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SMALL GUN PERFORATOR FOR WELLS

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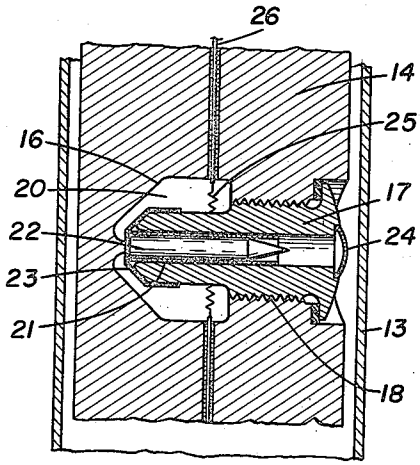


FIG. 1.

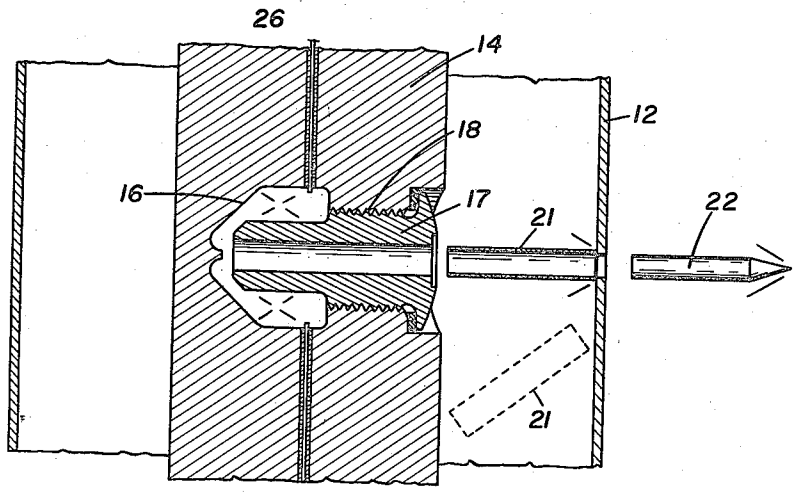


FIG. 2.

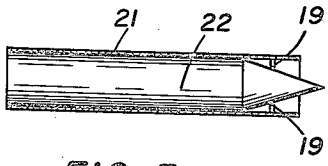


FIG. 3.

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SMALL GUN PERFORATOR FOR WELLS

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Application September 11, 1950, Serial No. 184,164

5 Claims. (Cl. 164—0.5)

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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 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. If shaped charges of explosives are used instead of guns which fire bullets, these also have been fixed in a carriage or gun body. 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 as conventionally used heretofore 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 September 11, 1950, 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 or gun body 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 in which gun barrels or shaped charges of explosive are fixed in position in the carriage or gun body but the gun body itself is made in sections which are hinged together on alternate sides so that they may be run into the well bore through tubing in a vertical position, then swung into a horizontal

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position for firing to perforate the casing in the well and, if desired, again brought back to a vertical position for retrieving 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 fragmentary vertical cross-sectional view of tubing in a well bore with a gun perforator constructed in accordance with the invention being lowered through it.

Fig. 2 is a fragmentary view in vertical cross-section of casing in a well bore and showing the lower portion of the tubing of Fig. 1 with the gun perforator of Fig. 1 emerging therefrom and taking its initial hinged position in the casing due to gravity.

Fig. 3 is a fragmentary view in vertical cross-section of the casing tubing and gun perforator of Figs. 1 and 2 with the latter shown in its firing position in the casing.

Fig. 4 is a side view of the upper part of the gun perforator of Figs. 1 to 3 with some of the upper or control section cut away to show the internal construction of the mechanism for stacking the gun sections.

Fig. 5 is a side view of two of the gun sections of the gun perforator of Figs. 1 to 4, the view being from the opposite side thereof than that shown in Fig. 3 and illustrating the wiring of the gun sections.

Fig. 6 is a transverse cross-sectional view of the gun sections of Fig. 5, the view being taken on the line 6—6 thereof.

Fig. 7 is a perspective view of the muzzle end of the lower gun section of the perforator of Figs. 1 to 6.

Fig. 8 is a view of a section of a gun which may be used instead of the sections of Figs. 1 to 7, and illustrating the use of shaped charges of explosives instead of bullets in the gun.

Referring to the drawings in detail and first to Figs. 1 to 7, it will be seen that the casing of an oil well is there shown at 12. A tubing 13 is positioned in the well with its lower end above the portion of the casing which is to be perforated, as shown in Figs. 2 and 3.

Within the tubing 13, as shown in Fig. 1 and beneath it, as shown in Figs. 2 and 3, is a gun perforator made of a number of gun sections 14 and a control section 16 which are lowered into the well on a cable 15. This perforator may be made of steel and each section 14 is of cylindrical shape and of a length greater than the diameter of the tubing 13 and only slightly less than the diameter of the casing 12. They are fastened

together on alternate sides by hinges 19. In order for these sections 14 to be lowered into the well through the tubing, it is necessary that they be held nearly in a vertical position as shown in Fig. 1. After they pass out of the bottom of the tubing gravity causes them to deflect slightly as shown in Fig. 2 and this slight or initial deflection then causes the control section 16 of the gun to function to cause the sections to stack as shown in Fig. 3.

The details of the control section 16 of the gun are shown in Fig. 4. As there illustrated, a long compression spring 17 is mounted in a longitudinally extending chamber 18. A tension spring could be used instead of this compression spring, as will be apparent to those skilled in the art, and the arrangement shown is to be considered as for purposes of illustrating only the basic principles of the invention.

