Feb. 29, 1944. M. SCHLUMBERGER 2,343,087

SWITCHING MECHANISM FOR BORE HOLE APPARATUS

Original Filed Jan. 23, 1940 2 Sheets-Sheet 1

Fig. 1

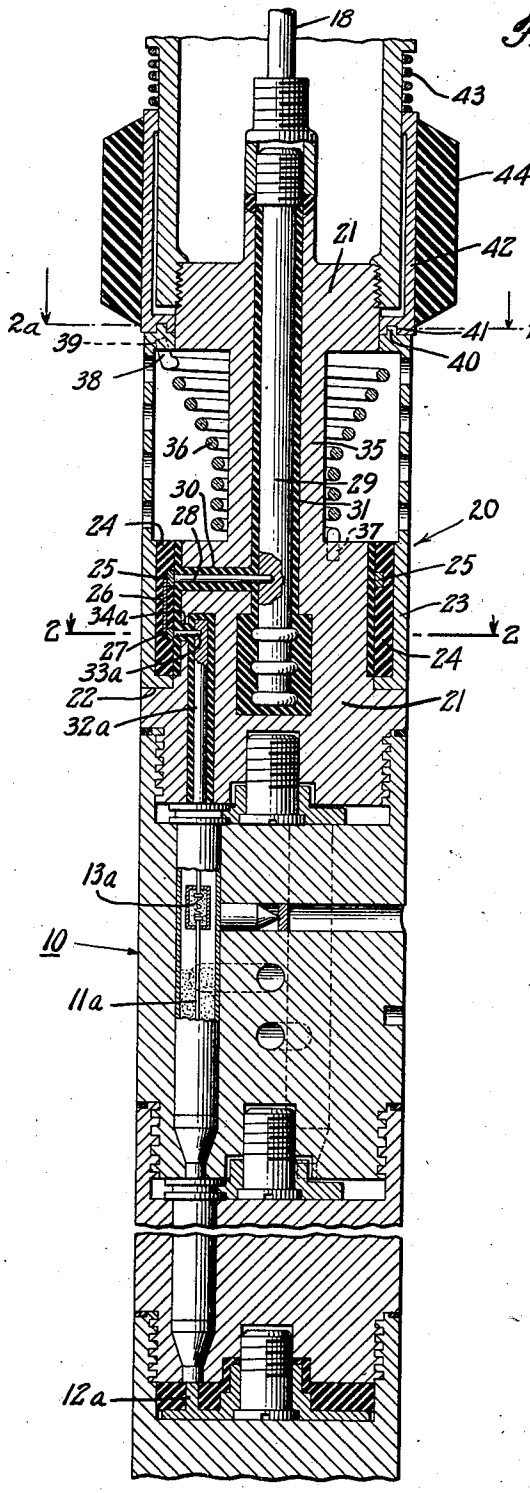
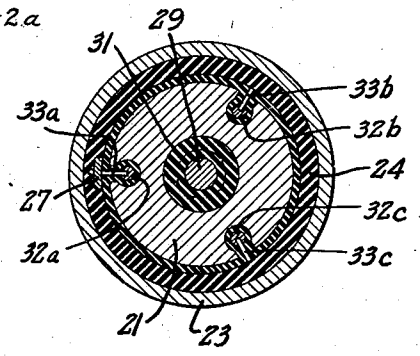


