of the piston and the relatively smaller internal effective area of the piston. In order to increase the volume of the forward piston chamber of the cylinder, and thereby to provide means to aid in reducing the pressure of the fluid admitted thereto and to maintain the pressure of the fluid after it is admitted I preferably provide suitable reservoir chambers in communication with said piston chamber, these chambers, in the submitted embodiment, taking the form of a plurality of holes 16′ drilled in the cylinder wall and intersecting the groove 16. The ports 13 and 14 preferably are so located with relation to each other and to the distributing passage 15 and groove 16 that an additional amount of air will be admitted to the front of the cylinder as the piston starts to return and as this will occur after the blow has been struck no harmful effect will result.

Preferably, I provide a port 17′ for establishing communication between the interior of the cylinder and the atmosphere when the piston is adjacent the forward end of its stroke for exhausting the rear end of the cylinder. In the embodiment of my invention illustrated, during the rearward stroke of the piston the hammer bar 3 pulls out of the chamber for reciving it in the front head, the air in the front end of the cylinder under these conditions exhausting through the passage 24ᶜ to the atmosphere in a manner which will hereinafter be more fully set forth.

It may happen in certain embodiments of my invention that when the motive fluid supply is cut off the piston may come to rest at the forward end of the cylinder, in which case the ports 13 may be closed and the piston may not start to operate when the motive fluid supply is reestablished. To obviate this, one or more ports 13′ of restricted area are formed through the front end of the plug. Preferably, these ports may be made so small that they play no part in the operation of the machine during the normal running conditions but under the conditions just mentioned they will admit sufficient air to the internal piston chamber slowly to move the piston rearwardly to uncover the ports 13 and initiate the normal running conditions. In this connection it is to be noted that the drill steel 6 may be provided with a bore 17ᵃ leading to the cutting end and communicating at the rear end with the chamber in the front head for receiving the hammer bar. With this construction, a portion of the air which exhausts from the front end of the cylinder when the hammer bar withdraws, will find its way into the bore 17ᵃ and be discharged into the drill hole and will cleanse the same of débris.

It will be noticed that as the hammer bar reciprocates in the chamber of the front head it tends, by its alternate expansion and contraction of said chamber when it covers the port 24ᶜ to create alternately a pressure and a vacuum in said chamber, which if not eliminated, will tend to slow up the piston and suck sludge into the chuck by way of the bore of the drill steel. To eliminate this pressure and vacuum I herein form in the wall of the extension 5 a longitudinally extending groove 18, which communicates with the atmosphere through

the passage 24c and conduits leading to the controlling valve as hereinafter more fully described, and therefore relieves any tendency to create a pressure or vacuum. It will thus be seen that the passage 24c serves both as an exhaust for the front end of the cylinder and breather passage for the hammer bar chamber.

For discharging the exhaust not discharged by the ports 17 and 24c, or in case I omit these ports, for discharging all of the exhaust, I may use an exhaust valve 28. For purposes of illustration I have shown this valve in the form of a double spool valve mounted on the upper portion of the cylinder. Preferably I may provide the cylinder with the boss 29 provided with a transverse bore in which is inserted from opposite ends, the bushings 30 and 31. Closing the ends of the bore are shown heads 32 and 33, respectively provided with inwardly projecting cylindrical stems 34 and 35, these stems fitting corresponding recesses in the end of the valve and one stem being of larger diameter than the other. To hold the parts in assembled relation the heads and valve are suitably apertured to receive a bolt 36. Preferably the portion of the central aperture of the valve between the end recesses is vented to the atmosphere to eliminate the transfer of pressure through the aperture from one recess to the other. This aperture may be in the form of a hole 37 drilled through the bolt and communicating with the aperture by means of a port 38.

