Sept. 28, 1954 W. E. KANADY 2,690,123

JET GUN PERFORATOR FOR WELLS

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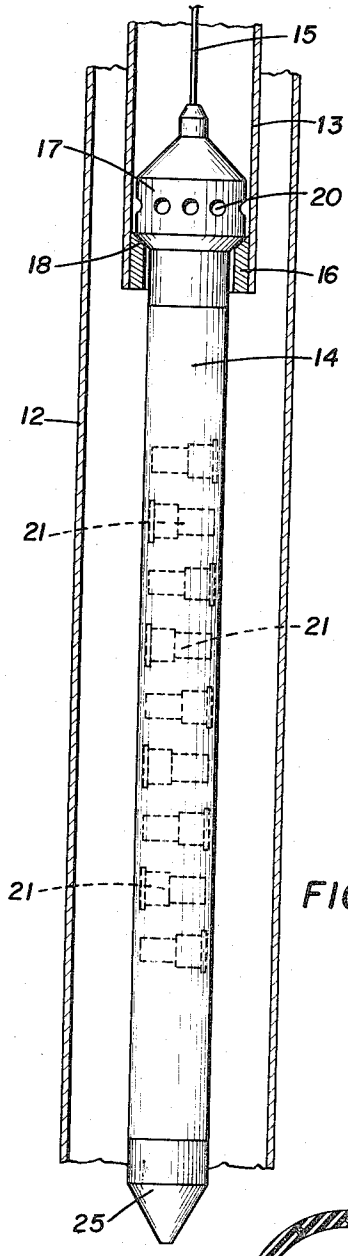


FIG. 1.

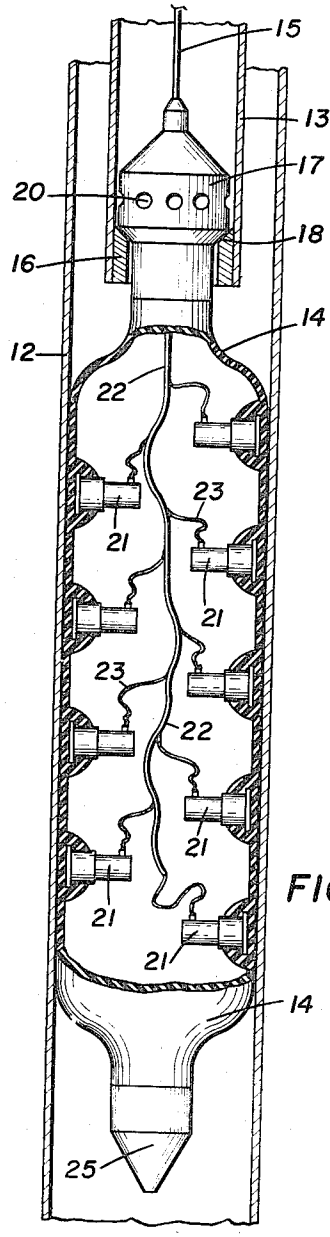


FIG. 2.

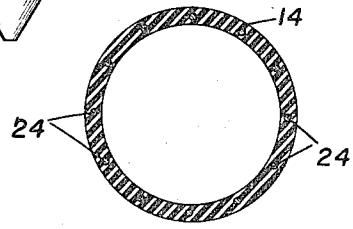


FIG. 3.

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JET GUN PERFORATOR FOR WELLS

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Application September 11, 1950, Serial No. 184,167

2 Claims. (Cl. 102—20.8)

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This invention relates to guns for perforating casing in oil wells or the like and more particularly to guns which use shaped charges of explosive to perforate casing with jet action.

Methods of perforating casing in oil wells with charges of explosive which utilize the "Monroe effect" are now common. Guns constructed for this purpose ordinarily consist of a steel body or carriage which is provided with a number of ports in which the charges of explosive are individually mounted and sealed. Since the carriage is ordinarily hollow and the interior kept free from liquid contamination as the gun is lowered through mud or the like in the well bore, it must be built strong enough, and each seal must be strong enough, to withstand the high fluid pressure encountered in deep wells. The cost of such carriages and the expense involved in reloading them is high.

Expendible carriages, such as those made of cardboard, various plastics or the like are proposed in the patent to Davis and Burrows No. 2,399,211, but these have not come into general use perhaps because of the inability of such materials to withstand high bottom hole pressures.

Carriages of solid concrete have also been proposed and these have been commercially used, but are thought by some people skilled in the art to be undesirable because of their tendency to burst the casing.

The problem of reducing the expense of jet perforation has recently been complicated by another factor. It has 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.

In accordance with application Serial No. 184,161, filed September 11, 1950, now Patent No. 2,639,770, dated May 26, 1953, by Theodore A. Huber, 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 application of Earl Babcock, Serial No. 184,166, filed on even date herewith, it is proposed to make a carriage for jet perforator guns of a thin expendible outer tubular container which completely surrounds

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the charges of explosives and seals them from fluid in the well bore. The charges are merely placed in the container so that expensive individual seals are not required, and each charge is enclosed in a sealed pressure resistant envelope. The spaces in the container between the charges of explosive are filled with inert filling material.

In accordance with the present invention it is proposed to use a gun having a container of flexible material for maintaining a seal around shaped charges of explosive. After the gun has been lowered down through tubing in a well, the elastic container is expanded or blown up by hydrostatic pressure so as to bring the shaped charges out into the proper position for firing to perforate casing beneath 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 and casing in an oil well with a gun perforator constructed in accordance with the present invention lowered into position therein, the view of the gun being in side elevation and showing the shape before the container is expanded.

Fig. 2 is a view similar to that of Fig. 1 but showing a portion of the container cut away and illustrating the shape of the container and the position of the charges of explosive after the container has been expanded.

