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Description

The present invention relates to a system for forming an explosive and more particularly to a system that is portable, self-contained and is capable of mixing essentially non-explosive ingredients from separate containers to form an explosive. The system is particularly adaptable for military or tactical applications.

Common uses for explosives in military or tactical applications are for demolition work, barrier creation, concrete breaching, concertina wire removal, etc. It often is necessary for infantry to carry explosives on their persons for such purposes. This creates a hazard for the person carrying the explosive as well as for those in the person's vicinity, because the explosive, which necessarily must be relatively sensitive to initiation in small quantity applications, may be susceptible to initiation by rifle bullet or other projectile or munition. A need therefore exists for a tactical explosive that can be carried by infantry in a non-explosive state and then rendered detonable at the desired time. This need is satisfied by the system and unit of the present invention which houses segregated non-explosive ingredients that can be readily mixed together at the intended time of usage to form a sensitive, detonable explosive.

In addition, a tactical explosive for infantry use must be capable of being transported in a backpack, must be able to be used with minimal preparation time and must be capable of use in varied weather and battle conditions. The system and unit of the present invention satisfy these requirements in that the unit can be sized to fit in a backpack; the self-contained unit readily can form an explosive within, for example, one minute; the mixing operation can be accomplished manually without any direct contact with the ingredients or the final explosive; the containers protect the ingredients from the environment; an inner container is housed within an outer container and thus the handling of separate containers is not required; the unit can be operated under water and the explosive composition itself can be designed to be flowable and waterproof thereby making it adaptable for a variety of applications.

Finally, a tactical explosive must be capable of producing sufficient energy and brisance to accomplish its intended purpose. Heretofore, a relatively powerful compound explosive has been used such as TNT (trinitrotoluene), Composition B, pressed RDX and C4. As explained more fully hereafter, the system of the present invention is capable of forming an explosive of equal or greater energy and brisance than such compound explosives but which is formed from non-detonable ingredients that can be transported safely.

FR-A-2119502 describes a portable self-contained unit for transporting and mixing ingredients to form an explosive comprising:

- (a) a first container for holding one or more ingredients,
- (b) a second container for holding one or more ingredients which when mixed with the ingredient(s) in the first container form an explosive, the second container being disposed within or contiguous to the first container, and
- (c) a means for rupturing the second container. Following rupturing of the second container the unit is held upside down or shaken to cause the ingredients to be mixed.

According to the present invention there is provided a unit of the type described in FR-A-2119502, but characterised in that a mixing element is provided for mixing together the ingredients in the first and second containers to form an explosive.

Preferably, one container holds an inorganic oxidizer salt solution and the other a fuel. When these ingredients are mixed together an explosive is formed from preferably non-explosive ingredients.

Referring to the FIGURE, there is shown one illustrative embodiment of a portable, self-contained explosives mixing unit 1 constructed in accordance with the present invention and including a first or outer container 2 for holding one or more ingredients of the explosive. This outer container preferably is rigid or semi-rigid and can be formed from any material compatible with the contained ingredients, such as plastic. Housed or disposed within or contiguous to the outer container 2 is an inner or second container 3 for holding one or more additional ingredients of the explosive which when mixed with the ingredient(s) in the outer container 2 will form an explosive. The inner container 3 has at its open end a flange 4 that abuts or sets upon a corresponding surface at the top of the outer container 1. The flange 4 is secured against the outer container 2 by means of a cap 5 that is threadably engaged with outer container 1 by threads 6. The flange 4 is sealed with respect to the cap 5 by means of an o-ring 7. (A similar o-ring seal could be placed between the flange and the adjacent surface of the outer container or the flange could be glued to such surface.) In this fashion, the ingredients within the inner container are segregated from the ingredients in the outer container.

The inner container 3 is composed of a material that is rupturable or frangible to allow mixing of the ingredients in the inner container with those in the outer container at the desired time. Such frangible materials include polystyrene or other plastics. The cap 5 also could function as an inner container if, for example, inner container 3 were an integral part of cap 5 or if cap 5 otherwise were modified to hold

ingredients that were separated from the ingredients in the outer container by means of a rupturable membrane. Thus the language "disposed within or contiguous to" includes configurations in which the inner or second container is adjacent to the outer or first container and separated therefrom by a rupturable membrane.

Slidably engaged with the cap 5 is a mixing element or plunger 8 in the form of a rod and piston assembly having a handle 9, a shaft 10, a baffle plate 11 at the end of the shaft opposite the handle and a base 12 disposed on the shaft 10 between the baffle plate 11 and the closed end 13 of the inner container 3. The shaft 10 extends through the axis of the inner container 3 and protrudes through its closed end 13.

