

Nov. 11, 1958

T. L. LONG

2,859,697

WELL PERFORATING DEVICE

Filed June 7, 1954

3 Sheets-Sheet 1

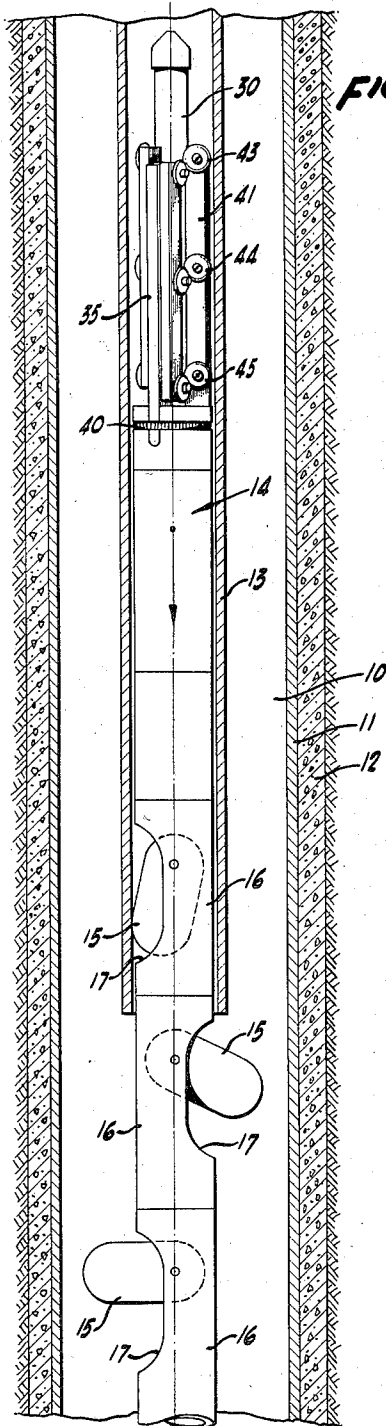


FIG. 1

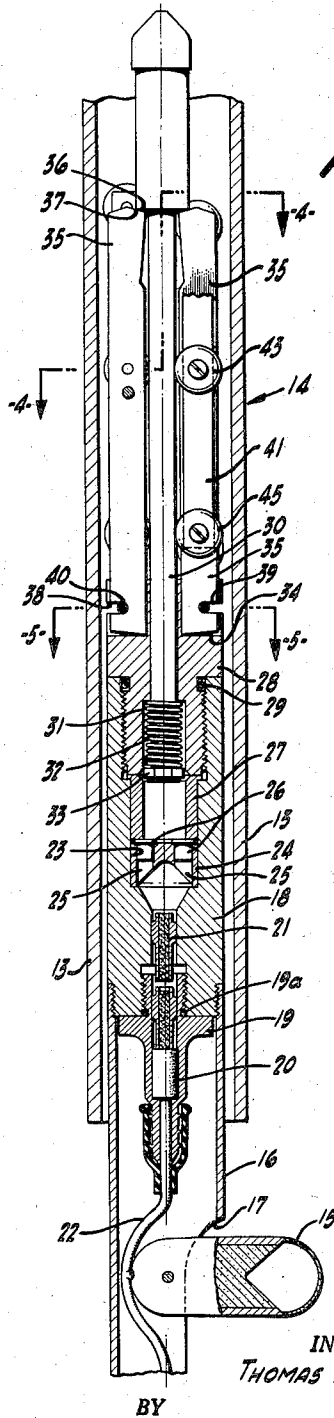


