May 21, 1963 H. G. REUTHER 3,090,306

EXPLOSIVE

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Fig.1.

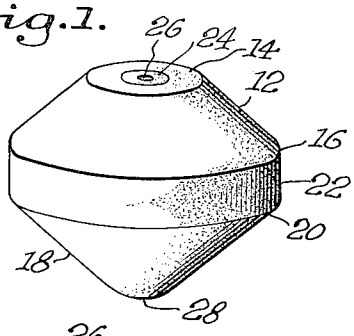


Fig.2.

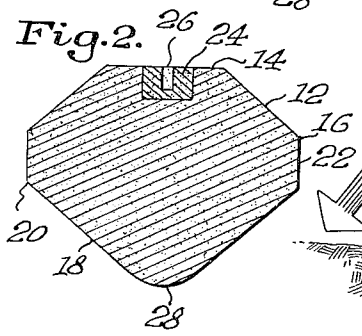


Fig.3.

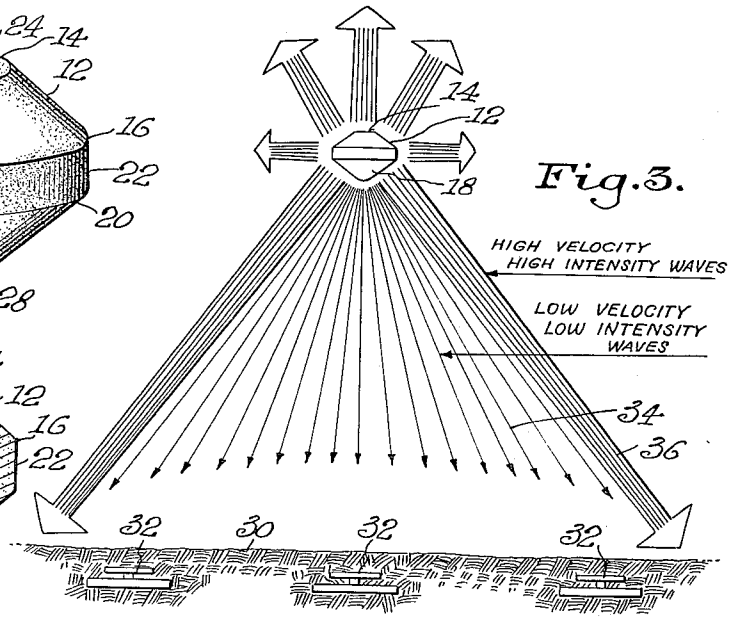


Fig.6.

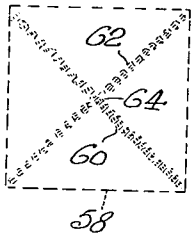


Fig.7.

Fig.4.

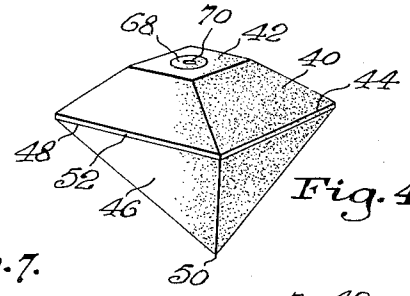
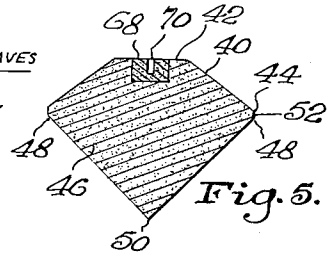


Fig.5.



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Fig. 8.

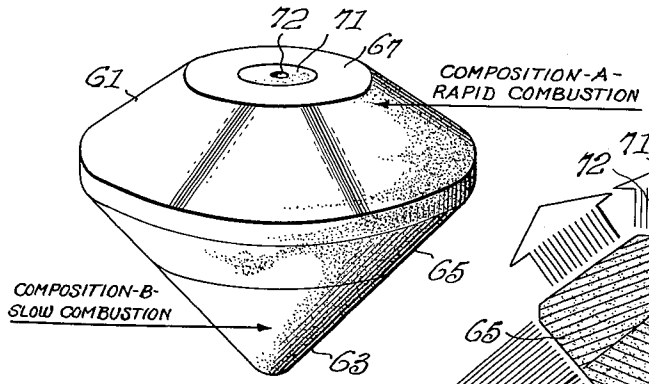


Fig. 9.

