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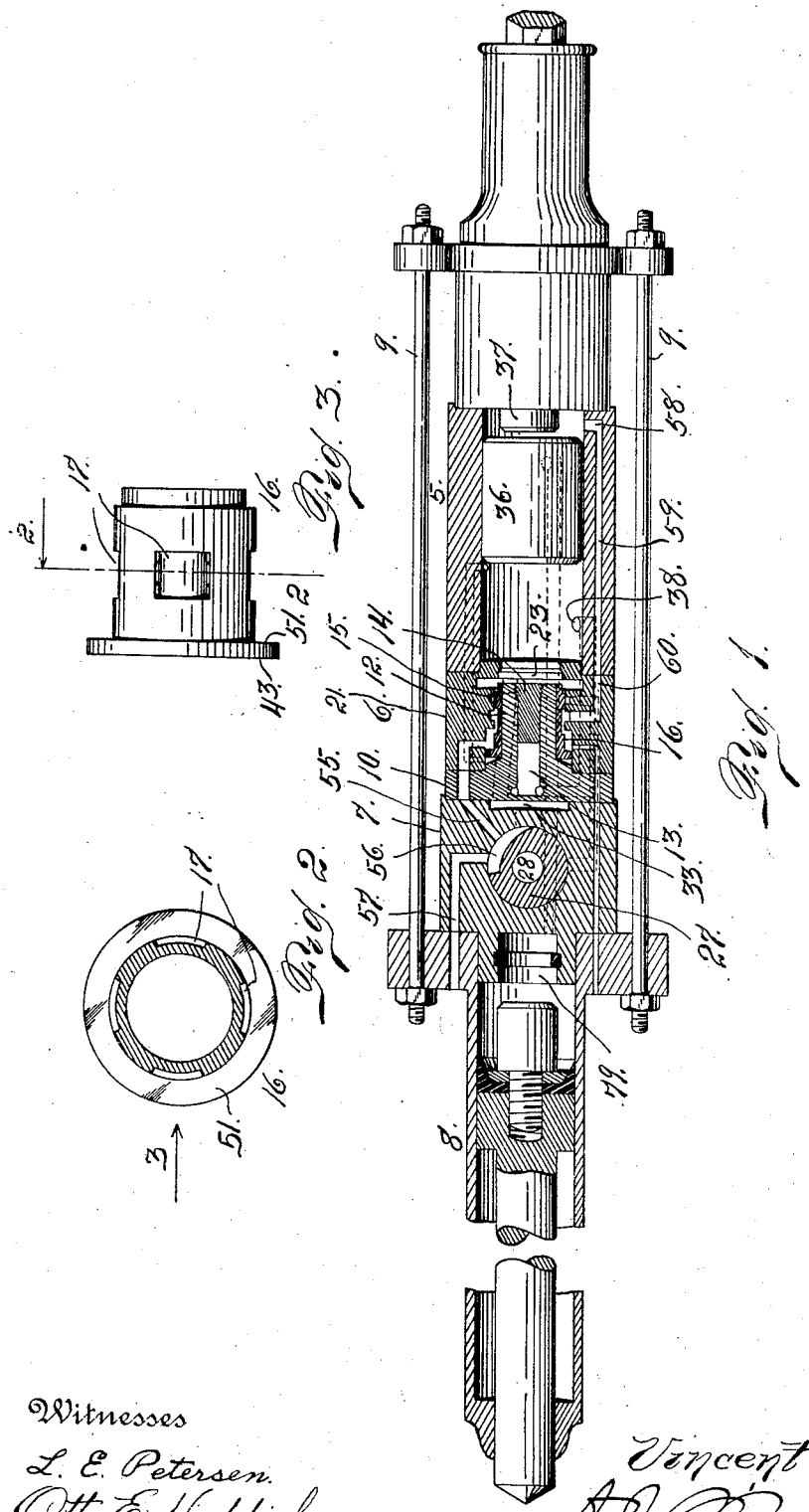
ROCK DRILL.

APPLICATION FILED APR. 8, 1913. RENEWED FEB. 3, 1914.

1,162,249.

Patented Nov. 30, 1915.

