Oct. 21, 1952 C. H. CARLISLE 2,614,804

APPARATUS FOR DRILLING UNDER WATER

Filed Jan. 29, 1949 2 SHEETS—SHEET 1

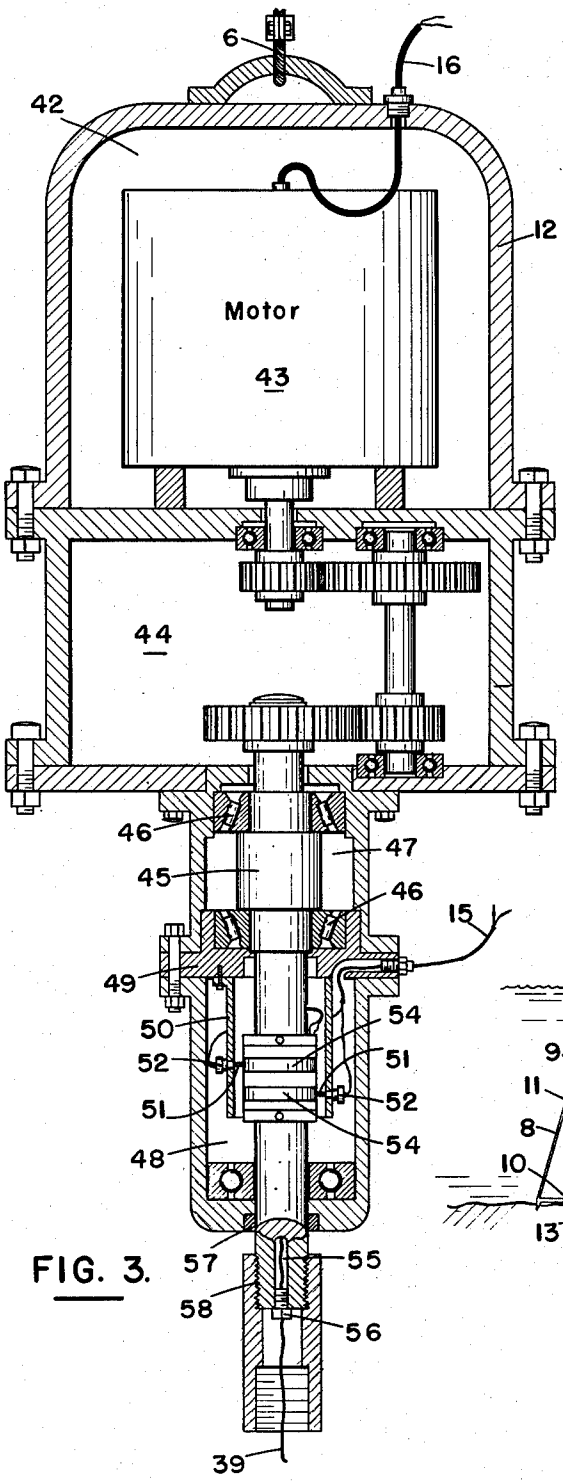

FIG. 3.

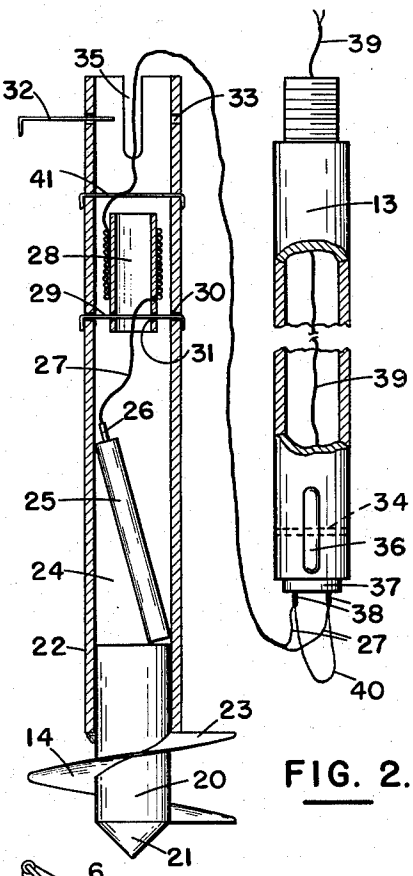

FIG. 2.