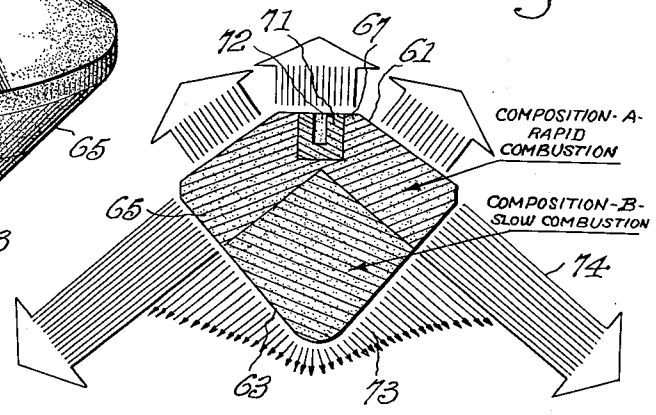
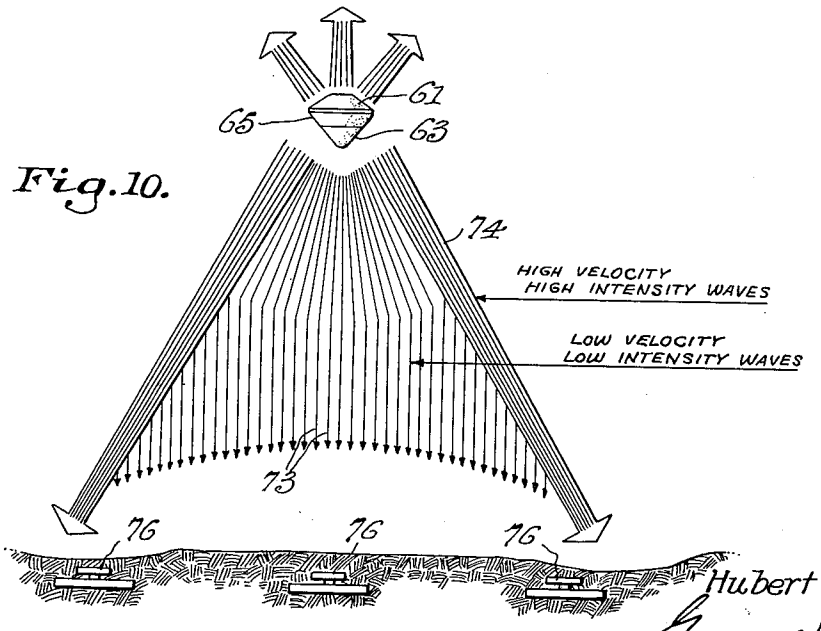


Fig. 10.



