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(54) **APPARATUS AND METHOD FOR USER CONTROL OF APPLIANCES**

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(60) Provisional application No. 60/227,623, filed on Aug. 18, 2000.

Publication Classification

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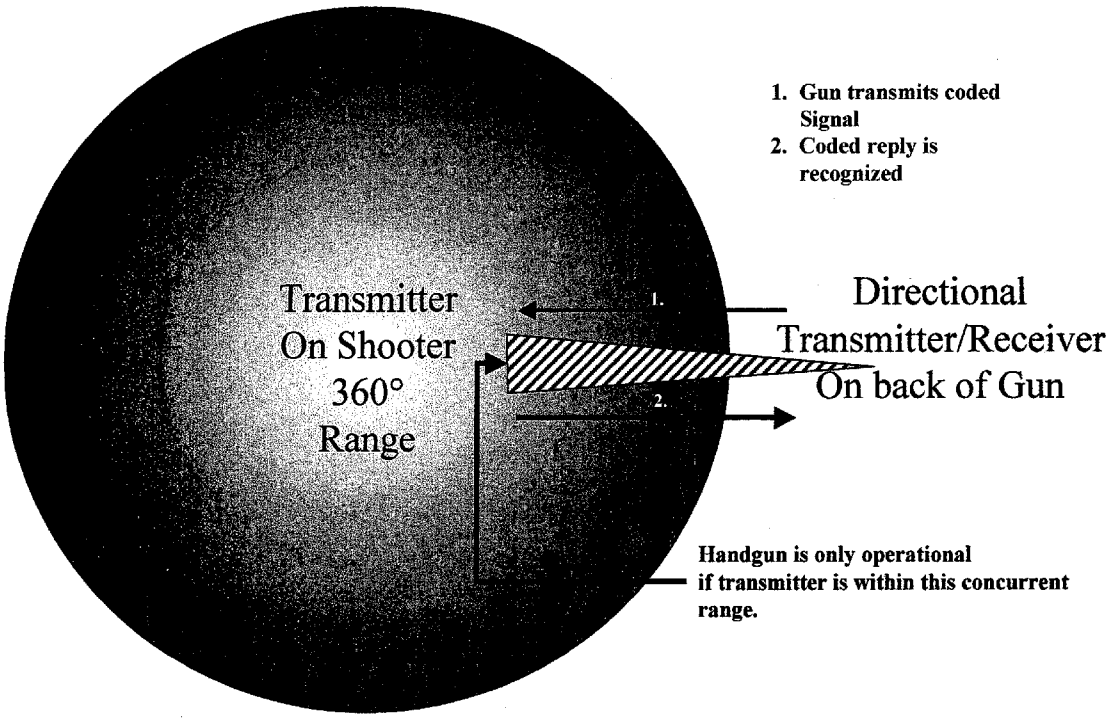
(52) **U.S. Cl.** **42/70.01**

(57) **ABSTRACT**

Apparatus and a method of controlling operation of a wide variety of appliances so the appliance can only be used by an authorized individual, and then only under certain specified conditions. The apparatus and method provide safe use of the appliance since presumably the person authorized to use the appliance is trained in its use, and where circumstances warrant, knows how to use the appliance safely. It is a particular advantage of the invention to prevent unsafe use of the appliance, even by an authorized user.



