Jan. 3, 1939. H. C. YARBROUGH 2,142,583

PERFORATING GUN

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Fig. 1

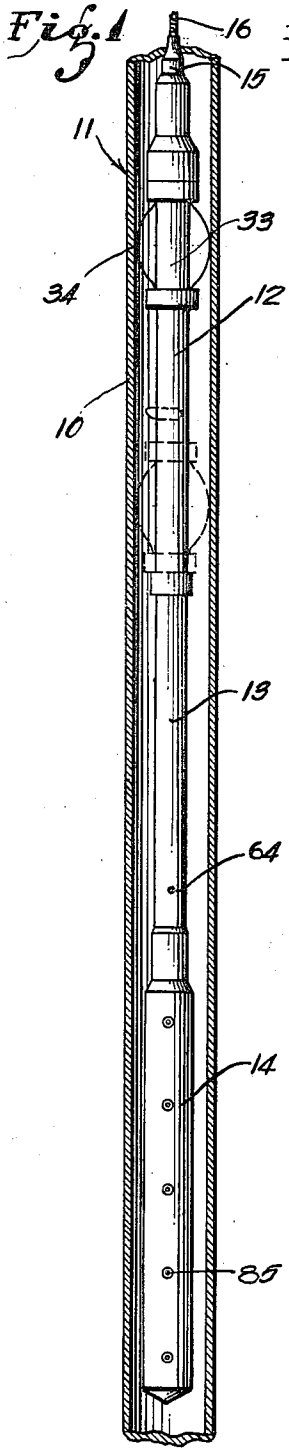


Fig. 2

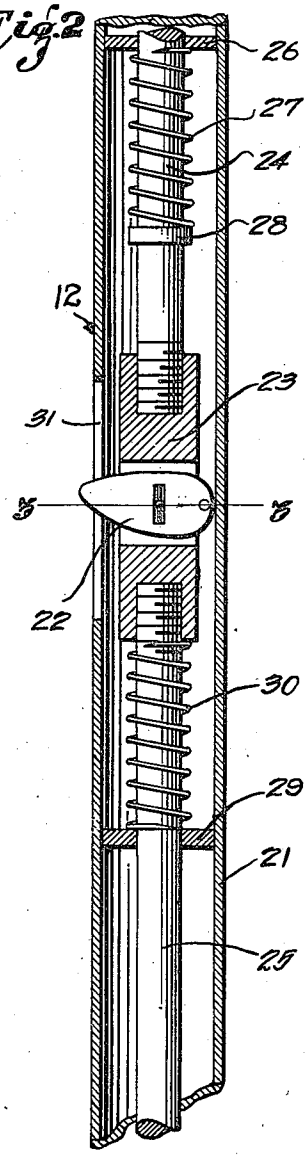
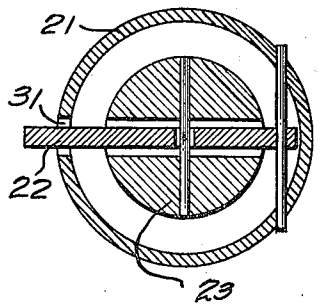


