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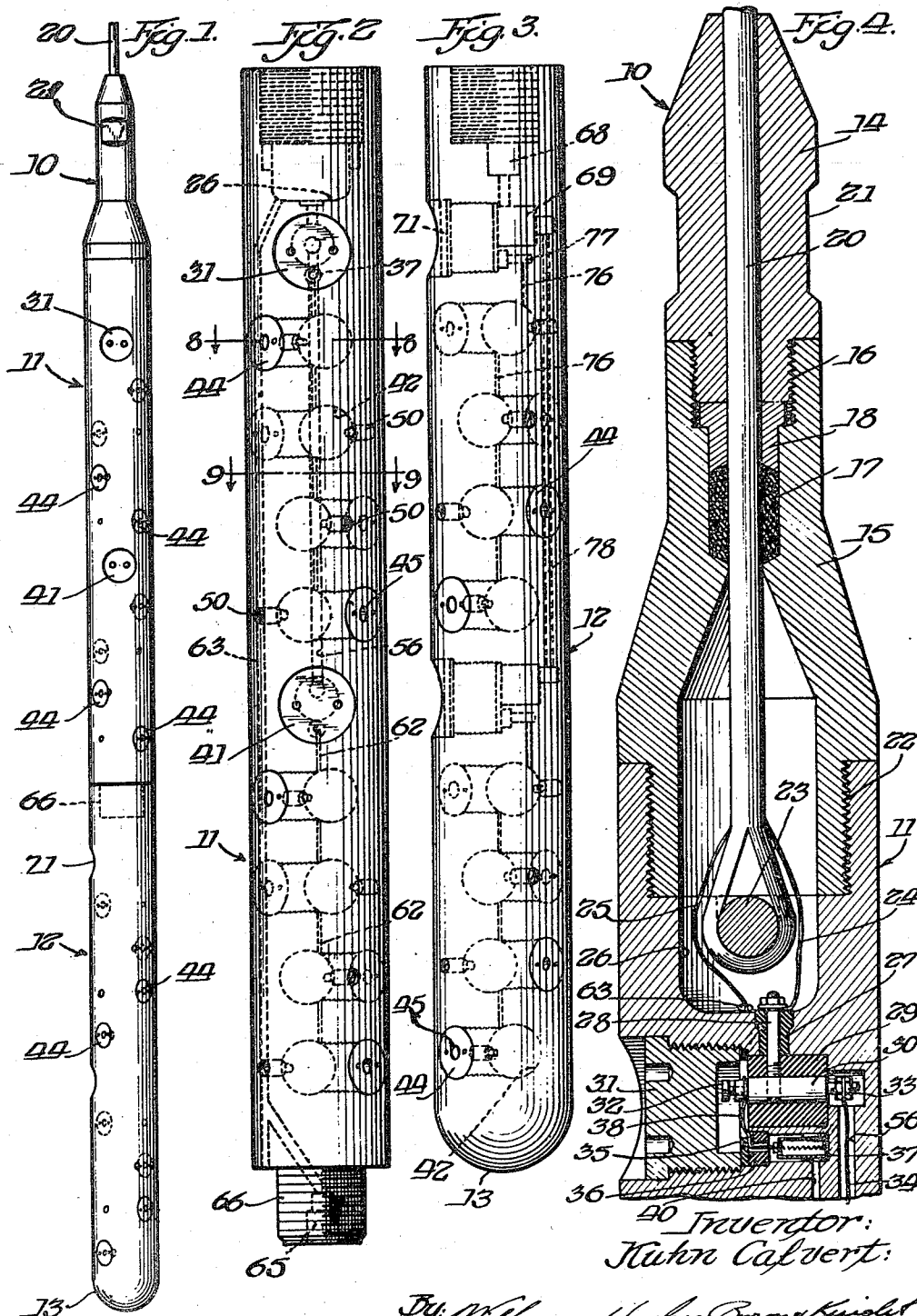
K. CALVERT

2,299,210

PERFORATOR

Filed April 14, 1941

2 Sheets-Sheet 1



40 Perforator:
Kuhn Calvert:

By: Wilkinson Hurley Brown & Knight
Attys.