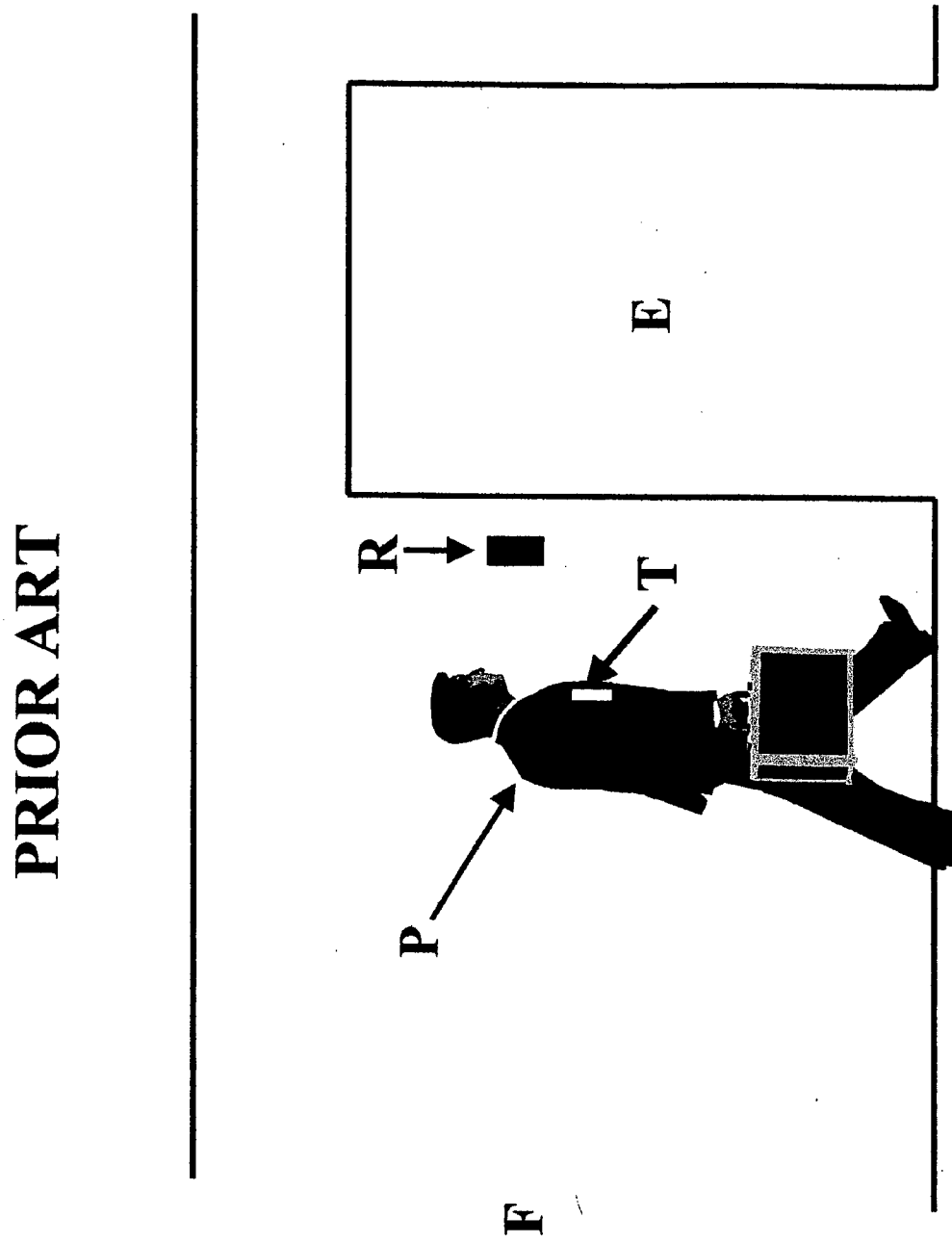


FIG. 1

PRIOR ART

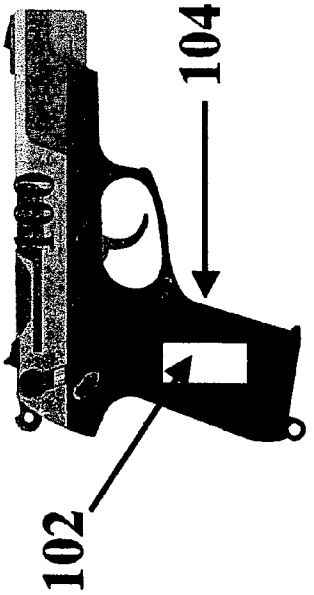


FIG. 2A

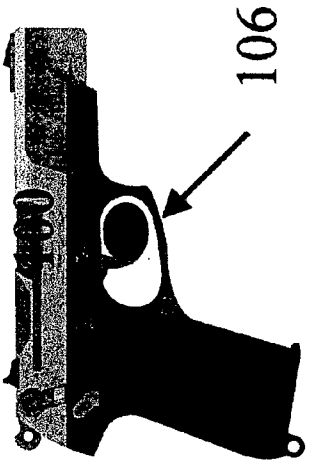


FIG. 2B

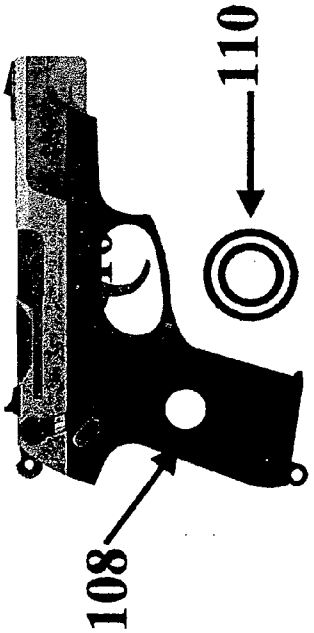


FIG. 2C

