

Dec. 29, 1953

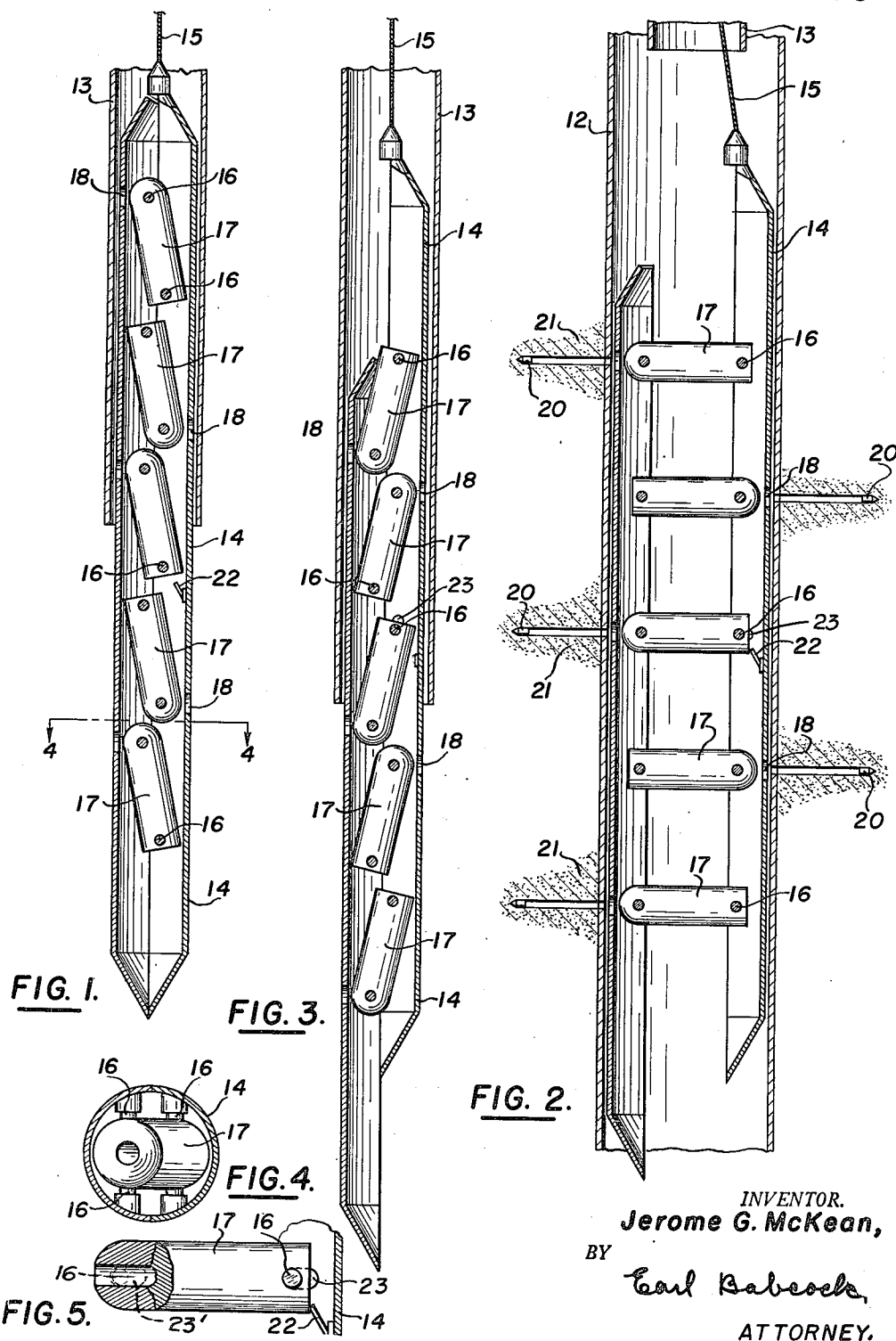
J. G. McKEAN

2,664,158

GUN FOR PERFORATING CASING

Filed Sept. 11, 1950

2 Sheets-Sheet 1



INVENTOR.
Jerome G. McKean,
BY
Carl Babcock,
ATTORNEY.