Herein, the space 39 about the central reduced portion of the valve 28 is in constant communication with the atmosphere through a passage 40, and the bushings 30 and 31 respectively are provided with grooves 41 and 42 which are adapted alternately to be alternately placed in communication with this space. Leading from the forward end of the cylinder to the groove 41 is shown a passage 26, and from the rearward end of the cylinder to the groove 42 a passage 25. Obviously when the valve is at the left hand end of its travel as illustrated by Fig. 4, the rear end of the cylinder will be put in communication with the atmosphere by means of the passage 25, groove 42 and passage 40, and when the valve is at the right hand end of its travel the passage 26 will be placed in communication with the atmosphere through a similar arrangement of ports, it being understood, of course, that when one port is opened, the other is closed and that when desired one port may be omitted in order that the valve may control but one end of the cylinder.

Suitable means for biasing the valve to move in one direction is preferably employed and for this purpose the smaller end of the valve may be subjected constantly to the pressure of the motive fluid supply. To cause the valve to move, the opposite end thereof may be intermittently connected to the source of fluid pressure and to the atmosphere. Leading from the right hand end of the valve, as viewed in Fig. 4, of the submitted embodiment of any invention, is a passage 21c communicating with the passage 21b which communicates with a groove 21a formed on the end face of the cylinder as is clearly shown in Figs. 1, 2 and 6, the opposite end of the groove 21a communicating with the port 21 bored through the cylinder wall and communicating with the interior of the cylinder by means of ports 19 and 23. Rearwardly of the port 19 in this embodiment is formed a passage 44 extending through the cylinder wall and so located that when the piston is at the forward portion of its travel the port 19 is put in communication with the atmosphere by means of a groove 45 formed in the exterior surface of the piston adjacent its rearward end. When the piston is in the rearward portion of its travel the interior piston chamber is placed into communication with the ports 19 and 23, thus supplying fluid to the larger end recess of the valve which forces it to such position as to close the passage 25 leading to the rear end and open the passage 26 leading to the front end of the cylinder. When the port 19 is in communication with the atmosphere, the air which has been admitted to the larger recess of the valve is exhausted to the atmosphere and the constant pressure on the smaller recess of the valve moves the same to such position as to close the passage 26 and open the passage 25.

Herein the valve 28 is mounted to move transversely to the direction of percussion in order that its motion will be unaffected by vibration.

In the head block 46 is shown a valve 47 through which motive fluid is admitted from the fluid inlet connection 48 to a passage 22, the latter herein supplying motive fluid to the chuck rotating motor and to the smaller recessed portion of the valve 28. Herein the valve 47 is so constructed that it may be manipulated to control the motive fluid supply for operating the piston and to supply live fluid to the exhaust passage 24c in such a manner that when the supply for the piston is cut off the supply to the passage 24c is open, and vice versa, the passage 22 however being always in communication with the source of motive fluid supply no matter what the position of the valve. As illustrated, leading from the passage 22 through the head block is a passage 20 communicating with a groove 20b formed in the rear cylinder head as is shown by Figs. 1 and 5, the groove 20b communicating with the pas-

sage 20^c formed in the wall of the cylinder as is shown by Figs. 1 and 2, the latter communicating with the port 20^d at the smaller recessed portion of the valve 28. From this it will be seen that when the supply of motive fluid to the cylinder is cut off and the supply to the passage 24^e is turned on the valve 28 will move to such position as to cut off the passage 26 exhausting the front end of the cylinder. With this construction, the fluid admitted to the passage 24^e, which will force the hammer bar 3 out of its chamber in case a short hammer bar is used, will not escape to the atmosphere by way of the passage 26 and in consequence the fluid will be forced through the bore 17^a of the drill steel to the cutting end of the drill. As will be obvious, my invention comprehends other equivalent means for moving the valve in combination with, or which means itself will provide, a force tending to close the valve when the motive fluid for operating the piston is cut off.

The valve 47 hereinbefore referred to is shown in the submitted embodiment of my invention in the form of a hollow tapered plug valve provided with a suitable handle 49 for manipulating the same. As illustrated, leading from the internal chamber 50 of the valve is a port 51 in the form of a groove of such dimensions respective to the permitted throw of the valve that no matter what the position of the valve, air is constantly supplied to the port 22 communicating therewith, this being clearly shown by Fig. 8.