FIG. 2D

PRIOR ART

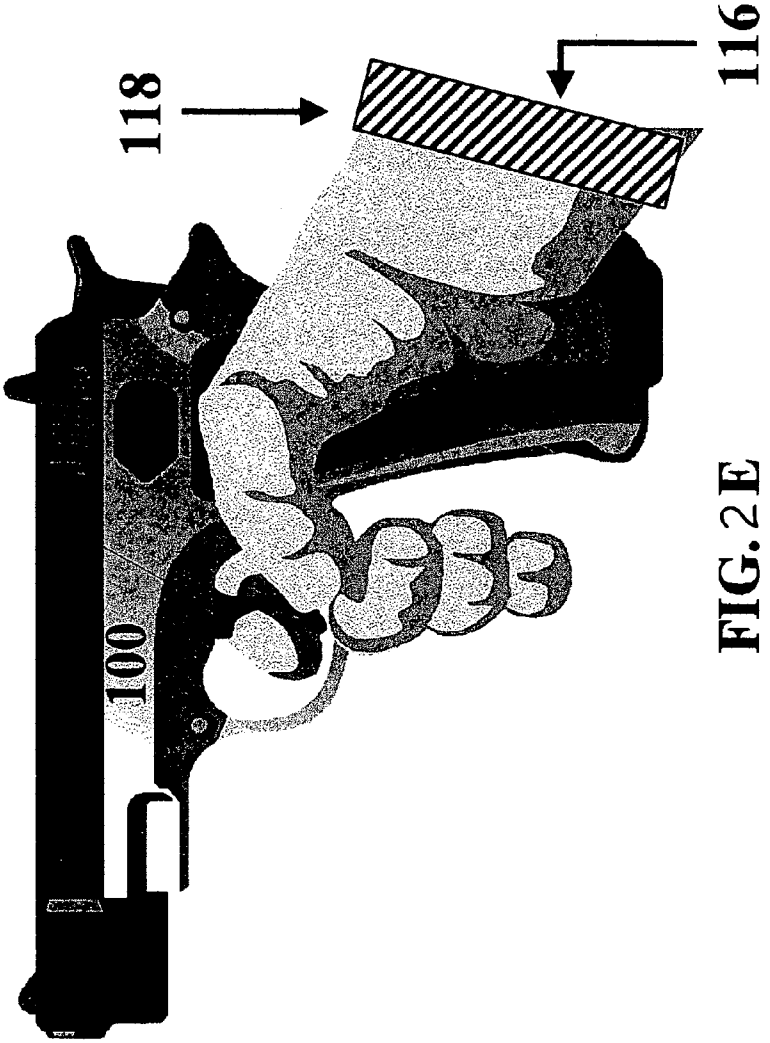


FIG. 2E

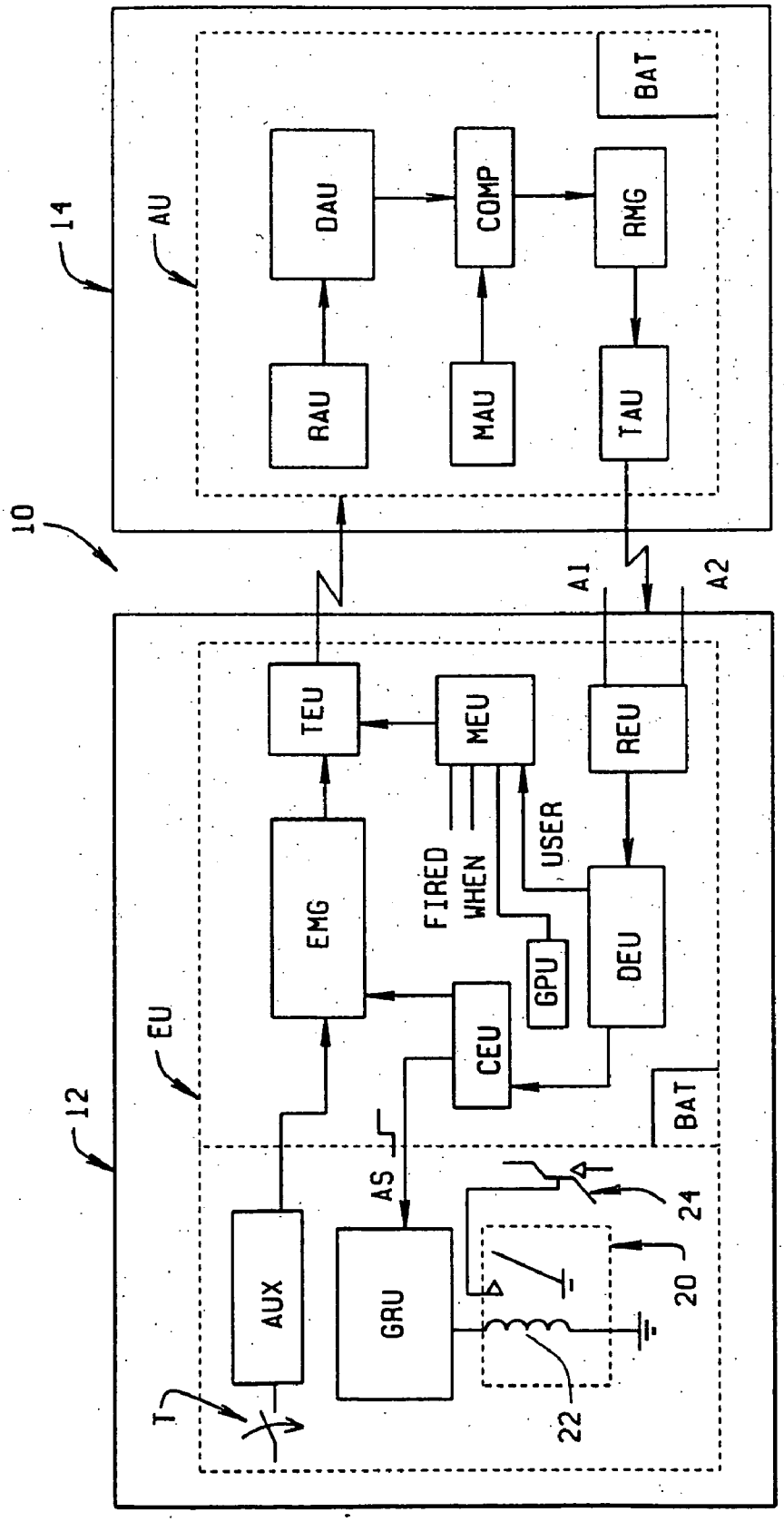

10
14
AU
DAU
COMP
RMG
BAT
RAU
MAU
TAU
A1
A2
12
EU
TEU
MEU
REU
EMG
FIRED
WHEN
USER
GPU
DEU
CEU
BAT
AS
AUX
GRU