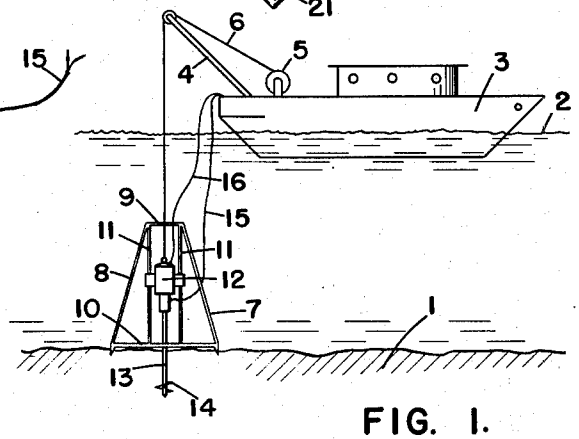

FIG. 1.

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FIG. 4.

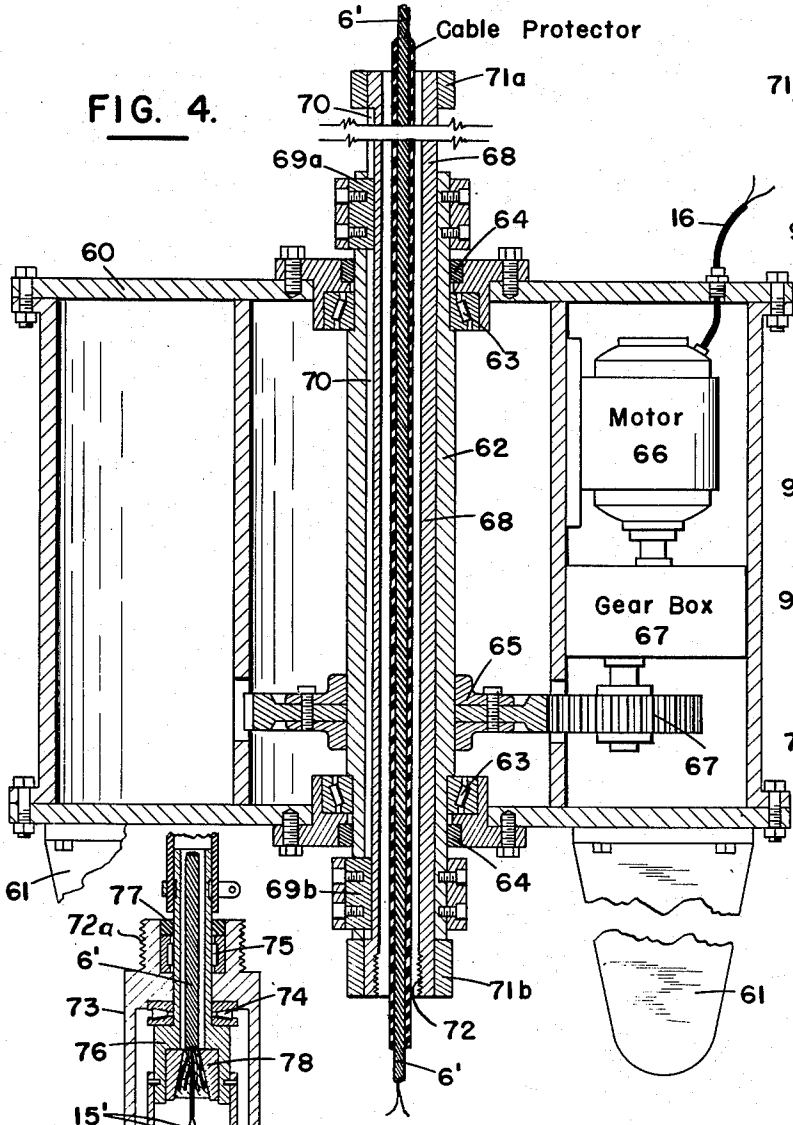

FIG. 5.

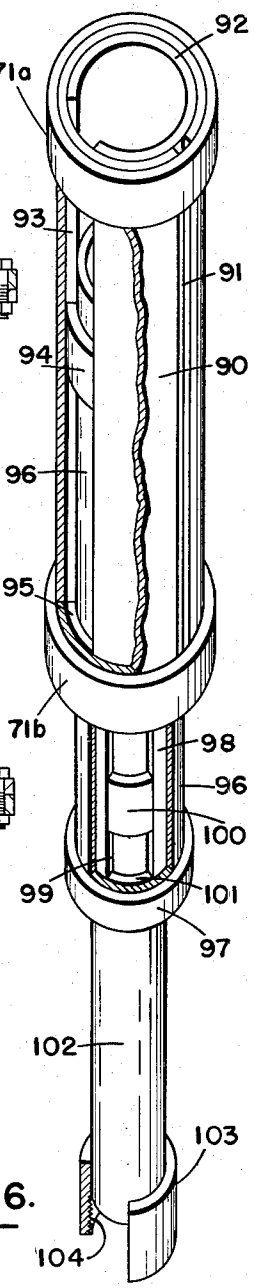

FIG. 6.

