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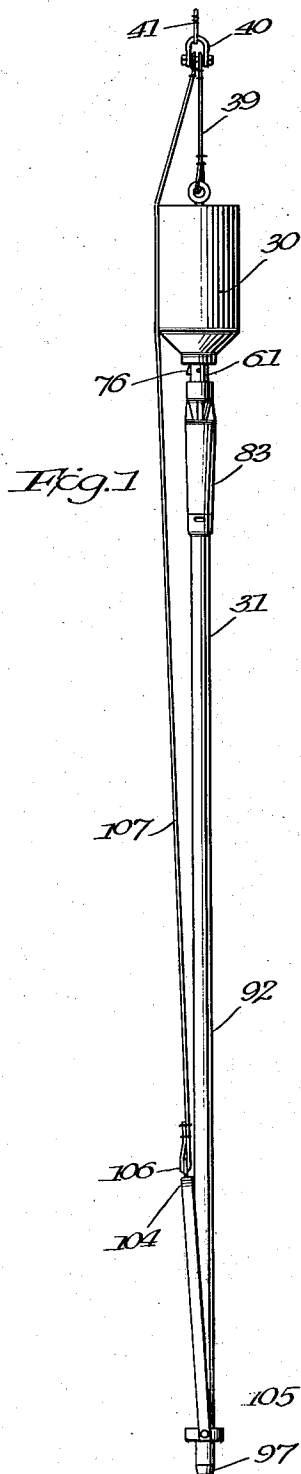
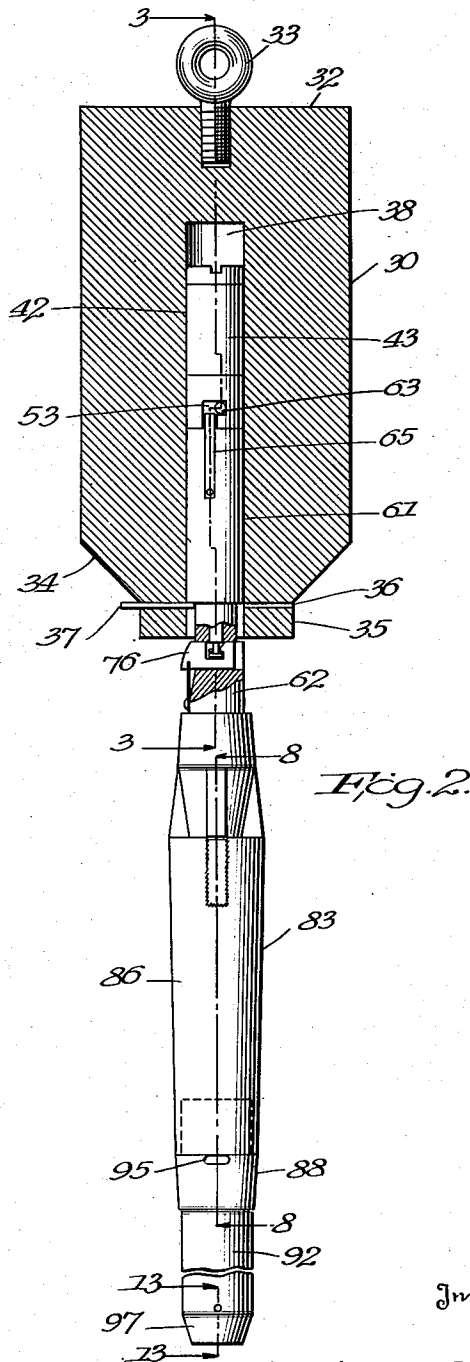
C. S. PIGGOT

