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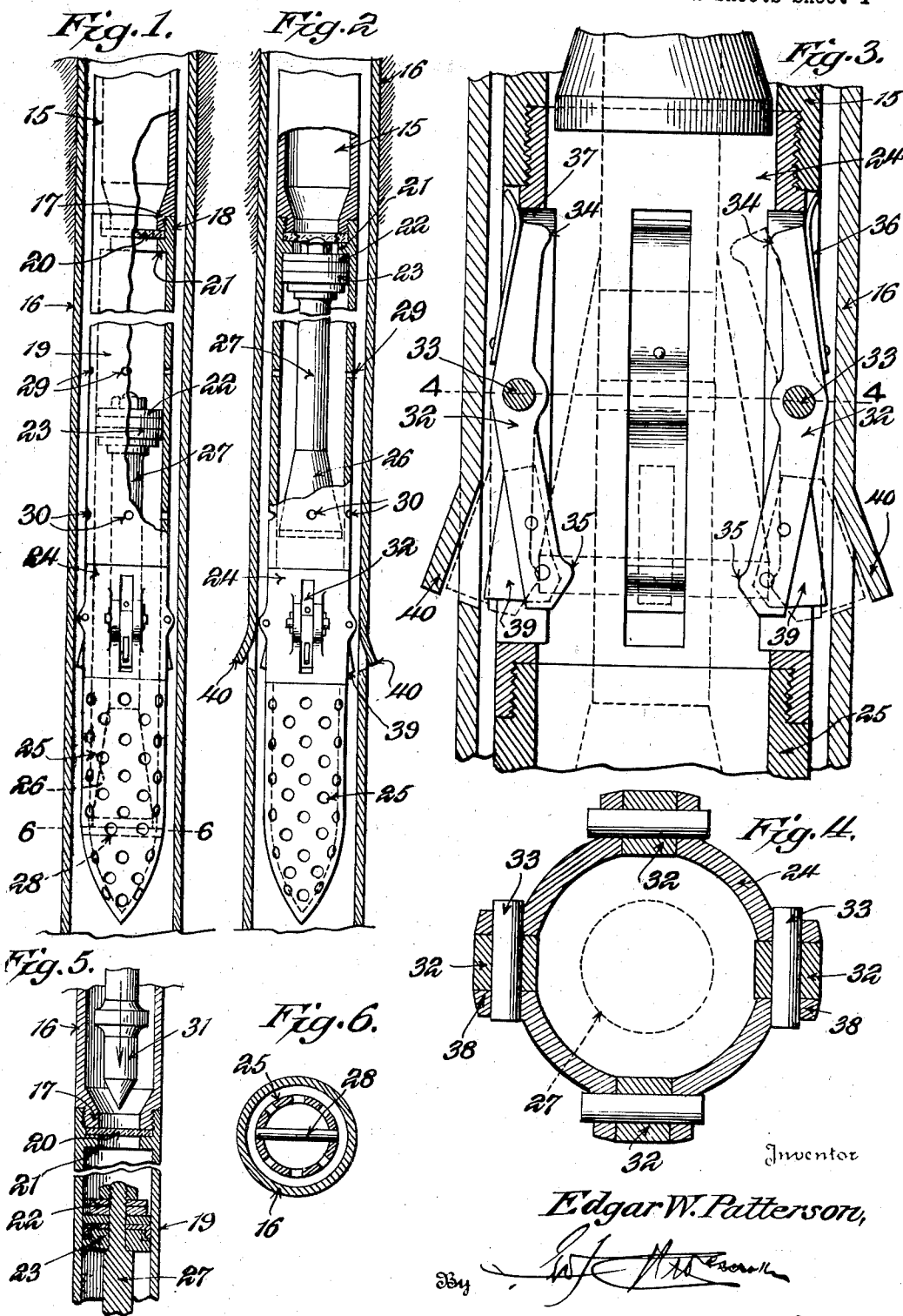
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2,116,465

