Sept. 29, 1936. M. SCHLUMBERGER 2,055,506

CORE TAKING DEVICE

Filed Dec. 13, 1935 4 Sheets-Sheet 1

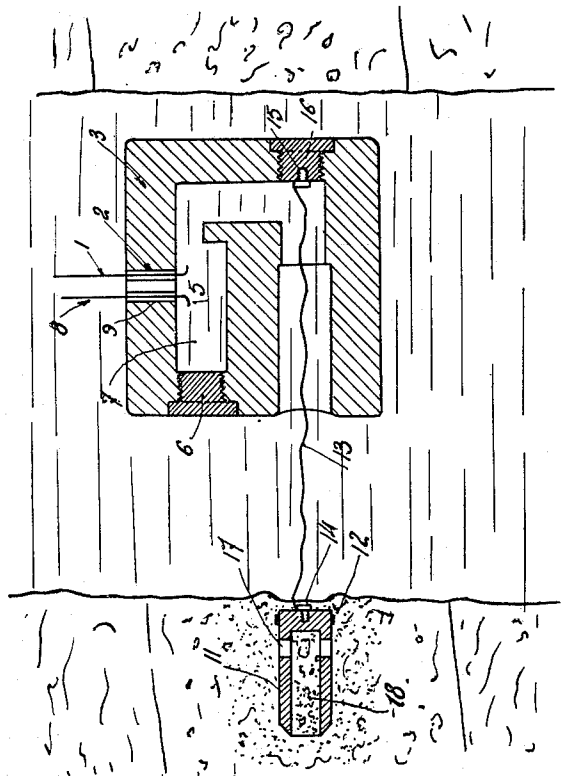


Fig. 2

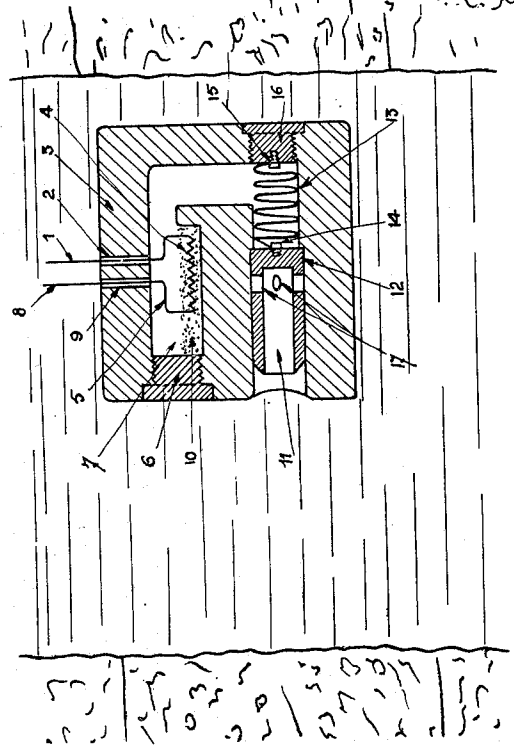


Fig. 1

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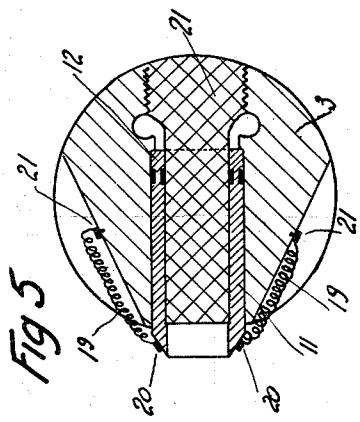