I may provide a second port 52 extending through the wall of the valve, and in the same plane therewith, a groove 53 on the exterior surface of the valve, as is clearly shown in Fig. 9. Communicating with the groove 53 in the position shown by Fig. 9 is a forwardly directed groove 54 in the valve casing leading to the atmosphere.

Herein from the valve 47 leads a passage 27 to the chamber 55 in the rear head block, the passage 27 being utilized to convey air to the chamber 55 and hence to the cylinder by means of the distributing plug when the valve is in the position shown by Fig. 9. In the same position of the valve the groove 53 is in communication with a passage 24 in the rear head block, said passage communicating with the groove 24^a extending as is shown in Fig. 5, across the face of the rear cylinder head, to a passage 24^b extending through the wall of the cylinder to the front cylinder head, where it communicates with the passage 24^c, as is clearly shown by Fig. 1.

Fig. 9 represents the valve in the normal running position of the machine. The valve may be turned from this position to such a position that the port 52 thereof is placed in communication with the passage 24, normally in communication with the groove 53, so as to supply air to the passage 24 and convey it to the passage 24^c for blowing the hole in the manner heretofore described. As shown in this latter position of the valve the passage 27 is not supplied with motive fluid and the piston therefore does not operate.

For suitably determining and retaining the valve in the adjusted positions thereof I herein provide a non-positive stop which may be in the form of a spring pressed ball 56 adapted to engage suitable spherical recess 57, formed on the exterior surface of the valve, as is shown by Fig. 7. In the position shown by Fig. 7, the valve is in full running position. When moved clockwise to bring the middle recess 57 into engagement with the ball 56, passage 52 of the valve is between the passages 24 and 27 and the supply to the cylinder is interrupted. Further clockwise movement will place the upper recess 57 into engagement with the ball and in this position the passage 52 will be placed in communication with the passage 24 and the hole will be blown. As shown by Fig. 3 the valve casing is provided with stops 57′ for engaging the valve handle and determining the limits of the throw of the valve. The angular position of these stops corresponds to the positions of the two end recesses of the row of recesses 57 in Fig. 7.

The passage 22 hereinbefore referred to may lead to a valve 58 of any suitable construction for controlling the motive fluid supply to the chuck rotating motor. As illustrated, the valve is shown as a plug valve provided with a handle 59 for manipulating the same, the valve 58 being provided with a suitable transverse passage 60 which is adapted to establish communication between the passage 22 and a passage 22^a the latter communicating with the intakes of the chuck rotating motor. To this end, the passage 22^a herein extends through the rear head block and communicates with a passage 22^b formed in the wall of the cylinder and front cylinder head, the latter communicating with a passage 22^c which is formed in the spacing ring 61, and communicates with the two inlet ports 7^c of the chuck rotating motor between the cylinder head and the motor casing 62. From the foregoing it will be obvious that the chuck rotating motor may be rendered operative or inoperative at the will of the operator by opening or closing the valve 58.

Herein, for supplying water to the drill bit a suitable tube 63 is provided which extends from a chamber 64 in the rear head block forwardly through the distributing tube and the piston to the interior of the bore of the drill steel, in which it has a loose fit to provide access for air supplied the hammer bar chamber. The rear end of

the tube is shown as provided with a flanged portion 67 seated in a packing or resilient material 68, the rear end of the chamber being closed by means of a screw threaded plug 69 and between the inner end of the plug and the flange of the tube is placed a washer 70 provided with suitable radial passages 71 for leading water from the chamber to the tube. Any suitable means may be provided for supplying the water to the chamber and in the embodiment shown this is done by providing a passage 65 extending through the rear head block from the water intake connection 66 to the chamber.