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Fig. 11

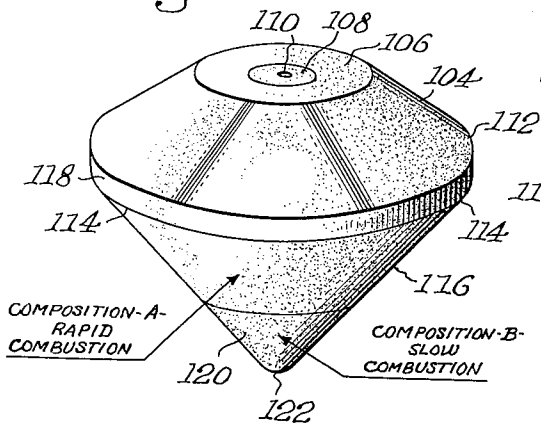


Fig. 12

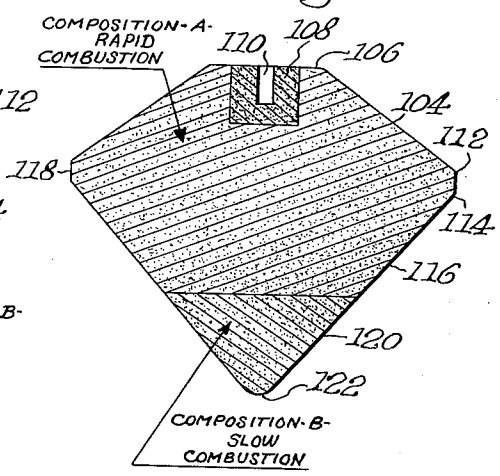
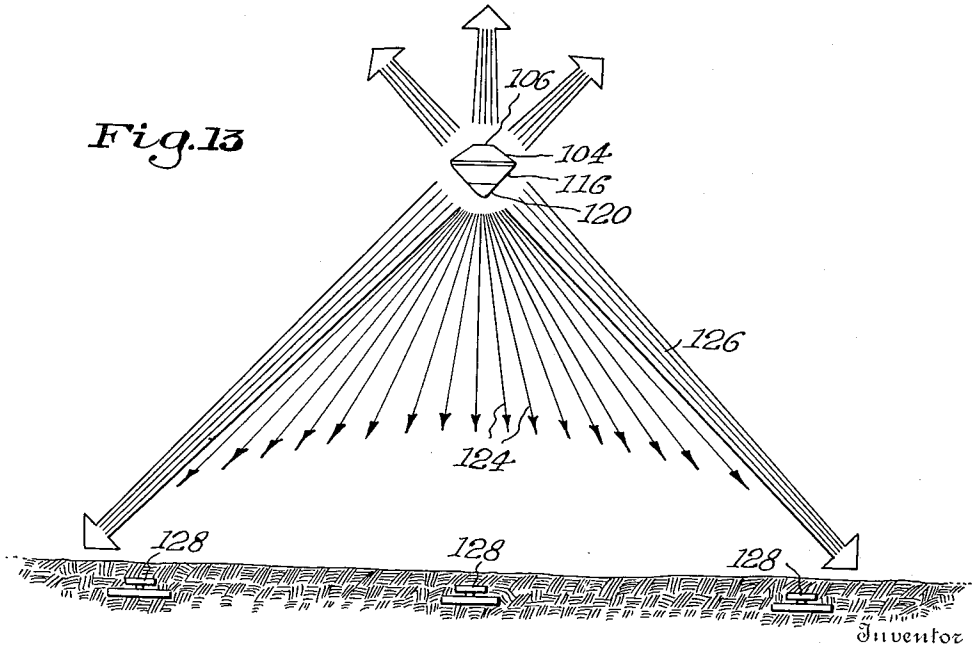


Fig. 13



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3,090,306

EXPLOSIVE

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2 Claims. (Cl. 102—22)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The present invention relates to military explosives designed primarily to detonate mines of a subterranean mine field by impacts of concussion waves produced by the detonation of an above-ground explosive charge.

It has been observed in practice that the individual mines of a subterranean mine field may be detonated effectively by impact on the ground of percussion waves of sufficiently high intensity, which waves may be produced by the detonation of an explosive charge held at a predetermined distance above the ground.

It has been found that the efficiency of the detonation of buried land mines by such percussion waves is much increased when the waves are controlled in a predetermined restricted pattern.

In accordance with the present invention there are provided improved explosive charges for the above-indicated purposes wherein there is effected a predetermined control of percussion waves and attendant pattern on the area of the explosive forces from the charge, the explosion waves forming a component pattern of high and low velocity and intensity waves wherein the latter are enveloped and given direction by the former. In accordance with the invention there is produced a high pressure encircling cone which has its apex near the point of detonation, thereby confining the enclosed shock waves to a restricted area. This in turn causes an even distribution of pressure inside the encircling area. This area can be controlled at will by varying the relation of the lower cone angle with the ground. It also utilizes the unused forces projected from the side and directs them earthward at right angles to the lower cone, and these can be in any number of sides from triangular to a circular cone.

As has been indicated above, the improved effects produced by the present invention may be obtained either by producing a higher speed encircling outer cone confining the shock or pressure wave inside of the cone over a given distributed area, by putting explosive materials of high combustion rate in the top portion of a charge having a double conical shape, and an explosive having a lower rate of combustion in the bottom portion of the charge, or by a suitable shape of a charge of homogeneous composition, or by a combination of a particular shape of the charge coupled with explosive materials having different rates of combustion, as will be pointed out in detail hereinafter.