Also shown is a port 14, through which ingredients may be loaded into the inner container 3 or through which a blasting cap may be inserted, and plug 15. A lid 16 is adapted to be removably engaged with the cap 5 to cover and prevent premature movement of the plunger 8.

Once the unit 1 is assembled as shown in the FIGURE with the separate explosive ingredients present in both the inner and outer containers, the unit can be operated to mix the ingredients together and produce an explosive as follows. The lid 16 first is removed and then the handle 9 of the plunger 8 manually is pulled or forced upward or away from the cap 5 and outer container 1. This causes the base 12 of the plunger to put a compressive force on the closed end 13 of the frangible inner container 3, and as the plunger 8 is continued to be pulled toward the top or opening of the outer container 1, the frangible inner container ruptures or breaks and the ingredients thereof are allowed to mix with those ingredients in the outer container. The closed end 13 of the inner container can have grooves or convolutions 17 as shown to ease or enhance the rupturing of the inner container. As the plunger then is forced to reciprocate within the confines of the outer container 1, the baffle plate 11 moves up and down (or back and forth) along the axis of the outer container 1, much like a piston within a cylinder, to mix uniformly the ingredients in the ruptured inner container with those in the outer container. The orifices 18 in the baffle plate 11 enhance this mixing action as the ingredients are forced to flow through the orifices. The ruptured or broken inner container 3 may break apart into several or more separate pieces which also enhance the mixing action, and it has been found that the presence of separate pieces of inner container 3 does not adversely affect the detonation results of the final mixed explosive.

The present invention can be further illustrated by reference to the examples given below.

In a unit similar in construction to that shown in the FIGURE, explosive compositions were formed under various conditions and were test detonated as follows:

Formulation (parts by weight of the final composition):			
Oxidizer Solution (outer container)		Fuel (inner container)	
Sodium perchlorate	40.5	Atomized aluminum	18.0
Water	31.0	Paint grade aluminum	2.0
Ethylene glycol	8.0		
Xanthan gum	.5		
	80.0		20.0

Testing Results:

Mix	1	2	3	4	5
Mixing Temp (°C)	25	25	25	25	-10
Mixing Strokes	20	150	50	50	50
Density (g/cc)	1.365	1.356	1.360	-	-
Detonation Temp (°C)	25	25	-10	25	-10
D-150 mm (km/sec) ¹				4.54	
-125				4.54	
-100				4.38	
-75	4.23	4.10	4.38	4.23	4.23
-63	-	-	-	3.97	-
-50	-	-	-	3.74	-
-38	-	-	-	3.34	-
-32	-	-	-	3.43	-
-25	-	-	-	3.26	-
-19	-	-	-	2.20	-
-12	-	-	-	Fail	-
MB-det/fail (cap#) ²	I2/I1	I3/I2	I3/I2	I1/-	I4/I3
1 Cloth Wrap*					
2 50 grain Cord Wraps	-	-	Det ³	-	-
1 Cloth Wrap*					
1 50 gr. Cord Wrap	-	-	Det	-	-
3 Cloth Wraps*					
1 50 gr. Cord Wrap	-	-	Det	-	-
Bullet Impact @ 25°C (22/.250) with Steel backing plate	-	-	Fail ⁴	-	-
*A plastic bottle (4.5 inches in diameter) was filled with the mixed explosive. A heavy canvas cloth was wrapped around bottle, and detonating cord was wrapped around the cloth. ¹ Detonation velocity in the given charge diameter at the given temperature. ² Minimum booster in a 75mm charge at the given temperature. The left number indicates that a detonation occurred with the designated cap and the right number indicates a failure. I1 is a blasting cap having 1 grain of loose PETN; I2, I3 and I4 have 2, 3 and 4 grains, respectively. ³ Charge detonated. ⁴ Charge failed to detonate.					

In the above example, the inner container was a rigid polystyrene plastic which was ruptured and broken into several pieces upon engagement of the mixing element (plunger comprising a handle, shaft and baffle plate). The outer container was polyethylene, the plunger assembly or mixing element was comprised of a polycarbonate shaft and base, and the baffle plate was a high density polyethylene. The cap element, similar in configuration to cap (5) shown in the FIGURE, was comprised of high density polyethylene, and the lid (16) was medium density polyethylene. The inner container contained 1000 grams of the atomized

and paint grade aluminum mixture and the outer container contained 3545 grams of the sodium perchlorate solution, which occupied about 2.36 liters of the 3.79 liter capacity of the outer container. The mixing strokes were done manually and each stroke occurred in less than 1 second. Thus all mixes except Mix 2 were formed in less than 1 minute. As indicated in the detonation results, all of the mixes were relatively sensitive to detonation even at a temperature of -10 °C.