24
20
22
I

FIG. 3

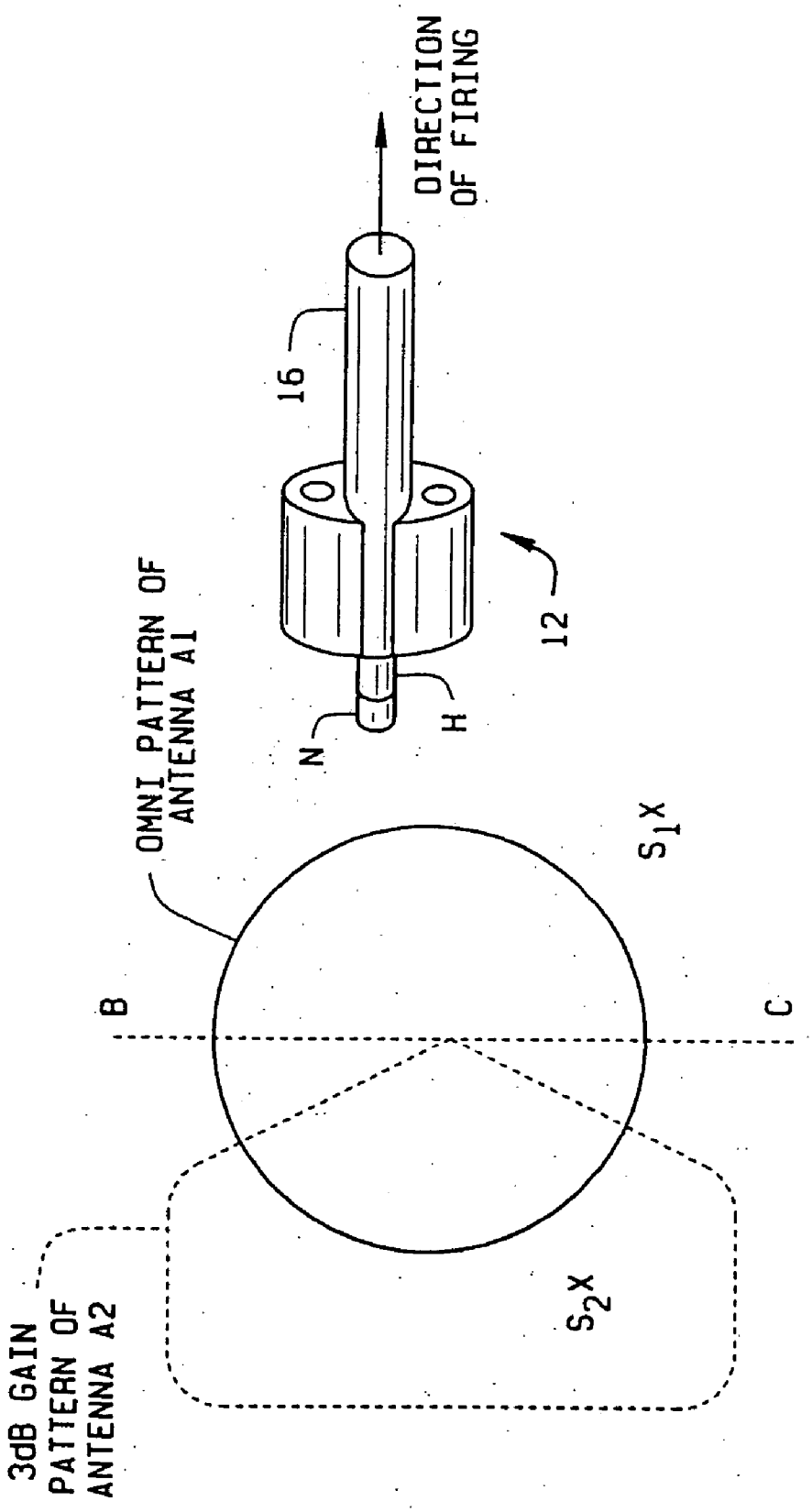

DIRECTION OF FIRING
16
12
N
H
OMNI PATTERN OF ANTENNA A1
S_1X
B
C
S_2X
3dB GAIN PATTERN OF ANTENNA A2

FIG. 4

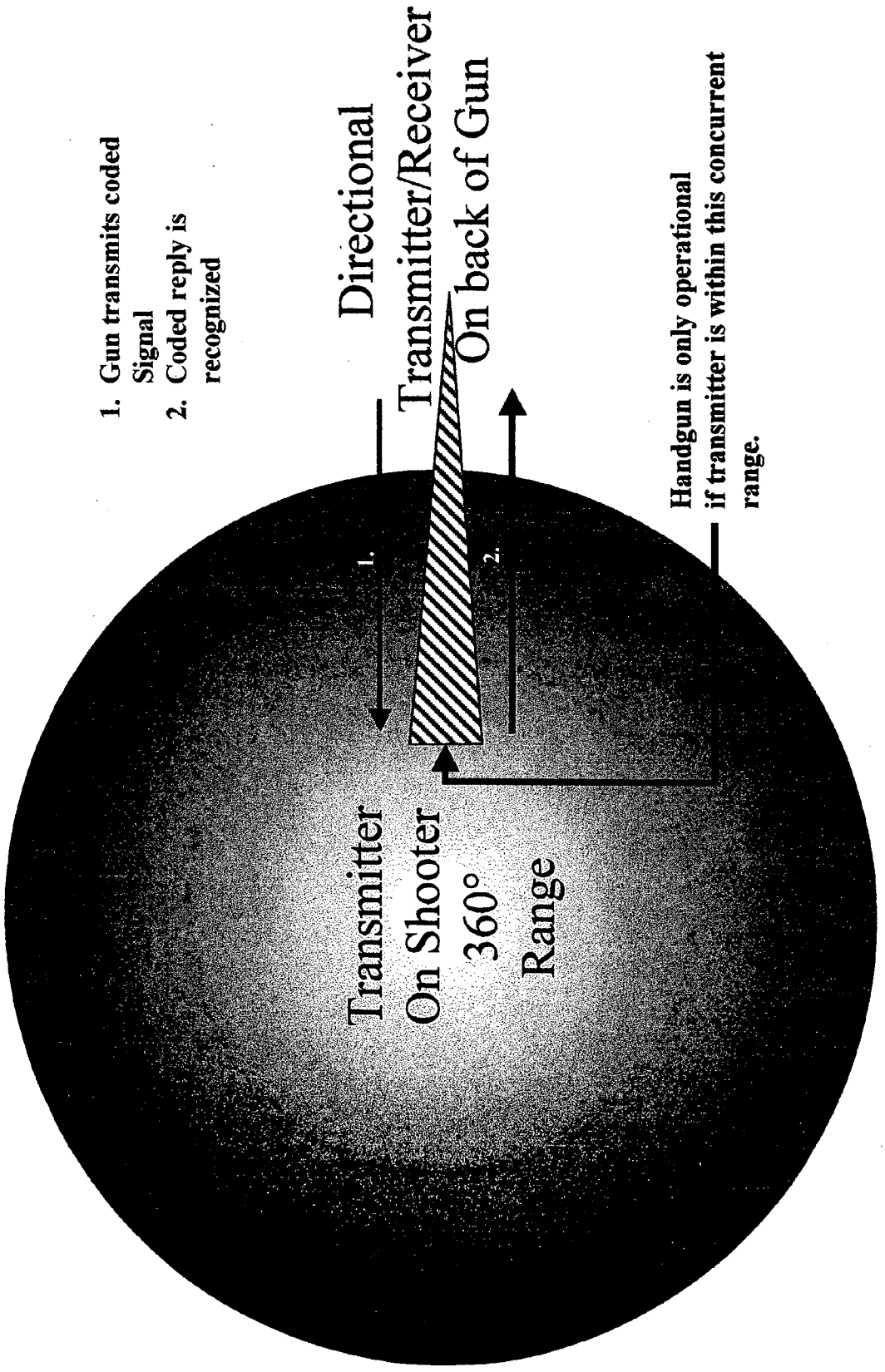

1. Gun transmits coded Signal
2. Coded reply is recognized
Directional
Transmitter/Receiver
On back of Gun
Handgun is only operational if transmitter is within this concurrent range.
1.
2.
Transmitter On Shooter
360° Range

