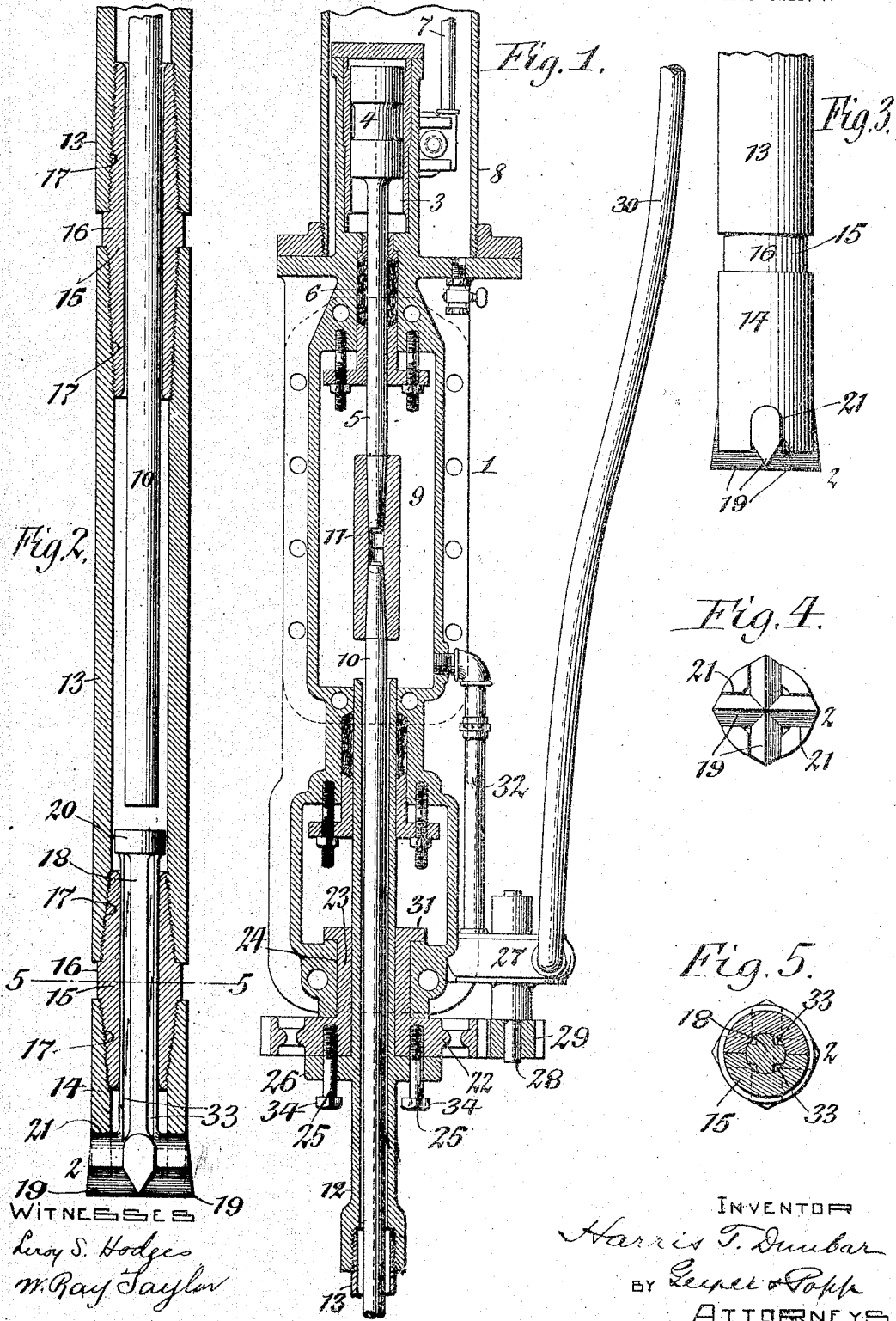


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Patented Mar. 21, 1916.
 4 SHEETS—SHEET 1.



1,176,041.

Patented Mar. 21, 1916.

4 SHEETS—SHEET 2.

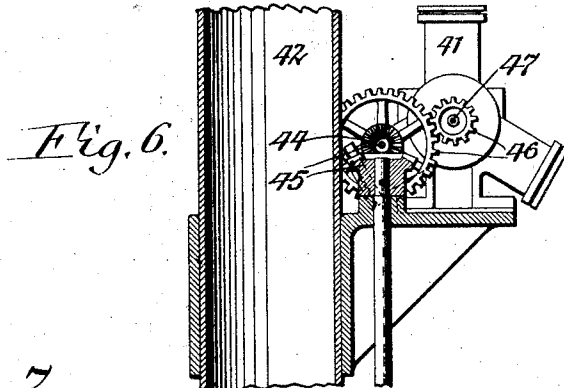
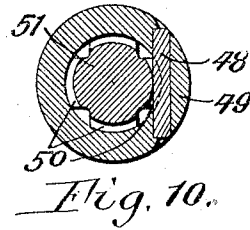


Fig. 7.

