Oct. 14, 1969 F. E. NULL 3,472,165

WARHEAD

Filed March 28, 1963 2 Sheets-Sheet 1

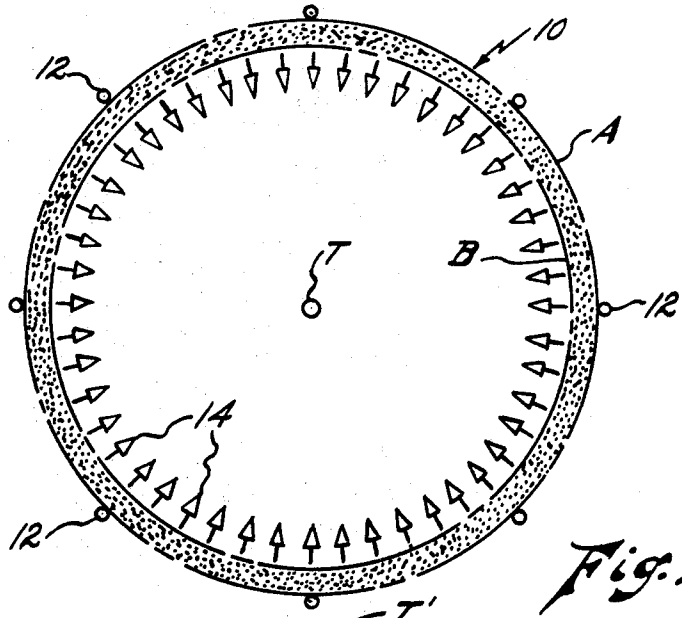


Fig. 1

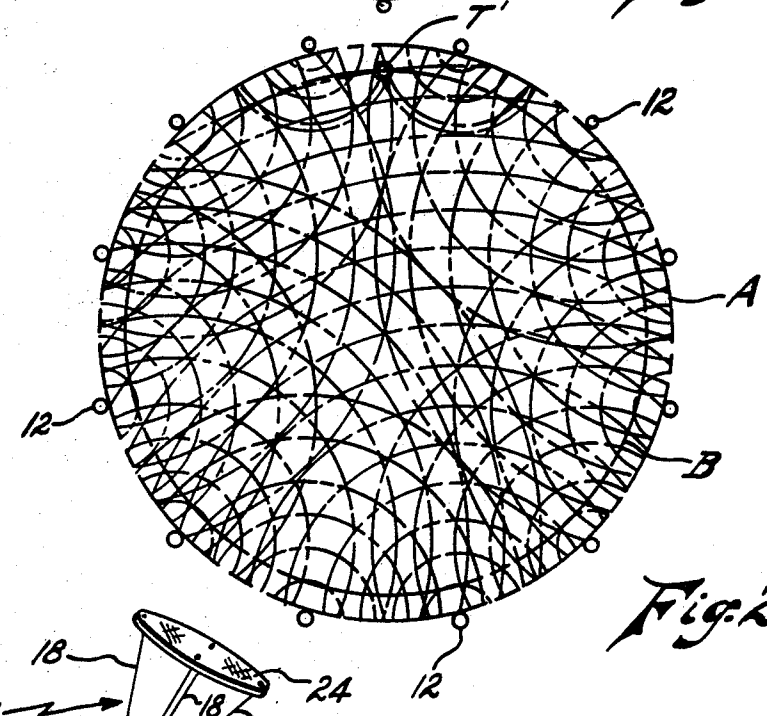


Fig. 2

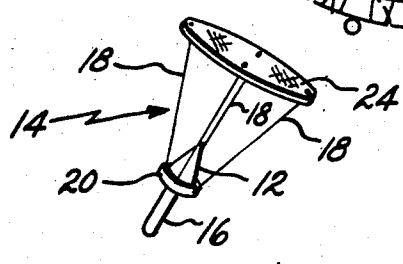


Fig. 3

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WARHEAD

Filed March 28, 1963 2 Sheets-Sheet 2

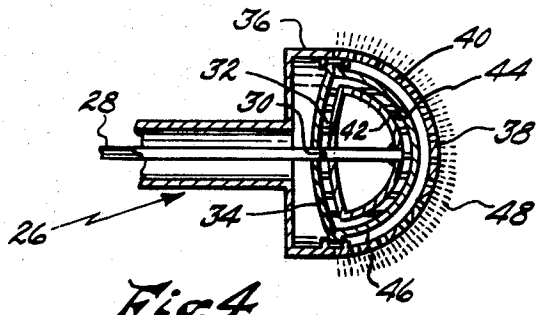


Fig. 4

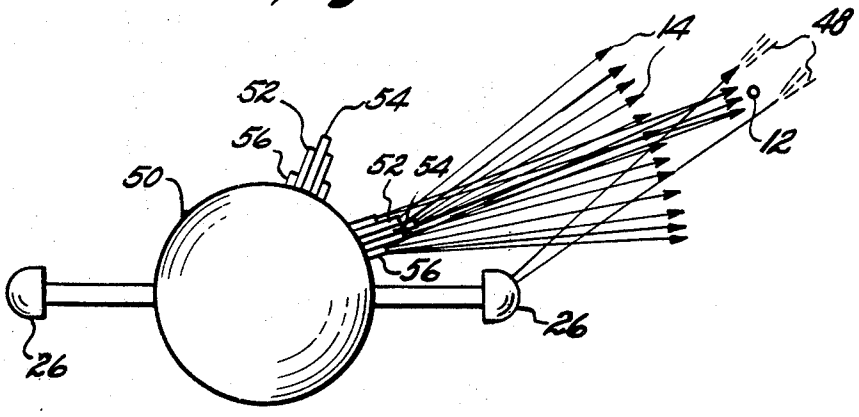


Fig. 5

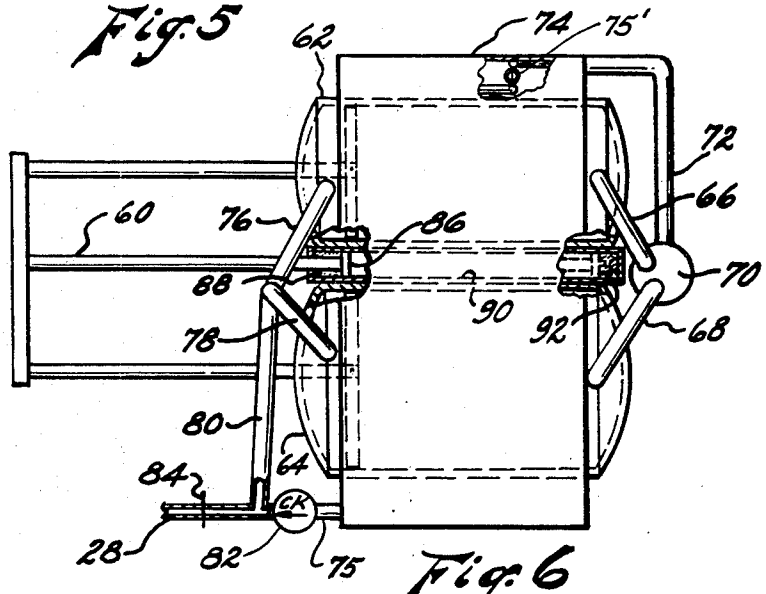


Fig. 6

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3,472,165

WARHEAD

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Int. Cl. F42b 25/00, 3/00
U.S. Cl. 102—1 17 Claims

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

This invention relates generally to warheads and, more particularly, to an imploded cloud warhead.

Conventional warheads utilize an outward explosion in order to cause fragments to hit a target after detonation of the explosive. These types are inherently inefficient compared with the instant invention since the outwardly directed explosion causes a decrease in the detonation wave velocity as the radius increases, and the average pressure within a sphere, including the warhead and target, decreases approximately as the cube of the radius. Thus, the fragment pattern density, and radiation are caused to fall off approximately as the radius squared.

The present invention has an opposite effect produced on a target which is located at the center of an imploding warhead. With this situation, the detonation wave velocity increases as the radius decreases, and the average pressure increases approximately as $1/r^3$, while the density of fragments and radiation increase as $1/r^2$ with the decreasing radius.

