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(54) **FORCED PREMATURE DETONATION OF IMPROVISED EXPLOSIVE DEVICES VIA CHEMICAL SUBSTANCES**

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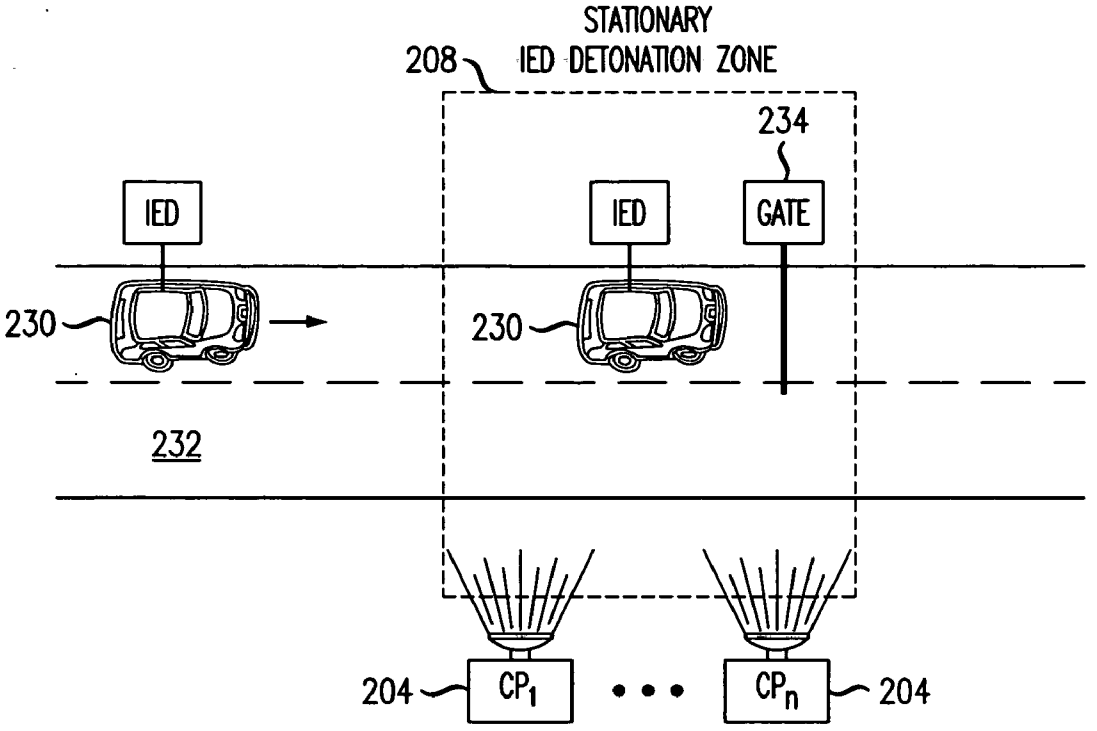
(52) **U.S. Cl.** ..... **89/1.13**

(57) **ABSTRACT**

An Improvised Explosive Device (IED) defense system is described that forces premature detonation of IEDs by releasing chemical substances from a stationary or mobile platform within a stationary or mobile "IED detonation zone." IEDs within the IED detonation zone that are triggered by chemical substances will receive the released chemical substances, thereby forcing premature detonation of IEDs in the detonation zone.



