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Ham et al.

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(54) **RADIO FREQUENCY JAMMER**

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(21) Appl. No.: **11/062,296**

(22) Filed: **Feb. 11, 2005**

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Related U.S. Application Data

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(51) **Int. Cl.**
H04K 3/00 (2006.01)

(52) **U.S. Cl.** **89/1.11**

(58) **Field of Classification Search** 89/1.11
See application file for complete search history.

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(57) **ABSTRACT**

A method and apparatus for broadcasting electromagnetic waves such that user-selected electromagnetic receivers are prevented from receiving an intended electromagnetic communication. Such device can be used to jam detonation of remote controlled explosive devices. The device can be portable or stationary, is preferably programmable, is low cost, and can be used by untrained personnel.

13 Claims, 7 Drawing Sheets

Threat	Center Frequency	Bandwidth	Power Level	Card	Channel
A	27.25 MHz	2.5 MHz	High	HF	1A
B	35 MHz	2.0 MHz	High	HF	1B
C	47.5 MHz	5.0 MHz	High	VHF1	2A
D	75 MHz	1.0 MHz	High	VHF1	2B
E	260 MHz	10.0 MHz	High	UHF1	3A
F	309 MHz	22.0 MHz	High	UHF1	3B
G	372 MHz	36.0 MHz	High	UHF2	4A
H	425.5 MHz	21.0 MHz	High	UHF2	4B
I	807 MHz	10.0 MHz	High	L-BAND	5A
J	842.5 MHz	20.0 MHz	High	L-BAND	5B