Fig. 2



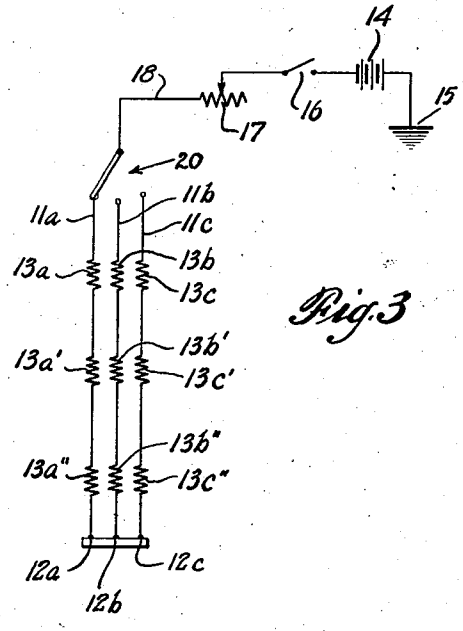


Fig. 3

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SWITCHING MECHANISM FOR BORE HOLE APPARATUS

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Fig. 4

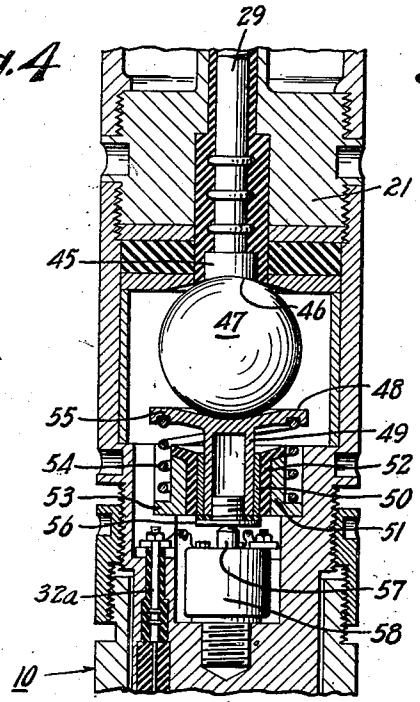


Fig. 2a

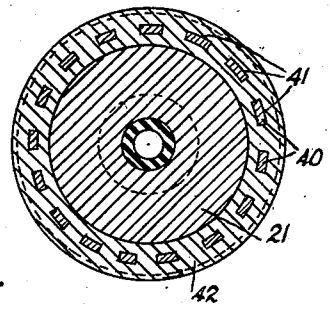
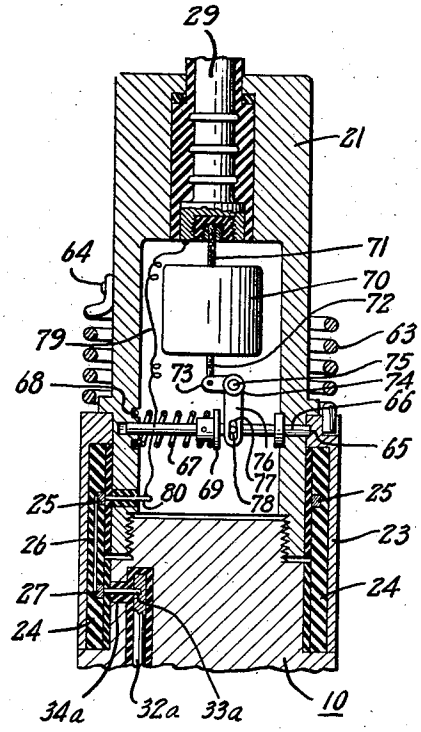


Fig. 6



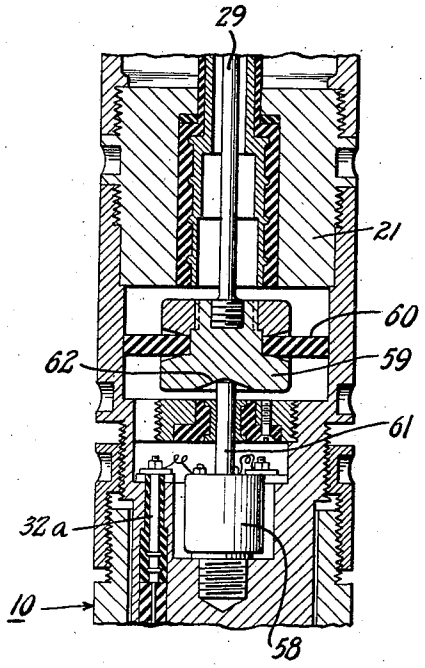


Fig. 5

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UNITED STATES PATENT OFFICE

2,343,087

SWITCHING MECHANISM FOR BOREHOLE APPARATUS

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Original application January 23, 1940, Serial No. 315,157. Divided and this application July 23, 1941, Serial No. 403,649. In France February 2, 1939

24 Claims. (Cl. 164—0.5)

The present invention relates to apparatus for controlling the firing of a plurality of explosive charges in a body such as a well casing perforator, for example, which is adapted to be located in a relatively inaccessible place.