Fig. 3



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PERFORATING GUN

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Fig. 4

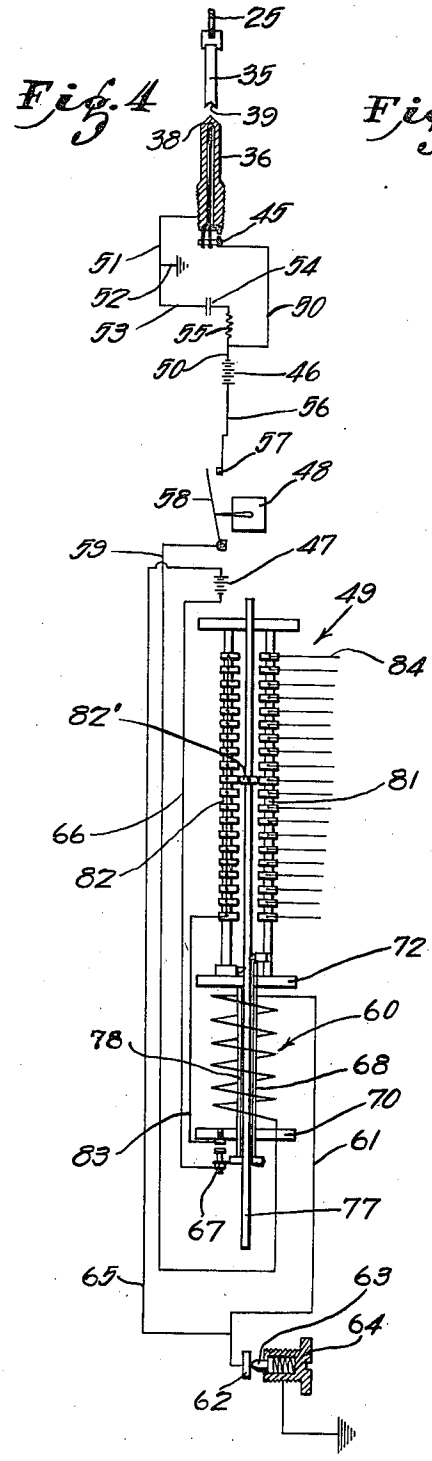


Fig. 5

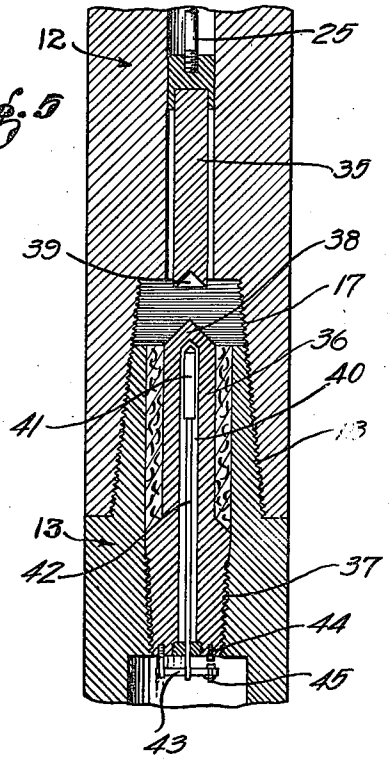
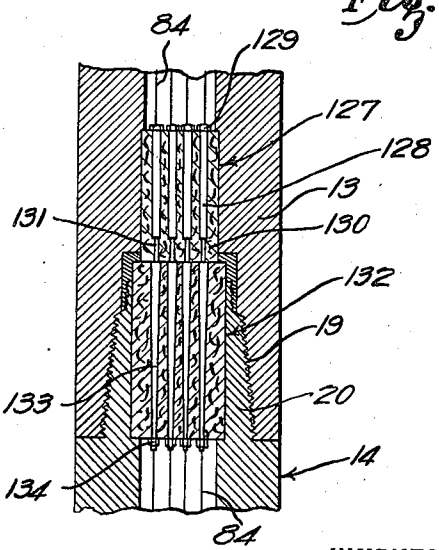


Fig. 6



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Fig. 7

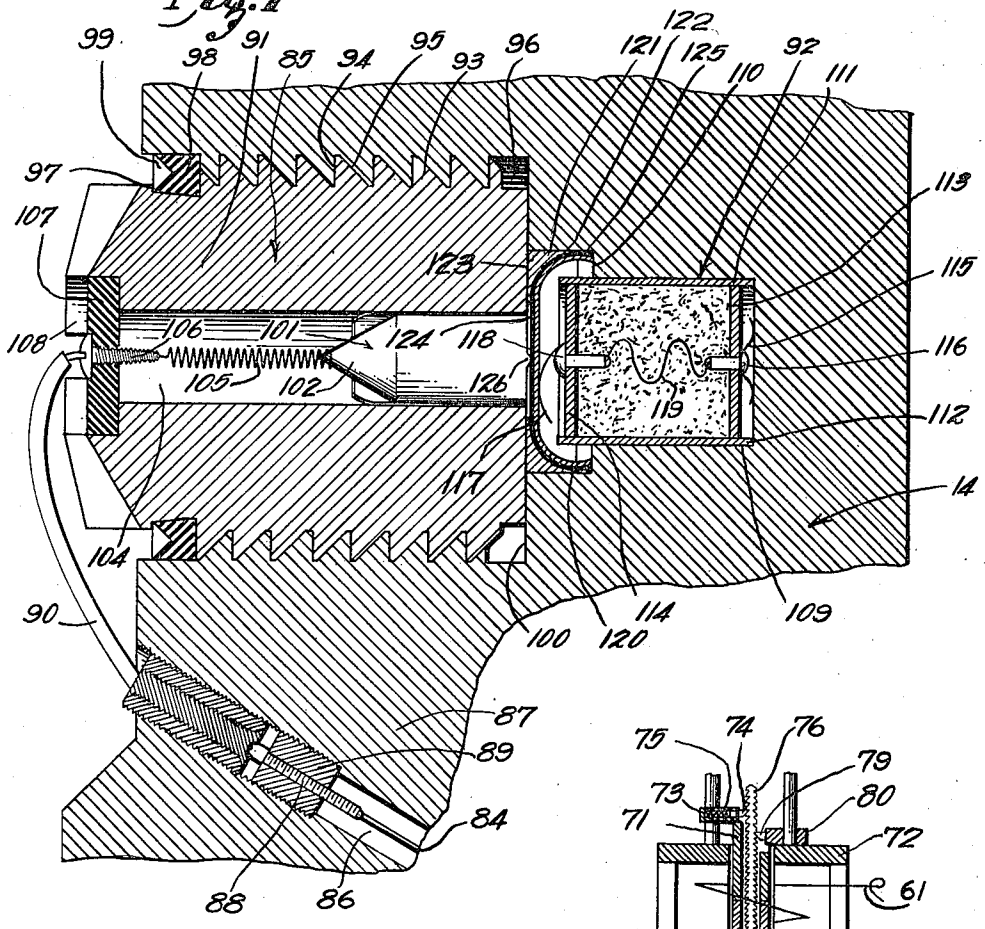
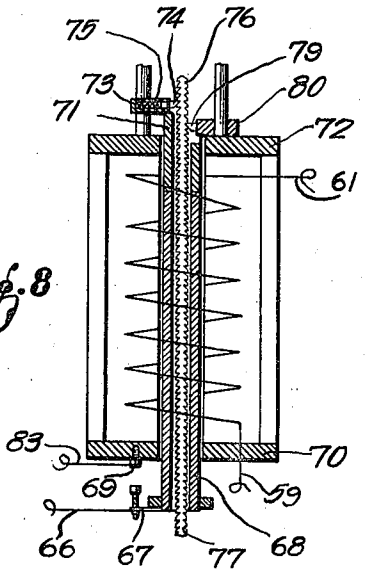


