

March 5, 1940.

F. I. ALEXANDER

2,192,591

CASING PERFORATING GUN

Filed Sept. 13, 1938

2 Sheets-Sheet 1

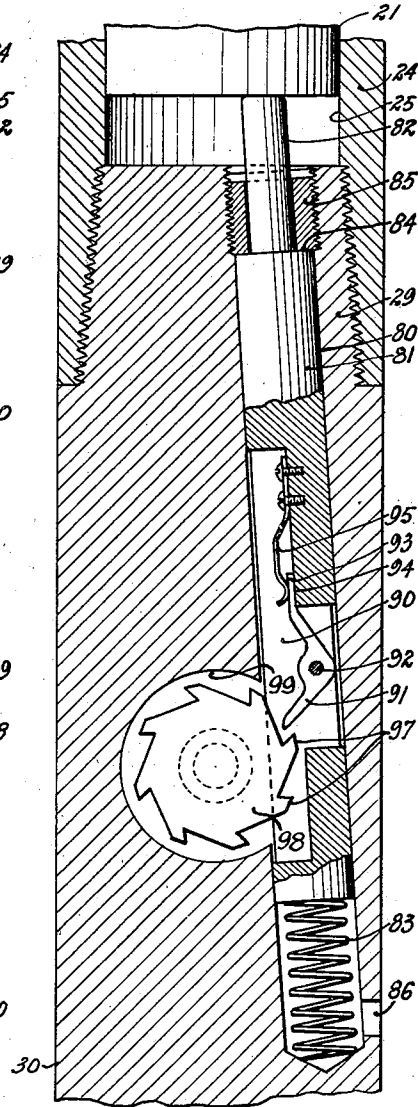
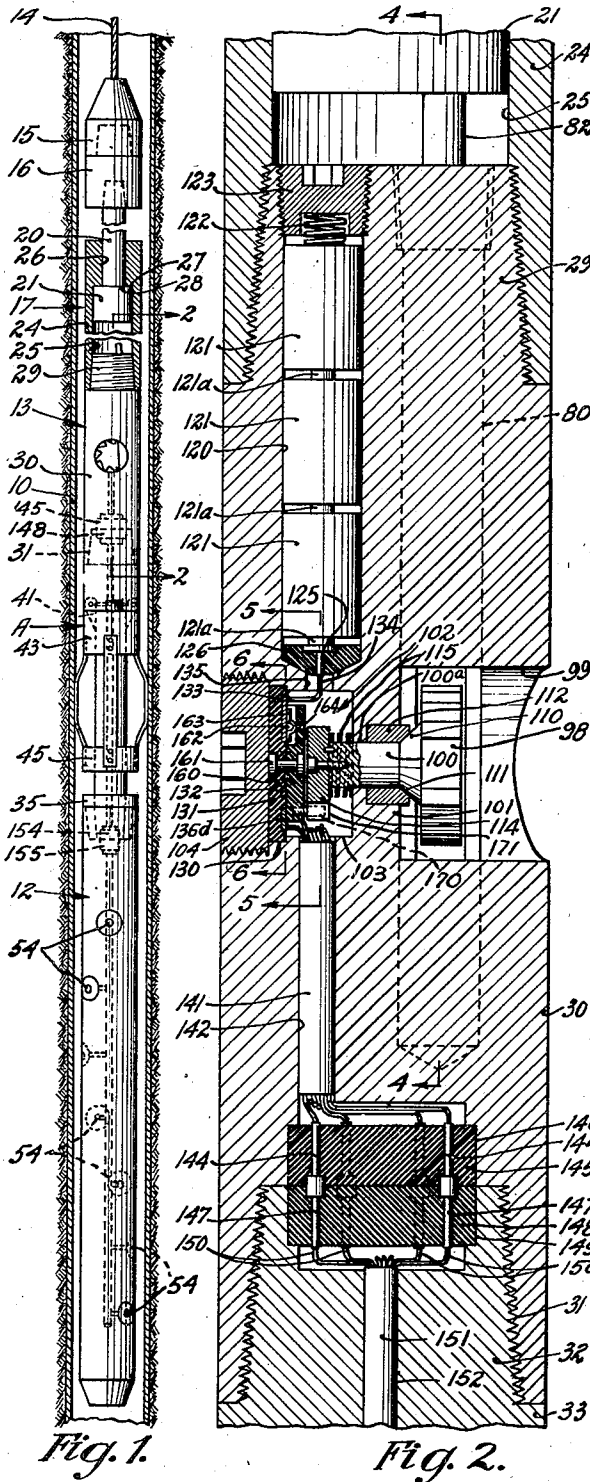


Fig. 4.