The invention comprises a warhead having an outwardly moving cloud or generally spherical shell of explosive particles with light, outwardly moving detonators which maintain a peripheral position around the cloud or shell. The detonators are fused and may be timed to be fired in their optimum relative phases which would produce an implosion with a high velocity shock wave which impacts the target near the center or at the edge of the cloud. In addition, darts or rods with attached parachute structures may be positioned in a layer inside the shell of explosive particles such that the high velocity shock wave and the detonation products behind the shock wave propel the darts or rods to produce a high velocity layer of projectiles capable of penetrating a target.

The foregoing arrangement has particular utility in dudding nuclear bombs and satellites, since a cloud of explosive several hundred feet in diameter is possible with the apparatus of this invention.

Accordingly, it is an object of this invention to provide a novel method and apparatus for dudding nuclear weapons, missiles and satellite vehicles.

It is another object of this invention to produce a novel warhead and means for forming it to produce a greater destructive effect upon a target than has been heretofore achieved.

It is still another object of this invention to produce a novel method and apparatus for creating an outwardly moving cloud or spherical shell of explosive particles.

It is a further object of this invention to produce a novel warhead structure comprising a cloud of explosive particles with outwardly moving detonators maintaining a peripheral position therearound and projectile means capable of being directed inwardly against a target.

It is a still further object of this invention to provide a novel imploding warhead which has its detonation shock wave enhanced by a convergent wave front.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiments in the accompanying drawings, wherein:

FIGURE 1 is a schematic representation of a cloud type warhead for illustrating the theory and technique of this invention;

FIGURE 2 is a graphic representation of the effect of an imploded cloud warhead upon a target at the edge of the cloud with proper triggering of the warhead;

FIGURE 3 is a pictorial view of a dart and parachute structure which may be utilized with the warhead of this invention;

FIGURE 4 is a cross-sectional view of the emitting end of the means for creating the cloud of explosive material;

FIGURE 5 is a schematic representation of a unit capable of setting out the cloud, detonators and projectiles for the warhead; and

FIGURE 6 is a view in elevation of the premixing and feed device for the preparation of the explosive medium.

Referring to FIGURE 1, there is illustrated a spherical shell **10** of explosive particles having limits between phantom lines A and B. Detonators **12**, shown arbitrarily at 45° intervals, are peripherally located and arranged to be fired simultaneously. The resultant shock wave from the firing of the explosive particles by the detonators travels across the gap to impact the target T from all directions, simultaneously. The pressure of this type of implosion is great enough to collapse any light target structure such as the pressurized cabin of a satellite. If required, an arrangement of darts **14** may be located within the explosive shell **10**. The dart assemblies **14** have parachute-like structures such that the passage of the detonation wave from the explosive particles and the resultant high velocity of the combustion products behind shock wave fronts are caused to impact on the fiber parachutes to cause the dart assemblies **14** to converge behind the converging shock wave until the gaseous products of the implosion are impacted at the center, thereby stopping parachutes and allowing the dart elements to penetrate the target T.

When a target is not centrally located as shown in FIGURE 1, an efficient target destructive force may still be realized by utilizing the implosion principles illustrated in FIGURE 2. This device utilizes the same structural relationship with the explosive detonators **12** and, if desired, the darts arrangement **14** except that a 30° interval is chosen for the detonators; however, the symmetry of the arrangement of FIGURE 1 is destroyed by the off-center position of the targe T^1. In an application of this type the detonator firing times are arranged such that the time between each individual detonator firing and the impact of its initiated wave on the targe T^1 is proportional to the distance the detonation wave has to travel from the detonator firing point to the target. The arrangement of the firing times insures the arrival of the detonation waves shown and darts **14** from all directions on the target at the same time. This application may have almost as large a destructive effect upon the target as that shown in FIGURE 1, especially where the velocity of the target relative to the cloud is very great.