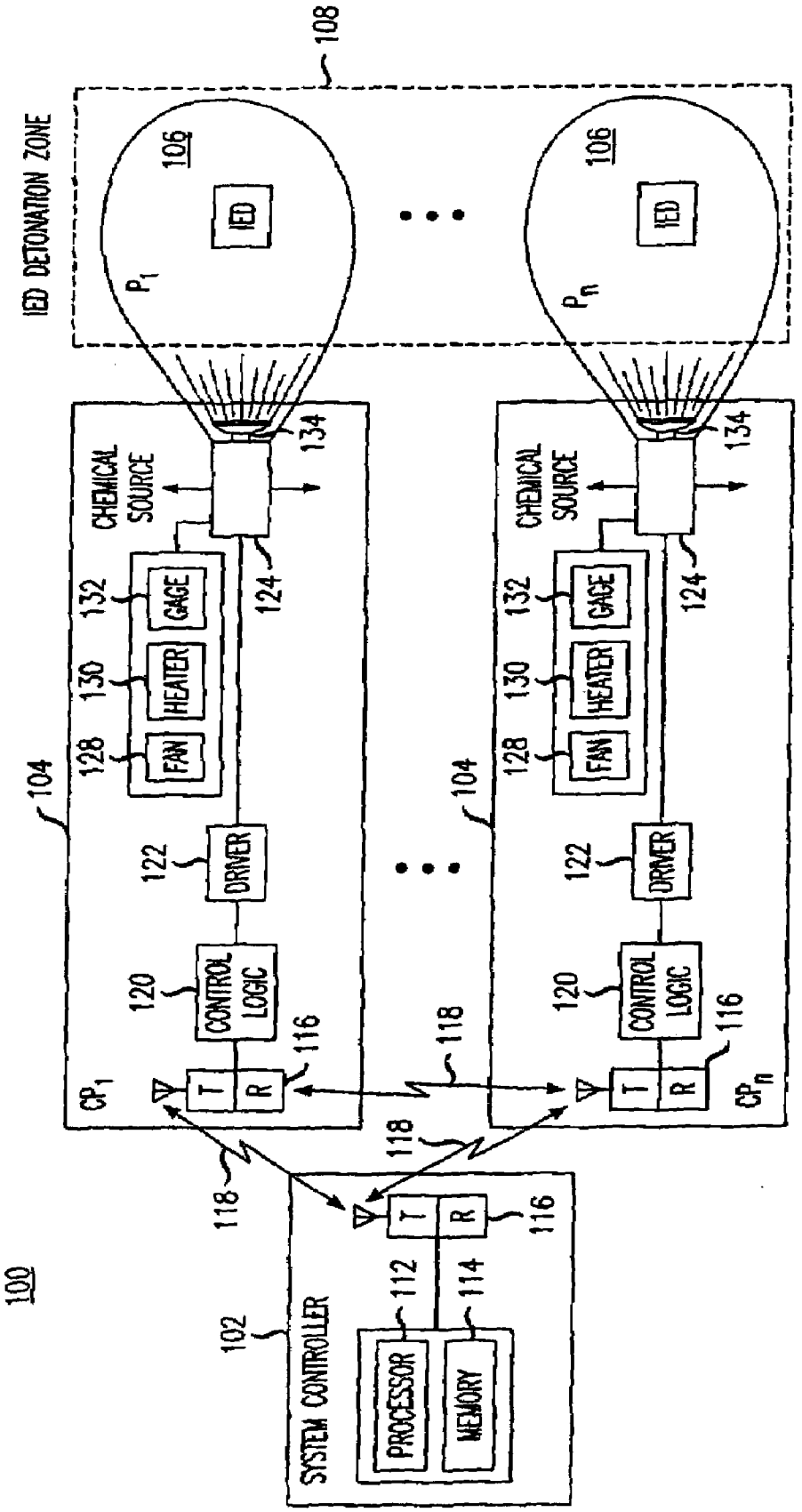

100
IED DETONATION ZONE
108
106
IED
$P_1$
$P_n$
CHEMICAL SOURCE
134
124
132
GAGE
130
HEATER
128
FAN
104
122
DRIVER
120
CONTROL LOGIC
116
118
T
R
$CP_1$
$CP_n$
SYSTEM CONTROLLER
102
112
PROCESSOR
114
MEMORY