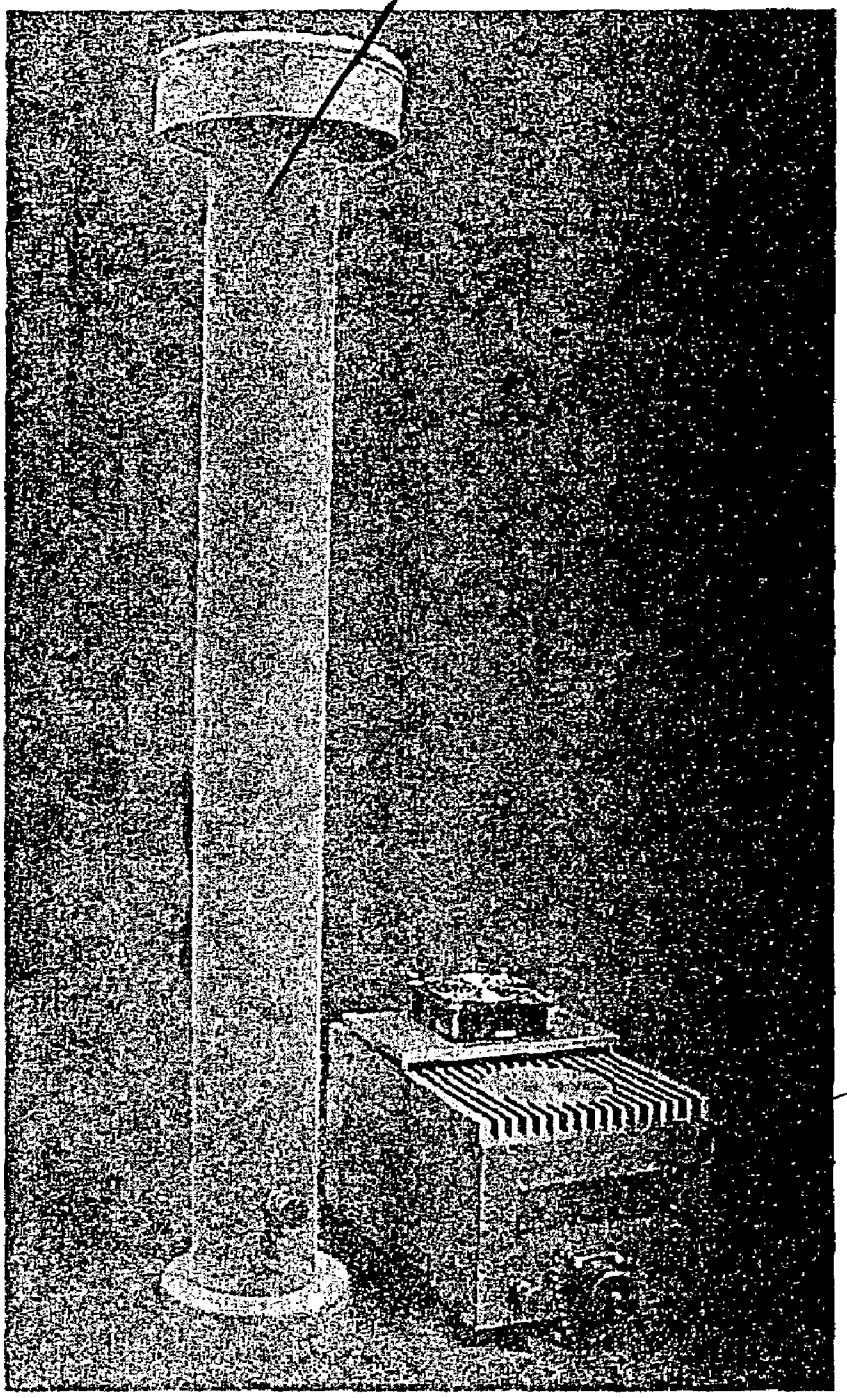


Fig. 1

Threat	Center Frequency	Bandwidth	Power Level	Card	Channel
A	27.25 MHz	2.5 MHz	High	HF	1A
B	35 MHz	2.0 MHz	High	HF	1B
C	47.5 MHz	5.0 MHz	High	VHF1	2A
D	75 MHz	1.0 MHz	High	VHF1	2B
E	260 MHz	10.0 MHz	High	UHF1	3A
F	309 MHz	22.0 MHz	High	UHF1	3B
G	372 MHz	36.0 MHz	High	UHF2	4A
H	425.5 MHz	21.0 MHz	High	UHF2	4B
I	807 MHz	10.0 MHz	High	L-BAND	5A
J	842.5 MHz	20.0 MHz	High	L-BAND	5B

