

June 1, 1954

V. L. FORSYTH ET AL
ORIENTED GUN PERFORATING

2,679,898

Filed Nov. 15, 1949

4 Sheets-Sheet 1

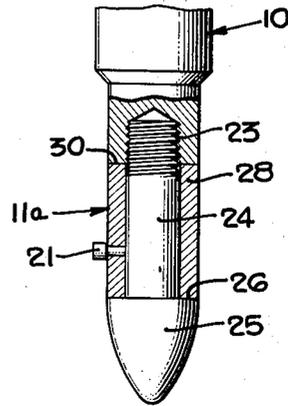
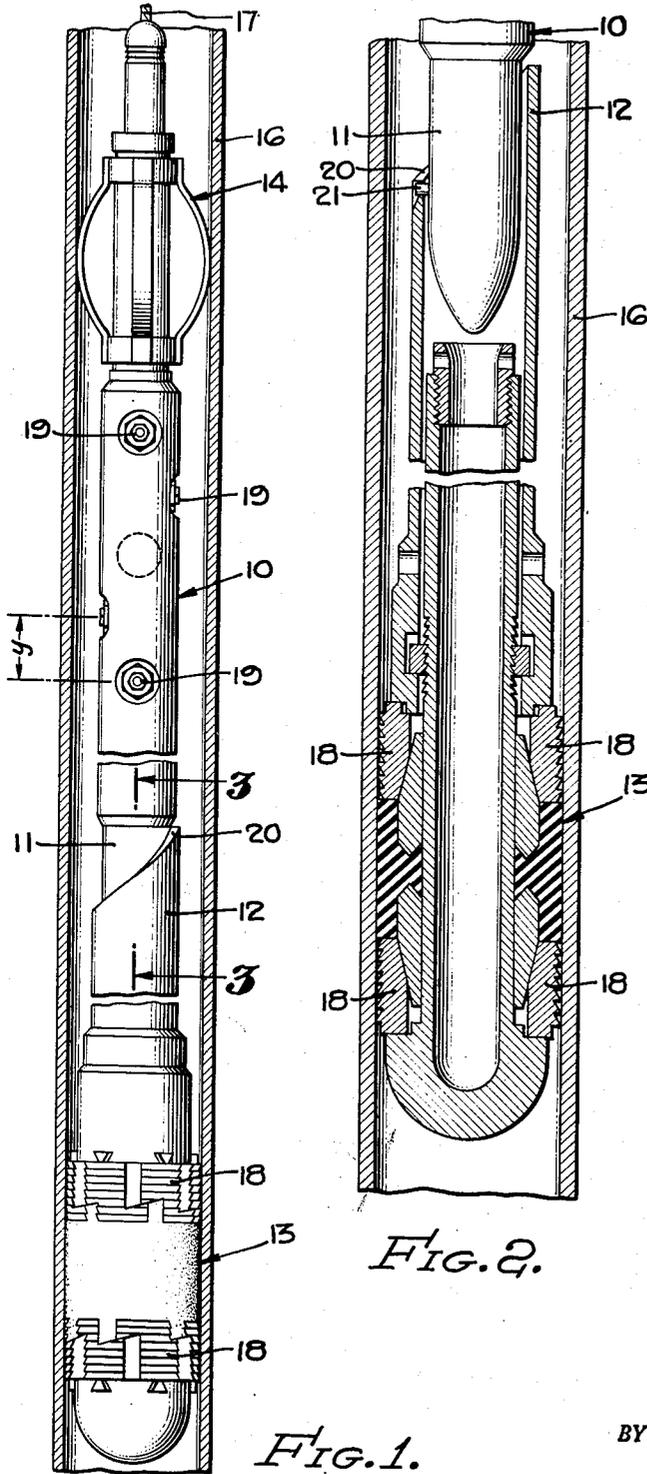


FIG. 6.

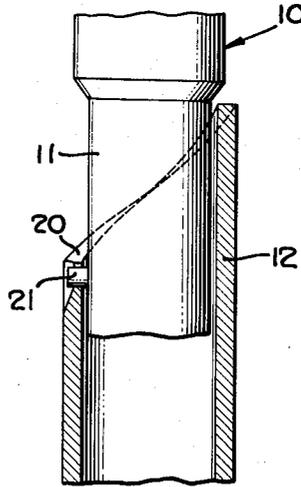


FIG. 3.