2,227,198

CORE-TAKING APPARATUS AND METHOD OF EXPOSING CORES

Filed Dec. 6, 1937

4 Sheets-Sheet 1



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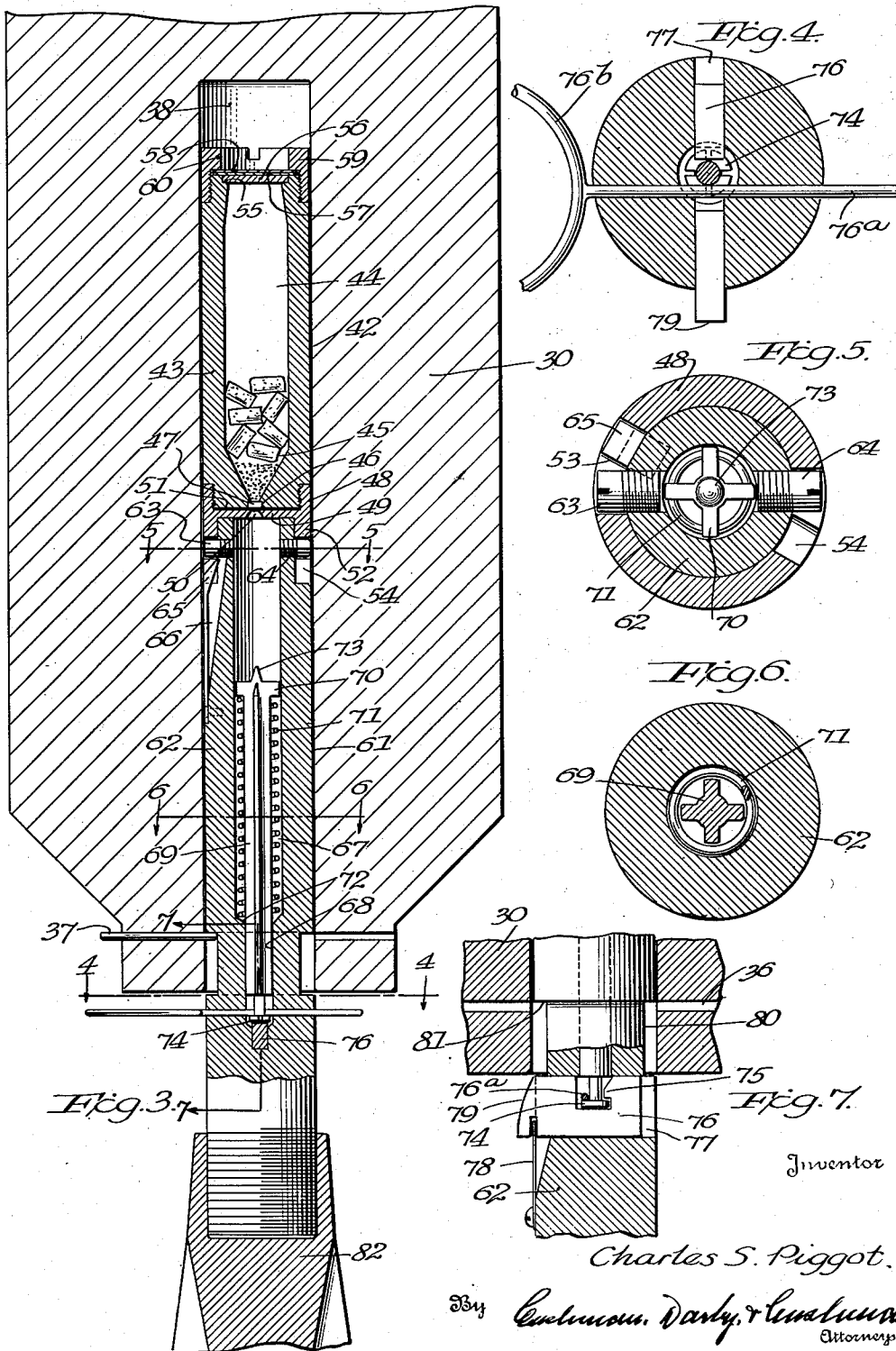
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CORE-TAKING APPARATUS AND METHOD OF EXPOSING CORES

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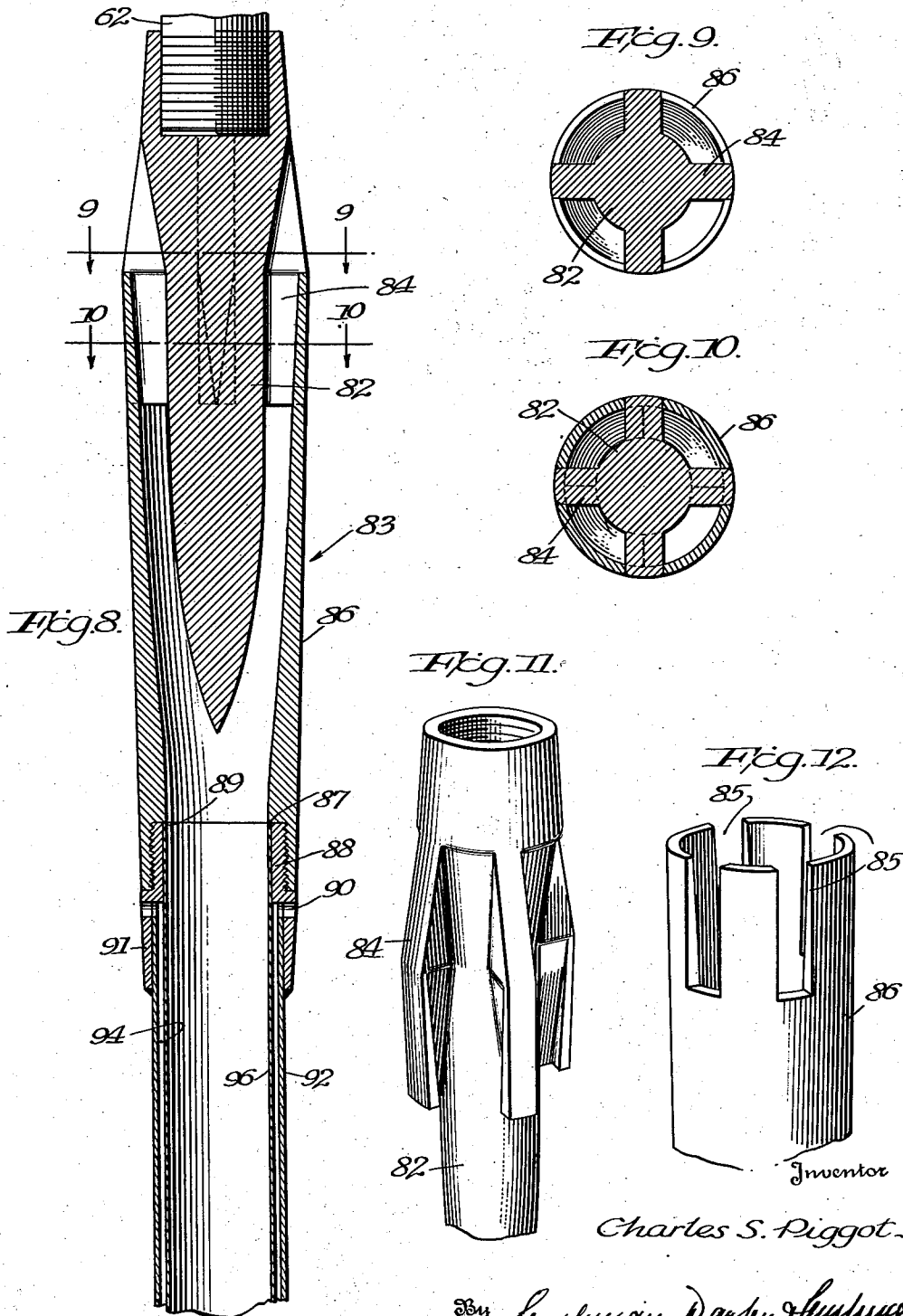
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CORE-TAKING APPARATUS AND METHOD OF EXPOSING CORES