Oct. 20, 1942.

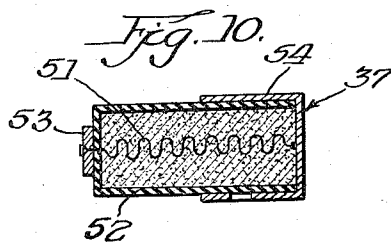
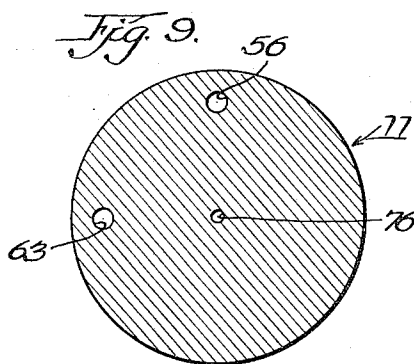
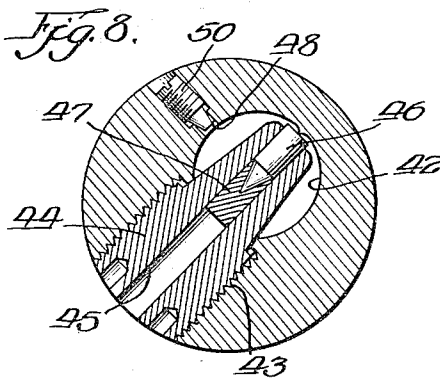
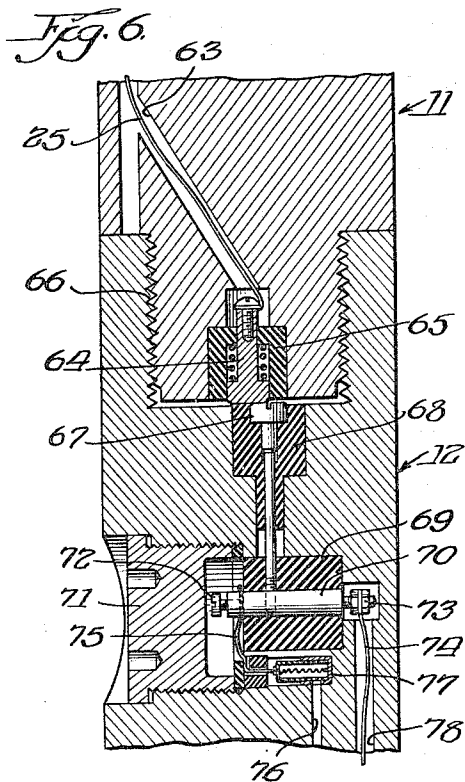
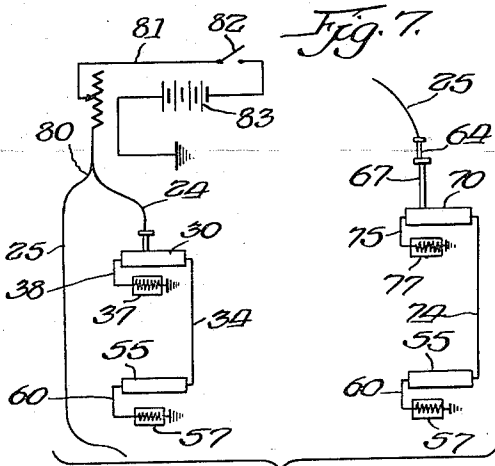
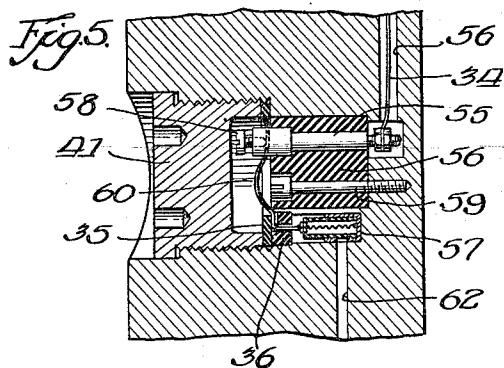
K. CALVERT