5 SHEETS—SHEET 1.



Witnesses

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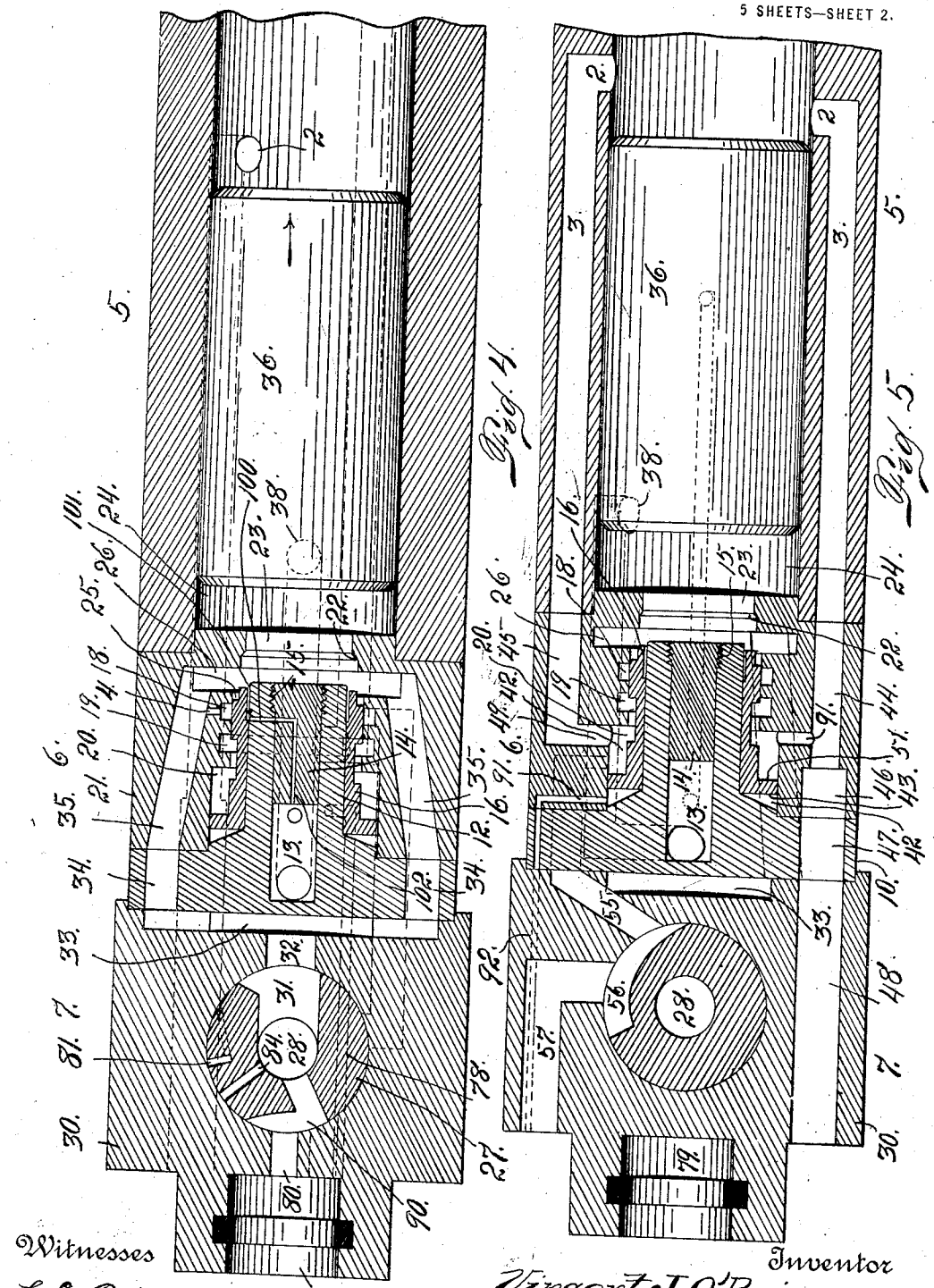
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5 SHEETS—SHEET 2.



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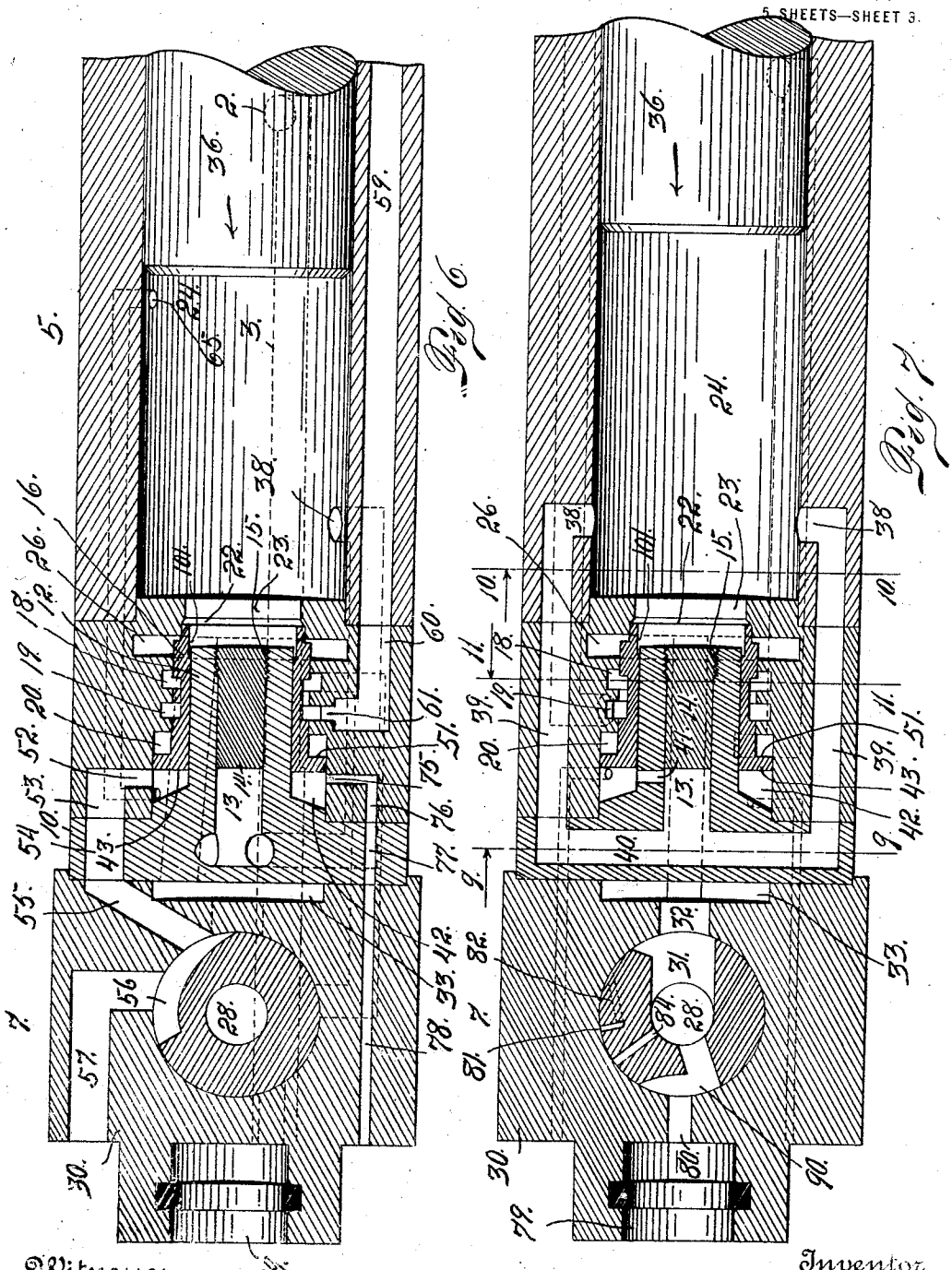
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5 SHEETS—SHEET 3.