METHOD AND MEANS FOR PERFORATING OIL WELL CASING

Filed July 25, 1936

2 Sheets-Sheet 1



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METHOD AND MEANS FOR PERFORATING OIL WELL CASING

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2 Sheets-Sheet 2

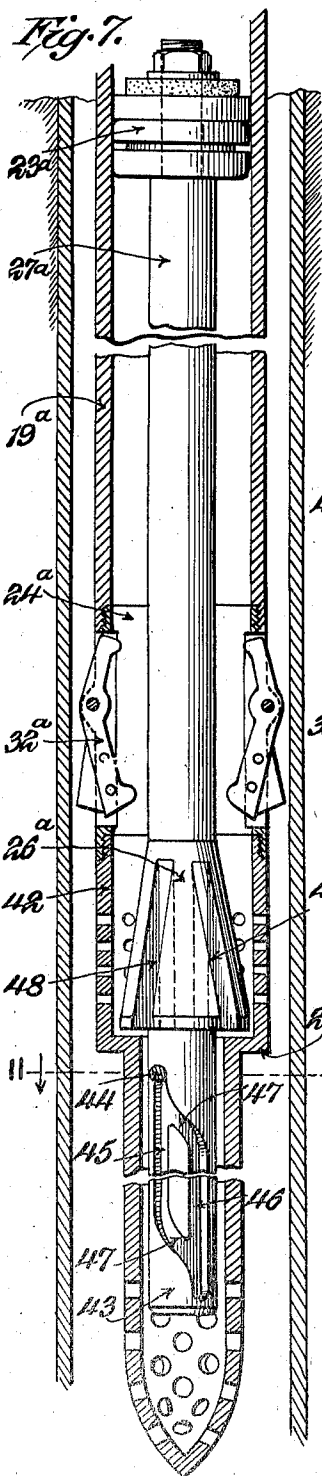
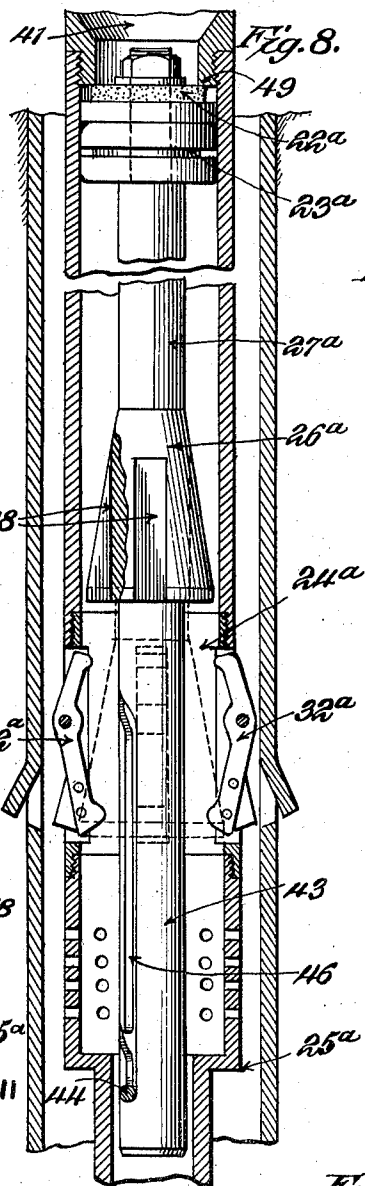
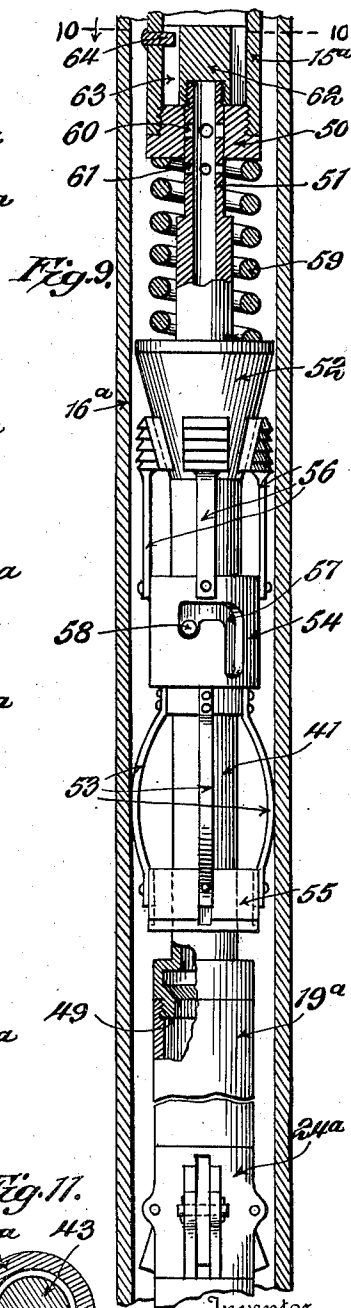
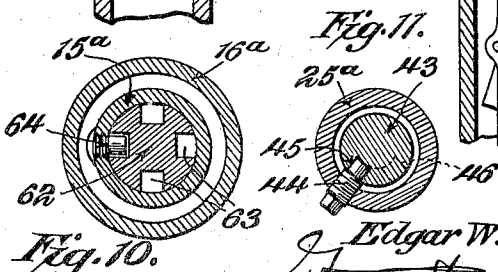
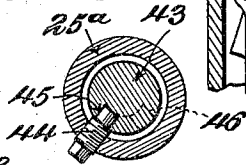


Fig. 11.