Fig. 5

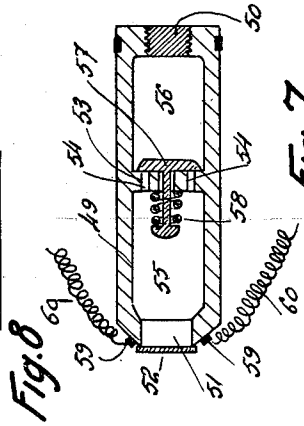


Fig. 8

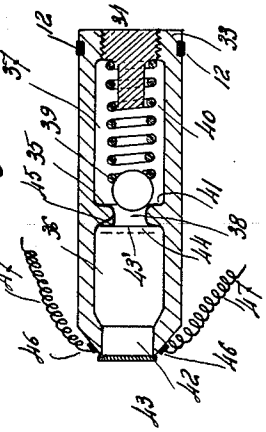


Fig. 7

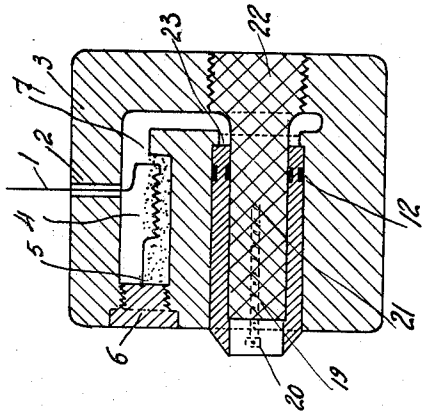


Fig. 4

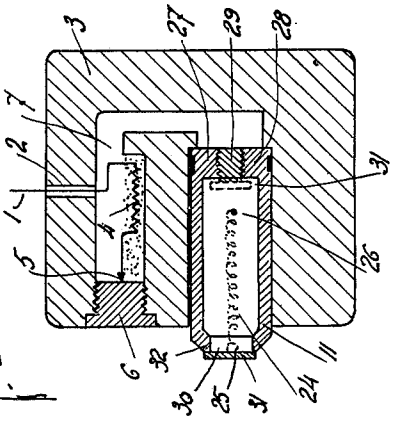


Fig. 6

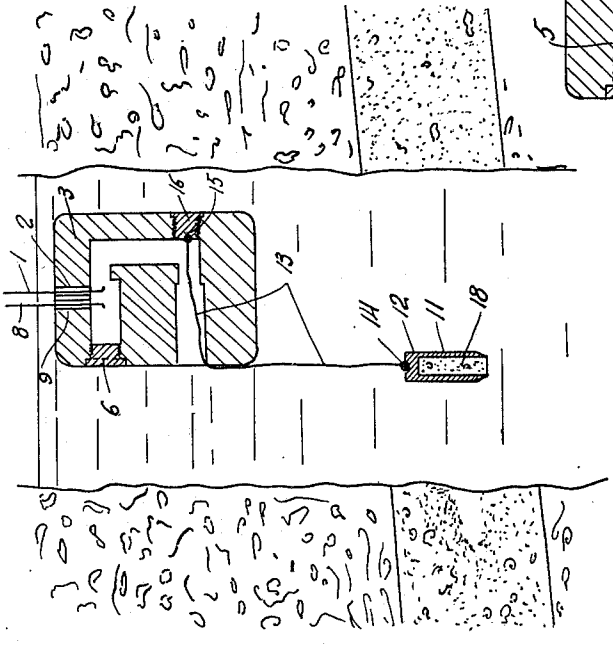


Fig. 3

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CORE TAKING DEVICE

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Fig. 11

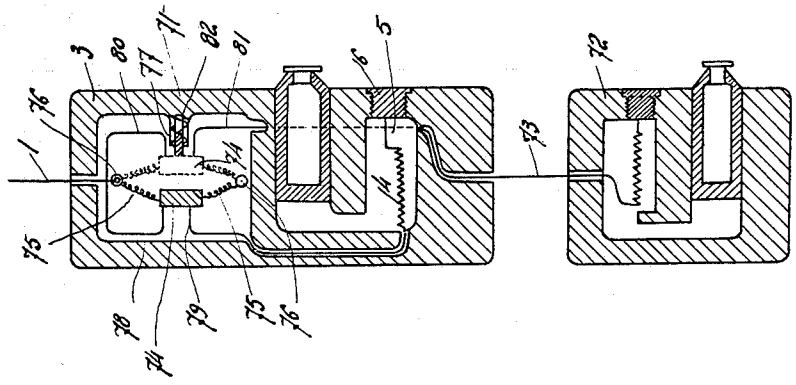


Fig. 10

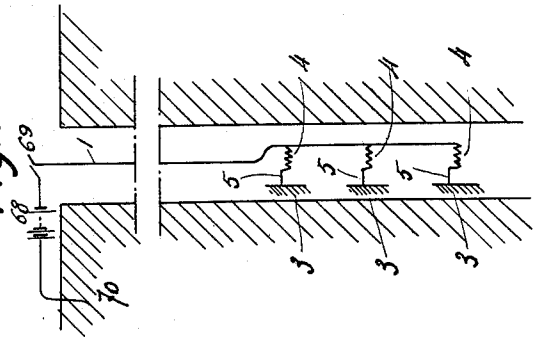
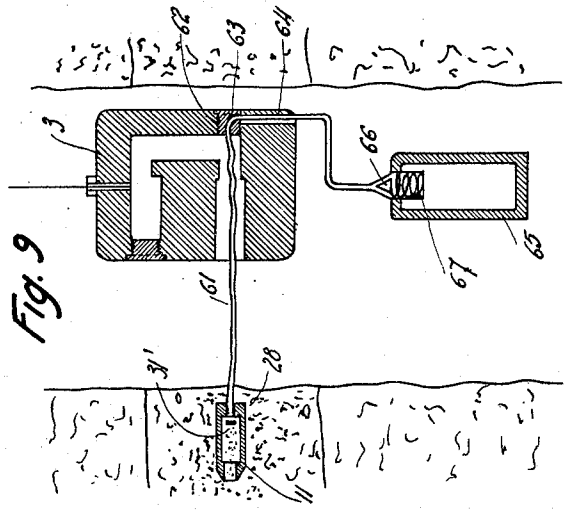


