Aug. 18, 1953 C. O. DAVIS 2,649,046

EXPLOSIVE PACKAGE

Filed May 1, 1947

Fig. 1.

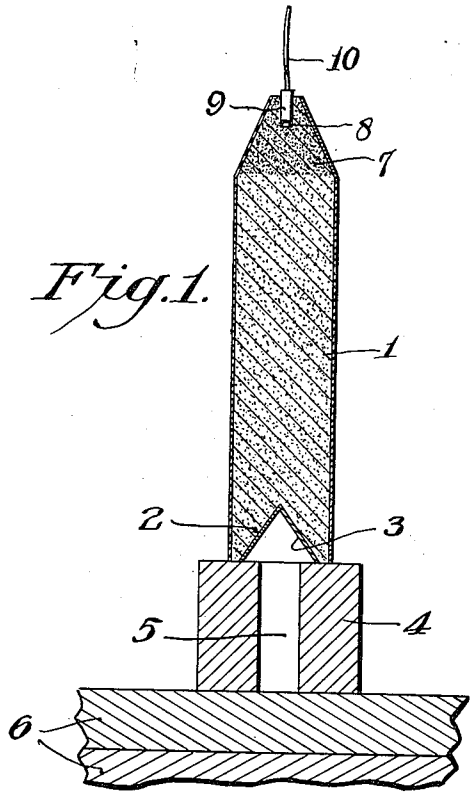


Fig. 2.

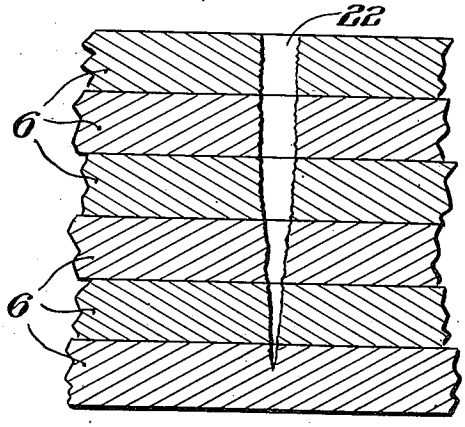
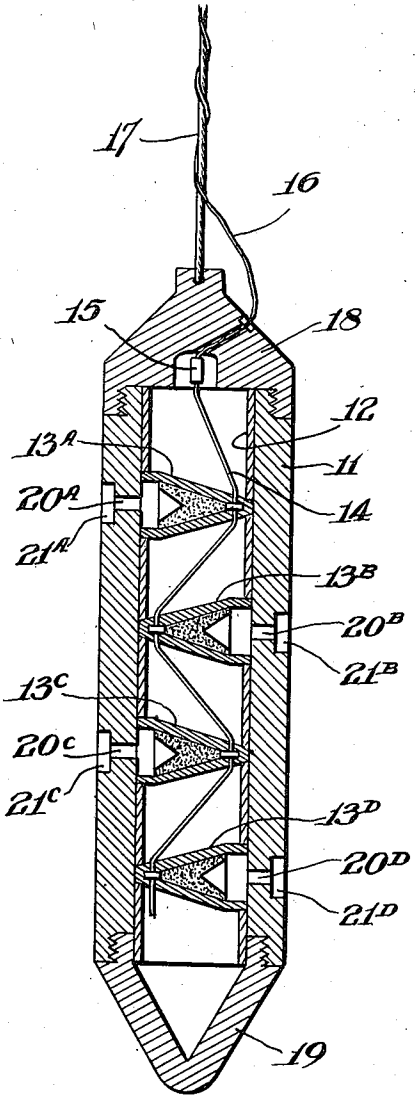


Fig. 3.



INVENTOR.
Clyde Oliver Davis
BY
Thos. A. Wilson
ATTORNEY

Patented Aug. 18, 1953 2,649,046

UNITED STATES PATENT OFFICE

2,649,046

EXPLOSIVE PACKAGE

Clyde Oliver Davis, Woodbury, N. J., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application May 1, 1947, Serial No. 745,209

2 Claims. (Cl. 102—20)

1

This invention relates to an explosive package and assembly so designed and arranged as to give unusual explosive effectiveness in certain respects and more particularly to such a package comprising shaped charges enclosed in a container adapted to be used repeatedly.