VALORIS L. FORSYTH
LYLE DILLON
INVENTORS

BY *Lyle Dillon*

ATTORNEY

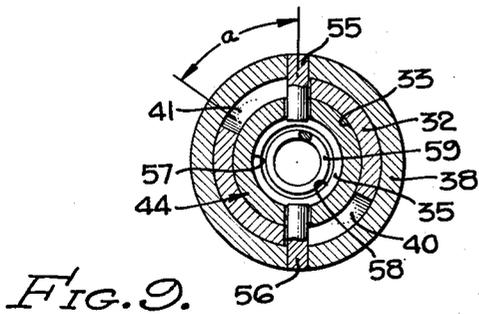
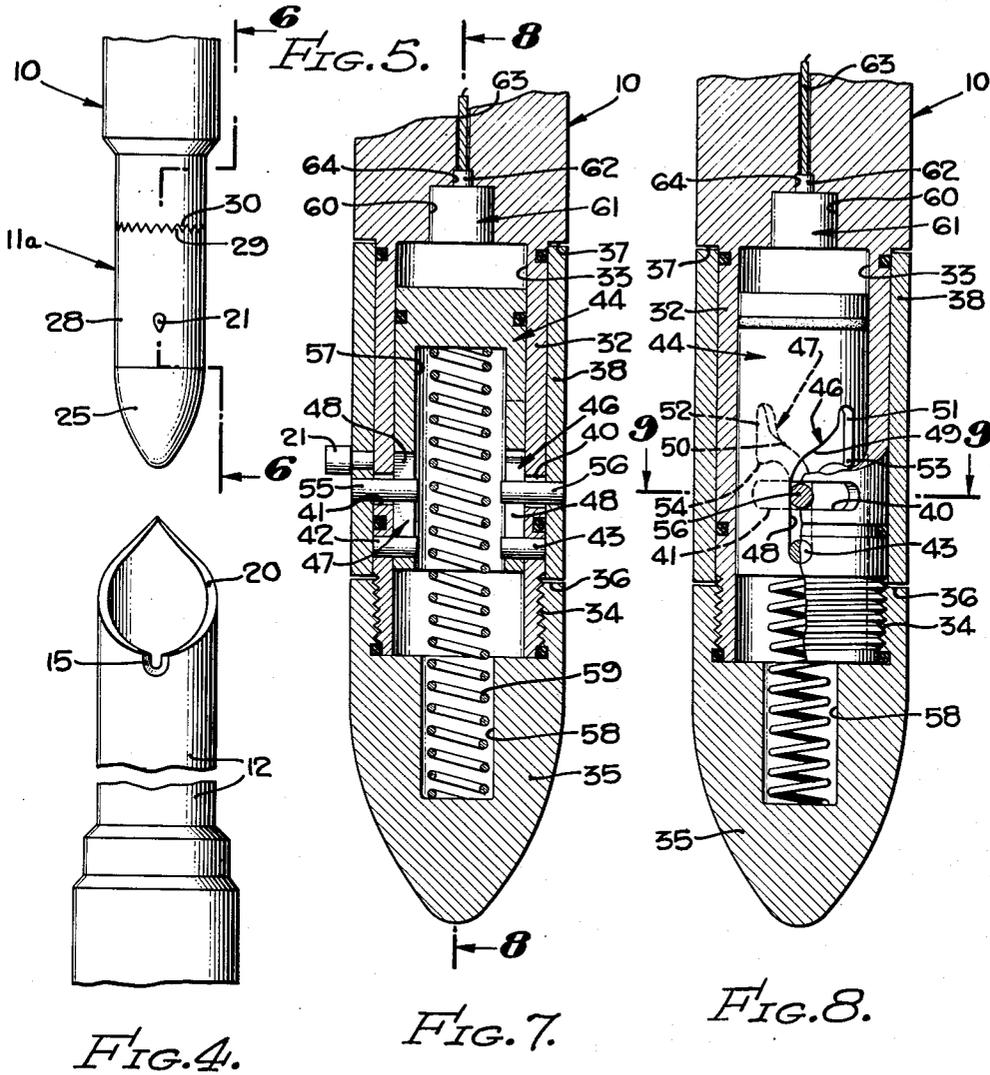
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VALORIS L. FORSYTH
LYLE DILLON
INVENTORS

BY *Lyle Dillon*
ATTORNEY

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FIG. 10.

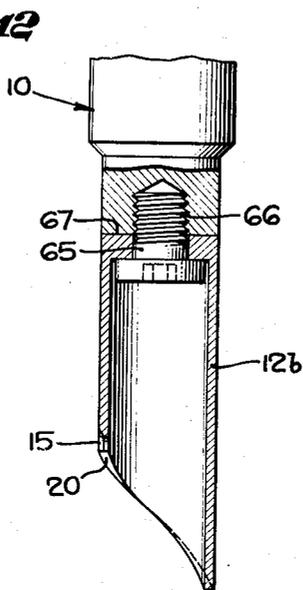
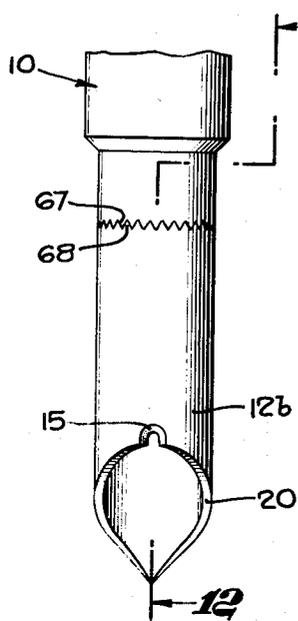


FIG. 13.

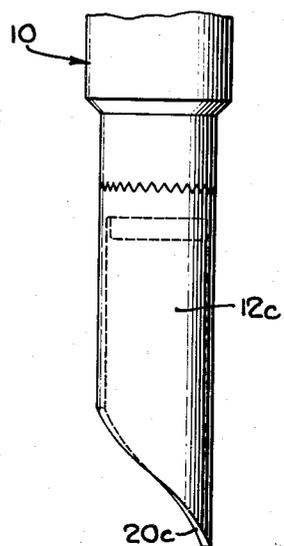


FIG. 12.

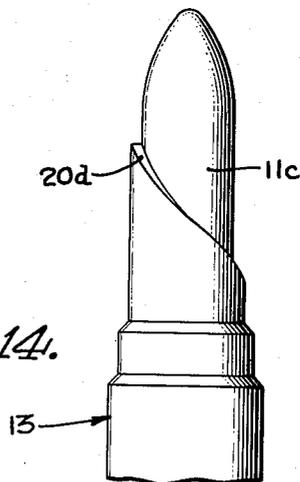
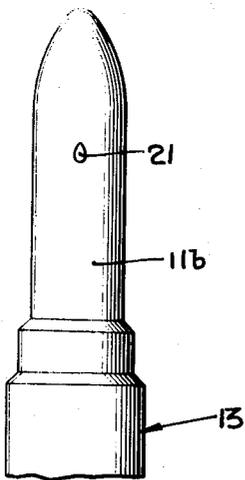


FIG. 14.