Fig. 9



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Fig. 14

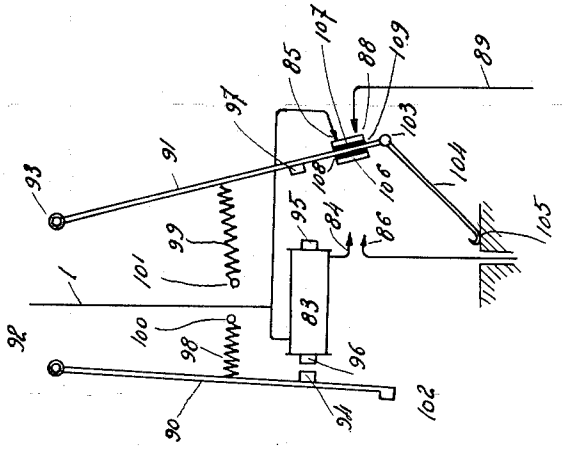


Fig. 13

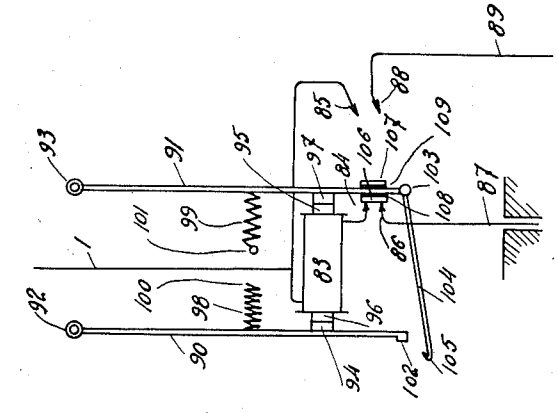
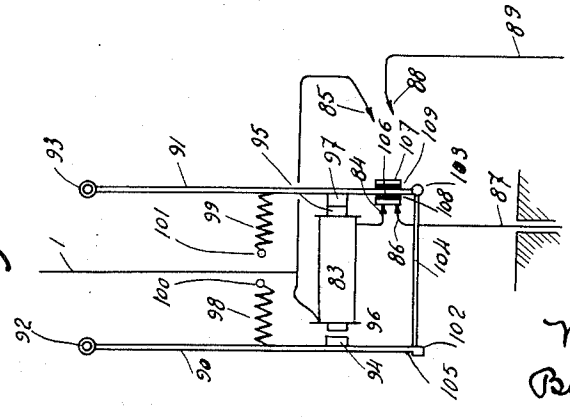


Fig. 12



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Patented Sept. 29, 1936 2,055,506

UNITED STATES PATENT OFFICE

2,055,506

CORE TAKING DEVICE

Marcel Schlumberger, Paris, France

Application December 13, 1935, Serial No. 54,340
In France July 12, 1935

31 Claims. (Cl. 255—1)

Devices are known by means of which cores, i. e. samples of the formations traversed by a bore hole, can be taken not only at the bottom of the latter as the boring progresses downwards, but also from the lateral wall of a hole already bored, and in fact at any depth and at any time before the lowering into place of the casing.

The operation of coring or sampling comprises three phases, first the penetration of the coring tool into the formation so as to cut out the sample or core, second the extraction of the coring tool complete with the core from the formation which it has entered, and third the raising of the coring tool to the surface of the ground without losing the core.

In present-day practice the kind of boring apparatus used mostly is of the rotary type and the cores are taken off at the bottom of the bore hole by means of a tool of tubular shape fixed at the bottom of the drilling string. However, this method takes a long time and is expensive, because each time a core is to be extracted and raised to the surface it is necessary for the entire drilling string to be raised to the surface of the ground and then lowered again.

The specification of the United States Patent No. 1,955,166 filed on the 20th July, 1931, describes apparatus by means of which cores can be taken from the yet unbored bottom of the bore hole. This apparatus is intended to be fixed at the bottom of the drilling-string and comprises the boring tool itself which is of a special type, together with firing mechanism for shooting hollow projectiles. The purpose of the projectiles is to take cores during the boring operation from the formation at the bottom of the bore hole. The projectiles are extracted out of the formation by the actual operation of boring, and are then raised to the surface by the circulation of the drilling-mud, on account of their lightness. However, this apparatus has the disadvantage of requiring a special boring tool which is quite different from the types which have long been consecrated by practice, in order that the coring projectile can be extracted without suffering damage. Moreover, the total volume of each coring projectile is much larger than the useful volume, on account of the necessity of incorporating with it a material of low specific gravity so that the whole projectile may be light enough to float up to the surface and so be recovered.

United States Patent 2,020,856 of Nov. 12, 1935 and 2,015,873 of Oct. 1, 1935 describe methods and apparatus for taking samples called "lateral cores". Apparatus of this kind has the characteristic that during all the three phases of operation mentioned above, the coring tool proper remains fixed on a lever itself integral with the remainder of the apparatus which has been lowered into the bore hole; this lever serves to embed the coring tool into the lateral wall of the bore hole and to withdraw it therefrom. Such an arrangement necessarily comprises a rigid connection of the coring tool with the rest of the apparatus, and due to this fact involves certain disadvantages of which the chief ones are the weight and bulk of the apparatus as compared with the dimensions of the coring member proper, the necessity of setting into movement numerous members for taking the core, which reduces the reliability of operation and requires increased power, the risk of sticking the apparatus if the lever does not return properly and a non-rectilinear movement of the coring member, which may contribute to the taking of an unsatisfactory lateral core.

The object of the present invention is an arrangement for taking cores in the lateral wall of a bore hole and intended to be lowered into the bore hole to the level of the bed to be investigated.