FIG. 1

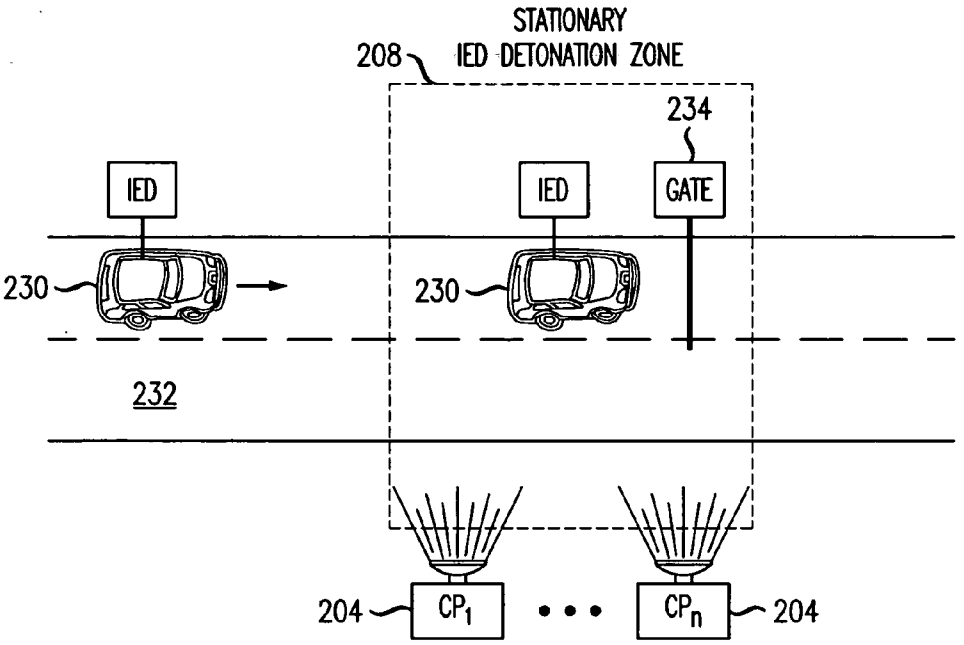

STATIONARY
IED DETONATION ZONE
208
234
IED
IED
GATE
230
230
232
204
CP1
CPn
204

*FIG. 2*

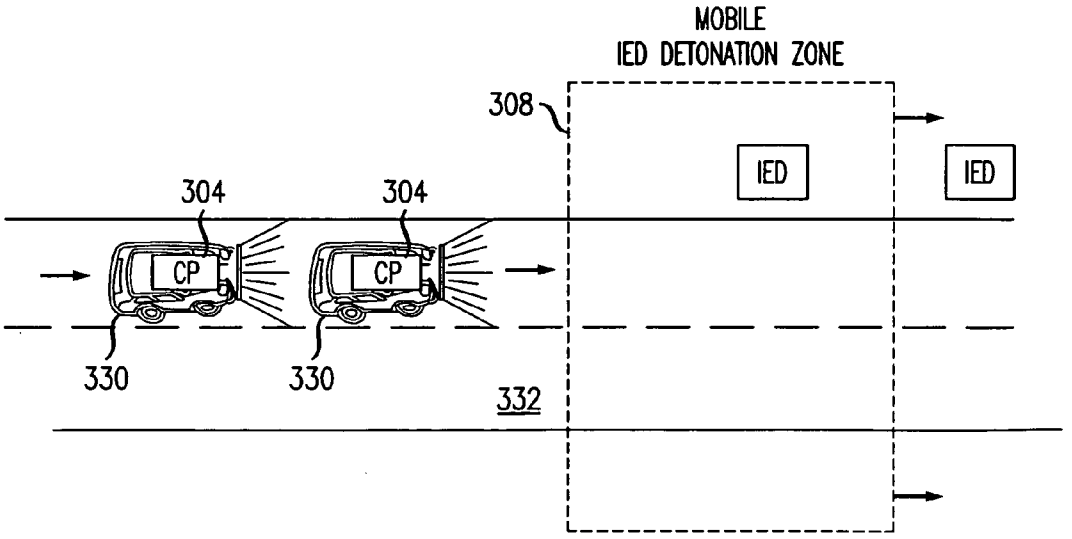

MOBILE
IED DETONATION ZONE
308
IED
IED
304
304
CP
CP
330
330
332

*FIG. 3*

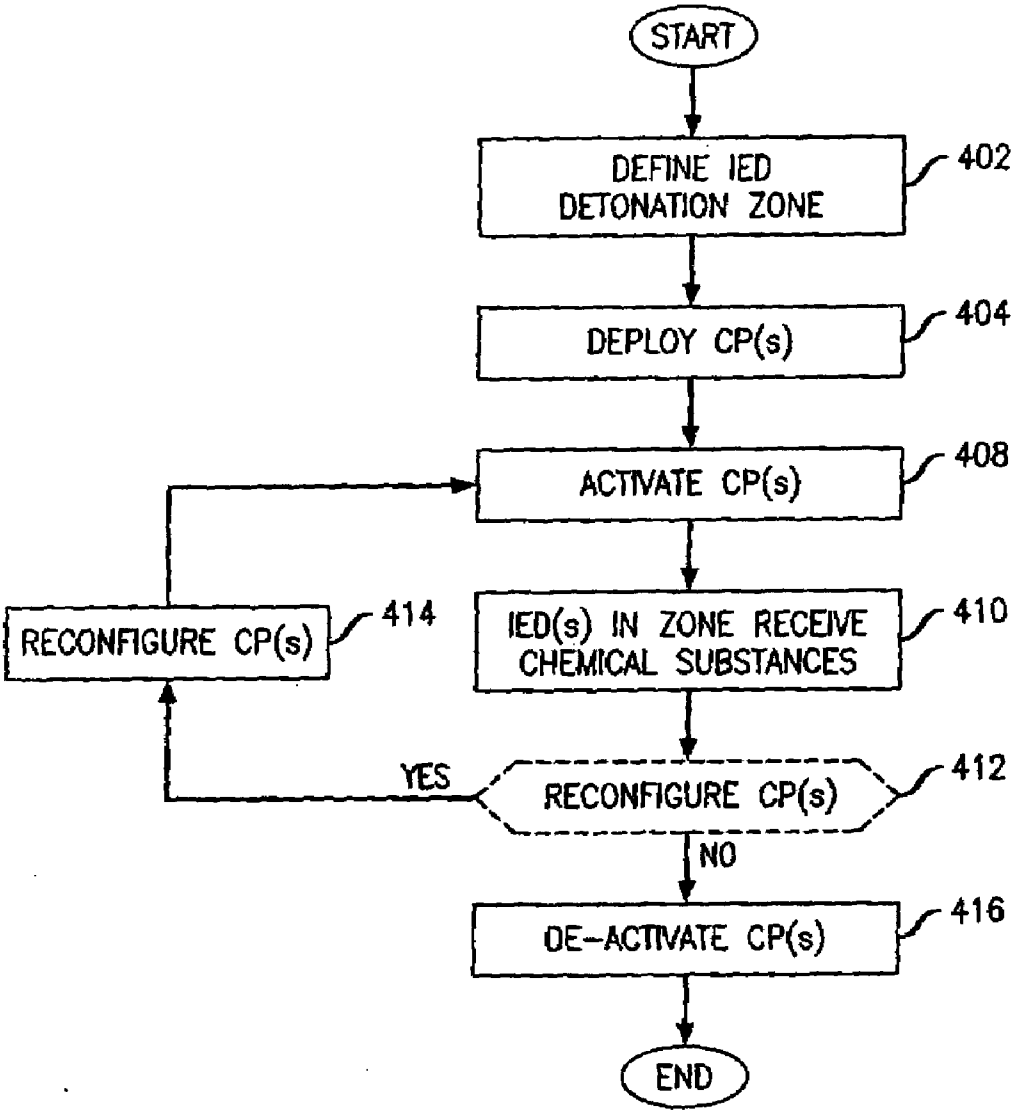

START
DEFINE IED DETONATION ZONE
402
DEPLOY CP(s)
404
ACTIVATE CP(s)
408
IED(s) IN ZONE RECEIVE CHEMICAL SUBSTANCES
410
RECONFIGURE CP(s)
412
YES
NO
RECONFIGURE CP(s)
414
DE-ACTIVATE CP(s)
416
END

*FIG. 4*

# FORCED PREMATURE DETONATION OF IMPROVISED EXPLOSIVE DEVICES VIA CHEMICAL SUBSTANCES

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is related to U.S. patent application Ser. No. [Goldman 28], titled "Forced Premature Detonation of Improvised Explosive Devices via Radiated Electromagnetic Energy," Ser. No. [Goldman 29], titled "Forced Premature Detonation of Improvised Explosive Devices via Heavy Vibration," Ser. No. [Goldman 30], titled "Forced Premature Detonation of Improvised Explosive Devices via Laser Energy" and Ser. No. [Goldman 33], titled "Forced Premature Detonation of Improvised Explosive Devices via Noise Print Simulation," each filed concurrently with the present application and assigned to the assignee of the present invention.

## FIELD OF THE INVENTION

**[0002]** This invention relates generally to counter-terrorism methods and devices and, more particularly, to methods and devices for triggering premature detonation of Improvised Explosive Devices (IEDs) utilizing chemical substances.