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2 Sheets-Sheet 2

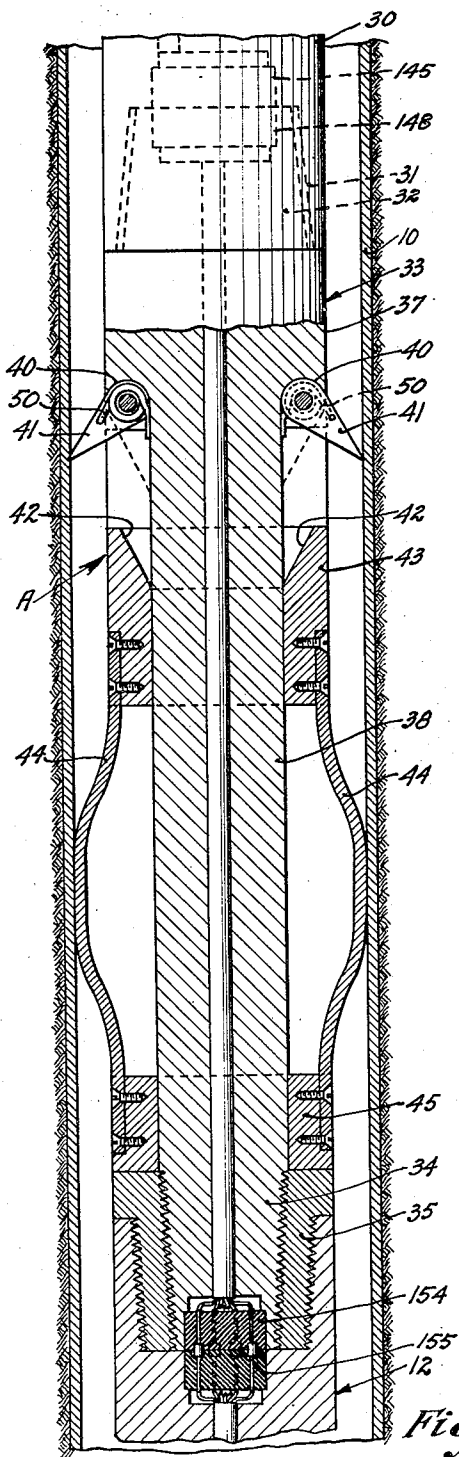


Fig. 3.

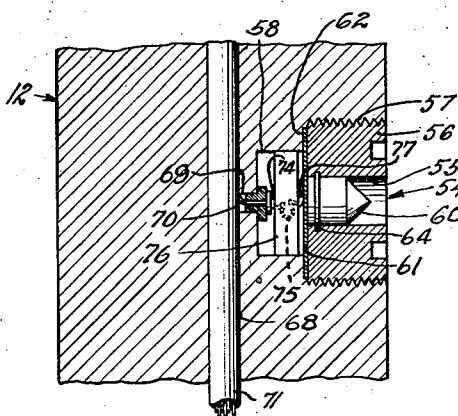


Fig. 3a.

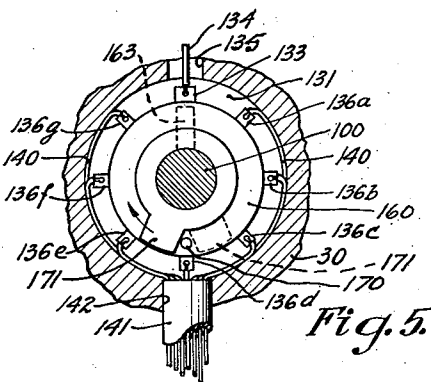


Fig. 5.

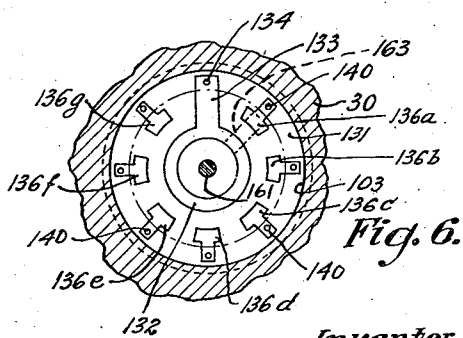


Fig. 6.

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UNITED STATES PATENT OFFICE

2,192,591

CASING PERFORATING GUN

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Application September 13, 1938, Serial No. 229,677

17 Claims. (Cl. 164—0.5)

This invention relates generally to perforating guns for well casing, and more particularly to electric firing systems for such guns.

Casing perforating guns are now well known, and the various types will require no particular description herein, beyond mention of the fact that they have all, insofar as I am aware, employed an electric firing system including an electric cable extending from the lowered gun to a control switch and source of electrical energy located at the ground surface. This cable, which ordinarily is used also to support the weight of the gun, is not only quite expensive, but constitutes a source of various difficulties. Because of the conditions of its use, it is subject to comparatively rapid wear and deterioration and must be replaced from time to time. It is cumbersome to handle, and adds greatly to the labor of transporting and manipulating the apparatus.

It is accordingly an object of the present invention to eliminate the long electric cable from the fire control system of casing perforating guns.

A further object of the invention is to provide a system for controlling the firing system of a casing perforating gun by the mechanical lowering line.

Further objects of the invention relate to the provision of an improved electrical firing system, and novel and improved mechanical means for actuating and controlling the firing system.