FIG. 2

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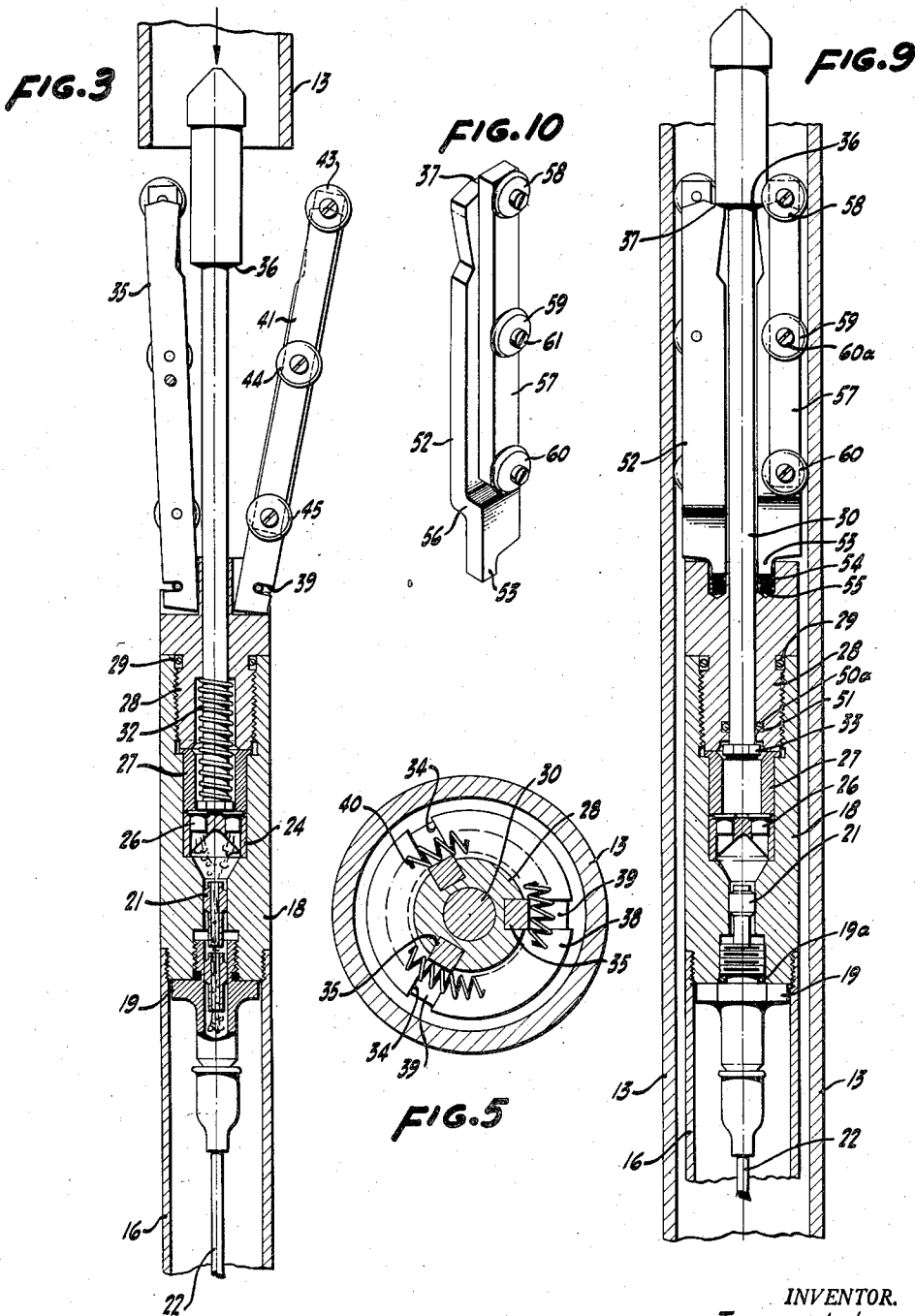
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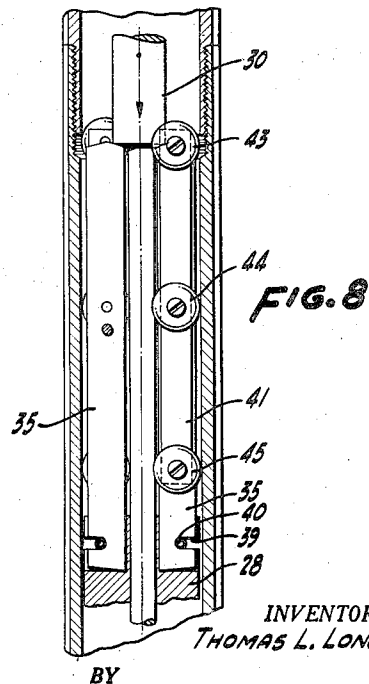