Fig. 2

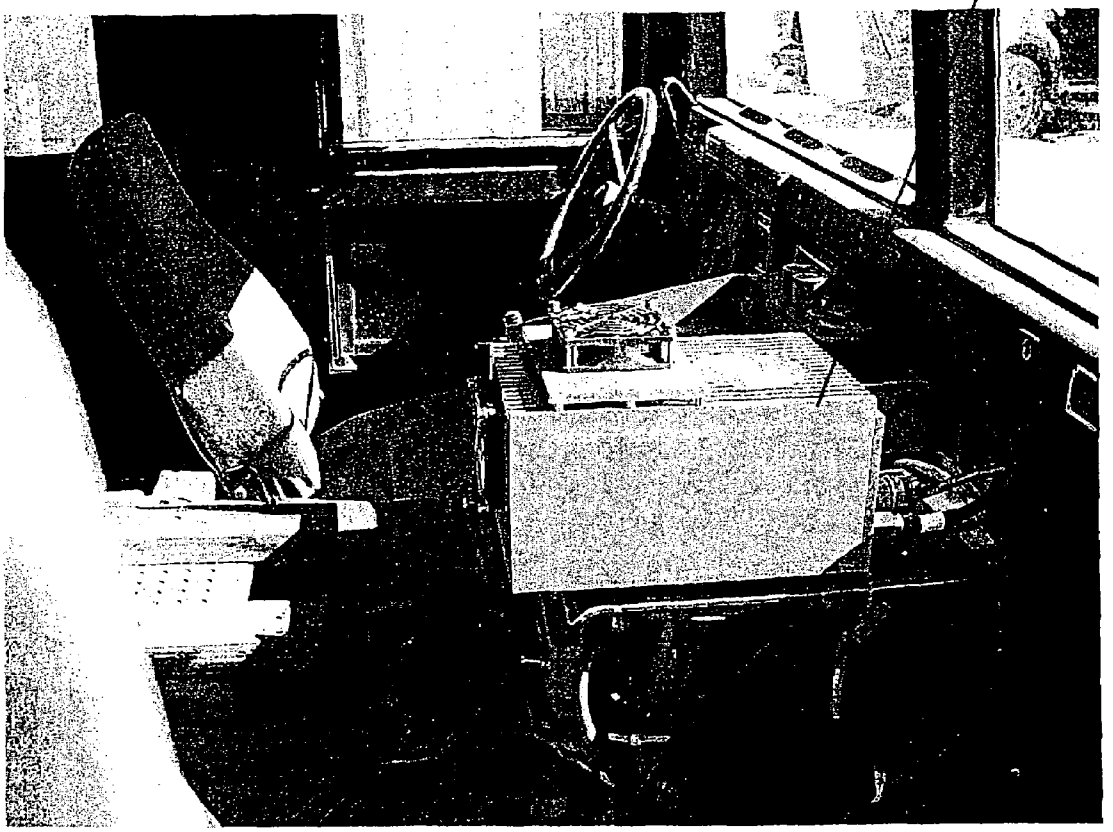
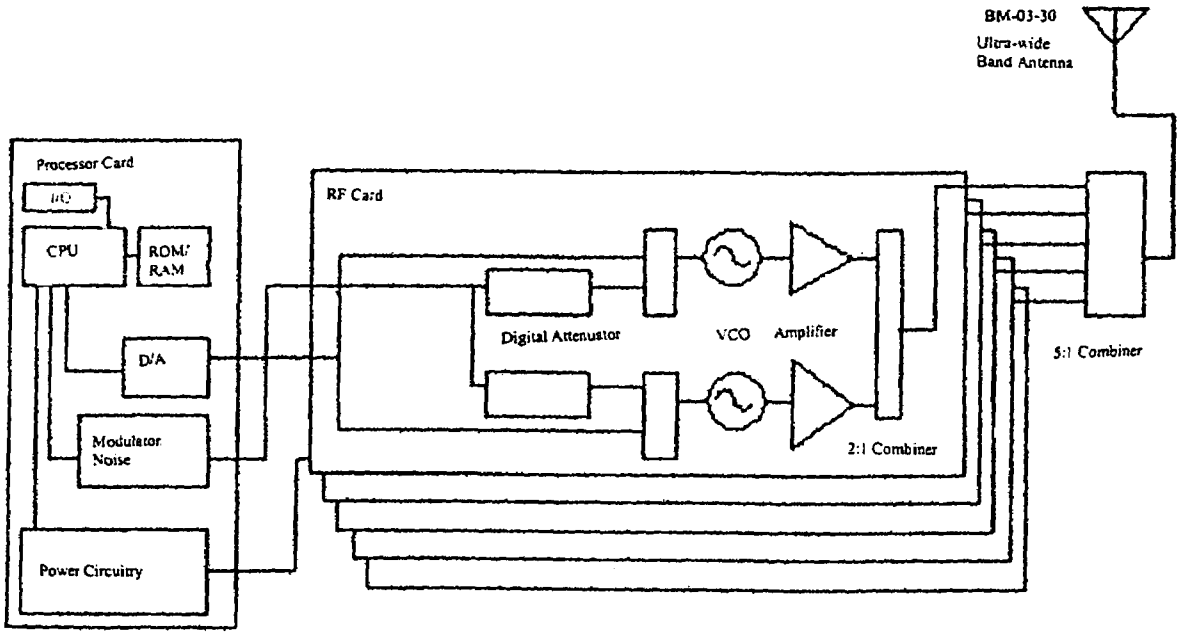