FIG. 5A

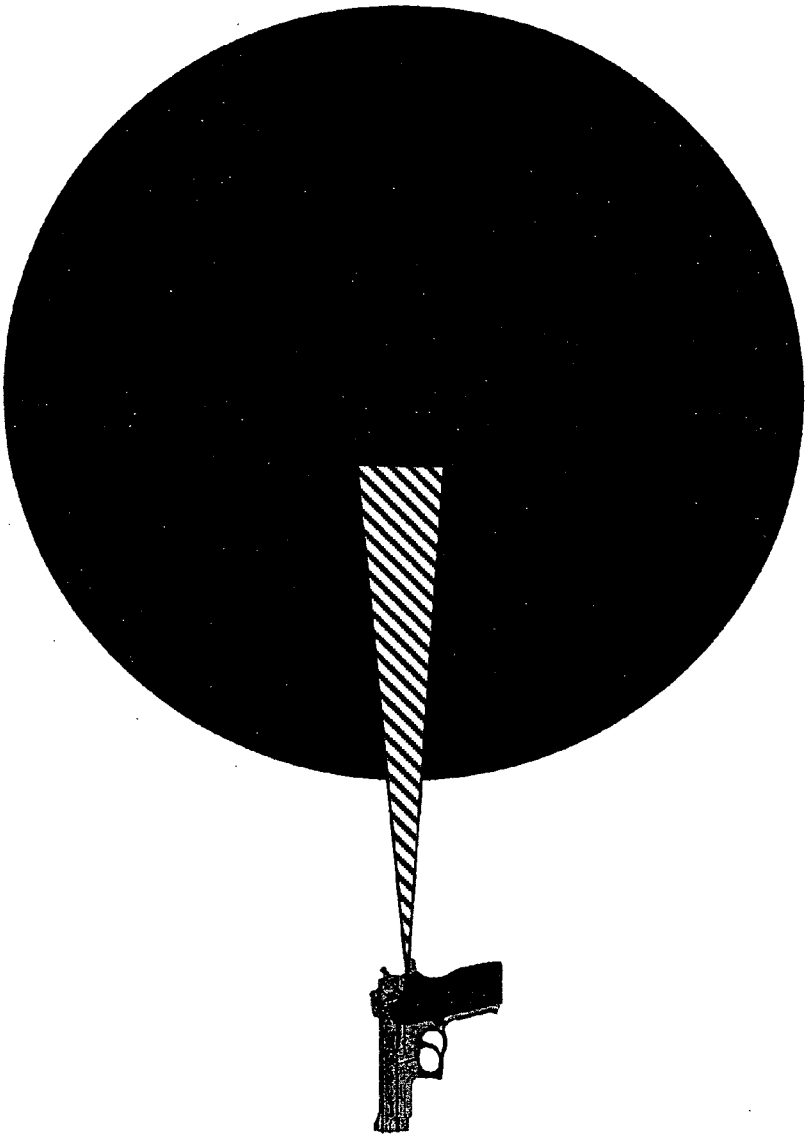


FIG. 5B

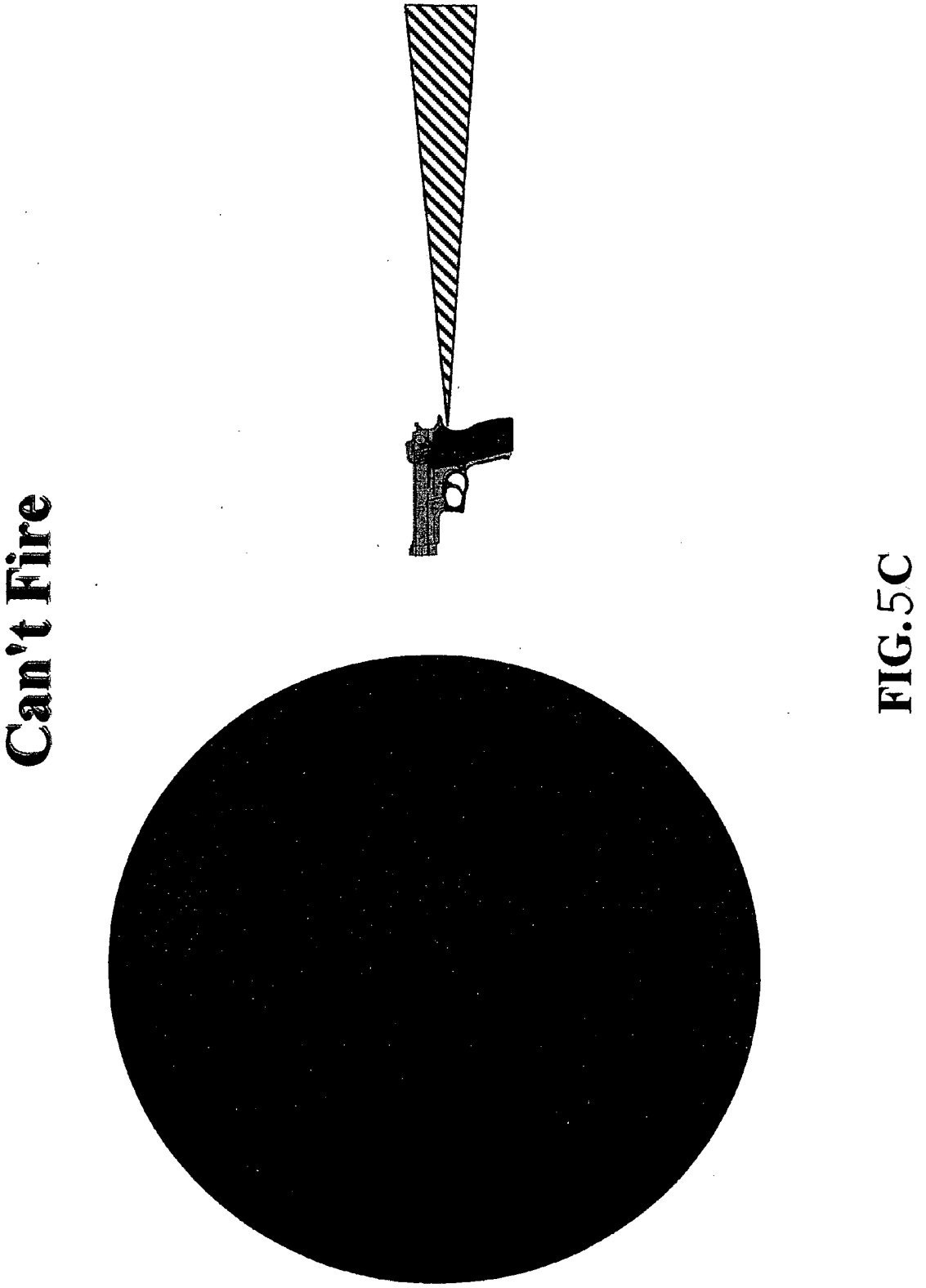


FIG.5C

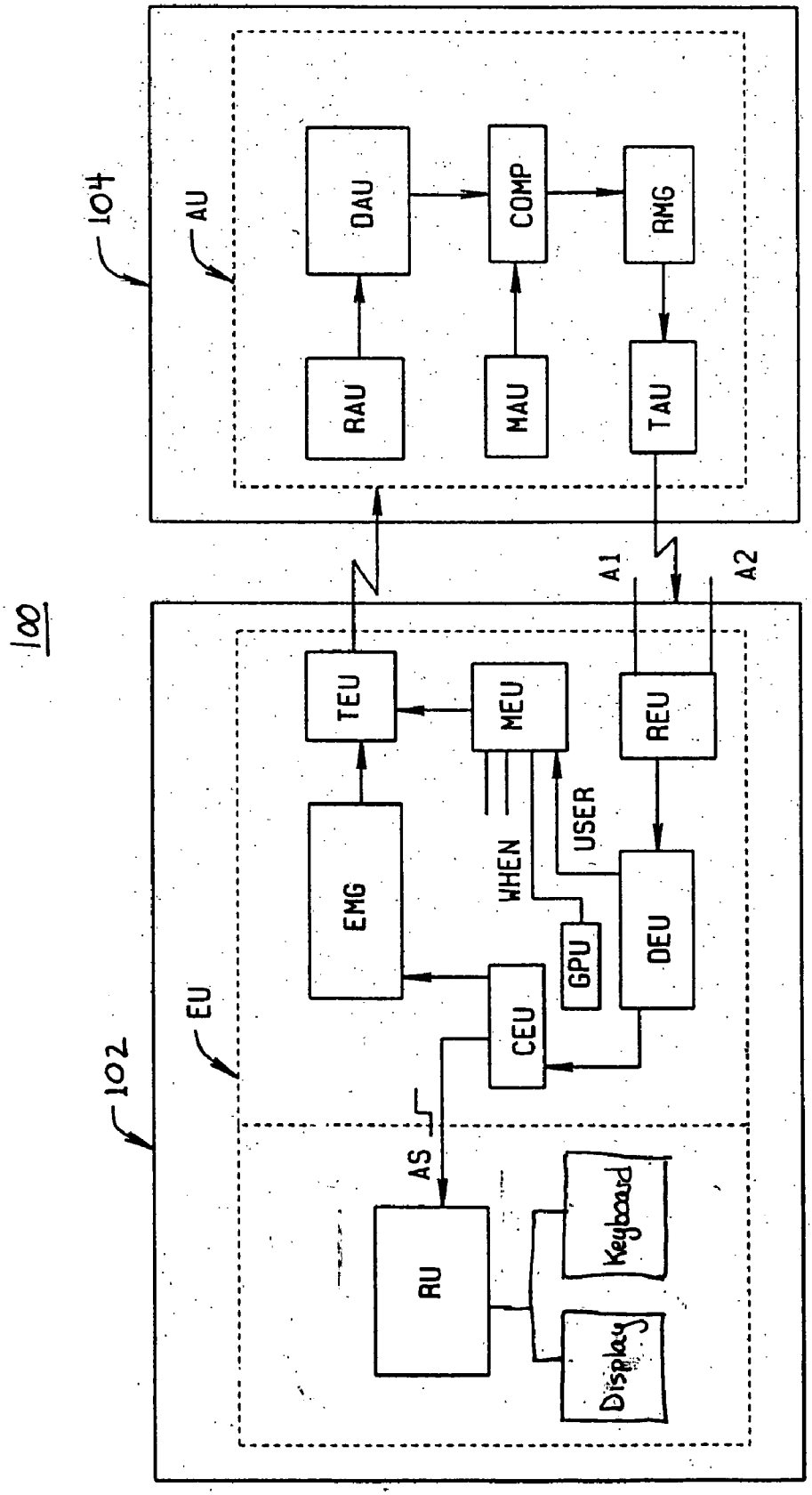