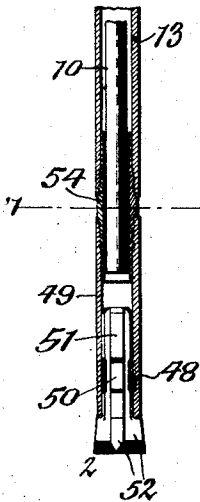
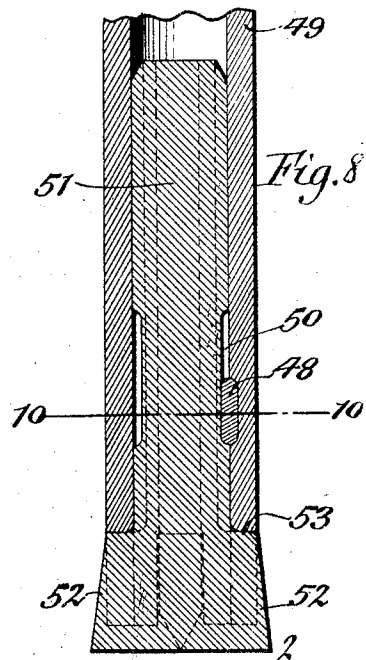
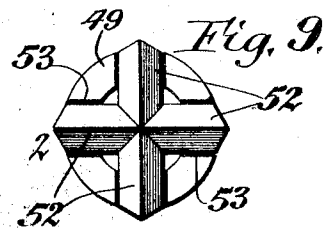
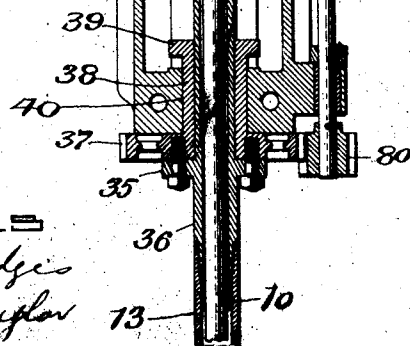


Fig. 11.



WITNESSES

Leroy S. Hodges
 M. Ray Saylor

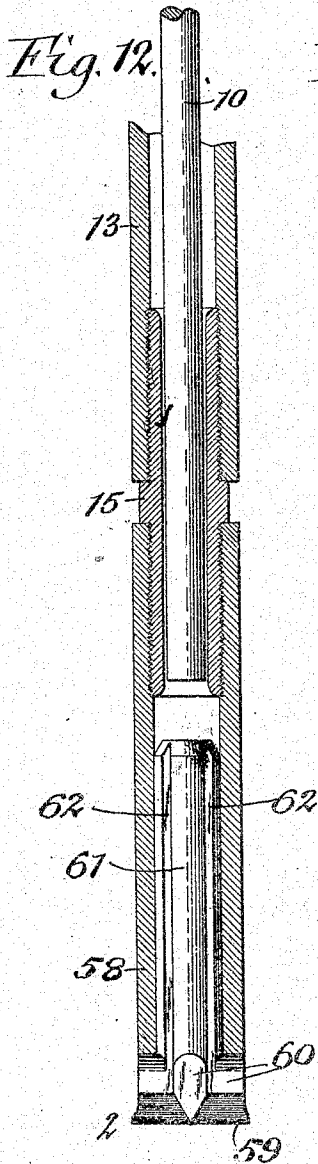
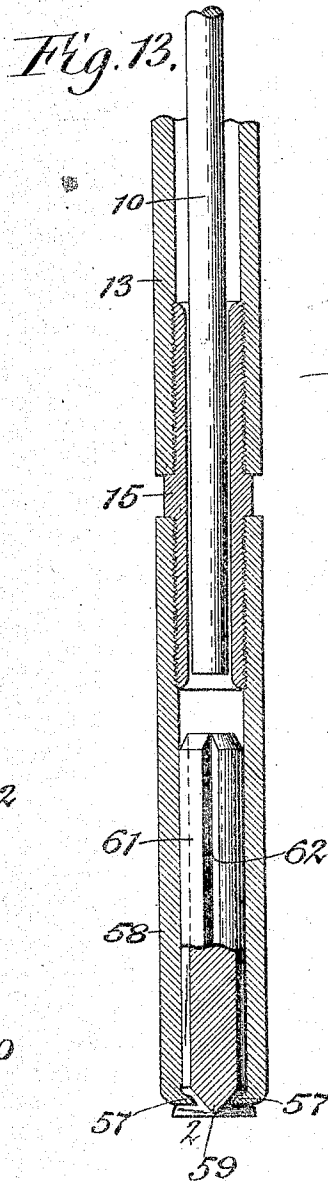
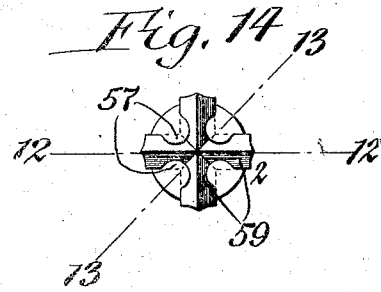
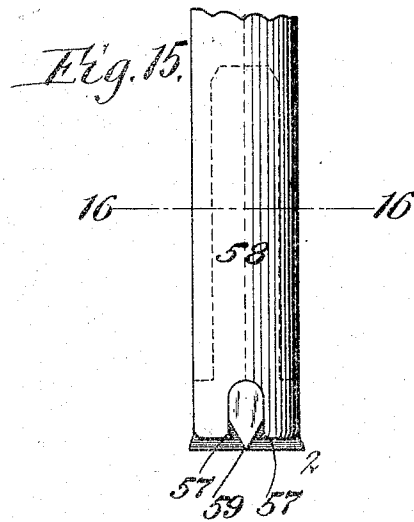
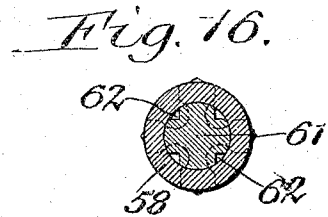
INVENTOR

Harris T. Dunbar
 BY Geier Rapp
 ATTORNEYS

H. T. DUNBAR.
 DRILLING MACHINE.
 APPLICATION FILED MAY 24, 1912.

1,176 041.

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 4 SHEETS—SHEET 3.



