April 22, 1947. M. SCHLUMBERGER 2,419,371

CARTRIDGE

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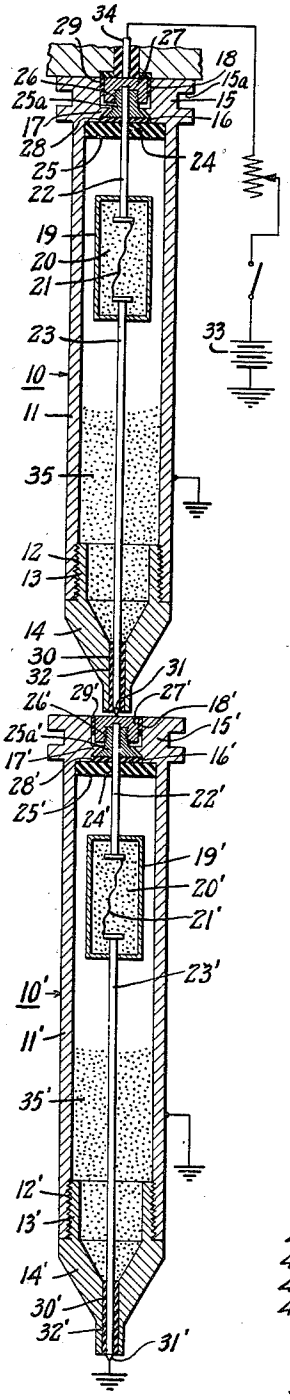


Fig. 1

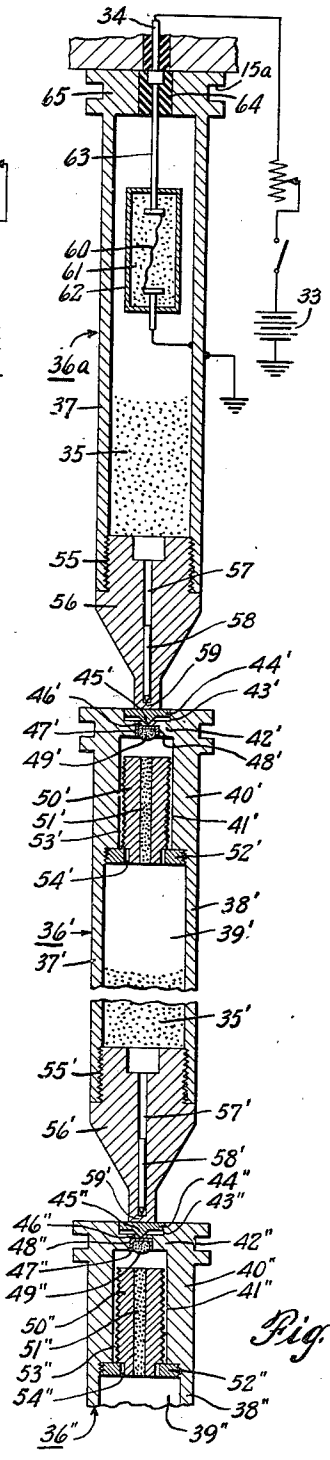


Fig. 2

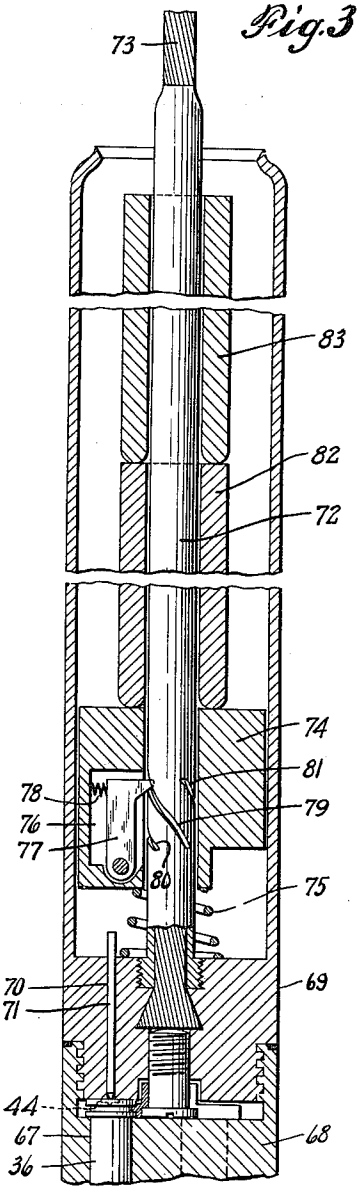


Fig. 3

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The present invention relates to cartridges and more particularly to cartridges for use in gun apparatus which is designed to be employed in relatively inaccessible places, such as a well casing perforator, for example.

