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W. G. SWEETMAN
MECHANISM FOR DETONATING EXPLOSIVES

2,566,682

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2 Sheets-Sheet 1

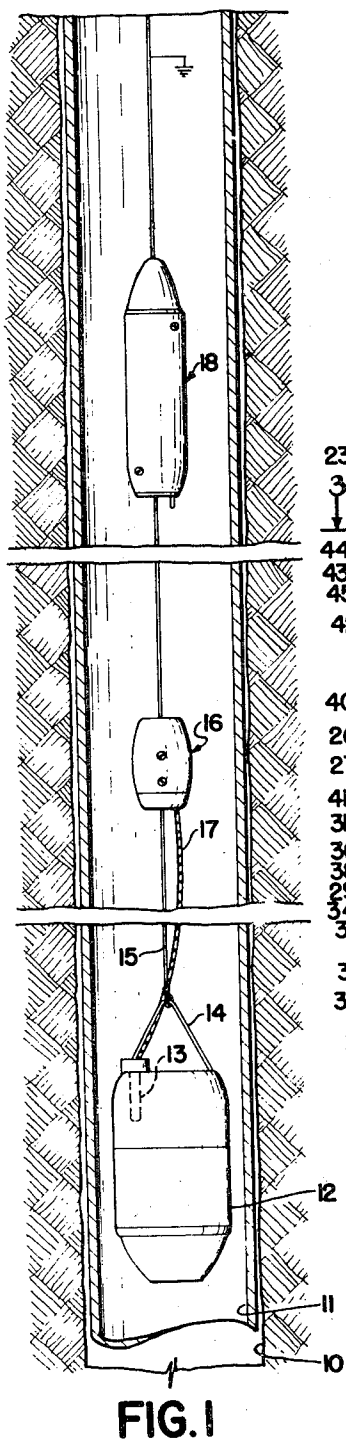


FIG. 1

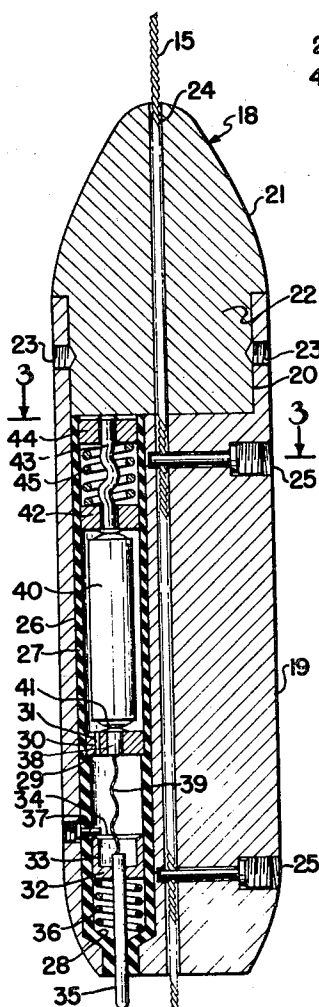


FIG. 2

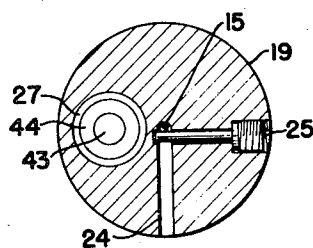


FIG. 3

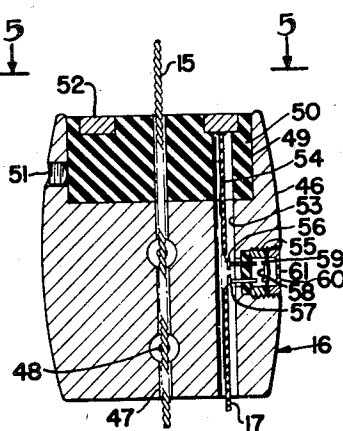


FIG. 4

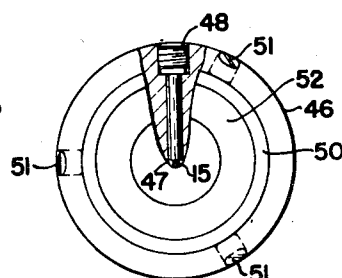


FIG. 5

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2 Sheets-Sheet 2

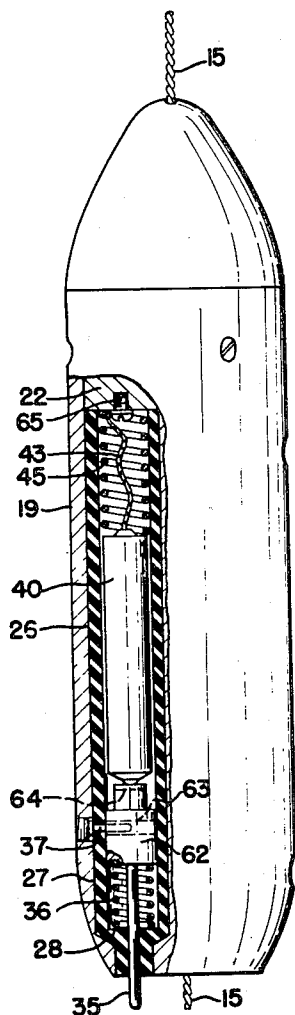


FIG. 7

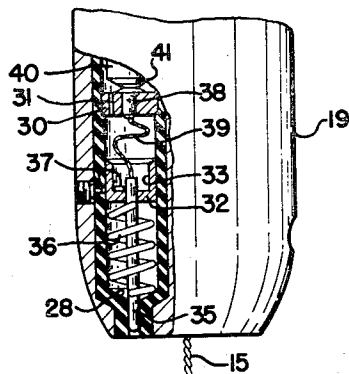


FIG. 6

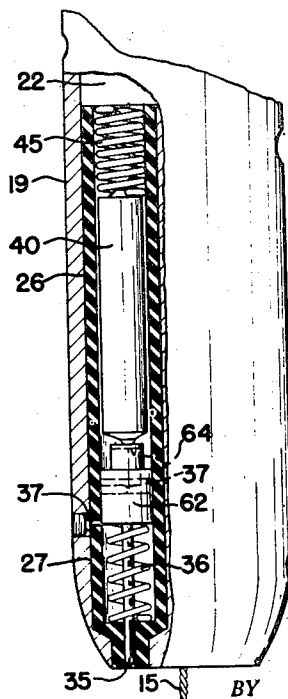


FIG. 8

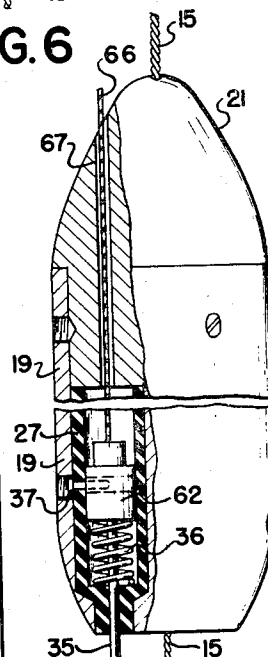


FIG. 9

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MECHANISM FOR DETONATING
EXPLOSIVES

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3 Claims. (Cl. 102—20)

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This invention relates to mechanism for detonating explosives and particularly to such mechanisms for use as initiators for setting off explosive charges in a well.

Explosive charges are employed in well operations for various purposes and various methods have heretofore been used for initiating the explosion of such charges. Charges of explosives have been set off by use of an electrical initiator, current for which is supplied from an external current source through leads from the top of the well, requiring, in many cases, thousands of feet of expensive electrical conductors and equipment for the handling of such lengths of material. Other types of initiators employ time controlled mechanisms which are closely connected to the explosive charge and which once lowered in the well are beyond the control of the operator. In still other instances, percussion methods are used in which a weight is dropped into the well on top of a percussion-type fuse connected to the explosive charge. This method is subject to frequent failures and is particularly difficult to employ in very deep wells.

The device in accordance with this invention is adapted to be included in an electrical circuit as a circuit-closing structure and comprises generally a pair of electrical contact members, one of which is stationary and the other movable relative thereto for closing the circuit. The movable member preferably has a self-contained source of electric current which constitutes the current supply for the circuit, but the current source may be located outside the circuit-closing structure, if desired.