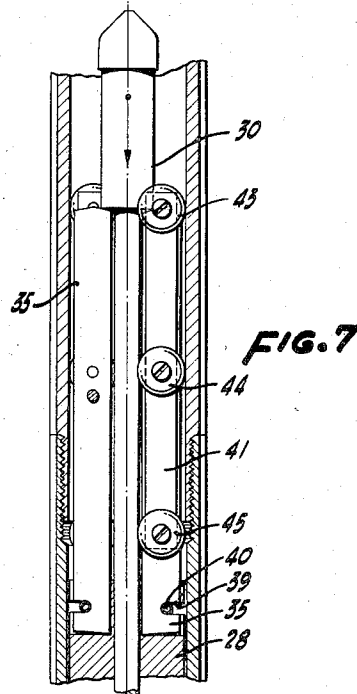
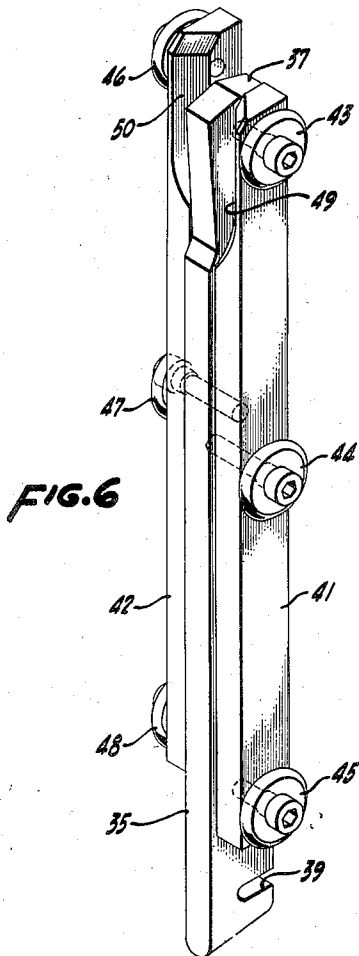
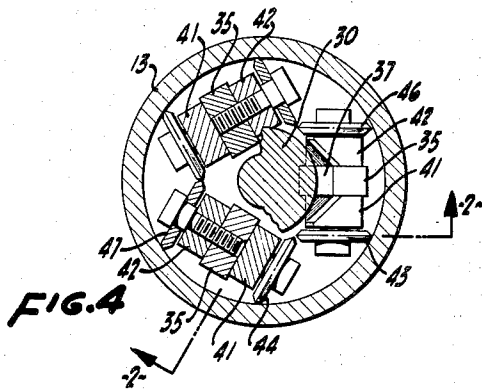
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3 Sheets-Sheet 3