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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR PERFORATING
OIL WELL CASINGEdgar W. Patterson, Los Angeles, Calif., assignor
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Application July 25, 1936, Serial No. 92,669

16 Claims. (Cl. 164-0.4)

The present invention relates generally to a method and means whereby to perforate casing in oil wells, taking advantage of certain natural conditions therein to provide the necessary power at the points of perforation, and more particularly to do so while the perforating operation is under full control of the operator at the surface in the respects which will presently appear.

The many advantages incident to the placement of casing in oil wells before perforation, and the subsequent perforation thereof, are now well known in the industry at the present time and, on the other hand, the present generally used method of shooting holes through such casing presents many disadvantages which may be said to be equally well known, one of the foremost disadvantages being that the perforations thus made will be burred on the exterior surface of the casing and the latter for this reason will be very difficult of removal in the event removal becomes desirable or necessary.

It is also well known at the present time that the hydrostatic head pressure of the fluid in a well is, especially in the deep wells of the present day, available as a source of power in perforating operations. I am not aware, however, that it has been utilized as power for such purpose except by the direct jetting of the pressure along with drilling fluid to erode holes through the casing. Obviously, such a use of the natural pressure leaves no way to control the character and area of the perforations and carries no assurance that the perforations will be completed through the casing before the necessary circulation of fluid fills the perforating stem to the head of the fluid in the casing around the stem.

With the above in mind, the present invention aims to actuate a mechanical perforating mechanism by the hydrostatic head pressure in a well and in a manner to avoid material reduction of said pressure during the perforating operation, and particularly to avoid such reduction as may have any serious effect upon the producing qualities of the formation.

The invention further aims to so actuate, and control the actuation of, a mechanical perforating mechanism as to avoid the necessity of packing off the well at any point incident to the harnessing and utilization of the hydrostatic head pressure thereof, and a still further object in this respect is to provide for actuation of casing perforators or perforating elements in such manner and by such means as will employ the well pressure over but a momentary period of time followed immediately by a closing off of the per-

forator stem or hollow tube string by which the perforating mechanism is lowered into a well.

A still further object is the provision of an actuating member for the perforators which, in connection with the perforating operation, is operated by hydrostatic head pressure and such pressure utilized in lowering or setting the mechanism in position, to balance said member and permit the latter to assume by gravity a normal position of rest.

A still further and substantial object is the provision of a mechanism which as to single operation may be readily brought into action by control of a valve from the surface through the tube string or stem, as well as by the dropping of a "go-devil" for breaking away a frangible control element, as well as a mechanism having provision for repeated use and in which, after each operation and without withdrawal from the well, the necessary operating and control parts may be reset for subsequent operation, for instance, at other producing strata either above or below the strata at which the preceding perforating operation was carried out.

Still other objects reside in the method utilized in the accomplishment of certain of the foregoing objects apart from the particular means employed therein, as well as in the actual perforating of the casing whereby the shape of the perforations may be varied through a wide range, the size thereof may be controlled within limits starting at a very small fraction of an inch, and whereby, irrespective of size or shape, the casing will remain, insofar as its perforations are concerned, in condition for ready removal.

These and other objects having to do with the more specific aspects of the invention will be better understood and more thoroughly appreciated from the following detailed description of the best mode so far devised for carrying the invention into practical effect, and by reference to the accompanying drawings, which form a part of this specification, and in which,

Figure 1 is a side view, partly in elevation and partly in section, of the single action perforating apparatus, with the parts in position as they are lowered into a well.

Figure 2 is a similar view with the parts in position after the perforating operation.

Figure 3 is an enlarged central vertical section through the perforating member.

Figure 4 is a horizontal sectional view through the perforating member taken substantially on line 4-4 of Figure 3.

Figure 5 is a vertical sectional view through a portion of the perforating tube.

Figure 6 is a detail horizontal sectional view taken on line 6—6 of Figure 1.

Figure 7 is a vertical sectional view taken through the perforator showing the parts constructed and arranged for repeated operations and positioned as they are lowered into a well.

Figure 8 is a similar view showing the parts in position immediately after each operation.

Figure 9 is an elevation partly broken away and in section showing the control parts for the apparatus of Figures 7 and 8, and

Figures 10 and 11 are detail horizontal sectional views taken respectively on lines 10—10 and 11—11 of Figures 9 and 7.

