April 12, 1955 W. E. KANADY 2,705,920

AUTOMATIC FIRING SYSTEMS FOR GUN PERFORATORS FOR WELLS

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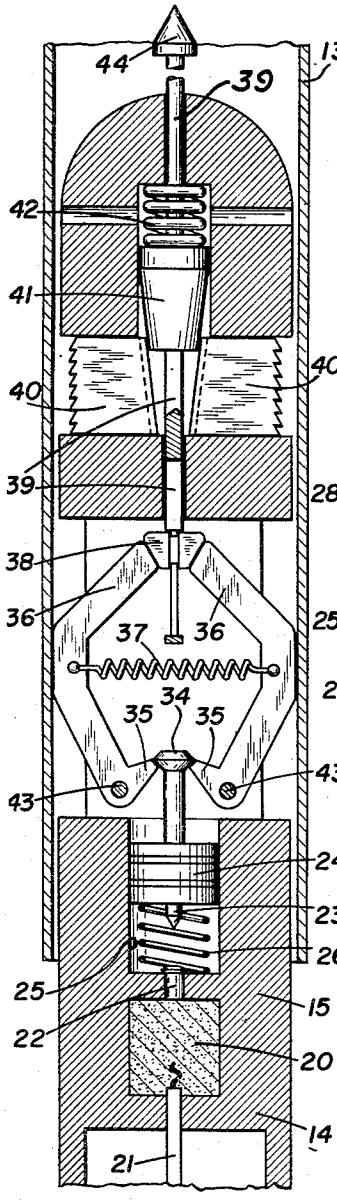


FIG. 3.

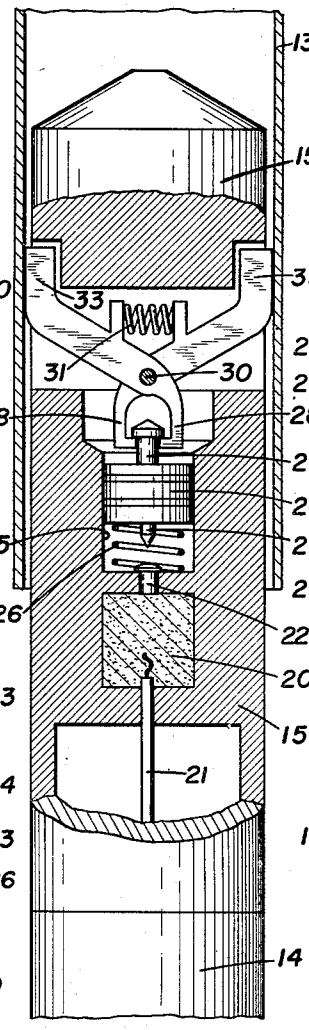


FIG. 2.

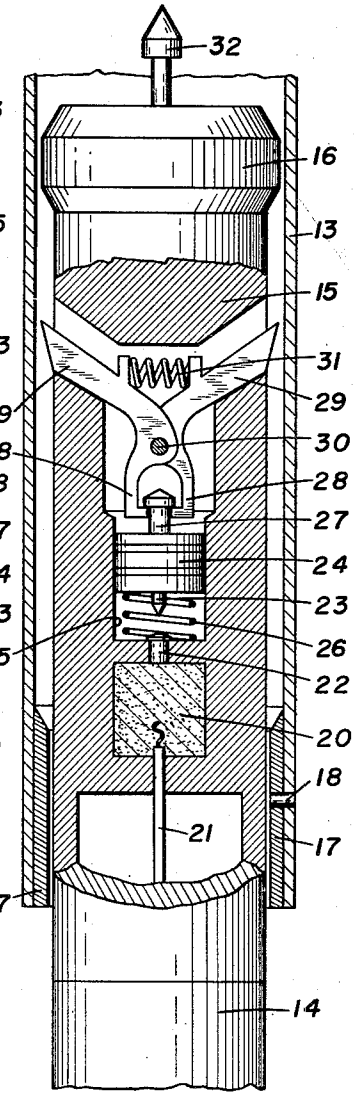


FIG. 1.

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AUTOMATIC FIRING SYSTEMS FOR GUN PERFORATORS FOR WELLS

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Application September 11, 1950, Serial No. 184,170

1 Claim. (Cl. 102—21.8)

This invention relates to guns for perforating casing in oils wells or the like and more particularly to automatic firing systems for such guns.