Fig. 3



SSVJ Block Diagram

Fig. 4

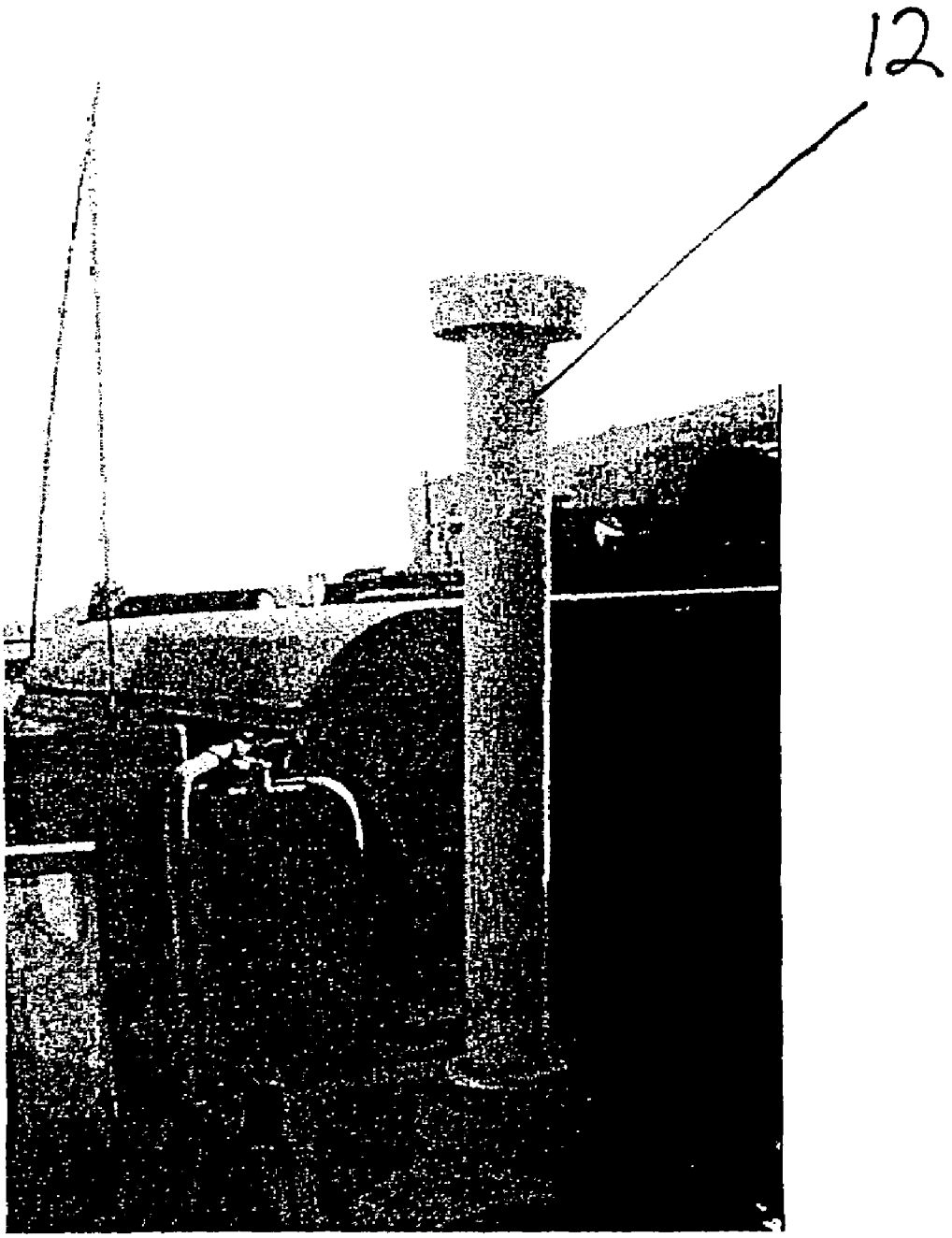
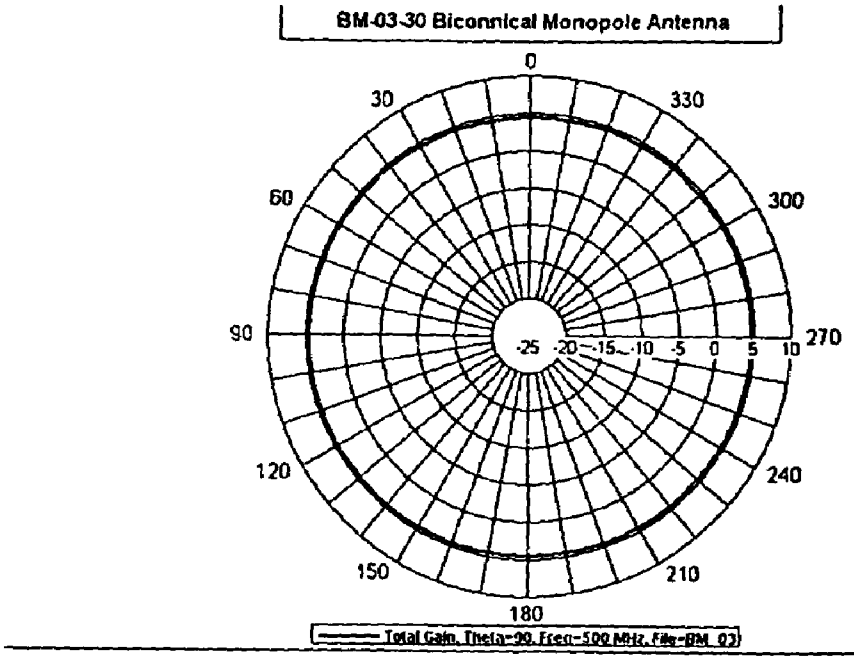