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ROCK DRILL.

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5 SHEETS—SHEET 4.

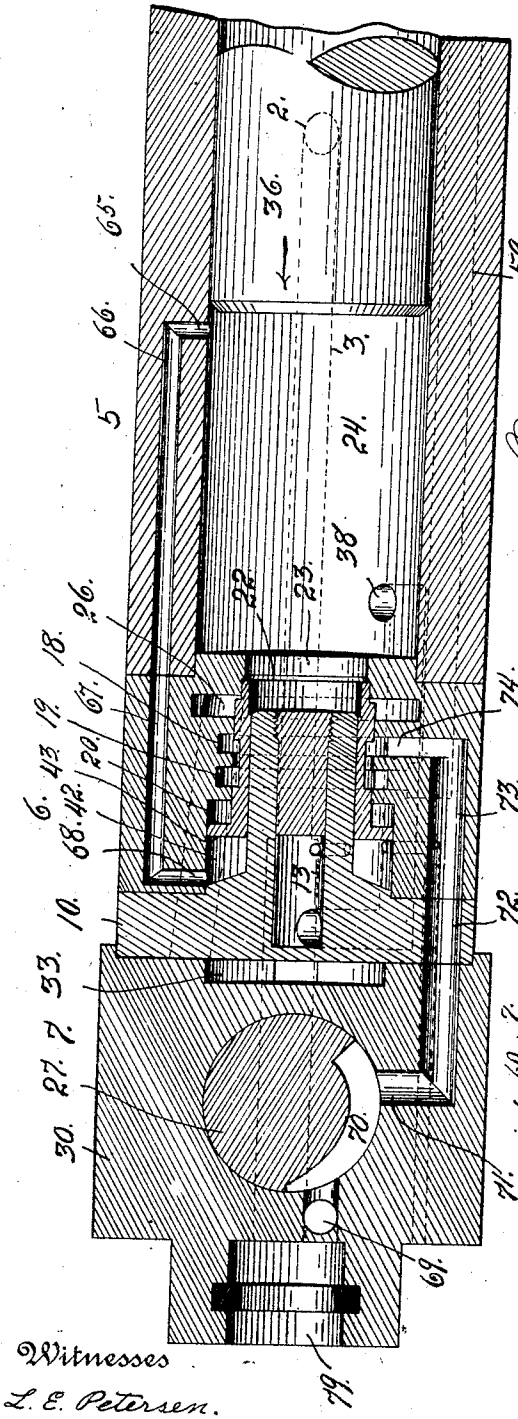


Fig. 8.

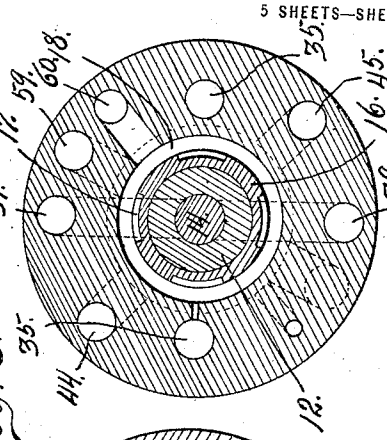


Fig. 11.

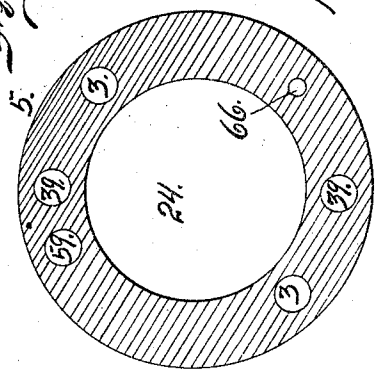


Fig. 10.

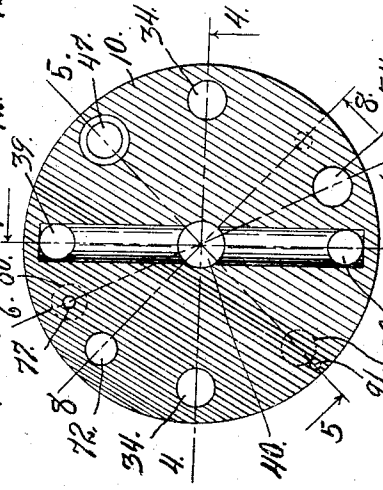


Fig. 9.

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5 SHEETS—SHEET 5.

