M. A. KNAPP.

ROCK DRILL.

APPLICATION FILED FEB. 7, 1910.

1,006,661. Patented Oct. 24, 1911.

Fig. 1.

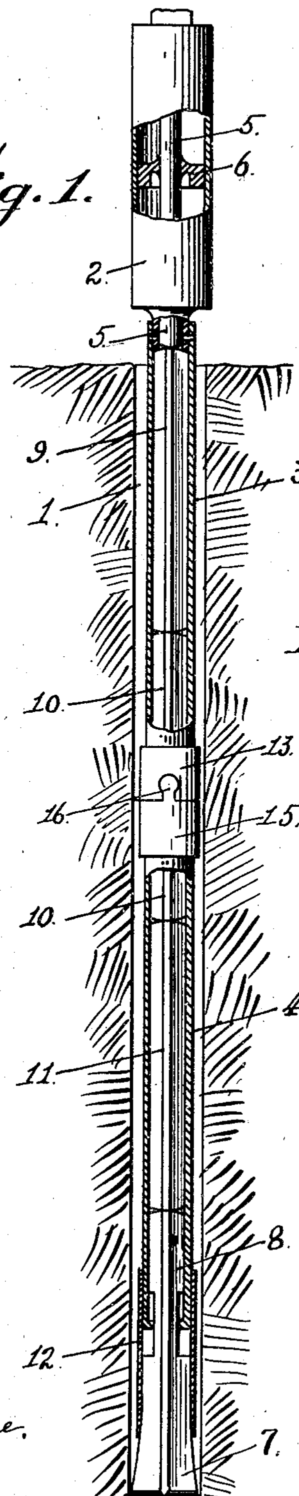


Fig. 2.

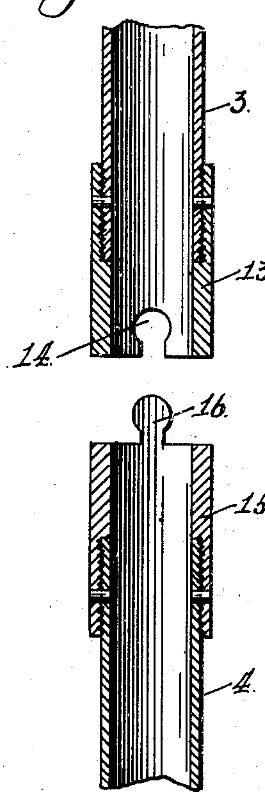
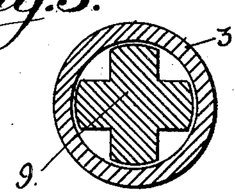


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ROCK-DRILL.

1,006,661. Specification of Letters Patent. **Patented Oct. 24, 1911.**

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To all whom it may concern:

Be it known that I, Moses Arthur Knapp, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented certain new and useful Improvements in Rock-Drills, of which the following is a specification.

My invention relates to the class of rock-drills, and it has for its object the provision of a drilling machine or device capable of penetrating rock or other hard material to depths to which it has not been practicable to drill with either churn drills or hammer drills; and further to provide for the use of much lighter machines for drilling holes to depths now reached by churn drills and the heavier hammer-drills.

My invention may be briefly stated to consist in a drilling device in which there is interposed and alined between the hammer and the drill-bit one or more separate bars or rods, each of approximately equal length to the drill bit.

In the accompanying drawings Figure 1 is a view, partly in section and partly in elevation, of my rock-drill. Fig. 2 is an enlarged sectional detail showing a practical means for coupling the sections of the guide-tube together, the sections being here shown uncoupled. Fig. 3 is a cross section, enlarged, through the guide tube and inclosed rod.

1 indicates the bore or hole in the rock in which the drill is operating.

2 indicates, in a general way, the hammer-carrying shell or casing in which any suitable arrangement of ports and passages may exist, which may be necessary to operate the hammer, through pneumatic or other fluid-pressure. Secured to this shell or casing is the first section 3 of the guide tube, to which a second section 4 is coupled.