To hold the valve 58 at the extreme portions of its throw the handle portion of the valve may be provided with a cupped member 72 having suitable recess 73 for engaging a plunger 74 of a yieldable non-positive stop. The member 72 also may be provided with stop members 75 adapted to engage an abutment 76 at the ends of the throw of the valve.

In order to lubricate the machine I may provide my rear head block with an oil reservoir which is provided with a filling orifice 78 closed by the plug 79. From the oil chamber to the motor I may convey oil in any suitable manner and as shown I provide the interior portion of the oil chamber with a boss 80, as is clearly shown in Figs. 3 and 10. The boss is provided with a central longitudinal bore 81 and leading therefrom to the motive fluid chamber 55 are a pair of spaced passages 82 and 83, and communicating with the bore intermediate the passages 82 and 83 are formed passages 84 and 85 leading to the oil chamber. Mounted in the bore 81 is a valve-like member comprising the heads 86 and 87 and an intermediate reduced portion 88. The valve is biased to move by the spring 89 in such a direction as to put the space of the valve between the heads 86 and 87 in communication with the passages 84 and 85 leading to the oil chamber. The spring 89 just referred to may be carried by a plug 90 closing the end of the bore shown in communication with that in which the valve-like member is mounted. To drain off any oil which may leak past the head 86 of the valve and thus interfere with the operation of the same is the vent passage 91 leading to the atmosphere.

The lubricating mechanism just described operates as follows:

When the supply of motive fluid to the machine is interrupted, the spring 89 moves the valve to the right hand end of its travel as viewed in Fig. 10, thus placing the portion about the reduced stem of the valve in communication with the ports 84 and 85 leading to the oil chamber which serves to trap a portion of oil in such space. When the motive fluid is supplied to the chamber 55, the air passing through the passage 83 forces the valve to the left as viewed in Fig. 10 and places the space about the stem 88 of the valve in communication with the passage 82 leading to the chamber 55, thus permitting the oil to enter said chamber 55 and mix with the motive fluid and be distributed to the various parts of the machine.

Although I have described one specific embodiment of the invention it will be understood that wide deviations may be made therefrom without departing from the spirit of the invention.

I claim:

1. A rock drill having, in combination, a hammer piston, a chuck, a motor for rotating said chuck, a casing for said hammer piston and chuck, a valve casing carried by said first named casing, a frusto conical chamber in said valve casing forming a seat for a frusto conical valve in said chamber, said valve having a longitudinal passage opening on the large end of said valve, a motive fluid supply connection to said chamber at the end thereof adjacent the large end of said valve, a port and passage intermediate the length of said valve for controlling the supply of motive fluid for operating said hammer piston, said valve by its turning movement opening and closing said port and passage, means for supplying motive fluid from said longitudinal passage to said motor for rotating said chuck comprising a cooperating port and recess in said valve and valve casing at that side of said first named port and passage which is opposite the large end of said valve, and stop means for limiting the extent of turning movement of said valve, said port and recess being in fluid communication in all positions of said valve.

2. A rock drill having, in combination, a hammer piston, a chuck, a motor for rotating said chuck, a casing for said hammer piston and chuck, a valve casing projecting from said first mentioned casing and having a frusto conical bore, a motive fluid supply connection to said casing at the large end of said bore, a frusto conical valve in said frusto conical bore, said valve having a longitudinal passage opening on its large end, a port intermediate the length of said valve opening to said longitudinal passage and controlling the supply of motive fluid to an intake passage for said hammer piston, stop means for limiting the extent of turning movement of said valve, a second valve casing, a passage connecting said valve casings, means placing said last named passage in constant communication with said longitudinal passage of said valve comprising a cooperating port and recesses in said valve and its valve casing at that side of

said port of said valve which is opposite the large end of said valve, and a valve in said second mentioned valve casing for controlling the motive fluid supply to said motor.