Fig. 8



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Fig. 9

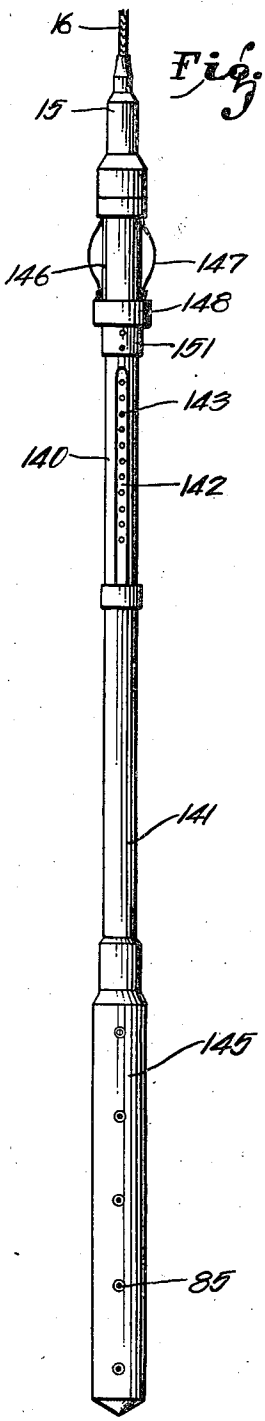


Fig. 10

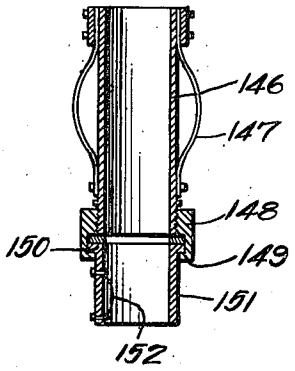
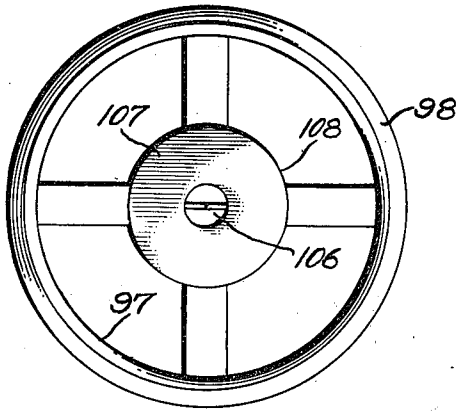


Fig. 12



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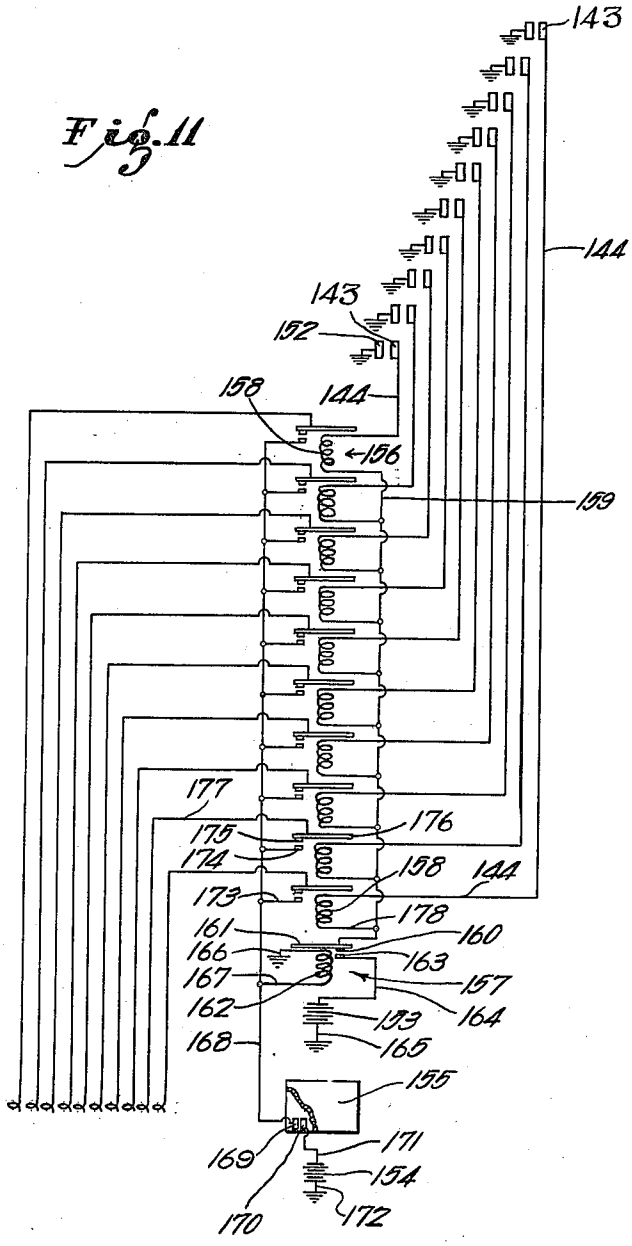
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Fig. 11



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Patented Jan. 3, 1939 2,142,583

UNITED STATES PATENT OFFICE

2,142,583

PERFORATING GUN

Harold C. Yarbrough, Los Angeles, Calif., assignor, by mesne assignments to Lane-Wells Company, Los Angeles, Calif., a corporation of Delaware

Application May 13, 1935, Serial No. 21,185

17 Claims. (Cl. 164—05)

This invention relates to a device for perforating metal and particularly pertains to a well casing perforating gun.

In the course of drilling a producing oil well it is often necessary to perforate the well casing after it has been set in the hole. Various mechanical structures have been provided for this purpose, which structures are usually manipulated from above ground and the operation of which is often attendant by considerable difficulty. Up to the present time various attempts have been made to perform perforations in well casing by the use of perforating guns which require a projectile to be forced from a gun barrel by an explosive charge. For the most part these operations have not been a success due to the fact that the enormous hydrostatic pressure of the fluid prevailing in the well and in the perforating zone causes a leakage of fluid into the powder chambers and renders the powder inert, or substantially so, and for the additional reason that since the powder is ignited by an electric charge of high voltage electricity led down to the tool through a supporting cable, the cable structure is not durable, so that it must be often replaced, and since this cable is very expensive its use is prohibitive.

It is the principal object of the present invention therefor to provide an oil well perforating gun which is simple in construction, is provided with a self-contained firing mechanism adapted to be actuated within the gun by manipulation of a suspending member without the necessity of providing a cable for conducting a firing current to the gun, the gun being so constructed as to insure that fluid under pressure will not force its way into any of the joints of the gun or into the firing chamber.