Dec. 29, 1953

J. G. McKEAN

2,664,158

GUN FOR PERFORATING CASING

Filed Sept. 11, 1950

2 Sheets-Sheet 2

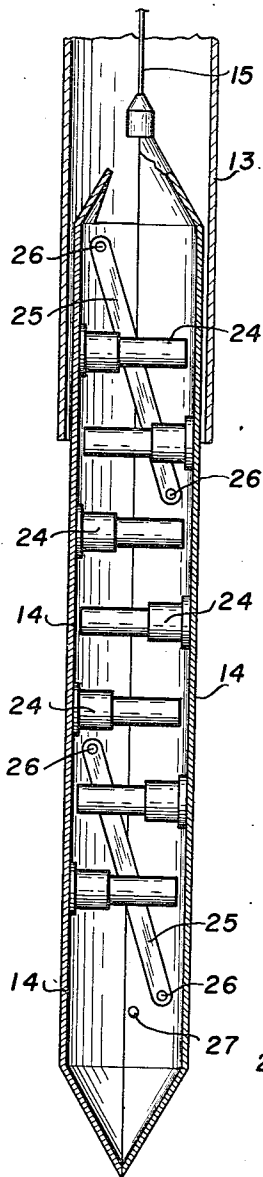


FIG. 6.

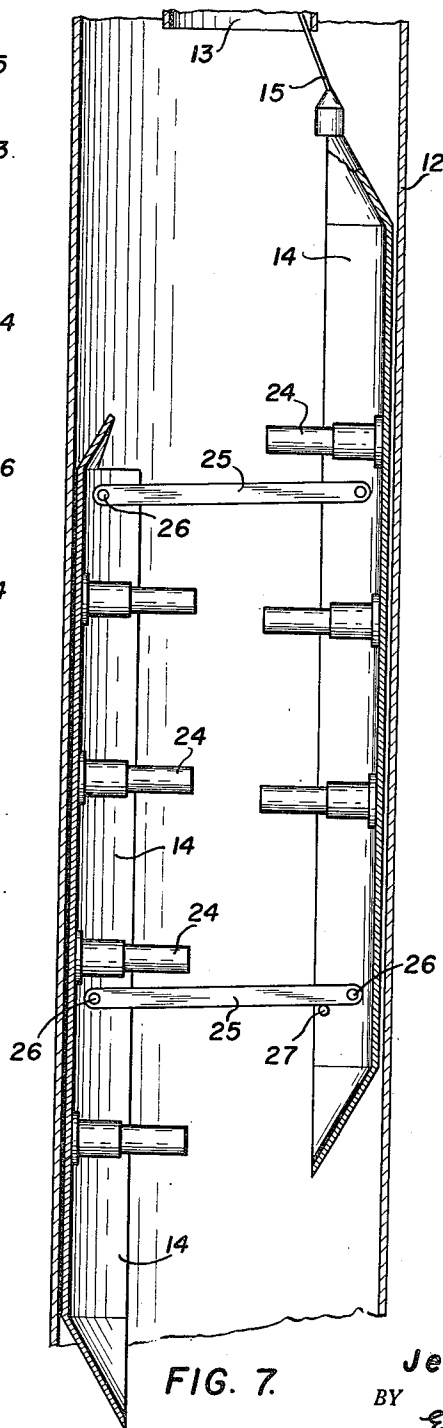


FIG. 7.

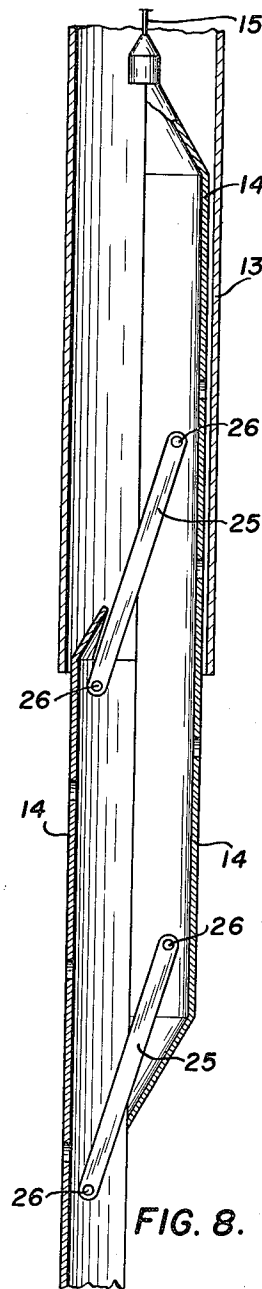


FIG. 8.