Fig. 5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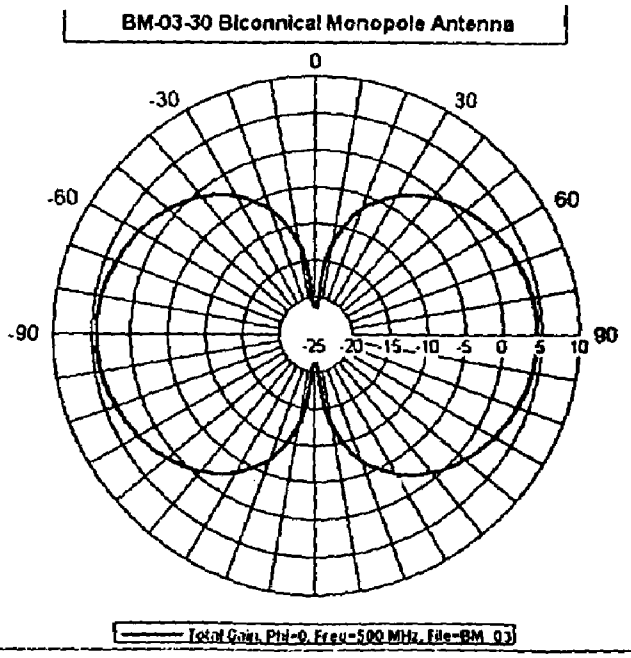
0
30
330
60
300
90
270
120
240
150
210
180
-25 -20 -15 -10 -5 0 5 10
Total Gain, Theta=90, Freq=500 MHz, File=BM_03

Fig. 6A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0
-30
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Fig. 6B

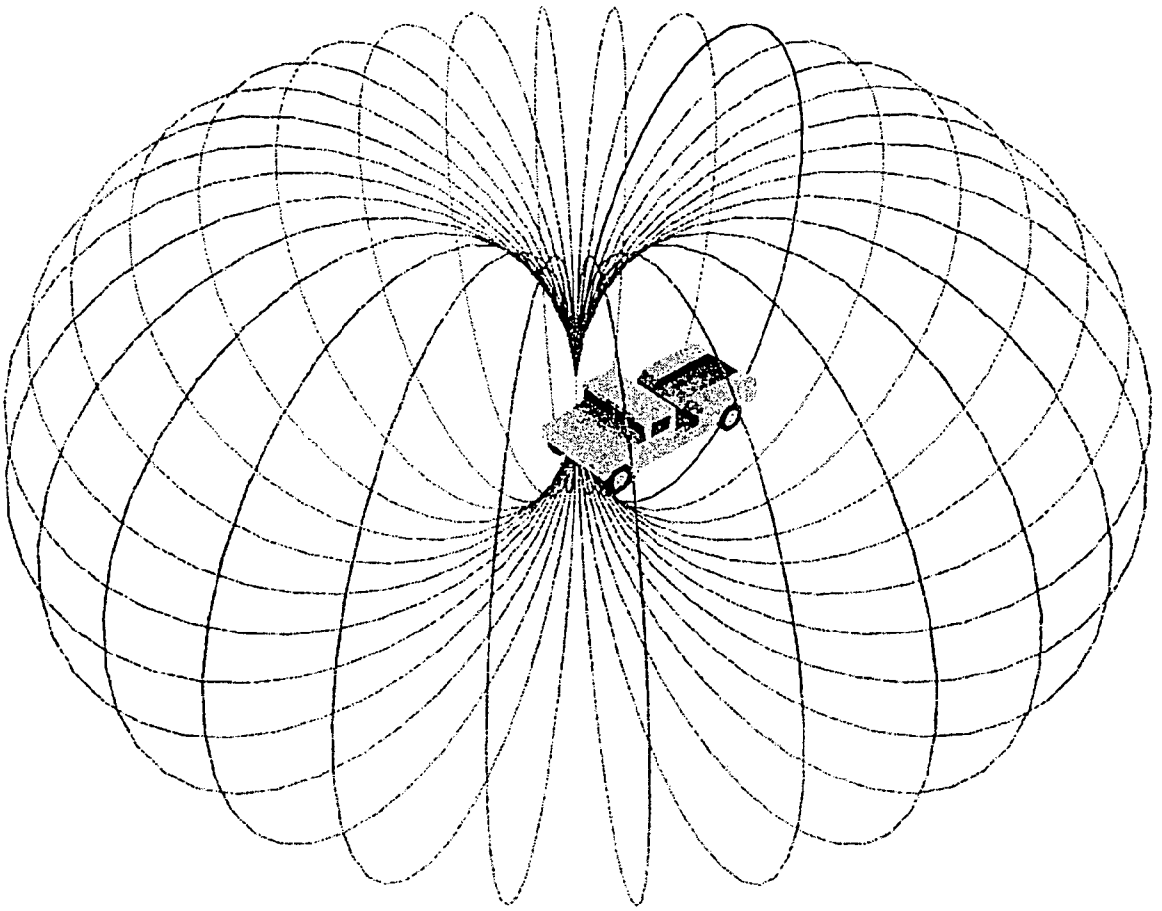

Fig. 6C

RADIO FREQUENCY JAMMER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing of U.S. Provisional Patent Application Ser. No. 60/543,615, entitled "Radio Frequency Jammer", filed on Feb. 11, 2004 and the specification thereof is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention (Technical Field)