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UNITED STATES PATENT OFFICE

2,614,804

APPARATUS FOR DRILLING UNDER WATER

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Application January 29, 1949, Serial No. 73,507

4 Claims. (Cl. 255—4.8)

1

The present invention is directed to apparatus for drilling in the earth. More particularly, the invention is directed to apparatus and a method useful in seismic prospecting and for placing charges of explosive in the earth beneath a body of water.

In conventional seismic prospecting on dry land it is common practice to drill a shot hole of desired depth in the earth, to place a suitable charge of dynamite or similar explosive in the shot hole, and to fire the charge of explosive in order to create an artificial seismic disturbance from which useful measurements may be made. The problems involved in drilling and loading the shoe hole are relatively simple and have been solved by employing either a hand operated or a power driven rotary bit to produce the shot hole. Except in sandy regions where the shot hole may tend to cave in if it is not cased, there is generally no difficulty in loading the explosive into the hole, it being usually sufficient to lower the charge into the hole or to push it downward through mud remaining in the hole by means of a pole or similar device.

However, when seismic prospecting is conducted over water covered areas, and particularly over areas submerged to a depth in excess of about ten or twenty feet beneath the surface of the water, the problems involved in placing shots or charges of explosive are greatly increased. The expense of building a stable platform from which a shot hole may be drilled is prohibitive especially when a large number of shot holes must be drilled. Accordingly, efforts have been made to drill shot holes from a floating barge or boat which could be readily moved from one location to another. These efforts have not been entirely successful since wave action upon the body of water interferes with the drilling operation. Furthermore, after a shot hole has been drilled under water, it is often difficult to find the hole and place the charge of explosive therein. I have now devised a simple and novel apparatus for solving the above problems which may be utilized to advantage not only in deep water, that is, in water exceeding about ten feet in depth, but also in relatively shallow water or in marshy areas.

In accordance with my invention, I provide a boat, barge or other suitable vehicle having a hoisting mechanism such as a winch and derrick boom carrying a hoisting cable. At the free extremity of the hoisting cable, I provide a housing which is adapted to stand on or adjacent the floor of the body of water, either fully or partly submerged depending upon the depth of the water. The housing is flexibly connected to the hoisting means and is arranged to be held against rotation with respect to the floor of the body of water.

2

Carried by the housing is a suitable motor and a torque transmission means mechanically coupled to a drill stem adapted to be rotated thereby. In one embodiment of the apparatus of my invention, the housing is slidably mounted in a supporting frame so that the housing may move substantially vertically with respect to the floor of the body of water but will not rotate with respect thereto. Thus the drill stem, which may be journaled in the housing, may be caused to rotate and advance downwardly into the earth. Upon the lower end of the drill stem and separably connected thereto, I provide a bit which is preferably of such construction that it will pull itself into the earth when rotated in a desired direction. The bit contains an internal cavity in which may be placed a suitable charge of explosive, a detonator for the explosive, and a coiled "cap line" which may be readily uncoiled and connected to conventional means for firing and detonator and explosive. The separable connection between the bit and the drill stem is so constructed and arranged that the bit may be rotated into the earth by the drill stem and the latter may then be separated from the bit leaving the bit and explosive buried in the earth while retrieving the free end of the cap line.

The apparatus and method of my invention may be better understood from the following description, read in conjunction with the accompanying drawing in which:

Fig. 1 is a schematic elevation view, partly in section, showing the general arrangement of components of my apparatus when drilling or placing a charge of explosive in the earth beneath a body of water;

Fig. 2 is a longitudinal section view of a preferred bit and a part of a drill stem in accordance with my invention;

Fig. 3 is an elevation view, partly in section, of a housing, motor, and gear case adapted to be used in the practice of my invention;

Fig. 4 is an elevation view, partly in section, of a second embodiment of a housing, motor, and gear case adapted to be used in accordance with my invention;

Fig. 5 is an elevation view, partly in section, of a swivel adapted to be used with the embodiment of Fig. 4; and

Fig. 6 is a pictorial view with parts cut away showing a preferred drill stem which may be used with the embodiment shown in Fig. 4.