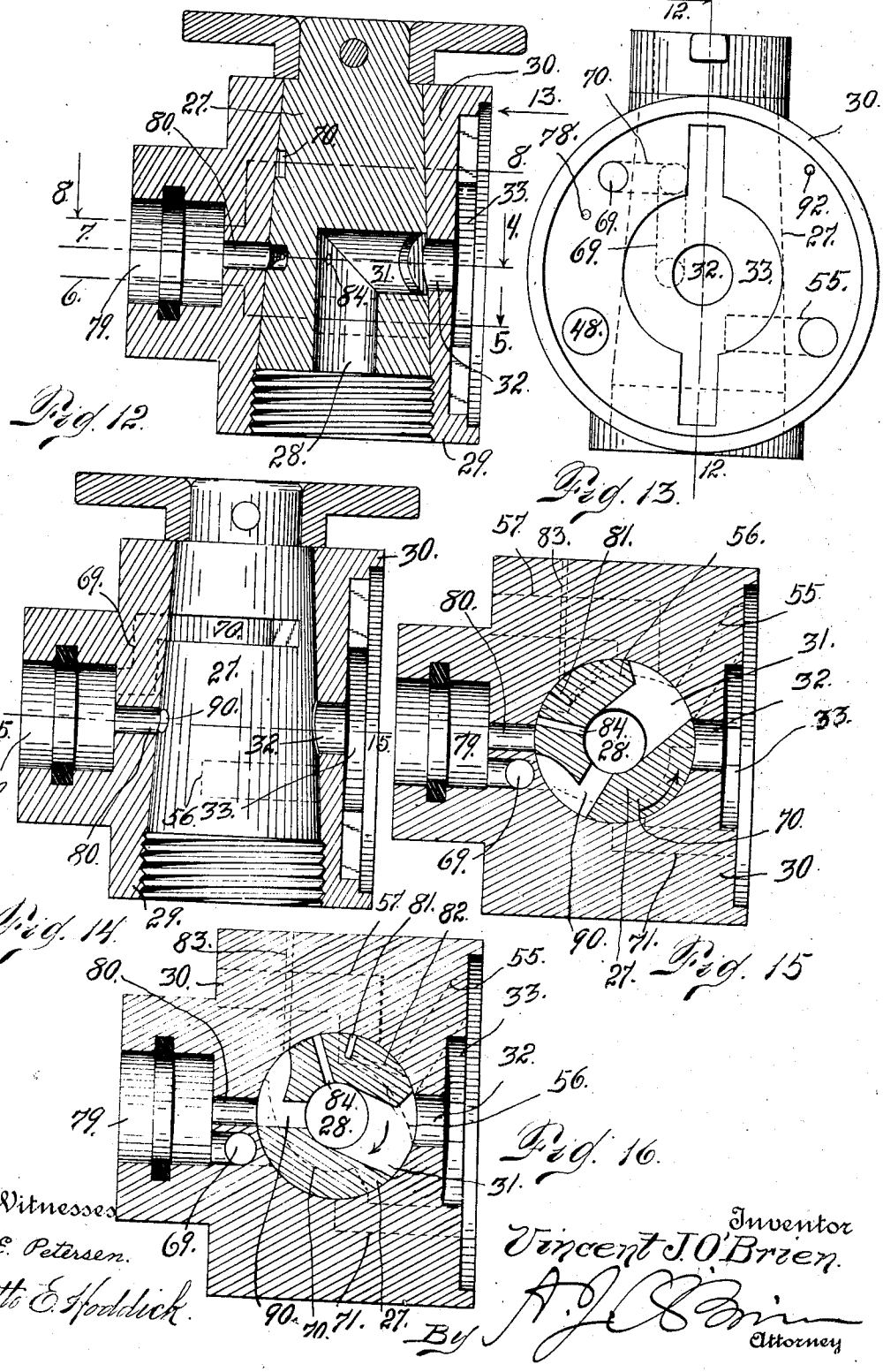


Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15

Fig. 16.

Witnesses:

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UNITED STATES PATENT OFFICE.

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ROCK-DRILL.

1,162,249. Specification of Letters Patent. Patented Nov. 30, 1915.

Application filed April 8, 1913, Serial No. 759,593. Renewed February 3, 1914. Serial No. 816,316.

To all whom it may concern:

Be it known that I, VINCENT JOHN O'BRIEN, citizen of the United States, residing at 514 Galapago street, in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Rock-Drills; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in rock drills of the hammer class, the general object of the invention being to provide an improved construction of this character.

The construction generally speaking consists of the engine mechanism and the throttle valve construction, these constructions in my improvement being so combined as to produce a number of novel features.

One, and a very important improvement in the art, so far as I understand it, consists in making provision for a graduated exhaust from the hammer cylinder, the exhaust being regulated to harmonize with the supply of air to the cylinder for reciprocating the hammer. In other words, the throttle valve is so constructed that as the supply of air to the hammer cylinder for reciprocating the latter is increased, the exhaust port in the valve is correspondingly increased. This feature has an important advantage over constructions heretofore in vogue and in which a permanent or fixed exhaust is employed. In constructions of the last-named character it is necessary that the exhaust shall be so restricted as to hold the cylinder valve in the closed position during the return of the hammer when the drill is running slowly or at minimum speed and consequently when the speed is normal or at the maximum with a full supply of motive fluid to the cylinder for reciprocating the hammer, the restricted exhaust retards the rearward movement of the hammer and consequently reduces the speed of the latter and seriously interferes with the effective operation of the construction. My improved construction, whereby the exhaust is regulated in harmony with the supply of air to the drill cylinder overcomes this difficulty and makes it practicable to obtain not only a hard blow with the travel of the hammer normal but also makes it practicable to obtain a relatively rapid light blow. This is accomplished by opening the exhaust port of the throttle valve to permit the maximum volume of motive fluid to pass therethrough, while at the same time the maximum amount of motive fluid is entering the drill cylinder. In this case the result is that by increasing the exhaust, the pressure on the rear and enlarged extremity of the cylinder valve upon which reliance is made for retaining the latter in the closed position during the return stroke of the hammer, is so reduced that the valve will open under the action of the contant live air pressure on a shoulder of the valve, after the hammer has traveled only a small proportion of the length of the drill cylinder between the rear extremity of the hammer and the rear end of said cylinder. This opening movement of the valve permits the entrance of the live air for driving the hammer forwardly and in this manner a very rapid, light blow may be obtained, which is impossible in constructions having a fixed or non-varying exhaust passage.

Another feature of novelty consists in a construction whereby the pressure within the feed cylinder is less during the return stroke of the hammer than during the forward stroke thereof. This result is obtained by taking the air from the feed cylinder which produces the return movement of the hammer and so arranging the ports and passages that the amount of air taken from the feed cylinder is greater than that which is delivered thereto simultaneously from the supply source. In this way pressure within the feed cylinder is weakened as compared with the pressure during the forward stroke of the hammer, since during the last named hammer movement there is no escape of motive fluid from the feed cylinder; consequently, there is full line pressure in the feed cylinder for holding a drill against the rock. By reducing the pressure within the feed cylinder, the force of the pressure of the drill bit against the rock is reduced during the return stroke of the hammer, thus making the rotary movement of the drill easier for the operator and at the same time diminishing the wear upon the drill bit.

