

B. H. COFFEY.
 SUBAQUEOUS ROCK BREAKER.
 APPLICATION FILED MAR. 3, 1909.

948,989.

Patented Feb. 15, 1910.

4 SHEETS—SHEET 1.

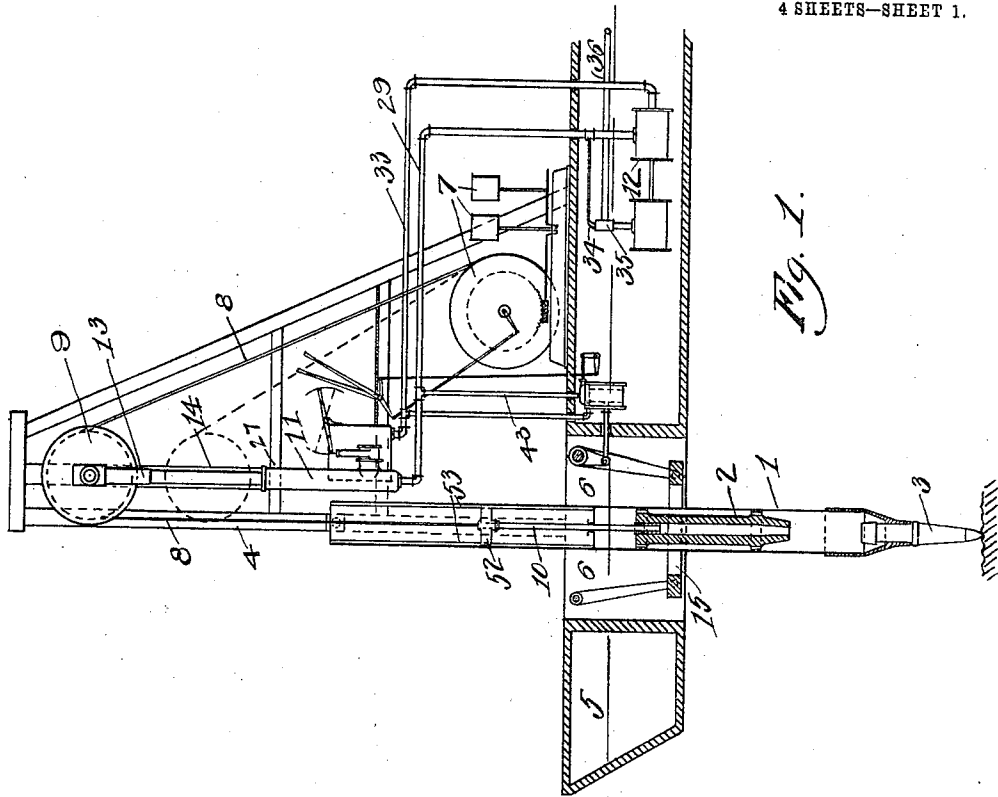


Fig. 1.

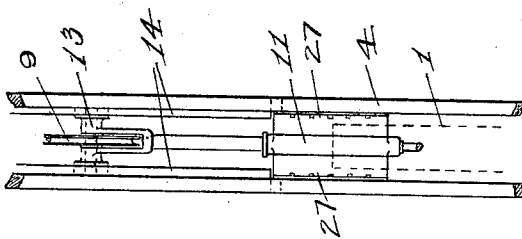


Fig. 2.