The mixing was accomplished by an individual who held the outer container on the ground with one hand while he reciprocated the plunger assembly with the other hand. Following completion of the indicated number of strokes, the resulting mixed explosive was poured into the various charge diameters and plastic bottles for detonation testing.

As shown in the preceding example, explosive compositions for use with the system and in the unit preferably are formed from a binary system of oxidizer and fuel, with the oxidizer in one container and the fuel in the other. The oxidizer component preferably is a solution of inorganic oxidizer salt selected from the group consisting of ammonium, alkali and alkaline earth metal nitrates, chlorates and perchlorates or mixtures thereof. Perchlorates are particularly preferred because they increase density and enhance sensitivity in explosive compositions of this type.

The fuel component can be a liquid, a solid or combinations thereof. The fuel used in the above example was a mixture of aluminum particles, with the paint grade aluminum acting as both a fuel and a sensitizer. Other solid fuels include finely divided carbonaceous materials such as gilsonite, finely divided vegetable grains such as wheat and potato starch, and sulfur. Liquid fuels include water-immiscible organic liquids such as mineral oil, waxes, paraffin oils, benzene, toluene, xylenes and petroleum distillates. Water-miscible organic liquids that can be used as fuels include alcohols such as methyl alcohol, glycols such as ethylene glycol, amides such as formamide, and analogous nitrogen-containing liquids. As shown in the example, a portion of the fuel (ethylene glycol) was contained in the oxidizer solution component, because ethylene glycol is a solvent for the oxidizer and as a liquid was easier to handle in the solution rather than in the dry (aluminum) component.

Water preferably is present in sufficient quantity to keep the oxidizer salt in solution at intended temperatures of use to allow for a fluid mixing medium. The xanthan gum thickening agent in the oxidizer solution renders the solution more viscous which aids in suspending the aluminum particles uniformly throughout the composition following mixing. Various thickening agents are well-known in the art. A density reducing agent, such as hollow glass or plastic spheres, may be included in either the oxidizer or fuel component to increase sensitivity.

The theoretically available energy of the formulation of the example is 1384 kcal/kg, which compares favorably with that for TNT of 1235 kcal/kg.

Although in the above example the oxidizer solution was in the outer container, and the aluminum fuel was in the inner container, this arrangement could have been reversed; however, it was easier to mix the solids into the liquid.

A preferred size of the unit of the present invention is as follows: An outer container capable of holding 4545 grams of mixed explosive and comprising a cylindrical container approximately 15 centimeters in diameter and 20 centimeters in height. The inner container would be about one-fourth of this size (if holding the fuel component). The size of the unit and its various components, however, can be varied as desired.

The explosive should be fluid at the mixing temperature for ease of mixing and to allow ease of removal from the outer container into a separate receptacle, if desired. Further, a fluid explosive can be used advantageously in a variety of applications.

The positioning of the second container within or contiguous to the first container is not critical; however, if the second container is axially positioned within or contiguous to the first container, then uniformity of the final mixture is somewhat easier to obtain. The concept of housing an inner container within or contiguous to an outer container is advantageous in that it dispenses with the need to handle separate containers. This prevents the possibility of separation or misplacement of one of the containers, does not require the handling of separate containers (which is time consuming and difficult if not impossible to accomplish under water) and prevents potential errors in attempting to combine ingredients from separate containers.

Claims

1. A portable self-contained unit for transporting and mixing ingredients to form an explosive comprising:
 - (a) a first container (1) for holding one or more ingredients,
 - (b) a second container (3) for holding one or more ingredients which when mixed with the ingredient(s) in the first container form an explosive, the second container (3) being disposed within

or contiguous to the first container (1), and
 (c) a means (12) for rupturing the second container;
 characterised in that a mixing element (11) is provided for mixing together the ingredients in the first and second containers to form an explosive.