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PERFORATOR

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2 Sheets-Sheet 2



Inventor:
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UNITED STATES PATENT OFFICE

2,299,210

PERFORATOR

Kuhn Calvert, Chauk, Burma, India

Application April 14, 1941, Serial No. 388,412

10 Claims. (Cl. 164—0.5)

The invention relates to improvements in apparatus for perforating a well casing and has more particular reference to a portable gun unit having a plurality of powder chambers that can be easily filled with powder for firing projectiles under the control of an operator at some distance from the unit.

When the production of an oil well has become exhausted, the procedure resorted to in an effort to secure additional oil from the well consists in perforating the casing at different levels where oil bearing sands forming productive horizons have been passed up in the drilling of the well. The present invention has for a primary object to improve the bullet type casing perforator of my Patent 2,200,487, granted May 14, 1940, to facilitate the firing and reloading of the fuse chamber containing an electric detonator.

A further object of the invention is to provide an improved detonator for casing perforators of the type disclosed consisting of a relatively small self-contained unit that may be easily inserted and removed from the casing and also readily connected with the necessary electric wires for firing the same.

A further object of the invention is to provide a bullet type casing perforator having a plurality of powder chambers with gun units associated with each powder chamber and which chambers are arranged in groups of four so that the groups may be fired individually, in pairs or simultaneously.

A further object of the invention is to provide a casing perforator having powder chambers with a gun unit associated with each chamber and additionally having an improved electric detonator for each group of four chambers so that they can be fired individually, in pairs or simultaneously at the will of the operator.

With these and other objects in view the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters designate like parts—

Figure 1 is an elevational view of a bullet type casing perforator coming within the invention and embodying an improved electric detonator;

Figure 2 is an elevational view of the upper intermediate section of the perforator showing the spiral orientation of the gun units and their

association with their respective powder chamber;

Figure 3 is an elevational view of the lower section of the perforator also showing the gun units, the detonator units and their spiral orientation;

Figure 4 is a vertical sectional view of the head end section of the perforator showing the cable attaching means and the electric detonating mechanism;

Figure 5 is a fragmentary sectional view showing a detonator unit and illustrating the improved electric detonator of the invention;

Figure 6 is a fragmentary sectional view illustrating the structure for electrically connecting adjacent sections and which structure includes the improved electric detonator;

Figure 7 is a view illustrating the electrical connections for the several detonator units in diagrammatic form;

Figure 8 is a transverse sectional view taken along line 8—8 of Figure 3 showing a powder chamber, gun unit and removable loading plug for the powder chamber;

Figure 9 is a sectional view taken along line 9—9 of Figure 2 illustrating the location and arrangement of the several vertical bores extending through the sections; and

Figure 10 is a detail sectional view illustrating the construction of the improved electrical detonator.

As shown in Figure 1 of the drawings, the perforating unit of the invention consists of a head piece 10, an upper intermediate section 11, and a lower section 12 having a rounded nose portion 13, all of said parts being formed of metal such as steel or a steel alloy. In Figure 4 the head piece is shown as consisting of two parts 14 and 15 having threaded connection at 16, which enables the lower part to receive packing 17 and a gland nut 18 in surrounding relation with the cable 20 which extends longitudinally through the head piece. Part 14 is provided with flat portions 21 in opposed relation for receiving a wrench which facilitates assembly of the head piece with respect to the intermediate section 11.