In accordance with the present invention, a casing perforating gun is provided in which all electrical parts of the apparatus are located at or immediately above the gun proper, and means are provided whereby the plurality of projectiles carried by the gun may be fired successively by a selective operation of the lowering line, preferably and here illustrated as a lowering cable. In accordance with the present invention, the apparatus is equipped with anchoring means operable by the lowering element; and when that anchor has been set then the firing system, associated with the apparatus, is actuated by movement of the lowering means relative to the anchored apparatus. In a broad view of the invention, such relative movement may be either rotational or vertical. In a particular and present preferred form of the invention, the apparatus is equipped with anchoring means adapted, when the apparatus has been lowered in the casing, to be expanded into engagement with the casing wall in a manner to support the apparatus against subsequent lowering. The anchoring means is controlled by the lowering line, being set in expanded position by virtue of a predeter-

mined elevation of said line. The apparatus being thus supported in the casing, the projectiles are then successively fired by selective manipulation of the lowering line. It may here be stated, however, that while the present preferred and illustrative form of the invention includes an anchoring device of the type indicated, the invention in its broader aspects is not necessarily limited thereto, and certain of my broader claims therefore do not include mention of wall anchoring means.

In the preferred and illustrative form of perforating gun in accordance with the present invention, a jar is incorporated in the apparatus and is operatively associated with the fire control means. This jar is operative to aid in lowering the apparatus in the casing, but thereafter functions as a part of the fire control system. In the present illustrative embodiment of the invention, the vertically travelling hammer of the jar controls or actuates the firing system by virtue of its relative vertical movement with relation to the body of the gun, such vertical movement of the hammer being accomplished by manipulation of the lowering line. A feature of the invention is the provision of means whereby the firing system is made capable of receiving a predetermined number of strokes of the jar before beginning to fire the projectiles, thus providing for a predetermined number of down jarring strokes to lower the apparatus in the well casing without firing the gun. When the jar hammer has thus been lowered relatively to the body said predetermined number of times, then each subsequent lowering operation of the hammer is effective to cause one of the projectiles of the gun to be fired, so that the projectiles may then be fired one at a time by simply alternately lowering and raising the lowering line. I regard the incorporation of a jar in the apparatus as an important feature of the present invention; however, in some situations or in some forms of the invention a jar as such may not be required, and the invention is therefore not to be regarded in its broader aspects, as limited to use in connection with a jar.

Various additional objects and features of the invention will be made apparent in the course of the following detailed description of a present illustrative embodiment thereof.

Reference is directed to the accompanying drawings, in which:

Fig. 1 is a vertical section end elevation showing a perforating gun provided with a firing system

in accordance with the present invention lowered within a well casing;

Fig. 2 is a section taken as indicated by line 2—2 of Fig. 1;

Fig. 3 is a view showing the anchoring means in section;

Fig. 3a is a view showing a portion of the gun proper in section;

Fig. 4 is a section taken on line 4—4 of Fig. 2;

Fig. 5 is a section taken on line 5—5 of Fig. 2; and

Fig. 6 is a section taken on line 6—6 of Fig. 2.

I illustrate in the drawings, and will now describe, one present preferred type of means capable of carrying my invention into practical effect, it being deemed that a full understanding of the nature and scope of the broad invention will be had from a consideration of the single specific embodiment which I have chosen for illustrative purposes.

With this understanding, and referring now to the drawings, I show in Fig. 1 a well casing 10, within which has been lowered a perforating gun 12, the latter being of any conventional or approved type. The fire control means provided by the present invention is indicated generally by numeral 13, being, in the present instance, positioned wholly between the gun proper, indicated at 12, and the lower end of lowering line 14. It is a feature of the illustrative form of the invention that lowering line 14 may be a cable, as illustrated in Fig. 1, though it is to be understood that any other common type of lowering line such as a string of pipe may be used if desired.

Cable 14 carries a socket 15, and connected to socket 15 by means of a suitable sub 16 is a tool or device 17 which preferably has the dual function of jar and actuating device for the firing system. For convenience, this device 17 will hereafter be referred to as a jar, though it will be understood that said device, whether or not used as a jar, constitutes a part of the actuating mechanism for the firing system. While it is within the broad scope of my invention to employ various types of jars, involving various types of relative movement, the present illustrated firing system is designed to be operated by the vertically or longitudinally acting hammer of the jar, a simple form of which is illustrated in Fig. 1. As there shown, jar 17 comprises a rod or shank 20 connected at its upper end to sub 16 and provided at its lower end with an enlarged, cylindrically shaped plunger head or hammer 21.

A sleeve 24 has a bore 25 which slidably receives plunger head 21, and has at the top a reduced counter-bore 26 which slidably embraces rod 20, sleeve 24 and the parts suspended therefrom being supported by engagement of a downwardly facing shoulder 27 formed at the juncture of bores 25 and 26 with upwardly facing shoulder 28 on plunger head 21. The lower end of sleeve 24 is internally screwthreaded to receive a screwthreaded pin 29 on the upper end of a cylindrical body 30 that houses parts of the firing system, pin 29 forming the anvil of the jar. Of course, in some situations it may be possible to lower the gun without jarring, and in such cases, or in case other jarring provisions should be employed, plunger head 21 would serve only as actuating means for the firing system, and would not need to be of the mass required when employed also as the hammer of a jar.