- 5 2. A unit according to claim 1, wherein the mixing element (11) forms part of a manually operable reciprocating plunger (8).
- 10 3. A unit according to claim 2, wherein the rupturing means (12) also forms part of the plunger (8), whereby when the plunger is reciprocated the rupturing means ruptures the inner container (3) and the mixing element (11) mixes uniformly the ingredient(s) in the ruptured inner container with the ingredient(s) in the outer container (1) to form an explosive.
- 15 4. A unit according to claim 2 or 3, wherein the plunger comprises a rod and piston assembly (9, 10, 11, 12) and the piston is in the form of a baffle plate (11).
5. A unit according to claim 4, wherein the baffle plate (11) has one or more orifices (18) through which at least part of the ingredients are forced to flow as the plunger reciprocates.
- 20 6. A unit according to any preceding claim, wherein the ingredient in one of the containers comprises a solution of inorganic oxidizer salt and at least one of the ingredients in the other container is a fuel.
- 25 7. A unit according to claim 6, wherein the inorganic oxidizer salt solution comprises water and salt selected from the group consisting of ammonium, alkali and alkaline earth metal nitrates, chlorates and perchlorates or mixtures thereof and the fuel is selected from the group consisting of solid fuels and liquid fuels.
- 30 8. A unit according to claim 7, wherein the fuel is selected from the group consisting of aluminum particles, carbonaceous materials, finely divided vegetable grains, sulfur and mixtures thereof.
9. A unit according to any one of claims 6 to 8, wherein at least one of the ingredients in the other container is a sensitizer.
- 35 10. A system according to claim 9, wherein the sensitizer is selected from the group consisting of compound explosives, particulate metals, density reducing agents and mixtures thereof.
11. A system according to claim 7 or 8, wherein the inorganic oxidizer solution comprises a solution of sodium perchlorate and the fuel comprises aluminum particles.
- 40 12. A unit according to any preceding claim, wherein the first and second containers are provided by a vessel having a rupturable membrane disposed therein so as to define the first and second containers on opposite sides of the membrane.

Patentansprüche

- 45 1. Tragbare, in sich abgeschlossene Einheit zum Transportieren und Mischen von Bestandteilen, um einen Sprengstoff zu bilden, mit:
 - a) einen ersten Behälter (1) zum Aufnehmen eines oder mehrerer Bestandteile,
 - 50 b) einen zweiten Behälter (3) zum Aufnehmen eines oder mehrerer Bestandteile, die durch Mischen mit dem (den) Bestandteil(en) im ersten Behälter einen Sprengstoff bilden, wobei der zweite Behälter (3) innerhalb des oder benachbart zum ersten Behälter (1) angeordnet ist, und
 - c) einem Mittel (12) zum Zerschlagen des zweiten Behälters,**dadurch gekennzeichnet,**
 daß ein Mischelement (11) zum Zusammenmischen der Bestandteile im ersten und zweiten Behälter
 55 vorgesehen ist, um einen Sprengstoff zu bilden.
2. Einheit nach Anspruch 1, dadurch gekennzeichnet, daß das Mischelement (11) ein Teil eines manuell betätigbaren, hin- und herbewegbaren Tauchkolbens (8) ist.

3. Einheit nach Anspruch 2, dadurch gekennzeichnet, daß das Zerklebungsmittel (12) ebenfalls ein Teil des Tauchkolbens (8) ist, wobei beim Hin- und Herbewegen des Tauchkolbens das Zerklebungsmittel den inneren Behälter (3) zerbricht und das Mischelement (11) den (die) Bestandteil(e) im zerbrochenen inneren Behälter mit dem (den) Bestandteil(en) im äußeren Behälter (1) gleichmäßig mischt, um einen Sprengstoff zu bilden.
4. Einheit nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß der Tauchkolben eine Stangen- und Kolbenanordnung (9, 10, 11, 12) und der Kolben die Form einer Verteilungsplatte (11) aufweist.
5. Einheit nach Anspruch 4, dadurch gekennzeichnet, daß die Verteilungsplatte (11) eine oder mehrere Öffnungen (18) aufweist, durch die wenigstens ein Teil der Bestandteile hindurchfließen muß, wenn sich der Tauchkolben hin- und herbewegt.
6. Einheit nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Bestandteil in einem der Behälter eine Lösung aus anorganischem Oxidationssalz aufweist und wenigstens einer der Bestandteile im anderen Behälter ein Treibstoff ist.
7. Einheit nach Anspruch 6, dadurch gekennzeichnet, daß die anorganische Oxidationssalzlösung Wasser und Salz aufweist, das aus der Gruppe aus Ammonium, Alkali und alkalischen Erdmetallnitraten, Chloraten und Perchloraten oder Mischungen hiervon ausgewählt ist und der Treibstoff aus der Gruppe aus Festtreibstoffen und Flüssigtreibstoffen ausgewählt ist.
8. Einheit nach Anspruch 7, dadurch gekennzeichnet, daß der Treibstoff aus der Gruppe aus Aluminiumpartikeln, kohlehaltigen Materialien, fein zerteilten pflanzlichen Körnern, Schwefel und Mischungen hiervon ausgewählt ist.
9. Einheit nach einem der Ansprüche 6 bis 8, dadurch gekennzeichnet, daß wenigstens einer der Bestandteile im anderen Behälter ein Sensibilisierungsmittel ist.
10. System nach Anspruch 9, dadurch gekennzeichnet, daß das Sensibilisierungsmittel aus der Gruppe aus Mischsprengstoffen, aus Partikeln bestehenden Metallen, die Dichte verringernden Mitteln und Mischungen hiervon ausgewählt ist.
11. System nach Anspruch 7 oder 8, dadurch gekennzeichnet, daß die anorganische Oxidationslösung eine Lösung aus Natriumperchlorat und der Treibstoff Aluminiumpartikel umfassen.
12. Einheit nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der erste und zweite Behälter von einem Behälter mit einer darin angeordneten zerbrechbaren Membran gebildet werden, so daß der erste und zweite Behälter auf den gegenüberliegenden Seiten der Membran definiert ist.