INVENTOR.
Jerome G. McKean,

BY
Earl Babcock,

ATTORNEY.

UNITED STATES PATENT OFFICE

2,664,158

GUN FOR PERFORATING CASING

Jerome G. McKean, Bellaire, Tex., assignor, by
mesne assignments, to Standard Oil Develop-
ment Company, Elizabeth, N. J., a corporation
of Delaware

Application September 11, 1950, Serial No. 184,168

3 Claims. (Cl. 164—0.5)

1

This invention relates to guns for perforating pipe in oil wells or the like and more particularly to guns which are small enough to run through tubing in a well for perforating casing beneath the tubing.

Guns and explosives have long been used for perforating casing in oil wells and the art is well developed. As commonly constructed, the barrels of bullet guns used for such purposes are fixed horizontally in a carriage and these barrels approach in length, as far as is practical, the diameter of the casing so as to obtain the maximum fire power. Where shaped charges of explosive are used for perforating casing, they also have been mounted in fixed position in a carriage which is nearly as large as the casing in the well so as to locate the charge in the optimum position or "stand-off" distance from the casing. Even under the best conditions, effective perforation of oil well casing and the cement which usually surrounds it, is difficult to accomplish, and since the size of the gun or explosive is important, casing perforators have not been run into the well through tubing or other pipe smaller in diameter than the casing.

It has recently been proposed to perform certain operations including the perforating of casing in an oil well while tubing is in it. See for example 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 can be effected in this way if effective perforation can be accomplished.

In accordance with application Serial No. 184,161, filed on even date herewith by Theodore A. Huber, now Patent No. 2,639,770, it is proposed to solve the problem of providing effective firing power to perforate casing with an assembly which is run into and out of the well through tubing by arranging the guns in their carriage on trunnions and by providing means for rotating them from the vertical positions which they occupy while being lowered into the well, into horizontal firing positions. Inasmuch as the guns may be fired by electricity, Huber proposed to employ an electric motor to rotate them exactly the right amount.

In accordance with the present invention, it is proposed to provide a structure which can be run into the well through tubing and which works automatically to swing the barrels of bullet guns or position shaped charges of explosive properly and accomplish the purposes proposed by Huber.

2

The carriage for the guns is made of two parts, one of which moves, under the influence of gravity, to effect the desired movement as it comes out of the tubing. When the guns fire, the reactive force causes further relative movement of the two parts of the carriage and brings them into such position that the carriage can be retrieved from the well 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 vertical cross-sectional view of tubing in an oil well and a cross-sectional view of a bullet gun, constructed in accordance with the present invention, located therein in the "running-in" position, it being understood that as many barrels as desired may be employed, all being like those illustrated.

Fig. 2 is a vertical cross-sectional view of tubing and casing in an oil well with the gun of Fig. 1 beneath the tubing with the barrels shown in horizontal position and being fired.

Fig. 3 is a vertical cross-sectional view of the tubing and gun of Fig. 1 but showing the position of the carriage and barrels after firing and in retrieving position.

Fig. 4 is an enlarged transverse cross-sectional view of the gun of Fig. 1, the view being taken on the line 4—4 of Fig. 1.

Fig. 5 is a side view of one of the barrels of the gun of Figs. 1 to 4, partly cut away and showing the arrangement for holding the barrels in horizontal position and releasing them when they are fired so that they can rotate an additional amount.

Fig. 6 is a vertical cross-sectional view of tubing in an oil well and a cross-sectional view of a gun, using shaped charges of explosives and constructed in accordance with the invention, located therein in "running-in" position.

Fig. 7 is a vertical cross-sectional view of tubing and casing in an oil well with the gun of Fig. 6 beneath the tubing and with the shaped charges of explosive in proper position for firing to perforate the casing.

Fig. 8 is a vertical cross-sectional view of the gun of Figs. 6 and 7 after the charges of explosive have been fired, the parts of the carriage being in such position that they can be retrieved from the well through the tubing.