WITNESSES
 Leroy S. Hodges
 M. Ray Taylor

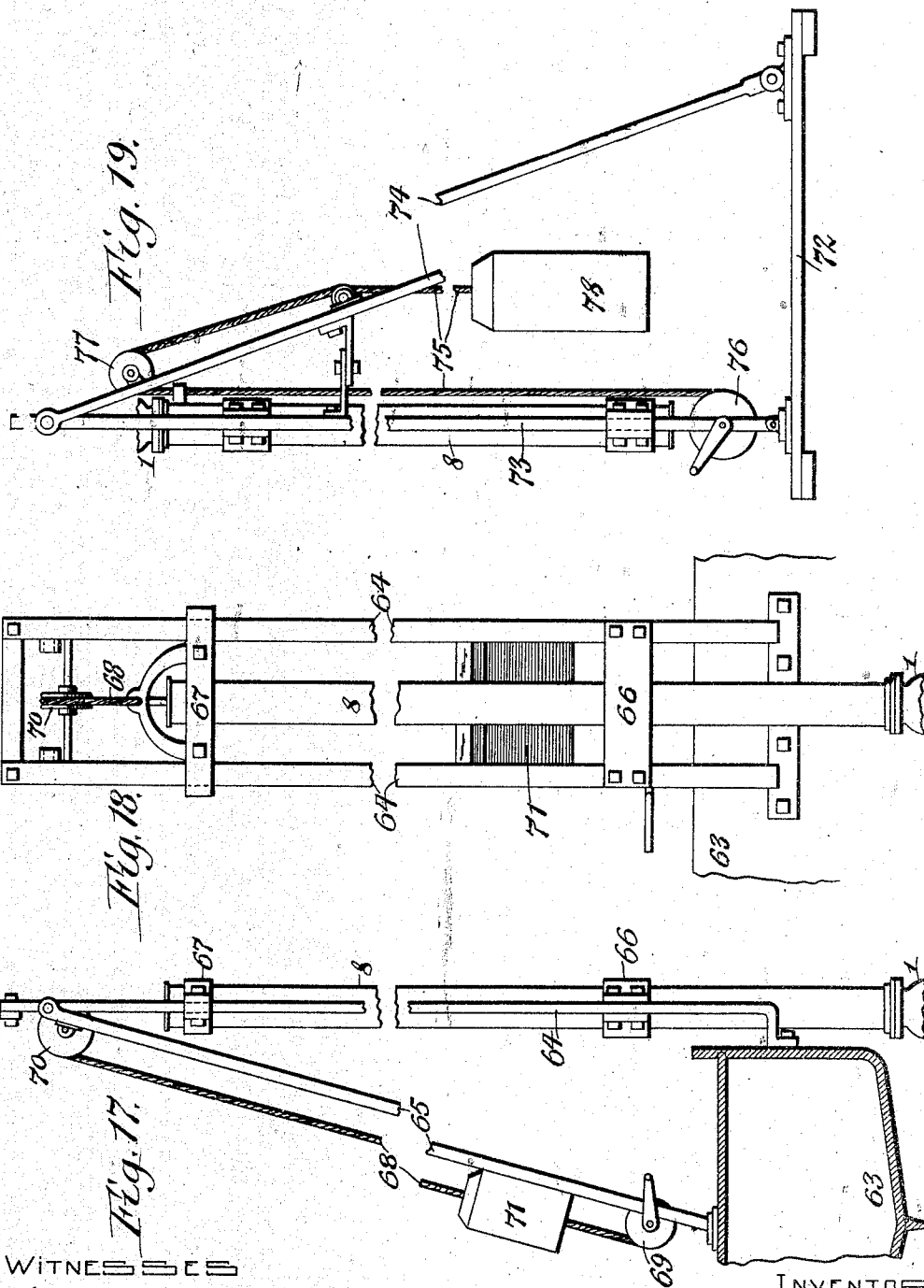
INVENTOR
 Harris T. Dunbar
 BY *Lever & Poff*
 ATTORNEYS

H. T. DUNBAR.
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1.176,041.

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4 SHEETS—SHEET 4.



WITNESSES

Leroy S. Hodges
 W. Ray Taylor

INVENTOR

Harris T. Dunbar

BY *Harper & Popp*
 ATTORNEYS

UNITED STATES PATENT OFFICE.

HARRIS T. DUNBAR, OF BUFFALO, NEW YORK.

DRILLING-MACHINE.

1,176,041.

Specification of Letters Patent.

Patented Mar. 21, 1916.

Application filed May 24, 1912. Serial No. 699,394

To all whom it may concern:

Be it known that I, HARRIS T. DUNBAR, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Drilling - Machines, of which the following is a specification.

This invention relates to a drilling machine which is more particularly designed for drilling holes in rocks under water preparatory to blasting the same, although this machine may also be used for drilling rock elsewhere and for other purposes.

In the past many attempts have been made to quicken, cheapen and simplify the operation of drilling rock. When drilling shallow holes pneumatic hammers will answer the purpose but when these holes are comparatively deep or located at a considerable distance from the source of power the bar between the bit or chisel and the motor is too long and not only renders it impracticable to handle the machine but the bar will also not stand the rapid hammering blows which it receives. In order to overcome these difficulties larger and heavier drilling machines have been employed which contain a reciprocating drill bar in order to gain by sheer force speed in drilling. In these prior drilling machines the bit was rotated by means of a ratchet mechanism which was operated by a reciprocating part of the machine. This is a drag on the work of the machine. Notwithstanding that this ratchet rotating mechanism is positive in action the spacing of the blows on the rock is irregular. It is possible for the bit to strike the same spot several times in succession. Large chips are liable to be formed which cannot be washed out of the holes by water and this necessitates pulverizing these chips to the proper degree of fineness before they can be so removed. In order to wash out the chips the diameter of the bit must exceed the diameter of the bar to such extent that a pipe of at least $\frac{1}{8}$ of an inch in diameter may be inserted between the wall of the hole and the bar in its center. Furthermore, in these large drilling machines the drill bar must be of very large diameter between its bit or chisel and the driving mechanism in order to avoid undue bending or deflection of this bar because the same is practically unsupported between its extremities. The large machines heretofore

in use are also disadvantageous on account of their excessive weight and also because they strike too heavy a blow regardless of the direction in which the drilling is being done. Such heavy blows are liable to produce a large chip in a drill hole when the drill approaches a seam inasmuch as the bridge or last part of the rock before reaching this seam often breaks down and the chip thus formed must be pulverized while loose. This results in delay and reduces the efficiency and capacity of the machine. Such chips sometimes fall from a seam behind the bit or gravel or chips wash from above into the hole and jam the drill bar so that great power is required to pull the bar and chip out of the hole. Often times the bar cannot be so removed and must be left in the hole, thereby not only losing the bar but also the time spent in forming the hole.