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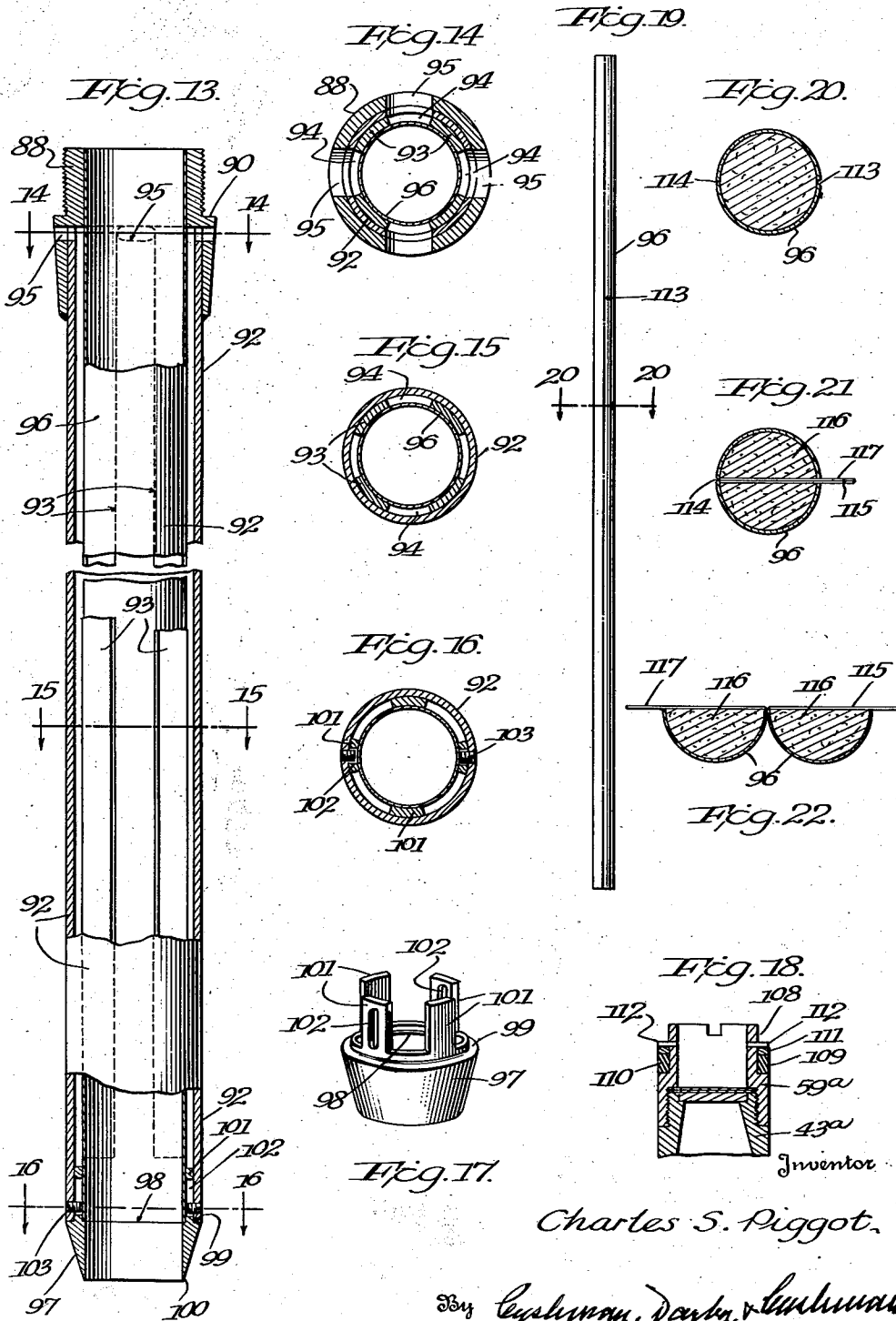
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CORE-TAKING APPARATUS AND METHOD OF EXPOSING CORES

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UNITED STATES PATENT OFFICE

2,227,198

CORE-TAKING APPARATUS AND METHOD
OF EXPOSING CORES

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31 Claims. (Cl. 255—1)

This invention relates to apparatus for taking core samples of geological materials or formations and to a method for exposing the samples without materially disturbing their condition.

5 An object of the invention is to provide such an apparatus of rugged and simple construction, particularly adapted to take samples from the ocean bottom, though not limited to this use.

10 The apparatus includes a core-taking projectile and means for projecting and retrieving the same. As projecting means, I preferably provide a gun charged with ordinary military powder, together with means for automatically deflagrating the charge when the gun and projectile
15 have been lowered to a suitable position relative to the formation to be sampled.

The projectile includes a tubular core-taking bit provided with a readily removable liner in which the core is preserved. An important fea-
20 ture of the invention is a fluid exit member which permits free escape of fluid from the projected bit, while also designed to transmit projective force to the bit on lines symmetrical to the bit axis. Also included in the projectile, in its pre-
25 ferred form, are a reusable cartridge and a firing device, these two elements, the water exit member, and the bit, being preferably separable from one another, but adapted to be readily assembled to form a rigid projectile unit.

