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Rotondi, Jr.

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[54] **ANTI-TANK MINE**

[76] Inventor: **Salvatore Joseph Rotondi, Jr.,** 1112 N. Pitt St., Alexandria, Va. 22314

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[52] **U.S. Cl.** ..... **102/8;** 102/24 HC

[51] **Int. Cl.** **F42b 23/04**

[58] **Field of Search** ..... 102/8, 22, 24 HC, 10 C

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Primary Examiner—Verlin R. Pendegrass
Attorney, Agent, or Firm—Robert P. Gibson; Nathan Edelberg; Vincent W. Cleary

EXEMPLARY CLAIM

1. In a demolition unit, a closed container, an explosive charge in said container, and a solid projectile plate of substantial thickness secured to the top wall of said container, said explosive charge comprising a center core portion in contact with said projectile plate for forming a shock wave when detonated to propel said projectile plate toward said target, and an annular portion concentric about said core and forming an annular shaped charge axially spaced rearwardly of said projectile plate and collapsible upon detonation to augment the explosive effect of said center core portion.

9 Claims, 4 Drawing Figures

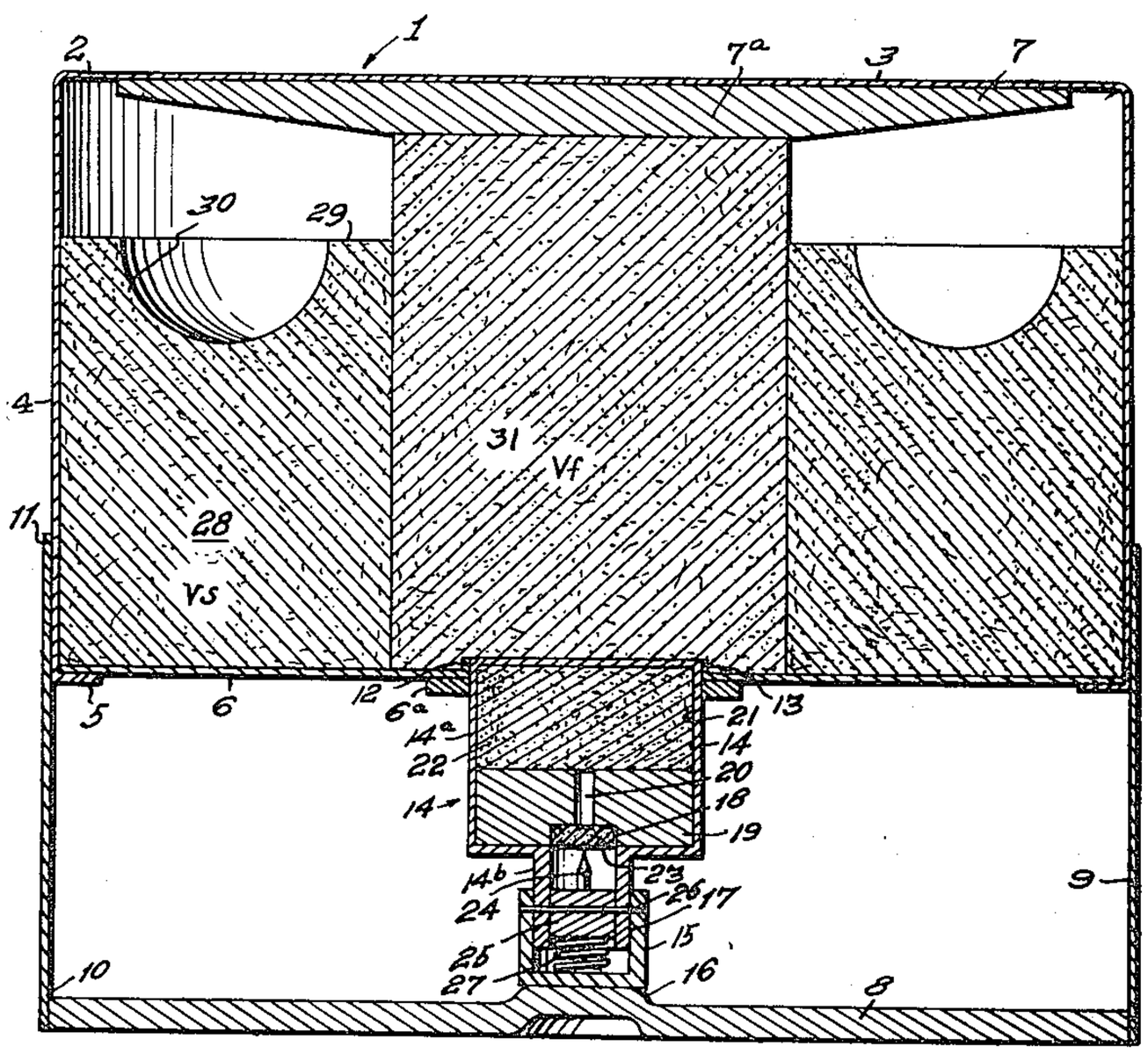


Fig. 1.