Owing to the great weight of the drilling machines heretofore in use and the number of parts which required manipulation it has been found necessary to employ a number of men to operate each drill. This is due to the fact that in submarine drilling the drill bars are often forty feet in length, two inches in diameter and provided with a bit which is three and a half inches in diameter. This necessitates the employment of a large number of men and hydraulic rams or steam winches to handle the drill bar in the various necessary operations.

It is the object of this invention to reduce some of the difficulties of drilling above mentioned. With this end in view a reciprocating hammer bar of comparatively small diameter is employed which is operated to strike a number of blows per minute much less than the pneumatic hammer and much more than in the heavy type of rock drills now in use, which hammer bar and the bit operated by the hammer bar are guided so as to hold them in position and prevent deflection of the bar under the thrust which the same receives from the motor. The guide tube serves also to keep chips from falling behind the bit, the diameter of bit exceeding that of the guide by the small amount necessary to give channel to the wash water and pulverized stone therein.

The machine forming the subject of this invention is practically automatic in its op-

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eration and the parts comparatively light in weight so that a crew of men with a boiler, pumps, &c., of a capacity heretofore necessary for operating a single drilling machine of the type heretofore in use can operate a number of drilling machines which are constructed in accordance with my invention. Furthermore, my improved drilling machine permits of producing smaller holes in the rock and also of rotating the bit with positive regular spacing, the idea being to strike a large number of closely spaced blows and reduce the rock to powder so that it will readily and quickly be carried up and away by water which is continuously forced down through the guide. Owing to the light blows the bridge at the seams in the rock are also not liable to be broken down so soon, thereby reducing the size of the chips which are formed, whereby the work of pulverizing the chips to permit of washing them out of the hole is lessened. The liability of jamming or locking the drill bar in the hole and losing the same is reduced to a minimum. By reducing the cubical contents of the hole, by reducing the interruption of the drilling operation, by enlarging the number of machines which any certain crew can operate the cost of drilling per foot is materially lessened.

In the accompanying drawings consisting of 4 sheets: Figure 1 is a vertical longitudinal section of the upper part of one form of drilling machine embodying my invention. Fig. 2 is a vertical longitudinal section, on an enlarged scale, of the lower part of said machine. Fig. 3 is a side elevation of the lower part of the drilling machine shown in Fig. 2. Fig. 4 is a bottom plan view of the bit and tubular guide of the parts shown in Figs. 2 and 3. Fig. 5 is a horizontal section taken in line 5-5, Fig. 2. Fig. 6 is a vertical longitudinal section of the upper part of another drilling machine constructed in accordance with my invention. Fig. 7 is a vertical longitudinal section of the lower part of the last mentioned form of drilling machine. Fig. 8 is a vertical longitudinal section, on an enlarged scale, of the construction shown in Fig. 7. Fig. 9 is a bottom plan view of the same. Fig. 10 is a horizontal section taken in line 10-10, Fig. 8. Fig. 11 is a cross section, on an enlarged scale, taken in line 11-11, Fig. 7. Fig. 12 is a vertical longitudinal section showing still another form of bit, hammer bar and the means for guiding the same embodying my invention, the section being taken in line 12-12, Fig. 14. Fig. 13 is a similar section of the last mentioned parts taken in line 13-13, Fig. 14. Fig. 14 is a bottom plan or end view of the parts shown in Figs. 12 and 13. Fig. 15 is a side elevation of the bit and guide shown in Figs. 12, 13 and 14. Fig. 16 is a horizon-

tal section taken in line 16-16, Fig. 15. Fig. 17 is a fragmentary side elevation showing one form of derrick whereby my improved drilling machine may be mounted on a boat for use in submarine rock drilling. Fig. 18 is a front elevation of the same. Fig. 19 is a side elevation showing one form of derrick for supporting my improved drilling machine on land when the drilling is to be done over head or at such an angle in which the weight of the machine cannot be utilized to hold the same to its work.

Similar characters of reference indicate corresponding parts throughout the several views.

Referring to Figs. 1-5, 1 represents the main frame of the drilling machine which may be of any suitable construction to support the main working parts of the drilling mechanism. In the position of the parts shown in Figs. 1, 2 and 3 the machine is adapted for drilling a hole in a rock downwardly, this being the position in which the machine is used when boring rock submerged in water while the machine is mounted on a scow floating upon the water or is otherwise supported. On the upper part of this frame is mounted a reciprocating engine or motor whereby motion is produced for delivering hammer blows with comparative frequency against a bit or tool 2 which drills the hole in the rock. This motor may be of any suitable construction but is preferably of the well known air operated type and only the main elements of the same are therefore shown in Fig. 1. As there shown this motor comprises an upright working cylinder 3 mounted on the main frame, a piston 4 reciprocating vertically within the cylinder and having a piston rod 5 projecting downwardly from its lower end through a stuffing box 6 at the lower end of the cylinder, and a pipe 7 connected with the cylinder and adapted to supply compressed air to the cylinder for alternately raising and lowering the piston therein. The valve mechanism whereby the compressed air is admitted into and exhausted from opposite ends of the working cylinder for raising and lowering its piston forms no part of this invention and as the same may be of any suitable construction the details of the same are not shown.

Extending upwardly from the frame and inclosing the reciprocating engine, its valve mechanism and the compressed air supply pipe or tube is a casing 8 which rises above the water level and is adapted to protect the engine and the parts connected from the water. This casing is therefore made of the required length to suit the particular depth at which the surface of the rock to be drilled is arranged below the surface of the water. Below the reciprocating engine a water chamber 9 is mounted on the

main frame which chamber incloses the stuffing box 6 at the lower end of the cylinder 3 and is preferably made water tight for purposes which will presently appear.