3. In a drilling machine, a tool, a motor for rotating said tool, a motor for hammering said tool, a source of motive fluid supply for said motors, conduit means for conducting motive fluid from said motor for hammering said tool to the work, a valve for establishing communication between said source and said motors, said valve having a position in which said communication with the motor for hammering said tool is interrupted without interrupting the communication with the motor for rotating said tool and for simultaneously connecting said conduit means to said source.

4. In a drilling machine, a tool, a motor for rotating said tool, a motor for hammering said tool, a source of motive fluid for said motors, conduit means for conducting to the work exhausted motive fluid from said motor for hammering said tool, coordinated valve means for interrupting the supply to said motor for hammering said tool without interrupting the supply to said motor for rotating said tool and for simultaneously supplying live motive fluid to said conduit means.

5. In a drilling machine, a tool, a tool rotating motor and a percussive motor for actuating said tool, an exhaust conduit for said percussive motor having a connection for supplying fluid to the work and a separate connection to the atmosphere, means for conducting motive fluid to said motors for their actuation, and means for interrupting said connection of said conduit to the atmosphere without interrupting the supply for the actuation of said tool rotating motor and for simultaneously supplying live fluid to said conduit.

6. In a drilling machine, a tool, a tool rotating motor and a percussive motor for actuating said tool, an exhaust conduit for said percussive motor having a connection for supplying fluid to the work and a separate connection to the atmosphere, means for conducting motive fluid to said motors for their actuation, and means for interrupting said connection of said conduit to the atmosphere without interrupting the supply for said tool rotating motor.

7. A drilling machine having, in combination, a chuck for a hollow drill steel, conduit means independent of the bore of said hollow drill steel for placing said chuck in communication with the atmosphere, a percussive motor, a chuck rotating motor, means for conducting motive fluid from a motive fluid supply connection to said motors for their actuation, and valve means for at will diverting the supply of motive fluid for said percussive motor to said conduit means without interrupting the supply to said chuck rotating motor.

8. In a drilling machine, a tool, a tool rotating motor and a percussive motor for actuating said tool, an exhaust conduit for said percussive motor having a connection for supplying fluid to the work and a separate connection to the atmosphere, means for conducting motive fluid to said motors for their actuation, and coordinated valvular means for interrupting said connection of said conduit to the atmosphere without interrupting the supply for the actuation of said tool rotating motor and for simultaneously supplying live fluid to said conduit.

9. In a drilling machine, a chuck adapted to carry a hollow drill steel with the bore of said steel in communication with said chuck, a percussive motor, a chuck rotating motor, means for conducting motive fluid to said motors for their actuation, an exhaust passage for said percussive motor, and coordinated valvular means whereby said exhaust passage may be blanked without interrupting the supply to said chuck rotating motor and live motive fluid may be simultaneously supplied directly to said chuck.

10. In a drilling machine, a chuck adapted to carry a hollow drill steel with the bore of said steel in communication with said chuck, conduit means independent of the bore of said steel for placing said chuck in communication with the atmosphere, a chuck rotating motor and a percussive motor, means for conducting motive fluid from a source of supply to said motors for their actuation, and a single valve for at will diverting the motive fluid supply for said percussive motor to said conduit means without interrupting the motive fluid supply to said chuck rotating motor.

11. In a drilling machine, a chuck having a chamber, means providing a conduit connecting said chamber to the atmosphere, said chuck adapted to carry a hollow drill steel with the bore of said steel in communication with said chamber, a percussive motor provided with a piston having a hammer bar which expands and contracts the volume of the chamber of said chuck, a chuck rotating motor, means for establishing a flow of motive fluid from a source of motive fluid supply through said motors for their actuation, and means for at will connecting said conduit to said source of supply without interrupting the flow through said chuck rotating motor.

12. In a drilling machine, a hammer piston having an extension, an exhaust passage controlled by said extension, conduit means connecting said passage to the work, a tool rotating motor, and coordinated valvular means providing a conduit for the fluid actuating said piston and motor and for sup-

plying live fluid to said exhaust passage without interrupting the flow of fluid for actuating said motor.