Witnesses
 A. Boulogne
 R. P. Aylsworth

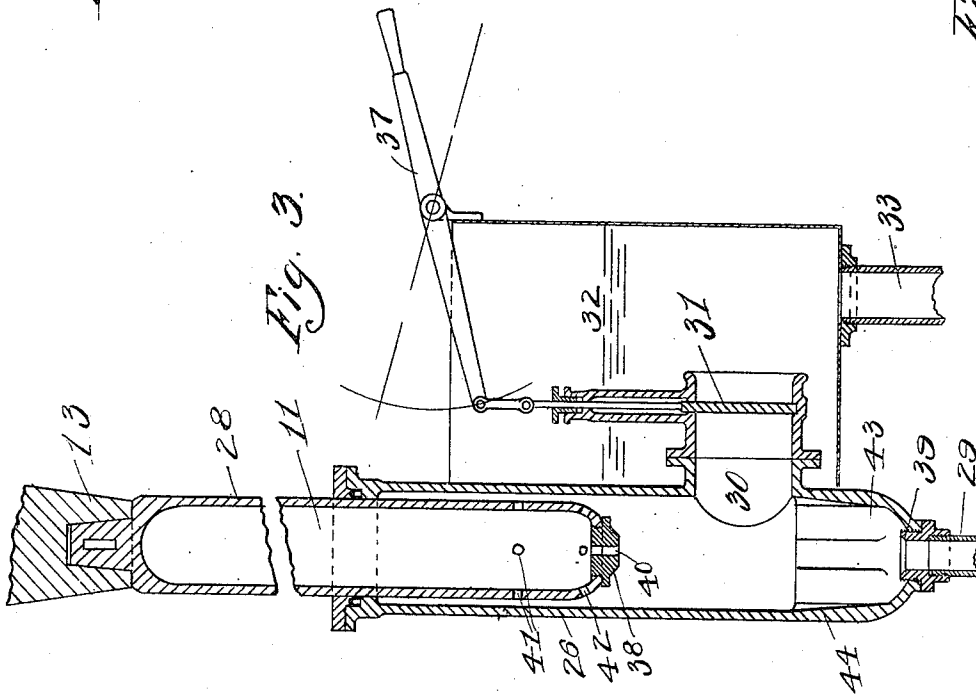
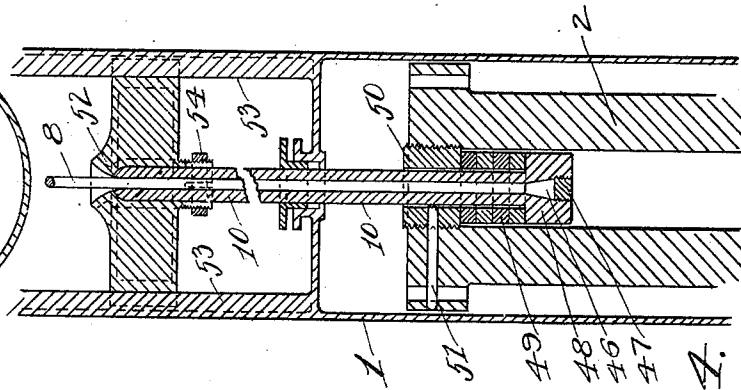
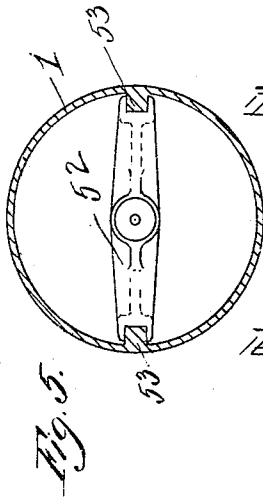
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4 SHEETS—SHEET 3.

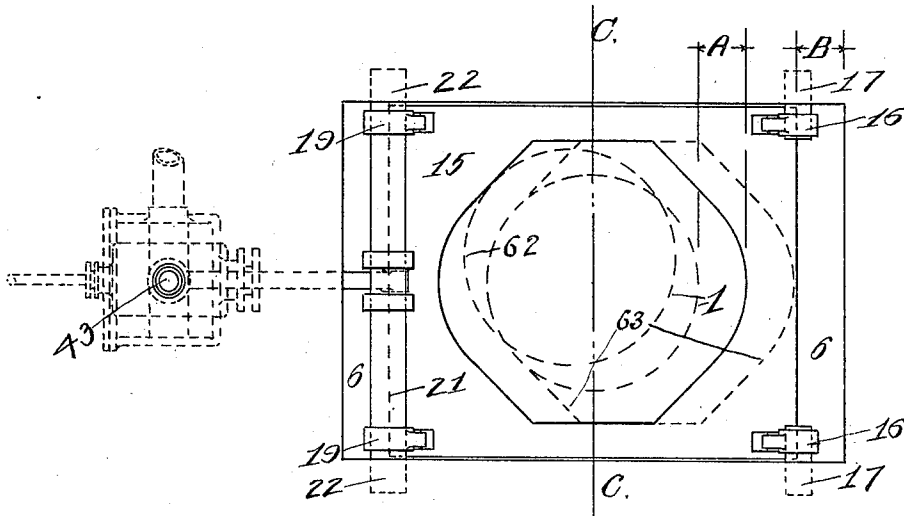


Fig. 6.