FIG. 11.

VALORIS L. FORSYTH
LYLE DILLON
INVENTORS

BY *Lyle Dillon*
ATTORNEY

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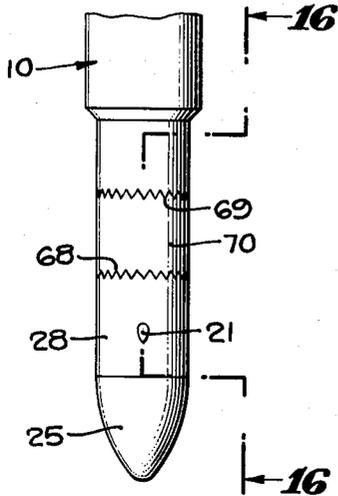


FIG. 15.

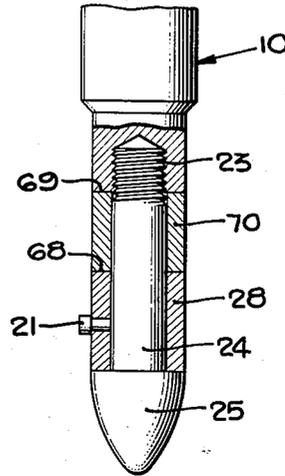


FIG. 16.

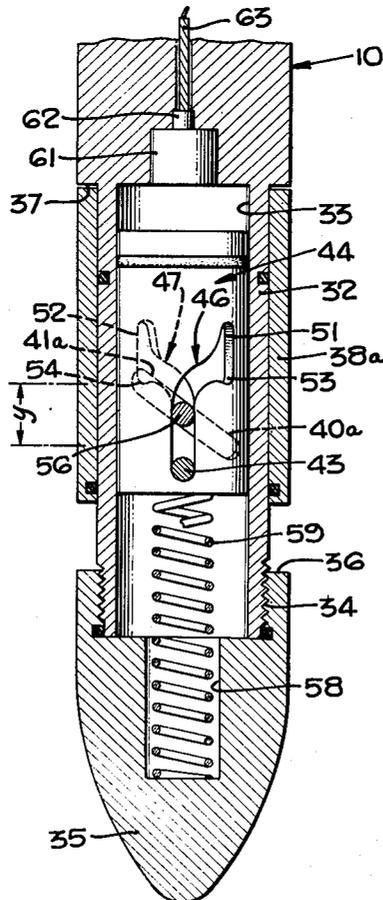


FIG. 17.

VALORIS L. FORSYTH
LYLE DILLON
INVENTORS

BY

Lyle Dillon

ATTORNEY

UNITED STATES PATENT OFFICE

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ORIENTED GUN PERFORATING

Valoris L. Forsyth, Los Angeles, and Lyle Dillon,
San Gabriel, Calif., assignors to Lane-Wells
Company, Los Angeles, Calif., a corporation of
Delaware

Application November 15, 1949, Serial No. 127,418

12 Claims. (Cl. 164—0.5)

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This invention relates generally to gun perforating of well casing and more particularly to methods and apparatus for positioning a gun perforator device repeatedly at the same location within a well casing or in different positions therein bearing predetermined relationships to one another.

Well casing or well borehole perforating as usually performed by either the conventional gun perforating devices or the more recently developed shaped charge perforating devices have been limited in depth and extent to that which may be accomplished by a single shot from a gun perforator unit or shaped charge perforator unit for each perforation. While under normal or usual conditions encountered in a cased well borehole, such penetration of the casings and surrounding cement and formations has usually been adequate, in some cases and under certain unusual circumstances, however, a deeper penetration may be desirable. Also at times it may be desirable to space the perforations closer either circumferentially, vertically, or both, and thus in greater number for a given length of well casing than is possible or practical with presently known perforating gun or shaped charge devices, because of the practical space limitations inherent in these devices. In other words, it may be desirable to space the perforations closer to one another than it is practicable to place the gun units or shaped charges in the perforator body.

To accomplish the beforementioned deeper penetration it has been found desirable to fire two or more gun or shaped charge perforator units through a single perforation. To accomplish the increased number of perforations per unit length of casing it has been found desirable to fire two or more perforating devices in succession in the same length of casing but preferably located and oriented in position therein so as to place the two or more resulting groups of perforations in the desired spaced position with respect to one another in accordance with a predetermined perforation pattern, wherein the perforation positions may be shifted vertically or circumferentially at the same level, or both.

It is therefore an object of this invention to provide a directional gun or shaped charge perforating device.

Another object of this invention is to provide means whereby a perforator device can be repeatedly positioned at the same position within a well casing.

A further object of this invention is to provide means whereby a perforator can be fired one or more times through the same perforations in a well casing.

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A still further object of this invention is to provide means whereby perforations produced by two or more gun or shaped charge perforating operations can be made in a predetermined pattern with respect to one another in a well casing.

These and other objects, advantages and features of novelty will be evident hereinafter.

In the drawings which show by way of illustration, preferred embodiments of the invention and in which like reference characters designate the same or similar parts throughout the several views:

Figure 1 is an elevational view of the general assembly of the apparatus of the invention as it appears set in operating position within a well casing.

Figure 2 is a longitudinal sectional view of a lower portion of the apparatus of Figure 1.

Figure 3 is a longitudinal sectional view, in enlarged fragmentary detail, of an upper portion of the apparatus of Figure 2 and as taken on line 3—3 of Figure 1.

Figure 4 is an elevational view of a portion of the apparatus shown in longitudinal section in Figures 2 and 3.

Figure 5 is an elevational view of an alternative arrangement of a portion of the apparatus of Figures 1 and 2.