This arrangement comprises in essence a projectile intended to penetrate into the formation constituting the wall of the bore hole and take a core in it, a gun intended to shoot the said projectile into the formation by the deflagration of an explosive charge and a flexible connection between the projectile and the gun for the purpose of extracting the projectile with its core out of the formation into which it has penetrated and of bringing it up to the surface together with the arrangement.

The present invention has the following advantages over the lateral coring apparatus previously described:—

1. By increasing the charge of explosive and the length of the flexible connection it permits the taking of lateral cores even in bore holes of very large diameter or those containing cavities and at a relatively great depth in the lateral wall.

2. There is no risk of sticking the apparatus lowered into the bore hole, because if by a mischance the projectile were embedded in the ground at such a depth in the wall that it would not be withdrawn with the gun, the flexible connection may be designed so as to break at a certain stress, so that the gun can be retrieved. The latter if left in the bore hole would be a source of danger in the further work to be effected therein, whereas the projectile remaining embedded in the formation is harmless.

3. The entire apparatus is very small in weight and bulk so that a certain number of such appliances can be lowered at the same time for taking several cores during one operation, and it is even possible to connect the bodies of the guns to electric cables with one or more conductors and utilize them as measuring electrodes in the electric prospection of formations by determining the resistivities and the spontaneous differences of potential, in accordance with U. S. Patents 1,819,923, Aug. 18, 1931, and 1,913,293, June 6, 1933. In this way it is possible, from the surface, to locate the exact position of the beds in relation to the coring apparatus and to bring the latter exactly to the depth of the bed which it is desired to sample.

4. By adjusting the filament used to deflagrate the explosive in the gun so that it only gives rise to this deflagration above a certain value of the current sent from the surface into the insulated cable, it is possible to use this same cable for any other apparatus at a lower current value, for example for effecting the electrical measurements mentioned above.

5. The coring tool projected into the wall follows a rectilinear path so that the cores can be taken exactly at the desired depth.

The present invention makes it possible, in particular, to take samples of the fluid impregnating a porous bed.

In the accompanying drawings various embodiments of the invention are shown, which are not to be taken as in any way limiting the scope of the invention, and therein:

Figure 1 is a sectional elevation of an appliance in which the flexible connection between the projectile and the gun is in the form of a flexible metallic cable attached at one end to the internal wall of the gun and at the other end to the rear wall of the projectile which is open at the front end only.

Figure 2 is a sectional elevation of the appliance shown in Figure 1 after the projectile has been shot into the formation,

Figure 3 is a sectional elevation of the same appliance while it is being raised to the surface,

Figure 4 is a sectional elevation of an appliance in which the flexible connection between the projectile and the gun is in the form of two flexible metallic cables each fixed, at one end, to the external wall of the gun, and, at the other, to the front wall of the projectile, which is open at both ends,

Figure 5 is a plan taken in section through the axis of the projectile which is used in the apparatus of Figure 4,

Figure 6 is a sectional elevation of an appliance having the same flexible connection between projectile and gun as in Figures 4 and 5, but with a closed and empty projectile having a front wall intended to be forced in by the impact of the projectile against the formation,

Figures 7 and 8 are sectional plans of projectiles shown with their flexible connections to the gun and provided with containers for receiving a sample of fluid and retaining it intact by means of a spring valve while the apparatus is being raised to the surface.

Figure 9 is a sectional elevation of an appliance in which the flexible connection between the projectile and the gun is in the form of a flexible tube for passing a sample of fluid into a container attached to the gun, and provided with a spring valve,

Figure 10 is an elevation on the axis of the bore hole showing diagrammatically the setting into operation of a plurality of appliances by means of a single conductor cable,

Figure 11 is a sectional elevation showing how two appliances in accordance with the invention are set into operation separately by means of an inertia relay in the upper gun released by the recoil of this gun, and

Figures 12, 13 and 14 show in three different operating positions a modified form of relay having the same function as that of Figure 11.

Referring to the drawings, 1 is an insulated conductor forming part of the cable which supports the apparatus, and which is used for lowering it to the level of the bed to be sampled. This conductor passes through the body 3 of the apparatus by means of an insulating bushing 2 and is connected to one terminal of a filament 4, having its other terminal 5 connected in different alternative ways. In Figure 4 the terminal 5 is connected to the body by contact with a plug 6 screwed into the body to close the detonation chamber 7. In Figure 1 the terminal 5 is connected to another conductor 8 of the supporting cable, this conductor also passing through the body 3 by means of an insulating bushing 9. The detonation chamber contains the explosive charge 10, the deflagration of which expels the projectile 11 out of the body; the projectile takes the form of a tube adapted to contain the core and may be of any appropriate form.

The operation of firing the projectile is effected in the different forms of apparatus referred to as will now be described. A suitable source of current located at the surface of the ground passes into the conductor 1 a current which returns to the other pole of the source of current either through the conductor 8 or through the body of the apparatus and the ground after passing through the filament 4, the heating of which causes the deflagration of the explosive charge 10. The pressure resulting in the detonation chamber 7 is transmitted to the rear end of the projectile 11 which is thus shot into the formation.

Rubber packing 12 prevents any leakage between the detonation chamber 7 and the bore hole outside.