30 Since the various novel features of the invention may be most clearly explained with reference to an illustrative embodiment, I shall proceed with reference to the embodiment shown by way of example in the accompanying draw-
35 ings, this particular embodiment being contemplated as destined for use in taking samples of submerged materials or formations.

In the drawings:

40 Figure 1 is an elevation of the apparatus shown as suspended preparatory to lowering.

Figure 2 is an enlarged view showing the gun in axial section and the projectile largely in elevation, although partly broken away.

45 Figure 3 is a section substantially on line 3—3 of Figure 2.

Figure 4 is a section substantially on line 4—4 of Figure 3.

Figure 5 is a section substantially on line 5—5 of Figure 3.

50 Figure 6 is a section substantially on line 6—6 of Figure 3.

Figure 7 is a section substantially on line 7—7 of Figure 3.

55 Figure 8 is a section substantially on line 8—8 of Figure 2.

Figure 9 is a section substantially on line 9—9 of Figure 8.

Figure 10 is a section substantially on line 10—10 of Figure 8.

Figures 11 and 12 show portions of the water 5 exit members, prior to their assembly, in perspective.

Figure 13 shows the bit in axial section and portions of the liner in elevation.

Figure 14 is a section substantially on line 10 14—14 of Figure 13.

Figure 15 is a section substantially on line 15—15 of Figure 13.

Figure 16 is a section substantially on line 16—16 of Figure 13. 15

Figure 17 shows a tip portion of the bit in perspective.

Figure 18 is a partial axial section of a modified form of cartridge.

Figure 19 is an elevation of a core liner, as- 20 sumed to contain a core, shown as being longitudinally scored in an initial step of the core exposing operation.

Figure 20 is a section substantially on line 25 20—20 of Figure 19.

Figure 21 a section similar to that of Figure 20, but showing a further step in the core exposing operation, and

Figure 22 is a section of the core and liner and illustrates a final step in the core exposing opera- 30 tion.

Referring to the drawings, reference numeral 30 designates the gun and reference numeral 31 designates generally the core-taking projectile. The gun is constituted by a cylinder of cold rolled steel and, as an example, is twenty inches in length and ten inches in diameter, so as to be of considerable weight. A gun of the dimensions just given will weigh in the neighborhood of 400 pounds. The rear or upper end 32 of the gun is 40 preferably flat or dished and has threaded therein a coaxial eye-bolt 33. The forward or lower end of the gun is conically reduced at 34 to a cylindrical portion 35 which is provided with four equi-distantly spaced radial bores 36, any one of 45 which is adapted to receive and frictionally retain a shear pin 37 adapted to project into the axial bore 38 of the gun. In using the terms "upper" and "lower" in describing the gun, and as these terms will be used hereinafter in describing the other parts, it will be understood that reference is had merely as a matter of convenience to the parts in the suspended position shown.

The eye-bolt 33 has secured thereto one end of a length of cable 39, whose other end is secured 55

to a ring or clevis 40 at the end of the usual sounding line 41, whereby the apparatus may be lowered and lifted. It is desirable to retrieve the gun under most circumstances, but if it is desired
5 to leave it on the bottom, a self-releasing hook may be utilized as a connection between the gun and the cable 39.

Reference numeral 42 designates generally a cartridge which comprises a cylindrical body portion 43 having a fairly close sliding fit in the bore
10 38. The cartridge body 43 (Fig. 3) has an axial cavity 44 which downwardly is tapered at 45 to a recess 46 of a size to receive snugly a primer 47 which may be a 30-30 rifle primer. The primer
15 seats on an annular shoulder and its recess 46 communicates with the cavity 44. The primer is flush with the lower face of the body 43.

The reduced lower end of the body 43 is threaded to receive a lower cylindrical cap piece 48
20 which has a transverse wall 49 provided with a central conical opening 50, and clamped between wall 49 and the end wall of body portion 43 is a relatively thin metal disc 51. In order to insure a tight seal, the lower face of body 43 may
25 be provided with fine annular ribs adapted to sink into the disc 51. The diameter of the upper smaller end of opening 50 is smaller than the diameter of recess 46, so that its margins overlie the rim of primer 47 to hold the latter securely
30 against ejection from the cavity.

The cap piece 48 has a lower cylindrical skirt portion 52 provided with diametrically opposite bayonet slots 53 and 54, for a purpose to be
hereinafter described.

The walls of cavity 44 are upwardly inwardly approached to an annular shoulder 55 on which
35 rests a pressure disc 56 which is adapted to withstand any hydrostatic pressure to which the apparatus may be subjected, the top of the disc being flush with the top of the body 43. Overlying disc 56 is a copper disc 57 of sufficient diameter to overlie also the top reduced and threaded
40 end of body 43. Superposed on disc 57 is a rupture disc 58 and both of these discs are clamped against body 43 by means of an upper cylindrical cap piece 59 which has a cylindrical opening 60 whose diameter is at least slightly greater than the diameter of the pressure disc 56.

The cavity 44 of cartridge 42 is designed to
50 receive an explosive charge and the latter consists desirably of a small quantity each of high speed black powder and of rifle powder and a varying number of pellets of 155 mm. howitzer powder. The small powder is provided for the
55 double roll of promoting ignition and quickly building up a pressure, in which environment the large grained powder will function explosively. The latter would not burn properly if this high pressure were not provided. The total available energy is regulated by counting into the cartridge, the cap piece 59 and discs 56, 57, 58 being removed, a varying number of pellets of the big powder. The required energy is of three
60 parts, (1) that which is necessary to overcome the hydrostatic pressure at a particular depth, (2) that which is necessary to overcome the inertia of the projectile and to put it into motion, and (3) that required to drive the bit into the particular material encountered. Only the second
65 can be determined in advance and the other two must be provided for at each sounding.