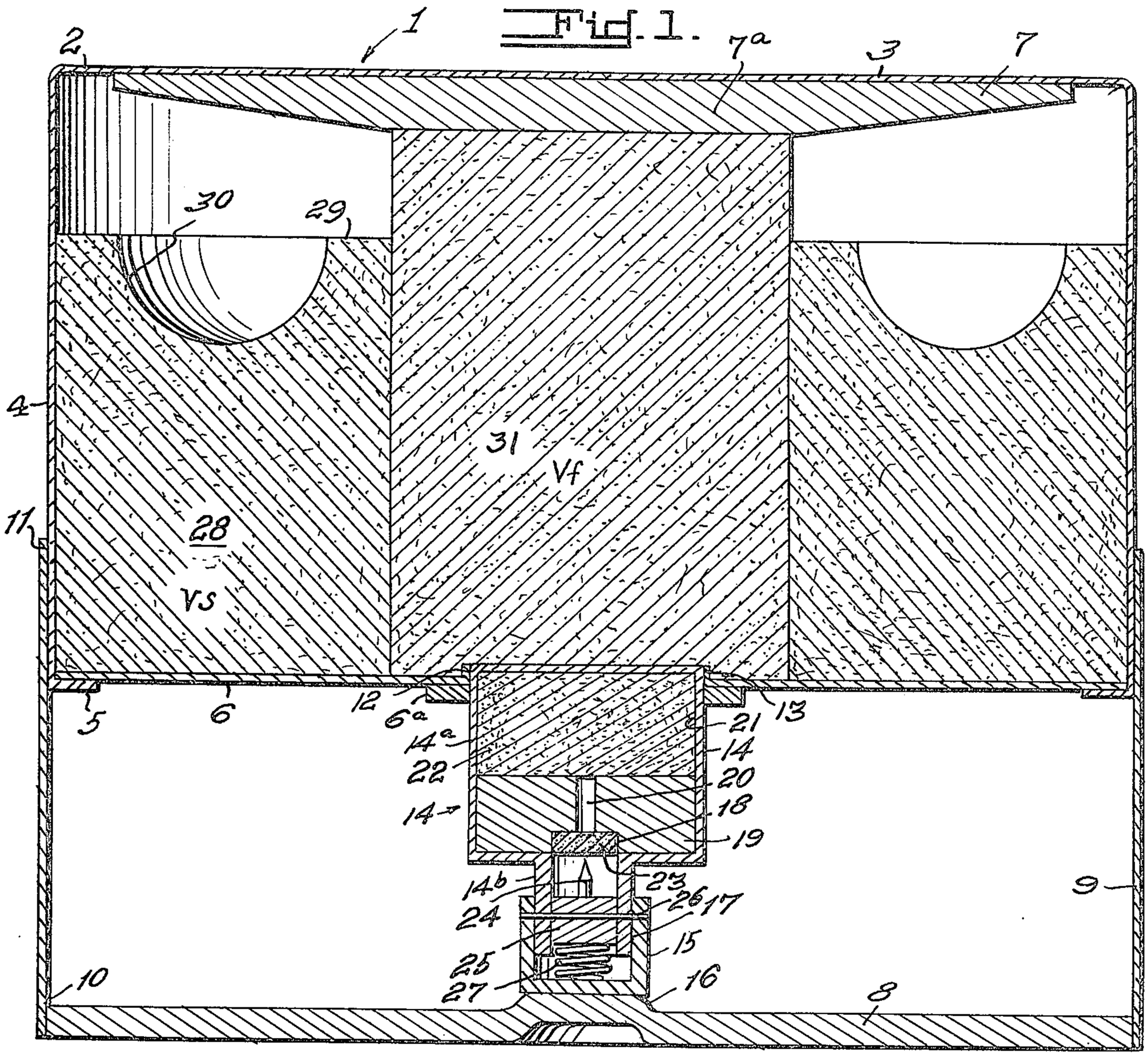


Fig. 2.