Generally speaking, the improved results of the present invention are obtained by enclosing detonation waves of relatively low magnitude or speed in an enveloping high intensity or high-speed wave envelope, which envelope and enclosed waves are directed to the objective by the particular shape of the charge itself. That is to say, the results of the improvements of this invention are obtained by exploding upper and lower charges, the lower charge, that is, the one closer to the ground, having less detonating effect than the upper charge. The explosive forces resulting from the upper charge control the area in which the explosive forces of the lower charge are confined. The charge of the present invention creates a conical or polygonal umbrella, limiting the dispersion of the second charge. The effect of the upper charge is to create a hollow cone or annulus of forces, which would restrict the expansion of the upper cone, thereby driving a higher speed encircling outer cone confining the shock or pressure inside of the cone or by shaping the charge into the

cones, one perpendicular to the vertical and the other parallel to the horizontal on the outer face of the lower cone. The length of the outer surface walls of the charge affect the direction of the forces from the explosion. The longer the outer surface, the greater total force from that surface, and the shorter the length of the outer surface, the smaller the total force, the two together combining to form a resultant force from the charge.

The invention will be understood more readily from a consideration of the accompanying drawings, wherein:

FIGURE 1 represents a side elevation of one form of charge shaped to produce the effects of the present invention;

FIGURE 2 is a sectional elevation through the vertical axis of FIGURE 1;

FIGURE 3 is a diagrammatic showing of the manner in which the explosion waves resulting from the explosion of the charge in FIGURES 1 and 2 are controlled by the shape of this charge and directed on to a subterranean mine field;

FIGURE 4 is an isometric view of a modified form of charge;

FIGURE 5 is a sectional elevation of the charge of FIGURE 4, taken along the vertical axis of FIGURE 4;

FIGURE 6 is a plan view showing the ground pattern obtained by the firing of the charge of FIGURE 4;

FIGURE 7 is a diagrammatic view, similar to FIGURE 3, but showing the control obtained by the modification of FIGURE 4;

FIGURE 8 is a perspective view of a still further modification, using explosive charges having differential rates of combustion;

FIGURE 9 is a sectional elevation of the modification of FIGURE 8 taken along the vertical axis of FIGURE 8, the view showing diagrammatically the initiation of explosive waves propagated by the explosion of the charge of FIGURE 8, at the instant of explosion;

FIGURE 10 is an explosion diagram showing the effects of the explosion of the charge of FIGURE 8;

FIGURE 11 is a perspective view of a further modified form of an explosive charge producing the results of the invention;

FIGURE 12 is a vertical sectional elevation taken along the vertical axis of the charge of FIGURE 11; and

FIGURE 13 is an explosion diagram showing the control of the explosive waves propagated by explosion of the charge of FIGURE 12.

It will be understood that the charges in each instance are enclosed in a suitable casing, not shown, which is provided with means for suspending the charges above the mine field to be detonated, at a height requisite for maximum effectiveness of detonation of the buried mines.

Referring more particularly to the drawings, and first to FIGURES 1, 2 and 3, the illustrated charge comprises a truncated, molded, conical portion **12**, having a flat, truncated surface **14** and a base **16**. The charge also has a wide conical portion **18** with a base **20** aligned with the base **16** of the conical portion **12**, the bases **16** and **20** being spacedly connected by a cylindrical portion **22**. The height of the conical portion **18** is approximately fifty percent greater than is the height of frusto-conical portion **12**, both portions **12** and **18** being right angle cones. A priming charge **24** is shown as inserted in the conical portion **12**, the priming charge being recessed, as indicated at **26**, for reception of an electrical lead, not shown, for the provision of a detonating spark. The conical portion **18** terminates in a wide apex **28** and, in use, the charge is suspended from a suitable mounting means not shown at a desired predetermined distance above a mine field **30** for detonation of the mines **32**

thereof, and when the charge is detonated, a wave pattern such as is indicated in FIGURE 3 is obtained.

In this diagram of FIGURE 3, heavy or concentrated percussion waves are propagated in all directions, including downwardly, in conformity with the angle of slope of the lower cone 18, the slope of the lower cone progressively reducing the amount of the explosive charge in a given volume. Hence, the waves 34 propagated from the apex 28 of the lower cone 18 are of less intensity than are the waves 36 propagated from the portions of the cone adjacent to the base, and such waves are enclosed and enveloped by the high intensity outside waves and are directed thereby onto a localized area of the mine field 30, the extent of which area is dependent upon, and controlled by, the angle of slope of the lower cone 18, to the vertical axis of the charge.