In copending application Serial No. 315,157, filed January 23, 1940, for Gun perforator, of which this application is a division, there is disclosed well casing perforating apparatus having a plurality of guns, the axes of which lie in different horizontal planes and are angularly spaced about the longitudinal axis of the apparatus. The guns are adapted to be fired by a plurality of ignition circuits extending along the perforator, which are grounded to the perforator body at one end, and which are connected at the other end to corresponding conductors in the cable supporting the apparatus in the bore hole. The igniting circuits are adapted to be energized by a source of electrical energy located at the surface of the earth, one terminal of which is grounded to earth and the other terminal of which is connected through conventional switching means to the conductors in the cable.

It is an object of the present invention to provide new and improved switching means for connecting each of the ignition circuits in a gun perforator of the above character selectively to a single conductor in the supporting cable, whereby a mono-conductor cable may be used for carrying out perforating operations in a bore hole.

Another object of the invention is to provide new and improved switching means of the above character which is adapted to be actuated when a gun in the perforator is fired.

A further object of the invention is to provide new and improved switching means of the above character which is adapted to be actuated by the shock produced when one of the guns of the perforator is fired.

Additional objects of the invention will become apparent from the following detailed description of several embodiments taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic diagram illustrating switching means constructed according to the present invention in a gun perforator circuit;

Fig. 2 is a cross sectional view taken along line 2—2 of Fig. 1;

Figure 2*a* is a view in cross section taken along line 2*a*—2*a* of Figure 1 and looking in the direction of the arrows;

Fig. 3 is a schematic diagram of the igniting circuits for the gun perforator shown in Fig. 1; and

Figs. 4, 5 and 6 are views in longitudinal section of modified forms of switching means constructed according to the invention.

In Figs. 1 and 2, the switching means of this invention is shown as embodied in a gun perforator of the type disclosed in the above mentioned copending application. The gun perforator 10 includes a plurality of igniting circuits 11*a*, 11*b* and 11*c* which are grounded to the body of the perforator 10 at the points 12*a*, 12*b* and 12*c* (Fig. 3). The ignition circuit 11*a* includes a plurality of igniting filaments 13*a*, 13*a'* and 13*a''* for firing the corresponding guns in the perforator 10.

The igniting filaments 13*a*, 13*a'* and 13*a''* require different current values to bring them to red heat and means (not shown) is provided for grounding the free end of the next filament when one filament has been destroyed by the firing of the gun corresponding thereto, as disclosed in the above mentioned copending application, so that the guns in the perforator 10 may be fired successively by controlling the value of the current flowing through the igniting circuit 11*a*.

In similar fashion, the igniting circuit 11*b* includes a plurality of igniting filaments 13*b*, 13*b'* and 13*b''*, and the igniting circuit 11*c* includes a plurality of igniting filaments 13*c*, 13*c'* and 13*c''* which may be energized successively by controlling the values of the currents flowing through the circuits 11*b* and 11*c*, respectively.

At the surface of the earth is disposed a source of electrical energy 14, one terminal of which is grounded to earth at the point 15 and the other terminal of which is connected through a conventional switch 16 and variable resistance 17 to a conductor 18 in the cable (not shown) on which the perforator 10 is supported in the bore hole. By means of the switching means 20 of this invention, the connections between the conductor 18 in the cable and the igniting circuits 11*a*, 11*b* and 11*c* are changed each time a gun is fired in the perforator 10.