An anchoring device A, for engaging the wall of the casing and supporting the gun with ref-

erence thereto, is here shown as located between body 30 and the gun proper, indicated at 12. Thus, the lower end of body 30 is provided with a threaded box 31, within which is screwed a pin 32 formed on the upper end of the tubular body 33 of anchoring device A. The lower end of said body 33 is connected by means of threaded pin 34 and adapter bushing 35 with the upper end of gun 12 (see Fig. 3). Sleeve 24, body member 30, anchor means body 33, and gun 12 may be regarded as the composite body of the apparatus as here illustratively described. It will be realized from what follows, however, that the gun 12 need not be rigidly a part of the same body that includes body 30, and that the anchor means may be connected to body 30 in any suitable manner and in any relative position. Broadly speaking, the functions of the whole apparatus and operation of the firing system require simply that the line operated element be movable relative to a body, which is here the body 30. The anchor, in the broad functional aspect of the invention, needs to anchor only that body, and can be connected thereto in any manner and relative position. The gun proper may be connected to that body in any suitable manner, preferably rigidly as here shown.

Anchoring device A is designed to become expanded into engagement with the casing when the gun is lowered to position and then elevated a predetermined distance, the gun thereafter being capable of further elevation, but being anchored against lowering. Any well known or approved type of anchoring device designed for this purpose may be used, though I here show a preferred type particularly well adapted to the requirements of the present invention.

The anchoring device here shown comprises the aforementioned body 33, formed with a head 37, of substantially the diameter of body 30, and a downwardly extending stem 38 threaded at its lower end, as at 34, for connection with adapter bushing 35. Pivotaly mounted in recesses 40 in the lower portion of head 37 are dogs 41, which are adapted to be held in contracted position by an overlying conical surface 42 formed in the upper end of a ring 43 slidable along stem 38. Ring 43 is connected by means of wall-drag elements in the form of bow springs 44 with a lower ring 45, also slidable on 38, bow springs 44 being adapted to frictionally engage or drag along the inner surface of casing 10, as illustrated. During lowering of the gun, the assembly consisting of rings 43 and 45 and connecting bows 44 is in the upper position illustrated in Fig. 1, dogs 41 being confined by ring 43, as indicated. It will be observed that when the device is in this position, there is a substantial clearance between the lower end of ring 45 and the upper end of the aforementioned bushing 35 at the top of gun 12, such that the assembly consisting of rings 43 and 45 and connecting bows 44 can be moved downwardly on stem 38 sufficiently to release dogs 41 for their expansive movement. Friction between bows 44 and casing 10 prevents such relative downward movement on stem 38 during lowering of the gun within casing 10. When the gun is elevated, however, the frictional engagement between bows 44 and the wall of the casing holds rings 43 and 45 back until lower ring 45 is engaged by bushing 35, dogs 41 thus becoming elevated above upper ring 43, and expanding into engagement with the casing by means of springs 50 coiled about their pivots and acting between the dogs and stem 38 (see Fig. 3).

Dogs 41 being thus released and urged into engagement with the walls of casing 10, the apparatus is anchored against further lowering, though remaining free for subsequent elevation.

Gun 12 is provided with a plurality of electrically controlled projectile-expelling means, Fig. 1 showing the gun to be provided with a plurality of muzzles 54 opening through its sides, and spaced longitudinally of and circumferentially about the gun. Fig. 3a shows a typical construction, projectile bore 55 being formed in a muzzle block 56 screwed within a bore 57 sunk in the side of the gun body, and a reduced bore 58 extending inwardly beyond bore 57 providing a firing chamber. A projectile 60 positioned in bore 55 is fastened, as by spot-welding or any other suitable means, to a frangible packing disc 61 confined between block 56 and shoulder 62 formed at the juncture of bores 57 and 58. A gas ring 64 of a conventional type is shown as placed around the rearward end of the projectile.

Extending inwardly from firing chamber bore 58 to bore 68 extending centrally and longitudinally of gun 12 is a duct 69 for one conductor 70 of a cable 71 extending through bore 68. This conductor 70 is connected to a firing element 74, which is in contact with a fuse 75 positioned within powder charge 76, fuse 75 being grounded at 77 on packing disc 61, which latter is in electrical communication with the grounded composite body of the apparatus. The typical cartridge construction here described is of a conventional type, forming no part of or limitation on the present invention. It will be understood that when a current of electricity is passed through conductor 70 to ground at 77, fuse 75 is heated, setting off powder charge 76 and so producing an explosive force within chamber 58 which ruptures packing disc 61 and causes projectile 60 to be expelled with sufficient force to pierce the well casing. It will of course be understood that cable 71 is made up of a number of conductors such as 70, each of which goes to an individual firing chamber of the gun.