In my improved construction, provision is further made for regulating the supply of motive fluid to the motor or drill cylinder

simultaneously with the regulation of the supply to the feed cylinder, thus regulating the pressure in the feed cylinder to harmonize with that in the drill cylinder. This is accomplished by actuating the throttle valve which is interposed between the motor and the feed cylinder in the usual manner.

Other features of novelty included in my present invention will be understood by reference to the accompanying drawing taken in connection with the specification.

In the drawing, Figure 1 is a top plan view, partly in horizontal section, illustrating a hammer drill equipped with my improvements. Fig. 2 is a section taken on the line 2—2 of Fig. 3. Fig. 3 is an elevation of the cylinder valve forming a part of the valve mechanism of the engine or motor. Fig. 4 is a fragmentary longitudinal section taken through the drill cylinder on the line 4—4, Fig. 9, and cutting the throttle valve on the line 4—7, Fig. 12. Fig. 5 is a similar section taken through the engine construction on the line 5—5, Fig. 9, and cutting the throttle valve on the line 5—6, Fig. 12. Fig. 6 is a similar section taken on the line 6—6, Fig. 9, and the line 5—6, Fig. 12. Fig. 7, is a similar section taken through the engine structure on the line 7—7, Fig. 9, and through the throttle valve on the line 4—7, Fig. 12. Fig. 8 is a section taken through the engine on the line 8—8, Fig. 9, and through the throttle valve on the line 8—8, Fig. 12. Figs. 9, 10 and 11 are cross-sections taken on the lines 9—9, 10—10 and 11—11, respectively, Fig. 7. Fig. 12 is a vertical section taken through the throttle valve mechanism on the line 12—12, Fig. 13. Fig. 13 is a view of the throttle valve mechanism looking in the direction of arrow 13, Fig. 12. Fig. 14 is a section taken through the block or casing of the throttle valve showing the latter in elevation. Fig. 15, is a cross-section taken through the throttle valve mechanism on the line 15—15, Fig. 14. Fig. 16 is a cross-section taken through the throttle valve mechanism on the line 4—7, Fig. 12, the valve piece being shown in a different position from that illustrated in Figs. 4 and 7. The same reference characters indicate the same parts in all the views.

From the brief description of the figures as already given, it will be understood that the relative positions of the throttle valve mechanism and the engine structure in Figs. 4 to 8, inclusive, must, at least so far as some of the views are concerned, be considered diagrammatic, and the excuse for this style of illustration in this particular instance is that I am, by adopting this course, better enabled to illustrate the operation and construction of the drill mechanism. It will, for instance, be readily observed that if, in Fig. 4, the engine mechanism and throttle valve mechanism are relatively so arranged that if the section is taken on the line 4—4, Fig. 9, through the engine and cuts the throttle valve horizontally, as shown in Fig. 4, if a view as Fig. 7 be taken on the line 7—7, Fig. 9, or at right angles to line 4—4, the section would not show the throttle valve in horizontal section as illustrated in Fig. 7 of the drawing. It is, however, believed that the license which I have assumed in the preparation of this drawing may be excused, in view of the great difficulty in clearly illustrating a structure of this character, where the ports and passages are so complicated and where their relation to each other in the throttle valve and engine mechanisms is so difficult of comprehension. In other words, it is thought that the clearness of illustration which is accomplished by these views will compensate for any inconsistency which a critical examination of the drawing would disclose. The license which I have indulged in is further believed excusable, in view of the fact that the correct illustration of the valve mechanism and its various parts is accurately shown in Figs. 12 and 16, inclusive. The same reference characters indicate the same parts in all the views.

Let the numeral 5 designate the drill cylinder; 6 the valve mechanism of the engine; 7 the throttle valve mechanism; and 8 the mechanism of the feed cylinder.

The feed cylinder is connected with the engine structure and throttle valve mechanism by means of rods 9, in the usual manner. Into the rear extremity of the engine adjacent the throttle valve mechanism is inserted a member 10 having a centrally located core 12, through which is formed a central cavity 13, the forward portion of which is closed by a plug 14, threaded in the core, as shown at 15. Surrounding this core is the cylinder valve 16, which for the most part is of the usual construction. The wall of the valve, however, is provided with a number of separated shallow recesses or cavities 17, which coöperate with circumferential grooves 18, 19 and 20, formed in the chest or casing 21 of the engine mechanism. By employing these shallow cavities which are separated by cylindrical segments of the structure, the valve is relieved of considerable wear during the operation of the machine while the novel structure disclosed is equally effective so far as the proper performance of its function is concerned. This cylinder valve is slidably mounted on the core 12, and has a range of longitudinal movement, sufficient for opening and closing purposes, the forward extremity of the valve when in the closed position being in engagement with a shoulder 22, formed in the valve chest and surrounding a forward opening 23, communicating with the piston chamber 24 of the drill.