Referring now generally to the several drawings and by way of briefly outlining the present invention and the method contained therein by which its many advantages are brought into being, a perforating member having a plurality of perforating elements is lowered into a well casing to be perforated, in connection with the lower end of a string of tubing. This tubing may, for the present purposes, be called the perforator tube, and is closed off at its lower portion above the perforating member so that as initially lowered into the fluid in the well its interior is at atmospheric pressure. In association with the perforating member and with said tube is an actuating member which, as initially lowered into the well, is balanced by the well pressure and remains of its own weight in inactive position until the tube closure is opened after the perforating member has been properly positioned opposite that portion of the well casing which it is desired to perforate. When the tube is thus opened to well pressure, the latter imparts to the actuating member a power movement, during which the perforating elements are forcibly thrust radially outwardly on arcuate paths and through the casing wall in an angular shearing action, resulting in the outward displacement of sections of the casing wall. These displaced portions or sections are in the form of tongues and project downwardly and outwardly from the casing so as not to impede upward movement of the casing, as, for instance, when it is to be removed.

The displaced sections or tongues are, moreover, sheared through on only three sides, and the upper ends thereof remain integral with the casing, the perforations being formed at the free ends of the tongues and the size thereof being controlled by the extent of displacement of said free ends from the outer surface of casing. This plainly permits of control of the size of the perforations by the extent of forced radial movement of the perforating elements and leaves a portion of the casing overlying and protecting its several perforations.

The same movement of the actuating member that forces the perforating elements radially outwardly serves to immediately return the same to normal position in the perforating member whereby upon withdrawal of the latter from the well an inspection thereof permits of determining at once the success, wholly or partially, of the perforating operation as presently more fully described, and likewise the actuating member serves, at the end of its effective stroke, to again establish a closure at the lower end of the perforating tube so that the only loss of pressure from the well into the tube, and this but momentary, takes place during the single continuous effective

movement of the pressure-operated actuating member.

These operations, as well as the novel method involved therein and the structure by which they are carried out, are first referred to in connection with the single operation perforator of Figures 1 to 6, inclusive.

In Figures 1 and 2, the perforator tube 15 is shown within a section 16 of well casing, with a reduced threaded lower end 17 by which it is engaged with the upper threaded end 18 of a piston cylinder 19 in such manner as to clamp, between these threadedly engaged ends, a frangible disc 20 which, while integral, forms a closure for the lower end of the tube.

The cylinder 19 has an internal upper circumferential rib 21 which not only forms a seat for disc 20 but has a second function in later operation to receive the upper flat valve disc 22 of the piston 23 at the end of the perforating operation. This cylinder has internal threads at its lower end to engage the upper externally threaded end of the cylindrical perforator barrel 24 and the latter is internally threaded at its lower end, as plainly seen in Figure 3, in complement to its upper end, whereby one or a series of such barrels may be utilized in line, each being approximately the diameter of the tube 15 and cylinder 19. The barrel, or the lowermost barrel, 24 receives the upper externally threaded end of an apertured guard point 25, into which the lower cone-shaped enlargement 26 of the piston rod 27 depends in the normal position before operation, said rod, its lower cone 26 and upper piston 23, constituting the actuating member, and resting, in such position, of its own weight on a transverse stop pin 28 diametrically of the guard point 25 as seen in Figures 1 and 6.

Cylinder 19 has upper and lower openings 29 and 30 which, when the apparatus is lowered into the fluid of a well, permits pressure to enter the spaces above and below piston 23 and thus balance the latter prior to the time the disc 20 is broken, as by means of dropping a "go-devil" 31 (Figure 5) through tube 15. When this is done, after setting the perforator barrel 24 opposite that portion of the casing 16 which is to be perforated, the hydrostatic head pressure forces the fluid upwardly into the tube 15, previously maintained at atmospheric pressure, and such fluid entering openings 30 and the apertures of guard 25 acts against the lower end of piston rod 27 and the lower surface of its piston 23, to thrust the rod, and hence the enlarged cone 26, upwardly. In this movement the actuating cone 26 passes from its lower position, resting on stop pin 28 as in Figure 1 (see also lower dotted position in Figure 3) through the perforator barrel 24, to its upper position shown in Figure 2 and also in Figure 3, and it will be noted from Figure 2 that, in this latter position of the actuator, piston valve member 22 closes tightly against the internal rib 21 of cylinder 19 and thus stops further flow of pressure into the perforator tube 15.

It is during the passage of cone 26 through the barrel 24 that the perforating operation is accomplished, and it is in this way that the hydrostatic head pressure in the well is utilized in the perforating operation, though but momentarily, so that such pressure is but slightly reduced and no such disturbance is created in the well as might adversely affect the producing qualities of the formation.

Set into the wall of the perforator barrel at equidistantly spaced points therearound are a

series of lengthwise disposed perforating elements 32, each centrally fulcrumed on a pivot bolt 33 and having inwardly extended contact bosses 34 and 35, respectively, at its upper and lower ends.