A bore 80 is drilled in a downward direction in cylindrical body 30 from the upper end of said body to a point near its lower end (see Figs. 2 and 4), and working in said bore is a plunger 81. This plunger 81 is provided with a reduced stem 82 which extends upwardly somewhat above the upper end of body 30, so that it may be engaged and depressed by the lower end of plunger head 21 of jar 17. The lower end of plunger 81 engages a coil compression spring 83 seated in the lower end of bore 80, and it will be understood that plunger 81 normally occupies its uppermost position, illustrated in Fig. 4, with its upwardly facing annular shoulder 84 in engagement with a bushing 85 screwthreaded in the upper end of bore 80. When plunger head 21 is lowered, it engages stem 82 and depresses plunger 81 against spring 83, the latter acting to elevate plunger 81 back to the position of Fig. 4 when jar plunger 21 is subsequently elevated. A port 86 communicating with the lower end of bore 80 and opening outside body 30 permits fluid below the plunger to escape and return as the plunger is reciprocated.

Plunger 81 is provided with a slotted recess 90, in which is disposed a pawl 91 mounted on a pivot pin 92 carried by said plunger. The rearward end portion 93 of this pawl normally engages a surface 94 of the plunger, being yieldingly held thereagainst by means of a spring member 95 mounted on the plunger within recess 90,

all in the manner clearly illustrated in Fig. 4. Pawl 91 is adapted to engage the teeth 97 of a ratchet wheel 98 mounted within a recess 99 which is sunk in one side of body 30, so as to communicate with plunger bore 80 and project into plunger slot 90 and engage pawl 91. (See Figs. 2 and 4.) Ratchet wheel 98 has an integrally formed axle or stubshaft 100 which extends through bore 100a in a wall 101 intervening between recess 99 and a chamber 102. This chamber 102 comprises a bore 103 sunk in the side of body 30, directly opposite recess 99, the outer end of which is enlarged and internally threaded for reception of a screw threaded plug 104.

Chamber 102 encloses certain electrical distributor means, later to be described, and it is therefore essential to maintain chamber 102 clean and dry. Since ratchet wheel 98 is exposed directly to the well fluids, provisions are made for preventing such fluids, which are normally under very high pressure, from working through bore 100a to the interior of said chamber. I find the simple bearing provisions illustrated in Fig. 2 to be adequate for this purpose. As there illustrated, ratchet wheel 98 of shaft 100 is formed with a conical portion 110, which bears against a conical seat 111 formed at the outer end of a bearing bushing 112 inserted in wall 101. Bushing 112 thus serves as a combined radial and thrust bearing. Mounted on the inner end of shaft 100 is a disc 114, and disposed around shaft 100 and confined between said disc and wall 101 is a compression spring 115, which acts to draw shaft 100 toward chamber 102, so that conical surface 110 is maintained tightly seated on conical seating surface 111. These provisions effectively safeguard against entry of well fluid into chamber 102, while at the same time supporting shaft 100 and ratchet wheel 98 for rotation by pawl 91.

It will thus be understood that each time plunger 81 is depressed, pawl 91 engages a tooth 97 of ratchet wheel 98 and advances said wheel ahead one tooth, spring 95 permitting pawl 91 to pivot sufficiently to ride over the next tooth of the ratchet wheel on the return or upward stroke of plunger 81. There is sufficient friction in the mounting of the ratchet wheel that the position of the latter remains undisturbed as plunger 81 and pawl 91 are elevated by spring 83.

The described plunger and ratchet mechanism operates a distributor for the electric firing circuit, as now to be described. Positioned in a bore 120 extending downwardly in body 30, preferably in vertical alinement with chamber 102, is a source of electrical energy, here in the form of a plurality of batteries 121 arranged in series in a usual manner. These batteries 121 are of a usual dry cell type, being here shown as positioned with their central electrical terminals 121a down. The uppermost battery is grounded through a spring 122 engaging its end and seated against a plug 123 screwthreaded in the upper end of bore 120. Plug 123 serves to keep the batteries dry. The central terminal 121a of the lowermost cell engages an electrical contact 125 mounted in an insulation member 126 placed in the lower end of bore 120.

Bore 103 is formed with a counter sink at 130, and mounted therein, in coaxial relation to ratchet wheel shaft 100, is an insulation distributor disc 131. This distributor disc is provided on its inner face with a conductive ring 132 having a radially projecting connection strip 133, to which is connected an electrical conductor 134

leading through a passageway 135 to the aforementioned electrical battery contact 125. A plurality of electrical contacts 136a, 136b, etc., are mounted in circularly spaced relation on the face of disc 131, outside conductive ring 132, and connected to these contacts are electrical conductors, 140, which are gathered together in a cable 141 extending downwardly through a bore 142 in body 30. The angular spacing interval between contacts 136a, 136b, etc., starting with first contact 136a, corresponds to the angular spacing of ratchet wheel teeth 97, but there is one less contact than ratchet teeth, and the aforementioned connection strip 133 occupies the space of the contact thus omitted (see Fig. 6).