Referring more particularly to Figures 1, 2 and 3, current is passed through two conductors 1 and 8 so that this apparatus can be used even in the part of the bore hole in which there is no water or mud. The flexible connection between the apparatus which forms the gun and the projectile takes the form of a flexible metallic cable 13, one end of which is fixed to the projectile by a screw 14 and the other end is fixed by a screw 15 to a metallic plug 16 screwed into the body 3 of the apparatus. The projectile 11 is open at its front end and has lateral apertures 17 at its rear end.

The projectile shot into the formation unwinds behind it the cable 13 and cuts out a core 18 as shown in Figure 2. If the bore hole contains water or mud the latter is expelled from the projectile through the apertures 17. To extract the projectile out of the formation it is sufficient to exert tension on the carrying cable from the surface, or better still to alternate tension on the cable with lowering of the apparatus and cable under their own weight, and the effect of these movements, acting on the flexible cable 13, will usually finally disengage the projectile together with its core.

Once the projectile is extracted, it is raised to the surface together with the whole apparatus,

below which it will hang by the flexible cable 13, as shown in Figure 3.

In the apparatus shown in Figures 4 and 5 the supply of current is effected through a single conductor, the circuit through the filament 4 being completed through the body of the apparatus, the water or mud which fills the bore hole up to at least the level of the apparatus and the ground. The flexible connection between gun and projectile is in the form of two flexible metallic cables 19 each having one end fixed to the projectile 11 by means of a welded lug 20 and the other end fixed to the body of the apparatus by a screw 21. The projectile 11 has both ends open and its bore is filled by a plug 22 screwed into the body 3 behind the rear end of the projectile.

After the deflagration of the explosive charge, the pressure of the gases produced is exerted on the rear annular end 23 of the projectile, which is thus shot into the formation, easily cutting out a core there.

The flexible metallic cables 19 are used for extracting the projectile as previously described by raising and lowering the apparatus alternately and for finally bringing it to the surface of the ground.

Referring to Figure 6, the flexible connection between the gun and projectile takes the form of two flexible metallic cables 24 fixed to the projectile by lugs 25 and to the body of the apparatus by screws 26. The projectile is tubular, for holding a sample, and is closed at its rear end by a base 27 in which a hole 28 is provided with a metallic screw plug 29. At its front end, the projectile has an opening 30 narrower than the internal diameter of the projectile and closed by a small plate 31 soldered to the edge 32 of the tube and so making it air and water-tight.

The plate 31 is sheared by the shock of the projectile on the formation and passes to the bottom of the projectile at the position 31' shown dotted. The extraction of the projectile and the raising of it to the surface are carried out as in the appliances previously described. To extract the core out of the projectile without destroying it, all that is necessary is to unscrew the plug 29 and to screw into the hole 28 a threaded rod which by pushing forward the little plate 31' pushes the core out of the projectile. The projectile in this case will be preferably emptied of air before lowering it into the bore hole, otherwise when it is being raised to the surface the air imprisoned at the bottom of the projectile might expand and drive the core out.

The projectile shown in Figure 7 takes the form of a sampling tube having a base 33 with an orifice for the reception of a screwed plug 34. A partition 35 divides the projectile into two compartments 36 and 37, and has in it an aperture 38, normally closed by a valve. The valve is made up of a metallic ball 38 and a spring 40 supported against the rear end of the projectile and pressing the ball on to the seat 41 of the partition 35. The front part of the projectile has an orifice 42 which is closed before the taking of the sample by a thin soldered plate 43. The partition 35 has on its front face a flat peripheral part 44 with a few recesses 45. The projectile is provided at the front with two lugs 46 to receive the flexible connecting cables 47 and it is provided at the rear with rubber packing 12 to ensure the air and water-tightness of the gun.

The projectile being previously empty, the shock of its impact on the formation forces in the little plate 43 which comes into place on the seating 44 in the position 43' shown dotted. At the same time as the formation enters the projectile, the ball 39 is pushed rearwards by the pressure of the fluid, which passes through the recesses 45 and aperture 38 and fills the rear container 37. As soon as the container is filled, so that the pressures are balanced in the two compartments 36 and 37, the ball 39 is pressed on to its seat 44 by the spring 40, and the fluid in the rear container 37 is brought intact to the surface, where it is recovered by unscrewing the rear plug 34.

The projectile shown in Figure 8 comprises a sampling tube 49 having a rear aperture closed by a threaded metallic plug 50, and having a front aperture 51 closed by a thin soldered plate 52. An intermediate partition 53 with holes 54 through it, divides the projectile into two compartments 55 and 56. A valve 57 of which the rod passes through one of the apertures 54 and which is provided with a spring 58, normally closes the holes 54. Two lugs 59 are provided at the front of the projectile for fixing the flexible connecting cables 60.

The shock of the impact on the formation forces in the plate 52; the formation and the fluid rush into the compartment 55 and their pressure pushes back the valve 57, uncovering the holes 54. As soon as the fluids have filled the rear compartment 56 the valve again closes the holes 54 under the effect of the spring 58. The fluid enclosed in the compartment 56 is brought intact to the surface and is recovered by unscrewing the plug 50.