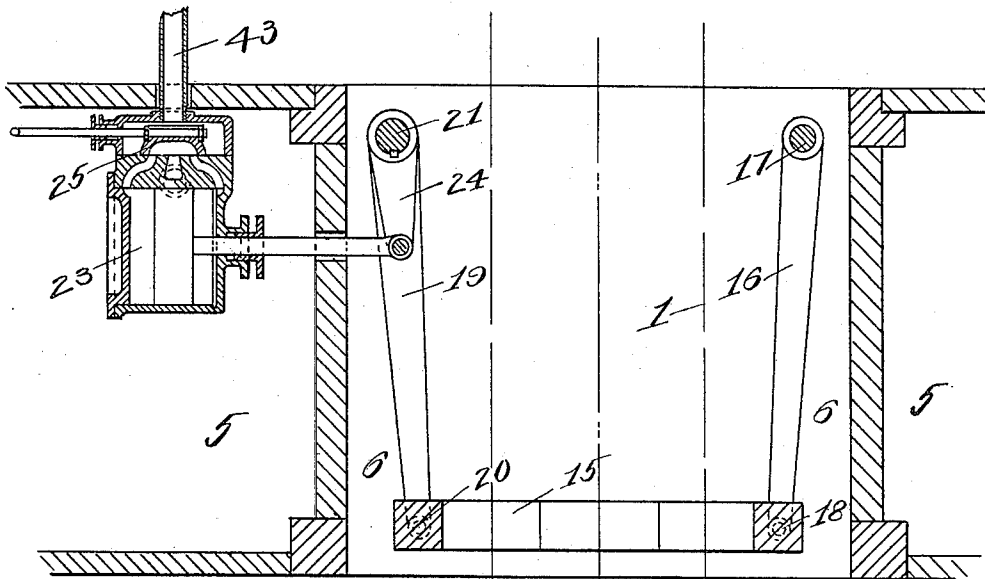


Fig. 7.

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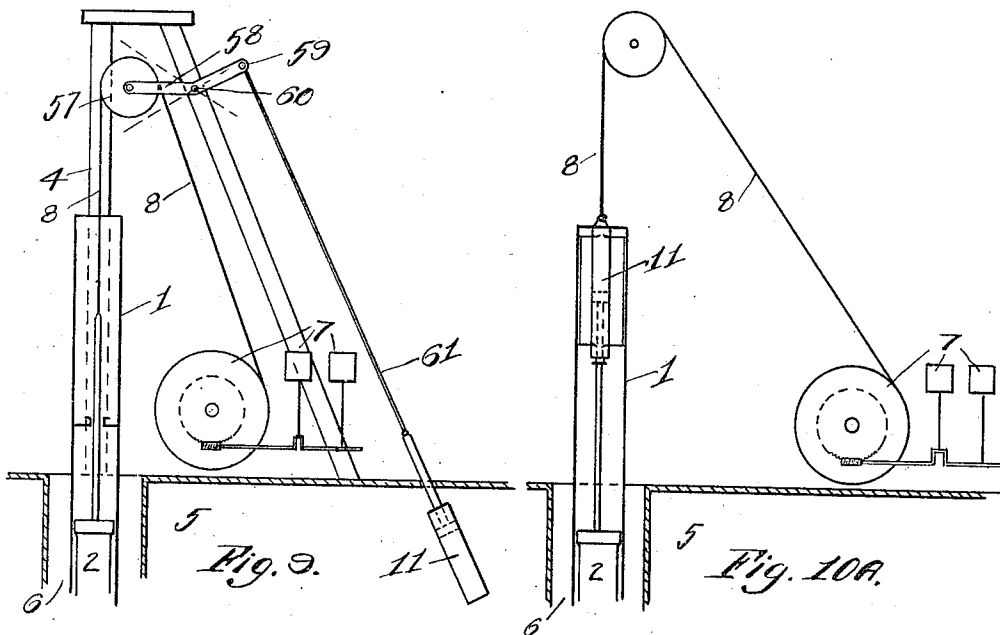
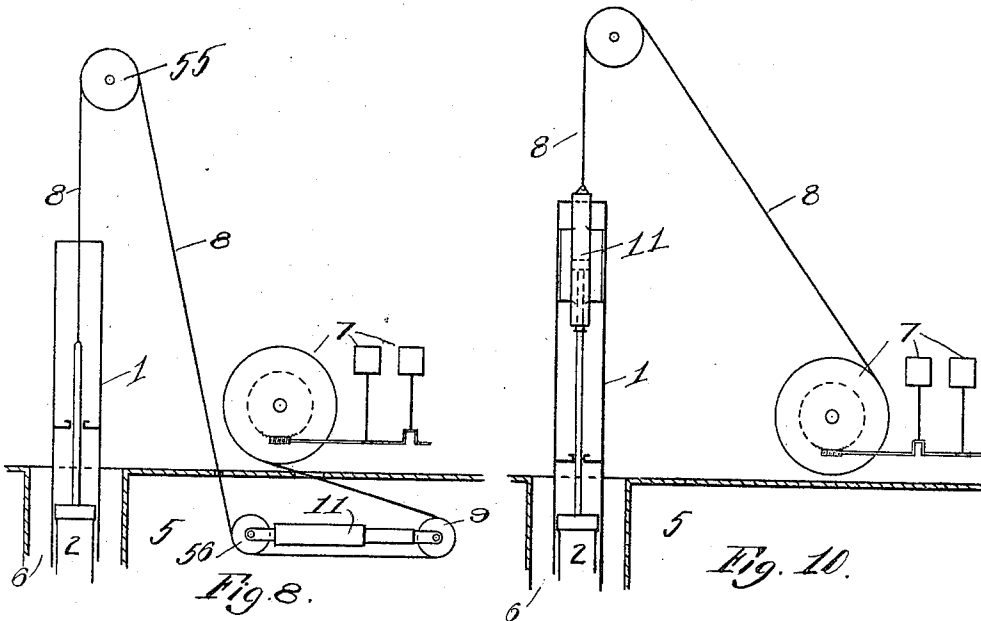
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4 SHEETS—SHEET 4.