The dart arrangement **14** is shown in FIGURE 3 and the individual darts are comprised of rods or conventional dart shaped metallic objects **16** having a series of shroud lines **18** attached to a collar **20** which surrounds the projectile. The projectile may have a shoulder **22** thereon to allow removal of the collar in only one direction. The shroud lines **18** are attached to a canopy or parachute-like structure **24** which may be of quartz fiber in order to resist the effects of the combustion products. The canopy **24**, after the detonation wave has passed over the darts, is carried along behind the shock wave by the high velocity combustion products until it reaches the target T or T^1, at which time the gases impact and stop the assembly, thereby allowing the projectiles **16** to continue

through the canopies 24 and release themselves, if necessary, from the collar 20.

The explosive shell or cloud is manufactured or created by means of a siren type ejector 26 as shown in FIGURE 4. The device creates tiny droplets of explosive liquid and is actuated by high pressure from a propellant gas. Once a droplet is launched from the ejector it starts to evaporate at a very fast rate. The evaporation, however, first requires a freezing of the liquid which reduces its temperature. The latent heat of the evaporation is greater than the heat of fusion and the specific heat until the temperature is reduced to about 32° K., at which point the vapor pressure of the drop is balanced by that of the vacuum environment as would be found near space vehicles. Liquid for making the explosive pellets forming the shell 10 is fed through an inlet pipe 28, and holes 30 in this pipe allow the liquid to enter the rotor reservoir indicated by the numeral 32. The rotor 34 is secured to the inlet pipe 28 which forms a hollow shaft for rotation of the unit. The stator 36 has in the hemispherical portion 38 a large number of spaced apart holes schematically illustrated at 40. Both the rotor 34 and stator 36 have a ground fit therebetween and would conveniently be made of glass. The holes 40 may be placed in the hemispherical portion 38 by means of a photographic reduction and etching process since their diameters and relationships are not critical. Rotation of the rotor 34 causes the flow of the liquid, which forms the explosive particles, around the central hollow element 42 of the rotor 34 against surface 44 of the rotor which has longitudinally oriented slots 46 connected with holes through surface 38 to receive fluid from the rotor reservoir 32. The longitudinal slots 46 revolve under the stator holes 40 thereby causing an emission of small droplets 48 from the stator 36.

The cloud material, after it is frozen, can be detonated by shock similar to shock action on a gas, since molecular impacts have equal velocity, and all molecules on the solid surface are impacted by the shock layer. Assuming there is no detonation of the pellets formed by the droplets 48, the relatively large ratio of area to mass allows the pellets to pickup the velocity of the shock flow. This causes complete evaporation of the pellets a very short distance behind the shock wave front, at which point their combustion would add energy to the shock front in the same manner as if the pellets were detonated.

Thus, it can be seen that once a detonator produces its wave it will be propagated inwardly even in a rare explosive medium because the shock wave is enhanced by a convergent form. Although the individual particles produce wavelets similar to those in an explosion, the detonation wave from the pellets spread spherically; however, the imploded wave front forms from the combination of the wavelets from a spherical shell of detonation points and is greatly increased in strength.

When the droplets 48 are sprayed from the dispenser 26 to form the cloud, either a small propellant charge or a source of pressurized gas is utilized to project a layer of dart assemblies 14 from a series of tube launchers. The arrangement shown in FIGURE 5 schematically discloses the assembly which creates the cloud and positions the darts and the detonators. The device comprises a sphere 50 within which a source of pressurized gas and propellant is stored and, in addition, contains the mechanism operated by the pressurized gas to cause rotation of the rotor 34 and its shaft 28. A series, only a few of which are shown, of dart projectors 52 are clustered around a conventional rifled detonator gun 54, the locations of which are in conformance with the final placement of the darts and detonators. The spherical housing 50 is projected or launched to the target site, and, when it reaches the appropriate location, conventional triggering means, such as a computer operated radio control, may be utilized to cause the pressurized gas source to release its pressure to drive a mechanism, for example, a turbine wheel, to cause rotation of the siren type ejectors 26 and at the same time force liquid to be pelletized through the shaft 28. This action causes the creation of the cloud and propellant particles. When the propellant cloud is formed, or while it is formed, the detonator guns 54 and dart projectors 52 are caused by gas pressure or explosive means to project their respective payloads outwardly such that, at the appropriate time, the detonators are located at the outer periphery A of the formed shell 10 of pellets. The dart assemblies 14 will have assumed a position within the warhead 10 adjacent the limit B.