The switching means 20 comprises a connector element 21 formed with a shouldered portion 22 on which a metallic sleeve 23 is adapted to be rotatably mounted. Within the lower portion of the sleeve 23 is disposed an insulating sleeve 24 in which is embedded a conducting ring 25. The conducting ring 25 is electrically connected through a conductor 26 to a conducting sector 27 which is also embedded in the insulating material 24.

The conducting ring 25 is maintained in engagement with a contact rod 28 which is electrically connected to an axial conducting rod 29

connected at its upper extremity to the conductor 18. The conducting rod 28 is insulated from the body of the perforator 10 by an insulating sleeve 30 and the axial conducting rod 29 is insulated in a similar manner by an analogous insulating sleeve 31.

Each of the igniting circuits is electrically connected to a contact member which is adapted to be engaged by the movable conducting sector 27 embedded in the insulating material 24. Thus the igniting circuit 11*a* is connected to an insulated conducting rod 32*a* which has secured thereto a radially extending contact rod 33*a* which is disposed within an insulating sleeve 34*a* and which is adapted to engage the contact sector 27 as the sleeve 23 is rotated with respect to the connector element 21. In similar fashion, the igniting circuits 11*b* and 11*c* are connected through insulated conductors 32*b* and 32*c*, respectively, to radially extending contact rods 33*b* and 33*c*, respectively, which are also adapted to engage the contact sector 27 when the sleeve 23 is rotated (Fig. 2).

The connector element 21 is provided with a portion 35 of reduced diameter on which is disposed a coil spring 36, one end of which is secured to the connector element 21 at the point 37 and the other end of which is secured to a link 38 which is connected to the rotatable sleeve 23 at the point 39. The rotatable sleeve 23 is provided with a plurality of longitudinally extending teeth 40 which are adapted to be received in corresponding recesses 41 formed in a sleeve 42 which is carried on the connector element 21 so as to be slidable axially thereupon without rotation.

The sleeve 42 is normally urged downwardly by means of a coil spring 43, thereby engaging the teeth 40 on the sleeve 23 in the recesses 41 provided in the sleeve 42 and locking the sleeve 23 in position. Mounted on the sleeve 42 is a ring 44 made of flexible material, such as rubber, for example, and which is of substantially the same diameter as the bore hole casing into which the perforator 10 is to be lowered.

Before any of the igniting circuits may be energized, the position of the sleeve 23 with respect to the connector element 21 must be such that one of the contact rods 33*a*, 33*b* or 33*c* is in engagement with the sector 27. If, for example, the conducting sector 27 is in engagement with the contact rod 33*a*, a circuit is completed from the ground point 15 at the surface of the earth through the source of electrical energy 14, the switch 16, the variable resistance 17, the conductor 18, the conducting rod 29, the contact rod 28 engaging contact ring 25, the conductor 26, the conducting segment 27 engaging contact rod 33*a*, the contact rod 32*a* and the igniting circuit 11*a* to the ground point 12*a* on the perforator 10, the circuit being completed through the liquid in the bore hole and the intervening earth formations.

In order to ignite the lowermost filament 13*a*'', the switch 16 is closed and the variable resistor 17 is adjusted to give the required current value to accomplish this. As indicated above, the electrical characteristics of the igniting filaments 13*a* and 13*a*' are such that they will not ignite at this value of current.

The igniting of the filament 13*a*'' fires the gun corresponding thereto, and the powder gases issuing from the corresponding gun barrel exert an upward thrust on the ring 44, thereby causing the teeth 40 to become disengaged from the recesses 41 and permitting the sleeve 23 to rotate with respect to the connector element 21. As soon as the energy in the gases has been dissipated, the spring 43 returns the sleeve 42 to its normal position. The teeth 40 slide on the unrecessed part of the lower face of the sleeve 42 and eventually snap into the recesses 41, again holding the sleeve 23 in fixed position.

