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A REACTIVE MINE CLEARING DEVICE: REMIC

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The prototype Reactive Mine Clearance device (REMIC) has been developed for in-situ neutralization of land mines in operations other than war (OOTW). The REMIC uses a proven and tested chemical agent, diethylenetriamine (DETA) and a linear shaped charge. This neutralization device is simple, low-cost, and safe to neutralize exposed and shallow-buried ordnance without causing a detonation. The REMIC device was tested to verify performance against defused antipersonnel and antitank mines. The results are discussed in terms of target mine types, mine cases, explosive fills, burial depth, effectiveness, and applicability in humanitarian demining environments.

INTRODUCTION

The world is polluted with more than 100 million mines in nearly 70 countries. More than 10,000 civilians are killed or wounded every year worldwide from land mines. Over the last three decades, land mines have been used in every level of conflict. The mines range from very crude to complex electromechanical systems, varying in size, material, fuse, explosive type, shape, and emplacement. Therefore the mine is a highly cost-effective weapon against innocent civilians. The existence of many different types of mines in different geographical regions points to the need to develop a suite of equipment and materials for mine detection, location, marking, clearance, and neutralization. Once land mines are detected, they can be neutralized by carefully defusing/disarming/deactivating as appropriate for the type of mine under consideration, through manual techniques. The actual neutralization process by manual techniques is very slow, tedious, and hazardous. Current methods for neutralizing mines in-situ use manually emplaced condensed explosive (C-4 or TNT block) within six inches of the mine for humanitarian area clearance

purposes. The mine is explosively destroyed. The resulting blast and fragments can damage surrounding structures, injure people within several hundred yards, and create additional false alarms (metal case anti-tank and anti-personnel mines) for the detection systems. Moreover, this approach suffers serious drawbacks such as safety, cost, effective destruction, time constraints, storage, transportation, and training.

A humanitarian demining program has been undertaken to provide the capability to clear mines specifically for use in operations other than war (OOTW), with particular emphasis on technologies that can be shared in an international environment. A low-cost, highly reliable, and effective in-situ neutralization system is needed. To meet in-situ neutralization requirements, explosive neutralization by a reactive mine clearance device is a viable concept for clearing an individual surface as well as shallow buried mines near bridges, houses, public buildings, and on roads. Described herein is a new technology that offers the benefits of both approaches mentioned above while minimizing the weakness inherent to each approach.

The reactive mine clearing device (REMIC) contains two unique but integrated components. A linear cutting charge is used to remove the overburden covering shallow-buried mines (up to 1 cm) and to cut through the mine casing, thereby exposing the explosive fill. The cutting charge is designed to minimize its own explosive fill and to insure that the cutting jet's energy does not detonate the target mine. The second component is a compartment containing a chemical agent, diethylenetriamine (DETA). This compartment is pushed into the mine from the expanding detonation products of the linear shaped charge. As the compartment approaches the mine it ruptures open and distributes the chemical agent over the exposed explosive of the mine. A hypergolic reaction immediately commences. The entire explosive contents of the mine are burned out. The remaining mine casing can safely be removed from the ground without fear of detonation.

CONCEPT DESCRIPTION

The REMIC device is designed to be simple and easy to use. The device contains two separate components that can be integrated in the field. Figure 1a shows a cross-section of the device in the assembled configuration. The top part of the device is a linear shaped charge. The shaped charge is designed to remove the overburden covering shallow-buried mines (up to 1 cm) as well as to cut the mine case open in order to expose the explosive fill. However, the linear shaped charge is designed not to cause a detonation of the mine's explosive fill. The explosive charge, liner material, and geometry determine the amount of energy in the cutting jet. The energy distribution within the jet, as it impacts the explosive, determines whether an energetic response will occur.