In Fig. 1 of the drawing, the numeral 1 designates earth structure defining the floor or bottom of a body of water having an upper surface 2. Floating upon the surface of the water is a boat or barge 3 which preferably may be self-propelled. Mounted in any suitable and convenient manner on boat 3 is a hoisting means which may include a hoisting boom 4, a winch 5, and a hoisting cable

6. The cable 6 is at least of sufficient length to reach to the bottom of the water when arranged for raising and lowering into the water a frame member, designated generally by the numeral 7. In the drawing, frame member 7 is illustrated as having legs 8 and top and bottom braces 9 and 10, respectively. It is to be understood, however, that frame 7 may be of any desired and suitable construction so long as the requirements of portability, reasonable strength and rigidity, and ability to hold firmly against rotation on the floor of the body of water are met. Mounted rigidly in frame 7 and substantially perpendicular to the base thereof are a plurality of track or guide members 11 adapted to guide a housing 12 for vertical motion without permitting rotary motion thereof with respect to floor 1.

Guide members 11 are provided, adjacent their upper and lower extremities, with suitable stops to prevent vertical movement of housing 12 above or below the confines of frame 7. Hoisting cable 6 is preferably attached directly to housing 12 rather than to frame 7 so that the former may be pulled upward within the latter. The aforementioned stops should, accordingly, be sufficiently strong so that hoisting of housing 12 against the upper stops will also permit hoisting of frame 7. It will be apparent, however, that separate hoisting means may be provided for frame 7, or the hoisting cable may be attached to frame 7 and the stops upon the lower ends of guide members 11 may be employed to prevent pulling housing 12 out of frame 7.

As will be described more fully with respect to Figure 3, housing 12 carries a suitable motor, preferably power transmission gears, and bearings in which are journaled a drill stem 13. At the lower end of drill stem 13 is a bit, referred to generally by the numeral 14. As will be more fully explained in connection with Figure 2, bit 14 may contain a charge of explosive, a detonator, and a cap line which may be connected to conventional means (not shown), arranged on boat 3, for firing the detonator and explosive. In a preferred embodiment of my invention, the aforementioned cap line is preferably connected through conductors within drill stem 13 and slip rings in housing 12 to an external cap line 15 which may be reeled aboard the boat 3 by conventional means, not shown.

The motor within housing 12 may be of any suitable type such as a compressed gas driven turbine, an hydraulic motor, an electric motor or the like. Because of its compactness, I prefer to employ a direct current electric motor. In any case, the motor may be supplied with energy through a power conduit 16 which may be reeled aboard boat 3 and may be connected to a source of power mounted thereon.

Turning now to Figure 2, the bit, designated generally by the numeral 14, is preferably so constructed and arranged that, by rotation thereof in a particular direction about its longitudinal axis while in contact with the earth, it will be drawn or forced downward therein. In a preferred form, bit 14 may be made up of a solid, cylindrical nose member 20 having a conical tip 21 and a tubular body member 22 welded or otherwise rigidly affixed thereto. Around nose member 20 are one or more helical fins 23 arranged somewhat in the form of a screw thread adapted to pull bit 14 into the earth when it is rotated. Tubular body member 22 defines a cavity 24 in which may be placed a suitable charge of explosive 25, such as dynamite, and a conventional blasting cap or detonator 26 for the explosive. Connected to blasting cap 26 in conventional manner is a pair of insulated conductors 27 constituting at least a part of a cap line which may be connected to conventional electrical means controllable from boat 3 for firing the detonator and explosive. Conductors 27 are preferably of suitable length to extend from beneath the floor 1 to above the surface 2 of the body of water. The length of the conductors 27 may conveniently be coiled on a spool or bobbin 28 which is placed within cavity 24 after loading explosive 25 and detonator 26 therein. Conductors 27 are wound upon bobbin 28 in a manner such that the ends thereof which are connected to detonator 26 are innermost on the bobbin and the free ends, adapted to be taken aboard boat 3, are outermost and capable of uncoiling freely when a gentle pull is applied in an upward direction, generally along the longitudinal axis of bit 14. After insertion of bobbin 28 within cavity 24, it is preferably fastened for retention therein as by inserting a wire pin or similar means 29 through openings 30 in diametrically opposite sides of body member 22 and through openings 31 provided in the lower end of bobbin 28. It will be seen that means 29 retains not only bobbin 28 but also explosive charge 25 and detonator 26 within cavity 24.