Conductors 140 are severally connected to the aforementioned conductors 70 making up the central cable 71 in gun 12. Thus, conductors 140 are shown as connected to contact elements 144 mounted in an insulation disc 145 set into a counter sink 146 in the lower end of body 30, inside box 31, and these contacts 144 are adapted to engage mating contact elements 147 mounted in an insulation disc 148 set into a counter sink 149 in the end of pin 32 of anchoring device A. Conductors 150 connected to contact elements 147 form a cable 151 extending downwardly through a central bore 152 in body 33 of anchoring device A. Cooperating electrical connector means 154 and 155 at the lower end of anchor body 33 and the upper end of gun 12, of the same type as used between body 30 and the upper end of anchor body 33, connect the conductors 150 making up cable 151 to conductors 70 making up the aforementioned cable 71 which extends down through the gun to the contact elements 74 in its several firing chambers, in the manner previously described. Thus, each of distributor contacts 136a, 136b, etc., is connected to the contact element 74 in one of the firing chambers of the gun, there being one distributor contact for each firing chamber. Of course, in any case in which the anchoring device is not positioned between body 30 and the gun proper, conductors 140 may be connected directly to conductors 70 without the intervention of the anchoring device and its cable 151.

Means controlled by plunger 81 and ratchet wheel 98 are provided for connecting conductive ring 132, which is connected to the source of electrical energy, successively to contacts 136a, 136b, etc., so as to supply electrical energy successively to the several firing chambers of the gun. For this purpose, an insulation, brush-carrying disc 160 is mounted for rotation coaxially with ratchet wheel shaft 100, and as here shown, is mounted on a pivot pin 161 extending through discs 131 and 160, which are supported thereby in face to face contact. The underside of disc 160 is formed with a recess 162, in which is positioned an electrical contact member or brush 163 adapted to bridge between conductor ring 132 and any one of electrical contacts 136a, 136b, etc.; in the particular instance here shown, this contact member is formed of some suitable resilient material, and has a central bowed portion secured to disc 160, as at 164, and oppositely extending legs adapted to bear on ring 132 and any one of contacts 136a, 136b, etc., respectively, ring 132 and contacts 136 preferably being sunk in and made flush with the surface of disc 131, all as illustrated in Fig. 2.

Disc 160 has a rearwardly projecting pin 170, which is adapted to be engaged by a lug 171 on

the previously described head 114 mounted on the inner end of ratchet wheel shaft 100.

The operation of the device is as follows:

The device is initially set with disc 160 in position with contact member or brush 163 overlying connector strip 133, so that the battery circuit is open, and with ratchet wheel 98 positioned with lug 171 on head 114 carried by the ratchet wheel shaft backed up against pin 170; in other words in the starting position of Fig. 5. From this position the ratchet wheel must be ratcheted ahead through a full revolution in order to carry lug 171 around into engagement with pin 170 and so move pin 170 and disc 160 ahead. The purpose of this lost motion provision will appear presently. Anchoring device A is initially set in contracted position, as illustrated in Fig. 1, and the apparatus is then lowered in the casing by means of cable 14.

In the event that the apparatus should hang up on the way down, jar 17 may be operated to drive it ahead. This is accomplished in the ordinary manner, the plunger or hammer element 21 of the jar being elevated to the position of Fig. 1, and the cable then being quickly lowered, so that hammer 21 drops suddenly and strikes a blow against the upper end of pin 29 of body member 30, which thus serves as the anvil for hammer 21. Hammer 21 in striking pin 25 in the manner described, of course also engages plunger stem 82 and therefore depresses plunger 81, pawl 91 accordingly advancing ratchet wheel 98 ahead one tooth each time the hammer 21 of the jar is dropped. Such depressions of plunger 81 will, however, not close the electrical firing circuit until the ratchet wheel has been ratcheted ahead through one complete revolution and lug 171 has come into engagement with pin 170 and moved disc 160 ahead one step to carry brush 163 into position across ring 132 and first distributor contact 136a. Thus, with a ratchet wheel of eight teeth, as illustrated, eight actuations of the jar cause the ratchet wheel to be advanced through one complete revolution, and the eighth actuation moves lug 171 from the dotted line to the full line position of Fig. 5, with brush 163 moving from strip 133 to the dot-dash line position of Fig. 6, across first distributor contact 136a and ring 132, thereby closing an electrical circuit to one of the firing chambers. Thus it will be understood that the jar may be operated up to seven times in lowering the apparatus through the casing without closing any electrical firing circuit. Of course, while I have for simplicity illustrated a ratchet wheel of eight teeth, this number may be varied as desired, and it will ordinarily be desirable to employ a ratchet wheel having a somewhat greater number of teeth, so as to allow for additional jarring operations which are ineffective to operate the distributor.

When the apparatus has been lowered to the desired position, cable 14 is lifted until the dogs of anchoring device A are released, in the manner previously described. The anchoring device is thereafter in the position of Fig. 3, and the apparatus cannot thereafter be lowered, though it may of course be elevated at will.

The apparatus being thus positioned, the projectiles carried by the gun are successively expelled by selective operation of operating line 14. In the particular form of the invention here shown, the line is alternately lowered and raised, causing jar plunger 21 to engage and depress plunger 81 on each lowering operation.

Each time plunger 81 is so depressed, pawl 91 advances ratchet wheel 98 one step, plunger 81 returning to its upper position under the influence of spring 83 as the jar plunger is elevated.