Referring to the drawing in detail, and first to the embodiment of the invention shown in Figs. 1 to 5, inclusive, it will be seen that an oil well casing is there shown at 12. A tubing 13 is positioned in the well with its lower end

3

above the portion of the casing which is to be perforated, as shown in Fig. 2.

Within the well is an elongated gun body or carriage 14 which is lowered into the well on a cable 15. This carriage may be made of thin steel and it is of cylindrical shape while being lowered into the well through the tubing 13, as viewed in Fig. 1. Within the carriage 14, mounted on pivot pins 16 are a number of gun barrels 17. The carriage 14 may be provided with ports or openings 18 to permit bullets to be fired there-through.

The gun barrels 17 are of a length greater than the diameter of the tubing 13 and only slightly less than the diameter of the casing 12. In order for them to be lowered into the well through the tubing, it is necessary that they be held approximately in a vertical position as shown in Fig. 1. After the carriage has passed out of the bottom of the tubing, the barrels 17 are to be rotated to the horizontal position as shown in Fig. 2. The carriage 14 can then be raised and lowered by the cable and the guns fired individually at different depths, or all of the guns may be fired at the same time, or nearly so, in accordance with well known perforating technique.

If the guns are of the type which shoot bullets, each barrel 17 may be loaded at both ends with the explosive charge in the center, as taught in the patent to Mims No. 1,582,184, with the result that bullets 20 are fired into the casing 12 and surrounding earth formation 21 in both directions. With such an arrangement, there is little strain on the supporting structure, because the reactive firing forces balance out. However, it is within the purview of the invention to load each barrel 17 with only one bullet so as to increase the effective gun barrel length and secure greater penetration and that is the type of arrangement illustrated in Fig. 5.

After the bullets have been fired, the arrangement is such that the barrels 17 may be rotated back into approximately a vertical position as shown in Fig. 3, so that they can be pulled back up through the tubing 13 to remove them from the well.

The sequence of steps of rotation are illustrated in Figs. 1, 2 and 3 and they are carried out automatically due to the construction of the device. When being lowered down through the tubing 13, as shown in Fig. 1, the barrels are held approximately in vertical position by the tubing 13 itself. This is due to the construction of the carriage 14 which is split longitudinally throughout its length. The barrels 17 are individually connected to both semi-cylindrical halves by the pivot pins 16 and the cable 15 is connected only to one half of the carriage 14 so that the whole constitutes a parallel linkage mechanism, the barrels 17 themselves serving as the bars linking the two halves of the carriage together. Thus the device may be run into the well with the two parts of the carriage 14 in the nested position shown in Fig. 1, and after the device has passed out of the lower end of the tubing the parts may separate into the extended position shown in Fig. 2. While in the "running-in" position, the barrels 17 are not quite vertical with respect to the center-line of the carriage 14 so that gravity tends to rotate them into a horizontal position, but so long as the gun is within the tubing they cannot be so rotated, because the carriage 14 is confined by the tubing 13.

4

As soon as the carriage 14 is brought to a point beneath the lower end of the tubing 13, gravity acts so that the parts of the carriage and the barrels 17 swing into the position shown in Fig. 2. This is the firing position of the gun.

If the barrels 17 are each loaded with only one bullet 20, they may be alternately directed, as illustrated, so that one fires to the left and the next to the right to stagger the perforations in the casing 12.

When the carriage and barrels take the firing position shown in Fig. 2, some means must be provided for holding them temporarily in that position while they fire. To this end, a projecting retainer 22 may be provided on the interior of the carriage 14 which come into engagement with one of the barrels 17, as shown in Fig. 2. As shown in Fig. 5, this particular barrel may have its right hand pivot pins 16 in a slot 23 in the carriage 14 and its right hand pivot pins 16 in a slot 23' in said carriage. Hence when this barrel is fired, the reaction causes it to kick to the right and shear the retainer 22. Gravity then acts to swing the parts on down to the position shown in Fig. 3, so that they can be retrieved through the tubing.

If each of the barrels 17 is loaded with two bullets which are discharged in opposite directions, as mentioned above, the particular barrel 17 which is associated with the retainer 22 may be so loaded as to create a reaction in the desired direction to shear the retainer 22, as by imparting a greater driving force to the left hand bullet than to the right hand bullet when the assembly is in the position shown in Fig. 2.