In my Patent 2,200,487, granted May 14, 1940, it was necessary to unscrew the head piece in order to renew the fuse each time the gun was used. This is not necessary with the improvements of this invention which essentially consist in the provision of removable detonator units in the intermediate section and lower section of the gun, each detonating unit providing a ther-

mal element for firing the gun units associated therewith. The head piece 10 is threadedly connected to the intermediate section 11 by the threads 22 and said section provides the pin 23 for connection with cable 20. Two wires forming conductors extend from the cable in advance of its connection with pin 23. Wire 24 is electrically connected with the detonator units in the intermediate section, whereas wire 25 bypasses the units in the intermediate section 11 but has electrical connection with similar detonator units in the lower section 12.

The upper end of intermediate section 11 is formed with a recess 26 for receiving pin 23 and the lower end of the cable 20. The base of said recess 26 is bored to receive an insulating plug 27, Figure 4, having a contact member 28 which electrically connects with wire 24. Contact member 28 extends downwardly into an insulating plug 29 to electrically connect with member 30 which extends horizontally of the plug and projects a distance from the respective sides thereof. Insulating plug 29 is located within a recess provided therefor which is normally closed by the detonator cap 31 having threaded connection with the intermediate section 11 and therefore being removable from said section. The bottom of cap 31 is recessed to accommodate the contact screw 32 threaded to one end of member 30. The other end of member 30 receives a pair of nuts 33 which electrically connect the conductor wire 34 to the member. Member 30, contact 28 and wire 24 comprise the elements for supplying an electric current to the detonator unit located in the upper end of section 11 and protected by cap 31. When cap 31 is removed the insulating disc 35 can be removed and also the insulating washer 36. The operator is then able to insert the detonator 37 in the recess provided therefor and electrically connect the same by means of wire 38 with contact screw 32. Since one end of the detonator 37 is grounded to the metal of section 11 it is only necessary to supply current to wire 24 electrically connecting with member 30 and thus with wire 38.

The detonator unit above described is provided for firing a group of gun units. In the illustrated embodiment four gun units are located in intermediate section 11 immediately below the detonator unit sealed within its recess by cap 31. Another detonator unit sealed by cap 41 is also provided in the intermediate section 11 and below the same are four gun units. The gun units are identical in construction and operation to those shown in my Patent 2,200,487. Each unit includes a recess providing at its inner end a powder chamber 42 and having a threaded portion 43 for receiving the gun barrel 44 horizontally positioned in the section and which is oriented so that the four gun units of each group are ninety degrees apart. The barrel 44 has a bore 45 for receiving a bullet 46 and rubber plug 47 which is placed in the bore following the positioning of the bullet therein in order to prevent water, oil or other liquid from coming into contact with and spoiling the explosive powder within chamber 42. Each powder chamber is filled by means of an auxiliary opening 48 leading into the side of the powder chamber and normally closed by the threaded plug 50. It will be noted that each barrel extends well within its respective powder chamber, in fact, each barrel extends almost to the rear wall of its powder chamber. This is desirable since it increases the length

of the bore and accordingly the bullet will issue with greater force and can be more accurately directed. After the bullets are in place the threaded plug 50 is removed and each powder chamber is filled with an explosive charge. By filling the chambers through this auxiliary opening a relatively safe procedure is provided since the gun units can be inserted when the chambers are empty. It is therefore not necessary to screw the gun units down onto a charge of explosive powder.

The powder chambers 42 of each group of gun units are connected by a longitudinally extending firing bore. For the detonator 37 a firing bore 40 is provided which is in communication with the detonator and has connection by a continuation of firing bore 40 with the four powder chambers located in the upper section 11 immediately below this detonator unit. It will be understood that when detonator 37 is electrically fired that the four gun units associated therewith will also be fired. This comes about by reason of the fact that when the powder chambers are filled with powder some of the powder will of course find its way into and fill the firing bore 40. Detonator 37, as best shown in Figure 10, is likewise filled with powder which when ignited by fusing the thermal element 51 will in turn ignite the powder in the first of the powder chambers adjacent thereto by the longitudinal firing bore 40 and accordingly the other powder chambers having connection therewith by the continuation of the bore 40 will be fired in succession. This can best be understood by referring to Figure 2.