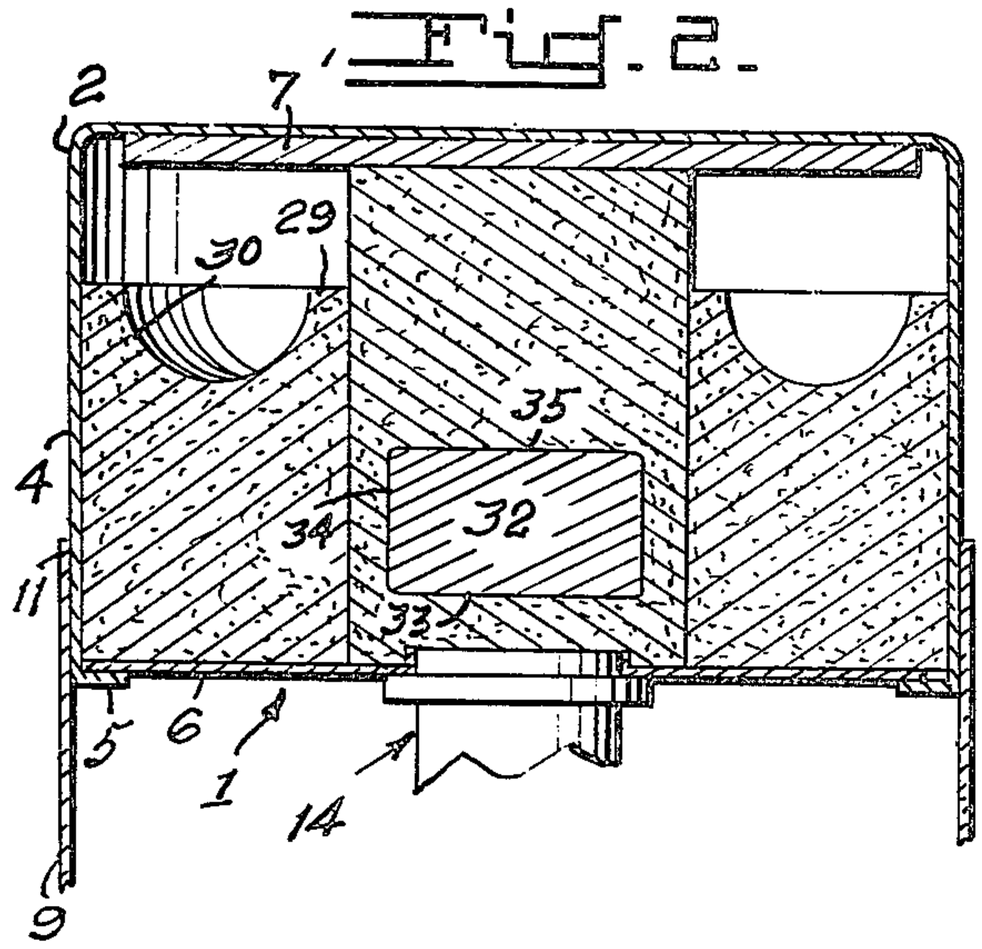
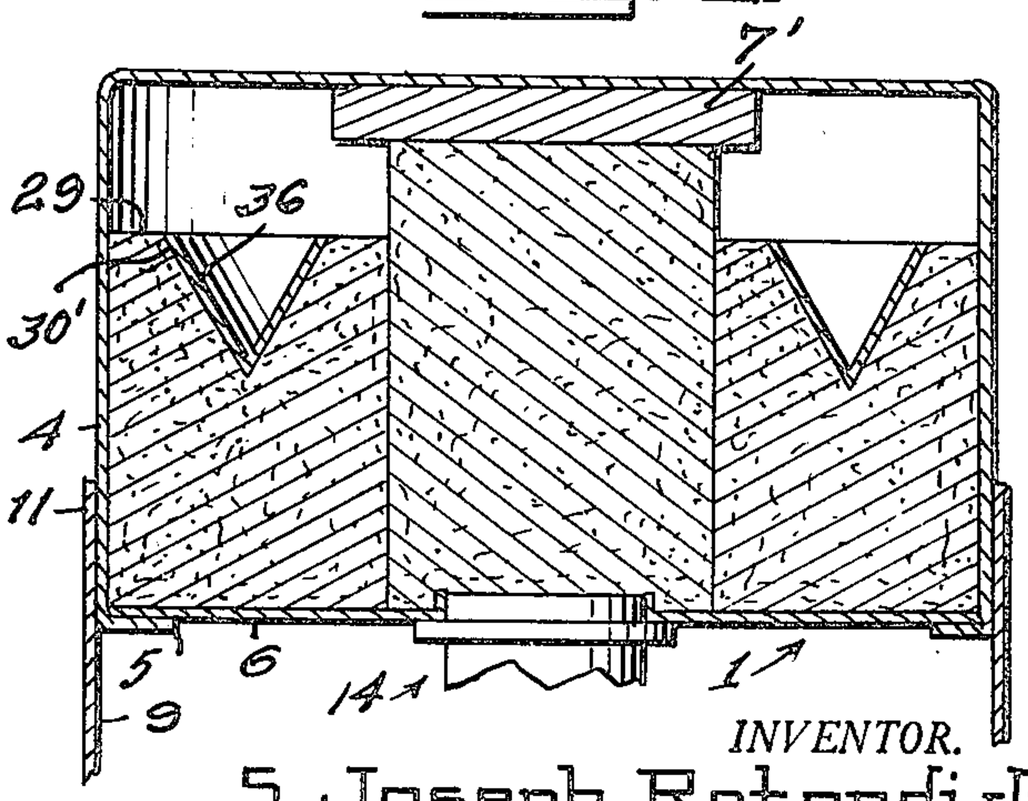