## BACKGROUND OF THE INVENTION

**[0003]** An Improvised Explosive Device (IED) is an explosive device that is cobbled together (or "improvised") for example, from commercial or military explosives, homemade explosives, military ordnance and/or ordnance components, typically by terrorists, guerrillas or commando forces for use in unconventional warfare. IEDs may be implemented for the purpose of causing death or injury to civilian or military personnel, to destroy or incapacitate structural targets or simply to harass or distract an opponent. IEDs may comprise conventional high-explosive charges alone or in combination with toxic chemicals, biological agents or nuclear material. IEDs may be physically placed at or near a pre-determined target or carried by person or vehicle toward a predetermined target or target of opportunity.

**[0004]** As will be appreciated, the design of construction of an IED and the manner and tactics for which a terrorist may employ an IED may vary depending on the available materials and sophistication of the designer. As such, a variety of different triggering mechanisms could be used to trigger detonation of IEDs. It is contemplated that certain IEDs, either by design or by nature of the triggering mechanism, may detonate responsive to chemical substances of a certain type or characteristic. For example and without limitation, exhaust fumes from a vehicle can yield chemical particles that may trigger detonation of IEDs. It is a concern that this tactic can be used to trigger bombings against civilian and military targets throughout the world. Accordingly, there is a need for precautionary measures to respond to this threat.

## SUMMARY OF THE INVENTION

**[0005]** The present invention provides systems and methods for guarding against chemical substance-triggered IEDs by forcing premature detonation of the IED at a safe distance from a prospective target, thereby reducing the effectiveness of the IED. Embodiments of the invention provide for releasing chemical substances from a stationary or mobile platform (hereinafter "Chemical Platform (CP)) to a stationary or mobile area defining an "IED detonation zone." IEDs within the IED detonation zone that are triggered by chemical substances will receive the radiated chemical substances, thereby forcing premature detonation of IEDs in the detonation zone.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

**[0007]** FIG. **1** is a block diagram of an IED defense system including one or more Chemical Platforms (CPs) according to embodiments of the invention;

**[0008]** FIG. **2** illustrates a manner of deploying CPs about a stationary target area defining a stationary IED detonation zone;

**[0009]** FIG. **3** illustrates a manner of deploying CPs about a mobile target area defining a mobile IED detonation zone; and

**[0010]** FIG. **4** is a flowchart of a method for implementing an IED defense system using mobile or stationary CPs to force premature detonation of IEDs within an IED detonation zone.

## DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

**[0011]** FIG. **1** shows by way of example and not limitation, an IED defense system **100** for guarding against chemical substance-triggered IEDs. A system controller **102** controls and coordinates operation of one or more Chemical Platforms **104** ($CP_1 \ldots CP_n$). The CPs **104** operate responsive to activation by the system controller to project plumes **106** ($P_1 \ldots P_n$) comprising one or more chemical substances within an IED detonation zone **108**.

**[0012]** The system controller **102** includes a processor **112** and memory **114** for controlling the operation of CPs within the IED defense system **100**. In one embodiment, the processor executes software routines for managing operation of the various CPs, including, for example and not limitation, activating and de-activating the CPs and controlling the type(s) and amount of chemical substances to be released. The memory stores software routines for controlling the CPs and information relating to the identity, characteristics and location of the various CPs in the IED defense system. Alternatively or additionally, the system controller may **102** operate responsive to manual input from a human operator (not shown). As will be appreciated, the system controller **102** is a functional element that may reside in a single device or may be distributed among multiple devices and multiple locations. For example and without limitation, the system controller functionality may reside in a centralized platform; or controller functionality may reside in individual CPs to allow for independent operation of the CPs.

**[0013]** As shown, the system controller includes a transceiver **116** for communicating with the CPs **104** via wireless resources **118**. The CPs **104** similarly include transceivers **116** for communicating with the system controller, or with each other, via wireless resources **118**. As will be appreciated, the wireless transceivers may be eliminated, for example, in embodiments where controller functionality resides within the CP. The wireless resources **118**, where applicable, may comprise narrowband frequency modulated channels, wideband modulated signals, broadband modulated signals, time division modulated slots, carrier frequencies, frequency pairs or generally any medium for communicating information to

or from the CPs. The wireless resources may implement air interface technologies including but not limited to, CDMA, TDMA, GSM, UMTS or IEEE 802.11.