5 A flat spring 36 is secured to each element 32 above its pivot bolt 33 and engages the upper end portion of the barrel as plainly seen in Figure 3 to normally hold the element generally parallel to the axis of the barrel in which its lower boss 35 projects into the interior of the barrel and into the path of upward movement of the actuating cone 26.

To provide for the perforating elements, and, as best seen in Figures 3 and 4, the barrel 24 has 15 vertically slotted openings 37 slightly longer than said elements located between vertically extending ribs 38 which support the pivot bolt 33, and to serve their purposes each of the elements 32 has a cavity in which a shearing cutter 39 is seated and secured so as to protrude radially outwardly of the barrel with its lower edge and portions of its side edges inclined downwardly and outwardly a predetermined distance from the element so that when the latter is at its maximum 25 outward position the said edges of the cutter will have sheared through the wall of the casing 16 to such a point that the tongue of metal 40 thus along its lower end and along its sides will be pressed outwardly to define a casing perforation in its outwardly and downwardly inclined relation beyond the outer surface of the casing as 30 plainly seen in Figures 2 and 3.

Thus when the frangible disc 20 is broken, as by the means previously set forth, and the piston 35 23 and its rod 27 move upwardly, the cone 26, in its passage through the perforator barrel 24, first engages the lower inner bosses 35 of the several perforating elements 32, rocking the latter on their pivots 33 and forcing the lower ends thereof outwardly so that the cutters 39 are 40 forced laterally, outwardly on an arc of movement which enables them to shear through the wall of the casing 19 and thus form and deflect the tongues 40 with the resulting covered and protected perforations of the casing. It is necessary then to retract the perforating elements and 45 thus, since the effective movements thereof just previously described have shifted their upper ends inwardly, the upper bosses 34 are in the path of the further upward movement of the cone 26 and the latter, engaging said bosses 34 will, by its outward pressure upon the upper ends of the perforating elements, withdraw the lower ends from the casing perforations to the normal position thereof where they will be retained by springs 36. At the upper limit of travel of the piston 50 and its rod, the cone will be above the perforating elements and, as before stated, the path of outlet of pressure into the perforating tube will again be closed off.

Obviously, the cutters 39 will be predetermined 60 as to size to bring about just the size of perforations desired in the casing and, by coating the sides of the cutters as by a previously applied paint and the like, an inspection thereof after 65 operation will show conclusively whether or not they have passed through the wall of the casing in the manner intended, so that the operator will know just how many perforations have actually 70 been made in the casing and just what relation they bear to one another. This eliminates all guess work and results in normally protected perforations which do not readily close or clog, it being noted that the tongues protruding from 75 the casing are downwardly, outwardly inclined

to free lower ends so as to offer minimum resistance to upward movement of the casing in withdrawing the same from the well.

The fact that but momentary passage of well 5 pressure into the tube 15 is necessary for the foregoing operation gives rise to another great advantage and that is the possibility of repetition of the perforating operation at several points at vertically spaced points of the well casing opposite different producing formations. This ob- 10 viously cannot be done with the previously described apparatus nor where a frangible disc 20 is used, for when once broken there is no way to replace the disc without withdrawing the apparatus from the well. It may be accomplished, 15 however, by utilizing the apparatus of Figures 7 to 11, inclusive, which includes the same perforating member and its elements and the same actuating member as previously described, though somewhat differently controlled and with certain 20 additions permitting the actuating member to return to a normal at rest position below the perforating member after each operation has been completed.

Thus, in the construction shown in Figures 7 25 to 11, inclusive, the cylinder 19^a is threaded at its upper end to the lower end of a hollow anchor stem 41 (see Figure 9) and is threaded at its lower end in connection with the upper end of the perforator barrel 24^a which, as to its elements 32^a and the other parts thereof, is precisely the same as previously described. The cylinder 19^a need not be apertured in the present construction, provision being otherwise made to balance 30 pressure under normal conditions upon opposite sides of the piston 23^a which, as in the preceding form of the invention, is at the upper end of a piston rod 27^a having a lower actuating cone 26^a.