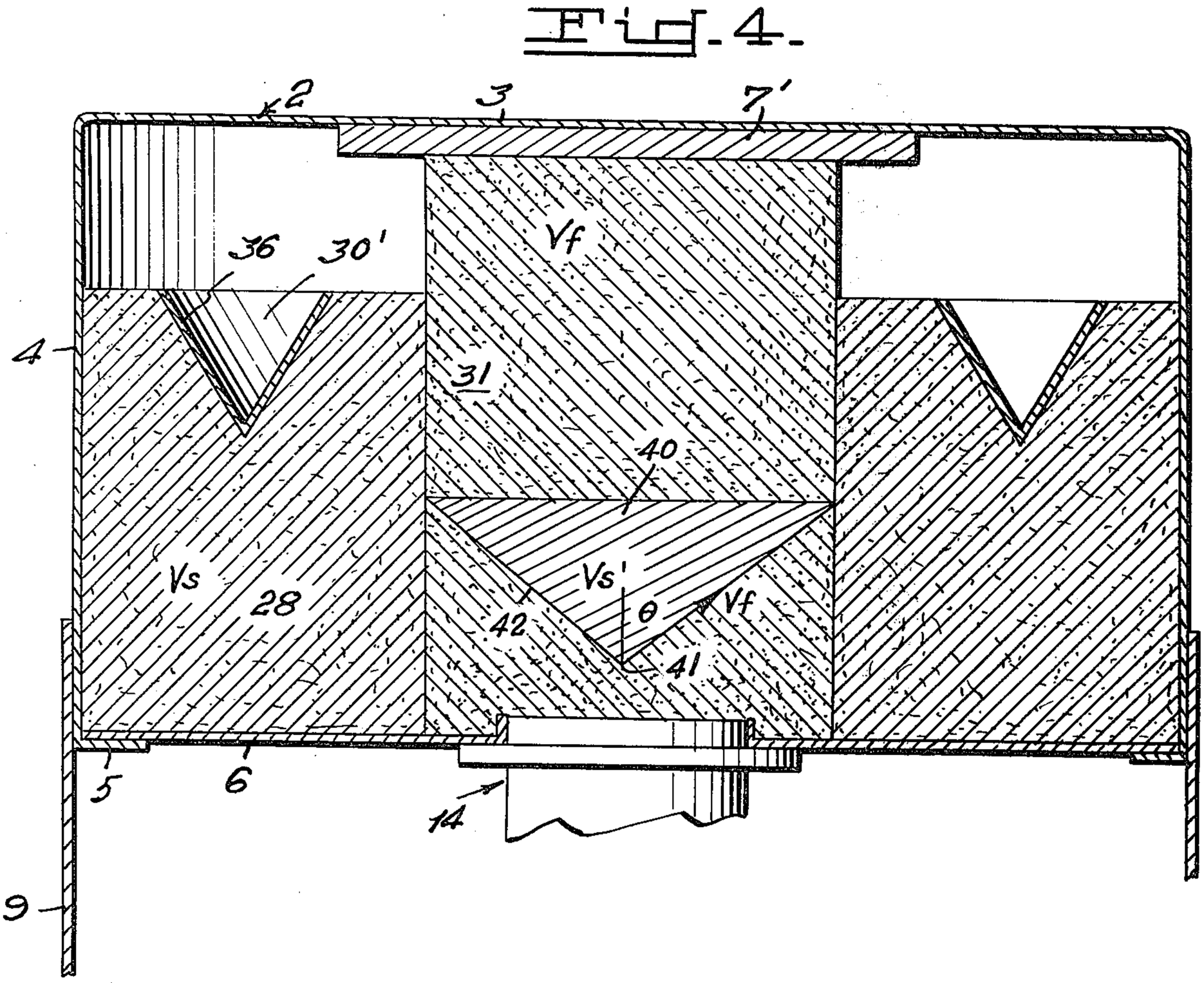