The other component of the device is a fluid-filled reservoir. The chemical agent fill causes TNT to spontaneously combust. The entire device, excluding the liner for the linear shaped charge, is made of plastic material and thus offers a twofold benefit of a lightweight unit (approximately 0.75 lbs.) and minimal blast fragmentation following operation of the device. Since the case is made of plastic and the REMIC unit does not detonate the target mine, no metallic fragments are produced, which prevents the recontamination of the minefield.

Figure 1a-f shows a computer simulation of the REMIC unit. Figure 1b shows the pressure of the explosive gases collapsing the liner, forming a high-speed jet of material. The jet from the liner emerges from the bottom of the REMIC unit and is the mechanism which cuts the mine case open (see Figures 1c-1d). The REMIC unit is designed to allow the explosive gases from the linear shaped charge to push the reservoir sections together and towards the exposed explosive of the mine. Figures 1e and 1f show the two halves of the reservoir colliding, yet still maintaining integrity, which prevents the chemical agent from being prematurely dispersed. As the chemical agent comes into contact with the explosive fill, a hypergolic reaction occurs immediately. This initial interaction of the chemical agent and TNT is sufficient to cause a self-sustaining reaction, which continues until the entire explosive contents of the mine are burned out. Following a sufficient cooling period, the empty mine case can be removed safely.

OPERATION

The design of the REMIC device was focused on simplicity of setup and use. Once a mine is detected and partially uncovered for verification purposes, the REMIC unit is simple to setup and position. Included in the REMIC packaging is a holder that suspends the device over the mine. This is a safety feature such that the REMIC unit is never in contact with the mine. No setup is required over the mine, which minimizes the risk of disturbing the mine. Figure 2 shows the setup of the REMIC device over a mine. The holder is placed at the side of the mine. The vertical portion of the holder is staked into the ground with a base that sets the correct height for operation of the device. The REMIC device easily slides onto the end of the holder. At this point, the detonator is attached to the top of the device. The REMIC device was designed to work with any detonator or blasting cap initiated electrically or by detonation cord. After the detonator is inserted, the device is then rotated over top of the mine and is ready for operation.

The resulting burn of the main fill of the mine is also shown in Figure 2b. The burning reaction may continue for a period of 1–25 minutes depending on the size of the mine, the type and quantity of explosive fill, and the prescence of any overburden. Figure 2c shows the remnants of an metal cased TNT-filled mine simulant following a successful operation of the REMIC device. Note the cut in the case on the right-hand side of the mine created by the linear shaped charge to expose the explosive fill. This opening provides venting of the burn products and prevents a buildup to a detonation reaction. The explosive did not detonate and minimal fragments are produced during the operation of the device. The entire explosive contents are burned out leaving an ash residue within the mine casing.

RESULTS AND DISCUSSION

The REMIC was tested against anti-personnel (AP) and anti-tank (AT) mines of various types (metal, plastic, and wood). Both the AP and AT mines were either flush buried or had one cm of soil overburden. The mines tested were not armed due to range safety procedures. The REMIC was placed over the explosive portion of each mine at a standoff

distance of four inches from the surface of each mine and was then initiated remotely using an electric cap. The mines were neutralized by an autocatalytic burning of explosives via the chemical agent, diethylenetriamine. The tests results achieved with the AP and AT mines are given in Table 1. From Table 1, it is clear that all mines were neutralized by a chemical agent with the exception one AT mine, in which the linear cutting charge failed to penetrate the mine casing. Each had a different burning time depending on the amount of explosive, type of explosive, burial depth, and type of mine case. The current configuration of the device and chemical agent limits its effectiveness to those mines that contain TNT, TNT-based explosives (Comp B, Pentolite, Tritonal, and Amatol), or tetryl. However, TNT or TNT-based explosives account for over 85% of the fills used in land mines. Product improvements to the REMIC device to neutralize any mine, irrespective of fill, are currently under development.

Table 1. Experimental Results.