While it is a well known fact that the pressure from conventional forms of explosive is exerted equally in all directions, recent investigations have developed possibilities for directing the explosive effect in a controlled manner by use of shaped charges. When, for example, a charge of high density, high velocity explosive is provided at one end with a dished cavity and is initiated at the opposite end, the blast from the hollowed end has a highly penetrating action, sufficient to perforate several inches of steel in many cases.

An object of the present invention is an explosive package comprising a suitable container and within said container a plurality of shaped explosive charges. A further object is such an assembly in which the container serves as a carrier for the explosive charges and is adapted to be used repeatedly for blasting purposes where perforation of adjoining material is desired. Another object is a pressure-resistant, reusable carrier for shaped charges, adapted for the perforation of oil well casings. A still further object is a method of shooting a destructive jet from an explosive charge through an aperture of a diameter substantially less than the diameter of the explosive. Additional objects will be disclosed as the invention is described more in detail hereinafter.

I have found that the foregoing objects are accomplished, and a very effective assembly provided, when I utilize an explosive package comprising a sealed metal container of pressure-resistant construction having assembled therein a plurality of shaped charges of high density, high velocity explosive, each of the charges having a dished cavity facing the wall of the container or carrier, said cavity being lined with a liner of a shape conforming to that of the cavity. Adjacent to each of the foregoing dished cavities is an opening through the walls of the container of a diameter substantially less than that of the cavity in the charge. Destructible sealing means are provided for each of these openings, and initiating means are present for the explosive charges. When the charges are fired, a jet of material is shot from each of said charges that passes through the openings in the container walls, penetrates and destroys the sealing means thereover, and perforates the walls of any tubing

2

within which the carrier and its charges is contained.

The attached drawings will serve to show more clearly the principles and working of the invention, but it will be understood that these are by way of illustration only and are not to be taken as limiting in any way.

Figure 1 is a vertical elevation of a lined shaped charge of the type described, mounted on a steel foundation in position to demonstrate the principle of the invention. Figure 2 is a sectional view of the penetrating effect on steel plates resulting from the firing of the charge of Figure 1. Figure 3 is an explosive package in accordance with the invention.

In Figure 1, 1 represents a substantially cylindrical block of a 50–50 blend of TNT and PETN, commonly known as Pentolite, and at a density of around 1.60 g./cc. This explosive block is in the form of a shaped charge having a conical cavity 2, lined with a steel cone 3. The explosive charge is 6 inches in length and 1⅝ inches in diameter, and is supported on a steel block 4, 2 inches high, having a central opening 5 vertically therethrough, ⅝ inch in diameter and directly beneath the apex of the conical liner. This perforated steel block 4 rests on a mass of steel plates 6. At the end of the explosive charge opposite to the lined cavity, a small body of explosive 7 is placed, having a preformed well 8 within it, adapted to hold the electric blasting cap 9. The priming explosive charge 7 is capable of initiation by means of a blasting cap, when electric current is applied thereto through the leading wires 10.

When the explosive charge 1 is detonated in the position and surroundings shown, the blasting effect is manifested by a jet of particles that passes down through the opening 5 in the steel block and penetrates the supporting steel plates 6 for a considerable distance. In spite of the fact that the opening 5 is only ⅝ inch in diameter against a charge diameter of 1⅝ inches, the explosive action is so focused that the sides of the hole are barely scarred.

Figure 2 is a cross section of the perforation 22 in the supporting steel plates 6, each one of which is one inch thick, the total penetration amounting to substantially 5.5 inches, the diameter of the perforation at the top being practically the same as that of the aperture in the steel block. This perforation is the result of the explosion of the charge 2.