Although the foregoing arrangement has been described relative to radio control which may be operated by a conventional computer, the unit itself could provide the signal for exploding the detonators, for example, by means of light sources at 56 which could be made to actuate detectors in the detonators to trigger the explosive therein.

The description thus far has utilized droplets of explosive liquid for creating the cloud; however, it should be understood that the cloud may comprise dust particles blown by nozzles with compressed air rather than utilizing the ejector shown in FIGURES 4 and 5. Layers of adsorbed air surrounding the dust would prevent detonation during its flow through the nozzle. Alternatively, an explosive which is made insensitive by a coating of, for example, alcohol, might be utilized such that the ejected particles would have their coating evaporated very quickly in a vacuum environment. The particles then would become very sensitive to shock and could be readily detonated.

Storage of liquids, which upon mixing become the explosive mixture, may involve some hazards if stored in the mixed state. Therefore, the embodiment of FIGURE 6 provides for the feeding of the oxygen and methane liquids which form the pellets. This apparatus would be mounted within the sphere illustrated in FIGURE 5. The mixing apparatus comprises a drive piston rod 60 which might be actuated by compressing gas within the sphere at a predetermined time on the recept of a signal. Movement of the drive piston rod 60 forces pistons within the methane cylinder 62 and the oxygen cylinder 64 to move to the right as illustrated in the drawings. Both the oxygen and methane are forced through separate tubes 66 and 68 from their respective cylinders into a mixing chamber 70 wherein the two fluids are joined. The mixing chamber is attached to direct the premixed fluid by means of conduit 72 to an ultrasonic mixing chamber 74. The ultrasonic mixing chamber comprises a convoluted passageway having wedges 75 therein which are actuated by a 30 kc. signal to cause resonance of the wedge, thereby producing a complete mixing of the two liquids. The output from the ultrasonic chamber 74 is directed back through feed line 75, check valve 82 and conduits 80, 76 and 78 into the cylinders 62 and 64, which originally contained the methane and oxygen in separated conditions.

The piston rod 60 may be attached to a piston 86 in a cylinder 90, at the end of which an explosive charge 88 may be fired to cause the aforesaid movement of piston rod 60. Upon a signal to eject the particles, the drive piston rod 60 is reversed in direction by actuating in a conventional manner the explosive charge 92 at the opposite end of the cylinder 90 from explosive charge 88. Motion of the piston rod 60 and its connected pistons in cylinders 62 and 64 causes the premixed fluid to be directed through conduits 76, 78 and 80, through check valve 82 and a diaphragm 84 to the ejectors. The diaphragm 84 is arranged to be ruptured only upon movement of the piston rod 60 in its reverse direction. The diaphragm 84 functions to divert the fluid when it is being transferred from the ultrasonic mixer 74 to the cylinders 62 and 64.

The imploding cloud concept of this invention would permit 150 lbs. of explosive pellets and 65 lbs. of darts to be dispersed to form a hollow shell to produce a great concentration of fire power and pressure. It is contemplated that at the start of the implosion $1.08(10)^{-3}$ lbs. per cubic foot of $1.0(10)^{-3}$ inch diameter pellets of