This application is a continuation-in-part of an application for Gun perforator, Serial No. 315,157, filed January 23, 1940, now Patent No. 2,381,081, which application describes well casing perforating apparatus comprising an assembly of a plurality of similar units each having a plurality of longitudinal powder chambers therein, each communicating with at least one laterally extending gun bore.

It is an object of the present invention to provide a new and improved cartridge for use in well casing perforating apparatus of the above character, which is adapted to comprise a component part of a continuous ignition path extending through the perforating apparatus and including similar cartridges in other units thereof.

Another object of the invention is to provide a new and improved cartridge of the above character in which a charge of powder is adapted to be ignited by electric means connected in an electric circuit extending therethrough and insulated therefrom.

A further object of the invention is to provide a new and improved cartridge of the above character which is adapted to maintain the ignition circuit, of which it forms a part, closed after the charge of powder therein has been ignited.

A still further object of the invention is to provide a new and improved well casing perforator cartridge which is adapted to be ignited by the ignition previously of another cartridge in the same ignition path in the perforating apparatus.

Another object of the invention is to provide a new and improved well casing perforator cartridge of the above character which is adapted to interposed a time delay between the ignition of adjacent cartridges in the same ignition path in the perforating apparatus.

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

Fig. 1 is a view in longitudinal section of one form of cartridge constructed according to the present invention;

Fig. 2 is a view in longitudinal section illustrating a modified form of cartridge, together with electrical means for igniting the same; and

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Fig. 3 is a view in longitudinal section illustrating a cartridge of the type shown in Fig. 2, together with mechanical means for igniting the same.

In Fig. 1, the invention is embodied in a cartridge which is adapted to be fired electrically as described in greater detail hereinafter. Referring to Fig. 1, a cartridge 10 is shown which comprises a metallic tubular casing 11, the lower end of which is internally threaded at 12 to receive the externally threaded portion 13 of a conical closure member 14. The upper end of the tubular casing 11 is provided with a closure member 15 within which is formed a circular aperture 16, tapering rearwardly to a restricted portion 17 which communicates with a larger circular recess 18 formed in the rear face of the rear closure member 15. In order to facilitate the removal of the cartridge 10 from a well casing perforator, a peripheral groove 15a is provided in the rear portion thereof.

The firing device for the cartridge 10 comprises an enclosed tubular casing 19, made of a suitable high resistance material, Bakelite, for example, which contains a small quantity of powder 20. The powder 20 is adapted to be ignited by a wire filament 21 which is connected at one end to a conducting rod 22 and at its other end to a conducting rod 23. The conducting rod 22 extends through the tubular casing 19 and through an aperture 24 in an ebonite plug 25, which is snugly fitted against the rear closure member 15, and into the recess 18. Secured at the end of the conducting rod 22 is a conical contact member 25a provided with a threaded portion 26 on which a second contact member 27 is adapted to be screwed.

The contact members 25a and 27 are maintained out of contact with the rear closure member 15 by an insulating disc 28, disposed between the upper face of the ebonite plug 25 and the lower face of the conical contact member 25a, and by a ring 29, of insulating material, which is inserted in the space between the second contact member 27 and the wall bounding the circular recess 18.

The conducting rod 23 extends through the other end of the casing 19 and through a narrow bore 30 formed in the conical closure member 14, and it has a pointed end 31 which extends slightly beyond the forward extremity of the conical closure member 14. A sleeve 32 of insulating material is fitted on the conducting rod 23, which serves to insulate the latter from the conical closure member 14.

When the respective units of the well casing perforator, which is described in the aforementioned copending application, are assembled together, at least one continuous ignition path is formed. This ignition path is constituted by a plurality of cartridges like the cartridge 10, which are mounted so that their longitudinal axes coincide. For the sake of simplicity, however, only two cartridges have been shown in Fig. 1 in the positions which they would assume in the assembled perforator. The second cartridge 10' is identical with the first cartridge 10 and corresponding parts thereof have been designated by primed reference characters.

As indicated in the aforementioned copending application, each ignition circuit is energized by a source of electrical energy at the surface of the earth, one terminal of which is connected to ground and the other terminal of which is connected through a conductor in the supporting cable to the upper end of the ignition circuit. The lower end of the ignition circuit is grounded to the body of the well casing perforator and the metal casings of the cartridges are likewise connected to ground.