**[0014]** The CPs **104** execute control logic **120** responsive to instructions from the system controller **102** (or where applicable, from their own resident controllers) to activate respective drivers **122** for activating chemical sources **124**. Responsive to the control logic and drivers, the chemical sources release one or more chemicals defining respective plumes **106** ($P_1 \ldots P_n$) within the IED detonation zone **108**. As will be appreciated, the nature and type of the chemical sources may be selected or combined to produce one or more characteristic type(s) of chemical plumes that are believed to trigger detonation of IEDs. In one embodiment, the CPs are implemented to produce a chemical plume having a particular signature characteristic of a prospective target. For example and without limitation, the CPs may be implemented to simulate the exhaust fumes produced by a diesel truck. Generally, it is contemplated that virtually any type of chemical substances may be released and at varying volumes, temperatures, release sequences or the like to produce a desired characteristic plume. Further, the physical location and/or direction of the sources may be varied, individually or collectively.

**[0015]** As shown, a fan **128** and heater **130** are provided for the purposes of cooling and heating the chemical sources **124**, respectively, as may be needed to realize a desired temperature or regulate the temperature of the chemical sources **124**. A gauge **132** measures and displays one or more parameters of the chemical substances. As will be appreciated, multiple gauges or multi-purpose gauges may be used to measure a plurality of parameters of the chemical substances. The parameters may include, for example and without limitation, the temperature of the chemical substance or the amount (e.g., volume) of chemical substance remaining. In one embodiment, the fan **128** and heater **130** are operated under control of the control logic **120** and/or the system controller **102**, such that operation of the fan **128** and heater **130** may be implemented by software routines executed within the control logic **120** and/or the system controller **102**. The gauge **132** is operably connected to the control logic **120** and/or system controller **102** to allow for monitoring and adjustment of one or more parameters as may be required, by the control logic **120** and/or system controller **102**.

**[0016]** A directional nozzle **132** (or optionally, nozzles) allows for spraying or directing the released chemical substances in a desired direction or multiple simultaneous directions. As will be appreciated, the nozzle(s) **132** may be implemented in a variety of forms, for example, to release chemical substances at a desired pressure or to achieve a desired spray pattern or characteristic.

**[0017]** As will be described in greater detail in relation to FIG. **2** and FIG. **3**, the CPs may be deployed on mobile or stationary platforms, or some combination thereof, to effect a mobile or stationary IED detonation zone **108**. In either case, the IED detonation zone is advantageously positioned a safe distance from civilian or military personnel or structural targets, such that detonation of IEDs in the zone will not cause significant damage to persons or property. Detonation of IEDs within the zone is referred to as a forced premature detonation since it is instigated by the IED defense system **100** and will occur before intended by the person or agency deploying the IED.

**[0018]** FIG. **2** illustrates a manner of deploying CPs about a stationary target area defining a stationary IED detonation zone. For convenience, similar reference numerals will be used to describe like elements in FIG. **1** and FIG. **2**, albeit with "**200**" series reference numerals in FIG. **2** rather than "**100**" series. For example, the IED detonation zone, referred to by reference numeral **108** in FIG. **1** will be referred to by reference numeral **208** in FIG. **2**.

**[0019]** In the embodiment of FIG. **2**, a stationary IED detonation zone **208** is defined by deploying one or more CPs **204** at predetermined fixed positions about a designated geographic area in which premature detonation of IEDs is desired. The designated geographic area may comprise, for example, a remote checkpoint or staging area situated a safe distance (e.g., 500 ft.) from persons or structures that may be targeted by IEDs. When activated, the CPs **204** release chemical substances within the IED detonation zone, substantially as described in relation to FIG. **1**, so as to force premature detonation of IEDs within or entering the zone **108**. The CPs may be activated responsive to a system controller (not shown in FIG. **2**) or a human operator.

**[0020]** As shown, vehicle **230** is traveling on a transportation path **232** (e.g., a roadway) toward a prospective target or target area. Vehicle **230** is carrying an IED that may be triggered to detonate by chemical substances. As the vehicle proceeds along path **232**, it encounters and enters the stationary IED detonation zone **208**. Generally, when a person or vehicle first approaches the IED detonation zone, it is not known to be carrying an IED and even if an IED is detected, the type of triggering device may not be known. Accordingly, any unidentified person or vehicle entering the IED detonation zone will at least initially be perceived as a threat. Consequently, in one embodiment, the person or vehicle is stopped upon entering the IED detonation zone. Optionally, a gate **234** is utilized to facilitate stopping the person or vehicle. While the person or vehicle is stopped, or generally at any time while the person or vehicle is within the detonation zone **208**, the CPs **204** may be activated to release chemical substances within the zone. In such manner, any IEDs carried by the person or vehicle that are triggered by chemical substances are prematurely detonated within the zone **208**. An alternative implementation is that the zone is sufficiently wide that the person or vehicle does not need to be impeded by a gate, but will be in the zone for sufficiently long enough time as to allow the chemical substances to cause premature detonation of the IED.