As mentioned hereinbefore, my invention contemplates rotating bit 14 into the earth and there separating the bit from drill stem 13. To accomplish this objective, bit 14 may be screw-threadedly engaged in suitable manner upon the lower end of drill stem 13. However, to insure trouble-free separation of the bit from the drill stem and to reduce the cost of construction, I prefer to make the lower end of drill stem 13 have a sliding fit into the upper end of tubular bit body 22. So that bit 14 will remain on drill stem 13 when the apparatus is lowered into the water, a suitable shear pin or similar means 32 may be inserted through openings 33 in diametrically opposite walls of member 22 and through corresponding openings 34 in the lower end walls of drill stem 13. A plurality of slots or key ways 35 are provided in the upper walls of member 22 and these slots are arranged to mate with corresponding keys or dog members 36 affixed upon the lower exterior walls of drill stem 13. It will be seen that slots 35, dog members 36, and shear pin 32 form a longitudinally slidable, keyed tool joint which cooperates on the lower end of the drill stem and upper end of the bit to hold the bit affixed to the drill stem when these elements are rotated and moved into the earth and also permits separation of the bit from the drill stem when the latter is pulled from the earth leaving the bit in the earth.

As will be seen from Fig. 2 of the drawing, drill stem 13 may be a tubular element. The extreme lower end of the tubular element may be closed with a tightly fitting plug 37 made of electrical insulating material retained rigidly in place by any suitable means. Passing through plug 37 substantially parallel with the axis of the drill stem are two or more electrical terminals 38. Within drill stem 13, terminals 38 are permanently connected to a pair of insulated leads 39 running up through the drill stem to slip-rings which will be described in connection with Figure 3. The protruding outer ends of terminals 38 are connected to cap line 27. As a safety precaution, terminals 38 may be short-circuited with a short loop of wire 40 which normally hangs

downward into cavity 24 of bit 14. A pin 41 may be passed through diametrically opposite holes in the walls of tubular body 22 and through the safety loop 40. Thus, when the bit is driven into the earth and the drill stem pulled out of the bit, loop 40 will be automatically broken, thereby breaking the safety shunt.

Referring now to Fig. 3, the housing, designated generally by the numeral 12, may provide a water-tight compartment 42 for the motor 43 which, for purposes of description, will be assumed to be an electric motor. If the motor 43 is, in itself, water proof or adapted to operate when submerged in water, compartment 42 need not necessarily be water tight. Power conduit 16, for supplying power to motor 43, may be brought through the walls of compartment 42 by any suitable water-tight bushing.

Below compartment 42 is a second compartment 44 containing gears or other torque transmission means for transmitting the rotary motion of the motor drive shaft to a shaft 45 journaled in bearings 46 arranged in a compartment 47. Since housing 12 is adapted to be submerged beneath a body of water, it will be apparent that compartments 44 and 47 should preferably be made water tight to exclude access of water to the gears and bearings housed therein.

Arranged below compartment 47 is another water-tight compartment 48 in which are arranged suitable brushes cooperating with slip rings mounted upon shaft 45 for rotatably bringing out electrical connections from cap line conductors 39 to cap line 15. As will be seen from Fig. 3 of the drawing, the upper wall of compartment 48 may be defined by a flange member 49 which may support one of the bearings 46. Attached to, and depending from, flange 49 is a cylindrical member 50 in which a plurality of contact brushes 51 are mounted in insulating bushings 52. The insulated conductors of cap line 15 may be brought into compartment 48 through a suitable water-tight joint arranged either in flange 49 or in the walls of housing 12, as desired, and are electrically connected to brushes 51. Secured to shaft 45 within chamber 48 is an insulated support member to which are affixed slip rings 54 which make electrical contact with brushes 51. A passage provided in the lower end of shaft 45 permits the insulated conductors of cap line 39 to be brought into compartment 48 and be electrically connected to slip rings 54. The entrance to passage 55 at the lower end of shaft 45 is preferably made water tight, as by means of a suitable bushing 56, after cap line 39 has been introduced therein.

As will be seen from Figure 3, shaft 45 extends through the lower wall of housing 12 through a water-tight gland 57. Drill stem 13 may be affixed rigidly to shaft 45 by screw threads 58 or by other suitable means.