Figure 3 represents a practical application for utilizing shaped charges and the principles illustrated in Figures 1 and 2. The container 11

of pressure-resistant steel construction may be designated a carrier for shaped charges and the whole assembly as an explosive package adapted for example, for perforating oil well casings. Within this carrier 11 is the container 12 of paper board or other destructible material, this container holding securely in position the four shaped charges 13A, 13B, 13C and 13D, which are placed with their longitudinal axes substantially at right angles to the longitudinal axis of the cylindrical container 12 and with their lined conical cavities adjacent to and facing the wall of the container, said charges being spaced a predetermined distance apart and being adapted to be initiated by the connecting line of Primacord 14, which passes through cap-sensitive portions of the explosive shaped charges. The Primacord is butted up against an electric blasting cap shell 15, which is adapted to be fired by the passage of electric current through the wires 16 at the desired time. The carrier 11 may be lowered into the well casing by means of the support 17. This carrier has demountable top and bottom portions 18 and 19 respectively, the removal of which allows the cleaning of the carrier after use and the separation of any debris. The particular feature of the carrier comprises the provision of apertures or channels through the walls at 20A, 20B, 20C, and 20D, these apertures being directly in front of and aligned with the apexes of the several conical liners and being of substantially smaller diameters than the bases of the explosive charges. Prior to use, the carrier is tightly sealed by closing the wall channels by means of sealing discs 21A, 21B, 21C and 21D. When the charges are fired by means of the line of Primacord 14, they are detonated in rapid succession and, because of their nature and design, they cause a high velocity jet of particles of great penetrating power to pass through the channels in the walls and to penetrate not only the sealing discs but the adjacent casing walls and cement. Because of the directed action of the explosive shaped charges, substantially no damage is done to the side walls of the apertures or to the carrier itself; consequently this latter can be reused repeatedly.

The explosive charges used according to the present invention will be of the high velocity detonating type and at high densities. While any explosive answering these requirements is applicable, I preferably employ such compounds as trinitrotoluene, pentaerythritol tetranitrate, cyclotrimethylenetrinitramine and ethylenedinitramine, or mixtures thereof. Blends of trinitrotoluene with an organic nitrated explosive compound of higher melting point are satisfactory for use, for example such mixtures as those designated as Pentolite, Cyclotol, Ednatol, and the like. The explosive used should desirably be of a density above 1.40, and preferably higher, around 1.60 for example, and may be in either cast or pressed form.

High density explosives of the type described are too insensitive to be capable of detonation by means of a blasting cap or detonating fuse. It is necessary, therefore to include a more sensitive portion in the explosive charge, one that is detonable by the usual means, either adjacent to or enclosed within the main charge, and in detonating relationship to the initiator. Since cyclotrimethylenetrinitramine is of high thermal stability characteristically, it is particularly suitable for use in oil well casings, where high temperatures may prevail, and an advantageous arrangement is to employ a high density main charge of this compound, with a wax content if desired, and a low density, cap sensitive portion of the same compound as primer charge.

The initiating means will preferably be a length of Primacord or other detonating fuse, in successive contact with the several charges, though blasting caps may be used, if desired. The Primacord will be butted up against an electric blasting cap shell at any desired position, preferably within the pressure resistant container, in order to be fired electrically.

The charges are adapted for perforation of the well casing by having a lined dished recess at the end facing said wall. Desirably this recess will be conical in shape, the cone angle being of any desired magnitude within limits, for example between 35° and 70°. The recess is not necessarily conical in shape, however, and may be hemispherical, pyramidal or of other hollowed form, an essential being that it be lined with a liner of a shape corresponding substantially to that of the recess. Various rigid lining materials may be used, preferably of metal such as steel or copper, or of glass. The effectiveness of the penetrating effect of shaped charges of the nature of those described is such that relatively small amounts of explosive may be used; for example, 25 grams of cyclotrimethylenetrinitramine charge is sufficient to perforate four to five inches of steel plate.