13. In a drilling machine, a cylinder, a piston in said cylinder, conduit means including a passage communicating with said cylinder and controlled by said piston for admitting fluid to the work when the piston is supplied with motive fluid for its actuation, a drill rotating motor, and coordinated valvular means affording a connection for the motive fluid supply for the actuation of said piston and motor, said valvular means controlling ports and passages for interrupting the actuation of said piston without that of said motor and simultaneously supplying motive fluid directly to said passage.

14. In a drilling machine, a chuck adapted to carry a hollow drill steel with the bore of said steel in communication with said chuck, a percussive motor having an exhaust outlet, a breather passage separate from said hollow drill steel connecting said chuck to the atmosphere, and means for interrupting the actuation of said motor and simultaneously supplying motive fluid to said passage.

15. In a drilling machine, a drilling tool, a chuck rotating motor, a percussive motor for hammering said tool, a chuck adapted to carry a hollow drill steel with the bore of said steel in communication with said chuck, a combined breather for said chuck and exhaust passage for said percussive tool connecting said chuck to the atmosphere independently of the bore of said steel, means including a valve for supplying said motors with actuating fluid, and ports for said valve whereby said passages may be supplied with live motive fluid without interrupting the actuation of said motor for rotating said tool.

16. In a drilling machine, a valveless fluid operated percussive motor for the drilling tool, a fluid motor for rotating the drilling tool, a chuck for the drilling tool, a passage for directly connecting said chuck to the atmosphere, a valve for conducting actuating fluid to said motors, said valve in one position thereof diverting the supply for said percussive motor to said passage and interrupting the connection of said passage with the atmosphere and without interrupting the supply of actuating fluid to said motor for rotating said tool.

17. In a drilling machine, a valveless fluid operated percussive motor for the drilling tool, a chuck, a pressure fluid actuated motor for rotating said chuck, a valve affording a conduit open in all positions of said valve for supplying said motor for rotating the chuck with actuating pressure fluid, and a passage controlled by said valve for optionally connecting said chuck to the atmosphere or for supplying it with live pressure fluid.

18. A drilling machine having, in combination, a cylinder, a hammer piston therein, a chuck for carrying a hollow drill steel, means for admitting motive fluid to the front end of said cylinder for actuating said piston, means for exhausting such motive fluid including a fluid actuated valve and a passage controlled thereby, said valve normally biased toward a position in which said passage is closed, said piston having a hammer bar for impacting the drill steel and for establishing communication between the front end of said cylinder and said chuck when said piston is moved rearward by motive fluid admitted to said end, and means including a manually operable valve means controllable for admitting a continuous supply of motive fluid to said chuck between the end of said hammer bar and the shank end of said hollow drill steel.

19. A drilling machine having, in combination, a cylinder, a hammer piston therein, a chuck for carrying a hollow drill steel, means for admitting motive fluid to the front end of said cylinder for actuating said piston, means for exhausting such motive fluid including a fluid actuated valve and a passage controlled thereby, said valve having a working pressure surface, conduit means for supplying motive fluid for acting upon said surface whereby said valve is normally biased toward a position in which said passage is closed, said piston having a hammer bar for impacting the drill steel and for establishing communication between the front end of said cylinder and said chuck when said piston is moved rearward by motive fluid admitted to said end, and means including a manually operable valve means controllable for admitting a continuous supply of motive fluid to said conduit means and to said working surface of said fluid actuated valve and to said chuck between the end of said hammer bar and the shank end of said hollow drill steel.

20. In a drilling machine, a percussive motor, an exhaust discharge means for said motor, a valve controlling said means, means normally holding said valve in position to close said exhaust discharge, means for causing said valve to open intermittently in consequence of movement of said motor, conduit means for conducting cleansing fluid to the work having communication with said exhaust discharge means, and means for interrupting movement of said motor and for supplying cleansing fluid to said conduit.