10 represents an upright hammer bar or rod which is preferably of cylindrical form in cross section and whereby a hammer blow is delivered against the drill bit. This hammer bar is arranged in an opening formed in the lower head of the chamber 9 and is preferably detachably connected at its upper end with the lower end of the piston rod within this chamber. The connection between these two rods may be effected by any suitable means, those shown in the drawings being suitable and comprising an upright coupling sleeve 11 having the upper and lower ends of its bore tapered inwardly and adapted to receive the corresponding tapering ends of the piston rod and hammer bar which are secured within the coupling sleeve by a driving fit.

12, 13, 14 represent the upper, intermediate and lower body sections and 15 the coupling sections of a guide tube which is mounted on the frame and which incloses the hammer rod throughout nearly its entire length and also incloses the greater part of the drill bit for the purpose of guiding and holding these parts in their proper working position. The uppermost body section 12 of the guide tube is arranged within a stuffing box on the lower head of the water chamber 9 and opens at its upper end into this chamber. The uppermost intermediate section 13 of the guide tube is connected by a screw joint with the upper guide tube section 12, as shown in Fig. 1 or any other suitable means. The opposing ends of the other intermediate body sections of the guide tube have their opposing ends connected by one of the coupling sections 15 each of the latter having its central enlarged part 16 and its ends provided with external screw threads 17 which engage with internal threads in the opposing ends of two intermediate body sections. The lowermost body section 14 has its upper end also connected with the lower end of the lowermost intermediate body section by one of the coupling sleeves 15. The number and length of intermediate body and coupling sections which are employed in the guide tube is determined by the depth of the rock to be bored below the surface of the water.

Although the form of the bit may be varied, that shown in Figs. 2, 3, 4 and 5 is suitable and comprises an upright shank 18 arranged within the lowermost coupling section 15 and the adjacent body sections of the guide tube, a plurality of cutting blades, jaws or teeth 19 projecting laterally from the lower end of the shank and each having its lower edge constructed in the form

of a chisel or cutter, and an enlargement, collar or stop 20 formed at the upper end of the shank within the lowermost intermediate body section. The blades of the bit are preferably four in number and arranged in the form of a cross, as shown in Fig. 4, and these blades are arranged within longitudinal notches or recesses 21 formed in the lower end of the lowermost body section of the guide tube and project laterally beyond the periphery of this tube so that the diameter of these blades taken collectively is greater than the diameter of the guide tube on the outside thereof. During the operation of drilling a hole in the rock the bit rests with its lower or cutting edge upon the rock, the guide tube rests by means of the upper end of its notches on the blades of the bit, and the frame of the machine and associated parts are supported by the guide tube, in which position of these parts the lower end of the lowermost body section is arranged above the lower edge of the bit and the stop collar of the bit is arranged above the upper edge of the lowermost coupling section. Upon starting the reciprocating engine while the parts are in this position the hammer rod or bar will be raised and lowered continuously and caused to strike a hammer blow against the upper end of the bit shank during each downward stroke, whereby the cutting or chisel edge of the latter is driven with a cutting action into the surface of the rock against which the same rests in substantially the same manner in which a stone cutter's tool is driven against the surface of the stone.

In order to reduce the weight of the guide tube and the hammer rod this guide tube and the hammer bar are made comparatively small in diameter, and in order to prevent undue lateral deflection of the hammer rod so that the same delivers an effective blow against the bit the coupling sections 15 of the guide sleeve have their bores constructed to fit comparatively close around the periphery of the hammer bar. While the drill bit is subjected to the blows of the hammer bar the same is also turned so as to engage the same with a new part of the rock for each blow of the hammer bar and thereby cause the rock to be cut away in comparatively small bits or chips which can be subsequently easily removed by a stream of water. This turning movement of the bit is preferably effected by mechanism which operates upon the upper part of the guide tube so that the latter is turned together with the bit which is interlocked therewith by engagement of the blades of the bit with the notches or recesses at the lower edge of the lower body section of the guide tube. The means for turning the guide tube and bit which are

shown in Fig. 1, for example, comprise a horizontally rotatable gear wheel 22 which has a hollow hub 23 journaled in a bearing 24 at the lower end of the frame and receiving the adjacent part of the upper guide tube section 12, a plurality of upright bolts 25 secured to the lower side of the gear wheel and arranged in openings formed in an annular flange 26 on said guide tube section, a water motor having its casing 27 arranged on the lower part of the main frame and provided on its driving shaft 28 with a pinion 29 engaging with the gear wheel 22, and a water supply pipe 30 leading from a pump on the scow or other source of supply to the inlet of the water motor for operating upon the blades or buckets which are secured to the shaft 28 within the casing and thereby turning the pinion and the parts operatively connected therewith. The gear wheel 22 is held against axial movement on the frame by engaging its upper side with the lower end of the bearing 24 and providing the upper end of its hub 23 with a lateral projecting flange 31 which engages with the upper end of said bearing, as shown in Fig. 1.

While disintegration of the stone or rock is being effected by the blows of the hammer bar against the bit the chips or pulverized rock resulting from the cutting action of the bit is preferably washed out of the hole continuously so as to permit the bit to work with the greatest freedom and efficiency. For this purpose water under pressure is preferably delivered into the upper end of the guide tube and conducted downwardly through the same and discharged at the lower end thereof adjacent to the cutting edge of the bit, whereby the bits of stone are carried upwardly out of the hole through the annular space of the guide tube and the bore of the hole to the exterior of the rock. The discharge of the water together with the bits of stone from the hole which is being bored is possible owing to the fact that the face of the chisel is of larger diameter than that of the guide tube, whereby an annular space of ample dimensions is provided between the guide tube and the bore of the hole for this purpose. The water may be supplied to the upper end of the guide in any suitable manner. In order, however, to dispense with separate means for this purpose the outlet of the water motor is connected by a pipe 32 with the water chamber 9, as shown in Fig. 1. By this means the pressure water supplied by the tube 30 after having been utilized for turning the guide tube and the bit is discharged from the outlet of this motor into the water chamber 9 from which latter it passes down through the guide tube to be again utilized for washing the stone dust and chips out of the drill hole. The

relative diameter of the periphery of the hammer bar and the bore of the different sections of the guide tube are such as to leave an annular space between these parts which is ample to provide the necessary passage for the wash water through the guide tube to the drill hole.