The possible work that can be done is a combination of the total available energy and an intensity factor, i. e., the pressure at which the
70 explosive gases are released. The control of this

working pressure is accomplished by the rupture disc 58, preferably of mild steel, at the mouth of the cartridge. Up to the time this disc is blown out, the powder is protected from the liquid. This disc is relatively thin and, therefore, capable of distortion and at a certain depth the hydrostatic pressure might conceivably be greater than the desired working pressure. Hence, the loose fitting hard steel pressure disc
5 56 which backs the rupture disc, relieving the latter of all strain due to external pressure, enables it to be adjusted to the existing requirement as determined by the stiffness of the particular formation to be sampled. By virtue of this arrangement, particularly as involving the use of the large grain powder, there is obtained a more or less automatic adjustment of the delivered power to the required work. For example, if thirty pellets of big powder are put into a cartridge and it is sent to 1000 fathoms and encounters a stiff clay, the added pressure and resistance (even after the rupture disc breaks, but before the gun is clear) will cause the powder to burn more rapidly and all of it will be converted into gas, whereas, if a projectile under the same charge encountered a very soft bottom at a shallow depth, only that powder would be consumed which had burned up to the time the muzzle was clear, and this would occur sooner than in the former case. An optimum load, therefore, is one which leaves a grain or two of partly burned powder in the cartridge.

Reference numeral 61 designates a firing device which includes a cylindrical housing 62 of the same diameter as the cartridge 42. The upper end of housing 62 is reduced to provide a cylindrical portion snugly receivable in the skirt portion 52 of cap piece 48 and is provided with diametrically opposite screwed-in studs 63 and 64 which are receivable in the bayonet slots 53 and 54. Set in the external surface of the body 62 is a longitudinally extending spring finger 65 having a nose which, in normal position, engages in one of the bayonet slots to prevent accidental unlatching of the parts. However, to release the parts it is only necessary to depress the finger 65 in the underlying slot 66, so that the parts may be relatively turned. The body 62 is provided with a downwardly extending axial bore portion 67 which is continued into a restricted bore portion 68. The firing pin 69 is of such cross-section so as to be slidably received in bore portion 68 and is of cruciform shape with ribs outwardly enlarged as at 70 to give a sliding guided fit with bore portion 67. A strong compression spring 71 is interposed between the enlargements 70 and the shoulder 72 which exists between the bore portions and tends to project the firing pin upwardly.

The pin has at its upper extremity a conical tip or point 73 adapted to enter the opening 50 and to fire the primer 47 through the disc 51. The deformability of the disc, the possible amount of projection of tip 73 through opening 50, and the strength of spring 71 are so related that the disc will merely be deformed and not ruptured upon operative engagement by the firing pin. In firing the primer the blunt tip forms a dome-like protuberance in the disc which aids in supporting the primer in its position against the high pressure of the explosion. Also, disc 51 is strong enough to prevent distortion of the primer by the hydrostatic pressure of the liquid.

The firing pin terminates downwardly in an axially grooved head 74 which is engageable,

when cocked, beneath a projection 75 of a trigger 76 in the form of a block slidable in a keyway 77 formed in the body 62 and intersecting the axis of the latter at right angles. The normal position of the trigger 76, in which it is yieldingly held by a flat spring 78, is shown in Figure 7 and in this position its cam-shaped end 79, opposite projection 75, extends outwardly of body 62. The latter, above the trigger, has a reduced portion 80 providing a shoulder 81 and in the normal assembled relation of the parts, this shoulder engages the inner end of the shear pin 37 so that the projectile is releasably held in a relation to the gun wherein the trigger 76 is just below the lower end of the gun. A safety pin 76a having an end loop 76b may be passed through aligned bores in body 62 above head 74 so as to hold the firing pin in retracted relation independently of the trigger.

The solid lower end of body 62 is threaded in a socket formed in an extension of a cone 82 which constitutes a part of the water exit member 83. The cone is streamlined to its point and has integrally formed therewith, and symmetrically disposed relative to its axis, a number of ribs 84, four being here shown. The ribs 84 merge upwardly into the socket portion of the cone and their lower outer portions are flushly received in slots 85 of an upwardly enlarging shell 86 and are welded therein. The shell is provided with a passage of circular section which enlarges upwardly from its minimum diameter at 87 and the cone 82 is coaxially disposed in this passage in spaced relation to the walls thereof. Upwardly, the passage is divided into a plurality of passages between ribs 84 which form connecting webs securely joining the parts 82 and 86, these passages being upwardly open. Between the two parts the ribs or webs 84 are tapered downwardly to radial edges. The proportions of the parts are such that the cross-sectional flow area in any plane above zone 87 is at least as great as the area at the said zone, and preferably at the upper part of shell 86 the available volume increases slightly. The vertical contours of cone 82 and the inner wall of shell 86 are suitable irregular curves.

Threaded in a lower socket in shell 86 is a tubular head or fitting 88 whose internal diameter is somewhat greater than the internal diameter of shell 86 at point 87 so that an annular overhanging shoulder 89 is provided. The head 88 also has an external shoulder which abuts the lower end of shell 86. The lower portion 91 of the head has an enlarged diameter and snugly receives the upper end of a steel tube 92 which constitutes the bit casing. The parts 88 and 92 are united by welding.