Methods of perforating casing in oil wells are now common. Both bullet guns and those using shaped charges of explosive have come into general use.

It has recently been proposed to lower perforating guns through tubing inside the casing in an oil well. See for example the application of Theodore A. Huber, Serial No. 133,025, filed December 15, 1949, for "Method of Completing and Repairing Oil Wells" where the use of a casing perforating gun capable of being run through tubing is required. Large savings in time and cost in drilling can be effected in this way if effective perforation can be accomplished.

The present invention relates to a firing system which is particularly adapted for use in connection with guns which are to be lowered through tubing in a well bore to perforate the casing beneath the lower end of the tubing. It can be used either with a bullet gun or with one using shaped charges of explosive. The arrangement is such that a firing pin is released automatically when the gun passes out of the lower end of the tubing, a trigger being pulled or released at that time. In addition, if desired, slips may be actuated to grip the tubing and connect the gun to the tubing automatically at the time of firing, or approximately at that time, so that the gun can be retrieved through the tubing.

The objects of the invention will be apparent from the following description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a view in vertical cross-section of tubing in a well bore with a gun firing system constructed in accordance with the present invention passing downwardly therethrough.

Fig. 2 is a similar view showing a second embodiment of the invention.

Fig. 3 is a similar view showing a third embodiment of the invention.

Referring to the drawing in detail, it will be seen that in all three figures, a section of well tubing is shown at 13. In each of the figures, a different construction of trigger or firing system is shown at the top of a gun perforator body 14, only a fragmentary portion of which is shown. The construction of the particular perforator gun has not been shown because, per se, it forms no part of the present invention. It may be of any construction, but is preferably of the type in which a flexible container is employed so that it may pass down through the tubing 13 even though the tubing is crooked or bent to some extent, as taught in the copending application of Earl Babcock, Serial No. 184,166, filed on even date herewith.

As shown in Fig. 1, the trigger system is contained within a housing 15 which may be integrally connected to the top of the gun body 14. At the upper end of the housing 15, an enlarged head portion 16 may be provided which may come to rest upon a seating ring 17 secured to the tubing at the bottom thereof, as by means of a shear pin 18.

Within the housing 15, there is a powder chamber 20 into which the upper end of the prima cord 21 may be brought, and which is provided with a firing cap 22. A firing pin 23 is mounted immediately above the cap 22 on a piston 24 within a cylinder 25 and it is normally held away from the cap 22 by a compression coil spring 26; while a piston and cylinder has been illustrated, obviously a diaphragm or bellows arrangement would be the equivalent.

On the top of the piston 24 there is a stud 27 adapted to be gripped and held against downward movement by the jaws 28 of a trigger consisting of arms 29 pivoted at 30. The upper ends of the arms 29 are urged outwardly at all times by a compression coil spring 31, so that the jaws 28 always tend to grip the stud 27 under the influence of the spring 31.

The operation of the firing system of Fig. 1 is dependent upon the presence of the seating ring 17 inside the tubing. When the assembly is lowered down through the tubing 13, before the head 16 comes to rest on the seating ring 17, the trigger arms 29 strike the ring 17 and their upper ends are forced inwardly so that the jaws 28 release the stud 27. Since the well contains liquid when the gun is lowered into it, the pressure on top of the piston 24 is large, so that when the stud 27 is released, the piston 24 moves downwardly rapidly and causes the firing pin 23 to strike the cap 22 and fire the powder in the chamber 20, igniting the prima cord and setting off the guns below.

Because of the spring 26, there is no danger of the gun being fired accidentally at the surface of the ground since there is no liquid pressure on top of the piston 24 until the gun has been lowered into the well. Hence even if the trigger arms 29 are struck accidentally in handling the gun, it will not go off.

After the gun of Fig. 1 has been fired, it may be retrieved by the fishing spear 32 on the top of the head 16 or it may be pumped to the bottom of the well by exerting pump pressure in the tubing to shear the pin 18.

The arrangement of Fig. 2 is similar in some respects to that of Fig. 1 and similar parts have been similarly designated. This arrangement is not dependent upon a seating ring in the tubing. The guns are fired automatically when the gun passes out of the tubing and the design is such that the assembly is not retrieved, after firing, but is dropped to the bottom of the well bore.