The barrel 24^a is threadedly connected at the 40 lower end thereof to the upper enlarged and apertured portion 42 of a somewhat elongated guard 25^a whose lower portion is reduced to a diameter but slightly exceeding that of a lower portion 43 of the piston rod, which portion depends into the guard from the cone 26^a. This 45 depending portion 43 of the rod has a continuous groove in its face forming a track for a pin 44 projecting inwardly from the wall of the guard. The groove includes parallel side channels 45^a and 46 connected adjacent to their upper and 50 lower ends by angular, inclined channels 47 so that in the up and down movements of the rod the pin 44 rides in the channels 45 and 46, respectively, and enters one from the other through 55 one of the inclined channels 47 as it approaches the end of each stroke, so that the rod and consequently the cone 26^a will be oscillated a quarter turn or through 45°, according to the illustrated arrangement utilizing four slots 48. 60

The cone 26^a is provided with circumferentially spaced vertical slots 48 and is so oriented that as it moves upwardly portions of its cone surface between slots 48 are positioned opposite the several perforating elements 32^a so as to 65 actuate the same in the manner and for the purpose previously set forth, while, when it moves downwardly, its slots 48 will be opposite the perforating elements to receive the same and permit downward movement of the cone with- 70 out actuating the perforating elements.

The lower end of the anchor stem 41 forms a valve seat 49 at the upper end of cylinder 19^a as seen in Figures 8 and 9 against which the valve disc 22^a of piston 23^a seats in the upper position 75

of actuating rod 27^a to close off passage of pressure upwardly through the stem 41.

For the support and control of the apparatus, the perforator tube 15^a as in Figure 9 has its lower end threaded to receive a plug 50, which is axially bored to slidably receive the upper reduced portion 51 of the anchor stem 41. On this stem below the reduced portion 51 is a downwardly tapering rigid gripper-expanding cone 52 and below this cone there is sleeved on the stem an anchor assemblage consisting of a lower series of spring friction members 53 for frictionally engaging the inner surface of well casing 16^a extending between upper and lower collars 54 and 55, and a series of spring slips 56 normally around the lower smaller portion of cone 52 in the retracted, unset position of the parts. The upper collar 54 has an L-shaped slot 57 including one short and one long leg into which a pin 58 rigid with stem 41 projects. In the normal position of the parts, when the apparatus is lowered into the well or adjusted between points of perforation of the casing 16^a, the pin 58 is in the short leg of slot 57 to thus hold the anchor assemblage in its lower inactive position.

Between the upper larger end of cone 52 and the plug 50 is a heavy coil spring 59 sufficiently strong to avoid flexing as the apparatus is lowered into a well and as the anchor is set at a desired point, to thus normally hold the reduced upper end 51 of stem 41 in such position that its upper openings 60 are within the plug 50 and its lower openings 61 are below the plug to permit entry of well-pressure on top of the piston 23^a. In this way the piston is balanced between the pressure above and pressure below the same, entering apertures of the guard 42 so that the actuating rod is free to rest of its own weight in the lower position shown in Figure 7.

Within the tube 15^a above plug 50 is a sliding block 62 which is fixed to the upper extremity of the reduced portion 51 of stem 41 and has a series of vertical slots 63, into one of which a pin 64 enters from the wall of the tube 15^a. Thus the stem 41 can slide vertically with respect to tube 15^a by a pressure on the latter, overcoming the resistance of spring 59, but these parts are constrained to simultaneous rotation.

In operation, with the parts as shown in Figures 7 and 9, the tube 15^a is raised slightly, lifting pin 58 of the anchor stem 41 out of the short leg of slot 57. The tube 15^a is then rotated to shift said pin 58 into line with the long leg of slot 57 so that, when the tube is again lowered, cone 52 moves downwardly between the anchoring slips 56 and spreads the latter into firm gripping engagement with the inner surface of the well casing 16^a. During this time the anchor assemblage on the stem 41 has been held stationary by reason of the frictional engagement of spring arms 53 with the casing.

Now, the apparatus is firmly anchored opposite that point of the casing which is to be perforated and, to bring about this operation, it is necessary that the tube 15^a be forced downwardly against the tension of spring 59 until the stem openings 60 are above the plug 50, thus permitting well fluid under pressure to rush upwardly into tube 15^a, which brings about an upward stroke of the actuator rod 27^a with consequent outward operative and inward return movements of the perforating elements 32^a in the manner previously described. Here again the pressure escape is but momentary, until the piston-carried

valve disc 22^a engages its seat 49. To return the parts, the pressure downwardly on tube 15^a is relieved, spring 59 expands, openings 60 covered by plug 50 and openings 61 exposed to permit entrance of pressure above the piston 23^a, whereupon the actuator is again balanced and falls by its own weight from the position shown in Figure 8 to the position shown in Figure 7. This movement of the actuator is permitted by reason of its before-described rotative movement as it nears the top of its upstroke to position the same with its slots 48 in line with the perforating elements 32^a so that it may pass the latter on its downstroke.