In order to obtain the greatest effectiveness of the bit on the stone when the same receives the blow of the hammer bar the shank of this bit is fitted comparatively snug in the lowermost coupling section of the guide tube and in order to permit the passage of the wash water downwardly between this shank and the respective coupling section 15 this shank is provided with a plurality of longitudinal grooves 33 in its periphery which serve as passages for the wash water through the guide tube to the drill hole. As the drilling of the hole by the bit progresses the weight of the bit and the machine resting upon the same causes the bit to automatically follow up the surface of the stone in the same measure as this surface is cut away underneath the bit. When the hole has been drilled to the desired depth the machine is lifted for disengaging the bit and guide tube from the hole and then lowered upon another part of the rock which is to be drilled. During this lifting of the bit and guide tube, the bit is permitted to drop in the guide tube until its stop collar engages with the upper end of the lowermost coupling section 15; the extent of this movement being so determined that when the stop collar engages with this coupling section the upper parts of the blades of the bit will be still within the notches of the lowermost body section of the guide tube. By thus slidably connecting the bit with the guide tube the blow which the bit receives from the hammer bar is not transmitted to the guide tube, on the contrary, the bit while receiving the blow is permitted to advance independently of the guide tube while producing its cutting action on the stone.

While the machine is in operation the gap or clear space between the shank of the bit and the hammer bar in the separate position of these parts is such that the valve mechanism of the reciprocating air motor will continue its normal operation for keeping this engine or motor running. In order to automatically arrest the hammer bar motor when the machine is lifted means are provided which permit the reciprocating piston of the hammer motor to descend in its cylinder an abnormal extent and thereby shift the ports of this motor so as to arrest the operation of this motor, this action being well known and similar to that found in the drilling machines in general use. For the purpose of permitting the hammer rod and the motor piston to descend an abnormal distance for arresting the operation of this motor the

guide tube is so mounted on the main frame that it is capable of a limited downward movement on the frame and enables the upper end of the shank of the bit to recede downwardly a sufficient extent so as not to interfere with the abnormal descent of the hammer bar which is necessary to effect the automatic stoppage of the hammer motor. Although various means may be provided for permitting this longitudinal movement of the guide tube relatively to the main frame and the engine cylinder that shown in Fig. 1 consists in arranging the heads 34 of the bolts 25, so that a gap is formed between the upper side of these heads when the flange 31 of the upper guide tube section is engaged on its upper side by the lower side of the gear wheel 22, as shown in Fig. 1. Upon lifting the machine the guide tube slides downwardly in the hub of the gear wheel 22 and the stuffing box at the lower end of the water chamber 9 until the flange 31 of the guide tube engages with the heads of the bolts 25 which latter serve as stops for limiting the extent of this movement. When the guide tube is thus lowered relatively to the reciprocating engine cylinder the upper end of the shank of the bit is carried a sufficient distance below the lower end of the hammer bar as will permit this bar and the motor piston to descend an abnormal distance and shut off the supply of compressed air to the cylinder. Upon again lowering the machine so that its bit rests upon the rock and the engine frame and associated parts rest upon the flange of the guide tube, the hammer bar will be pushed upwardly by the shank of the bit and the piston of the engine will be shifted within its cylinder into a position in which air will be again admitted to this motor for automatically restarting the same without requiring any manipulation for this purpose.

The shank, blades and stop collar of the bit shown in Fig. 2 are preferably constructed in one piece for greater durability and security and in order to permit of this form of bit being placed with its shank within the lowermost coupling section 15 of the guide tube this coupling section is preferably divided diametrically into two parts, as shown in Fig. 5, which permits the same to be readily applied to or removed from the shank of the bit.

In the form of drilling machine embodying my invention which is shown in Fig. 6 the slack connection between the guide tube and the cylinder of the hammer operating motor is produced by permanently connecting the flange 35 of the guide tube 36 with the driven gear wheel 37 of the tube rotating mechanism and providing the upper end of the hub 38 of this gear wheel with a laterally projecting flange 39 which during the normal operation of the machine is arranged

out of engagement with the upper end of the bearing 40 of the hub of this gear wheel, as shown in Fig. 6, but when the machine is lifted the gear 37 together with the guide tube 36 will drop until the flange 35 engages with the upper end of the bearing 40, and thereby permit the shank of the bit to drop away from the hammer bar a sufficient distance to cause the hammer bar and motor piston to descend an abnormal extent and automatically stop the hammer motor. Automatic starting of this engine or motor is also effected by again pushing the guide tube upwardly relatively to the engine cylinder in substantially the same manner as described with reference to the construction shown in Fig. 1. The slack connection formed between the guide tube and the motor which permits of a limited longitudinal movement of the guide tube relatively to the reciprocating part of the motor has a further important function in that it prevents the motor operated drilling bar from striking blows against the bit while the same is not in engagement with the surface of the rock but is supported on the guide tube. When the drilling machine is raised so that the bit does not engage the rock the bit drops into its lowest position in the guide tube and is supported by the same so that it is beyond the reach of the lower end of the hammer bar. The latter can therefore not strike the bit while the same at this time is supported by the guide tube whereby the tube and the parts connected therewith are saved from being broken by the blows of the hammer bar.