Witnesses
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 R. P. Appleworth

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UNITED STATES PATENT OFFICE.

BARTON H. COFFEY, OF ELIZABETH, NEW JERSEY.

SUBAQUEOUS ROCK-BREAKER.

948,989.

Specification of Letters Patent.

Patented Feb. 15, 1910.

Application filed March 3, 1909. Serial No. 481,092.

To all whom it may concern:

Be it known that I, BARTON H. COFFEY, a citizen of the United States, and resident of Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Subaqueous Rock-Breakers, of which the following is a specification.

The object of my invention is to provide an improved form of apparatus for producing the vertical and horizontal movements of a rock-breaking chisel, with special reference to the pneumatic caisson type of subaqueous rock-breaker, forming the subject matter of my Patent #657515, dated September 11th, 1900; reissued June 26th, 1906, No. 12501, and of other applications pending.

My improvements are applicable to different forms of subaqueous rock-breakers, and though described in connection with the pneumatic type, are not to be considered as limited to such connection.

As all subaqueous rock-breakers depend upon the energy of a falling hammer or chisel, ranging from ten to fifteen tons in weight to break up the rock, and as it is quite obvious that the capacity of the machine depends largely upon the number of blows that can be delivered in unit time, it is evident that the character of the hoisting apparatus employed to raise these heavy weights, is of great importance in determining the general efficiency of the method. There are two systems of hoisting in general use, both employing the ordinary hoisting engine with wire cable drum. In the first case the drum is driven directly through rigid connections, the engine being provided with reversing gear. The cable is attached to a clutch which in turn engages the weight to be lifted. The weight is raised to the desired height by the clutch, which is then tripped, allowing the weight to drop. The clutch is lowered for another drop, by reversing the engine. In the second case the drum is driven through a friction clutch, and the cable is directly attached to the weight. When the weight has been hoisted to the proper point, the friction clutch is released and the weight drops, overhauling the drum. This system is used on pile drivers, and is very quick and effective when the weights employed are small, the ordi-

nary pile hammer weighing between 2,500 and 3,500 lbs. When the weights, however, rise to the proportions employed in subaqueous rock-breakers, the case is very different, the engines and parts become so very massive, that quick reciprocations are impossible, without introducing destructive inertia strains, and consequently the number of blows delivered rarely exceed four per minute. The first system described is not quite as quick as the second, but possesses the advantage of giving the weight a free drop; in the second system a portion of the energy of the falling weight is absorbed in overhauling the drum and cable.

In all subaqueous rock-breakers the hoisting may be divided into two stages, a short hoist during rock-breaking, when the weights are lifted between three and eight feet and speed is very important, and a long hoist when the rock-breaking apparatus must be lifted out of the water for inspection, repairs, moving, etc., involving lifts up to fifty feet, and in which as they occur infrequently, speed is not important.

My improvement consists in using hoisting apparatus for each of these two stages, especially adapted to the particular duty as described, and so connected as to perform their individual functions without conflict.

Other improvements consist of an apparatus for centering the tube or caisson of my rock-breaker, in line with the guide frame, upon starting a penetration; with means for withdrawing it from contact with the tube during the breaking process. This provision is very essential, to secure accurate spacing of penetrations, any irregularities in which produce an uneven bottom. As rock rarely, if ever, splits in a vertical plane, there is consequently a lateral movement of the chisel point and connected parts as the penetration proceeds, which movement cannot be constrained or opposed without introducing disastrous strains in the mechanical parts; it is therefore essential that the centering device should be so constructed that while able to initially place the chisel on the proper point, it should in no way constrain or hold it while the penetration is being effected. In general, my improvement seeks to control both the vertical and horizontal movements of the chisel, by an apparatus especially adapted to each par-

ticular motion, in order that every operation may be executed with increased efficiency.