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2,859,697

WELL PERFORATING DEVICE

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Application June 7, 1954, Serial No. 434,856

3 Claims. (Cl. 102—21.8)

This invention relates to a well perforating device and more particularly to a well perforating device which is expendable and may be dropped free through a well tubing.

It is the principal object of this invention to provide an expendable well perforating device employing shaped charges and a firing mechanism therefor, wherein said firing mechanism is automatically actuated when the device issues from the lower end of a well tubing through which the device is dropped.

Another object of this invention is to provide an expendable well perforating device, employing a spring-loaded firing pin, and a latch for retaining said firing pin in its inoperative or cocked position in cooperation with the wall of a well tubing through which the device is dropped, and wherein said latch means is automatically released to permit actuation of said firing pin when said latch mechanism issues from the lower end of said tubing.

A further object of this invention is to provide an expendable well perforating device employing a firing pin adapted to be actuated by hydrostatic pressure existing within the well, and a latch for retaining said firing pin in its inoperative or cocked position in cooperation with the wall of a well tubing through which the device is dropped, and wherein said latch means is automatically released to permit actuation of said firing pin when said latch mechanism issues from the lower end of said tubing.

A preferred form of my invention is illustrated and described, by way of example, in the following specification and the accompanying drawings, wherein;

Fig. 1 is an elevational view of a perforating device embodying the principles of my invention.

Fig. 2 is a sectional view of the firing mechanism of the tool shown in Fig. 1, showing the firing pin cocked and latched, the section being taken on line 2—2 of Fig. 4.

Fig. 3 is a similar view to that shown in Fig. 2 and illustrating the position of the elements immediately after firing.

Fig. 4 is a sectional view taken on line 4—4 of Fig. 2.

Fig. 5 is a sectional view taken on line 5—5 of Fig. 2.

Fig. 6 is a perspective view of one of the latch assemblies used to retain the firing pin in its cocked position.

Figs. 7 and 8 illustrate the manner in which the latch assemblies traverse a coupling joint in the well string.

Fig. 9 illustrates a modification of the tool illustrated in Figs. 1 to 8, inclusive.

Fig. 10 illustrates a modified form of the latch assembly.

In Fig. 1 the well bore 10 has been drilled by the usual method of drilling, and a casing 11 has been inserted therein and cemented, as indicated at 12. After the casing 11 has been set, a production tubing 13 of relatively small diameter is inserted in the well so that its lower end is adjacent the upper level of the oil bearing formation.

The perforating device, generally indicated at 14, comprises a plurality of shaped charges 15, each pivotally mounted in a tubular skirt 16 adjacent an elongated open-

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ing 17 in the side of said skirt. The charges 15 are adapted to pivot from a position wherein their longitudinal axes are coincident with the axis of the tubular skirt 16 to permit passage thereof through the tubing 13 to a position wherein their longitudinal axes are at right angles to the axis of the skirt 16, after they emerge from the lower end of the tubing 13. It should be understood that the pivotal connections and the distribution of weight are arranged in such manner that the charges 15 will automatically assume the latter position when no longer confined by the well tubing 13.

Referring now to Fig. 2, the firing mechanism comprises a body 18 fastened to the upper end of the tubular skirt 16. A tubular plug 19 is adapted to be threaded into the lower end of the body 18 within the skirt 16 and sealed with respect to the body 18 by an O-ring seal 19a. A flame actuated blasting cap 21 is held in the body 18 by the plug 19. The plug 19 has an internal recess formed therein and a booster explosive charge 20 is contained in said recess. A length of primer cord 22 is connected to the lower end of the tubular plug 19, below the booster charge 20, and is connected to the rear surface of each of the shaped charges 15. Above the flame-actuated blasting cap 21, the body 18 is counterbored, as shown at 23, to receive a cylindrical plug 24 having two openings 25 formed therein designed to receive two impact operated blank cartridges 26. A sleeve 27 is adapted to be inserted in the counterbore 23 behind the sleeve 21 and cartridges 26 to retain the same in position within the body 18.

A tubular member 28 is threaded into the upper end of body 18 and bears against an O-ring seal 29, which seals the connection between the body 18 and the tubular member 28. A firing pin 30 is slidably mounted in the tubular member 28 with its upper end extending upwardly beyond the upper end of the member 28. The lower end of the tubular member 28 is counterbored as shown at 31. A spring 32 is received within said counterbore and bears against the upper end thereof, and is confined at its lower end by a firing nut 33 threaded on the lower end of the firing pin 30. The spring 32 normally urges the firing pin toward its lowermost position, illustrated in Fig. 3, wherein the firing nut 33 will strike and fire the cartridges 26.