Instead of effecting the turning of the guide tube and the bit by means of a water motor, as shown in Fig. 1, this may be effected by means of an air operated motor 41 which is mounted on the inclosing casing 42 or other stationary part of the machine so as to be above the level of the water when the machine is in use. Motion may be transmitted from this air motor to the guide tube in various ways, for instance, by the means which are shown in Fig. 6 and which comprise an upright shaft 43 journaled in suitable bearings on the main frame and provided at its lower end with a pinion 80 meshing with the gear wheel 37 and a horizontal shaft 44 journaled in suitable bearings on the upper part of the frame and connected by intermeshing bevel gear wheels 45 in the upper end of the upright shaft and by intermeshing spur gear wheels 46 with the shaft 47 of the air motor.

In Figs. 7, 8 and 10 other means are shown for permitting the bit to partake of the limited longitudinal movement within the lower section of the guide tube and still prevent this bit from becoming detached from the guide tube, these means comprising a key 48 arranged transversely in an opening

in the lower guide tube section 49 and projecting with its inner part into an annular groove 50 formed in the periphery of the shank 51 of this bit having laterally projecting blades 52 engaging with notches 53 in the tube section 49.

For greater convenience in assembling and dismembering the parts each of the upper coupling sections 54 of the guide tube which are similar to the sections 15 may be split diametrically into two parts, as shown in Fig. 11.

When an air operated motor is employed for rotating the guide tube and drill bit an independent water supply pipe 55 may be connected with the water chamber 56, as shown in Fig. 6, for furnishing the necessary water which passes from this chamber downwardly through the guide tube and into the drill hole for removing or washing out the loosened stone therefrom.

Instead of employing a stop collar on the bit, as shown in Fig. 2, or a key as shown in Fig. 10, for preventing the bit from becoming detached from the guide tube this may be effected by means of inwardly bent claws 57 arranged at the lower end of the lower guide tube section 58 and projecting partly underneath the beveled faces or inclined sides 59 of the blades 60 of the bit, as shown in Figs. 12, 13, 14, 15 and 16. In this last mentioned construction the shank 61 of the bit is provided with longitudinal grooves 62 which are in line with the corners between the blades of the bit and which serve as conduits through which water passes from the guide tube to the face of the bit for washing out the stone powder from the drill hole.

Although various means may be provided for mounting this drilling machine so as to lower the same into or raise the same out of the water this may be done by means of a derrick which is mounted upon a boat 63 and which comprises two upright guide bars 64 connected at their lower ends with the side of the boat while their upper ends are connected with the deck of the boat by braces 65, a cross piece 66 which connects the lower part of the guide bar and through which the drilling machine slides vertically, a cross head 67 slidable vertically on the upper parts of the guide bars and secured to the frame of the drilling machine, a hoisting cable 68 connected at one end with the movable cross head and passing at its opposite end around a hoisting drum 69 mounted on the lower part of the braces while its intermediate part passes around a guide pulley 70 at the upper end of the braces and a counterbalancing weight 71 connected with the hoisting cable. The counter weight is preferably of such heft as will permit the drilling machine to descend by gravity and enable the same to be raised more easily. By

turning the drum 69 the drilling machine may be raised.

When using the drilling machine for boring upwardly the same may be mounted on a derrick similar to that which is shown in Fig. 19 and which comprises a base 72, an upright guide 73 which is pivoted at its lower end on the base to swing in a vertical plane and upon which the drilling machine is capable of sliding up and down, a brace 74 pivotally connected at its upper end with the upright guide and connected for horizontal adjustment at its lower end with the base, a hoisting cable 75 connected with the drilling machine and at one end with a hoisting drum 76 mounted on the guide while its intermediate part passes around a guide pulley 77 arranged at the upper end of the brace, and a lifting weight 78 connected with the other end of the hoisting cable and operating normally to automatically lift the drilling machine so as to feed the bit upwardly as the depth of the hole increases. By turning the drum 76 the drilling machine may be lowered.

It will be noted that my improved drilling machine is comparatively light and can be readily handled with little labor and that the same permits of drilling holes in rocks rapidly and without liability of forming large chips or becoming caught in the hole, thereby effecting a material saving in the cost of drilling rock.

I claim as my invention:

1. A drilling machine comprising a bit adapted to engage the surface to be drilled, a hammer bar for operating said bit, a guide tube in which said bit and bar are arranged and which is adapted to enter the drill hole, and means for actuating said hammer bar.
2. A drilling machine comprising a bit adapted to engage the surface to be drilled, a hammer bar for operating said bit, a guide tube in which said bit and bar are arranged, and which is adapted to enter the drill hole, means for actuating said hammer bar, and means for turning said bit.
3. A drilling machine comprising a bit adapted to engage the surface to be drilled, a hammer bar for operating said bit, a guide tube in which said bit and bar are arranged, and which is adapted to enter the drill hole, means for actuating said hammer bar, and means for forcing a clearing fluid through said guide tube to said bit for removing from the hole the pulverized material formed by the bit.
4. A drilling machine comprising a guide tube, which is adapted to enter the drill hole, a bit guided on the lower end of said tube, a hammer bar for operating said bit arranged within said tube, and means for actuating said bar.
5. A drilling machine comprising a guide tube, which is adapted to enter the drill

hole, a bit guided on the lower end of said tube, a hammer bar for operating said bit arranged within said tube, means for actuating said bar, and means for turning said tube and the bit guided therein.

6. A drilling machine comprising a guide tube provided at its lower end with a longitudinal slot, a bit having a shank arranged within said tube and a blade projecting laterally from said shank through said slot and means for turning said tube and bit.

7. A drilling machine comprising a guide tube provided at its lower end with a plurality of longitudinal guide slots, a bit having a shank arranged within said tube and provided with a plurality of laterally projecting blades arranged in said slots and means for turning said tube and bit.

8. A drilling machine comprising a guide tube, which is adapted to enter the drill hole, a bit arranged in said tube and provided with a longitudinal conduit, and means for forcing a clearing fluid through said tube and the conduit for removing the pulverized material from the hole cut by the bit.

9. A drilling machine comprising a tube which is adapted to enter the drill hole and which has a plurality of sections, a bit guided on said tube, and a hammer bar arranged within said tube and operating said bit.