Referring more particularly to Figure 10, each detonator includes a cylindrical shell 52 of insulating material having a metal contact 53 and a metal jacket 54 protecting its rear end. The thermal element 51 extends from metal contact 52 to the metal jacket 54 and the jacket is provided in order to ground the electrical circuit at this point.

As previously explained, the second group of powder chambers is fired by a separate and distinct detonator located within the recess sealed by the cap 41, Figure 5. Conductor 34 electrically connects member 30 with a similar member 55. A small bore 56 extends longitudinally of intermediate section 11 to provide a passage for insulated conductor 34 so as to electrically connect the upper detonator unit with the lower detonator unit. Member 55 is encased in an insulating plug 56 suitably held within its recess by threaded screw 59. The contact screw 58 electrically connects the wire 60 to member 55 and said wire 60 in turn leads to the detonator 57. Said detonator 57 is similar to 37, having a metal jacket for grounding the electrical circuit to the intermediate section at this point and including a thermal element 51 embedded in an explosive charge of gun powder. The longitudinal firing bore 62 extends downwardly from the detonator and connects the explosive charge of the same with the four powder chambers located in this section below the detonator unit. With the cap 41 in place the insulating disc 35 of this unit is securely held so as to retain the insulating washer 36 also within the chamber receiving the detonator. Said washer in effect seals the chamber as only one small opening is provided for the wire 60 whereby the unit is connected to the electrical circuit. When the electrical circuit including member 55 and wire 34 is closed the thermal element fuses to ignite the powder within the unit 57 and in a manner as

described the fire and products of combustion will travel downwardly in the firing bore 62 to ignite and explode the powder charges of the group of four gun units in succession.

Figure 3 shows the location of the two detonator units in the lower section and the group of gun units associated therewith. In order to supply electrical current to the detonators of the lower section it is necessary for the insulated conductor 25 to extend completely through the intermediate section. The bore 63 is provided for this purpose in the intermediate section 11. As best shown in Figure 6, said bore has an angular direction at the lower end of said intermediate section in order that conductor 25 extending therethrough may electrically connect with the center contact 64. Contact 64 is located within the inverted cup 65 formed of insulating material and positioned in the lower end of the intermediate section 11 which end is threaded at 66 so that the same may be connected with lower section 12. The electrical circuit from wire 25 to contact 64 is continued by the fixed contact 67 provided by the lower section 12 and which is likewise insulated from said section by part 68. Contact 67 extends downwardly for some distance so as to have connection with the member 70 of the upper detonator unit provided by said lower section and which unit is sealed within its recess by cap 71. The construction of this detonator unit is substantially the same as that shown in Figure 4. Member 70 is insulated by plug 69 and at one end includes a contact screw 72 and at its other end is provided with nuts 73 for conductor 74. The wire 75 from contact screw 72 electrically connects with the thermal element of the detonator 77 and which is similar to that shown in Figure 10. The longitudinal firing bore 76 extends from detonator 77 in a downward direction substantially centrally of the lower section 12 to connect with the four powder chambers located below the detonator. When the explosive charge within detonator 77 is electrically ignited by thermal element 51 the fire is continued by the firing bore and is conducted by the same to the respective powder chambers so that their respective gun units are fired in succession.