5 Ratchet wheel 98 is thus rotated step by step, lug 171 moving around and finally coming into engagement with pin 170 on rotatable brush-carrying disc 160, and thereafter causing disc 160 to be advanced step by step, with brush 163 moving successively over contacts 136a, 136b, etc. Thus, starting with the eighth lowering operation of jar plunger 21 by operating line 14, electrical circuits are successively formed from battery through ring 132 to distributor contacts 15 136a, 136b, etc., as the jar plunger is thereafter successively lowered.

It will of course be understood that as contact is made to successive distributor contacts 136a, 136b, battery current is supplied to the fuses of the respective firing chambers, heating said fuses and thereby setting off the powder charges to fire the projectiles. The projectiles are thus fired one at a time as distributor brush 163 is moved successively over the described distributor contacts, all of which is accomplished by simply raising and lowering suspension cable 14.

It will be evident that, having fired a desired number of projectiles at one location in the casing, the entire apparatus may be elevated to a higher position, and the jar then operated as before to effect firing of further projectiles. After the anchoring means has once been expanded, the apparatus can thus always be elevated, and the anchoring means will support the apparatus at any such position while the jar is being operated to effect firing of the gun.

While I have now described in some detail a present preferred form of my invention, it will be understood this is for illustrative purposes only, and that various changes in design, structure and arrangement may be made without departing from the spirit and scope of my invention, or of the appended claims.

I claim:

45 1. A casing perforator adapted to be lowered in a well casing, comprising a body, a projectile expelling means associated with said body, a member connected with and movable relative to said body, an operating line connected to said movable member extending to the ground surface by which said movable member may be moved relative to said body, and firing control means, including a lost motion device, actuated by such relative movement of said member after at least one preliminary relative movement thereof.

2. A casing perforator adapted to be lowered in a well casing, comprising a body, a projectile expelling means associated with said body, firing control means carried by said body, a member connected with and movable relative to said body, an operating line connected to said movable member extending to the ground surface, and means operative after the gun has been lowered to position for restricting the movement of said body in said casing, said movable member being movable relative to said body by selective movement of said operating line when said body is restricted against movement in the casing, and being adapted to actuate said firing control means by such relative movement.

3. A casing perforator adapted to be lowered in a well casing, comprising a body, a projectile expelling means associated with said body, firing control means carried by said body, a member

connected with and movable relative to said body, an operating line connected to said movable member extending to the ground surface, and wall engaging means connected with said body operative upon predetermined withdrawal movement of said operating line, after the gun has been lowered to position, to expand into engagement with the casing wall to support said body against further lowering movement, said movable member being thereafter movable relative to said body by selective movement of said operating line, and said movable member being adapted to actuate said firing control means by such relative movement.

4. A casing perforator adapted to be lowered in a well casing, comprising a body, a projectile expelling means associated with said body, firing control means carried by said body, a member connected with and movable vertically relative to said body, said relatively movable member and said body forming the hammer and anvil, respectively, of a jar, an operating line connected to said hammer and extending to the ground surface, wall engaging means connected with said anvil operative upon predetermined vertical movement of said line to expand into supporting engagement with the casing wall, said hammer being adapted to be moved vertically with relation to said body subsequent to expansion of said wall engaging means by virtue of selective movement of said line, and firing control means adapted to be actuated by such relative vertical movement of said hammer.

5. A casing perforator adapted to be lowered in a well casing, comprising a body, a projectile expelling means associated with said body, firing control means carried by said body, a member connected with and movable vertically relative to said body, said relatively movable member and said body forming the hammer and anvil, respectively, of a jar, an operating line connected to said hammer and extending to the ground surface, wall engaging means connected with said anvil operative upon predetermined vertical movement of said line to expand into supporting engagement with the casing wall, said hammer being adapted to be moved vertically with relation to said body subsequent to expansion of said wall engaging means by virtue of selective movement of said line, and firing control means, including a lost motion device, adapted to be actuated by such relative vertical movement of said hammer after at least one preliminary relative movement thereof.

6. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a distributor on said body operable to connect said source of electrical energy successively to said conductors, a member connected with said body and movable with relation thereto, said member having connection with said operating line, and being movable relative to said body by means of said operating line, and means actuated by movements of said member relative to said body for operating said distributor.

7. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of elec-

trical energy carried by said body, a distributor on said body operable to connect said source of electrical energy successively to said conductors, a member connected with said body and movable vertically, with relation thereto, said member having connection with said operating line, and being movable relative to said body by means of said operating line, and means actuated by successive vertical movements of said member relative to said body for operating said distributor to connect said source of electrical energy successively to said electrical conductors.

8. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a distributor on said body operable step by step to connect said source of electrical energy successively to said conductors, means on said body operative by virtue of a predetermined withdrawal movement of said body to expand into engagement with the casing wall in a manner to support said body against subsequent lowering movement, a member connected with said body and limitedly movable vertically with relation thereto, said member having connection with said operating line and being vertically movable thereby relative to said body when said body is supported in the casing by said wall engaging means, and means adapted to be actuated by successive vertical movements of said member by said operating line for operating said distributor step by step.

9. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a distributor on said body operable step by step to connect said source of electrical energy successively to said conductors, means on said body operative by virtue of a predetermined withdrawal movement of said body to expand into engagement with the casing wall in a manner to support said body against subsequent lowering movement, a member connected with said body and limitedly movable vertically with relation thereto, said member having connection with said operating line and being vertically movable thereby relative to said body when said body is supported in the casing by said wall engaging means, and means engageable by said member as it is lowered relative to said body by said operating line, and adapted upon successive such engagements to operate said distributor step by step.

10. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a member connected with said body and limitedly movable vertically with relation thereto, said member having operative connection with said operating line, means on said body controllable by said line to expand into body supporting engagement with the casing wall, and means subsequently controllable by vertical movement of said member by said operating line for connecting said

source of electrical energy successively to said electrical conductors.

11. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a jar member associated with said body for limited vertical movement with relation thereto and adapted to deliver a blow on said body, said jar member having connection with said operating line, means on said body operative by predetermined withdrawal movement of said operating line to expand into body supporting engagement with the casing wall, and means on said body controllable by vertical reciprocation of said jar member relative to said body for connecting said source of electrical energy successively to said electrical conductors.

12. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a jar member associated with said body for limited vertical movement with relation thereto and adapted to deliver a blow on said body, said jar member having connection with said operating line, means on said body operative by predetermined withdrawal movement of said operating line to expand into gun-supporting engagement with the casing wall, and means including a lost motion device on said body actuated by repeated vertical movements of said jar member relative to said body, after a predetermined number of jarring strokes of said jar member, for connecting said source of electrical energy successively to said electrical conductors.

13. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a jar member associated with said body for limited vertical movement with relation thereto and adapted to deliver a downward blow on said body, said jar member having connection with said operating line, means on said body operative by predetermined movement of said operating line to expand into body supporting engagement with the casing wall, means on said body advanced step by step by said jar member as said jar member is vertically reciprocated relative to said body, and means operable by said last mentioned means after a predetermined number of advances by said jar member for connecting said source of electrical energy successively to said electrical conductors.

14. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a member associated with said body for limited vertical movement with relation thereto, said vertically movable member having connection with said operating line, means on said body operative by

predetermined withdrawal movement of said operating line to expand into body supporting engagement with the casing wall, a pawl supported by said body adapted to be advanced by vertical strokes of said movable member, a ratchet member on said body operated by said pawl, and a distributor operated by said ratchet member to connect said source of electrical energy successively to said electrical conductors.

15. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a jar member associated with said body for limited vertical movement with relation thereto and adapted to deliver a downward blow on said body, said jar member having connection with said operating line, means on said body operative by predetermined withdrawal movement of said operating line to expand into body supporting engagement with the casing wall, a pawl supported by said body adapted to be advanced by vertical strokes of said jar member, a ratchet on said body operated by said pawl, a distributor adapted to connect said source of electrical energy successively to said electrical conductors, and a lost motion driving device between said ratchet and distributor adapted to operate said distributor after a predetermined number of advancements of said ratchet by said pawl.

16. A casing perforating gun adapted to be lowered in a well casing on an operating line, comprising a body, a plurality of electrically controlled projectile expelling means associated with said body, an individual electrical conductor for controlling each of said means, a source of electrical energy carried by said body, a jar member associated with said body for limited vertical movement with relation thereto and adapted to deliver a downward blow on said body, said jar member having connection with said oper-

ating line, means on said body operative by predetermined withdrawal movement of said operating line to expand into body supporting engagement with the casing wall, a pawl supported by said body adapted to be advanced by vertical strokes of said jar member, a ratchet wheel on said body operable by said pawl, a brush carrier member rotatably mounted on said body, co-operating means associated with said ratchet wheel and brush carrier member, including a lost motion device, for rotating said brush carrier member step by step in accordance with step by step rotation of said ratchet wheel following a predetermined number of ineffective advancements of said ratchet wheel, a brush on said brush carrier member electrically connected to said source of electrical energy, and a relatively stationary distributor member on said body having a plurality of contacts connected to said conductors and adapted to be successively contacted by said brush on said rotatable brush carrier member as the latter is advanced by said ratchet wheel.

17. In a device of the character described, a cylindrical body threaded at both ends, a plunger bore extending downwardly from the upper end of said body, a plunger mounted in said bore, a spring in the lower end of said bore normally supporting said plunger in an elevated position, a recess sunk in a side of said body opening within said plunger bore, a chamber in said body positioned opposite said recess and separated therefrom by a dividing wall, a ratchet wheel disposed in said recess, a pawl on said plunger adapted to engage said ratchet wheel, a shaft for said ratchet wheel extending through said dividing wall, fluid tight thrust and radial bearing means for said shaft mounted in said wall, a spring surrounding said shaft inside said chamber for drawing said shaft tightly against said bearing means, a battery within said body, and battery current distributor means in said chamber operated by said ratchet wheel shaft.

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