10. A drilling machine comprising a tube having a plurality of body sections and a plurality of coupling sections each of which connects the opposing ends of two body sections, a bit arranged in the lower end of said tube, and a hammer bar arranged with the body sections and coupling sections of said tube and operating said bit.

11. A drilling machine comprising a tube having a plurality of body sections which have their opposing ends provided with internal screw threads, and a plurality of coupling sections each of which has its ends threaded externally and screwed into the ends of two of said body sections and each of which has a bore of smaller diameter than said body sections, a bit guided on the lower end of said tube, and a hammer bar for operating said bit arranged within said tube and guided by the coupling sections thereof.

12. A drilling machine comprising a tube having a plurality of body sections and a lengthwise divided coupling section having its ends connected by screw joints with the opposing ends of the body sections, a bit having a reduced shank arranged in said divided coupling section, an enlarged stop collar at its upper end adapted to engage the upper end of said coupling section and blades at its lower end, and a hammer bar arranged within the tube and operating said bit.

13. A drilling machine comprising a motor having a reciprocating part, a guide

tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube and operated by said bar and means for turning said guide tube and bit but permitting the bit to move lengthwise independently of said tube.

14. A drilling machine comprising a motor having a reciprocating part, a guide tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube and operated by said bar and means for permitting a limited longitudinal movement of said guide tube relatively to said motor.

15. A drilling machine comprising a motor having a reciprocating part, a guide tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube so as to be capable of longitudinal movement independently thereof and operated by said bar, and means for turning said tube and bit relative to said motor.

16. A drilling machine comprising a drilling motor having a reciprocating part, a guide tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube so as to be capable of longitudinal movement independently of said tube and operated by said bar, and means for turning said tube and bit relative to said motor comprising a gear wheel turning with said tube, a pinion meshing with said gear wheel, and a motor for operating said pinion.

17. A drilling machine comprising a drilling motor having a reciprocating part, a guide tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube and operated by said bar, and means for turning said tube and bit relative to said drilling motor comprising a gear wheel turning with said tube, a pinion meshing with said gear wheel, and a fluid operated motor which turns said pinion and which discharges into the interior of said guide tube for removing the pulverized material from the hole formed by said bit.

18. A drilling machine comprising a motor having a reciprocating part, a guide tube, a hammer bar arranged in said tube and connected with said reciprocating part, a bit guided in said tube so as to be capable of longitudinal movement independently of said tube and operated by said bar, and means for turning said tube and bit relative to said drilling motor comprising a gear wheel turning with said tube, a pinion meshing with said gear wheel and a motor connected by intermediate gearing with said pinion.

19. A drilling machine comprising a motor having a frame and a reciprocating part, a guide tube mounted on said frame, a

hammer bar connected with said reciprocating part and arranged within said tube, a bit mounted on said tube and operated by said bar, a driven gear wheel connected with said tube and having its hub mounted on said frame so as to be incapable of a limited longitudinally sliding movement relative to said reciprocating part, and a driving pinion meshing with said gear wheel.

20. A drilling machine comprising a motor having a frame and a reciprocating part, a guide tube mounted on said frame, a hammer bar connected with said reciprocating part and arranged within said tube, a bit mounted on said tube and operated by said bar, a driven gear wheel connected with said tube and having its hub mounted on said frame so as to be incapable of axial movement relatively to said reciprocating part, a driving pinion mounted on said frame and meshing with said gear wheel, and means for causing said tube to turn with said gear wheel but permitting a limited longitudinal movement of the tube relatively to said wheel.

21. A drilling machine comprising a motor having a frame and a reciprocating part, a guide tube mounted on said frame, a hammer bar connected with said reciprocating part and arranged within said tube, a bit mounted on said tube and operated by said bar, a driven gear wheel connected with said tube and having its hub mounted on said frame so as to be incapable of axial movement relatively to said reciprocating part, a driving pinion mounted on said frame and meshing with said gear wheel, and means for causing said tube to turn with said gear wheel but permitting a limited longitudinal movement of the tube relatively to said wheel comprising a plurality of longitudinal bolts secured to the gear wheel and passing through a flange on said guide tube.

22. A drilling machine comprising a guide tube, a bit guided on the lower end of the tube so as to be capable of longitudinal movement independently of said tube and adapted to rest on the surface to be drilled, a hammer bar guided in said tube, independently of said bit, means for reciprocating said bar for causing the same to strike

said bit intermittently and means for turning said tube and bit in unison.

23. A drilling machine comprising a guide tube, a bit guided on the lower end of the tube so as to be capable of longitudinal movement independently of said tube and adapted to rest on the surface to be drilled, a hammer bar guided in said tube, independently of said bit, means for reciprocating said bar for causing the same to strike said bit intermittently while the latter rests continuously on the surface being drilled and means for turning said tube and bit in unison.

24. A drilling machine comprising a guide tube, a bit guided on the lower end of the tube so as to be capable of longitudinal movement independently of said tube and adapted to rest on the surface to be drilled, a hammer bar guided in said tube, independently of said bit, means for reciprocating said bar for causing the same to strike said bit intermittently while the latter rests continuously on the surface being drilled, and means for turning the guide tube and bit during the drilling operation.

25. A drilling machine comprising a guide tube provided at intervals with internal reduced bearing portions, a hammer bar arranged in the guide tube and engaging said bearing portions, and a bit mounted on the guide tube and adapted to receive blows from said hammer bar.

26. A drilling machine comprising a bit having a reduced shank, an enlarged collar at the inner end of the shank and blades at the outer end of the shank; a split guide tube section embracing said shank and having the internal diameter smaller than said collar and blades, a non-split guide tube section on which said split tube section is mounted, means for rotating said guide tube sections, and a hammer bar reciprocating in said tube sections and engaging said bit.

Witness my hand this 23 day of May, 1912.

HARRIS T. DUNBAR.

Witnesses:

THEO. L. POPP,
E. M. GRAHAM.