Secured to the inner walls of the tube 92 are four equi-distantly spaced strips 93 of arcuate cross-section extending nearly to the lower end of the tube and defining between them four channels 94. Just below shoulder 90 the portion 91 of fitting 88 and the underlying portions of the tube are provided with equi-distantly spaced radial openings 95 which communicate with the channels 94. Frictionally engaged by the lands constituted by the strips 93 in a thin walled metal tube 96 whose upper end abuts the shoulder 89 and whose inner diameter is the same as the inner diameter of the shell passage at the plane 87. In a preferred form of construction the lands 93 are formed directly on the inner walls of tube 92 by providing the latter with four longitudinally extending grooves.

An annular fitting 97 has an inner diameter which is the same as the inner diameter of tube 96 and has an annular shoulder 98 on which the lower end of tube 96 is adapted to seat. The fitting has an outer annular shoulder 99 adapted to be abutted by the lower end of tube 92 and below the shoulder the fitting is tapered to an edge 100. Extending upwardly from the fitting are four equi-distantly spaced projections 101, these being of substantially the same section as the lands 93 and may be aligned with the latter, the lands terminating short enough of the end of the tube so as not to interfere with the said projections. Two of the extensions 101 are provided with longitudinally extending slots 102 in which are engaged the inner ends of screw studs 103 passed radially through the lower end of tube 92. These pin and slot connections are of an extent to enable the fitting 97 to move downwardly a certain distance from the position shown in Figure 13 so as to open the lower ends of channels 94, these channels being closed inwardly by the tube 96 when the latter is in position.

With the projectile assembled and associated with the gun, as shown in Figure 1, and ready for use, the gun and projectile are lowered by paying out the sounding cable 41 until the lower end of the bit encounters the formation to be tested, the safety pin 76a being first removed, as by pulling on a lanyard tied to the loop 76b. The bit will ordinarily sink a short distance into the formation due to the weight of the apparatus, but will eventually be arrested. While the cartridge and firing device housings have a close sliding fit in the bore 38 of the gun, nevertheless as the apparatus is lowered water enters and fills the bore above the cartridge so that pressures on the projectile are equalized. When the projectile is arrested and cable 41 is slackened as by continued lowering thereof, the weight of the gun 30 will cause the latter to slide downwardly relative to the projectile, forcing the water from the bore. The longitudinal extent of the reduced portion 80 of the firing pin housing 62 is sufficient to permit the gun to move downwardly until the muzzle end of the gun strikes the cam surface 79 of trigger 76 thereby forcing the trigger inwardly and releasing the previously cocked firing pin 69. Although the firing pin housing 62 is filled with water, the shape of the firing pin is such that it may be rapidly advanced by spring 71 to fire the primer 46 and thereby cause deflagration of the charge. When the pressure reaches a certain limit as determined by the rupture disc 58, the latter and disc 57 are ruptured by the upwardly expelled disc 56 and the projectile is shot from the gun, shearing the pin 37. The reaction of the explosion is largely counteracted by the gun due to its great weight and it may be also counteracted to some extent by the fact that the extensive upper surface 32 of the gun offers great resistance to the movement of the gun upwardly through the liquid.

When the projectile is fired there is, of course, a column of water in the tube or liner 96 and if the bit could not move readily relative to this, no core could be taken. However, due to the provision of the water exit member 83 the water column escapes readily between webs 84 which are designed to offer the least possible resistance. During rapid movement through the water there is partial vacuum or cavitation at the upper end of shell 86 so that back pressure is removed from the column of water inside the bit and an almost

open tube condition exists. The propelling force is transmitted symmetrically to the bit through the webs 84.

As the bit is driven into the formation the cutting end portion 97 occupies the relation shown in Figure 13 so that no mud can enter the channels 94.

It is, of course, necessary that means be provided for retrieving the bit and while a separate cable or a slack cable length in connection with the sounding cable 41 might be used, the inertia of such members would inevitably have a misdirecting effect on the projectile when the latter was shot. To avoid this I provide the retrieving devices shown in Figure 1.

The improved retrieving devices comprise essentially a retrievable loop or ring through which the projectile may be shot the necessary distance. In Figure 1 I show a stirrup comprising a yoke 104 having pivoted between the open ends of its arms a ring 105 of greater internal diameter than the external diameter of the bit, but of less diameter than the maximum diameter of shell 86 of the water exhaust member. The cross portion 25 of the yoke has an eye-bolt 106 fixed therein and a cable 107 has one end secured to the latter and the other to the clevis 40. The length of the cable and yoke together is such that with the parts suspended as in Figure 1, ring 105 is very near the lower end of the bit. The bit is shot through the ring without being influenced by the latter and when cable 41 is wound in, the ring will eventually engage the shell 86 so that the bit will be withdrawn and retrieved with the rest of the apparatus.

As the bit is lifted upwardly the fitting 97 remains stationary until screws 103 about the tops of slots 102. During this time water has entered ports 95 and descended through channels 94 to relieve the vacuum which would otherwise exist at the bit extremity and might cause the bit to be drawn away from the core. By providing means to let the water in at the bottom of the core the latter is readily withdrawn. The shoulder 98 of fitting 97 prevents the liner 96 from being pulled out of the tube 92 as the latter is lifted.