This is illustrated schematically in Fig. 1, in which is shown a source of voltage 33, one terminal of which is connected to ground and the other terminal of which is connected to a conducting rod 34 which is in engagement with the rear contact member 27 on the cartridge 10. The pointed end 31' of the conducting rod 23' in the cartridge 10' is likewise connected to ground, as are the metallic casings 11 and 11' of the cartridges 10 and 10', respectively. Also, the igniting filaments 21 and 21' in the cartridges 10 and 10', respectively, are adapted to be ignited by different current values, the igniting current for the filament 21' being lower than that for the filament 21.

In operation, the current supplied by the source of energy 33 is adjusted to give the value required to bring the igniting filament 21' to red heat, thus igniting the charge of powder 20' in the casing 19'. When the powder 20' is ignited, the combustion thereof bursts the casing 19' and thus transmits ignition to the explosive 35' present in the cartridge casing 11'.

At the time of the explosion, the ebonite plug 25' is liquefied by the heat and pressure to which it is subjected and it pushes the insulating disc 28' towards the rear so as to crush the metal contact member 25a' against the rear closure member 15'. The contact member 27' is now electrically connected to the rear closure member 15', which is connected to ground. Since the pointed end 31 of the conducting rod 23 of the cartridge 10 is now connected to ground, the firing circuit remains closed and operative. The current supplied by the source 33 is then adjusted to the value required to bring the filament 21 to red heat, whereupon the operation is essentially as described above in connection with the cartridge 10'.

Fig. 2 illustrates an embodiment of the invention in which the cartridge is adapted to be fired automatically by means actuated by the powder gases produced by the ignition of a preceding cartridge. In Fig. 2, the cartridge 36' includes a tubular metallic casing 37' having a thin walled forward portion 38' forming a main powder chamber 39', and a thicker walled rear portion 40' forming an auxiliary chamber 41' of lesser diameter.

The casing 37' is closed at its upper end by a transverse partition 42', in the upper face of which is formed a circular recess 43', which is adapted to receive a firing pin 44'. The firing pin 44' is provided with a conical portion 45' which is adapted to be projected through a small aperture 46' in the transverse partition 42' against a metallic cup 47' inserted in a recess 48' formed in the transverse partition 42', which contains a small disc of mercury fulminate 49' or other similar detonating explosive.

Disposed within the auxiliary chamber 41' is a hollow tubular member 50' containing a slow fuse composition 51' and having an outwardly extending flange 52' which is screwed within the casing 37' adjacent the thicker walled rear portion 40'. The tubular member 50' is externally threaded and it cooperates with the auxiliary chamber 41' to form a labyrinth-like passage 53' which communicates with the main chamber 39' through a plurality of apertures 54' formed in the flange 52'.

The forward portion of the casing 37' is internally threaded at 55' to receive an externally threaded conical plug 56' having a narrow axial bore 57' within which is disposed a pin 58'. The forward end of the bore 57' is normally closed by a thin wall 59' which is adapted to be pierced by the pin 58' when the cartridge 36' is fired.

The firing of a group of cartridges like the cartridge 36' may be initiated electrically or mechanically as shown in Figs. 2 and 3, respectively. In the electrically fired modification shown in Fig. 2, the first cartridge 36a is provided with an igniting filament 60 embedded in a charge of powder 61 contained in a casing 62. The igniting filament 60 is grounded at one end to the metallic casing 37 of the cartridge 36a and it is connected at its other end to a conductor 63 which passes through an insulated bushing 64 in the upper closure member 65 of the cartridge 36a. The conductor 63 is connected through the conducting rod 34 to one terminal of the source of electrical energy 33, the other end of which is grounded.

When the respective units of the well casing perforator have been assembled as described in the above mentioned copending application, at least one continuous ignition path is formed in the assembled perforator, which path is composed of cartridges like the cartridge 36', the axes of which coincide. Operation is effected by supplying current from the source of electrical energy 33 to the igniting filament 60 in the first cartridge 36a. This produces an explosion which forces the pin 58 in the bore 57 through the thin wall 59 and against the firing pin 44' of the next cartridge 36'. The impact of the blow forces the conical portion 45' of the firing pin 44' against the cup 47', thereby igniting the mercury fulminate 49' therein and simultaneously igniting the fuse composition 51' in the tube member 50'.