**[0021]** FIG. **3** illustrates a manner of deploying CPs about a mobile target area defining a mobile IED detonation zone. For convenience, similar reference numerals will be used to describe like elements in FIG. **1** and FIG. **3**, albeit with "**300**" series reference numerals in FIG. **3**. For example, the ED detonation zone, referred to by reference numeral **108** in FIG. **1** will be referred to by reference numeral **308** in FIG. **3**.

**[0022]** In the embodiment of FIG. **3**, one or more CPs **304** are deployed on vehicles **330** traversing a transportation path (e.g., roadway) **332**. In one implementation, the vehicles **330** comprise drone vehicles traveling in advance of a convoy of troops. At various points along the transportation path **332**, the vehicles **330** may encounter IEDs that are possibly triggered by chemical substances. The CPs **304**, when activated, produce a mobile IED detonation zone **308** that advances along the transportation path **332** along with the mobile platform. The CPs may be activated responsive to a system controller (not shown in FIG. **3**) or a human operator. The IED detonation zone **308** comprises chemical substance plumes substantially as described in relation to FIG. **1**. As such, any

IEDs on the transportation path that are encountered by the advancing IED detonation zone **308** are likely to become prematurely detonated if they are triggered by chemical substances.

**[0023]** Now turning to FIG. **5**, there is shown a flowchart for implementing an IED defense system using mobile or stationary CPs. At step **402**, an authority or agency responsible for implementing an IED defense system defines an IED detonation zone. The IED detonation zone may define a stationary detonation zone such as described in relation to FIG. **2** or a mobile detonation zone traversing a transportation path such as described in relation to FIG. **3**. As will be appreciated, multiple IED detonation zones may be defined to cover multiple geographic areas or transportation paths as needed or desired.

**[0024]** At step **404**, the responsible authority or agency deploys one or more CPs as necessary to obtain desired chemical coverage within the zone. For example, in the case where the IED detonation zone defines a stationary zone, one or more CPs may be deployed at one or more predetermined locations residing within or proximate to the stationary zone as necessary to obtain desired chemical substance coverage within the zone; or in the case where the IED detonation zone defines a mobile zone, one or more CPs may be deployed on drones or other suitable transport vehicles adapted to traverse a designated transportation path.

**[0025]** As has been noted in relation to FIG. **1**, the nature and type of the CPs may be selected to produce one or more characteristic type(s) of chemical substance plume(s) that are believed to trigger detonation of IEDs. In one embodiment, the chemical plume simulates the exhaust fumes of a diesel truck.

**[0026]** Sometime after the CPs are deployed, the CPs are activated at step **408** to release chemical substances within the zone. Depending on implementation, the CPs may be operated alone or in combination and at varying volumes, release sequences or the like to produce a desired characteristic chemical plume or plumes.

**[0027]** At step **410**, IED(s) within the designated stationary or mobile zone come into contact with the chemical plumes, causing the IED(s) to prematurely detonate if they include triggering mechanisms that respond to chemical substances.

**[0028]** Optionally, at step **412**, the responsible authority or agency may choose to reconfigure one or more CP(s) to obtain different coverage or define a different IED detonation zone. If reconfiguration is desired, reconfiguration is accomplished at step **414**. It is contemplated that reconfiguration may be accomplished while the CP(s) remain active or after they are de-activated. At some point when it is desired to cease releasing chemicals within the IED detonation zone, the CPs are de-activated at step **416**.