More specifically, the device in accordance with an illustrative embodiment of the present invention constitutes an electrical initiator which is adapted to be mounted on a metal cable which is employed to lower an explosive charge into a well and comprises a movable contact member which is adapted to be slidably mounted on the cable and contains a suitable source of electric current, such as a conventional dry-cell battery; and a stationary contact member which is adapted to be affixed to the cable and to be electrically connected to a conventional electrical detonating fuse embedded in the explosive charge. The current source contained in the movable contact member supplies the current for detonating the charge when the two contact members are brought into contact in a manner to be more fully described hereinafter.

The device in accordance with this illustrative embodiment is so constructed that the movable

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contact member containing the current source is slidably mounted on the cable only after the charge and the stationary contact member have been lowered into place in the well, whereby all danger of premature explosion of the charge is avoided. The initiating device in accordance with this invention is relatively simple in form and operation and adapted for relatively low cost construction and does not suffer substantial damage in use, whereby it may be readily recovered from the well for re-use.

It is a principal object of this invention, therefore, to provide an improved electrical circuit closing device.

15 An important object of this invention is to provide an improved apparatus for initiating the explosion of explosive charges.

Another important object is to provide an electrical initiating device for explosives which has a self-contained source of electric current.

20 Another object is to provide an electrical circuit closing device comprising a stationary contact member and a movable contact member having a self-contained source of electrical current constituting the current supply for the circuit.

Other and more specific objects and advantages of this invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate one useful embodiment in accordance with this invention.

In the drawings:

35 Fig. 1 is a longitudinal sectional view of a well showing relative positions therein of an explosive charge and the initiating device in accordance with this invention at one stage of operation;

Fig. 2 is a longitudinal sectional view through the movable member of the initiating device which contains the source of electric current;

Fig. 3 is a cross-sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a longitudinal sectional view of the stationary contact member of the initiating device in accordance with this invention;

Fig. 5 is a top view of the stationary contact member, being partly broken away to better illustrate some of the details thereof;

Fig. 6 is a fragmentary view of the structure shown in Fig. 2, illustrating another position of some of the parts thereof;

Fig. 7 is a view similar to Fig. 2 of an alternative form of the structure illustrated in Fig. 2;

Fig. 8 is a fragmentary view of the structure

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shown in Fig. 7 illustrating another position of some of the parts thereof; and

Fig. 9 is a partly-sectional longitudinal view of another embodiment in accordance with this invention.

Referring to the drawings and to Fig. 1 in particular, there is shown a well 10, which is lined with a casing 11 in the conventional manner. A metallic container 12, of any suitable or conventional form and which encloses an explosive charge (not shown) of any suitable type, and having embedded therein, an electrical detonator 13, also of any conventional construction, is suspended by means of a metal bail 14 from the end of a metal lowering cable 15, by means of which the charge and container 12 may be lowered from the top of the well to any suitable point in the well at which it is desired to explode the charge. Mounted on cable 15 at any suitable distance above container 12 is a stationary contact member, designated generally by the numeral 16, which is connected by means of an electrical lead 17 to detonator 13. Movably mounted on cable 15 above stationary contact member 16 is a movable contact member, designated generally by the numeral 18, which is adapted to slide down cable 15 into contact with member 16.

Referring now to Figs. 2 and 3, which illustrate the details of movable contact member 18, the member comprises a metallic body 19, which may be constructed of steel or any other suitable conducting metal. Body 19 is provided with a tubular socket 20 in the upper end thereof into which is fitted a tail piece 21, also of conducting metal, which serves primarily to add weight to body 19. Tail piece 21 is provided with a shank 22 which fits into socket 20 and is firmly locked therein by means of a plurality of set screws 23 which extend generally radially through the walls of socket 20 into compressive contact with shank 22 of the tail piece. When so joined to body 19, the tail piece becomes an integral part of the body. Body 19 and tail piece 21 are provided with a radial slot 24 extending from the center of the body to the exterior thereof and is adapted for slidable reception of cable 15. A pair of studs 25—25, spaced vertically apart, extend through the side of body 19 substantially at right angles to slot 24 and form spaced closures for the slot in order to prevent displacement of cable 15 from the slot, while permitting relative freedom for longitudinal sliding movement of member 18 along cable 15. A chamber 26 is bored longitudinally through body 19 at one side of the center thereof and is fitted with a hollow insulating liner 27 extending throughout its length. The lower end of the bore of liner 27 adjacent its exit from body 19, is constricted to form an internal shoulder 28. Liner 27 is also provided with an internal shoulder 29 above shoulder 28. A partition member 30 is inserted in the bore of liner 27 and is adapted to rest on shoulder 29, and is provided with a longitudinal passageway 31 extending therethrough. Mounted in the bore of liner 27 below partition member 30 is a piston member 32 which is slidable in the bore of liner 27 and is provided with a tubular skirt 33, the open end of which is outwardly tapered to form a relatively sharp shearing edge 34. An elongated contact pin 35, constructed of suitable electrically conducting metal such as brass or copper, is rigidly mounted in piston member 32 and is of such length as to extend exteriorly of body 19, when piston member 32 is in the position shown in Fig. 2. A coil spring 36 is mounted in the bore