The present invention relates to Radio Frequency (RF) jamming devices. Particularly, the present invention relates to an RF jamming apparatus and method which preferably operates at the same frequencies as those used to remotely detonate explosives commonly referred to as Improvised Explosive Devices (IEDs).

2. Description of Related Art

IEDs are explosive devices that are remotely detonated. These devices are used by military units, terrorist organizations, resistance groups, guerilla groups and the like, and are frequently employed to damage or destroy vehicles by remotely exploding an IED, by means of a radio frequency signal, when the vehicle comes within range of the IED. IED devices can also be employed against stationary targets, such as by having an IED in a vehicle that is parked in proximity to a target, and remotely detonating the IED. IEDs are a significant military challenge and threat. It is against this background that the present invention was developed.

BRIEF SUMMARY OF THE INVENTION

The present invention is a radio frequency jamming device comprising an electromagnetic radiating device comprising an antenna and an electronics unit, said electronics unit comprising: one or more analog radio frequency modulator cards, each of said cards comprising one or more Voltage Controlled Oscillators, one or more analog modulations, one or more power amplifiers and a single 2-way combiner; and one or more processor cards, said processor cards comprising a Central Processing Unit, and a Gaussian Noise generator, wherein an output from said electronics unit is electrically connected to said electromagnetic radiating device.

The present invention is also a method for preventing the detonation of a radio frequency controlled explosive device, the method comprising the steps of: selecting a frequency range, said range comprising the operating frequency of a receiver of the explosive device; and transmitting electromagnetic waves comprising Gaussian noise at frequencies of the selected frequency range, wherein the transmitting step comprises transmitting electromagnetic waves having a power of at least 10 watts.

A primary object of the present invention is to provide a low cost method and apparatus which saves lives and property from the destructive effects of explosive devices which are remotely detonated using radio frequencies.

Another object of the present invention is to provide a jamming device which can be operated by untrained personnel in the field.

A primary advantage of the device of the present invention is that it can be easily programmed in response to changing threats.

Another advantage of the present invention is that multiple different threats, which use different frequencies or modulation modes, may be eliminated simultaneously.

A further advantage of the present invention is that a user can prevent the detonation of radio frequency controlled explosive devices regardless of whether the user is moving or stationary.

Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

FIG. **1** is a photograph depicting a preferred embodiment of the present invention;

FIG. **2** is a table showing various frequencies commonly used in explosive devices for various regions of the world, as well as the power typically employed;

FIG. **3** is an image showing a side view of an electronics unit of a preferred embodiment of the present invention;

FIG. **4** is a block diagram of an embodiment of the present invention;

FIG. **5** is an image showing an electromagnetic radiating device used in an embodiment of the present invention; and

FIGS. **6**A, **6**B and **6**C are charts depicting the elevation and azimuth patterns produced by the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a low cost, portable, programmable jamming device for preventing detonation of remote controlled explosive devices.

The term "vehicle" as used throughout the specification and claims is used for the sake of simplicity and is intended to include any and all types of vehicles, including but not limited to those capable of traveling through the air, on the ground, across water, through water, or combinations thereof. While the term "vehicle" includes any device, apparatus, and/or structure capable of transporting people, the term "vehicle" is not limited to only those devices, apparatuses and/or structures capable of transporting people, but can also include devices, apparatuses, and/or structures capable of carrying cargo, including but not necessarily limited to the apparatus of the present invention. As such, the term "vehicle" can include a person carrying the apparatus of the present invention.

The present invention is directed to jamming Radio Frequency (RF) devices, particularly to jamming Improvised Explosive Devices (IEDs) as well as other remotely detonated explosives. While the present invention can of course be used in a stationary manner, such as, for example,

in or near an encampment, building, or other structure having a geographic location which remains fixed for extended periods of time, the present invention is also capable of operating while traveling and thus can be used with virtually any type of vehicle.