Proceeding now to the drawings in which similar characters refer to similar parts:—

- 5 Figure 1, is a longitudinal sectional elevation of a barge partly broken away, upon which is mounted a pneumatic subaqueous rock-breaker, provided with my improved apparatus for producing the required vertical and horizontal motions. The boiler and other auxiliaries, which do not directly concern the novel improvements, are not shown. Fig. 2, is a partial end elevation of Fig. 1, showing the guiding frames for both the pneumatic tube and the hoisting sheave, the balance of the elevation being broken away. Fig. 3, is a detail longitudinal sectional elevation of the hoisting ram, controlling valve, exhaust tank, and pipe connections. Fig. 4, is a partial longitudinal sectional elevation of the hammer, lifting rod and crosshead, as fitted in the tube of a pneumatic caisson, the lower and upper part of the tube and the lower part of the hammer being broken away. Fig. 5, is a plan of the crosshead and guides, on Fig. 4. Fig. 6, is a plan of the adjusting frame for producing the horizontal movements of the tube and chisel, as fitted within the well of a rock-breaking barge. Fig. 7, is a longitudinal sectional elevation of Fig. 6. Figs. 8 and 9 are alternate methods of hoisting. Fig. 10, and 10^A is another alternate method of hoisting.
- 35 1, is a pneumatic rock-breaking tube containing a hammer 2 and rock-breaking chisel 3, and guided in the frame 4, mounted on the barge 5, the tube extending through the well 6, as familiar to those skilled in the art.
- 40 The primary hoisting mechanism consists of a friction drum hoisting engine 7, operating the hoisting cable 8, which passes over the sheave 9 and is secured to the lifting rod 10 of the hammer 2. Assuming the
- 45 sheave 9 in a fixed position, the hoisting engine will lift tube, hammer and chisel in the usual way, to any desired height within the limits of the frame. The drum of this engine is preferably driven by worm gearing,
- 50 actuated by two small fast running cylinders, thus saving weight and cost, and giving a powerful lifting effect, though at the expense of speed. The engine is so indicated.
- 55 The secondary hoisting mechanism for reciprocating the hammer during breaking, consists of a hydraulic ram 11, driven by a pump 12. Attached to the piston of the ram is the crosshead 13, guided at 14, and carrying the sheave 9. Obviously if the engine and drum 7 be held and the ram 11 extended, the free end of the hoisting cable 8 will be raised a distance equal to twice the movement of the ram. In other words, the rela-

tive movements of hoisting cable and ram are, two to one. We thus have two separate and distinct means of imparting motion to the hoisting cable and attached parts that do not conflict, whether used separately or conjointly.

70 The horizontal movements are effected by a frame 15, fitting the well 6 snugly athwartships, but with sufficient clearance for fore and aft movement. There is an opening through the center of the frame to receive the tube 1 of the rock-breaker, shaped to conform to the radius of the tube, but with sufficient clearance to avoid contact by a definite distance, when both tube and frame are central in the well; this is shown clearly at Fig. 6. In practice, the clearance A is made equal to clearance B. It is now obvious if the tube 1 becomes displaced laterally as shown in broken lines 62, Fig. 6, it can be again centralized by thrusting the frame 15 against it, the position of the frame being indicated by broken lines 63. The frame is held in position by the two idler links 16, journaled to the hull 5 at 17 and to the frame at 18, and by the two thrust links 19 journaled to the frame at 20 and keyed to the shaft 21, which in turn is journaled to the hull 5 at 22. It will now be obvious that rotation of the shaft 21 in either direction will cause a corresponding fore and aft movement of the frame 15. This rotation is effected by the double acting hydraulic cylinder 23 acting upon the crank 24, keyed to the shaft 21, as clearly shown at Fig. 7. The admission and exhaust of the hydraulic cylinder is controlled by the slide valve and ports 25, so proportioned that when the valve is in its central position, the cylinder is open to exhaust at both ends, as indicated. It will now be clear that a movement of the slide valve in either direction will cause a corresponding movement of the frame to centralize the tube, and that with the valve on its center, the frame will be free to follow the horizontal movements of the tube without opposing any resistance.

We may now take up the detail of the secondary hoisting mechanism and its connection with horizontal adjusting apparatus just described.