The charges described will desirably be assembled within a holding container of paper board, plastic or other destructible material, desirably of substantially cylindrical shape with the various charges having their longitudinal axes approximately at right angles to the longitudinal axis of the container. The conically lined recesses will be adjacent to the container walls and the container will desirably be concentrically arranged within the casing.

The assembly of charges in the destructible container is enclosed within an outer container or carrier of pressure-resistant material, steel for example. It is an essential that this pressure-resistant container have openings in its walls at positions adjacent to the conical cavities in the charges, said openings being of substantially smaller diameter than the cone diameters and desirably less than three fourths of these diameters. Prior to the firing of the charges, the apertures are closed and the carrier maintained tight against oil, water or other fluid by means of sealing discs. Because of the design of the charges, penetrating jets of finely divided material are ejected from the conical ends of the charges at the time of detonation at extremely high velocity, and the jets are so focused that they are concentrated to streams of relatively small diameter compared with those of the cone bases. Consequently the jets pass through opening substantially less than the diameters of the cones without damaging the walls about said openings, perforate the sealing discs and penetrate the walls of the well casings as well as adjoining cement work.

The device of the invention and the method involved have great practical advantages. In the case of oil well casings, perforators are used at depths where oil and water are present under high pressure. A pressure resistant carrier for the charges is required therefor for their protection. The present invention makes feasible

a continuously reusable carrier, with the presence of preformed wall channels. By using the reduced diameters for said channels, as disclosed in the invention, a very considerable saving in the cost and practicability of the apparatus is effected. Because of the degree of curvature of the outer wall of a cylindrical casing of four to six inches outside diameter, the use of a sealing disc of a diameter of ½ to ⅝ inch, for example, rather than one of 1½ to 1¾ inches or more, is highly advantageous.

The invention has been described adequately in the foregoing, but it will be understood that many variations may be introduced in details of charges, assembly and procedures without departure from the scope of the invention.

I intend to be limited, therefore, only by the following claims.

I claim:

1. An explosive package comprising a sealed metal container of pressure-resistant construction; an assembly of more than one shaped charge of high density, high velocity detonating explosive within said container, each of the charges having a lined dished cavity facing the wall of the container; initiating means for the charges; openings through the walls of the container in front of each of the dished cavities and substantially symmetrically centered therewith, said openings being of substantially smaller diameter than said cavities; and destructible sealing means for each of said openings.

2. An explosive package comprising a sealed metal container of pressure-resistant construction; an assembly of a plurality of shaped charges of high density, high velocity detonating explosive within said container, each of the charges having a conical cavity facing the wall of the container, said cavities being lined with a rigid material; initiating means for said charges; openings through the walls of the container in front of each of the conical cavities and substantially symmetrically centered therewith, said openings being of a diameter less than one half the cone diameters; and destructible sealing means for each of said openings.

CLYDE OLIVER DAVIS.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,582,184	Mims	Apr. 27, 1926
2,043,340	Tilbury	June 9, 1936
2,210,192	Turechek	Aug. 6, 1940
2,250,055	Alexander	Jan. 22, 1941
2,399,211	Davis	Apr. 30, 1946
2,402,153	Elliott	June 18, 1946
2,407,093	Mohaupt	Sept. 3, 1946
2,419,414	Mohaupt	Apr. 22, 1947
2,419,841	Lampel et al.	Apr. 29, 1947
2,445,047	Turechek	July 13, 1948
2,446,235	Markham	Aug. 3, 1948
2,456,977	McCullough	Dec. 21, 1948
2,494,256	Muskat et al.	Jan. 10, 1950

FOREIGN PATENTS

Number	Country	Date
28,030	Great Britain	of 1911

OTHER REFERENCES

The Illustrated London News of November 25, 1944—pp. 604 and 605.

Bulletin of the University of Utah, vol. 37, No. 5, page 14, by Lewis and Clark.

"Casing Perforating with Shaped Explosive Charges"—by R. H. McLemore, in the Oil and Gas Journal issue of December 28, 1946.