From the description of Figures 1, 2 and 3 it may be seen that, when it is desired to place a charge of explosive in the earth beneath a body of water in accordance with my invention a charge of explosive 25, a detonator 26, and a coiled cap line 27 are loaded into bit 14. Cap line 27 is then electrically connected to terminals 38, together with shunt 40, if used, and bit 14 is slid onto the end of drill stem 13 and is fastened in place with shear pin 32. Frame 7 together with housing 12, drill stem 13 and bit 14 may then be lowered by means of hoisting cable 6 until the frame rests upon the earth beneath the water in a selected location. Since drill

stem 13 is of a chosen length such that bit 14 will protrude only slightly through the bottom of frame 7 when housing 12 is moved upward against the upper stops on guide rails 11, it will be seen that bit 14 rests against the surface of the earth and is pressed downward slightly by the weight of housing 12 and its contents when tension on cable 6 is slackened. Motor 43 within housing 12 may next be set in operation by supplying power through conduit 16, and drill stem 13 and bit 14 are thereby caused to rotate. By allowing tension on cable 6 to remain slack, bit 13 may be drawn into the earth until housing 12 reaches the lower stops on guide rails 11. At this time, motor 43 must be stopped, either manually or by automatic means not shown in the drawing. A strong upward pull applied to cable 6 will then cause shear pin 32 to break and effect separation of drill stem 13 from bit 14. Continued upward pull on cable 6 will raise housing 12 within frame 7 and will ultimately raise the frame off the bottom. As drill stem 13 is pulled away from the bit, cap line 27 will uncoil from bobbin 28, thereby providing continuous electrical connection from detonator 26 to means above the surface of the water so that the explosive charge may be fired after the boat 3 and frame 7 have been moved to a safe distance from the shot hole.

Since the depth of the shot hole produced by the apparatus heretofore described in conjunction with Figures 1, 2 and 3 will be limited by the length of drill stem 13 which, in turn, may be limited by the height of frame 7, it may be desirable under some conditions to employ an embodiment of apparatus such as is shown in Figs. 4, 5, and 6.

In the embodiment of Fig. 4, the numeral 60 designates generally a housing adapted to be submerged under water and be placed upon or adjacent the floor of the body of water. Accordingly, housing 60 is preferably water tight to exclude access of water to components arranged therein. As distinguished from the housing 12 described in the embodiment of Figures 1 and 3, housing 60 is preferably arranged to be placed directly upon the bottom of the body of water without support of the frame 7 of Figure 1. Housing 60 is preferably provided on the external bottom thereof with a plurality of rigid leg members 61 of a length sufficient to hold the housing slightly above the bottom of the body of water and permit the bit to contact said bottom. Leg members 61 are, desirably, in the form of vertically disposed fins adapted to hold housing 60 against rotation with respect to the bottom of the body of water.

Extending vertically through, and preferably coaxially within, housing 60 is a tubular shaft 62. Shaft 62 is journaled for rotation about its axis in housing 60 by means of bearings 63, and water may be excluded from entry into housing 60 along the shaft by suitable packing glands 64. Keyed, or otherwise suitably affixed, externally to shaft 62 within housing 60 is a bull gear 65. One or more motors 66, which may be of the types described with respect to Fig. 3 are rigidly mounted upon suitable supports within housing 60 and are mechanically connected for rotation of bull gear 65 and shaft 62 through gear train or other torque transmission means 67.

An elongated tubular drill stem, designated generally by the numeral 68, passes coaxially through the tubular bore of shaft 62, and is keyed or otherwise held against rotation with respect

thereto, as by keys 69a and 69b affixed to shaft 62, operating in key-way 70 in drill stem 68. While drill stem 68 may not rotate with respect to shaft 62, it is axially slidable with respect thereto by virtue of key-way 70 extending substantially throughout the length of drill stem 68. It will be understood that although drill stem 68 has been assumed to be circular in cross-section and to be keyed to shaft 62, drill stem 68 may be non-circular in cross-section and the inner bore of shaft 62 may be of similar cross section to permit the drill stem to slide axially but not to rotate therein. So that drill stem 68 will not move out of shaft 62, the former may be provided with stop members 71a and 71b affixed, respectively, at the upper and lower end thereof.

Affixed to the lower end of drill stem 68, as by screw threads 72 and 72a, or other suitable means, is a swivel joint (see Figure 5) the outer body of which is designated by the numeral 73. Arranged coaxially within body 73 and supported by thrust bearing 74 and needle bearing 75 is a hollow swivel member 76. Packing gland 77 in the upper end of body 73 permits swivel member 76 to rotate within body 73 without permitting water to enter therein.

Passing concentrically through drill stem 68 and swivel member 76 and clamped to the latter by clamping means 78 is a steel sheathed hoisting cable 6' containing insulated cap line conductors 15'. Below clamping means 78 and secured to swivel member 76 is an insulated cylindrical member 79, carrying slip rings 80 to which conductors 15' are electrically connected. Concentrically arranged around member 79 is a member 81, secured to body 73, carrying insulated brushes 82 which cooperate with slip rings 80.