The trigger arms 33 in the arrangement of Fig. 2 are different from those in Fig. 1 in that they cross on the pivot 30. The arms 33 are like a pair of pliers. Hence the spring 31 normally urges them into engagement with the inside of the tubing 13. When the assembly leaves the tubing, the arms 33 move outwardly and the stud 27 is released to fire the guns. All that is necessary to operate the gun of Fig. 2 is place it in the tubing and let it fall or pump it to bottom. As it leaves the tubing it goes off.

The arrangement of Fig. 3 is like that of Fig. 2 in that the trigger arms move outwardly on firing but the mechanism is different and means has been added which make it possible for the gun to be retrieved through the tubing by a fishing tool. A marked advantage in the arrangements of Figs. 2 and 3 over that of Fig. 1 is that the tubing may remain unobstructed. This is important because it enables a larger diameter gun to be employed, and the diameter of the gun is very important where it must be run into the well through tubing.

Parts of Fig. 3 similar to those of Figs. 1 and 2 are similarly designated and their operation will be clear from what has been said above. In Fig. 3, the stud 34 on top of the piston 24 is slightly longer than the studs 27 of Figs. 1 and 2 and the lower surface of its head is tapered to rest upon the upwardly inclined jaws 35 of the trigger arms 36. Tension springs 37 tend to draw the arms 36 inwardly, but until the assembly passes out of the lower end of the tubing 13, they cannot move inwardly because their upper ends are held apart by a wedge 38 on a stem 39.

The stem 39 may be rectangular in cross-section and the wedge 38 is mounted for limited sliding movement thereon as illustrated. Above the wedge 38, the stem 39 may be slotted transversely, as shown, to accommodate the upper ends of trigger arms 36 when the springs 37 draw them inwardly after the gun has been fired, the wedge 38 then being on the lower end of the stem 39. The springs 37 are offset sufficiently to allow the lower end of the stem 39 to pass between them.

A set of slips 40 are provided above the trigger arms 36 and these are adapted to be actuated by a slip body

41 mounted on the stem 39, to grip the tubing when the trigger arms 36 pass out of the lower end of the tubing. In accordance with the usual design of slips, they are held on the body with an interlocking tongue and groove sliding coupling arrangement. Thus the slips 40 cannot move outwardly until the body 41 moves downwardly and they are drawn in radially when the body 41 is moved upwardly with respect to the housing 15.

The stem 39 is urged downwardly by a compression coil spring 42 held between the slip body 41 and the upper interior wall of the housing 15. Thus the trigger arms 36 serve a double function in that they hold the stud 34 against downward movement and they hold the slips 40 out of engagement with the tubing. When the trigger arms move out of the lower end of the tubing, they are forced outwardly under the action of the coil spring 42 and the wedge 38 snaps past the upper ends of the arms 36. The arms 36 can then move inwardly about their pivots 43. When they move outwardly they first release the stud 34, causing the firing of the guns as outlined above. The action is such that the slips grip the tubing 13, and fix the gun with respect thereto, just after the firing of the guns, for the wedge 38 moves the upper ends of the trigger arms 36 outwardly before the slips are set. As the wedge 38 passes the upper ends of the arms 36, it drops to the lower end of the stem 39 and the arms 36 move inwardly so that when the assembly is retrieved, the arms can be pulled up into the tubing 13.

After the guns have fired, the assembly, or so much of it as has not been destroyed on firing, may be retrieved through the tubing by a fishing tool which may grip the fishing spear 44 attached to the upper end of the stem 39. By pulling up on the stem 39, the slips 40 are retracted inwardly at this time.

While only three embodiments have been shown and described herein, it is obvious that various changes may be made without departing from the spirit of the invention or the scope of the annexed claim.

I claim:

In an automatic firing system for use with a gun adapted to be run into a well through tubing to perforate casing beneath the tubing comprising, in combination, a housing adapted to be connected to the top of the gun body; pressure responsive means carried by said housing, said pressure responsive means carrying a firing pin; a firing cap disposed in the path of said firing pin; trigger means comprised of a plurality of arms pivoted in said housing, said arms being adapted normally to restrain said pressure responsive means against movement toward said cap; spring means biasing the arms of said trigger means outwardly so as to cause said arms to release automatically said pressure responsive means when said arms reach a point adjacent to the lower end of said tubing; a set of slips on said housing; and a slip body adapted to move said slips outwardly of said body on downward movement thereof, said slip body being biased downwardly by said spring means.

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