The present invention contemplates the provision of a perforating gun including a barrel section, a firing section, and a control section, which gun is adapted to be lowered into a well in any suitable manner and to thereafter by simple manipulation fire shots laterally into the circumscribing well casing as controlled from above ground, both as to the firing position and the firing operation.

The invention is illustrated by way of example in the accompanying drawings in which:

Figure 1 is a view in longitudinal section showing the perforating gun assembled and in firing position within a hole.

Fig. 2 is an enlarged view in longitudinal section showing the tripping mechanism by which the firing operation is controlled.

Fig. 3 is a view in transverse section through the tripping pawl showing its position relative to the tripping mechanism.

Fig. 4 is a view in diagram indicating the electrical arrangement of the gun and the manner in which its firing operation is controlled.

Fig. 5 is an enlarged fragmentary view showing the joint between the control section and the firing section.

Fig. 6 is an enlarged fragmentary view showing the joint between the control section and the barrel section of the gun.

Fig. 7 is an enlarged fragmentary view showing one of the barrels of the gun and indicating the detailed assembly of the gun when loaded.

Fig. 8 is an enlarged fragmentary view in longitudinal section showing the solenoid unit of the firing mechanism.

Fig. 9 is a view in side elevation showing another form of the present invention.

Fig. 10 is an enlarged view in longitudinal section showing the conductor for the gun.

Fig. 11 is a view showing a wiring diagram of the type of gun shown in Fig. 9, and in which separate electric relays are provided to control the firing circuits.

Fig. 12 is an enlarged view in end elevation showing the muzzle block.

Referring more particularly to the drawings 10 indicates a well casing into which a perforating gun 11 is lowered. The perforating gun comprises a control section 12, a firing section 13 and a barrel section 14. At the upper end of the control section a cable socket 15 is provided to receive a cable 16 by which the structure may be lowered into a well. At the lower end of the control section a threaded box member 17 is provided to receive the threaded pin 18 carried at the upper end of the firing section 13. At the lower end of the firing section 13 a threaded box member 19 is provided to receive a threaded pin 20 carried at the upper end of the barrel section 14. The control section comprises a tubular casing 21 having mounted within it a trip pawl 22. The trip pawl 22 is designed to pivotally connect with a shifting yoke 23 which reciprocates longitudinally within the tubular member 21. A guide pin 24 is secured to one end of the shifting yoke 23 and an operating rod 25 is secured to the opposite end of the shifting yoke. Interposed between the upper end of the yoke 23 and the shoulder 26 within the casing

21 is a spring 27 which acts against a collar 28 carried on the pin 24 and exerts pressure upon the yoke 23 in one direction. Interposed between the lower end of the yoke 23 and the shoulder 29 within the casing 21 is a spring 30 which tends to move the yoke in the opposite direction. The springs 27 and 30 counterbalance each other to hold the yoke 23 in a normal intermediate position, at which time the pawl 22 will project outwardly through a slot 31 in the side wall of the member 21 and into the path of travel of a trip sleeve 32 which is free to reciprocate upon the tubular member 21 a sufficient distance to allow the tubular member 21 and the pawl 22 to pass through the sleeve 33 and lengthwise thereof. The sleeve 33 is fitted with longitudinally extending bow springs 34 which are secured to the sleeve 33 and when fixed will produce a yielding gripping action within the casing sufficient to hold the sleeve and the springs against movement unless positively moved by the gun body. The rod 25 reciprocates longitudinally within the tubular member 21 as actuated by movement of the pawl 22. This pawl is articulately connected to the yoke 23 and when it encounters the sleeve 33 in either an up or down stroke it will act to similarly move the yoke 23 and the rod 25. The rod 25 at its lower end carries a bar magnet 35. This magnet will be moved downwardly to engage a brass plug 36. The plug 36 is threaded into a tapered hole 37 formed centrally of the pin 17. The upper end of the plug 36 has a conical point 38 which projects into a conical seat 39 of the bar magnet 35 when the magnet is moved to its lowermost position. Disposed within the plug 36 and extending longitudinally thereof is a passageway 40 which receives a small floating magnetic bar 41. The lower end of this bar is connected with an operating rod 42 which is secured to a switch lever 43 by which an electric circuit may be completed from a contact point 44 carried at the lower end of the plug 36, to a contact point 45 carried upon the free end of the switch member 43.