The upper end of the tubular member 28 has a plurality of slots 34 extending inwardly from the outer surface thereof to adjacent, but not intersecting, the central tubular passage therethrough. Three latch members 35 are mounted with their lower ends in the slots 34, and their upper ends abutting a downwardly facing shoulder 36 formed on the outer surface of the firing pin 30 adjacent the upper end thereof. The lower surface of the shoulder 36 on the firing pin 30 is tapered downwardly and inwardly, as illustrated in Fig. 2 of the drawings. The upper ends 37 of the latch members 35 are similarly tapered downwardly and inwardly, whereby the firing pin, being urged downwardly by the spring 32, tends to force the upper ends of the latch members outwardly to release the firing pin.

An annular groove 38 is formed in the outer surface of the tubular member 28 and intersects the mid-portion of the slots 34 formed therein. Each of the latch members 35 is formed with a laterally extending notch 39 formed in its lower end. As best seen in Fig. 5, when said latch members 35 are inserted in the slots 34, a circular spring 40, received in the annular groove 38 and the notches 39, holds the lower ends of the latch members 35 in their proper relation with the slots 34. A pair of elongated bars 41 and 42 are fastened at their mid-points, one on either side of each of the latch members 35. Bar 41 is provided with three wall engaging rollers 43, 44 and 45. Similarly, the bar 42 is provided with three rollers 46, 47

and 48. The upper end of the bar 41 is chamfered as indicated at 49, the chamfer being on the corner of the bar which will be adjacent the firing pin 30 and which also is adjacent the latch member 35. The bar 42 is similarly chamfered as shown at 50.

In the use of the perforating tool shown in Figs. 1 to 8, inclusive, the parts are assembled as illustrated in Figs. 1 and 2 and the device is inserted in the upper end of the tubing string 13 and dropped therethrough. As each of the charges 15 emerges from the lower end of the tubing 13, it will automatically swing outwardly into its horizontal position in the manner illustrated in Figs. 1 and 2, and when the latch assembly issues from the bottom of said tubing 13, the bevel faces 36 and 37 cooperate to force the latch members 35 outwardly, since the rollers 43 through 48 are no longer in contact with the inner wall of the tubing 13. When the latch members move outwardly, and no longer contact the shoulder 36, the spring 32 forces the firing pin downwardly, and the firing nut 33 strikes the cartridges 26. The flame from the cartridges 26 ignites the blasting cap 21, which in turn sets off the booster charge 20, firing the primer cord 22, and causing each of the shape charges 25 to fire and penetrate the casing 11, the cement 12 and the oil bearing formation. Any parts of the perforating mechanism remaining after the firing thereof are expendable and drop down into the bottom of the well bore.

Referring now to the modification shown in Fig. 9, the main parts are generally the same as those shown in Figs. 1 through 8 and are given the same reference numerals as used therein. One difference between the two structures is that the counterbore 31 and the spring 32 are omitted, and in place thereof an O-ring seal 50a is inserted in a groove 51 formed on the inner surface of the tubular member 28 and seals against the firing pin 31. Another difference is that the latch members 52 have a projecting lug 53 at their lower end, which is adapted to be received within a plurality of bores 54 provided in the upper end of the tubular member 28 adjacent the central bore thereof. A spring 55 is inserted in the bore 54 below the extending lug 53 of the latch member 52. As in the previous modification, the upper end of the latch member 52 is provided with a downwardly and inwardly tapered surface 37 for cooperation with the downwardly and inwardly tapered surface 36 formed in the outer surface of the firing pin.

As best seen in Fig. 10, the lower end of the latch member 52 is offset in the manner indicated at 56, and an elongated bar 57, having three rollers 58, 59 and 60 rotatably mounted thereon, is pivotally fastened adjacent its mid-portion with a pin 61 to the upper portion of the latch member 52 above the offset 56. The pin 61 extends through the central roller 59 and is threaded into the latch member 52. By using an offset latch member 52, only one bar carrying three rollers 58, 59 and 60 is required, since the rollers are mounted on the centerline of the projection 53 which is in contact with the tubular member 28.