Fig. 3.



INVENTOR.
S. Joseph Rotondi, Jr.
BY
W.E. Thibodeau, A.W. Dew
and S.J. Rotondi, Jr.
ATTORNEYS

Fig. 4.



INVENTOR.
S. Joseph Rotondi, Jr.

BY
W.E. Thibodeau, A.W. Deer
and S.J. Rotondi, Jr.
ATTORNEYS

ANTI-TANK MINE

This invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to improvements in land mines.

More particularly the invention relates to improvements in land mines in which a relatively dense or heavy projectile plate or disc is propelled forwardly or upwardly in one piece and at a high velocity when the mine is exploded.

A mine of the type which forms the basis of this invention may or may not be concealed and camouflaged by being buried beneath the surface of the earth, and is generally actuated by the weight of a vehicle, as a tank setting off a fuze attached to the mine. The fuze in turn detonates a high velocity explosive which produces a shock wave or advancing detonation front. In a homogeneous explosive charge, the detonation rate within the charge is constant for all practical purposes and the detonation front is concave and assumes the shape of an expanding sphere with its center at the point of initiation. Since the center of the projectile plate is first subjected to the wave front, this portion of of the plate is propelled forwardly ahead of the outer sections, thereby causing fragmentation of the plate. However, experience has indicated that optimum penetration and demolition of a target is obtained when the plate remains intact.

Early experiments relating to the increased effect caused by the provision of a hollow cavity in the face of an explosive charge in contact with or on the side directed toward an objective are well known. These early experiments advanced the theory, many times since proved correct, that the hollow cavity gives the gases of the detonated explosive an impulse in the direction of the target, since the combustion products are forced at an extremely high velocity into the free space formed by the cavity. Additionally the penetration caused by the jet formed by a shaped or hollow cavity, provided with a metal liner is also well known. To this end it is proposed to augment the destructive effect of a land mine in which a solid projectile plate is propelled toward a target, with the blast effect of a shaped or hollow charge, lined or unlined, to increase the destruction and demolition of a selected target.

It is accordingly an object of this invention to provide a land mine in which a solid projectile plate is propelled in one piece toward a target.

It is also an object of this invention to provide for a novel arrangement of an explosive charge in a land mine to avoid fragmentation of the projectile plate when it is subjected to the shock wave of the exploded charge.

It is also a further object of this invention to provide a novel arrangement of an explosive charge in a land mine wherein the blast effect of a hollow charge is utilized to augment the effect of the detonating wave produced by the explosive charge to propel a facing wave with increased velocity and energy toward a target.

It is yet a further object of this invention to provide for a novel arrangement of an explosive charge and including a shaped charge, wherein a slight delay in initiation of the shaped charge insures that its blast effect arrives at the aforesaid projectile plate substantially simultaneously with the detonation front of a high velocity explosive whereby the plate is propelled with increased velocity and energy toward a target to provide for increased destruction and demolition of the target.

With these and other objects in view which will become apparent as the specification develops, reference is made to the accompanying drawing forming a part of this specification, wherein like numerals have been used to designate like or corresponding parts throughout the several views, and in which

FIG. 1 is a longitudinal section through a typical mine.

FIG. 2 is a modification according to FIG. 1 and including an inert mass within the high velocity explosive to alter the wave shape of the detonation front prior to engagement with the projectile plate.

FIG. 3 illustrates a second modification corresponding to FIG. 1, and

FIG. 4 illustrates yet another modification in which a binary explosive charge is utilized to alter the wave shape to propel a projectile plate, the effect of which is supplemented by a shaped charge.

Referring to the drawing, and to FIG. 1 in particular, 1 designates the land mine generally in its entirety, and which includes a relatively shallow cylindrical container 2 having a top wall 3 and a side wall 4 struck inwardly or flanged as at 5 to provide support for a bottom wall 6. A disc-shaped heavy metal plate 7, which may be of the same depth throughout, or alternatively may have a thickened central portion 7*a* as shown, and of a diameter slightly less than the diameter of container 2 is secured to the underside of top wall 3 in any convenient manner, as by spot welding.

A support or spider for the entire land mine is provided, and is arranged to accommodate a fuze or detonator for initiating the explosive charge at the central point of its lower surface. This support comprises a substantially heavy disc-like plate 8 of the same diameter as container 2, and axially spaced from lower wall 6. A sleeve 9 having a plurality of air escape louvers or cut out portions (not shown) has its lower end 10 secured, as by spot welding, to the peripheral edge of plate 8, and its upper end 11 overlapping side wall 4 for a substantial distance and secured thereto in any convenient manner.