The parts being then in normal position, the anchor may be released by reversing the movements necessary to set the same and the apparatus then shifted to and re-anchored at any other point of the well above or below the previously perforated section for another perforating operation, and this may be repeated several times without withdrawing the apparatus from the well, since each operation requires the utilization of but a very small portion of the hydrostatic pressure in the well.

All of the above operations and advantages are obtained in a simple, readily controlled manner and, it is important to note, without packing off any portion of the well. The method of perforating well casing as proposed herein is highly desirable from the several standpoints to which reference has already been made, and the structure for carrying out this method is not only the best so far devised for that purpose, but is, in itself, peculiarly effective and efficient on account of its strength, simplicity and durability.

It is to be noted that according to either form of the invention, the piston (23 in the single action device and 23^a in the multiple action device) forms in itself a valve means to prevent fluid entering the perforator 2 above the piston when the latter is checked at the end of its upward stroke. In other words, the piston acts in these circumstances as a valve without relying upon the valve member 22 or 22^a engaging a valve seat 21 or 49 and follows from the fact that the piston is in leak-proof relationship with barrel 19 or 19^a.

What is claimed is:

1. A casing perforator including a cylindrical member, an annular series of perforating elements intermediately pivoted in the wall of said member for actuation from within the same and having cutters in the lower portions thereof, a cylinder connected to and extending above the said member, a tubular support in connection with the upper end of the cylinder for lowering the perforator into the fluid of a well and normally closed to the entrance of fluid under pressure, a fluid flow responsive actuating member including a rod having an upper piston normally subjected to balanced pressures above and below the same in the cylinder and a lower enlarged cone normally below the perforating elements for movement upwardly therethrough to successively engage the lower and upper ends of the perforating elements and thus actuate and retract the cutters carried thereby, and means for venting the tubular support to permit flow of fluid therein and impart an effective upward stroke to said actuating member.

2. A casing perforator including a cylindrical member, an annular series of perforating elements intermediately pivoted in the wall of said

member for actuation from within the same and having cutters in the lower portions thereof, a cylinder connected to and extending above the said member, a tubular support in connection with the upper end of the cylinder for lowering the perforator into the fluid of a well and normally closed to the entrance of fluid under pressure, a fluid flow responsive actuating member including a rod having an upper piston normally subjected to balanced pressures above and below the same in the cylinder and a lower enlarged cone normally below the perforating elements for movement upwardly therethrough to successively engage the lower and upper ends of the perforating elements and thus actuate and retract the cutters carried thereby, and means for venting the tubular support to permit flow of fluid therein and impart an effective upward stroke to said actuating member, the piston of the actuating member having a valve member, and means forming a valve seat at the upper portion of the cylinder for engagement by said valve member at the upper limit of the stroke of said actuating member to again close the tubular support.

3. A casing perforator including a cylindrical member, an annular series of perforating elements intermediately pivoted in the wall of said member for actuation from within the same and having cutters in the lower portions thereof, a cylinder connected to and extending above the said member, a tubular support in connection with the upper end of the cylinder for lowering the perforator into the fluid of a well and normally closed to the entrance of fluid under pressure, a fluid flow responsive actuating member including a rod having an upper piston normally subjected to balanced pressures above and below the same in the cylinder and a lower enlarged cone normally resting by gravity in lower position with its cone below the perforating elements while the tubular support is closed, means to vent the said tubular support to permit inflow therein of fluid pressure and thus impart an upward stroke to the actuating member for successively actuating and retracting the perforating elements, said last-named means being operable to subsequently reclose the tubular member and permit the actuating member to drop by gravity, the cone having slots therein to receive the perforating elements during downward movement of the actuating member, and means for partially rotating the actuating member adjacent to the ends of its upward and downward movements to respectively align and disalign its slots with respect to the perforating elements.

4. A casing perforator including perforating elements operable to shear through the wall of a well casing from within the same, a device for lowering and positioning said perforating elements in a well and forming a conduit for the outlet of fluid under pressure from a well, means normally closing said conduit, means to release said closing means, and means operable upon flow of well fluid into said conduit for actuating said perforating elements.

5. A casing perforator including a series of perforating elements operable to shear through the wall of a well casing from within the same, a device for lowering and positioning said perforating elements in a well and forming a conduit for the outlet of fluid pressure from a well, means normally closing said conduit, means to release said closing means, means operable upon flow of well fluid into the said conduit for actuating said

perforating elements, and means in connection with said last-named means and effective at the end of the operating movement of the actuating means to close off the said conduit.

6. A casing perforator including an annular series of radially shiftable perforating elements, a piston cylinder, a support for said elements in connection with said cylinder, an actuating member movable axially of said support and having means to actuate the perforating elements during its actuating movement in one direction and to pass said elements without actuation during its return movement, a piston on said actuating member in the said cylinder, and means for establishing and cutting off flow of fluid in a well to respectively impart actuating movement to the actuator and release the latter for return movement, whereby its actuation may be repeated.