The cylindrical valve 16 is normally held

open or in its rearward position, as illustrated in Figs. 4 and 5, by the action of the live air on a narrow shoulder 25, in the usual manner. In other words the circular cavity 26 in the forward portion of the valve chest of the engine is always in communication with live air or other motive fluid from the source of supply, the said fluid entering the throttle valve 27, through a vertically disposed longitudinal opening 28, leading upwardly from the base 29 of the valve block 30. From the opening 28, the motive fluid passes forwardly through a port 31, formed in the throttle valve, thence through a port 32, formed in the valve block, thence into a forward cavity 33, and thence in opposite directions through ports 34 to passages 35, whose forward extremities communicate with the cavity 26. Hence, whether the cylindrical valve is in the open position, as shown in Figs. 4 and 5, or in the closed position as shown in Figs. 6, 7 and 8, the shoulder 25 is at all times in communication with the live motive fluid when throttle valve is open. If we assume that the cylinder valve is open, the live motive fluid, after having traversed ports and passages just explained, will enter the cylinder chamber 24 in the rear of the hammer through the forward opening 23 in the valve chest and drive the hammer 36 forwardly in the drill cylinder until it engages the striking pin 37 (see Fig. 1). In the hammer chamber a short distance forward of its rear extremity are formed two ports 38, which communicate with passages 39 extending rearwardly through the drill cylinder and the valve chest and communicating at their rear extremities with a transverse passage 40 formed in the base of the core member 10, the passage 40 communicating with the central cavity 13 formed in the core, as heretofore explained. Leading from this central cavity are ports 41 formed in the shell of the core and communicating with the space 42, in which the rear enlarged portion 43 of the cylinder valve travels. These ports 41 are closed when the cylinder valve is open, which for the present purpose is its assumed position. While the live motive fluid in the rear of the hammer will enter and fill the ports and passages which place the hammer chamber in communication with the space 42, during the initial forward travel of the hammer there will be no exhaust through this path while the valve 16 remains in the open position. As the hammer continues its forward movement the motive fluid forward of the hammer will first exhaust through ports 2 and passages 3, extending rearwardly through the shell of the cylinder and communicating with passages 44 and 45, the passage 44 being in communication with ports 46 and 47 formed in the valve chest and core member 10, respectively, the line of communication being continued through a passage 48 of the valve block or casing 30, whose rear extremity communicates with the atmosphere. The exhaust from the passage 45 passes inwardly through a port 49 to the space 42 forward of the rear extremity or face 43 of the cylinder valve, the exhaust from said cavity being through a port 52, passages 53 and 54 formed in the valve chest, and core member 10, respectively, and thence through a passage 55 formed in the valve block 30, thence into a port 56 formed in the valve piece of the throttle valve mechanism, and thence through a passage 57 formed in the valve block to the atmosphere. The port 56 varies in size whereby the exhaust from the cylinder may be regulated and controlled by the proper adjustment of a valve piece of the throttle valve mechanism to cause the exhaust to harmonize with the introduction of motive fluid to the hammer cylinder. After the hammer passes the ports 2 and closes the latter, the exhaust from the cylinder forward of the hammer is continued through a port 58, and passage 59 formed in the wall of the cylinder, and passage 60 in the valve chest, port 61 which communicates with a circumferential groove 19 formed in the valve-chest adjacent the cylinder valve and in communication with the cavities 17 of the last-named valve. From this groove exhaust continues rearwardly through recesses 17 of the valve 16 to the space 42 forward of the shoulder 51 of the valve 16. From this space exhaust continues to the atmosphere through a port 75 and passages 76, 77 and 78 on one side of the machine; while on the opposite side the exhaust continues from the said space 42 forward of the shoulder 51 of the cylinder valve, through the ports 52, 53 and 54, the passage 55, the graduated port 56, and the passage 57 to the atmosphere.

Just before the hammer engages the striking pin a port 65 is uncovered in the cylinder and the live motive fluid acting on the rear thereof passes through the port 65 and passages 66 and 67 to a port 68 communicating with the extreme rear portion of the cavity 42 in the rear of the enlarged area 43 of the cylinder valve and this live motive fluid acting on this enlarged area will serve to drive the valve forwardly since the pressure on this enlarged area in the forward direction is sufficient to overcome the other tendency, namely, the action of the live air on the small end of valve. The valve then moves to the closed position illustrated in Figs. 6, 7, and 8. The live motive fluid is then cut off from the rear extremity of the hammer chamber and motive fluid from the feed cylinder 8 is introduced to the hammer chamber forward of the hammer by

way of the following route, namely, from the feed bar casing through an angular port 69, which extends upwardly in the valve block, as indicated by dotted lines in Fig. 14, thence through a port 70 formed in the throttle valve; thence through an angular passage 71 in the valve block and passages 72 and 73 formed in the core member 10 and the valve chest, respectively; thence through a port 74 into cylindrical groove 18 formed in the valve chest and surrounding the cylinder valve; thence through the cavities or recesses 17 of the valve into the cylindrical groove 19; thence through passages 61, 60, 59 and port 58, heretofore described, into the hammer cylinder forward of the hammer. The latter then begins its rearward travel and the exhaust from the hammer chamber in the rear of the hammer begins through the ports 38, the passages 39 and 40, to the cavity 13; thence through the ports 41 to the space 43 in the rear of the cylinder valve, where the exhaust serves to hold the valve in the closed position, the escape of the exhaust, however, in a restricted manner being continued through a port 75, passages 76 and 77 formed in the valve chest, and core member and thence through the passage 78 to the atmosphere. The exhaust also passes from the space 43 in the rear of the cylinder valve, through the ports 52, 53 and 54, the passage 55, the port 56 of the throttle valve piece and the passage 57 to the atmosphere.

The exhaust as just explained continues until the hammer closes the port 38, after which the air cushions between the hammer and the rear extremity of its chamber and acts on the forward extremity of the cylinder valve and in conjunction with the action of the live motive fluid on the small shoulder 25 serves to move the cylinder valve rearwardly to the open position. As soon as the ports 38 are covered, the ports 2 are opened forward of the hammer and the exhaust from the hammer chamber in front of the latter commences through the passages 3, and continues on one side of the machine through the ports 46 and 47 and the passage 48 to the atmosphere; while on the opposite side the exhaust from the hammer chamber in front of the hammer enters the space 42 and acts upon the shoulder 51, which also aids in imparting the opening movement to the cylinder valve. The exhaust from the space 42 as soon as the cylinder valve is opened continues through the ports 52, 53 and 54, the passage 55 and the port 56 and passage 57 to the atmosphere in the same manner as heretofore explained. As soon as the cylinder valve is opened, the live motive fluid enters the cylinder chamber in the rear of the hammer and the forward stroke of the latter is repeated, as heretofore explained.