Revendications

1. Unité autonome portative pour transporter et mélanger des ingrédients afin de former un explosif, comportant :
 - (a) un premier récipient (1) destiné à contenir un ou plusieurs ingrédients,
 - (b) un second récipient (3) destiné à contenir un ou plusieurs ingrédients qui, lorsqu'ils sont mélangés à l'ingrédient ou aux ingrédients dans le premier récipient, forment un explosif, le second récipient (3) étant disposé à l'intérieur du premier récipient (1) ou étant contigu à celui-ci, et
 - (c) un moyen (12) pour rompre le second récipient ;
 caractérisée en ce qu'un élément de mélange (11) est prévu pour mélanger ensemble les ingrédients dans les premier et second récipients afin de former un explosif.
2. Unité selon la revendication 1, dans laquelle l'élément (11) de mélange fait partie d'un plongeur (8) pouvant être animé manuellement d'un mouvement alternatif.
3. Unité selon la revendication 2, dans laquelle le moyen (12) de rupture fait également partie du plongeur (8), grâce à quoi, lorsque le plongeur est animé d'un mouvement alternatif, le moyen de rupture rompt le récipient intérieur (3) et l'élément (11) de mélange mélange uniformément le ou les ingrédients dans

le récipient intérieur rompu avec le ou les ingrédients dans le récipient extérieur (1) pour former un explosif.

- 5 4. Unité selon la revendication 2 ou 3, dans laquelle le plongeur comporte un ensemble à tige et piston (9, 10, 11, 12) et le piston se présente sous la forme d'une plaque (11) à chicanes.
- 10 5. Unité selon la revendication 4, dans laquelle la plaque (11) à chicanes présente un ou plusieurs orifices (18) à travers lesquels au moins une partie des ingrédients sont forcés de s'écouler lorsque le plongeur exécute un mouvement alternatif.
- 15 6. Unité selon l'une quelconque des revendications précédentes, dans laquelle l'ingrédient dans l'un des récipients comprend une solution d'un sel comburant inorganique et au moins l'un des ingrédients dans l'autre récipient est un combustible.
- 20 7. Unité selon la revendication 6, dans laquelle la solution de sel comburant inorganique comprend de l'eau et un sel choisi dans le groupe constitué de l'ammonium, d'un alcali et de nitrate de métaux alcalino-terreux, des chlorates et des perchlorates ou des mélanges de ceux-ci et le combustible est choisi dans le groupe constitué de combustibles solides et de combustibles liquides.
- 25 8. Unité selon la revendication 7, dans laquelle le combustible est choisi dans le groupe constitué de particules d'aluminium, de matières carbonées, de grains végétaux finement divisés, de soufre et de mélanges de ceux-ci.
- 30 9. Unité selon l'une quelconque des revendications 6 à 8, dans laquelle au moins l'un des ingrédients dans l'autre récipient est un sensibilisateur.
- 35 10. Système selon la revendication 9, dans lequel le sensibilisateur est choisi dans le groupe constitué d'explosifs composés, de métaux en particules, d'agents de réduction de densité et de mélanges de ceux-ci.
- 40 11. Système selon la revendication 7 ou 8, dans lequel la solution comburante inorganique comprend une solution de perchlorate de sodium et le combustible comprend des particules d'aluminium.
- 45 12. Unité selon l'une quelconque des revendications précédentes, dans laquelle les premier et second récipients sont formés par une cuve dans laquelle est disposée une membrane pouvant être rompue de façon à définir les premier et second récipients sur des côtés opposés de la membrane.
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