As above mentioned, water enters the bore of the gun during the lowering operation and must be expelled before the gun can be fired. The expelling operation may take some time in view of the fact that the cartridge has a snug fit within the bore in order to take full advantage of the force of the explosion. The cartridge shown in Figure 18, however, is designed to have a somewhat looser fit in the bore. It comprises a body 43a and a cap member 59a, the latter being upwardly reduced at 108 to provide a shoulder 109 against which rests a ring 110 of relatively soft rubber, the ring having an outer diameter slightly less than the maximum diameter of the cap member 59a. Freely mounted on the reduced portion above the rubber ring is a metal washer 111 which is held against loss by pins 112. With this arrangement, the firing pin housing being also of slightly reduced diameter, the gun can slide readily relative to the projectile so that water expulsion is accelerated. However, the force of the explosion causes the washer 111 to compress and thus radially expand the rubber ring 110 against the bore walls so that loss of gases is minimized. The action of ring 110 is that of a valve.

When the apparatus has been retrieved either the bit is unscrewed from the head 88 or else

fitting 97 is removed and the liner 96 extracted from the outer casing. It is then sawed off above the core and its ends securely plugged.

In exposing the core it is essential for scientific purposes that its longitudinal structure be undisturbed. To prevent such disturbance I have devised the method of core exposure shown in Figures 19 to 22.

Referring to these figures, reference numeral 96 represents the liner with a core therein. In order to expose the latter, the liner is first carefully scored completely through along one side as at 113 and then scored nearly through along a diametrically opposite line at 114. A thin metal strip as at 115 is then inserted through the slit 113 and worked completely through the core 116 to the opposite wall. A second similar strip 117 is then worked across on top of the first and then the strips are swung apart to open the core to the position shown in Figure 22, a break ordinarily occurring at the score 114. Of course, in working the strips through the core there is some lateral displacement in the latter, but this disturbance can be later obliterated. The important thing is that there has been no longitudinal disarrangement of the core particles.

The disclosed principles are, of course, susceptible of varied embodiment and I do not limit myself to details of form and construction except as in the following claims.

I claim:

1. Core taking apparatus comprising a gun and a core taking projectile projectible from the gun upon explosion of a charge in the gun, lifting and lowering means for the gun and projectile including means operative to retrieve the projectile after the latter has been shot from the gun, and means for automatically exploding said charge when the gun and projectile reach a suitable lowered position relative to the formation to be sampled.

2. Core taking apparatus comprising a gun and a core taking projectile from the gun upon explosion of a charge in the gun, lifting and lowering means for the gun and projectile including means operative to retrieve the projectile after the latter has been shot from the gun, and means for automatically exploding said charge when the gun and projectile are lowered to an extent to cause the projectile to encounter the formation to be sampled.

3. Core taking apparatus comprising a gun having a bore therein, means for suspending and lowering the gun with the bore muzzle faced downwardly, a core taking projectile partly in said bore and partly exposed, means for releasably retaining said projectile in association with the gun while permitting contractive telescoping movement of the two, said gun sliding downwardly relative to said projectile when the exposed end of the latter during lowering reaches the formation to be sampled so that downward movement of the projectile is arrested, and means actuated upon such movement of said gun relative to said projectile for setting off an explosive charge in said bore.

4. Core taking apparatus comprising a gun having a bore therein, means for suspending and lowering the gun with the bore muzzle faced downwardly, a core taking projectile partly in said bore and partly exposed, means for releasably retaining said projectile in association with the gun while permitting contractive telescoping movement of the two, said gun sliding downwardly relative to said projectile when the ex-

posed end of the latter during lowering reaches the formation to be sampled so that downward movement of the projectile is arrested, and means actuated upon such movement of said gun relative to said projectile for setting off an explosive charge in said bore, said last-named means including a trigger carried by said projectile and engageable by the gun.

5. In apparatus of the class described, a projectile comprising a cartridge at one end, core taking means at the other end, an intermediate portion connecting said end portions, and a firing pin carried by said intermediate portion.

6. In apparatus of the class described, a projectile comprising a cartridge at one end, core taking means at the other end, an intermediate portion connecting said end portions, a firing pin carried by said intermediate portion, and an externally engageable trigger also carried by said intermediate portion for releasably holding said firing pin in a retracted position.

7. For use in apparatus of the class described, a re-usable cartridge comprising a cylindrical metal body having a cavity for receiving an explosive charge, a pressure disc closing the cavity at one end of the body, a rupture disc overlying the pressure disc, said pressure disc supporting the rupture disc against external pressure and the latter being rupturable only upon development of a suitably high pressure in the cavity, means securing the rupture disc in position, the pressure disc being retained against outward movement only by the rupture disc, there being a primer recess at the opposite end of said body from said discs and communicating with said cavity, and means for securing a primer in said recess against outward ejection through pressure in the cavity.

8. A cartridge according to claim 7, wherein the cavity is tapered toward the primer recess.

9. A cartridge according to claim 7, wherein the retaining means for the rupture disc is constituted by a clamping ring threaded on the cartridge body and having an opening large enough to pass the pressure disc.

10. For use in apparatus of the class described, a cartridge and a firing device for the cartridge, said cartridge comprising a cylindrical body adapted to be received within the bore of a gun, said cartridge having a cavity for an explosive charge and an end wall provided with a primer recess communicating with said cavity, said firing device comprising a cylindrical housing also adapted to be received within the bore of a gun and securable in aligned relation to the cartridge housing over the end wall of the latter and having an adjacent wall provided with an aperture aligned with said recess but smaller than the latter, a firing pin in said firing device housing through said aperture under spring action, and a firing disc engaged between said walls, said disc being of such deformability and the range and force of projection of said tip through said aperture being such that a primer in said recess may be fired through said disc by deforming but not rupturing the latter.