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of liner 27 between the head of piston 32 and shoulder 29, surrounding contact pin 35, and is held in compression by means of a shear pin 37, which may be constructed of solid plastic or other suitable easily rupturable material, and which extends through the walls of body 19 and liner 27 above shearing edge 34 of the piston skirt. A contact stud 38 constructed of electrically conducting material is mounted in partition member 30 and is connected by means of a flexible electrical lead 39 to the inner end of contact pin 35. An electric battery 40, which may be of the conventional one and one-half volt dry-cell type, is mounted in the bore of liner 27 above partition member 30 with its positive pole 41 in contact with contact stud 38. A spacer member 42, which is slidable in the bore of liner 27, is arranged therein for contact with the opposite end of the case of battery 40 and is connected by means of a flexible electric lead 43, to a second spacer member 44 mounted in the bore of liner 27. A coil spring 45, of lesser strength than spring 36, is mounted in compression between spacer members 42 and 44 and surrounding flexible lead 43. The latter extends through spacer member 44, the outer end thereof being arranged to make electrical contact with the inner end of shank 22 of tail piece 21, when the latter is inserted into socket 20.

Stationary contact member 16 (Figs. 4 and 5) comprises a body portion 46, constructed of a suitable conducting metal, and provided with an axial bore 47 through which cable 15 may be passed, and is provided with one or more threaded studs 48 which extend through body 46 into contact with cable 15, and are adapted to compress cable 15 tightly against the wall of bore 47 so as to clamp member 16 tightly in place on the cable. The upper end of body 46 is counter-bored to provide a socket 49 in which is fitted an insulating block 50 which is held in place therein by means of a plurality of radially disposed set screws 51. Embedded in the upper end of insulating block 50 is an annular ring 52, constructed of a suitable electrically conducting metal such as brass or copper. The inner and outer diameters of ring 52 are such as to provide an annular contact surface on which contact pin 35 will strike when the movable contact member 18 is brought in contact with stationary contact member 16. A passageway 53 extends longitudinally through body 46 and insulating block 50 and forms a conduit for the reception of an electrical lead 54, one end of which is connected to ring 52 and the other to one contact 56 of a conventional hydrostatic switch 55. The other contact 57 of switch 55 is connected to electrical lead 17, which, as noted above, is connected to fuse 13. Switch 55, which is normally open, includes a contact 58 mounted on the inner face of a flexible diaphragm 59 which is responsive to fluid pressure to cause contact 58 to close the circuit between contacts 56 and 57 when diaphragm 59 is depressed. Switch 55 is enclosed within a casing 60, the outer cover of which has an orifice 61 for the admission of fluid pressure to act upon diaphragm 59.

Cable 15 is employed as the ground lead for completing the electrical circuit through fuse 13. It will be understood that the usual second lead (not shown) of fuse 13 may be grounded in any conventional manner, as by connecting it to the metallic housing 12, which will then be grounded through bail 14 and cable 15, or by connecting the second lead directly to bail 14 or to cable 15, or in any other convenient

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manner. The bodies of contact members 16 and 18 are likewise grounded through cable 15 by their physical contact therewith.