The tensions in the springs 36 and 43 are so adjusted as to permit the sleeve 23 to rotate through a sufficient angle after it has been released to move the sector 27 out of engagement with the rod 33*a* and into engagement with the rod 33*b* in the igniting circuit 11*b*. The lowermost filament 13*b*'' may then be ignited as indicated above in connection with the igniting filament 13*a*''. In similar fashion the ignition of the filament 13*b*'' connects the source of electrical energy 14 to the igniting filament 13*c*'' which may then be ignited.

The ignition of the filament 13*c*'' connects the source of energy 14 to the filament 13*a*'. Since the resistance of the latter is different from that of the filament 13*a*'', the variable resistance 17 must be adjusted to give the current value required for its ignition. Once that has been done, the filaments 13*a*', 13*b*' and 13*c*' may be ignited in that order, the ignition of each resulting in the connection of the source of electrical energy to the next. When these have been fired and the source 14 is connected to the filament 13*a*, the current is again adjusted by the variable resistance 17, whereupon the filaments 13*a*, 13*b* and 13*c* may be ignited, in that order.

In the modification shown in Fig. 4, the conducting rod 29, which is in electrical connection with the conductor 18, terminates in an enlarged portion 45, the lower surface of which is curved at 46 and is in engagement with a spherical conducting ball 47. The conducting ball 47 rests upon a cup-shaped member 48 provided with a tubular shaft 49 which is movable axially in a bushing 50 secured within a tubular member 51 fixed to the connector element 21, and insulated from the member 51 by an insulating sleeve 52.

The tubular element 51 is provided with an outwardly extending flange 53 at the lower extremity thereof which is adapted to seat a compression spring 54, the upper end of which is seated in an annular recess 55 formed in the lower face of the cup-shaped member 48, thereby maintaining the spherical ball 47 in good electrical contact with the enlarged portion 45 of the conducting rod 29.

At the lower end of the tubular portion 49 on the cup-shaped member 48 is fitted a contact plate 56 which is continuously engaged by the actuator 57 of a conventional type commutating switch 58 such as that shown in prior Patent No. 2,210,125 to Raymond, for example. The actuator 57 is made of conductive material and it serves to complete the circuit from the conducting plate 56 to one element of the switch 58. The switch 58 is adapted to connect the conducting rod 29 selectively to the conductors 32*a*, 32*b* and 32*c* in the igniting circuits 11*a*, 11*b* and 11*c*, respectively.

In operation, the shock produced when one of the guns in the perforator 10 is fired moves the spherical ball 47 transversely within the perforator 10, thereby moving the cup-shaped member 48 axially against the force of the compression spring 54. This action depresses the actuator 57 of the switch 58, connecting the conduct-

ing rod 29 to the next igniting circuit which is to be energized.

The modification illustrated in Fig. 5 is similar to that shown in Fig. 4, except that the spherical ball 47 is replaced by a cylindrical conducting mass 59 which is elastically suspended in the connector element 21 by suitable supports 60 made of resilient material, such as rubber, for example. In this modification, the switch 58 is provided with an extended actuator 61 which projects into a conical recess 62 formed in the lower face of the cylindrical mass 59. As in the previous case, when one of the guns in the perforator 10 is fired, the latter is moved laterally with respect to the mass 59 and the inclined surface of the conical recess 62 therein depresses the switch actuator 61, thereby disconnecting the conducting rod 29 from one igniting circuit and connecting it to a different igniting circuit.

The modification shown in Fig. 6 is similar to that shown in Fig. 1. In this embodiment, however, the sleeve 23 is adapted to be rotated with respect to the connector element 21 by means of a coil spring 63 which is secured on the connector element 21 at the point 64. The interior wall of the sleeve 23 is provided with a plurality of spaced recesses 65, within which a transversely extending rod 66 is adapted to be received for the purpose of holding the sleeve 23 in fixed position. The rod 66 is continuously urged into engagement with the recess 65 by means of a compression spring 67, one end of which is seated within an annular recess 68 formed in the wall of the connector element 21 and the other end of which is seated against a disc 69 secured to the rod 66.