In further explanation of the operation of the drill mechanism, it should be explained that when the machine is at rest and the hammer inactive, the feed bar cylinder 8 is in communication with the atmosphere through a cavity 79 in the throttle valve block or casing, a port 80, a small recess 81 in the throttle valve, a passage 82 in the throttle valve and a passage 83 in the throttle valve block or casing. This condition allows the air in the feed bar casing to exhaust to the atmosphere as there is no necessity for holding the drill against the rock when not in use. When this condition exists the throttle valve piece 27 is turned considerably farther in the direction of the arrow, in Fig. 15, than is illustrated, or so that a port or passage 84 in the throttle valve will extend beyond the port 80 in the direction of the valve's rotary movement, indicated by the arrow in said figure.

Now, when it is desired to set the drill against the rock the throttle valve piece will be rotated in the direction opposite the said arrow, first to turn the port 84 into communication with the port 80, in which event the motive fluid which enters through the passage 28 of the throttle valve piece will pass to the feed bar casing and supply the necessary pressure therein to hold the drill against the rock. At this time, however, the hammer is in a condition of rest as the live motive fluid has not been introduced to the hammer chamber. Then, in order to start the hammer, the throttle valve piece is turned farther in the direction opposite that of the arrow, or until the port 31 in the throttle valve piece is brought into communication with the port 32 of the throttle valve block or casing, in which event the live motive fluid passes from the source of supply to the hammer chamber in the rear of the latter to drive the hammer forwardly, as heretofore explained.

When the throttle valve piece is adjusted to deliver the maximum supply of motive fluid to the engine and the feed bar casing, the exhaust port 56 in the throttle valve piece occupies approximately the position illustrated in Figs. 5 and 6. During the rotary action of this valve piece until the exhaust port occupies such position, the opening movement of the port 31 in the valve piece for the introduction of motive fluid to the engine and also the opening of the port 90 in the valve piece which communicates with the feed bar cylinder is continually increasing. The position of the variable exhaust port 56 corresponding with the last-named position of the ports 31 and 90 is such as to allow the necessary exhaust when the hammer has its normal action in the engine cylinder or travels the full length of the cylinder between the striking pin and the rear extremity of the chamber. Now if

it is desired to increase the exhaust through the variable port 56, the rotary action of the throttle valve is continued in the direction opposite the arrow, in Fig. 15, and this movement will increase the exhaust through the port 56 inasmuch as this action of the valve piece increases the depth of the portion of the port 56 which is brought into register with the passage 57 until the deepest portion of this port is brought into register with the last-named passage. During this movement of the throttle valve, the rearward travel of the hammer during each reciprocation will diminish since as the exhaust opening through the valve piece increases in size or volume, the pressure on the rear extremity of the cylindrical valve diminishes. Consequently, the last-named valve will open before the hammer reaches the rear extremity of its chamber, and when the exhaust through the port 56 is at its maximum the strokes of the hammer will be very short and exceedingly rapid. At the same time the ports 31 and 90 are so constructed that the adjustment of the throttle valve for the purpose of increasing the exhaust through the port 56 does not vary the volume of motive fluid which passes to the engine and the feed bar cylinder. This is a very important feature of my improvement and enables me to accomplish an object not heretofore attainable in previous constructions, so far as I am aware.

In further explanation of the construction, it may be stated that a relatively small port 91 is in communication with the space or cavity 42. This port communicates with a small passage 92 leading to the atmosphere and permits the escape of any motive fluid that may leak into the cavity 43 in the rear of the cylinder valve when the latter is in the open position and obviates any tendency to close the cylinder valve when it should remain open or during the forward travel of the hammer in the cylinder.

In further explanation of the construction, it may be stated that a small port 4 (see Fig. 4) is for the purpose of compensating for any slight irregularity, should it occur, as regards the simultaneous opening of ports 31 and 70. It is of importance only when the throttle valve is slightly open and the machine is reciprocating slowly; whereas, on account of its relatively small cross-sectional area, it does not interfere with the action of the mechanism of the machine as described, when the hammer is moving at medium or maximum speed.

Still another feature consists in forming an interior annular groove 101 at the forward extremity of the cylinder valve 16, which communicates at its forward extremity when the cylinder valve is open, with the cavity 26, and at its opposite extremity with a port 100 communicating with a passage 102 which leads to the central cavity 13. The said groove 101, the port 100 and the passage 102 are relatively small, their only object being to allow enough motive fluid to pass during the first part of the forward movement of the hammer 36, to fill the passages 39 and 40 by the time the ports 38 are uncovered, thus obviating any diminution of the motive fluid pressure acting on the hammer, which diminution of pressure would result by the filling of the said passages with the motive fluid from behind the hammer as soon as the ports 38 were uncovered, if the said passages had not already been filled.

I claim—

1. In mechanism of the character described, the combination with a motor including a cylinder and a hammer mounted to reciprocate therein, of a valve for varying the supply of motive fluid to the motor, said valve being also equipped to gradually and continuously increase the exhaust from the motor as the valve is moved from closed to fully open position.

2. In mechanism of the class described, the combination of a motor and feed bar casing, of a valve interposed between the motor and said casing and adjustable to control the passage of motive fluid to both, the said valve being also equipped to gradually and continuously increase the exhaust from the motor as the valve is moved from the closed to the fully open position.

3. The combination with a motor, including a cylinder and a hammer mounted to reciprocate therein and a feed bar casing, of a valve interposed between the motor and said casing and adjustable to control the passage of motive fluid to both the motor and casing, the said valve being also equipped to gradually and continuously increase the exhaust from the motor as the valve is moved from the closed to the fully open position.

4. The combination with a motor and feed bar casing, of a valve interposed between the motor and said casing to control the passage of motive fluid to both, and equipped with a port arranged to vary the exhaust from the motor while the supply to both motor and feed bar casing remains uniform.