5 is the hammer, here shown as of the bar type, and 6 is its piston collar, on which the fluid pressure acts.

7 is the drill-bit, the shank 8 of which is housed within the lower end of the second section 4 of the guide tube.

9 is a rod or bar the upper end of which is contiguous to the lower end of the hammer.

10 is a second rod or bar which lies between the lower end of the first rod and the upper end of a third rod 11, the lower end of which is contiguous to the upper end of the shank 8 of the drill bit. Each of these rods is of approximately equal length to that of the drill bit.

Theoretically, and in practice, initially, the length of each rod will be equal to that of the drill bit, but in view of the fact that the latter wears down, this absolute equality of length cannot be maintained, but it should be kept as near as possible, and I have indicated this by the word "approximately". When a bar-hammer is used, such as I here show, it is best that the approximate equality of length extend to it also, and that it shall be of approximately equal length to the rods and the drill bit. Also for the best effect there should be approximate equality of weight in these several parts.

The ends of the rods should be tempered to prevent battering. I have found that a row of steel bars of equal length and approximately equal weight, placed end to end (though not necessarily in contact) when struck a blow on one end, transmits the blow throughout the series, with a loss of but one or two per cent. of its energy for each contact in the series. The tempered steel acts as a perfectly elastic body losing only a small amount of the energy in production of heat and sound waves. Applying this to my rock-drill, it will be seen that I have utilized this principle by substituting for the first rod or bar of the series the drill hammer, and for the last rod or bar of the series I have substituted the drill bit. I am thus enabled to carry the effect of a blow, from the hammer, through the intervening rods, to the drill bit, with but an insignificant loss of energy, and to drill into the rock with a hammer drill, as rapidly at the end of such a composite drill rod of ordinary length, as with a short drill. This being true it is obvious that by interposing more sections of drill rods, and by coupling up more sections of guide tube, I can drill to depths heretofore deemed impracticable; and even at depths to which the ordinary hammer or the churn drill is fitted, I can use a much lighter machine. These advantages especially adapt my device for prospecting. For example, in contrast to the small percentage of loss in my device, I have found that a 6 pound hammer, 9 inches long, striking an equal weight bar 3 feet long, loses 20% of the energy; and a 3 pound hammer on the same bar, with a quarter pound tappet interposed, loses 40% to 50% of the blow. It has been considered by mechanical engineers engaged in this work that the effect of the blow of a hammer on a drill is to carry the latter forward with the striking mass. This is not the case, except when the soft metal of one is being battered up under the blow.

When there is sufficient elasticity of the metals to prevent battering, as in all hammer drill work, the action is that of elastic impact, and the losses of energy are due to the waves of compression traversing the two striking masses. These waves travel apart along the rods from the point of contact and return to meet again on equal length rods. But infinitesimal separation having yet taken place, the two waves dampen each other, and cause rebound of the rods at such a speed as to practically stop the forward motion of the striking one, and greatly to increase the speed of the rod struck.

The several rods are best made of cross-steel as seen in Fig. 3, which shape has the good effect of permitting the passage of such air or water as may be introduced to clean out the bottom of the hole; and in order to carry this fluid directly to the bottom of the hole, in the angles of the bit-shank, I prefer to secure to the bit a light sleeve 12 which telescopes the adjacent guide-tube and forms a confining casing for the fluid. The guide tube sections should be connected by couplings sufficiently rigid to stand the strain, and yet easy to be made and broken. A good form of coupling I show in Fig. 2. Upon the end of one tube section is screwed and riveted fast a hard steel nipple 13 in which is made a key-hole aperture 14, one on each side. To the end of the next tube section is screwed and riveted a similar nipple 15, which is formed with keys 16, one on each side. To fit the nipples together they are presented side by side and the keys of one passed into the key-holes of the other. Then when the drill rods are within, a rigid coupling is made, which will not turn, and can only be dismembered by removing the interior rods.