A large mass 70 is suspended within the connector element 21 on a flexible cable 71 and it is connected at its lower end by means of a flexible cable 72 to one arm 73 of a bell crank mechanism 74 which is pivoted at 75. The other arm 76 of the bell crank mechanism 74 is provided with a slot 77 within which a pin 78 on the rod 66 is adapted to be received. The conducting rod 29 which supplies current to the igniting circuits is connected by means of a conductor 79 to an insulated conducting rod 80 which is maintained in engagement with the conducting ring 25 in the sleeve 24.

When one of the guns in the gun perforator 10 is fired, the shock imparted to the perforator assembly causes the latter to move laterally with respect to the mass 70, turning the bell crank mechanism 74 about the pivot point 75 and disengaging the rod 66 from the recess 65. This permits the sleeve 23 to rotate under the influence of the spring 63 through a sufficient angle to bring the conducting sector 27 into engagement with the conducting rod 32b corresponding to the next igniting circuit 11b. By this time the mass 70 has returned to its normal position and the rod 66 is again moved into engagement with one of the recesses 65 by means of the compression spring 67.

While several specific embodiments of the invention have been described above in detail, these are intended to be illustrative and not restrictive and they are susceptible or numerous changes in form and detail within the scope of the following claims.

I claim:

1. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, an energizing circuit, and switching means responsive to the firing of any of said gun mechanisms for controlling the connections between said energizing circuit and said respective ignition circuits.

2. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, an energizing circuit, and switching means actuated by the shock produced by the firing of any of said gun mechanisms for controlling the connections between said energizing circuit and said respective ignition circuits.

3. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of explosive charges therein, a plurality of ignition circuits for said explosive charges, an energizing circuit, and switching means actuated by the gases produced when any of said explosive charges is fired, for controlling the connections between said energizing circuit and said respective ignition circuits.

4. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, each of said circuits being connected at one end to ground, a conductor extending from said body to the surface of the earth, a source of electrical energy at the surface of the earth, having one terminal connected to ground and a second terminal connected to said conductor, and switching means responsive to the firing of any of said gun mechanisms for changing the connections between said conductor and said respective ignition circuits each time one of said gun mechanisms is fired.

5. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, each of said circuits being connected at one end to ground, a conductor extending from said body to the surface of the earth, a source of electrical energy at the surface of the earth, having one terminal connected to ground and a second terminal connected to said conductor, and switching means actuated by the shock produced by the firing of any of said gun mechanisms for changing the connections between said conductor and said respective ignition circuits each time one of said gun mechanisms is fired.

6. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of explosive charges therein, a plurality of ignition circuits for said explosive charges, each of said circuits being connected at one end to ground, a conductor extending from said body to the surface of the earth, a source of electrical energy at the surface of the earth, having one terminal connected to ground and a second terminal connected to said conductor, and switching means actuated by the gases produced when any of said explosive charges is fired for changing the connections between said conductor and said respective ignition circuits each time one of said explosive charges is fired.

7. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series, a conductor adapted to supply electric current to said ignition circuits, and means rendered operative by the firing of any of said gun mechanisms for switching the connection of said cur-

rent supply conductor from one of said ignition circuits to another one every time a gun mechanism is fired.

8. A gun apparatus which comprises, in combination, at least two series of gun mechanisms having powder charges therein, an electric ignition circuit for each of said series, a conductor adapted to supply electric current to said electric ignition circuits, and means rendered operative by expansion of the powder gases from any of said gun mechanisms after the firing thereof, for switching the connection of said current supply conductor from one of said ignition circuits to another one, every time one of said gun mechanisms is fired.

9. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series, a conductor adapted to supply electric current to said ignition circuits, and means rendered operative by the shock produced by the firing of any of said gun mechanisms, for switching the connection of said current supply conductor from one of said ignition circuits to another one, every time one of said gun mechanisms is fired.