In FIGURES 1, 2 and 3 the charge is a molded charge of uniform composition which is not critical, but may be molded trinitrotoluene, for example, also, where the charge is detonated electrically, the priming charge 24 actually is optional, but it is preferred to assure smooth explosion of the charge.

FIGURES 4 through 7 show a different form of charge operating on a similar principle to the charge of FIGURES 1, 2 and 3, except instead of being conical, the charge is pyramidal in shape. The truncated pyramidal upper charge portion 40 has a flat truncated surface 42 and base 44. The lower pyramid 46 has a base 48 and terminates in apex 50. Base portions 44 and 48 are in registry, but are spaced by a narrow, substantially rectangular band 52. As shown in FIGURE 5, the height of the lower pyramid 46 is approximately twice that of the upper truncated pyramid 40. This modification produces wave propagation similar to that shown in FIGURE 7, wherein the waves 54 of high intensity from the sides of the pyramid 46 enclose the waves 56 of lower intensity produced from the apex 50 of the pyramid, the waves 56 being limited and guided by the high intensity and velocity waves 54, the angular direction of which is determined by the slope of the pyramid 46. FIGURE 6 shows a diagrammatic representation of the ground pattern produced by the detonation of this charge, which pattern acts as confirmation of the diagram of FIGURE 7. It will be seen from FIGURE 6 that the outline 58 of the pattern is formed by the intersection of the high velocity, high intensity waves 54 with the ground, producing the substantially square outline 58 corresponding to the square base 48 of the pyramid 46, the diagonals 60 and 62 representing the intersecting edges of the pyramid 46, the intersection 64 of the diagonals 60 and 62 corresponding to the apex 50 of the pyramid 46. Highly effective detonation of the mines 66 is obtained.

Like the precedingly described modification of FIGURES 1 and 2, the embodiment of the invention shown in FIGURES 4 and 5 may be of uniform composition, for instance trinitrotoluene, provided with a priming charge 68, recessed at 70 for reception of an electric firing lead, not shown.

The modification of FIGURES 8 and 9 is similar to the modification of FIGURES 1 and 2. The truncated cone 61 is of a composition that has a substantially higher rate of combustion than the full conical portion 63 of the lower cone 65, the truncated cone, therefore, being a relatively higher explosive than portion 63, the relative amounts of the two compositions being about as shown in FIGURE 9, the composition of the truncated cone 61, occupying also upper portions of the lower cone 65. The truncated surface 67 is provided with the priming charge 71, which is recessed as shown at 72 for the reception of a firing lead, not shown. The particular explosive compositions are dependent upon the use, the requirement in this case being a substantial differential in the speed and volume of the wave propagation from the different explosive charges. For example, the higher explosive charge may be pentolite, for example, with a 50–50 amatol combination for the lower explosive.

FIGURE 10 shows directive guidance of the slower interior waves 73 by the enveloping high velocity waves 74, and directed on the mines 76.

FIGURES 11 and 12 show an embodiment somewhat similar to that shown in FIGURES 8 and 9, and the operation is on the same principle resulting from the use of different explosive compositions having a substantial differential in combustion rates. The frusto-conical upper portion 104 of this embodiment has the flat truncated surface 106 thereon and contains the priming charge 108, recessed at 110 for reception of the firing lead, not shown. The base 112 of the upper frusto-conical portion 104 is aligned with the base 114 of the lower conical portion 116 through the cylindrical portion 118. The composition of the charge is the same except for the portion 120 adjacent to the apex 122 of the cone.

FIGURE 13 shows the explosion diagram for this modification. The low-intensity waves of low velocity indicated at 124 are limited and directed by the high-intensity, high-velocity waves 126 and localized over the mines 128.

In all of the forms of the invention herein illustrated and described, the control of the propagated waves is effected in either one of three methods, i.e., (*a*) by progressively reducing the intensity of the waves by progressive reduction of the explosive charge from maximum amount to minimum amount, the minimum amount being in an apex of a cone or pyramid directed toward the ground, (*b*) by utilizing different explosive compositions possessing differentials in the rate of combustion and hence wave propagation, the slower burning composition being located within the confines or boundaries (actual or projected) of the rapidly burning composition, or (*c*) a combination of (*a*) and (*b*).