The fuse composition 51' now burns at a rate depending upon the ingredients from which it is made. This rate may be so chosen that the ignition of the explosive in the main powder chamber 39' will not take place until after a predetermined period of time has elapsed, corresponding to the interval which it is desired to produce between the firing of two successive cartridges. The gases produced by the burning of the composition 51' flow into the auxiliary chamber 41', through the labyrinth-like passage 53' and through the apertures 54' into the main chamber 39'. In traversing this path, the gases

are cooled to a considerable extent by expansion, so that when they enter the main chamber 39' they are not hot enough to ignite the explosive 35' contained therein.

The combustion of the last remnants of the fuse composition 51' will ignite the explosive 35' in the main chamber 39', the gases from which will force the pin 58' through the wall 59' to the firing pin 44'' of the next cartridge 36'' which will then be fired in an analogous manner.

If desired, the cartridge 36*a* may be ignited mechanically by apparatus of the type shown in Fig. 3. In this figure, the cartridge 36 is identical with the cartridge 36' of Fig. 2, and corresponding parts have been designated by unprimed reference numerals. Referring to Fig. 3, the cartridge 36 is shown disposed in one of the powder chambers 67 in a well casing perforating unit 68 of the type disclosed in the above mentioned copending application. The well casing perforating unit 66 is provided with three powder chambers like the powder chamber 67, which extend longitudinally therethrough and the axes of which form the apices of an equilateral triangle. Accordingly, in actual operation, there will be three cartridges 36 and three firing means therefor. For the sake of simplicity, however, only one firing means will be described hereinafter.

The well casing perforator unit 68 is threadedly secured to a connector element 69 provided with a longitudinal bore 70 within which is disposed a firing pin 71, the lower end of which rests against the firing pin 44 of the cartridge 36. Secured to the connector unit 69 is an elongated sleeve 72 through which the supporting cable 73 passes, the latter being secured to the connector element 69 in any suitable manner.

Slidably mounted on the sleeve 72 is an anvil 74 which is normally maintained out of engagement with the firing pin 71 by means of a compression spring 75. Within the anvil 74 is formed a recess 76 having a pivotally mounted pawl 77 therein which is urged in the direction of the sleeve 72 by means of a compression spring 78. The pawl 77 is adapted to cooperate with three spiral grooves 79, 80 and 81 formed in the sleeve 72 to reset the anvil 74 after it has been actuated, in preparation for the firing of another cartridge. It will be noted that the upper end of each groove overlies the lower end of the next adjacent groove.

In operation, let it be assumed that the anvil 74 is in the position shown in Fig. 3. If now it is desired to fire the cartridge 36, a split cylindrical weight 82 is placed around the cable 73 and is allowed to drop into the bore hole. The impact produced when the weight 82 strikes the anvil 74 moves the latter downwardly against the compression spring 75, and drives the firing pin 71 sharply against the firing pin 44 in cartridge 36. This ignites the cartridge 36 as described above in connection with Fig. 2.

As the anvil 74 moves downwardly, the pawl 77 is forced out of the upper end of the groove 79, and when the anvil 74 has reached the bottom of its stroke, the pawl 77 will enter the lower end of the spiral groove 80. When the energy of the blow produced by the weight 82 has been entirely dissipated, the restoring force of the compression spring 75 begins to move the anvil 74 upwardly to its normal position. During the return trip the pawl rides in the groove 80, and thus rotates the anvil 74 through an angle of approximately 120°, so that it is in position to fire the cartridge 36 in another series in the well casing perforator. The initiation of ignition in the second series of cartridges is accomplished by dropping a second weight 83 down the cable 73, the operation of the apparatus being the same as described above.

The several representative embodiments described above are intended merely to be illustrative and not restrictive of the invention, and they are suspectible of numerous changes in form and detail within the scope of the appended claims.

I claim:

1. In a cartridge for a sequentially dischargeable cartridge train, the combination of a tubular casing, means forming a closure having an electrically conductive portion at one end of said casing, means forming a second closure at the other end of said casing, an explosive charge in the casing, means for igniting said explosive charge, means forming in said electrically conductive closure portion a conduit having a restricted portion, an electrical contact element mounted in said conduit, frangible insulating material insulating said contact element from the walls of said conduit, said contact element having an external portion adapted to cooperate with a preceding cartridge in a cartridge train to form a firing circuit component, and having an internal portion of such shape that it cannot pass through the restricted portion of said conduit, whereby the explosion of said charge will cause the internal portion of said contact element to destroy said frangible insulating material and to be moved into engagement with the walls of said conduit.