Figure 6 is a longitudinal sectional view taken on line 6—6 of Figure 5.

Figure 7 is a longitudinal sectional view of another alternative construction of a portion of the apparatus of Figures 5 and 6.

Figure 8 is a longitudinal sectional view of the apparatus taken on line 8—8 of Figure 7.

Figure 9 is a cross-sectional view taken on line 9—9 of Figure 8.

Figures 10 and 11 are elevational views of still another alternative arrangement of the apparatus of Figures 4, 5 and 6.

Figure 12 is a cross-sectional view taken on line 12—12 of Figure 10.

Figures 13 and 14 are elevational views of still another alternative construction of the apparatus of Figures 4, 5 and 6.

Figure 15 is an elevational view of a variation in the construction of the apparatus of Figures 4, 5 and 6.

Figure 16 is a longitudinal sectional view of the apparatus taken on line 16—16 of Figure 15.

Figure 17 is a longitudinal sectional view of a modified form of the apparatus of Figures 7 and 8.

The apparatus is as follows:

Referring first primarily to Figures 1, 2 and 3, the main elements of the apparatus of the invention are: a perforator body 10, a pointed

centering plug or nose piece 11 extending coaxially from the lower end of the gun body, a guide socket 12 adapted to receive said centering plug, a casing gripping means 13 for supporting and centering the said guide socket 12 within a casing, and a centering case spring assembly 14 located at the upper end of the gun body 10. The perforator body 10 may be of any suitable type of construction as, for example, that disclosed in the patents to Lane 2,062,974 and 2,062,975 and Turechek 2,092,294 utilizing bullet type gun perforator units or it may be of a type adapted to employ, as beforementioned, the recently developed shaped charge perforator units. As disclosed in the aforesaid patents, the perforator body may be lowered into and suspended within the well borehole and the casing 16 by means of a conductor cable as shown at 17 in Figure 1 or by means of tubing, drill pipe, the well rig sand line or other suitable means. The perforator gun units 19 contained in the perforator body 10 may be of any suitable design and may be adapted to be fired simultaneously or consecutively, individually or in banks by suitable mechanically or electrically actuated firing mechanisms well known in the art, some of which are illustrated in the aforesaid patents.

The casing gripping means 13 may be of any suitable type such as, for example, a liner hanger device, a bridging plug as illustrated in Figures 1 and 2 of the drawings having suitable slips 18 or the like devices for gripping the surrounding casing, or a special casing shoe or casing collar gripping means or the like. The bridging plug shown herein by way of example, but not by way of limitation, may be similar to that shown and disclosed in Barnes 2,241,532 or Turechek 2,382,455. Such bridging plug, instead of having a straight cylindrical adapter sleeve, as shown at 25 in Turechek 2,382,455 or as shown at 11 in Spangler 2,326,404 and extending upwardly from the top of the slip actuating portion of the bridging plug, may instead carry the beforementioned guide socket 12. The top end of the guide socket 12 as herein illustrated forms a cam like guide surface 20, diagonally directed or sloping with respect to the longitudinal axis and has a chamfered locking notch 15 located and centered in the lowermost portion thereof.

The centering plug 11 of the perforator body is provided with a locating device such as the laterally extending locating pin or lug 21 best shown in Figure 3, adapted to be brought into contact and to follow the cam-like surface 20 when the centering plug 11 is inserted into the guide socket 12.

In operation the bridging plug may be set in a well casing in a conventional manner such as disclosed either in Spangler 2,326,404 or the copending application of Luther C. Thaxton, Serial No. 25,925, filed May 8, 1948.

In Figures 5 and 6 in which an alternative form of centering plug 11a is shown, the perforator body 10 is provided with an internally threaded lower end as shown at 23 to receive a threaded shank member 24. The shank member 24 is formed with a lower, tapered head 25 of larger diameter than the shank member, providing thereby an upwardly facing annular shoulder 26. An orienting sleeve 28 is rotatably supported on the shank member 24. The upper end of the sleeve 28 is serrated as shown at 29 in Figure 5, and the lower end of the perforator body 10 surrounding the threaded portion 23 is provided with serrations 30 adapted to mesh in locking engage-

ment with the beforementioned serrations 29. The orienting sleeve 28 carries fixed to it the beforedescribed laterally projecting locating pin or lug 21. The azimuthal angular position of the orienting sleeve 28 and locating lug 21 carried thereby, may be adjusted rotationally about the longitudinal axis of the perforator body by loosening the shank 24 at the threads 23 sufficiently to permit disengagement of the serrations 29, 30 after which the rotational position of the orienting sleeve 28 may be adjusted, to the nearest serration width, followed by tightening of the shank 24 into the threads 23 thereby bringing the annular shoulder 26 of the head 25 to bear upward against the bottom end of the sleeve 28 to hold the serrations 29, 30 in firm locking engagement with one another.

Such adjustment of the orienting sleeve 28 and locating pin 21 must be made manually prior to a run of the gun into a well casing or more usually intermediate a pair of gun perforating runs as more fully explained hereinafter in connection with the description of the operations. Thus a close circumferential spacing of perforations may be made at the same level as determined by the angular spacing of serrations 29, 30.

Referring now primarily to Figures 7, 8 and 9, a further modification of the centering plug mechanism is shown in which a limited degree of rotational adjustment of the orienting sleeve 28 and locating pin 21 relative to the perforator body 10 may be accomplished while the apparatus is remotely located within the well casing.