The above described device is operated in the following manner: Stationary contact member 16 is threaded over the lower end of cable 15 and clamped in place on cable 15 by means of studs 48. The position of contact member 16 on the cable may be at any desired height above the point of attachment of the lower end of cable 15 to bail 14 of the explosive charge container 12. Lead 17 is then connected to a lead of detonator 13, the other lead being grounded as noted above. Cable 15, having container 12 suspended therefrom and contact member 16 mounted thereon, is then lowered into the well until container 12, with its explosive charge, attains the desired point in the well at which the explosive is to be set off. Movable member 18 will then be mounted on cable 15 at the top of the well by inserting cable 15 laterally through slot 24 until the cable rests against the bottom of the slot, whereupon studs 25—25 will be inserted in a position to span the slot and hold cable 15 in place therein, thereby preventing dislodgment of member 18 from the cable. When member 18 is in place on cable 15, it will be released and allowed to slide down the cable by its own weight until it comes in contact with stationary member 16. When contact pin 35 of the movable member strikes ring 52 of the stationary contact member, electrical contact will be made between members 18 and 16 and current from battery 40 will flow to detonator 13 and electrically detonate the fuse which will, in turn, detonate the explosive charge in container 12. When contact pin 35 thus strikes contact ring 52, the force of the impact will cause shearing edge 34 on piston skirt 33 to cut shear pin 37 and piston 32 will then be forced, under pressure of coil spring 36, upwardly through the bore of liner 27 to the position shown in Fig. 6, contact pin 35, being thus withdrawn into the interior of the bore of liner 27. This provides a safety feature in the device, in that with pin 35 thus withdrawn into the interior of body 19, the electrical circuit, including battery 40 and fuse member 13, will be broken so that, should the charge of explosive fail to go off in the response to the initial contact, the initiating device and the charge may be withdrawn with safety from the well.

Hydrostatic switch 55 in stationary contact member 16 forms an additional safety device for the structure, particularly when the apparatus is used in a well in which there is a standing column of liquid, as is normally the case. Switch 55 will normally be set to close at some given pressure less than the hydrostatic head above the point at which the explosive is to be set off, so that as the explosive charge and contact member 16 are lowered in the well, the electrical circuit between these members will remain open until these members attain a relatively safe depth within the well. Thereafter, the increasing hydrostatic head will close the hydrostatic switch and complete the connection between ring 52 and the explosive charge. It will be understood, of course, that if the device is to be used where there is no fluid pressure, switch 55 may be dispensed with and direct connection made between leads 55 and 17.

The hydrostatic switch also provides a further safety feature in the event the explosive charge, for any reason, does not go off when members

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18 and 16 of the initiating device are brought into contact, as previously described. In that event, it is normally necessary that the charge and initiating device be withdrawn from the well, whereupon, as contact member 16 reaches an elevation at which the hydrostatic pressure is lower than the switch setting, the switch will open and provide an additional break in the circuit between the members of the initiating device and the charge.

With the described arrangement, it will be seen that the device in accordance with this invention eliminates the need for a source of electric current at the surface and the need for electric cables connecting such a surface source with the explosive charge. Furthermore, by providing the self-contained electric current source within the movable member 18, no source of current which could prematurely explode the charge is available until after the charge is in place in the well and movable member 18 has been mounted on the lowering cable. This reduces the hazard of premature explosion to an absolute minimum. Furthermore, since the only direct connection between the initiating device and the explosive charge is that comprising contact member 16 and lead 17, contact member 16 may be placed at any desired height above the explosive charge such that it will be unaffected by the force of the explosion. As a result, once the explosion has taken place, lowering cable 15 may be withdrawn from the well and will bring with it members 16 and 18 in relatively undamaged condition so that they may be re-used, thereby eliminating the cost of new initiating devices for setting off a plurality of explosive charges.

Normally the only replacements required for re-using the initiating device are battery 40 and shear pin 37. To replace battery 40, member 18 is removed from cable 15 by withdrawing studs 25—25. Thereupon, member 18 may be disassembled by removing set screws 23 to permit removal of tail piece 21. Body 19 will then be inverted and battery 40, spacer members 42 and 44, and coil spring 43 will drop out of the body. With these elements removed, a slender tool may be inserted through passageway 31 in partition member 30 to push piston 32 back toward shoulder 28 until a point is reached at which a new shear pin 37 may be put in position to hold the piston down and with contact pin 35 in its extended position. Thereupon, a new battery may be put in place and the spacer members 42 and 44 again re-inserted in liner 27. Tail piece 21 will then be replaced and fixed in position by means of set screws 23, whereupon the movable member will be ready for re-use.