The apparatus of Figs. 6, 7, and 8 is somewhat similar to that of Figs. 1 to 5, inclusive and functions in a similar manner, except that the casing perforating guns consist of shaped charges of explosive instead of barrels for shooting bullets, and utilize jet action. Since these shaped charges disintegrate upon being fired, there is nothing to retrieve from the well except the carriage. The parts which are the same as those in Figs. 1 to 5 are similarly designated.

The shaped charges of explosive are shown at 24. These charges are individually attached to the interior of the two halves of the carriage 14. They remain in horizontal position no matter how the two halves of the carriage move with respect to each other but they are nested together, as shown in Fig. 6 when being lowered through the tubing 13. To provide the desired parallel linkage mechanism, bars 25 are pivoted by pins 26 to the two halves of the carriage 14. When the carriage comes out of the lower end of the tubing 13, the two halves separate radially and bring the shaped charges 24 into the proper "stand-off" position with respect to their target, the casing 12. It will be observed that the firing position of Fig. 7 is such that the bars 25 are not exactly horizontal, the pins 26 on the left being slightly lower than those on the right. The two halves of the carriage 14 are held in this position, until the charges are fired, by a temporary retainer or shear pin 27. When the charges are fired, due to the offset position of the pins 26, the reaction force shears the pin 27 and permits the two halves of the carriage to take the retrieving position shown in Fig. 8.

The firing mechanism and circuits for the guns herein illustrated and described have not been set forth for the reason that they may be conventional. They form no part of the present invention. It will be understood that the firing

5

may be controlled from the surface of the ground through a conductor in the cable 15. It is also possible to cause the gun to fire upon the parts moving to the positions shown in Figs. 2 or 7, utilizing the firing systems of the applications of Earl Babcock or William E. Kanady, Serial Nos. 184,166 and 184,167, filed on even date herewith. The invention is capable of use without the cable 15 if means is provided for securing the upper part of the right hand part of the carrier 14 to the bottom of the tubing 13 so that the left hand part can swing down.

It is to be understood therefore that various changes may be made without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. A device for perforating casing in an oil well below tubing suspended within said casing comprising an elongated gun carriage split longitudinally throughout its length to divide it into two parts, gun barrels pivoted to the two parts of said carriage and forming therewith a parallel linkage mechanism, a retainer for holding said parts temporarily in an extended position and a means for shearing said retainer which utilizes the reaction force of one of said barrels when it is fired, whereby said carriage may be held with the two parts thereof in nested position by the tubing through which it is lowered into the well, separate, under the influence of gravity, into an extended position after it has passed out of the lower end of the tubing and then fall into a retrieving position when said retainer is sheared.

2. A device for perforating casing in an oil well below tubing suspended within said casing comprising an elongated carriage split longitudinally throughout its length to divide it into two parts, bars pivoted to the two parts of said

6

carriage and forming therewith a parallel linkage mechanism, shaped charges of explosive each of which is individually secured to the wall of said carriage, a retainer for holding said parts temporarily in an extended position and means for shearing said retainer which utilizes the reaction forces set up in the carriage when the charges are fired, whereby said carriage may be held with the two parts thereof in nested position by the tubing through which it is lowered into the well, separate, under the influence of gravity, into an extended position after it has passed out of the lower end of the tubing and then fall into a retrieving position when said retainer is sheared.

3. A device for perforating casing in an oil well below tubing suspended within said casing comprising an elongated carriage split longitudinally throughout its length to divide it into two parts, bars pivoted to the two parts of said carriage and forming therewith a parallel linkage mechanism, explosive means disposed within the carriage for perforating the casing, a retainer for holding said parts temporarily in an extended position and means for shearing said retainer which utilizes the reaction force of said explosive means when it is fired, whereby said carriage may be held with the two parts thereof in nested position by the tubing through which it is lowered into the well, separate under the influence of gravity into an extended position after it has passed out of the lower end of the tubing and then fall into a retrieving position when said retainer is sheared.

JEROME G. MCKEAN.

References Cited in the file of this patent

FOREIGN PATENTS

Number	Country	Date
174,459	Great Britain	Feb. 1, 1922