The second detonator unit in the lower section 12 is electrically connected to insulated conductor 74 which extends through passage 78 provided therefor. The details of this second detonator unit are not shown except in the elevational view, Figure 3, but it will be understood that the individual elements making up said detonator unit are in all respects similar to that shown in Figure 5. In other words, the second detonator for the intermediate section 11 is repeated for the unit corresponding thereto in the lower section 12. Each section is very similar in construction and in operation. Four gun units are provided for each group and each gun unit includes a powder chamber 42 and barrel 44 as shown in Figure 8. The powder chambers of each group are connected by a longitudinal firing bore and each firing bore at its upper end is in communication with a detonator such as shown in Figure 10. The detonator is connected by the conductors and wires described to a source of electricity, as will also be understood by reference to the wiring diagram shown in Figure 7. The main element of each detonator unit in addition to the detonator thereof includes a horizontally positioned metal member 30, 55 and 70 which in each instance is encased in an insulating plug so that

the member is insulated from the metal of its particular section. The structure for connecting member 70 with the conductor wire 25 includes several additional elements which are not found in Figure 4 since the elements are not necessary to connect the member 30 with the conductor wire 24. The additional structure shown in Figure 6 makes it possible to mechanically connect the intermediate section 11 with the lower section 12 as by the threads 66 and to automatically complete the electrical circuit required for the detonator units in said lower section.

Referring to the wiring diagram of Figure 7, the conductor wires 24 and 25 join at 80 to the main conductor wire 81 having switch 82. The switch is closed by the operator after the casing perforator has been lowered to the desired depth within an oil well. The closing of the switch 82 closes the electric circuit including the source of current, namely, the battery 83, and the detonators 37, 57 and 77. One terminal of the battery is grounded and the detonators are each grounded so that the metal of the perforator is used as a return conductor. If the thermal element in each detonator is of the same electrical resistance the said elements will be fused simultaneously and the gun units of each group will be fired at approximately the same time. It is possible, however, in accordance with the invention, to fire the gun units of the various groups at different times either in pairs or individually. This can be accomplished by changing the electrical resistance of the thermal element in the various detonators. The potential or voltage of the battery 83 can be progressively increased so that the thermal elements are fused according to their resistance. For example, the thermal element in 37 may have the lowest resistance, with the thermal element in 57 having a higher resistance. The first charge of electricity upon closing switch 82 would have a voltage sufficient to fuse only the thermal element in 37. As the voltage of the current is increased eventually the element in 57 is caused to fuse and fire its respective gun units. In a similar manner the detonators in the lower section 12 can be adjusted to fire simultaneously with those in the intermediate section 11 or at different times.

After the gun has been fired the detonator caps must be removed so that access may be had to the detonator units for placing new detonators therein. This is a relatively simple procedure and may be done either before or after the powder chambers 42 have been filled with their explosive charges. Also the units can be inserted without separating the sections of the member from each other. A further improvement of the invention resides in the provision of electrical contact means between sections 11 and 12 which permits mechanical removal of one section from the other and their connection again without interfering with the wires and contacts of the electrical circuit. The central contact 64 is yieldingly forced in a downward direction by a spring so as to at all times maintain engagement with the fixed contact 67.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In a gun type casing perforator, comprising

a plurality of sections forming an elongated member, a plurality of gun units provided by the member each having association with a powder chamber, a longitudinal firing bore connecting groups of powder chambers whereby each group has its individual firing bore, a detonator unit for firing each group of gun units, each detonator unit including an electrically fused element having an explosive charge in surrounding relation therewith, and each said detonator unit having communication with the powder chambers of its group by means of its respective longitudinally extending firing bore.

2. In a gun type casing perforator, comprising a plurality of sections forming an elongated member, a plurality of detonator units located in spaced relation longitudinally of the member, gun units located below each detonator unit to form a group with respect thereto, each gun unit including a gun barrel positioned within a recess which terminates in a powder chamber for containing an explosive charge, each detonator unit including a contact member electrically connecting with a source of current supply and a detonator having electrical connection with the contact member, and a longitudinal firing bore for each group of gun units intersecting the powder chambers of its group and having communication with the detonator of its respective detonator unit.

3. In a gun type casing perforator comprising a plurality of sections forming an elongated member, a plurality of detonator units located in spaced relation longitudinally of the member, spirally arranged gun units located below each detonator unit to form a group with respect thereto, each gun unit including a gun barrel positioned within a recess which terminates in a powder chamber for containing an explosive charge, the detonator units each including an insulated contact member electrically connected with a source of current, a detonator electrically connected to the contact member, and a removable cap for retaining the detonator within its recess, and a longitudinally extending firing bore for each group of gun units intersecting the powder chambers of its group and having communication with the detonator of its respective detonator unit.