21. In a percussive motor, an auxiliary exhaust passage for an expansible chamber of said motor, an automatically acting controlling valve for said exhaust passage, valve means independent of said controlling valve

for admitting cleansing fluid to said chamber, means conducting such fluid from said chamber to the work, and means for causing said valve to close said exhaust passage when said cleansing fluid is admitted to said chamber.

22. In a percussive motor, a valveless admission and a main and auxiliary exhaust means for an expansible chamber of said motor, an automatically acting controlling valve for said auxiliary exhaust means, means admitting cleansing fluid to said chamber, and means for causing said valve to close said auxiliary exhaust means when said cleansing fluid is admitted.

23. In a percussive motor, a main and an auxiliary exhaust means for an expansible chamber of said motor, an automatically acting controlling valve for said auxiliary exhaust means, fluid means for causing said valve to close said auxiliary exhaust means irrespective of the pressure condition of said chamber, means responsive to motion of said motor for periodically causing said valve to open said exhaust, conduit means having communication with said chamber for conducting cleansing fluid to the work, and means for interrupting motion of said motor and for admitting cleansing fluid to said conduit means.

24. In a drilling machine, a piston having a head and hammer bar, a cylinder having chambers for said head and hammer bar, said hammer bar when said piston is in its rearward position establishing communication between said chambers, means for admitting live motive fluid to the chamber, for said bar and conducting it to the work, an exhaust means for the chamber for said head, and means for closing said exhaust means when said chamber for said head is supplied with said cleansing fluid whereby escape of such fluid by way of said exhaust is prevented.

25. A percussive motor having, in combination, a cylinder, a hammer piston in said cylinder, said piston having an internal chamber the forward end of which forms a forwardly acting pressure face for said piston, a tube carried by said cylinder projecting into said chamber for supplying motive fluid thereto, cooperating ports and passages formed in said piston and cylinder for establishing communication between said internal chamber and the forward end of said cylinder during the latter part of the forward stroke of said piston, motive fluid conducting means formed in said tube for establishing communication between the interior and exterior of said tube at its forward portion, said means including a laterally opening port controlled by said piston for establishing communication between the interior of said tube and said internal chamber when the piston is at the rearward portion of its stroke.

26. A percussive motor having, in combination, a cylinder, a hammer piston in said cylinder, said piston having an internal chamber the forward end of which forms a forwardly acting pressure face for said piston, a tube carried by said cylinder projecting into said chamber for supplying motive fluid thereto, cooperating ports and passages formed in said piston and cylinder for establishing communication between said internal chamber and the forward end of said cylinder during the latter part of the forward stroke of said piston, motive fluid conducting means formed in said tube for establishing communication between the interior and exterior of said tube at its forward portion, said means including a laterally opening port controlled by said piston for establishing communication between the interior of said tube and said internal chamber when the piston is at the rearward portion of its stroke and restricting such communication when said piston during its forward stroke establishes communication between the forward end of said cylinder and said internal chamber.

27. A percussive motor having, in combination, a cylinder, a hammer piston in said cylinder, said piston having an internal chamber the forward end of which forms a forwardly acting pressure face for said piston, a tube carried by said cylinder projecting into said chamber for supplying motive fluid thereto, cooperating ports and passages formed in said piston and cylinder for establishing communication between said internal chamber and the forward end of said cylinder during the latter part of the forward stroke of said piston, motive fluid conducting means formed in said tube for establishing communication between the interior and exterior of said tube at its forward portion, said means including a laterally opening port controlled by said piston for establishing communication between the interior of said tube and said internal chamber when the piston is in its extreme forward position relative to said cylinder.

28. A percussive motor having, in combination, a cylinder, a hammer piston therein, said motor comprising means forming two expansible chambers respectively including a forwardly acting pressure surface and a rearwardly acting pressure surface on said piston, means for supplying motive fluid to the expansible chamber which includes said forwardly acting surface for driving the piston forward and from said chamber to the other expansible chamber for driving the piston rearward, said means including a port

controlled directly by said piston for establishing communication between said chambers when said piston is at the forward portion of its stroke, and a motive fluid conducting means controlled by said piston for establishing communication between a source of motive fluid supply and that chamber which includes said forwardly acting surface, said motive fluid conducting means being restricted by said piston when the latter approaches the forward end of its stroke.