solid oxygen and methane would produce a detonation velocity of 9,200 feet per second. Approximately 5,680 darts would acquire this velocity in two feet of depth of the imploding gas, thereby presenting a capability for dudding nuclear weapons. Each dart would be approximately 1.0 inch long with a diameter of 1.66 inches and a weight of $6.18(10)^{-3}$ lbs. Thus, a large number of darts may be fanned out from the individual dart guns **52**. The pellets, detonators and the darts are projected at a velocity of 500 feet per second. Thus, with proper timing, the elements will assume the position shown in FIGURE 1 or 2. The droplets which are projected at the aforementioned velocity would be aproximately .001 inch in diameter with a linear spacing of the same amount. This may be achieved by the holes in the stator having the same diameter and spacing. It is contemplated that approximately $4(10)^{8}$ holes placed in the stator will produce the proper structural arrangement for creation of the cloud. Each siren ejector, which ejects the droplets, is arranged to spray 1,830 cubic inches of liquid in .01 second at 1,900 lbs. per square inch in order to give the droplets sufficient kinetic energy. Sixteen (16) lbs. per square inch pressure is required to overcome the resistance of the holes. With a centrifugal pressure of about 4,840 lbs. per inch, 1,960 lbs. per square inch pressure is needed in the rotor reservoir. When one utilizes a $1(10)^{-3}$ inch diameter drop of liquid oxygen and methane at the ambient pressure of a satellite environment of $2.53(10)^{-10}$ mm. Hg, the droplet would evaporate very fast initially, since the mean latent heat of vaporation (81.2 calories per gram) is large compared to the means specific heat (.383 calorie per gram per degree centigrade) and the mean heat of fusion (5.2 calories per gram). With these conditions the drop quickly freezes and continues to evaporate until the vapor pressure falls to the ambient pressure. Approximately 61 percent of the original drop mass is left at the equilibrium pressure. Assuming a failure of detonation of some of the droplets, the velocity of the shock front would cause the droplet to pick up the velocity of the shock front in view of the relatively large ratio of area to mass of the droplet. This velocity would be achieved in .012 inch; therefore, the pellets would evaporate a short distance back of the shock front where combustion would add energy to the shock front in the same manner and effect as if it were detonated by the detonator.

From the foregoing, it can be seen that a novel warhead and method and apparatus for making the same has been presented which utilizes the principle of implosion whereby greater force upon a target is exerted than occurs with the explosion phenomenon.

Although the invention has been described relative to particular embodiments, it should be understood that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims. For example, the mode of control of the explosion of the detonators could be a simple timing mechanism rather than the utilization of light operated detectors or computer controlled radio signals.

What I claim is:

1. An imploding cloud warhead comprising an airborne unconfined shell of explosive particles, and a series of detonators peripherally located about the outer extremity of said shell of explosive particles, said detonators being fuzed to fire in the optimum relative phases to produce an implosion of said explosive particles to cause a high velocity shock wave to impact a target within the outer periphery of said shell.

2. The combination of claim **1** including a series of darts located at the inner periphery of said shell of explosive particles, said darts having a parachute structure releasably secured to each dart such that the detonation products behind said shock wave react with said parachutes to impart a high velocity to said darts in the direction of travel of said shock wave.

3. In combination, a cloud of outwardly moving explosive particles, and a series of outwardly moving detonators which maintain a peripheral position around said cloud, said detonators being arranged to be fired at relative phases to produce an implosion of said explosive particles to cause a high velocity shock wave to impact a target within said cloud.

4. The combination defined in claim **3** including a series of darts, a parachute structure secured to each of said darts, said darts with said parachute structures being outwardly moving and occupying a peripheral position within said cloud such that the detonation products behind said shock wave imparts a high velocity to said darts in the direction of travel of said shock wave toward a target.

5. The combination as defined in claim **4** including ejector means to form said outwardly moving cloud of explosive particles, said ejector means comprising an outer stator, a series of small openings through said stator, a rotor mounted to revolve within said stator and having its outer surface in contact with the inner surface of said stator, said outer surface of said rotor having slots therein for containing explosive material under pressure to be ejected, a reservoir connected with said slots such that explosive material under high pressure passes from said reservoir into said slots and when a slot passes over a set of stator openings said explosive material is ejected from said openings to form said cloud.

6. The combination as defined in claim **5** including means for mixing two liquids to form the material to be fed to said rotor, said mixer comprising a pair of cylinders each containing one of said liquids, a piston for each of said cylinders, a pressurized gas source for driving said pistons from one end of said cylinders to the other, outlet means in the other ends of said cylinders, conduit means connected to said outlets for premixing said fluids driven from said cylinders upon movement of said pistons by said pressurized gas source, ultrasonic mixing means connected with said premixing chamber, conduit means connected with said ultrasonic mixing means and the first-mentioned ends of said cylinders to return fluid thereto, and means for driving said pistons toward said first-mentioned ends of said cylinders, said conduit means serving as an outlet and connected with said reservoir.