115 The cylinder 26 of the ram is firmly bolted to the frame-work at 27 as shown, the piston 28 is rigidly keyed to the crosshead 13, carrying the sheave 9. Liquid under pressure is admitted to the ram by the pipe 29, and the exhaust takes place at the outlet 30, controlled by the exhaust valve 31. The exhaust liquid enters the open tank 32, from which it flows by gravity to the pump suction via the pipe 33. In order to produce rapid reciprocations of the ram, it is necessary first that there should be as free an

exhaust as possible, and second, that destructive water hammering should be prevented in the pressure piping. It will be observed that the exhaust opening and valve 5 are made very large relatively to the bore of the ram cylinder, thus insuring minimum frictional resistance at exhaust, and as the discharge enters the open tank 32, there is no other resistance except the slight head 10 above the discharge pipe.

The avoidance of water-hammer in the supply pipe 29 is accomplished as follows:—The pump 12 is kept continually running supplying a constant flow of liquid to the ram, thus avoiding the sudden starting and stopping of the stream through the supply pipe 29, and eliminating water-hammer. With valve 31 closed, the ram will be obviously extended. Upon opening the valve, 20 the exhaust, consisting of the combined flow through pipe 29, and liquid equivalent to the ram displacement, will take place, and the ram will descend. The pressure in pipe 29 will be obviously reduced while 25 exhaust takes place, which would cause the pump 12 to run away but for the pressure regulating valve 35 in the steam supply pipe 36 of the pump, which regulates the steam pressure on the pump, in conformity 30 with the water pressure in pipe 29, this water pressure is transmitted to the regulator through the pipe 34. Thus the pump retains a constant speed and delivery, regardless of the pressure it is working 35 against, producing reciprocations of the ram of a rapidity depending upon the capacity of the pump and the speed with which the valve 31 is operated by the handle 37. Upon the completion of a penetration, the 40 valve 31 is left open, and the ram will descend until the conical valve 38 rests upon the seat 39, the engine 7 is then thrown in and the whole apparatus hoisted clear of the ledge in the usual way; under these 45 circumstances the downward pressure on the ram equals double the weight of the lifted parts, which pressure is transmitted to the valve and seat 38 and 39, thus throwing pressure on the pump. This pressure can 50 be made any constant amount by introducing a small waste opening 40 through the valve 38, the liquid passing to exhaust via holes 41. This constant pressure is employed to operate the centering frame 15, 55 by acting upon the hydraulic cylinder 23, in a manner already described. As the centering frame can only be operated while the chisel is clear of the ledge, the above arrangement fulfils all requirements. In 60 case the ram is extended beyond its proper stroke, the holes 41 pass the packing, and the liquid escapes via holes 42 and 41, thus reducing the pressure and stopping the ram. In the event of the ram descending below

the exhaust opening 30, the space 43 acts 65 as a dashpot to cushion and check its velocity, the taper grooves 44 serving to gradually shut off the escape of liquid, so bringing the ram to rest without shock.

A great advantage possessed by the hydraulic ram in producing the reciprocations consists in the fact that it is only necessary for it to fall at half the speed of the hammer, thus in spite of the friction of packing and exhaust, unless these resistances exceed 75 one-half the weight of the ram and sheave, the ram in falling will oppose no resistance whatever to the hammer.

The hoisting cable 8 passes through the hollow lifting rod 10, and is secured in the 80 conical recess 46, in the standard way, the plug 47 prevents any downward movement of the cable. The lifting rod has an enlarged end 48, bearing upon the rubber springs 49, in turn bearing upon the nut 50, 85 threaded into the top of the hammer 2. The nut is prevented from turning by the locking-pin 51, as clearly shown. Embracing the top of the lifting rod is the crosshead 52, secured thereon by the friction 90 nut and split recess 54 from lifting off, and by the bearing at top of rod from slipping down. The crosshead is guided at 53, as clearly shown. The advantages of this connection consists in giving an elastic grip 95 on hoisting the hammer 2, and in eliminating all impacts from the lifting rod, when the hammer comes suddenly to rest. The crosshead takes all side strains due to angularity of the hoisting rope with center 100 line of tube, from off the lifting rod and stuffing box, transferring them direct to the guides 53.

In operation the ram will be reciprocated as described, until the penetration is complete, then the tube, hammer and chisel are 105 together lifted from the reef, the centering frame moved against the tube, thus holding it in line with the guide frame. The hull is then moved to a fresh spot, the apparatus 110 lowered until again in contact with the reef, the slide valve of the double acting cylinder put at center, thus releasing the centering frame, and breaking operations resumed.