Bottom wall 6 is provided with a central opening 12, symmetrical about the longitudinal axis of the land mine, and with the peripheral edge turned up to provide a flange 13. A hollowed out cylindrical fuze or detonator body 14 snugly engages flange 13 and is provided with a downwardly extending reduced portion 14*b* slidably received within an upwardly opening cup shaped member 15 supported on a centrally disposed raised portion 16 of plate 8. Reduced portion 14*b* extends to within a short distance of the bottom of cup 15, and is provided with an enlarged axial bore 17 in alinement with a recess 18 formed in the lower surface of insert 19, received in the enlarged portion 14a of detonator body 14 and occupying the lower half of the aforesaid enlarged portion. Insert 19 is also provided with an axial flash passage 20 communicating at its lower end with recess 18 and at its upper end with a space 21, formed by the upper remaining half of enlarged portion 14a, and adapted to receive a detonating substance 22 of relatively high sensitivity.

A primer or detonating substance 23 occupies recess 18, and is adapted to be initiated by an upwardly extending firing pin 24 having an enlarged portion 25 reciprocable within and slidably engaging the inner wall

of bore 17. A sheer pin 26 extends through portion 25 of the firing pin, through the wall of reduced portion 14b and is received in the upstanding wall of cup 15 to maintain the pin in safe position. A helical spring 27 compressed between the lower surface of firing pin portion 25 and raised portion 16 of plate 8 urges the firing pin 24 into positive engagement with igniter 23 when the shear pin is broken, in the well known manner. An annular ring 6a snugly received about detonator body 14, has its upper surface engaging the lower surface of bottom wall 6 to provide additional means to secure the detonator or fuze body 14 to the land mine.

The explosive charge for propelling the projectile plate 7 includes an annular or toroidal charge 28, comprising a low velocity (V4) explosive such as baratol, which is a mixture of granular TNT and barium nitrate. Alternatively granular TNT or nitroguanadine may be used. Though the named explosive is typical it is not intended to be exclusive. Charge 28 is arranged in container 2 to engage side wall 4 and bottom wall 6. However its upper surface 29 is spaced rearwardly of top wall 2 a predetermined distance and is provided centrally with an annular cavity 30 to form a shaped charge. Although the cavity 30 is shown as semicircular in cross section, any other well known shapes forming surfaces of revolution such as a parabola, elipse or isosceles triangles may be used. Since the blast effect from a charge as shown is less concentrated and is therefore distributed over a wider area than, for example, a charge having a triangular shaped cavity in cross section this shape is preferred. Additionally although the cavity is shown unlined, a liner may be added thereto in the well known manner. However in view of the penetration and cutting produced by the jet formed when the linear collapses, it is preferably omitted.

Charge 28 is provided with a core 31 of high velocity (V*f*) explosive, as for example a mixture of RDX and TNT, commonly referred to as Composition B. Alternatively Pentolite or TNT may be used. Core 31 is arranged within charge 28 so that its upright wall tightly engages the inner wall of toroidal charge 28, and with its upper and lower surfaces respectively engaging the under surface of plate 7 and bottom wall 6 of the container.

Operation of the land mine is as follows. Initiation first occurs on the longitudinal axis of the mine, centrally in the lower surface of high velocity explosive 31. A shock wave or detonation front is formed which is semi-spherical and concave with respect to the point of initiation. In view of the fact that the velocity of the blast effect produced by a shaped charge is greater than the rate of propagation of the shock wave produced in the high velocity explosive, the arrangement of the charges provides for a delay in the collapse of shaped cavity. Low velocity and high velocity explosives must be selected so that the blast effect arrives at the plate just as the plate has commenced to be propelled forwardly by the detonation front produced in the high velocity explosive. This delay is readily accomplished for known explosives since the "peak" of the shock wave proceeds rapidly through the high velocity explosives whereas the fringes or edges of the front are retarded or delayed as they progress through the low velocity explosive. The rate or propagation of shock waves in the respective components of the explosive charges, and the required "standoff" distance of the shaped charge are capable of ready determination, and may be selected to insure that the plate is propelled forwardly at increased velocity and maximum destructive effect. The "peak" portion of the shock wave strikes the center portion of the plate while the blast effect of the shaped charge strikes an annular outer portion of the plate. The tendency of the center portion of the plate to bulge or curve outwardly is thus inhibited to a large extent. Experience has shown that this "bulging" causes fragmentation. To further decrease the bulging effect the plate may be thickened centrally as at 7*a*.