The present invention preferably interferes with remote control devices which can be used to detonate IEDs. The present invention is capable of protecting vehicles by blocking RF signals within an effective radius of the IED, thus preventing RF detonated devices from exploding near the present invention. In one embodiment, the present invention is preferably mounted in or on a vehicle. Vehicles having the present invention mounted thereon or therein are thus able to prevent RF triggered IEDs from exploding near them and are thus protected therefrom. The apparatus of the present invention is highly effective, rugged, and can be produced in large quantities in a short period of time.

FIG. **1** shows an embodiment of RF jammer **10** of the present invention. As depicted therein, jammer **10** preferably comprises a plurality of electromagnetic radiating devices **12** and electronics unit **14**. FIG. **3** depicts a side view of electronics unit **14** disposed in a vehicle. For reference, FIG. **2** is included and shows the frequencies, regions, and power which can be used in accordance with the RF jammer of the present invention.

The present invention preferably produces simultaneous and continuous interfering electromagnetic waves, preferably comprising Gaussian noise, in one or more frequency ranges which correspond with and block those frequencies typically associated with an IED (20-1000 MHz). The actual frequencies, bandwidths, and power levels of the interfering electromagnetic waves produced by the present invention are preferably programmable and may be changed as the IEDs used are changed. The modulation mode used is also preferably programmable, and comprises one or modes known in the art, including but not limited to $\Delta P/\Delta T$, $\Delta F/\Delta T$, and frequency hop modes. The exact frequencies and bandwidths used in accordance with the present invention are preferably determined and programmed based on the most recent information available. With the ability to program jammer **10**, the ability to adapt to changing tactics used by those making and using IEDs is thus realized.

FIGS. **6**A, **6**B and **6**C depict the toroid-shaped pattern typically generated by a monopole radiator, and the pattern depicted in these figures is also preferably produced by electromagnetic radiating device **12** of jammer **10** of the present invention.

FIG. **4** is a block diagram of preferred control electronics for an embodiment of the present invention. As shown therein, electronics unit **14** of jammer **10** preferably comprises a plurality of analog radio frequency (RF) modulator cards. Each card preferably comprises two digital attenuators, two voltage controlled oscillators (VCO's), two analog modulation blocks, two power amplifiers and a single 2-way combiner. The processor card (see FIG. **4**) preferably comprises a central processing unit (CPU), a Gaussian noise generator, and various digital logic control circuits that provide the necessary inputs to each RF modulator card. As depicted in FIG. **4**, the outputs from each of the analog modulator cards are preferably combined in a combiner before being passed to a wide-band antenna. A backplane for the antenna is preferably disposed as depicted in FIG. **3**.

By applying Gaussian noise from the Gaussian noise generator through the digital attenuators and the VCOs on each RF modulator card, the bandwidth is easily adjustable and programmable. The higher the attenuation is, the narrower the bandwidth. The bandwidth can preferably be varied from a narrow spike to about 40% of the center frequency.

Jammer **10** is preferably easily manufacturable using low cost components and modular to allow for the changing of major components, as well as for troubleshooting and repairing jammer **10**. The primary components of the jammer of the present invention preferably include: A wide band antenna, microprocessor card, high frequency (HF) RF card, a Very High Frequency (VHF1) RF Card, an Ultra-High Frequency (UHF1) RF Card, a second Ultra-High Frequency (UHF2) RF Card, and an L-Band RF card covering a lower end of frequencies. Each RF card preferably provides two frequencies in the appropriate frequency range.

While the power required to jam a RF device varies according to the particular device desired to be jammed, the present invention is preferably capable of transmitting at least about 10 watts of electromagnetic radiation from 25 MHz to 1000 MHz (continuous coverage). While an antenna of almost any size produces desirable results, it is preferable that electromagnetic radiating device **12** be less than or equal to about 32 inches high by about 4 inches in diameter. Electromagnetic radiating device **12** of the present invention also preferably has no active components. The antenna of electromagnetic radiating device **12** is preferably housed in a rugged radome capable of withstanding mechanical and environmental stresses and may be mounted externally or internally to any vehicle using a magnetic mount or other fastening element, system, or apparatus. Furthermore, electromagnetic radiating device **12** of the present invention is intended to appear to be part of the normal equipment commonly found on military vehicles, including but not limited to a Deep Water Fording kit.

Although reprogramming of the apparatus of the present invention can be accomplished in the field, it is preferable that such programming be performed by a depot level maintenance function. A more highly trained in theater military technician, a contractor in theater technician, or a technician at the contractor facility can preferably perform this function.