In the latter version of the apparatus the lower end of the perforator body 10 terminates in a bored cylindrical extension 32 of reduced external diameter with respect to that of the gun body 10 and forming thereby on the interior a cylindrical bore 33 and on the exterior a downwardly facing annular shoulder 37. The lowermost, external portion of the cylindrical extension 32 is threaded at 34 to receive corresponding internal threads of a tapered centering plug head member 35. The centering plug head member 35 is of slightly larger external diameter than the beforementioned cylindrical extension 32, forming thereby at its upper end an upwardly facing annular shoulder 36. An orienting sleeve 38 is rotatably supported upon the beforementioned cylindrical extension 32 and retained there between the beforementioned shoulders 36 and 37. The orienting sleeve 38 carries a radially extending locating lug 21.

The cylindrical extension 32 is provided at an intermediate section thereof with a pair of diametrically opposite, circumferentially extending slots as best shown at 40 and 41 in Figures 8 and 9.

The cylindrical extension 32 also carries a pair of diametrically opposite, radially inwardly directed pin members 42 and 43, the outer ends of which are fixed in the walls of the said cylindrical member 32.

A piston 44 is contained within the bore 33 of the cylindrical extension 32 of the perforator body 10 and is longitudinally slidable or reciprocable therein as and for the purpose hereinafter more fully described. The piston 44 carries a pair of irregularly shaped cam slots positioned diametrically opposite one another as best shown at 46 and 47 in Figure 8. The cam slots 46 and 47 are each formed with a lower longitudinally extending portion as shown at 48, an intermediate, diagonally directed portion as shown at 49 and 50 and an upper longitudinally directed end

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portion as shown at 51 and 52. The lower end of the upper slot portions 51 and 52 are each formed with slight depressions as shown at 53 and 54 which, in operation serve as catches for receiving and retaining orienting sleeve actuating pins 55 and 56 as hereinafter explained.

The pair of orienting sleeve actuating pins 55 and 56 are fixed at their outer ends in the orienting sleeve 38, coaxially with respect to one another at diametrically opposite sides and extend radially inward through the beforementioned slots 40 and 41 of the cylindrical extension 32 and into the cam slots 46 and 47 of the piston 44. The beforementioned pin members 42 and 43 extend radially inward from the cylindrical extension 32 into the beforementioned cam slots 46 and 47 in the piston 44.

The piston 44 is cupped on its lower side to form a cylindrical recess as shown at 57 and the tapered plug head member 35 is similarly recessed at 58. A helical spring 59, normally compressed to apply an upward force to the piston 44 extends between the beforementioned cylindrical recesses 57 and 58 in the piston 44 and tapered centering plug head member 35 respectively.

A cylindrical chamber is provided as shown at 60 at the upper end of and in communication with the cylinder bore 33 for containing a combustible gas-pressure generating means or charge cartridge 61. When a gas-pressure generating cartridge is used as shown at 61 it may be provided with an ignition cap 62 of conventional design, a suitable recess for which is shown at 64 in the upper end of the charge chamber 60, and which may be electrically ignited by means of an insulated conductor making connection with it, as shown at 63, or by any suitable, well known mechanical means such as by a go-devil, not shown, adapted to be dropped down the supporting cable or tubing. The conductor 63 extends upward through suitable passages in the perforator body 10 and makes electrical connection with either a separate conductor in the supporting conductor cable 17 extending to the top of the well borehole or makes connection with one of the electrical switch contact points which may be employed in the perforator for firing the perforator units sequentially as disclosed in the beforementioned patents to Lane 2,062,974 or Turechek 2,062,975.

Instead of employing gas pressure, for actuating the piston device for rotating the orienting sleeve 38, other means may be employed such as, for example, an electrically energized solenoid or a spring, fluid pressure or the like suitable means, not shown.

Referring now primarily to Figures 10, 11, and 12, a modified form of the apparatus for guiding, orienting and supporting the perforating tool in place in the well, is shown, in which the arrangement of the centering plug 11 and 11a and locating and guide socket 12 and 12a, as shown in Figures 1 to 6, inclusive, are inverted with respect to one another, the centering plug as shown at 11b in Figure 11, for example, being attached to and supported by the casing gripping means 13 and the guide socket 12b as shown in Figure 10 being attached to and extending downwardly from the lower end of the perforator body 10.

As illustrated in Figures 10 and 12, the guide socket 12b is attached to the bottom end of the perforator body 10 by means of a central screw 65 threaded at 66 into the lower end of the said perforator body. Mating serrations 67 and 68 are

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provided on the bottom end of the body 10 and the top end of the guide socket 12b, respectively, as beforedescribed in connection with Figures 5 and 6 for adjustment of the angular position of the socket 12b about the longitudinal axis of the perforator body 10.

Referring now primarily to Figures 13 and 14 an alternative arrangement of the guide socket and centering plug apparatus elements is shown, where instead of employing a cam-like surface 20 on only one of the elements and a locating lug on the other, matching cam-like surfaces are provided on both the guide socket 12c and the centering plug 11c as shown at 20c and 20d respectively.

In Figures 15 and 16 apparatus similar to that of Figures 4-6 and 10-13, inclusive, is shown except provision is made for not only adjusting the angular position of the centering plug orienting sleeve 23 and locating lug 21 around the longitudinal axis of the body 10 but also provision is made for adjusting the axial position of the orienting sleeve and the locating lug by the addition of filler or extension sleeves of suitable length as illustrated at 70. Such extension sleeves are serrated at opposite ends as shown at 68 and 69 to mesh with the serrations on the bottom end of the body 10 and the top end of the orienting sleeve 23 whereby the orienting sleeve 23 will be securely locked against rotation with respect to the body 10.