7. The combination as defined in claim **6** including a check valve connected in said conduit means to inhibit passage of said mixed fluids into said ultrasonic mixing means when said pistons are driven toward said first-mentioned ends of said cylinders.

8. An imploding cloud warhead comprising an air-borne unconfined shell of explosive particles, and a series of detonators peripherally located about the outer extremity of said shell of explosive particles, said detonators being fuzed to fire in the optimum relative phases to produce an implosion of said explosive particles to cause a high velocity shock wave to impact a target in the center of said shell.

9. The combination of claim **8** including a series of darts located at the inner periphery of said shell of explosive particles, said darts having a parachute structure releasably secured to each dart such that the detonation products behind said shock wave react with said parachutes to impart a high velocity to said darts towards the center of said shell.

10. In combination, a cloud of outwardly moving explosive particles, and a series of outwardly moving detonators which maintain a peripheral position around said cloud, said detonators being arranged to be fired at relative phases to produce an implosion of said explosive particles to cause a high velocity shock wave to impact a target at the edge of said cloud.

11. The combination as defined in claim **10** including a series of darts, a parachute structure secured to each of said darts, said darts with said parachute structures

being outwardly moving and occupying a peripheral position within said cloud such that the detonation products behind said shock wave imparts a high velocity to said darts in the direction of travel of said shock wave toward a target.

12. The combination as defined in claim **11** including ejector means to form said outwardly moving cloud of explosive particles, said ejector means comprising an outer stator, a series of small openings through said stator, a rotor mounted to revolve within said stator and having its outer surface in contact with the inner surface of said stator, said outer surface of said rotor having slots therein for containing explosive material under pressure to be ejected, a reservoir connected with said slots such that explosive material under high pressure passes from said reservoir into said slots and when a slot passes over a set of stator openings said explosive material is ejected from said openings to form said cloud.

13. The combination as defined in claim **12** including means for mixing two liquids to form the material to be fed to said rotor, said mixer comprising a pair of cylinders each containing one of said liquids, a piston for each of said cylinders, a pressurized gas source for driving said pistons from one end of said cylinders to the other, outlet means at both ends of said cylinders, conduit means connected to the outlets at said other ends of said cylinders for premixing said fluids driven from said cylinder upon movement of said pistons by said pressurized gas source, ultrasonic mixing means connected with said premixing chamber, conduit means connected with said ultrasonic mixer and said outlets at said one ends of said cylinders to return fluid thereto, and means for driving said pistons toward said one ends of said cylinders, said outlets at said one ends of said cylinders being connected with said reservoir.

14. The combination as defined in claim **13** wherein said ultrasonic mixing means includes resonant wedges vibrated at a high frequency to achieve mixing.

15. A means for forming an imploding cloud warhead comprising a housing, ejector means on said housing for ejecting small particles of explosives in a direction outwardly from said ejectors, means in said housing for rotating said ejectors such that said outwardly moving

particles form a generally spherical cloud, means mounted on said housing for firing detonators toward the outer periphery of said cloud of explosive material to assume a peripheral position at the outer limits of said cloud, means for projecting dart and parachute assemblies toward the outer periphery of said cloud to assume positions within the outer limits of said cloud, and means for firing said detonators at their optimum phases to produce an implosion of said explosive particles to cause a high velocity shock wave to travel toward a target within the outer periphery of said shell, said shock wave reacting with said parachutes of said assemblies to cause said darts to travel toward said target.

16. A method for creating an imploding cloud warhead comprising the steps of radially emitting explosive particles to form a spherical cloud, positioning detonators around the outer periphery of said cloud and positioning parachute and dart assemblies within the outer periphery of said cloud.

17. The method as defined in claim **16** including the step of exploding said detonators at their optimum relative phases to produce an implosion of said explosive particles thereby causing a high velocity shock wave to travel toward a target within said shell while carrying said parachute and detonator assemblies toward said target.

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U.S. Cl. X.R.

102—2, 9, 22, 56