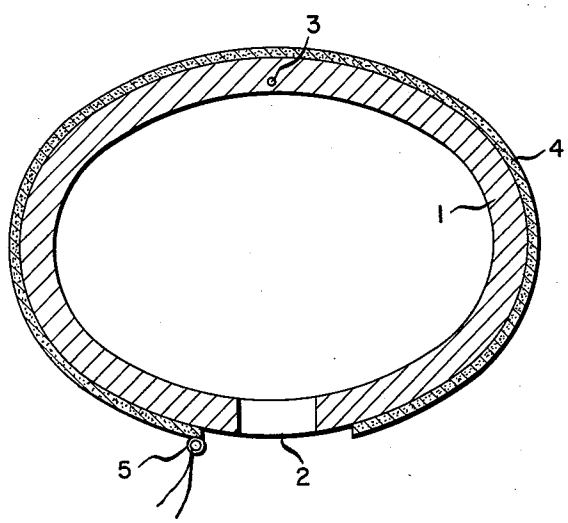
Dec. 19, 1961 W. R. BURKE 3,013,333

RESTORATION PROCESS

Filed Aug. 8, 1957



INVENTOR
WILLIAM R. BURKE

BY Thos. A. Wilson
ATTORNEY

United States Patent Office 3,013,333 Patented Dec. 19, 1961

3,013,333

RESTORATION PROCESS

William R. Burke, Dallas, Tex., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Aug. 8, 1957, Ser. No. 677,049
3 Claims. (Cl. 29—534)

The present invention relates to the restoration of carriers for oil-well perforating units. More particularly, this invention relates to providing increased life for such carriers.

In the perforating of oil wells by means of shaped-charge perforating units, one method widely used involves the positioning of a plurality of individual perforating units within a heavy-walled tubular carrier provided with sealed ports corresponding to the units positioned therein. The carrier is sealed against the entrance of well fluids and is lowered by means of a cable to the desired level within the well casing. The units are then initiated and the jet produced by the detonation of the shaped charge passes through the port and provides the desired perforation in the well strata. The carrier is then raised to the surface for reuse.

As a consequence of the detonation of the explosive charges, tremendous pressures are applied to the walls of the carrier, particularly to the portion of the walls directly adjacent to the main body of the explosive charge. These pressures cause localized permanent expansion of the carrier diameter and eventually cause rupture of the carrier. In addition to the pressure, particles of the casing about the explosive contribute considerably to the expansion of the carrier. When the metal failure point is reached, the next pressure application bursts the carrier and thus greatly increases its diameter. Inasmuch as the diameter of the carrier is only slightly smaller than the diameter of the well casing, a burst carrier may present a serious and expensive removal problem, particularly because the carriers are made of high-grade steel which is difficult to drill and because the carrier may be jammed in the casing at depths of 10,000 feet or more.

Because of the foregoing, the practice in the industry has been to reuse a carrier only until its expansion indicates that the rupture point has been reached. Normally, from about 10 to 15 salvos or shots can be made before the carrier is discarded as scrap. Inasmuch as a 24 port carrier, a widely used size, is a relatively expensive item, such discard represents an undesirable economic loss to the industry.

Accordingly, an object of the present invention is to provide a method whereby the useful life of a perforator carrier can be extended. Additional objects will become apparent as the present invention is more fully described.

I have found that the foregoing object may be achieved when I apply a layer of a detonating explosive to the outside of the carrier at the portions which have been expanded, and thereafter initiate the explosive, the quantity of explosive being sufficient to restore that portion of the carrier to substantially its original diameter.

In order to more fully illustrate this invention, reference is now made to the accompanying drawing in which 1 is the metal carrier, 2 is a port, 3 is a recess for positioning a perforator in alignment with port 2, 4 is a layer of a detonating explosive, and 5 is an electric initiator. In this drawing, the expansion of the walls to an oval configuration has been emphasized to illustrate the direction in which normal expansion occurs.

The present invention is further described by means of the following examples, the example being illustrative only and not representing limiting embodiments of this invention.

EXAMPLE I

A conventional carrier fabricated of 8640 tool steel and having a nominal outer diameter of 4 inches (actually 4.004 inches average) and an inner diameter of 2.6 inches was used in testing commercial perforating units each of which contained an 18 gram charge of RDX as the explosive charge. The port diameter was 1.25 inches. After eleven salvos, the maximum outer diameter (at points 90° from the port) was 4.120 inches. On the next salvo, the carrier split at the section where the diameter had been 4.120 inches.