In the modification illustrated in FIG. 2 the land mine 1 again comprises container 2, top wall 3 and side wall 4 flanged over at 5 to support a bottom wall 6. A projectile plate 7 is secured to the underside of top wall 3, and the container is provided with an explosive charge comprising low velocity explosive 28 with shaped cavity 30 in its top surface, and core 31 formed as a high velocity explosive. The explosives are arranged substantially as shown in FIG. 1 and detonator 14 to initiate the high velocity explosive is located centrally at its lower surface. The modification comprises an inert non-explosive wave absorbing mass or insert 32 having a bottom surface 33 spaced a short distance above container bottom 6, a side wall 34 spaced radially inwardly of container side wall 4, and a top wall 35 located a substantial distance below container top wall 3. Insert 32 may be any non-explosive substance compatible with the high velocity explosive, as for example bakelite, vermiculite, or an inorganic powder such as lead oxide.

Insert 32 is a wave shaping mass which alters the wave shape by peripherally initiating the high velocity explosive above it. Operation of the land mine is as follows. Assuming an organization without inset 32 in place, initiation of the high velocity explosive centrally at its lower surface produces a shock wave which is semispherical and concave with respect to the point of initiation. As the wave progresses through the high velocity explosive, contact is first made so that the lower surface of plate 7 becomes tangent to the wave envelope. The wave, in effect, continues to roll along the plate surface, and before the plate is released or propelled, its central area is forced outwardly and becomes convex (or concave with respect to the point of initiation). Since each particle, or molecule, in the plate tends to take a path normal to the resulting convex surface, the resulting divergence in the paths of the particles sets up shearing stresses to cause fragmentation and shattering of the plate.

With the insert 32 in place, initiation again produces a wave which is concave with respect to the point of initiation. However non-explosive insert 32 absorbs the "peak" or central portion of the shock wave, whereas the remainder of the wave travels radially outwardly through the high velocity explosve lying between the lower surface of insert 32 and the bottom of the container. Actually complete absorption is not achieved, instead the intensity of the shock wave through the inert material is degraded or delayed so that upon emerging from the opposite end of the insert the wave will not have sufficient intensity to cause the high explosive to detonate. Additionally the detonation rate of the high explosive may compare with the rate of shock propagation through the insert material in such a manner that the detonation will proceed around the inert material and reach the opposite surface before the

shock wave passing through the inert material actually reaches that surface. It is to be noted at this time, that only sufficient high explosive need be provided in the annulus to effect continuity of detonation. In effect therefore the wave "bends" about the lower horizontal and vertical edges of the insert, until peripheral or circumferential initiation of the high explosive occurs about a circle defined approximately by the upper peripheral edge of the insert. A detonation front occurs which in any cross section may be seen as two waves each having a locus or origin at diametral points on the circle of initiation, and converging at their lower ends, while diverging at the upper portion which contact the projectile plate. Actually the wave front produced is a toroidal wave front expanding from the point of initiation. The effect of this wave front is to subject the plate to a propulsive force that engages the plate at the periphery of the high velocity explosive, and progressively rolls along towards the geometrical center of the plate. The wave front is thus convex with respect to the original point of initiation below the insert, and the plate is propelled forwardly in intact condition.

While this is occurring, the fringes or edges of the original concave wave are delayed through the low velocity explosive, as explained above with respect to the mine of FIG. **1,** and the blast effect from the shape charge is made to contact the outer portion of the solid projectile plate almost simultaneously with and to augment the propulsive effect produced by the convex wave.

In the species illustrated in FIG. **3,** a land mine generally similar to the land mine of FIG. **1** is provided low velocity explosive **28,** high velocity explosive core **31** and with a projectile plate **7'** of smaller diameter than plate **7** and only slightly greater in diameter than high velocity explosive core **31.** Instead of a cavity which is semi-circular in cross section, the low velocity explosive **28** is provided in its upper surface with a shaped cavity **30'** which is an isosceles triangle in cross section, and which is provided with a metallic liner **36** in the well known manner. In the operation of this species, the collapse of the shaped cavity produces a penetrating or cutting jet which travels unimpeded toward the target and is effective to cut a hole in the target when supplemented by the destructive action of plate **7'** as it is propelled by the high velocity explosive shock wave. Alternatively, if desired, the core **31** may also be provided with a wave shaping non-explosive inert mass **32** similarly as in FIG. **2.**