The firing section 13 is tubular and carries a main electric battery 46 and a firing battery 47, as well as a time clock 48, and a selective switch unit 49. The battery 46 is provided with a lead wire 50 which is attached to the contact 45 on the free end of the switch member 43. The switch member 43 is formed of dielectric material so that when the contact 45 engages the contact 44 a circuit will be completed through a wire 51 to ground indicated at 52. The ground side of this circuit also connects with a wire 53 leading to a condenser 54 and a rheostat 55. The rheostat is in turn connected with the wire 50. The opposite side of the main battery 46, which may be of a voltage of the order of sixty volts, is connected with a conductor 56 leading to a switch contact 57. A switch blade 58 may move toward and away from said contact as actuated by suitable mechanism of a time clock diagrammatically indicated at 48. The time clock 48 may be of any desired construction, and is provided so that there will not be any possibility of a complete circuit within the apparatus before the gun is lowered to its firing position within the hole. The switch blade 58 connects with a main feed line 59 which leads to one side of a solenoid coil 60. The opposite side of this coil connects with a conductor 61 leading to a safety contact 62 which is engaged by a contact pin 63 mounted within a threaded member 64. This member may be removed from the firing unit 13 when not in use. The wire 61 also connects with a wire 65 which leads to one pole of the ignition battery 47. This battery is of relatively low voltage and is designed for use in igniting the firing charges, as will be hereinafter described. The opposite side of the battery 47 is provided with a conductor 66 which leads to a contact 67 carried at the lower end of a solenoid sleeve 68. A contact 69 is carried on an end disc 70 of the solenoid coil 60 and is engaged by the contact 67 upon impulse of the solenoid. The solenoid sleeve carries an extension 71 which projects upwardly through an upper disc 72 of the solenoid coil 60. This extension carries a head 73 within which a yieldable pawl 74 is mounted. The pawl 74, as more clearly shown in Fig. 8 of the drawing, is provided with a point having a relative under face and which pawl is urged outwardly by a spring 75. The point of the pawl engages serrations 76 formed throughout the length of a connector rod 77. This rod reciprocates through the solenoid sleeve 68 and is guided by a nonmagnetic bushing 78. The opposite sides of the rod are formed with transverse serrations 76, all of which have holding shoulders face downwardly so that as the rod is lifted increment by increment it will be held against a lowering action by the pawl 74 and a pawl 79 mounted in a head 80 and carried upon the upper solenoid disc 72. Disposed longitudinally of the rod 77 and upon opposite sides thereof are a plurality of pairs of contact fingers 81 and 82. The fingers 82 are here shown as connected to a common feed wire 83 which is connected at its lower end to the contact point 69. The complementary fingers 81 of each pair are provided with lead wires 84 through which a circuit is conducted to an individual firing unit 85, as indicated in Fig. 7 of the drawing. The wires 84 are led through passageways 86 within the body 87 of the barrel unit 14. These wires may be suitably connected with screws 88 which are led through insulating plugs 89 and to which screws an outside feed wire 90 leads to the firing unit. The firing units, as shown, comprise a removable muzzle section 91 and a replaceable firing charge section 92. The muzzle member 91 is made of especially treated steel and is formed on its outer face with an especial thread 93 which has a square lateral face 94 and an inclined back face 95. This threaded portion engages a complementary threaded section in the bore 96 of the barrel unit 14. Circumscribing the muzzle 91 at a point adjacent its outer end is a groove 97 which receives an annular packing ring 98. This ring sets within the groove and extends laterally thereof to fit tightly along its outer circumferential edge within the bore 96. The outer face of the packing ring is formed with an annular V-shaped groove 99 by which the ring is expanded in position due to the fluid pressure acting against it. Attention is directed to the fact that one of the main problems in the construction of a casing perforating gun is to exclude the fluid of the well from the firing chamber 92. For this reason the threads of the muzzle 91 are formed as here shown and the packing ring 98 is provided. The muzzle 91 is screwed into position against a bottom face 100 of the bore 96, it having first been fitted with a projectile 101. This projectile is preferably made of high grade steel and acts as an electrical conductor when the firing current is completed. The outer end of the projectile 101 is formed with a conical point 102 while the cylindrical body of the projectile is wrapped with a layer of Cellophane

which will act as an electrical insulator after which the projectile with its Cellophane wrapper is forced into position within the muzzle bore 104. Connected to the point 102 of the projectile is a stiff steel spring 105 which also connects with a screw 106. This screw is threaded through a packing disc 107. The disc 107 is preferably made of laminated Bakelite and is forced into a counterbore 108 at the outer end of the muzzle 91. The conductor 90 is attached to the screw 106. The spring 105 thus acts as a conductor for the electric current, as well as provides a member for forcibly holding the projectile 101 in its innermost position within the bore 104. The firing charge section 92 is mounted within a firing chamber 109 which is formed within the barrel body 14 as a continuation of the muzzle bore 96. A counterbore 110 is formed around the mouth of the firing chamber 109 and communicates with the muzzle bore 96. The bore 109 is lined with a layer of insulating material 111 by which the firing section or unit 92 is insulated against the action of moisture which might otherwise enter into the explosive charge. The firing unit 92 comprises a cylindrical container 112 preferably made of Bakelite and into the lower end of which is pressed an end wall 113. At the opposite end an end wall 114 is pressed and within the container thus formed there is an explosive charge. A spring contact member 115 carried on the end wall 113 engages the end face of the bore 109. This contact member is secured to the end wall by a pin 116 which extends into the container. A contact member 117 is carried upon the opposite end wall 114 by a pin 118 which extends into the explosive charge. The pins 116 and 118 are connected by a fuse wire 119 which is of sufficient resistance to the flow of current to become heated and to thus ignite the charge through which it passes. The contact member 117 rests against the under face of a metal cup 120 which is convexed and is of a diameter to snugly fit within the bore 110. This cup extends with its open mouth circumscribing the outer end of the wall 112 of the explosive charge container. A metal ring 121 is formed with its inner face concaved to conform to the contour of the convexed outer face of the cup 120. The ring 121 is substantially triangular in cross section, having a cylindrical outer wall 122 agreeing substantially with the wall of the counterbore 110, and a flat face 123 against which the inner face 100 of the muzzle is pressed. The ring 121 has a central opening 124 agreeing substantially with the diameter of the bore 104 within which a projectile 101 is placed. Interposed between the concave face of the ring 121 and the convex face of the cup 120 is a layer of fluid packing 125 which prevents the leakage of fluid into the bore 109. The ring 121 due to its central opening discloses the end of the cup 120 and makes it possible for the force of the explosive charge to shear a circular hole through the cup when the explosive force has reached a desired amount. An extending tip 126 formed on the end of the projectile 101 contacts with the disclosed end face of the cup 120 so that the electric charge may pass from the projectile to the cup 120 and then to the contact member 117.