Burial Depth	Mine Type	Explosive	Mine Case	Explosive Burn Time (min)
Flush	AP	Tetryl	Plastic	Detonate
Flush	AP	TNT	Metal	10
1 cm	AP	TNT	Metal	17
Flush	AP	TNT	Wood	5
Flush	AT	Comp. B	Plastic	8
1 cm	AT	Comp. B	Plastic	25
Flush	AT	Comp. B	Metal	11
Flush	AT	Comp. B	Metal	12
Flush	AT	TNT	Metal	8
Flush	AT	TNT	Wood	8
Flush	AT	Comp. B	Plastic	Failed

CONCLUSION

BAE SYSTEMS has experimentally demonstrated a device (REMIC) that neutralizes TNT-filled land mines via a chemical reaction. The REMIC device (US Patent 5936184) contains a chemical agent that reacts with the explosive fill of the mine to cause a burning reaction that continues until all explosive contents are consumed. The device itself is made almost entirely of plastic to minimize any fragments and to maintain a lightweight system. The plastic fragments from the device and the non-high order reaction of the target mine assure that the minefield will not be recontaminated and minimize the potential danger to surrounding structures and personnel. The REMIC device is useful for clearing mines near buildings, public buildings, on, below or near bridges, and on roads and is a good quality control method for mine clearance. Because of the design simplicity and ease of use, this low-cost technology shows promise that it maybe an ideal solution for humanitarian demining efforts.

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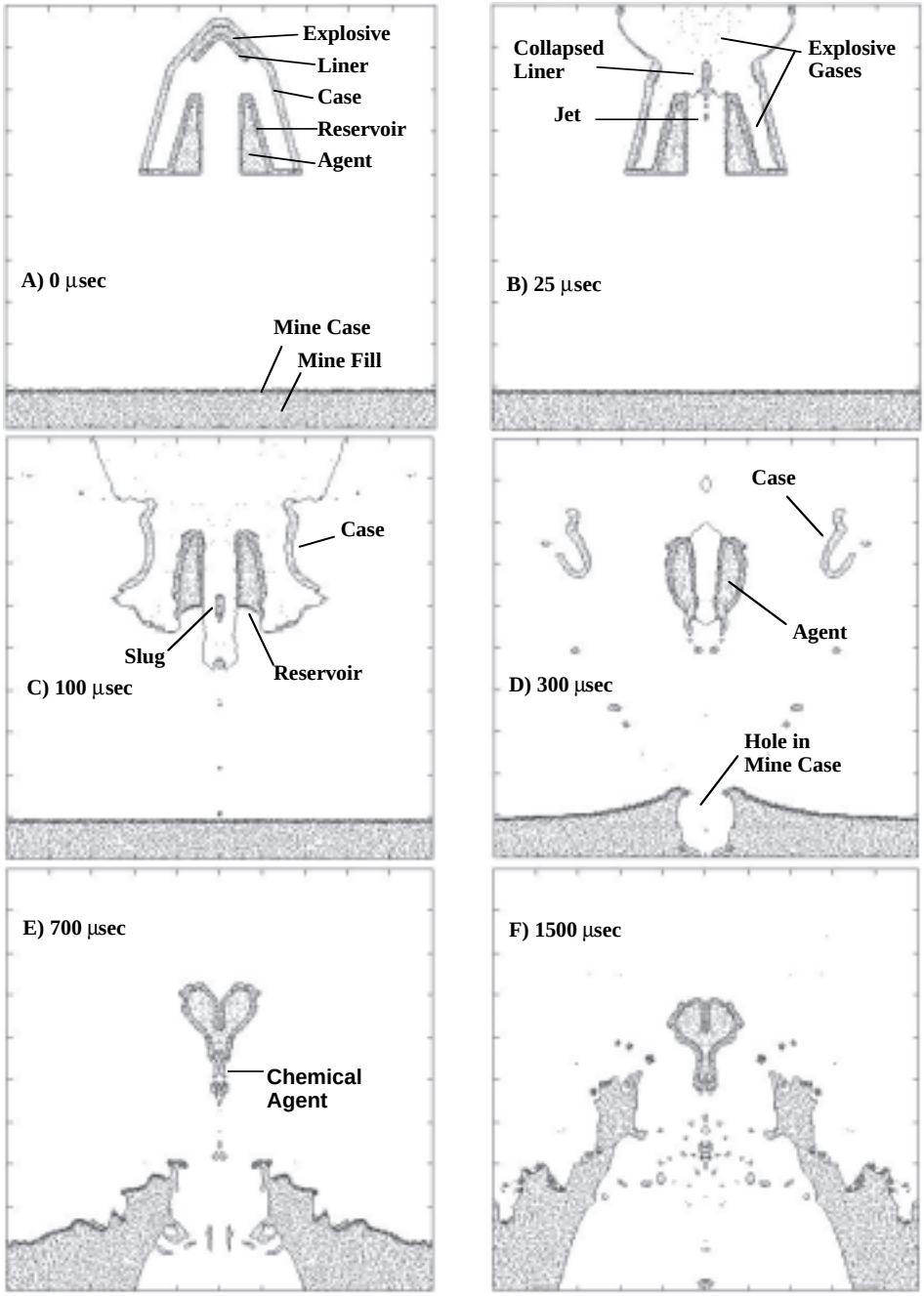