FIG. **4** illustrates a land mine corresponding generally to FIG. **3** with the addition of a low velocity explosive insert within the high velocity explosive to alter the shape of the wave from a concave to a flat wave. In general the land mine comprises container **2** having top wall **3,** and side wall **4** flanged over at **5** to support bottom **6.** A projectile plate **7'** similar to that shown in FIG. **3** is secured to the underside of top wall **3.** The explosive charge comprises low velocity (V_s) explosive annulus **28** and high velocity (V_f) explosive core **31,** with a shaped cavity **30'** formed in surface **29** of charge **28.** The shaped cavity **30'** is provided with a metal liner **36** and a fuse **14** is located centrally in the bottom surface of core **31.** A low velocity (V_s') explosive insert **40** is embedded within core **31,** and is formed as a conical member having a base **41** parallel to and located a substantial distance below top wall **3,** and a rearwardly tapering side wall **42** ending in an apex at the longitudinal axis of the land mine and a short distance above detonator **14.** If as indicated above, the low velocity explosive insert is designated V_s', and the high velocity explosive core is given the designation V_f, then θ, which is one half the apex angle should be given a value such that $\cos\theta = V_s'/V_f$. For this value of the apex angle and for a relative small distance between the point of initiation and the apex of insert **40,** which may be termed "offset", the result is substantially a plane wave just above base **41** of the low velocity insert this wave engages plate **7'** substantially as a plane wave to propel the plate in one piece toward the target. A low velocity explosive is selected for annulus **28** such that the jet produced by the liner **36** upon the collapse of shaped charge **30'** arrives at the target substantially at the same time as plate **7'** to supplement the destructive action of the projectile plate.

Although the mine has been shown as cylindrical, the illustration is intended to be merely exemplary. It is also within the purview of this invention to make the mine square, triangular or any other suitable regular polygonal configuration. In like manner the shape of the insert may be altered to conform to the configuration of the mine. The container may be of any suitable metal, and the projectile plate a dense or heavy steel or iron plate. Additionally it is contemplated that the mine may be non-metallic to avoid detection, and the projectile plate a non-metallic substance of suitable density. Other modifications and alterations of the structure disclosed herein will be apparent to one skilled in the art, and it is obvious that the same may be made without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. In a demolition unit, a closed container, an explosive charge in said container, and a solid projectile plate of substantial thickness secured to the top wall of said container, said explosive charge comprising a center core portion in contact with said projectile plate for forming a shock wave when detonated to propel said projectile plate toward said target, and an annular portion concentric about said core and forming and annular shaped charge axially spaced rearwardly of said projectile plate and collapsible upon detonation to augment to the explosive effect of said center core portion.

2. In a demolition unit, a closed container having an explosive charge received therein, a solid projectile plate of substantial thickness and density secured to and substantially coextensive with the top wall of said container, said explosive charge comprising a first portion in contact with said plate for forming a shock wave when initiated for engaging the central portion of said plate, and a second portion comprising a shaped cavity for circumferentially and simultaneously engaging said plate radially outwardly of said central portion, and means located in the lower surface of said first portion for initiating said explosive charge.

3. The demolition unit of claim **2** wherein said first portion comprises a high velocity explosive, and said second portion comprises a low velocity explosive.

4. The demolition unit of claim **3,** including a wave shaping insert completely embedded within said high velocity explosive.

5. In an anti-tank mine, a closed container, an explosive charge received in said container, a solid projectile plate secured to the top wall of said container, and means for detonating said explosive charge centrally in

its lower surface, said explosive charge comprising an annular portion formed of a low velocity explosive and engaging the side and bottom walls of said container and axially spaced rearwardly of the top wall of said container, said annular portion having a center core formed of a high velocity explosive engaging said projectile plate at its upper end and the bottom of said container at its lower end, there being an annular cavity formed in the upper surface of said annular portion.

6. A demolition unit comprising a container having a flat top, flat bottom and side walls of uniform height extending upwardly from the periphery of said bottom to define a chamber having a vertical central axis of symmetry, a solid projectile plate of substantial density secured to the underside of said flat top, an explosive charge within said chamber comprising an annular low velocity explosive portion engaging said side and bottom walls and having a top surface spaced rearwardly of said projectile plate, a high velocity explosive center core portion for said annular portion and having its upper surface in contact with said projectile plate and its lower surface abutting said bottom, means forming an annular shaped charge in the top surface of said annular portion, and means operable to detonate said explosive charge at a point on said axis of symmetry.

7. The combination in claim **6** wherein said projectile plate is of uniform thickness and substantially coextensive with said container top, an insert of inert material completely embedded within said core portion, said insert having a vertical axis of symmetry coincident with the axis of symmetry of said container, a flat bottom spaced a short distance above and parallel with said container bottom, a flat top spaced a substantial distance below and parallel with said container top, and a side wall spaced slightly inwardly of the inner peripheral wall of said annular portion.

8. The combination of claim **6** wherein said projectile plate has an outer diameter slightly greater than the diameter of said core portion, and a metallic liner for said shaped charge.

9. The combination in claim **8** including an insert of low velocity explosive embedded within said core portion; said insert having an axis of symmetry coincident with the axis of symmetry of said container, a base in substantially coextensive spaced parallel relation with the top of said core portion, and a rearwardly tapering wall portion varying proportionately with the radial distance from said axis.

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