4. In a well casing perforator, an elongated member having a plurality of detonator units located in spaced relation longitudinally of the member, a plurality of gun units located below each detonator unit to form a group with respect thereto, a longitudinally extending firing bore connecting each detonator unit with the gun units comprising its particular group, and electrical means provided by each detonator unit including a thermal element having an explosive charge surrounding the same for firing the group of gun units in associated relation therewith, the thermal element of the detonator units having different electrical resistance whereby the groups of gun units may be fired individually.

5. In a well casing perforator, an elongated member including a head end portion, a lower end section and at least one intermediate section, a cable attached to the head end portion for suspending the member and whereby the same may be lowered into a well casing, a plurality of explosive charges carried by the intermediate section and said lower end section, a gun unit associated with each explosive charge, at least two detonator units provided by each section and positioned so as to divide the gun units into

groups, and a longitudinal firing bore extending from each detonator unit and intersecting the explosive charges of its respective group of gun units for firing the gun units of each group successively.

6. In a well perforating gun, in combination, an elongated body member having a plurality of vertically spaced gun openings and at least one detonator opening, said openings each extending inwardly from the outer surface of the member, a barrel to receive a projectile located within each gun opening and said barrel forming a powder chamber with the inner wall of its gun opening, a substantially vertical firing bore of relatively small diameter connecting the said powder chambers with each other and extending to and connecting with the detonator opening, and a detonator unit located within the detonator opening.

7. In a well perforating gun, in combination, an elongated body member having a plurality of vertically spaced gun openings and at least one detonator opening, said openings each extending inwardly from the outer surface of the member, a barrel to receive a projectile located within each gun opening and said barrel forming a powder chamber with the inner wall of its gun opening, a substantially vertical firing bore of relatively small diameter connecting the said powder chambers with each other and extending to and connecting with the detonator opening, a detonator unit located within the detonator opening and including a thermal element having an explosive charge surrounding the same, said element and explosive charge having a location within said opening to directly communicate with said firing bore.

8. In a well perforating gun, in combination, an elongated body member having a plurality of vertically spaced gun openings and at least one detonator opening, said openings each extending inwardly from the outer surface of the member, a barrel to receive a projectile located within each gun opening and said barrel forming a powder chamber with the inner wall of its gun opening, a substantially vertical firing bore of relatively small diameter connecting the said powder chambers with each other and extending to and connecting with the detonator opening, a detonator unit located within the detonator opening, and conductor means extending from the member at one end thereof and electrically connecting with the said detonator unit.

9. In a well perforating gun, in combination, an elongated body member having a plurality of vertically spaced gun openings and at least two detonator openings, said openings each extending inwardly from the outer surface of the member and the detonator openings being located vertically to divide the gun openings into groups, a barrel to receive a projectile located within each gun opening and said barrel forming a powder chamber with the inner wall of its gun opening, an axially disposed firing bore connecting the powder chambers of each group and extending to and communicating with the detonator opening for its respective group, a detonator unit located within each said detonator opening, and conductor means extending through a vertical passage in the member for electrically connecting the detonator units.

10. In a well perforating gun, in combination, an elongated body member having a plurality of vertically spaced gun units extending from the outer surface inwardly of the member and each

communicating at its inner end with a powder chamber, said member having a detonator opening in associated relation with the gun units, an axially disposed firing bore connecting the said powder chambers with each other and extending into and communicating with the detonator opening, an insulated contact member located within the detonator opening and electrically

connecting with a source of current, a detonator located within said opening and removably positioned in communication with the firing bore, means electrically connecting the detonator with the contact member, and a removable cap for closing said opening to seal the detonator within the same.

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