Figure 1. A) The REMIC unit is spaced above the mine. B) Upon detonation, the liner collapses and forms the high-speed cutting jet. C–F) The explosive gases of the cutting charge force the reservoir sections towards and into the mine.

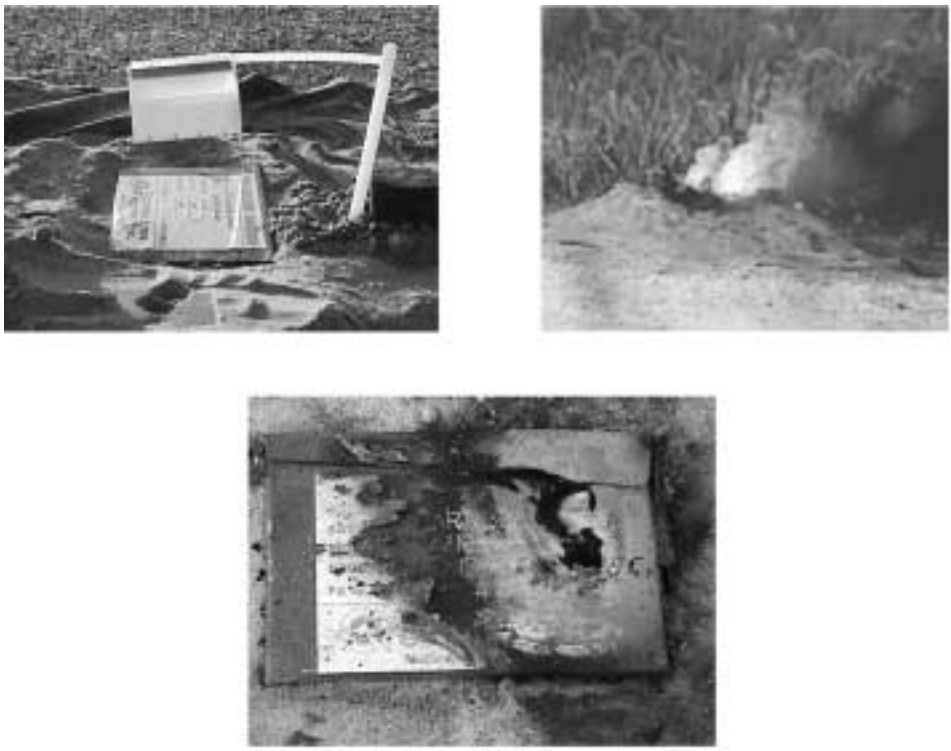

Figure 2. Setup, operation and post-test of a TNT-filled metal case. Complete burnout is achieved with no fragmentation of the case. About 8 minutes of burn time was observed for the six pounds of TNT.