The apparatus shown in Figure 17 is similar to that of Figures 7 and 8 except that the cylinder slots shown as circumferentially directed at 40 and 41 in Figure 8 are diagonally positioned as shown at 40a and 41a in Figure 17, whereby, upon imparting downward motion to the piston 44 the orienting sleeve 38a is, in addition to being rotated by the action of the piston cam slots 46 and 47 upon the orienting sleeve actuating pins 55 and 56 as hereinbefore described, also caused to move downward a distance y by the action of the diagonal slots 40a and 41a upon the same sleeve orienting pins 55 and 56. The locating lug 21 carried by the orienting sleeve 38a is thus caused to be simultaneously rotated through a predetermined angle α about the longitudinal axis and lowered axially a predetermined distance y . The angle α and distance y through which the lug 21 is thus moved may be made, by suitable construction of the device, to correspond with the angular and longitudinal spacing pattern of the perforator units in the perforator gun. For example, in a gun perforator having gun units arranged spirally about the gun body, as illustrated in Figure 1 the cam slots 46 and 47 may be of such length as to rotate the lug 21 through an angle about the longitudinal axis of the gun equal to the angular displacement of any two adjacent gun units and the length and slope of slots 40a and 41a may likewise be of such length and slope as to cause the orienting sleeve 38a and lug 21 to be lowered relative to the gun body 10 a distance y equal to the longitudinal spacing of the same two adjacent gun units.

Instead of employing the locating lug 21 carried in the sleeve 38 as shown in Figure 7 or as shown at 38a in Figure 17, the alternative types of locating and orienting apparatus illustrated in Figures 10, 11, 13 and 14 may obviously be incorporated therewith. For example, a cam-like guide means of the shape shown at 20c in Figure 13 may be attached to, or made a part of the exterior of the orienting sleeves 38 or 38a, and a locating or centering means of the type shown in

Figure 14 be employed in connection therewith to position the tool in the well borehole or casing.

The operation of the apparatus is as follows:

A suitable casing gripping means 13 such as described hereinbefore incorporating the special guide socket 12, is first run into the well casing and set in the casing by conventional means as shown in the beforementioned patents. Next the perforator assembly is lowered into the well casing on the conductor cable 17 until the centering plug 11 enters the guide socket 12, in which position the locating lug 21 will make contact with the cam-like guide surface 20. Unless the locating lug 21 happens to make contact with the cam-like surface 20 of the locating guide socket member 12 at the exact dead center location of its upper extremity, which is an improbable condition, further lowering of the perforator will cause the locating lug to slide down the cam-like guide surface 20, thereby imparting the necessary rotational adjustment to the position of the perforator body 10 until the locating lug 21 falls into the locking notch 15. To assure the perforator being lowered into the position in which the locating lug 21 may be guided by the cam surface 20 into the locking notch 15 the perforator assembly may be moved up and down at short distance after it first makes contact with the top of the guide socket 12.

After lowering the perforator into position as hereinbefore described and as shown in Figures 1 and 2, the perforator units 19 in the perforator body 10 may be fired to perforate the surrounding casing, and then the perforator assembly may be withdrawn by the conductor cable 17 from the well casing. If desired, the perforator units 19 may then be reloaded and the perforator reintroduced into the well casing 16 and again lowered into oriented, seated, position within the locating guide socket 12 and the perforator units again fired through the same perforations previously made in the previous perforating run.

If desired, the type of locating apparatus illustrated in Figures 5 and 6 may be employed and prior to the second run of the perforator employing such apparatus, the angular position of the orienting sleeve 28 on the shank member 24 may be changed by loosening the threads 23 sufficiently to permit the serrations 30 to disengage, whereupon the orienting sleeve 28 may be rotated with respect to the perforator body 10 through any angle desired. Threads 23 may then be tightened to reengage the serrations 29, 30 to hold the orienting sleeve 28 firmly against further rotation with respect to the body 10. The perforator assembly may then be again lowered through the casing 16 into seated position within the locating guide socket member 12 as before described, and the perforator units 19 again fired to perforate the casing at different points from these previously perforated, the angle between the former and the latter perforations being determined by the angular adjustment previously made to the sleeve 28 relative to the body 10 as hereinbefore described.

Referring now primarily to the apparatus of Figures 7, 8 and 9, the operation is as follows:

The perforator assembly 10 having the centering plug mechanism constructed in accordance with that shown in Figures 7, 8 and 9 is lowered into the well casing 16 in the same manner as that hereinbefore described until the locating pin 21 is brought into contact with the cam surface 20 of the guide socket 12 and thereby caused to be lodged in the locking notch 15. The per-

forator unit thus oriented may be fired in any order desired in accordance with the design of the perforator and its firing mechanism. For example, all the units may be fired simultaneously or consecutively, or if desired, certain of the gun units 19 may be fired leaving certain others unfired. Following such firing, the electrical circuit is completed from a suitable current source through the insulated conductor 63 to the igniter cap 62 and return through the ground. The igniter cap 62 is thus fired which in turn ignites the combustible pressure generating cartridge 61. The resultant gas pressure in the top of the cylinder bore 33 drives the piston 44 downward against the opposing force of the helical spring 59. During its downward travel the piston 44 is restrained from any rotational movement by the guide pins 42, 43 which extend inwardly from the cylindrical extension 32 of the perforator body into the lower longitudinal portions 48 of the piston cam slots 46 and 47. Downward motion of the piston 44, however, brings the intermediate, diagonally directed portions 49 of the cam slots 46 and 47 to bear upon the orienting sleeve actuating follower pins 55 and 56 extending inwardly from the orienting sleeve 38. Rotation is thus imparted to the orienting sleeve 38 sufficient to allow pins 55 and 56 to pass upward into the longitudinally directed end portions 51 and 52 of the cam slots 46 and 47. The orienting sleeve 38 has thus imparted to it an angular rotational displacement with respect to the body 10 equal to the angular separation (α) of the longitudinal portions 48 from the longitudinal portions 51 and 52 of the cam slots 46 and 47, peripherally on the piston 44 as best shown in Figures 8 and 9.