Fig. 3 is a transverse cross-sectional view of the container of the gun of Figs. 1 and 2.

Referring to the drawing in detail, it will be seen that the casing of an oil well is there illustrated at 12. Tubing 13 is shown within the casing 12 with its lower end just above the portion of the casing which is to be perforated. An elongated container 14, which constitutes the body of the gun, is shown as having been lowered down through the tubing 13 of an electric cable 15, although it is within the purview of the invention to pump the gun down the tubing or let it fall by gravity and have no electrical connections to the parts therein.

To position the gun properly with respect to the tubing 13, so that it will occupy the proper vertical position in the casing 12, and for other purposes as will presently be described, the bottom of the tubing 13 is provided with a locator or seating ring 16 and the top of the container 14 is provided with a head 17 having a tapered shoulder 18 adapted to come to rest on the ring 16 and effect a seal therewith.

The head 17 is hollow and it is provided with a number of ports 20 above the shoulder 18 so as to establish connections between the interior of the container 14 and the fluid in the tubing 13 whether or not the head 17 is seated on the ring 16.

Within the container 14 there are a number

of shaped charges of explosive 21, each individually sealed in its own pressure resistant envelope. These charges may be arranged all pointing the same way or all pointing in different directions. As shown they alternately point to the left and right. They are individually secured to the wall of the container 14 so that when the container expands, as shown in Fig. 2, the charges are so positioned with respect to the casing 12 as to have the proper "stand-off" distance for most effective perforation of the casing.

If an electric cable 15 is employed to lower the gun into the well, the charges 21 may be fired electrically and, for purposes of illustration, a cable 22 is shown inside the container 14 with leads 23 coming off to each charge 21. If the charges are in copper or other metallic housings, these housings may be grounded by one of the wires in the cable 22 and leads 23 to the head 17 while another wire of the cable 22 and leads 23 is connected to the conductor of the lowering cable 15. If no electrical cable 15 is employed, the charges may be fired by a prima cord connected to a firing system located in the head 17 in accordance with the teachings of the Babcock application referred to above.

As shown in Figs. 2 and 3, the container 14 may be made of rubber, neoprene, elastic plastic or like expendible material. It could be made of canvas or other cloth and it need not be absolutely water tight though it must be so nearly so as to cause it to expand when the internal pressure exceeds the external pressure thereof. It may be provided with vertically extending cords 24, as shown in Fig. 3 of cotton, nylon, steel or other material. These cords serve to hold the container in shape, to some extent, but their main purpose is to make a connection from the lower shoe 25 of the gun body to the head 17. Since it is intended that the body 14 blow up when the charges are fired, and since it is desirable to remove from the well as much of the remnants thereof as possible, without fishing for them, it is desirable to maintain connection with as much of the container 14 as possible. However, the invention is not limited to such a construction and in any event the cords 24 should not be so strong but what they will break and permit the head 17 to be retrieved from the well, no matter what happens to the remainder of the gun when it is fired.

In considering the operation of the gun, let it be assumed that the well bore is filled with oil and it is desired to lower the gun down through the tubing 13 and perforate the casing 12. The gun is placed in the tubing 13 at the well head while it is empty so that there will be no tendency for the container 14 to bulge or belly out which would cause difficulty in placing it in the tubing. After it is in the tubing it may fill with oil from the tubing but this is of no moment since the ports 20 in the head are open and there is no difference in pressure across the walls of the container 14 and hence no forces tending to move it out of the natural hanging position shown in Fig. 1.

When the gun is in position at the bottom of the tubing as shown in Fig. 1, pressure is put on the oil in the tubing 13, as by a pump at the surface of the ground. Since the ports 20 are above the seating ring 16, this will create a difference in pressure between the inside and outside of the tubing and a differential pressure across the walls of container 14 and cause the gun to take the shape shown in Fig. 2, with the charges 21 in the optimum position for effective perforation of the casing 12 when they are fired. If fired electrically, a source of electricity may then be connected to the conductor of the cable 15 and all the charges 21 fired simultaneously or practically so. The head 17, so much of the container 14 as remains attached thereto and the shoe 25, if it is still attached to the head 17 may then be retrieved from the well by the cable 15 and the well completed in accordance with the teachings of the Huber application, Serial No. 133,025 mentioned above.

While only one embodiment of the invention has 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 claims.

I claim:

1. In an arrangement for perforating casing in an oil well or the like, in combination, an elongated, hollow, expansible, flexible container small enough to be run through tubing inside the casing to be perforated, said tubing having a ring affixed to its inner surface adjacent its lower end, a head on said container having means for engaging the ring in the lower end of the tubing and maintaining a seal therewith, said head having ports for maintaining fluid connection from a point above said engaging means to the interior of said container and a plurality of shaped charges of explosive within the container and individually secured to the wall thereof, the arrangement being such that said head may support the container and charges on the ring at the lower end of the tubing and the charges may then be brought into optimum firing position with respect to the casing by exerting fluid pressure in the tubing.

2. In an arrangement for perforating casing in an oil well or the like, in combination, a tubing string suspended in said oil well within said casing, a ring affixed to the inner surface of said tubing adjacent its lower end, an elongated, hollow, expansible, flexible container small enough to be run through said tubing, a head on said container small enough in diameter to pass through said tubing and having means for engaging said ring and maintaining a seal therewith, said head having ports for maintaining fluid connection from a point above said engaging means to the interior of said container and a plurality of shaped charges of explosive within the container and individually secured to the wall thereof, the arrangement being such that said head may support the container and charges on said ring and the charges may then be brought into optimum firing position with respect to the casing by exerting fluid pressure in the tubing above said ring.

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