In order to insure that the electrical connections of the firing unit 13 are not injured by moisture or liquid which might force its way into the interior of the firing unit the connection between the firing unit 13 and the barrel unit 14 is of especial construction, as particularly shown in Fig. 6 of the drawings. Here it will be seen that at the lower end of the section 13 a plug or cylinder 127 is provided and is pressed into a counterbore. This cylinder is preferably made of laminated Bakelite through which pins 128 extend. The upper ends of these pins are threaded and fitted with nuts 129 by which the various electrical conductors 84 are attached. Openings 130 occur within the member 127 at the lower ends of each plug. These openings receive a connecting pin 131. The pins 131 project from the end of a plug 132 which is of similar construction to the plug 127. The pins 131 are continuations of the upper end of pins 133 which are longitudinally tapered and driven into position within the plug 132. The lower ends of the pins project through the plug 132 and are threaded to receive nuts 134 which carry the extensions of wires 84 leading to the individual muzzle units.

In operation of the form of the invention shown in Figs. 1 to 8, inclusive, the structure is assembled as shown in Fig. 1, and the firing units 85 are loaded and assembled as shown in Fig. 7. At this time the safety member 64 is removed from its position in the outer wall of the firing section 13. The sleeve 33 with its springs 34 are positioned at the upper end of their path of the travel on the control member 12, and when it is desired to place the gun in a well preparatory to firing the member 64 is screwed into position so that a ground contact will be made from conductors 61 and 65. The device is then lowered into the well. During the lowering operation the springs 34 will hold the sleeve 33 at the top of the stroke since the springs will engage the side walls of the casing 10. When the gun has been lowered to the desired position for firing the entire structure may be lifted until the pawl 22 encounters the under face of the sleeve 33, it being understood that this sleeve will be frictionally held against motion by engagement of the springs 34 with the casing. As the structure is further raised the pawl will force the rod 25 downwardly and will move the permanent bar magnet 35 into engagement with the point end 38 of the plug 37, which plug extends upwardly at the upper end of the firing unit. The magnetic influence of the bar magnet 35 will thus exert a lifting action on the magnetic bar 41 so that the rod 42 will be raised. This will complete an electric circuit through the switch member 43 to ground, and at the same time will establish a circuit from a wire 50 which leads to a source of electric energy 46, such as a dry cell battery enclosed within the firing unit. During the interval of time required for lowering the gun into the well the timing clock 48 will hold switch member 58 from engagement with contact 57, but at the time the firing manipulation takes place the clock 48 will have permitted the lever 58 to move to a contacting position with the member 57 so that the other side of the circuit including the battery 46 will be completed to a conductor 59 leading to the solenoid coil 60. This circuit will then continue to ground through a conductor 61. When the circuit is thus completed the solenoid coil 60 will be energized and will tend to move the rod 77 upwardly. This upward movement will be limited by physical engagement of contact 67 and 69 which will complete an electric circuit from a battery 47 along a wire 66 to the battery and then along the wire 65 from the battery. The circuit from wire 66 through the contact 67 and through the contact 69 will continue along the wire 69' leading to each of con-

tact fingers 82 and thus provide a common supply for these fingers. The initial movement of the rod 77 will bring the contact element 82' into a position to establish a circuit from members 82 to members 81 and thence along a conductor 84 of the particular contact 81 to the desired firing unit 85. The circuit will then be completed through the wire 84 to the screw 106, and then along spring 105 to the projectile 101, after which it will flow through the cup member 120 to the contact 117 and thence through the fuse wire 119 to the ground. The fuse wire will ignite the charge of powder within the member 92, but due to the manner in which the cup 120 is positively held over the mouth of the firing chamber the burning powder will be confined until enormous pressure has been stepped up. At that time the explosive force of the charge will cause a center disc of the cup 120 to be forced through the central opening 124 of the metal ring 121 and against the muzzle block 91 and sheared clear of the cup. The explosive force will then act upon the projectile 101 to force it outwardly through the packing disc 107. It will be recognized that due to the retarding action of the explosive charge as brought about by the cup 120 and the ring 121, a high degree of efficiency can be obtained even though the structure is limited to a very short muzzle. It will further be seen that by the arrangement here disclosed the explosive charge will be adequately protected from the pressure of the fluids in the well. After one of the muzzles has been fired the successive muzzles may be fired by rising and again lowering the gun with relation to the sleeve 33 and the springs 34 which with the sleeve is held in a set position within the casing. After the sleeve and the control section of the gun have been restored to their original position the gun structure may be adjusted to assume a different position within the well casing, after which the gun may be fired again. It will be noted that due to the solenoid 60 the rod 77 will be moved upwardly a determined amount each time the solenoid is energized. The members 74 and 79 will act to engage the serrations on the rod 77 and will hold the rod in its upwardly moved position. In this manner the rod will move by increments at each impulse of the magnet 41 so that a step by step action will take place to complete circuits through the successive sets of contacts 81 and 82, which contacts control the separate firing circuits. By this arrangement it will be seen that it is not necessary to provide any electrical cable or conduit for leading an electric current to the device, and that the self-contained gun structure may be actuated by a simple mechanical operation initiated from above ground.