A button 20 rests upon the top of the spring 17 and is connected to a wire 21 which extends out of the lower part of the chamber 18 and is connected across the muzzle of the lower one of the gun section 14 as shown in Figs. 2 and 7.

Also associated with the upper section 16 is a suitable latch for holding the spring 17 compressed while the gun is being lowered through the tubing 13. This consists of a catch 22 pivoted to the section 16 as shown at 23 and adapted to engage the button 20 and hold it down when the button is brought below it and the catch rotated to the left, as viewed in Fig. 4.

Coupling rod 24 is connected to the catch 22 and terminates in a rider or cam follower 25 which is arranged to rest upon the cam surface 26 of a link 27 pivoted to the lower end of the section 16 as shown at 28 and connected by a hinge 29 to the upper one of the gun sections 14.

The construction is such that when the gun is being lowered down through the tubing 13, the link 27 is held substantially aligned with the section 16. In this position, the rider 25 is held up and the catch 22 is held rotated to the left so that the spring 17 is held compressed.

As soon as the link 27 passes the bottom of the tubing the parts take the position shown in Fig. 2, under the influence of gravity and when this occurs, the link 27 has rotated enough to permit the rider 25 to move down slightly and release the catch 22 so that the spring 17 forces the button 20 upwardly exerting tension in the wire 21 and drawing the gun sections 14 into their stacked position as shown in Fig. 3. A coil spring 30 on the pivot pin 28 of the link 27 may assist in releasing the spring 17.

As indicated in dotted lines in Fig. 5, each section 14 may contain a bullet 31 and a charge of explosive 32 and these may be so arranged, as illustrated, that adjacent guns fire in opposite directions. For firing the charges of explosive, as shown in Figs. 5 and 6, an electrical fuse may be employed, and an electrical conductor 33 may be mounted in slots 34 in the gun sections 14 to convey electric current from the cable 15 to the charges of explosive. The conductor 33 may extend up through the section 16 for making this connection.

It is within the purview of the invention to load each section 14 with two bullets which are discharged from opposite ends of each section, as taught in the copending application of Theodore Huber mentioned above and in that case there will be little reaction force set up in the gun sections. However, if the sections are each loaded with only one bullet, as illustrated,

they should have interfitting means for coupling them so as to withstand the shock or reaction forces. One way of interfitting them is to provide lugs and sockets on the sections as shown at 35 and 36.

If desired, shaped charges of explosive, such as shown at 37 in Fig. 8 may be employed instead of bullets to perforate the casing 12. In that event the entire sections 14 may be blown up when the explosive is fired and only the section 16 removed from the well bore.

In any event, since the wire 21 passes over the muzzle of the lower section 14, the wire 21 will be broken when the gun is fired and the sections 14 pulled back up through the tubing.

It will thus be seen that the invention provides gun sections of adequate length to give sufficient fire power if bullets are used or of such shape as to bring shaped charges into the proper "stand-off" position with respect to the casing, if they are used to perforate and still permits these sections to be lowered down through the tubing with a minimum of inconvenience.

If some obstruction is first located in the casing at the point where perforating is to take place, the wire 21, spring 17 and the control mechanism can be eliminated since the sections can be caused to stack on the obstruction. It is also within the purview of the invention to lower the sections 14 to the bottom of the well to stack them. They may then be latched together by suitable means and brought up in the well to the point where the casing is to be perforated before firing them.

It is common knowledge that tubing in oil wells is often bent and long cylindrical bodies approaching the internal diameter of the tubing cannot be passed by such bends. Because of the hinged arrangement of the sections of the gun of the present invention, this difficulty is obviated.

While only two embodiments of the invention are shown and described it will be obvious 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 oil wells beneath tubing suspended within said casing comprising a control section; a plurality of cylindrical gun sections; hinges for hingedly connecting said sections together at their ends and for connecting the uppermost of said gun sections to said control section, alternate hinges being affixed to the ends of the gun sections at diametrically opposed points thereon in such a way as to permit the gun sections to assume a position wherein their longitudinal axes are substantially vertical and to permit said gun sections to assume a position wherein their longitudinal axes are substantially horizontal; and means carried by the control section for causing the gun sections to assume automatically a position for firing such that their longitudinal axes are substantially horizontal when the gun sections are not prevented from assuming said firing position, the cylindrical gun sections being longer in axial direction than in cross-sectional diameter, whereby said sections will pass through said tubing when arranged so that their longitudinal axes are substantially vertical and will assume a position wherein the longitudinal axes are substantially horizontal when they have cleared the lower end of the tubing.

2. The device defined in claim 1 in which each

section is loaded with one bullet, a charge of explosive, and a detonator for the explosive adjacent sections being so loaded that they fire in opposite directions.

3. The device defined in claim 1, adjacent sections having interfitting means which couple them together so as to withstand the reaction forces created when they are fired.

4. A device for perforating casing in oil wells beneath tubing suspended within said casing comprising a control section, said control section carrying a movable element biased upwardly within said section; a plurality of cylindrical gun sections, the uppermost of said gun sections being hingedly connected at its upper end to said control section and the remainder of said gun sections being hingedly connected at their upper end to the lower end of the gun section immediately thereabove, the point of hinged connection

at the upper end of each gun section being diametrically opposed to the point of hinged connection on the gun section immediately therebelow; and a flexible connecting means interconnecting said movable element in the control section with the end of the lowermost gun section removed from the end which is hingedly connected, whereby the longitudinal axes of said gun sections are substantially vertical as they pass through the tubing and then assume a position such that their axes are substantially horizontal when they have been lowered to a point beneath the lower end of the tubing.

5. The arrangement defined in claim 4 in which said flexible means is a wire line.

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No references cited.