Figs. 7 and 8 illustrate another embodiment of movable contact member 18. In this embodiment shoulder 29 in liner 27 is dispensed with, as well as partition member 30, and spacer members 42 and 44. A solid piston 62, constructed of any suitable conductor metal and carrying contact pin 35, is provided with a diametrically extending hole 63 to receive shear pin 37, and its upper end being provided with a kerf 64 which is adapted to receive a screw driver blade or other tool for orienting the piston for insertion of shear pin 37 into hole 63. The positive pole 41 of battery 40 is placed in direct contact with the upper end of piston 62 to provide electrical contact therebetween, thereby eliminating flexible lead 39 of the previously described embodi-

ment. The lower end of flexible lead 43 is soldered to the lowermost convolution of enclosing coil spring 45 and its upper end is connected directly to shank 22 of tail piece 21 by means of a screw stud 65. With this arrangement coil spring 45, lead 43 and tail piece 21 form a unitary structure, so that when battery 40 has been put in place, the assembly may be completed upon the insertion of the tail piece in body 19 with coil spring 45 and lead 43 entering the bore of liner 27 to thereby provide electrical connection between the negative terminal, that is, the case of battery 40, and body 19. As in the previously described embodiment, coil spring 36 will be of somewhat greater strength than coil spring 45, so that when shear pin 37 is broken, following the impact of contact pin 35 upon contact ring 52, the pressure of coil spring 36 will overcome that of coil spring 45 and will force piston 62 and battery 40 upwardly in the bore of liner 27, at the same time retracting contact pin 35 to a position well within body 19, and will hold these elements in their retracted position, as is shown in Fig. 8, thereby re-opening the initiator circuit. In all other respects the operation of this embodiment is identical with that previously described.

The embodiment illustrated in Fig. 9 employs a movable member having a structure substantially like that of Fig. 7, except that battery 40 is eliminated and an electrical conductor 66, which connects to any conventional current source (not shown) located at the top of the well, is inserted through a passageway 67 in tail piece 21 and is passed into the bore of liner 27 where it is connected directly to piston 62.

With this embodiment, container 12, and stationary contact member 16 are lowered into the well on cable 15, as previously described. When the charge is in the desired position in the well, movable member 18 with its attached conductor 66 is mounted on cable 15 in the same manner as before and allowed to slide down cable 15 under its own weight, drawing lead 66 with it. The contact of member 18 with member 16 closes the circuit in the same manner as previously described and current supplied through lead 66 flows through the circuit to detonate detonator 13. Again, as in the previously described embodiment, the force of the impact between the contact members will break shear pin 37 and the thrust of coil spring 36 will retract piston 62 and contact pin 35 into the bore of liner 27 and re-open the circuit. It will be understood that the

current source will be suitably grounded in any conventional manner at the top of the well to complete the circuit.

In this embodiment, although a current supply lead extending to the top of the well is required, the important safety feature is retained which permits the withholding of the current from access to the explosive charge detonator until the charge is in place in the well, and the movable member is permitted to slide down the lowering cable into circuit closing contact with the stationary contact member.

It will be understood that various alterations and changes may be made in the details of the device in accordance with this invention within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. The method of detonating an explosive charge in a well, comprising, lowering an explosive charge and its electrically fired detonator with its electrical contact into a well and thereafter lowering into the well a body provided with a source of electric current and its contact in order to engage said contact so as to detonate the charge.

2. Mechanism for detonating an explosive charge in a well, comprising, means for lowering into a well an explosive charge having an electrically fired detonator, a contact for said detonator mounted on said lowering means, a body provided with a source of electric current and having a contact adapted to engage said first contact, and means for separately and subsequently attaching said body to said lowering means for guidance of said body along said lowering means in order to engage said contacts so as to detonate the charge.

3. Mechanism according to claim 2 wherein said source of electric current is a battery mounted on said body.

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