5. The combination with a motor and feed bar casing, of a valve interposed between the said motor and casing to control the passage of motive fluid to both, and equipped with a port arranged to increase the exhaust from the motor as the supply is increased to both casing and motor until the maximum supply to both is attained, the exhaust port being so constructed that by further adjustment of the valve the exhaust may be progressively increased until a predetermined maximum is reached, without

changing the supply to the motor and said casing.

6. The combination with a motor and feed bar casing, of a valve interposed between the motor and said casing and controlling the supply of motive fluid to both, the said valve having an exhaust port varying in volume in the direction of its length and arranged to progressively increase the exhaust as the movement of the valve is continued in the same direction after the maximum supply to both motor and casing is reached and without varying the supply to either the motor or casing.

7. The combination with a cylinder and a piston mounted to reciprocate therein, a movable valve for controlling the supply of motive fluid to and its exhaust from the cylinder, the valve having differential pressure areas and the pressure of the exhaust on the larger area serving to hold the valve closed during the rearward movement of the hammer, and a second valve having a port arranged in the path of such exhaust and adjustable to vary the length of time during which the pressure of the exhaust on the larger area of the first-named valve is exerted for the purpose set forth.

8. The combination with a cylinder, a hammer mounted to reciprocate therein and a movable valve for controlling the supply of motive fluid to and its exhaust from the cylinder, the valve having differential pressure areas and the pressure of the exhaust on the larger area serving to hold the valve closed during the rearward movement of the hammer, against the tendency of the live motive fluid on the lesser area to open the said valve, and a second valve having ports through which the supply and exhaust to and from the cylinder pass, the second valve being adjustable to increase both the supply and exhaust until the maximum supply is reached, and to further increase the exhaust without changing the supply, until a predetermined maximum exhaust is attained.

9. The combination with a cylinder, a hammer mounted to reciprocate therein and a movable valve for controlling the supply of motive fluid to and its exhaust from the cylinder, the valve having differential pressure areas and the pressure of the exhaust on the larger area serving to hold the valve closed during the rearward movement of the hammer, and a second valve having ports through which the supply and exhaust to and from the cylinder pass, the second valve being adjustable to increase both the supply and exhaust until the maximum supply is reached and to further vary the exhaust within a pre-determined range after the maximum supply limit is attained, without varying the supply for the purpose set forth.

10. In a tool of the class described, the combination with a motor including a cylinder and a motive fluid actuated hammer mounted to reciprocate therein, a feed cylinder for holding the motor to its work, the motor having a movable valve for regulating the supply and exhaust to and from the cylinder, the said valve having differential pressure areas upon the larger of which the exhaust acts to hold the valve closed during the return of the hammer, and a second valve interposed between the motor and feed cylinder and having ports through which the supply to the motor and feed cylinder passes and a port through which the exhaust from the motor cylinder passes, the second valve being adjustable to control the supply to both cylinders and the exhaust from the motor cylinder and to vary the last-named exhaust within a pre-determined range without varying the supply to the motor or feed cylinder.

11. In a rock drill, the combination of a motor and feed cylinder, the motor including a cylinder and a hammer mounted to reciprocate therein, the motor having a valve movably mounted to regulate the supply and exhaust of the motive fluid to and from the hammer cylinder, and a second valve interposed between the motor and feed cylinder and having ports arranged for the passage of the motive fluid supply directly from its source to both cylinders, said drill having a passage for the transmission of motive fluid from the feed cylinder to the motor cylinder for the return of the hammer, said passage being larger than the said port leading to the feed cylinder and said passage being arranged to be controlled by the motor valve.

12. In apparatus of the class described, the combination with a motor including a cylinder, a hammer mounted to reciprocate therein and a valve movably mounted to regulate the supply and exhaust of motive fluid to and from the cylinder, and means for subjecting the valve to a portion of the exhaust from the cylinder forward of the hammer shortly before the hammer has reached its limit of rearward travel to aid in opening the said valve.

13. In an apparatus of the class described, the combination of a motor, a feed cylinder, a movable piston therein and mechanism whereby a lower pressure prevails in the feed cylinder when the hammer is moving rearwardly than when the hammer is moving forwardly or toward the striking pin.

14. In a fluid driven rock drill, a slide valve having surfaces of different areas at its ends, means for subjecting the surface of greater area to the pressure of the exhausting fluid while the valve is in one position, and means for regulating the speed of the exhaust.

15. In a fluid driven rock drill, a slide

valve having surfaces of different areas at its ends, said smaller surface being constantly under the influence of line pressure, means for subjecting the said larger surface to the pressure of the exhausting fluid, while the valve is in one position, and means for regulating the speed of the exhaust.

16. In apparatus of the class described, the combination with a motor including a cylinder, a hammer mounted to reciprocate therein, and a valve movably mounted to regulate the supply of motive fluid to the cylinder, said cylinder having an exhaust passage arranged to be uncovered by the hammer when near its rear limit of movement only, said valve having a projection and said cylinder having a port adapted to maintain communication between the said passage and one side of said projection.

17. In a rock drill, a feed cylinder, a hammer cylinder, a motor valve interposed between said cylinders, said drill having passages for feeding motive fluid continuously to said valve, a feed cylinder and a passage leading from the feed cylinder to the forward end of the hammer cylinder, said last named passage being arranged to be controlled by the movement of the motor valve.

18. In a rock drill, a feed cylinder, a hammer cylinder, a motor valve interposed between said cylinders, said drill having passages for feeding motive fluid continuously to said valve, a feed cylinder and a passage leading from the feed cylinder to the forward end of the hammer cylinder, said last named passage being larger than the feed passage to the feed cylinder and being arranged to be controlled by the movement of the motor valve.

19. In a rock drill, a hammer, a hammer cylinder, a motor valve for controlling the flow of motive fluid to said cylinder, the latter having an exhaust passage extending through and controlled by said valve, and means for regulating the size of said passage at one point.

In testimony whereof I affix my signature in presence of two witnesses.

VINCENT JOHN O'BRIEN.

Witnesses:
A. J. O'BRIEN,
C. M. WAUDBY.