7. A casing perforator including a series of perforating elements operable to shear through the wall of a well casing from within the same, a device for lowering and positioning said perforating elements in a well and forming a conduit for the outlet of fluid pressure from a well, means normally closing said conduit, means to release said closing means, and means operable upon flow of well fluid into the said conduit for actuating said perforating elements including an actuator having a fluid flow responsive piston and provided with means for closing off the said conduit at the end of its effective movement.

8. A casing perforator including an annular series of intermediately pivoted, laterally swingable perforating elements, a support therefor, a fluid flow responsive actuator movable axially through said support to successively engage the opposite end portions of said elements and first actuate and then retract the same, a device for lowering and positioning said support in a well and forming a normally closed conduit for outlet of fluid under pressure in a well, and means for opening said conduit to receive well fluid for imparting effective movement to said actuator.

9. A casing perforator including an annular series of intermediately pivoted, laterally swingable perforating elements, a support therefor, a fluid flow responsive actuator movable axially through said support to successively engage the opposite end portions of said elements and first actuate and then retract the same, a device for lowering and positioning said support in a well and forming a normally closed conduit for outlet of fluid under pressure in a well, means for opening said conduit to receive well fluid for imparting effective movement to said actuator, and means carried by said actuator and operable at the end of its effective movement to again close the said conduit.

10. In a casing perforator, a pressure operated perforating mechanism including a perforating element, an actuator therefor, a cylinder for said actuator having fluid inlet means above and below the actuator for normally balancing the actuator in the fluid under pressure of a well, means forming a fluid outlet leading from said cylinder, means normally closing said outlet, and means to open the said pressure outlet.

11. In a casing perforator, a pressure operated perforating element, an actuator therefor, a cylinder for said actuator having fluid inlet means at opposite sides of the actuator for normally balancing the actuator in the fluid under pressure of a well, means forming a fluid outlet leading from said cylinder, means normally closing said outlet, means to open the said pressure out-

let, and means for subsequently closing the pressure outlet to provide for restoration of said actuator to normally balanced position.

12. In combination with a hollow stem forming a normally closed conduit of reduced pressure when within the fluid of a well, a fluid pressure operated perforating mechanism carried thereby, means normally closing said conduit above the perforating means, means for admitting fluid pressure below said closure for normally holding said mechanism in pressure balanced inactive position in the fluid pressure of a well, and means for opening said conduit of reduced pressure to permit inrush of fluid under pressure for operating the perforating mechanism.

13. A casing perforator including one or more perforating elements operable to shear through the wall of a well casing from within the same, a device for lowering and positioning said element or elements in a well and for forming a conduit for the outlet of fluid under pressure from a well, means for normally closing said conduit, means for opening said conduit in a well to the inflow of fluid under pressure, means operable upon flow of fluid under pressure into the said conduit for actuating said perforating element, or elements and means for automatically closing the outlet conduit immediately following operation of the said actuating means.

14. A casing perforator including one or more perforating elements operable to shear through the wall of a well casing from within the same, a device for lowering and positioning said element or elements in a well and for forming a conduit for the outlet of fluid under pressure from a well, means normally closing said conduit, means for opening said conduit in a well to the inflow of fluid under pressure, means operable

upon flow of fluid under pressure into the said conduit for actuating said perforating element or elements, and means for again closing off the flow of fluid under pressure into the said conduit after operation of said actuating means.

15. The herein described method of perforating deep well casing, which consists in lowering a perforating mechanism into the fluid under pressure in a well casing, selectively positioning said mechanism while in a balanced inactive state in the fluid opposite that portion of the casing to be perforated, opening a fluid outlet through said mechanism to an area of reduced pressure to provide for outflow of fluid under pressure from the well and operation of the perforating mechanism thereby at the start of such outflow, and then closing the fluid outlet immediately following operation of the perforating mechanism to thus prevent prolonged loss of well fluid.

16. The herein described method of perforating deep well casing, which consists in lowering a perforating mechanism into the fluid under pressure in a well casing, selectively positioning said mechanism while in a balanced inactive state in the fluid opposite that portion of the casing to be perforated, opening a fluid outlet through said mechanism to an area of reduced pressure to provide for outflow of fluid under pressure from the well and operation of the perforating mechanism thereby at the start of such outflow, and closing the fluid outlet immediately following operation of the perforating mechanism in a manner to bring about restoration of the previous balancing effect of the well fluid for again maintaining the mechanism in a balanced inactive state whereby the perforating operation may be repeated by again opening the outlet for well fluid.

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