In Figs. 8 and 9, alternate arrangements 115 of hoisting gear employing similar principles, are shown diagrammatically, which will be clear in connection with the foregoing description. In Fig. 8, the ram 11 and sheave 9 are placed beneath the hoisting engine 7, 120 and two fixed sheaves 55 and 56 introduced. Inspection will show that this arrangement is a mechanical and kinematic equivalent of Fig. 1 plus the added complication of the additional sheaves. In Fig. 9, the cable 8 125 passes over a sheave 57 secured to a bent lever 58, fulcrumed to the frame 4 at 60. This lever is oscillated by the ram 11 through

the tension rod 61, and so reciprocates the hammer. The rod 61 might be secured to a revolving crank, thus oscillating the sheave 57 with a fixed amplitude.

- 5 In Fig. 10, the ram 11 is secured firmly to the shell of the caisson, so reciprocating the hammer directly, the engine 7 serving to lift the entire apparatus when desired.

In Fig. 10^A the ram 11 is secured also to the shell of the caisson, but placed in the working chamber, thus dispensing with a stuffing-box in the diaphragm. In the constructions of both Figs. 10 and 10^A, the cylinder might be made double-acting and similar to that employed on standard steam hammers, if air were employed as the operating agent, the exhaust could be turned into the working chamber to exclude the water. In Figs. 10 and 10^A, the ram 11 and the caisson 1 are themselves links in the chain of connected parts, through which the entire rock-breaking apparatus is lifted. Obviously these alternate combinations involve the underlying principle of Fig. 1.

- 25 The apparatus for producing the horizontal adjustments Figs. 6 and 7 may be modified in many ways familiar to those skilled in the art; for instance the frame 15 might move in guides, motion being produced by a direct acting ram; or it might be made in two parts divided at the line C—C and each half moved independently.

As it is obvious from the above there are many modifications of my invention apparent to those skilled in the art, without departing from the spirit of the underlying principles, I do not confine myself to the specific construction shown.

I claim as my invention:—

- 40 1. In a subaqueous rock-breaker, a lifting means consisting of continuous rigid and flexible elements connecting the rock-breaking apparatus and a primary hoisting means, such as a winding engine; in combination with a secondary hoisting means, such as a piston and cylinder, adapted to reciprocate the hammer or chisel through the said lifting means; for the purposes set forth.

2. In a subaqueous rock-breaker, a centering frame adapted to impart horizontal motion to the rock-breaking apparatus, and means to move the frame horizontally; for the purposes set forth.

3. In a subaqueous rock-breaker, a lifting means consisting of continuous rigid and flexible elements connecting the rock-breaking apparatus and a primary hoisting means, such as a winding engine; a secondary hoisting means, such as a piston and cylinder, adapted to reciprocate the hammer or chisel through said lifting means; in combination with a centering frame, adapted to impart horizontal motion to the rock-breaking apparatus, and means to move the

frame horizontally; for the purposes set forth.

4. In a subaqueous rock-breaker, a hoisting cable connected at one end to a rock-breaking hammer or chisel, and at the other end to a winding engine, and passing over appropriate lead sheaves; in combination with means to shift the axis of one sheave, whereby the cable may exert lifting power independently of the winding engine; for the purposes set forth.

5. In a subaqueous rock-breaker, a hoisting cable connected at one end to a rock-breaking hammer, and at the other end to a winding engine, and passing over a lead sheave; in combination with a fluid pressure single-acting ram, adapted to elevate or depress said sheave, whereby the cable may raise or lower the hammer independently of the winding engine, substantially as described.

6. In a subaqueous rock-breaker, a single acting hydraulic ram adapted to reciprocate a rock-breaking hammer, said ram operating with a constant flow of liquid by opening and closing an exhaust valve; in combination with a pressure pump governed for constant speed under fluctuating pressure; substantially as described and for the purposes set forth.

7. In a subaqueous rock-breaker, a centering frame embracing the rock-breaking apparatus and having an opening relatively larger than said apparatus, supported in a horizontal position by two idler links, journaled to the frame and to the rock-breaking barge, and by two thrust links journaled to the frame and rigidly secured to a rock-shaft in turn journaled to the barge; in combination with a double-acting fluid pressure cylinder for oscillating said shaft, and so imparting horizontal motion to said frame; substantially as described.

8. In a subaqueous rock-breaker, a centering frame of the character described; in combination with a double-acting fluid pressure cylinder, so controlled that both ends of the cylinder may be simultaneously open to exhaust; substantially as described and for the purposes set forth.

9. In a subaqueous rock-breaker, a rock-breaking hammer adapted to reciprocate, and a lifting means to produce the reciprocation; in combination with an elastic connection between the hammer and lifting means to reduce shock when lifting, and clearance between the lifting means and hammer to prevent transmitted shock when falling, for the purposes set forth.