In years of experiment the light air-hammer drills have only partially replaced the heavy two-man machines which reciprocate the whole drill bar. With a long air-pressure cylinder to force them up against the rock, the former, one-man machines, weighing 50 to 100 lbs. with 3 to 5 lb. hammers, can drill upper holes to a depth of 3 to 4 ft., making a very large saving as against the old style of drill. Beyond 3 ft. however, the power of the blow of a short light hammer is largely lost in the vibration of the steel, and cutting speed is rapidly lowered. With the more powerful drills, in hard rock, this vibration causes "crystallization" of the steel and breakage of drill shanks, making their use inadvisable in some cases.

The light hammer machines were first introduced as hand machines on the lines of the pneumatic riveter. It is impossible, however, for a man to hold up in his hands a machine vibrating a 3 lb. hammer in a 2 in. cylinder 1000 times a minute. The 20 lb. hand machines with 2 lb. hammers in $1\frac{1}{4}$ in. cylinders, now on the market, are hard to hold and drill slowly beyond one ft. in depth. Pneumatic riveters, held in the hands of the workmen are in constant use. They have hammers of $\frac{3}{4}$ to 1 lb. in weight. A 20 lb. hand machine with a 1 lb. bar-hammer 10 in. long, could be easily held; and with my composite drill rod, could cut as fast at 4 ft. depth as one with a short 3 lb. hammer striking a long solid bar. The loss in the latter case is due first to the 20 to 40% loss in impact, but still more to the fact that the slow blow of the heavy drill powders the rock and does not cut as fast as the sharp chipping blow of the lighter drill with the same kinetic energy.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. In a rock-drill of the hammer type, and in combination with its hammer and drill-bit, a separate rod alined with and intermediate the hammer and drill-bit and in such contiguity thereto that the blow from one is transmitted through the rod to the other, said rod having a length approximately equal to that of the drill-bit.

2. In a rock-drill of the hammer type, the combination of a drill-bit, a bar-hammer, and a separate rod alined with and intermediate the hammer and drill-bit and in such contiguity thereto that the blow from one is transmitted through the rod to the other, said rod, bar-hammer and drill bit having approximately equal lengths.

3. In a rock-drill of the hammer type, and in combination with its hammer and drill-bit, a series of separate rods alined with each other and with the hammer and drill-bit and intermediate said hammer and drill bit in such contiguity thereto and to each other that the blow from the hammer is transmitted through the rod series to the drill bit, each rod of the series being of a length approximately equal to that of the drill-bit.

4. In a rock-drill of the hammer type, the combination of a drill-bit, a bar-hammer, and a series of separate rods alined with each other and with the hammer and drill-bit and intermediate said hammer and drill bit in such contiguity thereto and to each other that the blow from the hammer is transmitted through the rod series to the drill-bit, each rod of the series and the hammer being of a length approximately equal to that of the drill-bit.

5. In a rock-drill of the hammer type, and in combination with its hammer and

drill-bit, a series of separate rods alined with each other and with the hammer and drill-bit and intermediate said hammer and drill bit in such continguity thereto and to each other that the blow from the hammer is transmitted through the rod series to the drill bit, each rod of the series being of a length approximately equal to that of the drill-bit, and a guide-tube for said rods formed of sections releasably coupled.

6. In a rock-drill of the hammer type, the combination of a drill-bit, a bar-hammer, a series of separate rods alined with each other and with the hammer and drill-bit and intermediate said hammer and drill-bit in such contiguity thereto and to each other that the blow from the hammer is transmitted through the rod series to the drill-bit, each rod of the series and the hammer being of a length approximately equal to that of the drill-bit, and a guide-tube for said rods formed of sections releasably coupled.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

MOSES ARTHUR KNAPP.

Witnesses:

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