**[0029]** In one embodiment, activation or de-activation of the CPs at steps **408** and **416** is implemented by software routines executed within the system controller **102**. As has been noted, the system controller functionality may reside in a centralized platform; or controller functionality may reside in individual CPs to allow for independent operation of the CPs. Alternatively or additionally, one or more CPs may be activated or de-activated responsive to human control. Generally, instructions for activating and operating the CPs or de-activating the CPs may be implemented on any computer-readable signal-bearing media residing within the system controller or residing in individual CPs. The computer-readable signal-bearing media may comprise, for example and without limitation, floppy disks, magnetic tapes, CD-ROMs, DVD-ROMs, hard disk drives or electronic memory. The computer-readable signal-bearing media store software, firmware and/or assembly language for performing one or more functions relating to steps **408** and **416**.

**[0030]** The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. For example, the CPs may be deployed with or without a system controller **102**; and the CPs may be implemented alone or in combination to release chemical substances of various types and/or characteristics that may differ from the described embodiments. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

**1**. An IED (Improvised Explosive Device) defense system for forcing premature detonation of IEDs triggered by chemical substances, the IED defense system comprising:

one or more chemical platforms adapted for releasing chemical substances within a predefined defense zone defining an IED detonation zone; and

one or more controllers for activating the platforms to release said chemical substances within the IED detonation zone, thereby forcing premature detonation of IEDs triggered by chemical substances within the IED detonation zone.

**2**. The IED defense system of claim **1**, wherein at least one of the one or more platforms is adapted to release chemical substances defining a characteristic pattern of a prospective target.

**3**. The IED defense system of claim **1**, wherein at least one of the one or more platforms is adapted to release chemical substances simulating vehicle exhaust fumes.

**4**. The IED defense system of claim **1**, wherein at least one of the one or more platforms defines a stationary platforms adapted to release chemical substances within a geographic zone defining a stationary IED detonation zone.

**5**. The IED defense system of claim **1**, wherein at least one of the one or more platforms defines a mobile platforms adapted to traverse a transportation path, the mobile platforms adapted to release chemical substances while advancing along the transportation path defining a mobile IED detonation zone.

**6**. The IED defense system of claim **5**, wherein the mobile platform comprises a terrestrial vehicle adapted to traverse a terrestrial path, the mobile IED detonation zone defining at least a portion of the terrestrial path.

**7**. The IED defense system of claim **1**, wherein at least one of the one or more controllers comprises a system controller for activating the one or more platforms to release chemical substances within the IED detonation zone.

**8**. The IED defense system of claim **1**, wherein at least one of the one or more controllers defines an independent controllers for independently activating a corresponding at least one platform to release chemical substances within the IED detonation zone.

**9**. An article comprising:

one or more computer-readable signal-bearing media; and

means in the one or more media for activating one or more platforms to release chemical substances within a predefined defense zone defining an IED (Improvised

Explosive Device) detonation zone, thereby forcing premature detonation of IEDs triggered by chemical substances within the IED detonation zone.

**10**. A method for implementing an IED (Improvised Explosive Device) defense system comprising:

deploying one or more stationary platforms about a predefined stationary defense zone defining a stationary IED detonation zone, the stationary platforms adapted to release chemical substances within the stationary IED detonation zone; and

activating the platforms to release chemical substances within the stationary IED detonation zone, thereby forcing premature detonation of IEDs triggered by chemical substances within the stationary IED detonation zone.

**11**. A method for implementing an IED (Improvised Explosive Device) defense system comprising:

deploying one or more mobile platforms adapted to traverse a transportation path, the mobile platforms adapted to release chemical substances along a predefined mobile defense zone defining a mobile IED detonation zone; and

activating the platforms to release chemical substances within the mobile IED detonation zone, thereby forcing premature detonation of IEDs triggered by chemical substances within the mobile IED detonation zone.

**12**. The IED defense system of claim **1**, wherein the one or more controllers are positioned remote from the IED detonation zone, for remotely activating the platforms to release said chemical substances within the IED detonation zone.

**13**. The IED defense system of claim **1**, wherein the one or more controllers are positioned remote from the IED detonation zone, for remotely activating the platforms via wireless resources to release said chemical substances within the IED detonation zone.

**14**. The IED defense system of claim **1**, wherein the one or more platforms comprise unmanned platforms.

**15**. The IED defense system of claim **10**, wherein the step of activating comprises remotely activating the platforms via wireless resources to release chemical substances within the stationary IED detonation zone.

**16**. The IED defense system of claim **11**, wherein the step of activating comprises remotely activating the platforms via wireless resources to release chemical substances within the mobile LED detonation zone.

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