Referring particularly to Figs. 9, 10, and 11 of the drawings a somewhat different electrical arrangement is provided, although the results obtained in firing the gun are substantially the same. This structure, however, has considerable to recommend it since the individual firing circuits are controlled by electrical relays which may be cheaply manufactured and which will operate directly as the gun is manipulated. In the form of the drawings shown in Fig. 9, a control section 140 is provided to which is connected a firing section 141 and the previously described barrel section 14. The control section 140 is formed with a longitudinally extending slot 142 in its side wall and within which slot a plurality of electric contact members 143 are fitted. These members are preferably spaced equidistant from each other lengthwise of the slot and are connected with a series of electric conductors 144 which are shown more in detail in Fig. 11 of the drawings. The upper end of the cylindrical control member 140 is fitted with a rope socket 15 and its lower end is threaded into the cylindrical casing 145 of the firing unit 141. The connection between the units 140 and 141 is a threaded connection, and since the control unit 140 carries a plurality of conductors 144 through which circuits must pass to the firing unit 141 the plug and the socket members 127 and 132 are provided as shown in Fig. 6 of the drawing. This will prevent leakage into either of the units. Slidably mounted upon the body of the control unit 140 is a sleeve 146 similar to the sleeve 33 previously described as being mounted on control unit 12. This sleeve carried bow springs 147 which engage the wall of the casing 10. At the lower end of the sleeve a threaded sleeve nut 148 is provided. This nut has an overhanging end wall 149 which engages an annular flange 150 of a contact tube 151. The inner diameter of the contact tube 151 is slightly larger than the outer diameter of the body of the control unit 140. Due to the method of connecting the members 151 and 148 the tube 151 may have rotational movement with relation to the sleeve. The tubular member 151 carries a spring contact 152 within it, said contact being designed to project into the longitudinal slot 142 in the side face of the control unit 140 and to contact the members 143 when in register therewith. It will be evident that due to the fact that the contacts 143 are set into the recess 142 there will not be any damage to them as the device is lowered through the well casing and its joints. The firing unit 141 carries relay batteries 153 and firing batteries 154. It is also desirable that a timing clock 155 be provided. The firing unit also includes a plurality of firing relays 156 and an initial circuit relay 157. The coils 158 of the various relays 156 are connected on one side of the conductors 144 previously described as leading to the control unit. The opposite sides of these magnet coils are connected to a common lead wire 159 which in turn is connected to a contact 160 of the initial control relay 157. The contact 160 is carried on the armature 161 of the relay. This armature is energized by magnet coil 162 which would draw the contact 160 downwardly and make an electrical connection with the contact 163. A conductor 164 connects contact 163 with one pole of the relay battery 153. The opposite pole of the battery is connected to a ground wire 165. One side of the magnet coil 162 of relay 157 is connected with a ground wire 166. The opposite side of this coil is connected with a wire 167 which leads to a common lead wire 168 for the switches of the various firing relays. The wire 168 connects with one contact 169 of the time clock 155. Another contact 170 of the clock is connected with a wire 171 which in turn is secured to one pole of the firing battery 154. The opposite pole of the firing battery is connected to ground by wire 172. The wire 168 provides a common lead wire for each of the firing relays 156. Separate wires 173 connect the lead wire with contacts 174. Movable contacts 175 may be brought into engagement therewith, these contacts being carried on the armatures 176 of the relays 156. The movable contacts 175 are secured to separate wires 177, one of which leads to each of the firing units 85.

In the operation of the form of the invention

shown in Figs. 9, 10, and 11 of the drawings, the structure is assembled as shown, and the sleeve 146 is disposed at its uppermost position beneath the shoulder on the rope socket 15. This member will retain this position as the gun is lowered into the hole due to the fact that the bow springs 147 will continuously engage the side wall of the well casing 10, and make it necessary for the weight of the gun to pull the springs 147 downwardly and along the inner surface of the casing. When the gun has reached its proper position for firing operation will be delayed if necessary until the time clock 155 has moved the contacts 169 and 170 together. The firing battery 154 will then be electrically connected to the common supply line 168 for the firing relays. This will also supply an initial circuit to the wire 167 leading to the relay 157. This will energize magnet 162 and will connect the relay battery wire 164 with the lead wire 159, for each of the firing magnets. Circuits will then be partially completed through conductors 178 from the lead wire 159 through the relay magnets 158 and to the separate relay wires 144. As the tool is then drawn upwardly the sleeve 146 carrying the bow springs 147 will remain stationary and the control unit 140 will be lifted through the sleeve 146. This will successively move the contact member 152 into engagement with the contacts 143 which are positioned along the longitudinal slot 142. As these contacts are successively engaged by the member 142 the relay circuits through conductors 144 will be successively closed by being grounded. This will successively energize the relay magnets 158 of the several firing relays 156 and will complete electric circuits from the firing battery 154 through conductor 168 to contacts 174 and 175, and thence through conductor 177 to the individual firing units where the circuit will be completed in the manner shown in Fig. 7 of the drawings.

It will thus be seen that by the structure here disclosed it is possible to lower a perforating gun into a well, the gun being equipped to produce a large number of perforations which may be selectively made through the wall of a well casing at the option of the operator, and with the assurance that the powder will be maintained in a suitable firing condition and will provide an explosive force sufficient to cause a perforation to be made in a well casing and further penetration of the surrounding earth formation. It will also be evident that by the arrangement here shown it is unnecessary to utilize high voltage current in carrying out the present invention. Consequently, although the contacts 143 are exposed to well fluid which may be semi-conductive, the resistance of such liquid to low voltages is sufficient to prevent ignition of the powder charges. Furthermore it is unnecessary to provide expensive cable for conducting an electric current to the gun from above ground, and which cable has the additional objection of becoming readily worn and useless.

While I have shown the preferred form of my invention, as now known to me, it will be understood that various changes might be made in the combination, construction, and arrangement of parts, by those skilled in the art, without departing from the spirit of the invention as claimed.

Having thus described my invention what I claim and desire to secure by Letters Patent is:

1. A perforating gun, suspending means for lowering the gun and positioning it within a well bore, muzzles carried by the gun to receive a projectile and an explosive charge and to direct it laterally of the gun, self-contained electrical firing means for igniting said charges, an enclosure for hermetically sealing said firing means within the gun structure, and means responsive to manipulation of the suspending means for reciprocation with respect to said gun, and a device for translating such reciprocation through said enclosure to operate said firing means.

2. A perforating gun, suspending means for lowering the gun and positioning it within a well bore, muzzles carried by the gun to receive a projectile and an explosive charge and to direct it laterally of the gun, self-contained electrical firing means for igniting said charges, said firing means being hermetically sealed within the gun structure, contacts therefor exposed to the exterior of the gun, and a firing means including a cage engageable with the surrounding casing and shiftable axially with respect to the gun upon reversal in movement of the gun, and a contactor carried by said cage for engaging and closing said contacts upon such reversal.