The operation of the modification shown in Figs. 8 and 9 is the same in all respects with that shown in Figs. 1 through 8, the differences being that the firing pin 30 instead of being forced downwardly by an actuating spring, is forced downwardly by the hydrostatic pressure acting against the upper end thereof. The lower end of the rod 30 is subjected to atmospheric pressure in the open area within the sleeve 27, since the well fluid pressure is prevented from entering into said open area by means of the O-ring seals 19a, 50a and 29.

From the foregoing description, it is evident that I have provided a well perforating device which is capable of being dropped through a production tubing string, and which will automatically fire to perforate the casing and well when the device issues from the lower end of said production tubing.

It is further evident that I have provided a spring-

actuated perforating device, which may be used in wells with or without fluid in the well at the time of use. I have further provided a hydrostatically actuated perforating device which is safe and easy to handle for use with wells having fluid therein, said hydrostatically operated device reducing the hazard of an accidental firing before insertion into the upper end of the production tubing, and being capable of firing only when fluid is present in the well to supply the actuating force to the firing pin.

While I have shown and described the preferred forms of my invention, it is evident that certain changes may be made therein by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

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

1. A firing mechanism for a well perforating device comprising a housing, a cartridge mounted in said housing, a firing pin slidably mounted in said housing above said cartridge and extending upwardly above said housing, said firing pin being adapted to strike said cartridge, means for causing said firing pin to strike said cartridge, latch means for retaining said firing pin inoperative comprising a downwardly facing abutment formed on said firing pin adjacent the upper end thereof, a plurality of latch bars axially confined with their opposite ends in abutting relation with said downwardly facing abutment and the upper end of said housing respectively, a plurality of bars pivotally connected at their mid-points to said latch bars adjacent the mid-portion thereof, and a plurality of rollers rotatably mounted on each of said last-mentioned bars, said rollers being adapted to bear against the inner surface of a well tubing through which the device is to be dropped to retain said latch bars in latching position.

2. A firing mechanism for a well perforating device adapted to be lowered through a well tubing, comprising a housing, initial firing means mounted in said housing, a firing pin slidably mounted in said housing above said initial firing means, means for biasing said firing pin to strike said initial firing means, latch means for retaining said firing pin inoperative comprising a plurality of latch bars, means for restraining outward movement of the lower ends of said latch bars, abutment means on the upper end of each of said latch bars, downwardly facing abutment means on an upper portion of said firing pin, at least one of said abutment means being tapered downwardly and inwardly, and means carried by each of said latch bars for contacting the well tubing and for urging said abutment means into mutual engagement when the firing mechanism is within the well tubing comprising at least one roller bar and three wall engaging rollers, pivot means securing each said roller bar to its respective latch bar, means securing at least two of said wall engaging rollers to its respective roller bar above and below said pivot means and means securing one of said wall engaging rollers to its respective roller bar in the vicinity of said pivot means.

3. A firing mechanism for a well perforating device adapted to be lowered through a well tubing comprising a housing, initial firing means mounted in said housing, a firing pin slidably mounted in said housing above said initial firing means, means for causing said firing pin to strike said initial firing means, and latch means for holding said firing pin inoperative comprising a plurality of latch bars having abutment means on their upper ends, downwardly facing abutment means on said firing pin, at least one of said abutment means being tapered downwardly and inwardly, means for restraining outward movement of the lower ends of said latch bars, a roller bar pivotally secured at a central point therealong to each of said latch bars, at least three rollers pivotally secured to each roller bar, the central roller being pivoted at said central point, said rollers being arranged to contact the well tubing and to urge said latch bars inwardly to en-

gage said abutment means thereon with said abutment means on said firing pin when the firing mechanism is within the well tubing.

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