10. A gun casing perforator which comprises, in combination, a plurality of units detachably assembled in consecutive series in a longitudinal direction, each unit being provided with gun mechanisms including at least two longitudinal powder chambers therein and at least one gun barrel for each chamber, electric igniting means for each of said chambers, the igniting means for one chamber in one unit being adapted to be connected automatically to the igniting means for the corresponding chamber of the next unit so as to form at least two ignition circuits extending through said series of units, an electrical conductor associated with said perforator, and means responsive to the firing of each of said gun mechanisms for connecting said conductor selectively to said ignition circuits.

11. A gun casing perforator which comprises, in combination, a plurality of units detachably assembled in consecutive series in a longitudinal direction, each unit being provided with at least two longitudinal powder chambers and at least one gun barrel for each chamber, electric igniting means for each of said chambers, the igniting means for one chamber in one unit being adapted to be connected automatically to the igniting means for the corresponding chamber of the next unit so as to form at least two ignition circuits extending through said series of units, an electrical conductor for supplying current to said circuits, and means rendered operative automatically by shocks produced by the successive firing of each of said chambers in each unit, for connecting said conductor alternately to said ignition circuits.

12. A gun casing perforator which comprises, in combination, a plurality of units detachably assembled in consecutive series in a longitudinal direction, each unit being provided with at least two longitudinal powder chambers and at least one gun barrel for each chamber, electric igniting means for each of said chambers, the igniting means for one chamber in one unit being adapted to be connected automatically to the igniting means for the corresponding chamber of the next unit so as to form at least two distinct ignition circuits extending through said series of assembled units, an electrical conductor associated with said perforator, a switch having two positions for connecting said conductor alternately to each of said ignition circuits, and inertia operative means adapted to be actuated by the successive firing of said powder chambers in each unit for controlling the position of said switch.

13. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series of gun mechanisms, a current supply conductor mounted in said apparatus, a switch having an input terminal connected to said current supply conductor and at least two output terminals connected to said respective ignition circuits, an actuator for said switch, and means rendered operative by the shocks produced by the firing of said gun mechanisms for manipulating said switch actuator every time a shot is fired.

14. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series of gun mechanisms, a conductor connected to a contact member mounted in said apparatus, a switch having an input terminal and at least two output terminals connected to said respective ignition circuits, an actuator for said switch, said actuator being made of conducting material and being connected to the input terminal of said switch, a conducting cup-shaped member mounted on said switch actuator, a conducting ball mounted between said cup-shaped member and said contact member, and means for maintaining said ball and cup-shaped member in yielding engagement with said contact member, whereby said switch will be actuated every time one of said gun mechanisms is fired to change the connection of said conductor from one ignition circuit to another.

15. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series of gun mechanisms, a conductor in said apparatus, a laterally yieldable conducting mass suspended on said conductor and having a conical recess formed in the lower face thereof, a switch having an input terminal and two output terminals connected to said respective ignition circuits, and an actuator for said switch, extending into the recess in the conducting mass and engaging the wall thereof, said actuator being made of conducting material and being connected to the input terminal of said switch, whereby said switch will be actuated every time one of said gun mechanisms is fired to change the connection of said conductor from one ignition circuit to another.

16. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series of gun mechanisms, a conductor associated with said apparatus, a rotatable member on said apparatus for successively connecting said conductor to said respective ignition circuits, elastic means for constantly tending to rotate said rotatable member about said apparatus, locking means for retaining said rotatable member in fixed position with respect to said apparatus, and means rendered operative by the firing of any of said gun mechanisms for rendering said locking means temporarily ineffective every time a gun mechanism is fired, whereby said rotatable member may rotate a sufficient distance to change the connection of said conductor from one ignition circuit to another.

17. A gun apparatus which comprises, in combination, at least two series of gun mechanisms,

an electric ignition circuit for each of said series of gun mechanisms, a main conductor mounted in central position at the upper end of said apparatus, an annular member rotatably mounted on said end of the apparatus for successively connecting said main conductor to said respective ignition circuits, elastic means for constantly tending to rotate said annular member about said main conductor, locking means for normally retaining said annular member in fixed position with respect to said main conductor, and means rendered operative by the shock produced by the firing of any of said gun mechanisms for rendering said locking means temporarily ineffective every time a gun mechanism is fired, whereby the connection of said main conductor may be switched from one ignition circuit to another.

18. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, each having a powder charge therein, an electric ignition circuit for each of said series of gun mechanisms, a main conductor mounted in central position at the upper end of said apparatus, an annular member rotatably mounted on said end of the apparatus for successively connecting said main conductor to said respective ignition circuits, elastic means for constantly tending to rotate said annular member about said main conductor, locking means for normally retaining said annular member in fixed position with respect to said main conductor, and means rendered operative by the expansion of the powder gases produced by the ignition of a powder charge in any of said gun mechanisms for rendering said locking means temporarily ineffective every time a gun mechanism is fired, whereby the connection of said main conductor may be switched from one ignition circuit to another.

19. A gun apparatus for use in a bore hole casing which comprises, in combination, at least two series of gun mechanisms, each having a charge of powder therein, an electric ignition circuit for each of said series of gun mechanisms, a main conductor mounted in central position at the upper end of said apparatus, an annular member rotatably mounted on said end of the apparatus for successively connecting said main conductor to said respective ignition circuits, elastic means for constantly tending to rotate said annular member about said main conductor, a sleeve mounted for axially slidable movement with respect to said apparatus, locking means carried by said sleeve for retaining said annular member in fixed position with respect to said main conductor and a flexible ring on said sleeve and adapted to fit snugly in said casing, said ring being adapted to be moved axially by the pressure of the powder gases released by the firing of a powder charge in any of said gun mechanisms for rendering said locking means temporarily ineffective every time a gun mechanism is fired, whereby the connection of said main conductor may be switched from one ignition circuit to another.

20. A gun apparatus which comprises, in combination, at least two series of gun mechanisms, an electric ignition circuit for each of said series of gun mechanisms, a main conductor mounted in central position at the upper end of said apparatus, an annular member rotatably mounted on said end of the apparatus for successively connecting said main conductor to said respective ignition circuits, said annular member being provided with at least one recess therein, elastic means for constantly tending to rotate said annular member about said main conductor, a transverse locking bar adapted to be received in said recess for normally retaining said annular member in fixed position with respect to said main conductor, spring means for urging said bar toward said recess, and inertia operative means actuated by the shock produced by the firing of any of said gun elements for temporarily withdrawing said locking bar from said recess every time a gun mechanism is fired, whereby the connection of said main conductor may be switched from one ignition circuit to another.

21. In apparatus for use in a bore hole drilled into the earth, which apparatus includes an explosive charge, circuit means to fire said explosive charge, at least one electrical circuit and means actuated by said circuit, the combination of switching means responsive to the firing of said explosive charge for controlling automatically said electrical circuit.

22. Apparatus for use in bore holes drilled into the earth, comprising a support adapted to be lowered into the bore hole and having a plurality of electrical circuits associated therewith, each having electrical means therein, an energizing circuit for energizing said plurality of electrical circuits, an explosive charge mounted on said support, circuit means to fire said explosive charge, and switching means responsive to the firing of said explosive charge for controlling automatically the connections between said electrical circuits and the energizing circuit.

23. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, an energizing circuit, switching means for controlling the connections between said energizing circuit and said respective ignition circuits, resilient means for urging said switching means in the direction to break one connection and make another connection, and locking means for retaining said switching means in fixed position, said locking means being adapted to be rendered ineffective each time one of said gun mechanisms is fired, to permit the resilient means to actuate the switching means, thereby disconnecting the energizing circuit from one ignition circuit and connecting it to another ignition circuit.

24. Gun apparatus comprising a body adapted to be lowered into a bore hole and having a plurality of gun mechanisms therein, a plurality of ignition circuits for said gun mechanisms, an energizing circuit, switching means for controlling the connections between said energizing circuit and said respective ignition circuits, and inertia means, rendered operative by the firing of one of said gun mechanisms, for controlling automatically said switching means to disconnect the energizing circuit from one ignition circuit and to connect it to another ignition circuit.

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