3. A perforating gun adapted to be lowered into a well on a suspending member, said gun having a barrel section within which a plurality of muzzles are formed, the muzzles being adapted to direct projectiles laterally of the gun by explosive force, electric means for igniting explosive charges in each of the muzzles, an enclosure hermetically sealing said means within the gun structure, a magnetic device operable through said enclosure to actuate said means, and a mechanical device manipulated by movement of the suspending means to control said magnetic device.

4. In a gun structure adapted to fire an explosive charge while submerged within a fluid under pressure which structure comprises a muzzle, a projectile and explosive charge hermetically sealed therein, firing means sealed therein, and magnetic means acting magnetically through the casing of the gun to initiate operation of the firing means.

5. A perforating gun adapted to be lowered into a well and including a hermetically sealed chamber and firing mechanism contained within said chamber and having a magnetically responsive operating element, and a movable magnet located exteriorly of the said chamber and operating magnetically through the wall thereof for actuating the magnetically responsive member.

6. A perforator gun comprising: a body structure having a gun unit and a firing mechanism; means for lowering and raising said body structure in a well bore; a device carried by said body structure and engageable with the well bore to move axially on the body structure upon lifting the body structure subsequent to lowering the same; and an instrumentality operatively associating said device with said firing mechanism.

7. A gun perforator comprising: a body structure having a plurality of laterally directed gun units, and a firing mechanism adapted to operate said gun units in sequence; means for lowering and raising said body structure in a well bore; and an operating device for said firing mechanism carried by said body structure, said operating device being engageable with the well bore and initially positioned to move axially relative to said body structure upon lifting thereof after being lowered thereby to operate said firing mechanism.

8. A casing perforating gun comprising a gun body having a laterally directed gun unit; a self-

contained, hermetically sealed electric firing unit for said gun unit, said firing unit including a magnetically responsive element; magentic means externally of the gun; and means for moving said magnetic means with respect to said element thereby to actuate said element to initiate operation of the firing means.

9. A casing perforating gun comprising a gun body having a plurality of laterally directed gun units; a hermetically sealed housing; a self-contained electric firing unit in said housing for sequentially firing said gun units including an element responsive to a magnetic field actuating externally of said housing; magnetic means externally of the housing; and means for moving the field of said magnetic means into and out of influencing relation with said element to initiate operation of the firing means.

10. A gun perforator comprising: a gun body having a plurality of laterally directed gun units; a sealed housing connected with said gun body; a self-contained firing mechanism within said housing including electrical connections with each of said gun units, a source of electrical energy, a controller for effecting connection of said source with said gun units in sequence, and a magnetic field responsive element for initiating operation of said firing mechanism; and a magnetic device externally of said housing and movable into and out of magnetic association with said element.

11. A gun perforator comprising: a gun body having a plurality of laterally directed gun units; a sealed housing connected with said gun body; a self-contained firing mechanism within said housing including electrical connections with each gun unit, a source of electrical energy, means for connecting said source with said gun units in sequence, and a plurality of contacts for said means exposed to the exterior of the housing; and a device engageable with the surrounding wall of a well bore to move relative to said housing and engage said contacts.

12. A gun perforator comprising: a gun body having a plurality of laterally directed gun units; a sealed housing connected with said gun body; a self-contained firing mechanism within said housing including electrical connections with each gun unit, a source of electrical energy, means for connecting said source with said gun units in sequence, and a plurality of contacts for said means exposed to the exterior of the housing; means for lowering and raising said body structure and housing in a well bore; and an operating device for said firing mechanism carried by said housing, said operating device being engageable with the well bore and initially positioned to move relative to said housing upon lifting thereof after being lowered thereby to engage and close said contacts.

13. In a gun perforator: a gun body having explosive receiving chamber and a barrel receiving recess communicating therewith; a gun barrel for said recess; an insulated bullet fitting said gun barrel; an insulated closure for the outer end of said gun barrel; a current supply lead extending through said closure and connected with said bullet; and an electrically fired cartridge grounded at one end and electrically connected at its other end with said bullet.

14. An apparatus for perforating well casing embodying: a body adapted to be suspended in the casing and having a transverse chamber therein; a cartridge in said chamber adapted to be fired through said casing; a sleeve member on said body; means associated with said sleeve and operative during relative movement between said sleeve and said body for firing said cartridge; and means on said sleeve engaging the interior of said casing for restraining said sleeve against movement relative to said casing.

15. A perforating gun comprising a barrel section having a plurality of laterally directed muzzles, electric firing means self-contained within the gun and connectable individually with the muzzles for firing charges therein in sequence, suspending means for the gun, means engageable with said casing and manipulated by successive reciprocation of said suspending means for connecting the electric firing means with said muzzles in sequence.

16. In a gun perforator: a gun body having a cartridge socket open at one end only, and a gun barrel receiving counterbore continuing from the open end of the chamber; an electrically fired cartridge having a terminal grounded against the inner or closed end of said cartridge socket and an insulated end facing into the counterbore; a barrel fitting said bore; a projectile fitting said barrel; and means incorporating said projectile for making an electrical connection with the insulated end of said cartridge.

17. An electrically fired gun perforator comprising: a body member having a plurality of laterally directed gun units, each including an electrically responsive cartridge, a gun barrel, and a projectile; leads for said gun units extending through said body member and outwardly thereof to enter the gun units through the muzzle ends of said barrels, and electrically associated with said cartridges; a source of electrical energy for said leads of sufficiently low potential that no material loss of energy occurs by reason of exposing said leads to electrolytic liquids; and controller means for connecting said source with said leads.

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