In the apparatus shown in Figure 9 the flexible connection between the gun and the projectile is in the form of a flexible metallic tube 61 of which one end is screwed into the rear aperture 28 of the projectile 11 of Figure 6 and the other end into a metallic plug 62 itself screwed into the body 3. This plug has an aperture 63 communicating with a tube 64 of which one end is soldered to the plug 62 and the other to a reservoir 65. The tube 64 terminates in this reservoir by a conical valve comprising a cone 66 and a spring 67 which normally applies the cone to its seating.

The projectile and the reservoir being initially empty or filled with air, the shock of the impact of the projectile 11 on the wall moves the plate originally closing its front aperture to the position 31'. By its pressure the fluid passes through the flexible tube 61, the opening 63 of the plug 62 and the tube 64 and, pushing back the cone 66, enters the reservoir 65. As soon as the latter is filled the spring 67 replaces the cone 66 on its seat, and the fluid contained in the reservoir is raised intact to the surface. The extraction of the projectile can be effected as in the case of the appliances previously described.

The small weight of the appliances makes it possible to fix several simultaneously on one supporting cable, so that a certain number of cores can be taken. However, so as not to increase unduly the number of insulated conductors in the cable it is advantageous to use a single conductor to fire several guns.

To put into operation the appliances indicated in Figure 10, three filaments 4 contained in guns, which themselves are not shown, are connected at one end of each to the insulated conductors 1 and at the other end 5 to the body 3 of each apparatus. At the surface a source of

current 68, and regulating means, has one pole connected to the conductor 1 by means of a switch 69 and the other pole 70 to the ground.

The passage of a current in the closed circuit, which is completed through the mud of the bore hole and the ground, will cause the heating of the filaments and the simultaneous taking of samples by the three appliances if the filaments 4 are identical with each other and have equal resistances. If the filaments are different or have different resistances, it is possible to effect separate and successive taking of cores by increasing the current after each appliance has been brought to the desired depth.

Figure 11 shows suspended on the cable 1 having a single insulated electric conductor, a group of two appliances 71 and 72 connected together by a cable 73, which likewise has only a single insulated conductor. In the upper appliance 71 there is a relay comprising an inertia mass 74 held between compression springs 75 which are fixed by insulating supports 76 to the body 3 of the appliance. The relay can also take up the position 74' shown in dotted lines. In the first position this relay completes the electric circuit via cable 1, cable 78, body 74, cable 79, filament 4, wire 5, plug 6, ground. In the second position it completes the circuit via cable 1, cable 80, body 74', cable 81, cable 73, filament of the lower appliance 72, ground. The apparatus also comprises a dash-pot 82, the piston of which is insulated at its front part where it comes into contact with the body 77.

The relay 74 is originally in the first position, which is shown in full lines in the figure, thus completing the first circuit above mentioned, and accordingly current passes into the conductor 1 and the ground effects coring by means of the upper appliance 71. In consequence of the recoil of the gun and the inertia of the body 74, the latter now takes up the position 74' and completes the second of the circuits above described. The dash-pot 82 breaks this movement sufficiently at its latter part to make it possible to break the circuit at the surface before the second circuit is established. After the lower appliance 72 is brought opposite a bed which appears to be of interest, a fresh passage of current into the conductor 1 effects coring by means of the second appliance.

In this way it is possible to combine a plurality of appliances each of which, except the last, is provided with a relay as described. All the appliances are then connected to a single conductor cable and can be used for successive coring at any desired level. Each time one gun is fired the recoil will act on the relay associated with it and thus put into circuit the filament of the next appliance.

In Figures 12 to 14 the conductor 1 of the insulated cable on which the set of guns is suspended, is connected to one of the terminals of an electromagnet with core 83 and to the contact 85. The other terminal of the electromagnet is connected to the contacts 84 and 85. A contact 86 is connected by the conductor 87 to the filament, not shown, of the gun to which the relay described is attached. A contact 88 is connected by a conductor 89 to the filament, not shown, of another gun. Two metallic blades 90, 91 pivoted on fixed axes 92 and 93 carry metallic masses 94 and 95 opposite the poles 96 and 97 respectively of the electromagnet. Springs 98 and 99 having one end of each fixed respectively to stationary points 100 and 101, tend to move the blades 90 and 91 away from the electromagnet. The blade 90 has at its lower extremity a small shoulder 102. The blade 91 carries at its lower extremity, by means of a pivot 103, a bar 104 with a hook at its end 105. This blade 90 also carries two wide metallic contacts 106 and 107 insulated from the blade by insulating plates 108 and 109.

Figure 12 shows the relay ready to operate. The hook 105 of the bar 104 encompasses the blade 90 above the shoulder 102; the spring 98, which is stronger than the spring 99, acts through the rod to apply the contact piece 106 to the contacts 84 and 86, thus completing the circuit via cable 1, electromagnet 83, contact 84, contact piece 106, contact 86, conductor 87, filament of the gun to which the relay is attached.

Figure 13 shows the relay when current has been passed. If a current passes through the above circuit which is completed by the body of the gun and the ground, the pole 96 then attracts the blade 90 by means of the metallic part 94. The hook 105 is disengaged and the rod 104 being released falls down, pivoting about the axis 103. The above described electric circuit remains until the projectile is fired by the gun and the filament is broken.