11. In apparatus of the class described, a core taking projectile comprising a forward tubular core taking portion of substantially cylindrical form and a rearward portion having a symmetrical rearwardly enlarging interior passage in continuation of the passage of the forward portion, a cone coaxially disposed in said enlarging passage and pointed toward said forward por-

tion, and a plurality of symmetrically disposed axially extending webs securing said cone to said rearward portion and dividing said enlarging interior passage into a plurality of passages which are rearwardly open, the cross sectional flow area at any point throughout the length of said rearward portion being at least as great as the cross sectional flow area of said forward portion, said webs being adapted to transmit to said rearward portion and therethrough to said forward portion projecting force imparted to said cone.

12. A projectile according to claim 11, wherein said webs are formed integrally with said cone and are welded in slots formed in said rearward portion.

13. In apparatus of the class described, a projectile core taking bit comprising inner and outer tubes in spaced relation so that an upwardly open passage is provided between the tubes, extending longitudinally of the latter, and means closing the lower end of said passage while the bit is penetrating the formation to be sampled and opening the lower end of said passage when the bit is lifted, whereby fluid may pass downwardly through and out of said passage to facilitate detachment of the core.

14. In apparatus of the class described, a projectile core taking bit comprising inner and outer tubes in spaced relation so that an upwardly open passage is provided between the tubes extending longitudinally thereof, an annular member coaxial with said tubes and secured to the lower end of the outer tube by a lost motion connection, said connection permitting said member to close said passage while the bit is penetrating and enabling the bit to move slightly away from said member when the bit is lifted whereby said passage is opened.

15. A bit according to claim 14 wherein the annular member has a lower cutting edge.

16. A bit according to claim 14 wherein the annular member serves to hold the inner tube against sliding out of the outer tube when the bit is lifted.

17. Apparatus for taking cores comprising a gun, a core taking projectile in the gun, a loop through which the projectile is projectible a certain distance, and a line connected to the loop for retrieving the projectile.

18. In apparatus of the class described a core taking projectile, a yoke including a pair of arms, a ring pivoted between the free ends of said arms, the projectile being proportioned to be projectible a certain distance through said ring, and a retrieving member connected to said yoke.

19. An arrangement for taking cores, to be lowered in any desired depth, and comprising a hollow projectile for penetrating a formation and for taking a core from it, a gun for shooting the said projectile into the said formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, permitting movement of the gun in any direction relatively to the projectile after the shooting thereof, means for lowering the gun and projectile and for lifting them, and means for deflagrating the explosive charge.

20. An arrangement for taking cores comprising a projectile in the form of a sampling tube open at its front end and provided with apertures at its rear end, a gun for shooting the said projectile into a formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, permitting movement of the gun in any direction

relatively to the projectile after the shooting thereof, means for lowering the gun and projectile and for lifting them, and means for deflagrating the explosive charge.

5 21. A core taking device having in combination a gun provided with a bore, a hollow core taking projectile in the bore of the gun, and flexible connecting means between the projectile and the gun.

10 22. The method of taking a core which comprises shooting a core taking projectile into the ground to take a core, maintaining at all times a flexible connection to said projectile, and retrieving said core taking projectile and contained
15 core by pulling in said flexible connection.

23. A core taking device adapted to take a core from a formation under a great depth of liquid, having in combination a gun provided with a bore, means to lower the gun to and recover
20 the gun from the vicinity of the formation, a hollow core taking projectile in the bore of the gun, explosive means in the gun to drive the projectile from the gun into the formation to take a core thereof, means protecting the explosive
25 means from the liquid, means to fire the gun, and flexible connecting means between the projectile and the the gun, operative after the gun is fired, whereby at least that portion of the projectile containing the core may be recovered
30 from the formation.

24. A core taking device adapted to take a core from a formation under a great depth of liquid, having in combination a gun provided with a bore, means to lower the gun to and
35 recover the gun from the vicinity of the formation, a hollow core taking projectile in the bore of the gun, explosive means in the gun to drive the projectile from the gun into the formation to take a core thereof, and flexible connecting means between the projectile and the
40 gun operative at all times.

25. A core taking device having in combination a gun, a hollow core taking projectile in the gun, and flexible retrieving means secured to the projectile, permitting movement of the gun in any
45 direction relatively to the projectile after the shooting thereof.

26. A core taking device having in combination a hollow core taking projectile, means for explosively forcing said projectile into a formation, and a flexible retrieving cable secured to the projectile.

27. In apparatus for obtaining a sample of the formation at the bottom of a well, the combination of a projectile-firing device, means for lowering the same into the well, a projectile for said firing device formed with a sample-taking cavity in its front end, and flexible connecting means
10 securing said projectile to said firing device operative after said firing device is fired, to permit movement of the gun in any direction relatively to the projectile.

28. Core taking apparatus comprising a body having a bore therein and a tubular core taking member in the bore, means for lowering the apparatus to a formation to be tested, and means rendered effective upon contact of the apparatus
20 with the formation to move the core taking member into the latter relative to the body.

29. The combination with a tubular core taking bit adapted to take a core from a formation under a liquid, of means rendered operative when
25 the bit is lifted from a formation after penetration thereof to communicate the liquid from the upper to the lower end of the bit.

30. Core taking apparatus comprising a gun having a bore and a core taking projectile in the muzzle end of said bore, and valve means permitting ingress and egress of liquid to and from the inner end of said bore when the apparatus is subjected to hydrostatic pressures but closing
35 when subjected to high internal pressure of an explosive nature.

31. A method for exposing a core in a metal tube, said method comprising forming a longitudinal slit in the tube, inserting a strip in the slit and working it through the core to the opposite wall of the tube, and bending the tube
40 apart on a line opposite said slit whereby to expose the split core.

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