As will be seen from the showing in Figure 5, the lower end of swivel body 73 is preferably constructed similar to the lower end of drill stem 13 illustrated in Fig. 2 so that it is adapted to receive bit 14. Thus, the lower end of swivel body 73 may be provided with dogs 35 and with passage 34 adapted to receive shear pin 32. It may also be provided with insulated plug 37 having electrical terminals 38. Conductors 39 electrically connect terminals 38 to brushes 82. It will be understood that the entire swivel assembly, including the point of entry of cable 6' therein is preferably made waterproof by any suitable means to prevent entry of water into the swivel bearings and slip rings. Since details of suitable water proofing means will be apparent to a skilled mechanic, they are not fully described herein.

From the foregoing description, it may be observed that the operation of the embodiment of Figs. 4 and 5 is slightly different from, but basically similar to, the operation of the embodiment described in connection with Figs. 1, 2 and 3. Thus, referring in part to Figs. 1 and 2 and in part to Figs. 4 and 5, the housing 60 may be lowered from boat 3 on cable 6', extending through drill stem 68, until housing 60 or leg members 61 rest upon the bottom of the body of water and explosive laden bit 14 is in contact with said bottom. Tension on cable 6' is suitably slackened and motor 66 is placed in operation causing bull gear 65, shaft 62, drill stem 68 and bit 14 on the end thereof to rotate. Bit 14 is thereby moved downward into the earth and drill stem 68 slides axially downward in shaft 62 until upper stop 71a contacts shaft 62, whereupon further rotation of the drill stem will tend to cause bit 14 to pull off of the drill stem. Operation of motor 66 may then be stopped manually or by automatic means (not shown) and drill stem 68 may be pulled out of bit 14 by operation of hoisting means 5. Continued operation of the hoisting means will not only separate the drill stem from the bit but also will permit the raising of housing 60 off of the bottom of the water as described in conjunction with Fig. 1. Boat 3 and housing 60 may then be moved to a safe distance from the shot hole, whereupon the explosive may be fired by an electric current passed through conductors 15', 39, and 27.

The embodiment of apparatus shown in Figs. 4 and 5 has advantages over that shown in Figs. 1–3 in that it is less bulky and the depth of shot hole is not limited to a convenient size of supporting frame. Nevertheless, the depth of placement of the explosive charge which may be placed with the embodiment of apparatus shown in Figs. 4 and 5 is limited by the length of drill stem 68 which may be conveniently employed. Accordingly, it may be preferred to replace the single length of drill stem 68 by a telescopic drill stem such as is shown in Fig. 6 so that charges of explosive may be placed at greater depths.

In Fig. 6, the numeral 90 designates an outer tubular member adapted to replace tubular member 68 shown in Fig. 4. Arranged longitudinally throughout the length of member 90 is a key-way 91 adapted to receive the keys 69a and 69b shown in Fig. 4. Similar to the embodiment shown in Fig. 4, member 90 is provided with stops 71a and 71b which may be in the form of narrow collars affixed circumferentially around member 90 at the extremities thereof. Affixed concentrically within member 90, as by spot welding at numerous points, and extending throughout its length is a second tubular member 92. Tubular member 92 is slotted longitudinally throughout the greater part of its length to provide an internal key-way or channel 93 adapted to receive a key or spline 94. The lower end of key-way 93 is blocked by a stop 95 adapted to prevent key 94 from passing downward and out of channel 93.

Key 94 is secured to a third tubular member 96 adjacent the upper end thereof and member 96 is adapted to slide telescopically within member 92. Secured circumferentially around the lower extremity of member 96 is a collar 97 forming a stop to prevent member 96 from passing upwardly out of member 92. Secured concentrically within member 96, as by spot welding, is a fourth tubular member 98 which, similar to member 92, is slotted longitudinally throughout the greater part of its length to provide a second internal key-way or channel 99 adapted to receive key or spline 100. Channel 99 is blocked at its lower end by a stop 101, which may be a part of member 98, adapted to prevent key 100 from passing downward out of channel 99.

Key 100 is secured adjacent the upper end of a fifth tubular member 102 which is adapted to slide telescopically within member 98. Affixed externally over the lower end of member 102 is a collar 103 which serves as a stop to prevent member 102 from sliding upward out of member 98. Collar 103 may be provided with screw threads 104 or other suitable means comparable to the means 72, described in connection with Fig. 4, adapted to affix swivel body 73 to tubular member 102.