Since the locating lug 21 is firmly locked in the locking notch 15, the beforedescribed angular rotation of the orienting sleeve 38 relative to the body 10 results in rotation of the perforator assembly through an angle α in the opposite direction about its longitudinal axis relative to the guide socket member 12 and casing 16. The balance of the perforator units, 19 may then be fired through the casing 16. Thus, two separate sets of perforations at different perforator body orientations may be made through the same length of casing at a single run of the perforator gun.

Obviously the perforator units 19 may be arranged in the perforator body 10 in accordance with any desired pattern. For example, if the units 19 are arranged in the body 10 such that the angular rotation imparted by the mechanism shown in Figures 7, 8 and 9 is such as to bring a second unfired gun unit to bear upon the same point in the casing as that upon which a perforator unit bore prior to the rotation, then two units may be fired through the same perforations for increased penetration.

If, on the other hand, the beforementioned angular rotation is made to be less than, for example half, that separating any two adjacent gun units, then a modified pattern of perforations may thus be made having closer spaced perforations than would be possible with a single firing of the same gun in the conventional manner. The perforation density in a given length of casing or formation can thus be systematically increased.

If desired, the perforator employing the orienting and locating apparatus illustrated in Figures 4 to 6 or 10 to 14, inclusive, may be employed. Upon removal of the perforator from the borehole after the first perforation run, the filler

sleeve or extension sleeve 70 may be added and a centering plug member 25 having a shank 24a of suitable length for accommodation and attachment of such filler sleeve, may be employed, and the perforator then again run into the borehole and a second set of perforations made. If the length of filler sleeve 70 is equal to the longitudinal spacing of any two adjacent perforator units and the angular adjustment of orienting sleeve 28 and the lug 21 for the second run, relative to that of the first run is made equal to the angular separation about the longitudinal axis of the aforesaid adjacent units, then one of the adjacent perforator units in the second run may be brought to bear upon the same perforation previously made by the other unit in the first run. Thus, if desired, every other alternate perforation unit may be fired in the first run and then the remaining unfired units fired through the same perforations in the second run.

A number of variations of the foregoing procedure will result in either consecutive firing of the gun units through the same perforations or result in various perforating patterns depending upon the choice of arrangement of the gun units in the gun body and the size and type of filler sleeves employed and angular adjustments between the lug 21 or other locating means about the longitudinal axis of the apparatus as before-described.

The apparatus of Figure 17 is adapted to accomplish the before-described angular and longitudinal shift of the positioning and orienting means simultaneously and while in place within a well borehole. The operation is as follows: firing of the gas generating charge 61 causes the piston 44 to be forced downward in the cylinder bore 33 imparting relative motion between the orienting sleeve actuating follower pins 55 and 56 and the cam slots 46 and 47 in the piston, such motion causing the said pins 55 and 56 to move into and come to rest in the longitudinal end portions 51 and 52, thereof, thereby causing the orienting sleeve 38a to be rotated through the before-mentioned angle α . At the same time the orienting sleeve actuating follower pins 55 and 56 are caused to move downward in the inclined slots 40a and 41a in the wall of the cylinder 32, thereby causing the orienting sleeve 38a to be lowered a distance y relative thereto. The sleeve 38a and the lug 21 are thus caused simultaneously to be rotated through an angle α about the longitudinal axis and to be lowered a distance y axially.

After the piston 44 has been forced downward through its full stroke and due to cooling the gas pressure in the cylinder above the piston decreases, the piston may tend to move upward under the force of spring 59. Such motion will cause the pins 55 and 56 to come to rest in the slight depressions 53 and 54 formed at the bottom ends of the longitudinal end slots 51 and 52. The orienting sleeve 38a and locating device such as lug 21 carried thereby will thus be locked in position.

The various guide and supporting means illustrated in the several views may be employed in connection with the apparatus illustrated in Figures 7, 8 and 17 instead of the orienting sleeve and locating lug arrangement there shown.

If desired, the weight of the perforator assembly may be lifted off of the locating guide socket or other form of perforator supporting means associated with the casing or gripping means herein illustrated, while the mechanism of the type

illustrated in Figures 7, 8 and 17 is actuated, after which the apparatus may again be lowered into place. This procedure has the advantage of relieving the load from the orienting mechanism during its operation.

While the present invention has been described, for convenience as applicable to the perforation of casing in a well borehole, the invention is also applicable to perforation of open, uncased borehole formations in similar manner, it being necessary only to choose a suitable means for setting and holding a suitable guide and locating means, such as illustrated at 12 in Figures 1, 2, 4, 11 and 13, within the uncased borehole. Such devices for gripping the formation walls surrounding a borehole are well known and similar in construction and operation to the bridging plug apparatus herein illustrated.

The foregoing is illustrative only of a preferred embodiment and the invention is not limited thereby but may include various modifications and changes made by those skilled in the art without distinguishing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In combination with a well tool apparatus for rotational movement thereof through a predetermined angle about its longitudinal axis while lowered within a borehole comprising: a cylinder in said tool; a piston in said cylinder; a locating element extending from said tool; orienting means rotatable about the longitudinal axis of said tool and supporting said locating element for rotational movement relative to said tool through an angle in a plane substantially perpendicular to the said longitudinal axis; means linking said piston to said orienting means to convert displacement of said piston in said cylinder to angular rotational displacement of said rotatable orienting means about said longitudinal axis relative to said tool; and means actuable from outside of said borehole to apply fluid pressure to said piston in said cylinder.