EXAMPLE 1

An RF jammer in accordance with the teachings of the present invention was constructed as follows:

First, the threat was evaluated. Based on the devices currently in use to remotely detonate improvised explosive devices (IEDs), the frequency range was found to be from 20 to 1000 MHz. The second step in this process was to establish which frequencies should not be interfered with. In this case, communications bands in use for HF satellite communications, VHF radio channels and UHF channels are designated as areas to avoid. The third step was to determine the power level and modulation required to interfere with the desired devices but to avoid frequency ranges of devices that should not be interfered with. An additional requirement was that the invention be highly cost effective, mass producible, programmable as the threats change, and be 100% effective.

Engineering challenges included the wide-band, electrically small and stealth appearing electromagnetic radiating device. The radiating device developed houses the BM-03-30, a biconnical monopole antenna. This antenna is a variant of the original biconnical monopole antenna developed by TMC Design Corporation in 1997 and extends the range and increases the gain of that original antenna to meet the needs of present invention.

The second major engineering challenge for the present invention was the development of an amplifier that was both cost effective and would have sufficient power output. The wide band amplifier developed has proven to be both with the added benefit of graceful degradation.

The third major engineering challenge was to allow the system to be effectively operated by non-trained operators. The operations and control methodology was therefore divided into three levels of control. The first level was the operator level, which is for the system operator requiring little or no intervention. For this level of control the operator turned the device on and checked for the operational status on operational indicators. The second level of operation was the maintenance mode, where the maintenance person assessed the operation of the device and repaired the unit by replacing cards. Additionally, the maintenance person was able to download threat database updates into the device. The threat database was generated at the third level of control for the system. The threat database was updated and changed based on the latest intelligence information concerning which remote devices were in use. In this way the jammer of the present invention was highly flexible and responded to changing threats but was still easy to operate by an untrained operator.

The final challenge was to transform the custom built jammer into one that is mass producible and can be supported in a field environment. The mechanical and electrical tolerances were adjusted to insure the final devices would perform properly, and assembly and automated test and tracking software and techniques were developed to allow the units to be assembled in large quantities while maintaining all operational specifications.

After the requirements were established, a prototype was fabricated and demonstrated. Based on the success of those tests, more elaborate electrical and thermal testing was performed to insure the electrical and mechanical design was sound. Simultaneously, the control and interface software was developed to allow control of this complicated device to appear simple. One final addition to the interface and control software was developed. This was in the form of a Windows-based program which allowed the user to update the threat database and load the new parameters directly into the electronics unit of the jammer.

The preceding example can be repeated with similar success by substituting the generically or specifically described operating conditions of this invention for those used in the preceding example.

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above and/or in the attachments, and of the corresponding application(s), are hereby incorporated by reference.

What is claimed is:

1. A radio frequency jamming device comprising:

an electromagnetic radiating device comprising an antenna; and

an electronics unit, said electronics unit comprising:

one or more analog radio frequency modulator cards, each of said cards comprising one or more Voltage Controlled Oscillators, one or more power amplifiers and a combiner; and

at least one processor card, said processor card comprising a processor and a Gaussian noise generator;

wherein an output from said electronics unit is electrically connected to said electromagnetic radiating device.

2. The jamming device of claim **1** wherein said device is portable.

3. The jamming device of claim **2** wherein said antenna is mounted on a vehicle.

4. The jamming device of claim **1** wherein said antenna is selected from the group consisting of a wideband antenna, a monopole antenna, and combinations thereof.

5. The jamming device of claim **1** wherein said electromagnetic radiating device is less than approximately 32 inches high and less than approximately 4 inches in diameter.

6. The jamming device of claim **1** wherein said electromagnetic radiating device appears as if it were part of normal equipment.

7. The jamming device of claim **1** comprising modular components.

8. The jamming device of claim **1** wherein said output comprises a programmable bandwidth or programmable frequency range.

9. The jamming device of claim **1** wherein said output is programmable by depot level maintenance personnel.

10. The jamming device of claim **1** further comprising at least one modulation mode selected from the group consisting of $\Delta P/\Delta T$, $\Delta F/\Delta T$, and frequency hop.

11. The jamming device of claim **1** further comprising a threat database.

12. The jamming device of claim **1** wherein at least one of said power amplifiers is a wide-band amplifier.

13. The jamming device of claim **1** capable of transmitting at least approximately 10 watts of electromagnetic radiation across a desired frequency range.

* * * * *