EXAMPLE II

A carrier identical to that described in Example I was used in testing the same type of perforators. After 12 salvos had been fired, a maximum outer diameter of 4.114 inches was measured. A layer of an explosive composition (consisting of 85% by weight of PETN and 15% inert binding agent) 10 inches in length and two inches in width having a loading ratio of 4 grams of composition per square inch was positioned as shown in the drawing, and initiated by means of a conventional blasting cap.

The diameter was reduced to 4.063 inches perpendicular to the port axis. The carrier was used again for 9 further salvos, at which time the maximum diameter was 4.088 inches. This diameter was reduced to 4.023 inches by the procedure described, using the same explosive loading. Six more salvos were fired, at which time a crack was noted and further testing was discontinued.

The foregoing examples clearly show that the reduction in diameter obtained by means of the detonation of the explosive restores the carrier to not only its earlier size but also, at least partially, its former strength. While I do not wish to be bound by any theory, I believe that the detonation has effectively reduced the fatigue of the metal so that the original elasticity is approached, or possibly the combined effects of the squeeze by the explosive applied externally, followed by expansion from the explosion of the perforating units cause the steel of the carrier to be stressed in a manner similar to autofrettage, thus appreciably increasing the strength of the vessel walls.

The type of detonating explosive used is not critical to the carrying out of the present invention. By the term detonating explosive, I exclude materials which decompose or react at velocities less than that of sound in the reaction medium. Preferably, the detonating explosive used will be one which can be initiated by conventional initiators, such as blasting caps and detonating fuse, so that the need for a booster or primer is avoided. I prefer to use the explosive in the form of a composition which can be formed in a layer directly adjacent to the carrier. A flexible sheet of explosive having an essentially uniform loading density is highly satisfactory. However, powders which are packaged in flexible containers can be used.

The quantity of explosive required will depend upon the carrier material, the wall thickness of the carrier, and the particular explosive used. The following table shows the shrinkage obtaned by varying the explosive loading. In the tests, a carrier identical to that described in Examples I and II was used, and the explosive composition was the same as used in the examples. The variation in loading density was obtained by regulation of the thickness of the 10 inch by 2 inch layer.

Table I

Loading Density of Explosive Composition (grams/sq. in.)	Diameter Reduction (inch)
2	0.028±0.008
3	0.046±0.010
4	0.066±0.010
5	0.086±0.010
6	0.106±0.010
7	0.129±0.010

The explosive layer must extend over the portion of the carrier which has been expanded. For convenience, it is simplest to use a single strip as shown in the drawing, i.e., extending from one side to the port around the carrier to the other side of the port. To prevent damage to the port itself, the explosive layer will normally not extend completely to the port. To prevent damage due to converging shock waves, the layer should be initiated at one end rather than in the middle. I prefer to use a layer of explosive having a width of from 1 to 2 times the diameter of the port, and a length of from 70 to 90% of the expanded circumference of the carrier.

When more than one portion of the carrier is to be reduced in diameter, a plurality of layers can be initiated in one operation by connecting them with detonating fuse. The layers of explosive may be held in place by any convenient means, such as by taping, by use of adhesives, etc. If desired, the reduction in diameter may be accomplished by shooting two or more layers separately in lieu of a single heavy layer.

The invention has been described in detail in the foregoing. Obvious modifications and variations will occur to those skilled in the art. Accordingly, I intend to be limited only by the following claims.

I claim:

1. A method for reclaiming a perforator carrier which has been expanded and fatigued by the detonation of perforating units which comprises applying a layer of detonating explosive to the outside surface of the carrier at the fatigued, expanded portion thereof so that the said explosive substantially, but not completely, encircles the carrier and leaves the port free of explosive material, said explosive being of sufficient magnitude to restore the carrier wall to substantially its original diameter, and thereafter initiating the said explosive layer.

2. A method as claimed in claim 1, wherein said explosive layer has a width of from 1 to 2 times the diameter of the port and a length of from 70 to 90% of the expanded circumference of the carrier.

3. A method as claimed in claim 1, wherein a plurality of single explosive layers applied individually to the weakened, fatigued and expanded portions of the said carrier are initiated in one operation to effect reduction in diameter of a number of areas of the carrier.

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