From the foregoing description it will be apparent that the device of Figure 6 provides a drill stem comprising a plurality of tubular members telescoped one within another in a manner such that each succeeding internal member is axially slidable within, but not rotatable with respect to the next succeeding external member. Although the device of Fig. 6 has been described in accordance with a convenient manner of fabricating it, it will be understood that pairs of tubular members **90—92**, and **96—98** may each be single tubular members provided with suitable splines and grooves adapted to provide axial slidability with respect to one another. It will also be understood that, although three members have been described as capable of being telescoped one within another, a greater or less number may be so arranged. The lengths of members **90**, **96**, and **102** may be chosen according to convenience in handling the assembled drill stem and according to the desired depth of drill hole.

As in the embodiment of Fig. 4, the hoisting cable **6'** is passed axially through the elements **90**, **96** and **102** of Fig. 6 and is attached to swivel member **76**. Thus, when the telescopic drill stem is employed, rotation thereof, with bit **14** arranged on the lower end of swivel **73** and the latter affixed upon the lower end of the drill stem, causes the bit to advance downward into the earth and this, in turn, causes successive sections of the drill stem to be extended. Keys **94** and **100** contact stops **95** and **101**, respectively, and upper stop **71***a* contacts shaft **62** at the extreme extension of the drill stem. Further rotation of the drill stem and bit tends to cause the latter to pull off. When rotation of the drill stem is stopped and an upward pull is applied to cable **6'**, the swivel body is pulled away from the bit, and the drill stem is caused to telescope until stops **103** and **97** contact the lower ends of members **96** and **90**, respectively, and lower stop **71***b* contacts the lower end of shaft **62** whereupon housing **60** and its contents are raised above the earth.

While my invention has been described with particular reference to means for placing charges of explosive in shot holes particularly for seismic prospecting purposes, it is apparent that the invention is also applicable to the placement of charges beneath the surface of a body of water for other purposes.

Having fully described the apparatus of my invention and a preferred mode of operating it, what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for placing a charge of explosive in the earth beneath a body of water comprising a bit member defining a cavity therein closed at its lower end and adapted to retain a charge of explosive, a drill stem adapted to advance said bit member into the earth, and means including a longitudinally slidable joint cooperating on adjacent ends of the bit member and drill stem adapted to release the former from the latter during withdrawal of the drill stem from the earth.

2. Apparatus for placing a charge of explosive in the earth beneath a body of water comprising a rotary bit defining a cavity therein closed at its lower end and adapted to retain a charge of explosive, means secured around the exterior of said bit for fastening the latter into the earth by rotation thereof, a drill stem adapted to rotate said bit, and means including a longitudinally keyed joint cooperating on adjacent ends of the bit and drill stem for releasing the former from the latter during withdrawal of the drill stem from the earth.

3. Apparatus for placing a charge of explosive in the earth beneath a body of water comprising, in combination, a bit defining a cavity therein closed at its lower end and adapted to retain a charge of explosive and a detonator, means secured around the exterior of said bit for pulling the latter into the earth by rotation thereof, a drill stem capable of rotating said bit in the earth, means including a longitudinally slidable keyed joint cooperating on the lower end of said drill stem and upper end of said bit constructed and arranged to hold said bit affixed to said drill stem when the bit and drill stem are rotated and moved into the earth and to effect separation of the bit from the drill stem when the latter is pulled from the earth, driving means above and connected to said drill stem for rotating the latter, and means for pulling said drill stem from the earth.

4. Apparatus for placing a charge of explosive in the earth in seismic exploration under water covered areas comprising, in combination, a bit defining a cavity therein adapted to retain a charge of explosive and a detonator for said explosive, a helical blade secured around the exterior of said bit for drawing the latter into the earth by rotation of the bit, a tubular drill stem having a longitudinal passage therethrough, insulated electrical terminals affixed in the lower end of said drill stem, insulated conductors passing through said longitudinal passage and electrically connecting said terminals to means adapted to fire said detonator, a tool joint including longitudinally keyed means cooperating on the lower end of said drill stem and the upper end of said bit adapted to affix the bit rigidly to the drill stem while the bit and drill stem are rotated and moved into the earth and to effect separation of the bit from the drill stem as the latter is pulled from the earth, a pair of insulated conductors electrically connected to said detonator and to said insulated terminals, said pair of conductors being coiled within said cavity in a manner to permit uncoiling when the drill stem is separated from the bit, rotating means above, and mechanically coupled to, said drill stem, and means for pulling said drill stem from the earth.

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