29. A percussive motor having, in combination, a cylinder, a hammer piston therein, said motor comprising means forming two expansible chambers respectively including a forwardly acting pressure surface and a rearwardly acting pressure surface on said piston, means for supplying motive fluid to the expansible chamber which includes said forwardly acting surface for driving the piston forward and from said chamber to the other expansible chamber for driving the piston rearward, said means including a port controlled directly by said piston for establishing communication between said chambers when said piston is at the forward portion of its stroke, and a motive fluid conducting means controlled by said piston for establishing communication between a source of motive fluid supply and that chamber which includes said forwardly acting surface, said motive fluid conducting means being closed by said piston when the latter is in its extreme forward position relative to said cylinder.

30. In a motor, a cylinder, a piston therein having an internal chamber, means for admitting and exhausting motive fluid to and from said cylinder for actuation of said piston, said means including a valve, and means for connecting said internal chamber to said valve for actuation thereof in one position of the piston.

31. In a motor, a cylinder, a piston therein having a distributing conduit, means for admitting and exhausting motive fluid to and from said cylinder for actuation of said piston, said means including a valve, and means for connecting said conduit to said valve for actuation thereof and to a cylinder end during the reciprocation of said piston.

32. In a motor, a cylinder, a piston therein having a distributing conduit, means for admitting and exhausting motive fluid to and from said cylinder for actuation of said piston, said means including a valve, and means for connecting said conduit to said valve for actuation thereof and to opposite cylinder ends during the reciprocation of said piston.

33. In a motor, a cylinder, a piston therein having an internal chamber the forward end of which forms a forwardly acting pressure surface for said piston, a motive fluid supply conduit communicating with said chamber, means for admitting and exhausting motive fluid to and from said cylinder for actuation of said piston, said means including a valve, and passage means controlled by said piston for connecting said conduit to said valve for actuation thereof and to opposite cylinder ends, during the reciprocation of said piston.

34. In a percussive motor for a drill steel, a cylinder, a piston therein having an internal chamber the forward end of which constitutes a forwardly acting pressure surface for said piston, a motive fluid conducting conduit connected with said chamber, said conduit supplying motive fluid to said chamber when said piston is at the rear end of its stroke, an exhaust controlling valve for the opposite cylinder ends, and means controlled by said piston for connecting said conduit to said valve and to opposite cylinder ends during the reciprocations of said piston for actuating said piston and valve.

35. In a percussive motor, a cylinder, a piston, admission means controlled solely and directly by said piston, exhaust means directly controlled by said piston, an auxiliary exhaust valve, a conduit passing through said piston for controlling said valve, said conduit having a lateral port, and a passage in said cylinder having a lateral port positioned to communicate intermittently with said first named port for actuation of said valve.

36. In a motor, a cylinder, a piston therein having an interior chamber the forward end of which forms a forwardly acting pressure surface for said piston, an exterior chamber, a plug for conveying fluid to said interior chamber, a plurality of conduit means adapted to establish communication between said interior and exterior chambers, one of said conduit means including a passage formed by the cylinder wall, and means for progressively putting said conduit means in communication with said interior chamber for first conducting cushioning fluid to the end of the cylinder by one conduit means and then conducting additional fluid thereto by another conduit means.

In testimony whereof, I have signed my name to this specification.

GEORGE H. GILMAN.

CERTIFICATE OF CORRECTION.

Patent No. 1,663,403. Granted March 20, 1928, to

GEORGE H. GILMAN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, line 25, claim 23, strike out the word "exhaust" and insert instead "auxiliary exhaust means"; same page, line 37, claim 24, after the word "chamber" strike out the comma; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of April, A. D. 1928.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

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