Figure 14 shows the relay when, after the interruption of the current, the blades 90 and 91 under the influence of their springs move away from the electromagnet and the blade 91 applies the contact piece 107 to the contacts 85 and 88. This completes the circuit via cable 1, electromagnet 83, contact 85, contact piece 107, contact 88, conductor 89, filament of the next gun. A fresh passage of current in this circuit, which is completed by the body of the gun and the ground, will fire the second gun.

A plurality of appliances, each one except the last being provided with such a relay, can thus be connected to a single conductor for separate and successive taking of cores, since the relay of one gun after firing puts into circuit the filament of the next gun.

By connecting one or more of the insulated conductors of the cable carrying the gun or guns to one or more electrodes fixed to the said cable at the level of the guns it is possible to determine the exact position of the guns in reference to the beds to be sampled, by measuring the resistivities and the spontaneous potential differences of the strata forming the wall of the bore hole; each gun electrically connected by means of its filament to one of the conductors before the taking of the sample could then itself serve, if required, as electrode.

As stated above, the herein described invention is an improvement upon that described in United States Patent 2,020,856, which describes a core-taking device comprising a hollow projectile, firing mechanism for shooting said projectile into the adjacent soil, and retrieving means for withdrawing the hollow projectile with its enclosed core from the soil. The invention herein described differs from that of said patent mainly in that it comprises flexible connecting means, instead of rigid connecting means, between the projectile means and the gun, or the body which carries the gun. Therefore, the combination of gun, coring projectile and retrieving means broadly is not claimed broadly herein, such broad subject-matter of invention being described in said Patent 2,020,856 and being claimed in an application for the reissue thereof, filed July 11, 1936.

What I claim is:

1. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing, to be lowered to any desired depth and comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

2. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the rock by the deflagration of an explosive charge, a flexible metallic cable fixed at one end to the inside of the gun and at the other end to the rear part of the projectile, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

3. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible metallic cable fixed at one end to the outside of the gun and at the other end to the front part of the projectile, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

4. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a plurality of flexible metallic cables fixed at one end of each to the outside of the gun and at the other end to the front part of the projectile, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

5. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing 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 the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

6. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a projectile in the form of a sampling tube open at both ends, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

7. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a projectile in the form of a sampling tube open at both ends, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a core fixed inside the gun for guiding the projectile, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

8. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a projectile in the form of a sampling tube closed at both ends and even empty of air, the front wall of the said tube being adapted to be forced in by the impact of the projectile on to the formation, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

9. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a projectile in the form of a sampling tube closed at both ends and even empty of air, the front wall of the said tube being constituted of a plate soldered on and adapted to be sheared by the impact of the projectile on to the formation, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

10. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a projectile in the form of a sampling tube closed at both ends and even empty of air, the front wall of the said tube being adapted to be forced in by the impact of the projectile on to the formation and the rear wall of the said tube having an aperture closed by a removable plug permitting the extraction of the core from the projectile, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

11. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, means for ensuring tightness between the detonation chamber of the gun and the bore hole, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

12. An arrangement for simultaneously tak-

ing cores and samples of the fluid permeating a porous bed in the lateral wall of a bore hole in the part thereof not yet lined with casing, comprising a projectile in the form of a sampling tube closed at both ends, the front wall of the said tube being adapted to be forced in by the impact of the projectile onto the formation, an empty container arranged inside the said projectile, a spring valve closing the said container so as to permit the sample of fluid to enter the container when the core is taken and to retain it therein thereafter, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

13. An arrangement for simultaneously taking cores and samples of the fluid permeating a porous bed in the lateral wall of a bore hole in the part thereof not yet lined with casing, comprising a projectile in the form of a sampling tube closed at both ends, the front wall of the said tube being adapted to be forced in by the impact of the projectile onto the formation, an empty container arranged inside the said projectile, a spring valve closing the said container so as to permit the sample of fluid to enter the container when the core is taken and to retain it therein thereafter, an aperture closed by a removable plug being provided in the rear wall of the projectile to permit the recovery of the fluid stored in the said projectile, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible connection between the projectile and the gun, means for lowering the gun and projectile into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

14. An arrangement for simultaneously taking cores and samples of the fluid permeating a porous bed in the lateral wall of a bore hole in the part thereof not yet lined with casing, comprising a projectile in the form of a sampling tube closed at both ends, the front wall of the said tube being adapted to be forced in by the impact of the projectile onto the formation, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a flexible tube fixed inside the gun, connected at one end to the rear part of the projectile, an auxiliary reservoir for receiving the sample of fluid, the other end of the flexible tube being connected to the said reservoir, a spring valve being provided at the entrance of the reservoir to permit the sample of fluid to enter the reservoir when the core is taken and to retain it therein thereafter, means for lowering the gun, the projectile and the auxiliary reservoir into the bore hole and for bringing them up to the surface, and means for deflagrating the explosive charge.

15. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a filament in contact with the explosive charge enclosed in the detonation chamber of the gun, this filament being connected at one end to one pole of an external source of current, having its other pole connected to ground, and at the other end to the body of the gun, means for causing current to pass from the source to the filament so as to cause the deflagration of the explosive charge by the heating of the said filament, a flexible connection between the projectile and the gun, and means for lowering the gun and projectile into the bore hole and for bringing them up to the surface.

16. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising a hollow projectile for penetrating the formation forming the wall of the bore hole and for taking a core from it, a gun for shooting the said projectile into the formation by the deflagration of an explosive charge, a filament in contact with the explosive charge enclosed in the detonation chamber of the gun, this filament being connected at one end to one pole of an external source of current and at the other end to the other pole of the said source, means for causing current to pass from the source to the filament so as to cause the deflagration of the explosive charge by the heating of the said filament, a flexible connection between the projectile and the gun, and means for lowering the gun and projectile into the bore hole and for bringing them up to the surface.

17. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing, comprising in combination a plurality of guns adapted to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, means for lowering the group of guns into the bore hole and for bringing them up to the surface, and means for deflagrating simultaneously or successively the explosive charge in each gun.

18. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground, and from the other end to the body of the corresponding gun, means for causing current to pass from the source to the set of filaments so as to cause the simultaneous deflagration of the explosive charges in the guns by the heating of the said filaments, and means for lowering the group of guns into the bore hole and for bringing them up to the surface.

19. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation form-

ing the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, different filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground, and from the other end to the body of the corresponding gun, means for causing current to pass from the source to the set of filaments and for varying the said current so as to cause the successive deflagration of the explosive charges in the guns by the heating of the said filaments, and means for lowering the group of guns into the bore hole and for bringing them up to the surface.

20. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground and from the other end to the body of the corresponding gun, means for causing current to pass from the source to the filaments in succession so as to cause the successive deflagration of the explosive charges in the guns by the heating of the said filaments, and means for lowering the group of guns into the bore hole and for bringing them up to the surface.

21. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground and from the other end to the body of the corresponding gun, a movable mass constituting a contact member combined with each gun in such a way as to move under the effect of the recoil of the gun to break the circuit of the filament associated with the said gun and put into circuit the filament associated with the next gun, means for causing current to pass from the source to that filament which is in circuit so as to cause the deflagration of the explosive charge in the corresponding gun by the heating of the said filament, and means for lowering the group of guns into the bore hole and for bringing them up to the surface.

22. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground and from the other end to the body of the corresponding gun, an electromagnetic relay combined with each gun so as to break the circuit of the corresponding filament after the operation of the said gun and put into circuit the filament of the next gun, and means for causing current to pass from the source to that filament which is in circuit so as to cause the deflagration of the explosive charge in the corresponding gun by the heating of the said filament.

23. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, means for deflagrating the explosive charge in each gun, means for lowering the group of guns into the bore hole and for bringing them up to the surface, electrodes attached to the said means at the levels of the several guns, and means for measuring with the aid of the said electrodes the resistivities and/or the spontaneous potential differences of the formation forming the wall of the bore hole.

24. An arrangement for taking cores from the lateral wall of a bore hole in the part thereof not yet lined with casing comprising in combination a plurality of guns arranged to be lowered simultaneously into the bore hole each to a different depth thereof, hollow projectiles each associated with one gun for penetrating the formation forming the wall of the bore hole and for taking a core from it, a flexible connection between each projectile and the corresponding gun, means for lowering the group of guns into the bore hole and for bringing them up to the surface, filaments in contact with the explosive charges enclosed in the detonation chambers of the several guns, electrical connections from one end of each filament to one pole of an external source of current having its other pole connected to the ground and from the other end to the body of the corresponding gun, means for measuring with the aid of the guns acting as electrodes the resistivities and/or the spontaneous potential differences of the formation forming the wall of the bore hole, and means for causing current to pass to each filament so as to deflagrate the explosive charge in the corresponding gun by the heating of the said filament.

25. A core-taking device having in combination a gun, a hollow core-taking projectile in the gun, and flexible connecting means between the projectile and the gun.

26. 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 core by pulling in said flexible connection.

27. A core-taking device adapted to take a core

from a formation under a great depth of liquid, having in combination a gun, means to lower the gun to and recover the gun from the vicinity of the formation, a hollow core-taking projectile in 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 means from the liquid, means to fire the gun, and flexible connecting means between the projectile and the gun, operative after the gun is fired, whereby at least that portion of the projectile containing the core may be recovered from the formation.

28. A core-taking device adapted to take a core from a formation under a great depth of liquid, having in combination a gun, means to lower the gun to and recover the gun from the vicinity of the formation, a hollow core-taking projectile in 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 gun operative at all times.

29. 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.

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

31. 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 securing said projectile to said firing-device operative after said firing device is fired.

MARCEL SCHLUMBERGER.

DISCLAIMER

2,055,506.—*Marcel Schlumberger*, Paris, France. CORE TAKING DEVICE. Patent dated September 29, 1936. Disclaimer filed December 12, 1939, by the assignee, *Schlumberger Well Surveying Corporation.*

Hereby enters this disclaimer to claims 1, 2, 3, 4, 5, 6, 11, 25, 26, 27, 28, 29, 30, and 31.

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