2. In a cartridge for a sequentially dischargeable cartridge train, the combination of a tubular casing, means forming an electrically conductive closure at one end of said casing, means forming a second closure at the other end of said casing, means forming in said electrically conductive closure a conduit having a restricted portion, an electrical contact element mounted in said conduit, frangible insulating material insulating said contact element from the walls of said conduit, said contact element having an external portion adapted to cooperate with a preceding cartridge in a cartridge train to form a firing circuit component, and having an internal portion of such shape that it cannot pass through the restricted portion of said conduit, a second contact element mounted in said second closure and insulated therefrom, said second contact element having an internal portion and an external portion adapted to cooperate with a succeeding cartridge in a cartridge train to form a firing circuit component, an explosive charge in said casing, and an electric igniting element connected to the internal portions of said first and second contact elements.

3. In a cartridge for a sequentially dischargeable cartridge train, the combination of a tubular metallic casing, means forming an electrically conductive closure at one end of said casing, means forming a second closure at the other end of said casing, means forming in said electrically conductive closure a conduit comprising an internal conical portion tapering outwardly to a portion of smaller diameter communicating with an external portion of larger diameter, an electrical contact element mounted in said conduit, said contact element having an external portion disposed in the external portion of said conduit and spaced from the walls thereof, and an internal portion of conical shape disposed in the conical portion of said conduit and spaced from the walls thereof, insulating material between

said contact external portion and the walls of said conduit external portion, frangible insulating material between said contact internal portion and the walls of said conduit internal portion, a plastic plug snugly fitted in the casing over the internal portion of said conduit, a second electrical contact mounted in said second closure and insulated therefrom, said second contact having an internal portion and an external portion projecting beyond said second closure, an explosive charge in said casing, and an igniting filament connected between the internal portions of said first and second contact elements.

4. A sequentially dischargeable cartridge train comprising a plurality of cartridges in end to end relation, each of said cartridges comprising a tubular casing, an electrically conductive closure for one end of said casing, a second closure for the other end of said casing, means forming in said electrically conductive closure a conduit having a restricted portion therein, an electrical contact element mounted in said conduit, said contact element having an external portion and an internal portion of such shape that it cannot pass through the restriction in said conduit, frangible insulating material between said contact element and the walls of said conduit, a second contact element mounted in said second closure and insulated therefrom, said second contact element having an external portion and an internal portion, an explosive charge in the casing, and electrical igniting means connected between the internal portions of said contact elements, the external portion of the second contact elements of each cartridge being adapted to engage the external portion of the first contact element of the adjacent cartridge, and the electrical igniting means in successive cartridges being adapted to ignite at successively greater electric currents, whereby explosion of the charge in one cartridge causes the internal portion of the first electrical contact element therein to destroy the frangible insulating material and to engage the walls of the conduit in the electrically conductive closure therein, thus preparing the firing circuit for an adjacent cartridge.

5. A sequentially dischargeable cartridge train comprising a plurality of cartridges in end to end relationship, each of said cartridges comprising a tubular metallic casing, an electrically conductive closure for one end of said casing, a second closure for the other end of said casing, means forming in said electrically conductive closure a conduit comprising an internal conical portion tapering outwardly to a portion of smaller diameter communicating with an external portion of larger diameter, an electrical contact element

mounted in said conduit, said contact element having an external portion disposed in the external portion of said conduit and spaced from the walls thereof, and an internal portion of conical shape disposed in the conical portion of said conduit and spaced from the walls thereof, insulating material between said contact external portion and the walls of said conduit external portion, frangible insulating material between said contact internal portion and the walls of said conduit internal portion, a plastic plug fitted in the casing over the internal portion of said conduit, a second electrical contact mounted in said second closure and insulated therefrom, said second contact having an internal portion and an external portion projecting beyond said second closure, an explosive charge in said casing, and an igniting filament connected between the internal portions of said first and second contacts, ground connections to the casings of each of said cartridges, the projecting external portion of the second contact of each cartridge engaging the external portion of the first contact element of the next cartridge, a ground connection to the external portion of the second contact element of one end cartridge in the series, and a source of electric current having one terminal grounded and the other terminal connected to the external portion of the first contact element of the other end cartridge of the series, the igniting filaments in successive cartridges having different resistances per unit length.

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