It will be observed also that, while the effective waves are propagated from the lower portions of each charge, it is desirable for maximum effectiveness that the charges hang plumb from their suspensions and be as free as possible from oscillation. In each form there is an upwardly tapered section (truncated) and a lower section sloping to an apex in a symmetrical manner, surfaces in the upper and lower sections sloping in the same direction being substantially parallel and forming an angle with the base of approximately 45°.

While it is shown on the drawings that the explosive waves from the upper truncated portions of the charges are dissipated and only those from the lower sections are effective for the intended purpose, nevertheless, the tapered upper portion is found in practice to be desirable, although not wholly necessary, as such increases stability of the charge while suspended for detonation and increases the directional effect and intensity of the downwardly directed waves, by controlling the area in which the explosive forces of the lower charge are confined, propagation of all of which waves is in a direction normal to the surfaces of the charge.

It is found in practice that the charges should be detonated so that the ground pattern produced by each overlaps that produced by the succeeding charges. It is found also in practice that the shapes of various charges change their characteristic pattern in relation to their angles and the angles and the mass of the charges. The length of the angles in relation to each other and according to the mass and element of time of combustion of a charge has a pronounced effect in the dispersion and concentration of the resulting explosion waves when the charge is fired statically above the ground. Any two or more angles produce a jet effect corresponding to their respective angles and length. From this factor a charge can be made to disperse or to concentrate into a crater caused by the concentrated charge, the explosion waves from which can be confined to the crater section as a shaped charge, or in a limited number of concentric circles. In

the case of the charge with the truncated pyramidal top and a pyramidal lower inverted section (see FIGURES 4 and 5) the length of the angles of the lower section equal twice the length of the truncated top section, this causing a very pronounced jet effect from the four corners of the square formed by the bases of the top truncated section and the lower pyramidal section. An unexpected result is observed in this connection, as most of the encasing material (a very light metal) becomes concentrated in the four corners of the quadrangular figure on a parallel plane with the truncated top, as shown by the impact on the ground (see FIGURE 6). This is found to be true when a line is projected parallel to the hypotenuse of the truncated top. Where this line contacts the ground, it designates the center of the crater thus formed.

From the foregoing, it will be apparent that initiation of combustion of each charge is adjacent to each of the enlarged base portions, and progresses along the sloping body, uniformly progressively decreasing portions of the charge then undergoing combustion. In all forms, it will be seen that the lower portion of the charge, that is, that which points to the ground, slopes uniformly from the enlarged base portion to the apex, and that is true whether the lower portion is conical or pyramidal in shape.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. An explosive charge adapted to produce directionalized blast effects comprising a body including upper and lower body sections, a common planar base portion for the sections, the base portion having opposite planar surfaces from which the body sections converge oppositely, the upper body section terminating in a truncated surface paralleling said planar surfaces, the lower body section terminating in an apex, a source of detonation initiation mounted centrally of said truncated surface and symmetrically with respect to the planar surfaces of the common base portion, the source of detonation initiation producing upon detonation a detonation wave which,

passing through the body section in which detonation originated, impinges simultaneously all points of the planar base portion whereby an explosive pattern consisting of high velocity, high intensity shock waves, enclosing waves of lesser intensity and velocity, is propagated by the body section opposite to that containing the source of detonation initiation.

2. An explosive charge adapted to produce directionalized blast effects and comprising a homogeneous explosive composition including an upper body portion, a lower body portion, and a planar base portion common to the two body portions, the upper and lower body portions joining the planar base portion and tapering oppositely therefrom, the upper body portion being truncated and the lower body portion terminating in an apex, means located centrally of the truncated portion of the upper body portion for initiating combustion of the charge, said lower body portion adjacent the planar base portion projecting explosive waves of high velocity and intensity while said apex of the lower body portion propagates explosive waves of less intensity and velocity, the shaped charge being disposed relative to a surface receiving said explosive waves so that the said waves are directed against the surface with the high velocity intensity waves enveloping the waves of less intensity and velocity.

References Cited in the file of this patent

UNITED STATES PATENTS

221,830	King	Nov. 18, 1879
1,181,190	Welton	May 2, 1916
1,295,213	Saladiner	Feb. 25, 1919
2,066,634	Lux	Jan. 5, 1937
2,247,111	Batchelor et al.	June 24, 1941
2,419,854	Peterson	Apr. 29, 1947
2,433,875	Walker et al.	Jan. 6, 1948

FOREIGN PATENTS

305,618	Germany	July 2, 1919