2. Apparatus according to claim 1 and guide means fixed in the borehole to receive the lower end of said well tool and to receive and hold said locating element from rotational movement relative to the longitudinal axis of said borehole.

3. Apparatus according to claim 1 and guide means attachable to the inside of a well casing to receive the lower end of said well tool and to receive and hold said locating element from rotational movement relative to the longitudinal axis of said borehole.

4. Apparatus according to claim 1 and guide means attachable to the inside of a well casing to receive the lower end of said well tool; a locking notch in said guide means to receive and hold said locating element; and means to guide said locating element into said notch when said lower end of said well tool is lowered into said guide means.

5. In combination with a well tool apparatus for rotational movement thereof through a predetermined angle about its longitudinal axis while lowered within a borehole comprising: a cylinder in said tool; a piston in said cylinder; a lug extending laterally from said tool; a sleeve member rotatable coaxially about the longitudinal axis of said tool and supporting said lug for limited rotational movement relative to said tool through an angle in a plane substantially perpendicular to the said longitudinal axis; cam and follower elements, one of said elements form-

ing part of said piston and the other of said elements forming part of said lug-supporting sleeve, said cam and follower elements being thereby arranged to convert longitudinal displacement of said piston in said cylinder to angular rotational displacement of said rotatable lug-supporting sleeve relative to said tool about said longitudinal axis; and means actuatable from outside of said borehole to apply fluid pressure to said piston in said cylinder.

6. In combination with a well tool apparatus for rotational movement thereof through a predetermined angle about its longitudinal axis while lowered within a borehole comprising: a coaxial cylinder in said tool; a piston in said cylinder; a locating element extending laterally from said tool; an orienting sleeve member concentric with and rotatable about said cylinder and supporting said locating element for limited rotational movement relative to said tool through an angle in a plane substantially perpendicular to the said longitudinal axis; cam and follower elements, one of said elements forming part of said piston and the other of said elements forming part of said orienting sleeve, said cam and follower elements being thereby arranged to convert longitudinal displacement of said piston in said cylinder to angular rotational displacement of said rotatable orienting sleeve relative to said tool about said longitudinal axis; and means actuatable from outside of said borehole to apply fluid pressure to said piston in said cylinder.

7. In combination with a well tool apparatus for rotational movement thereof through a predetermined angle about its longitudinal axis while lowered within a borehole comprising: a coaxial cylinder in said tool; a piston in said cylinder; an orienting sleeve member supported concentric with and rotatable through a limited angle about the longitudinal axis of and relative to said cylinder; cam and follower elements, one of said elements forming part of said piston and the other of said elements forming part of said orienting sleeve, said cam and follower elements being thereby arranged to convert longitudinal displacement of said piston in said cylinder to angular rotational displacement of said rotatable orienting sleeve relative to said cylinder about said longitudinal axis; and means actuatable from outside of said borehole to apply fluid pressure to said piston in said cylinder.

8. Mechanism for use with an elongated casing perforating gun having a plurality of laterally directed, casing perforating charges disposed in spaced relation along said gun and firing means associated with and capable of operation to discharge selectively different ones of said casing penetrating charges, said mechanism comprising: a separate supporting means arranged to be attached at a predetermined location to the inside surface of a well casing; coupling means for detachably connecting to and supporting said gun upon said supporting means and operable to position said gun initially substantially immovable within said casing for discharging a charge to effect a lateral penetration of said casing; and gun shifting means in said coupling means operable to move said gun a predetermined distance and in a direction to position another charge of the gun opposite said penetration to permit the discharge of said another charge laterally into said penetration.

9. Apparatus according to claim 8 in which

said gun shifting means includes therewith energy-containing means releasable to energize said gun shifting means; and means operable from a remote point outside the casing for releasing said energy to said gun shifting means to effect said movement of said gun.

10. Mechanism for use with an elongated casing and formation perforating gun having a plurality of laterally directed, casing and formation perforating charges disposed in spaced relation along said gun, and firing means associated with and capable of operation to discharge selectively different ones of said casing and formation perforating charges, said mechanism comprising: a supporting means arranged to be attached at a predetermined location to the inside surface of a well casing, said supporting means including packing means to make sealing engagement with the said casing adjacent said supporting means; coupling means for connecting to and supporting said gun upon said supporting means above said packing means and operable to position said gun initially immovable within said casing for discharging a perforating charge to effect a lateral penetration of said casing and surrounding formation above said packing means; and gun shifting means in said coupling means operable to move said gun a predetermined distance and in a direction to position another perforating charge of the gun opposite said penetration to permit the discharge of said another perforating charge laterally into said penetration.

11. In combination with a well tool apparatus for rotational movement thereof through a predetermined angle about its longitudinal axis while lowered within a borehole, comprising: a cylinder in said tool; a piston in said cylinder; a locating element extending from said tool; orienting means rotatable about and axially slidable along the longitudinal axis of said tool and supporting said locating element for rotational movement thereby relative to said tool through an angle lying in a surface transverse to said longitudinal axis; means linking said piston to said orienting means to convert displacement of said piston in said cylinder to angular rotational displacement of said rotatable orienting means about and longitudinal movement thereof along said longitudinal axis relative to said tool; and means actuatable from the outside of said borehole to apply fluid pressure to said piston in said cylinder.

12. In combination with a well tool apparatus for movement thereof relative to its longitudinal axis while lowered within a well borehole, comprising: a cylinder in said tool; a piston in said cylinder; a locating element extending from said tool; orienting means slidable longitudinally on said tool and supporting said locating element for longitudinal movement relative to said tool; means linking said piston to said orienting means to convert displacement of said piston in said cylinder to longitudinal displacement of said orienting means relative to said tool; and means actuatable from outside of said borehole to apply fluid pressure to said piston in said cylinder.

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