10. In a subaqueous rock-breaker, a hydraulic ram comprising a cylinder having an opening in the lower end for the entry of liquid under pressure, a plunger shaped at its lower end to partly close said opening

when at the inner end of its stroke, and cause a rise of liquid pressure; in combination with a double-acting hydraulic cylinder adapted to be operated by said increased pressure; substantially as described and for the purposes set forth.

11. In a subaqueous rock-breaker, a cross-head as 52 secured to the lifting rod by a split shank and nut as 54, and adapted to engage guides as 53, whereby all cross strains are transmitted to said guides; substantially as described.

12. In a subaqueous rock-breaker, a hammer provided with a central cylindrical recess threaded at its upper end, a nut adapted to engage said thread and provided with a central circular opening, a locking pin engaging the hammer and nut to prevent relative movement, a hollow lifting rod of constant circular section passing through the nut and provided with an enlarged end adapted to engage a spring which in turn engages the nut, thus affording elastic means of raising the hammer by the lifting rod, and a cable passing through the hollow rod and secured thereto by expanding in a tapered recess at the lower end of the rod; substantially as described.

13. In a subaqueous rock-breaker, a hammer provided with a central cylindrical recess threaded at its upper end, adapted to reciprocate and lifting means to produce such reciprocation; in combination with a nut adapted to engage said thread and take the strain imposed by the said lifting means; for the purposes set forth.

14. In a subaqueous rock-breaker, a hollow lifting rod, terminating in a tapered recess; in combination with a hoisting cable passing through said rod and expanded into said tapered recess; substantially as described and for the purposes set forth.

15. In a subaqueous rock-breaker, a single acting hydraulic ram adapted to reciprocate a rock-breaking hammer, comprising relief openings for preventing over extension, and a dash pot or hydraulic buffer for preventing shock at the end of the in stroke; substantially as described and for the purposes set forth.

16. In a subaqueous rock-breaker, a rock-breaking apparatus comprising a water excluding tube, and a weight, a primary hoisting means such as a winding engine adapted to lift the rock-breaking apparatus; in combination with a secondary hoisting means consisting of a fluid pressure cylinder and piston adapted to effect the reciprocation of the weight.

17. In a subaqueous rock-breaker, a rock-breaking weight, a primary hoisting mechanism as a winding engine, and an operating connection between the weight and primary hoisting mechanism, combined with a sec-

ondary hoisting mechanism adapted to hoist said weight through said connection.

18. In a subaqueous rock-breaker, a rock-breaking weight, a primary hoisting mechanism as a winding engine, and an operating connection comprising flexible portions extending between the weight and primary hoisting mechanism; combined with a secondary hoisting mechanism adapted to hoist said weight by displacement of said flexible connection portions.

19. In a subaqueous rock-breaker, the combination of a rock-breaking weight, a flexible connection or cable connected therewith and extending to where it may be held from running, a sheave over which an intermediate portion of said connection passes, and means for shifting said sheave and thereby lifting said weight.

20. In a subaqueous rock-breaker, the combination of a rock-breaking weight, a hoisting cable connected therewith, then extending upward over a shiftable sheave and downward and to where it may be held from running; in combination with means for causing said sheave to rise and fall for lifting and dropping said weight.

21. In a subaqueous rock-breaker, the combination of a rock-breaking weight, a hoisting cable connected therewith, then extending upward over a shiftable sheave and downward and to where it may be held from running; in combination with a hydraulic ram operatively connected with said sheave for causing said sheave to rise and fall for lifting and dropping said weight.

22. In a subaqueous rock-breaker, the combination of a rock-breaking weight, a hoisting cable connected therewith, then extending upward over a shiftable sheave and downward and to where it may be held from running; in combination with a hydraulic ram having pumping apparatus and a controlling valve regulated by the operator for causing said sheave to rise and fall for lifting and dropping said weight.

23. In a subaqueous rock-breaker, the combination of rock-breaking means and a single acting hydraulic ram having connections for operating said means, the said ram operating with a constant flow by the regulation of a liquid escape valve; and means for producing a constant flow of liquid for said ram.

24. In a subaqueous rock-breaker, the combination of a vertically disposed rock-breaking apparatus, a float carrying the same, a centering frame embracing part of said apparatus, and means for moving said frame horizontally to impart horizontal movement to said apparatus.

25. In a subaqueous rock-breaker, the combination of a vertically disposed rock-breaking apparatus, a float carrying the same, a

centering frame embracing part of said apparatus and having an opening substantially larger than the same, a series of swinging links supporting said frame, and power operated means for swinging one or more of
5 said links to move said frame.

Signed at New York city in the county of

New York and State of New York this second day of March A. D. 1909.

BARTON H. COFFEY.

Witnesses:

W. A. TOWNER, Jr.,

ELIZABETH B. KING.