100
104
AU
DAU
COMP
RMG
RAU
MAU
TAU
A1
A2
102
EU
TEU
MEU
REU
EMG
WHEN
USER
GPU
DEU
CEU
AS
RU
Keyboard
Display

FIG. 6

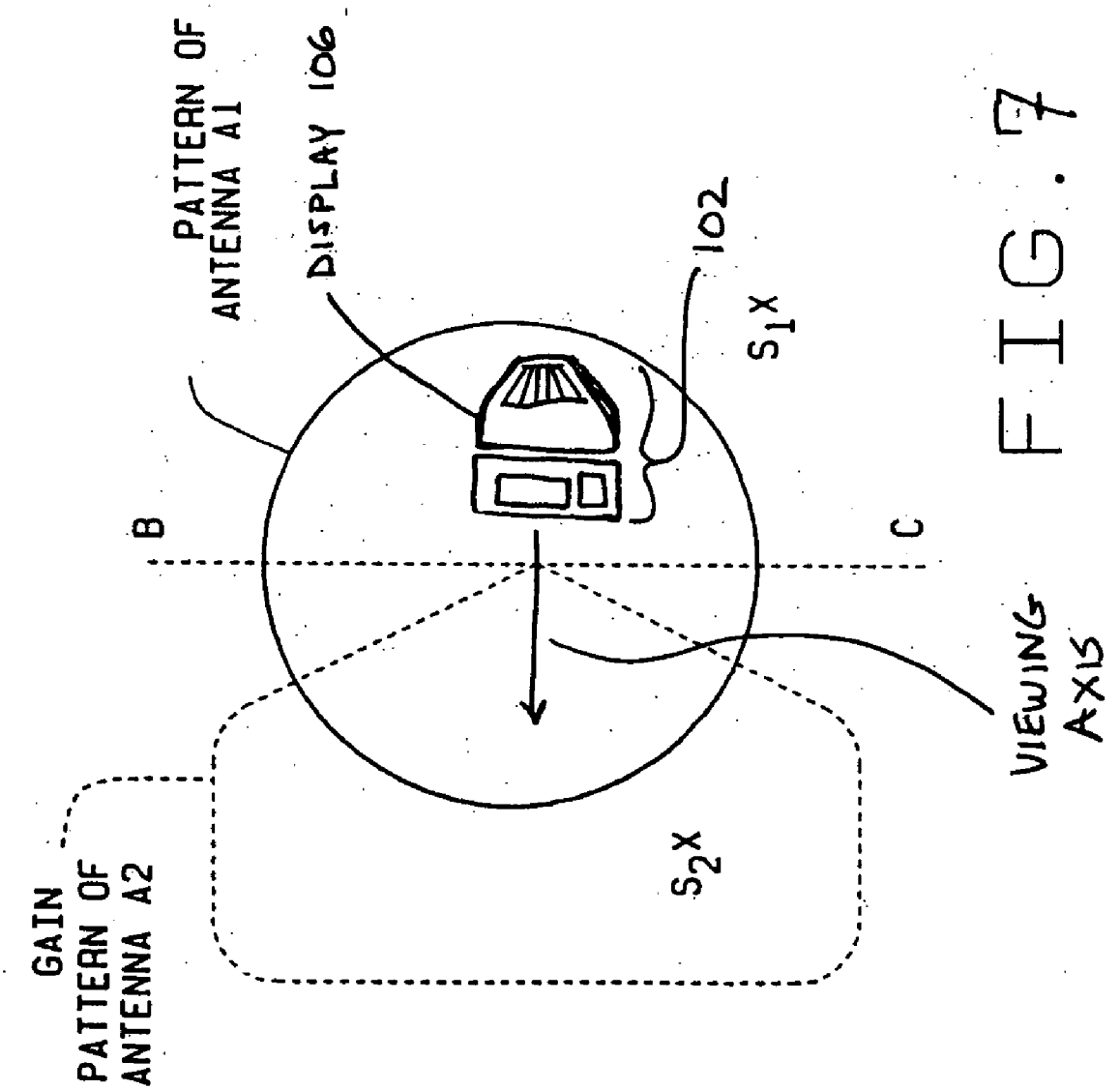

PATTERN OF ANTENNA A1
DISPLAY 106
102
S_1X
B
C
VIEWING AXIS
S_2X
GAIN PATTERN OF ANTENNA A2

FIG. 7

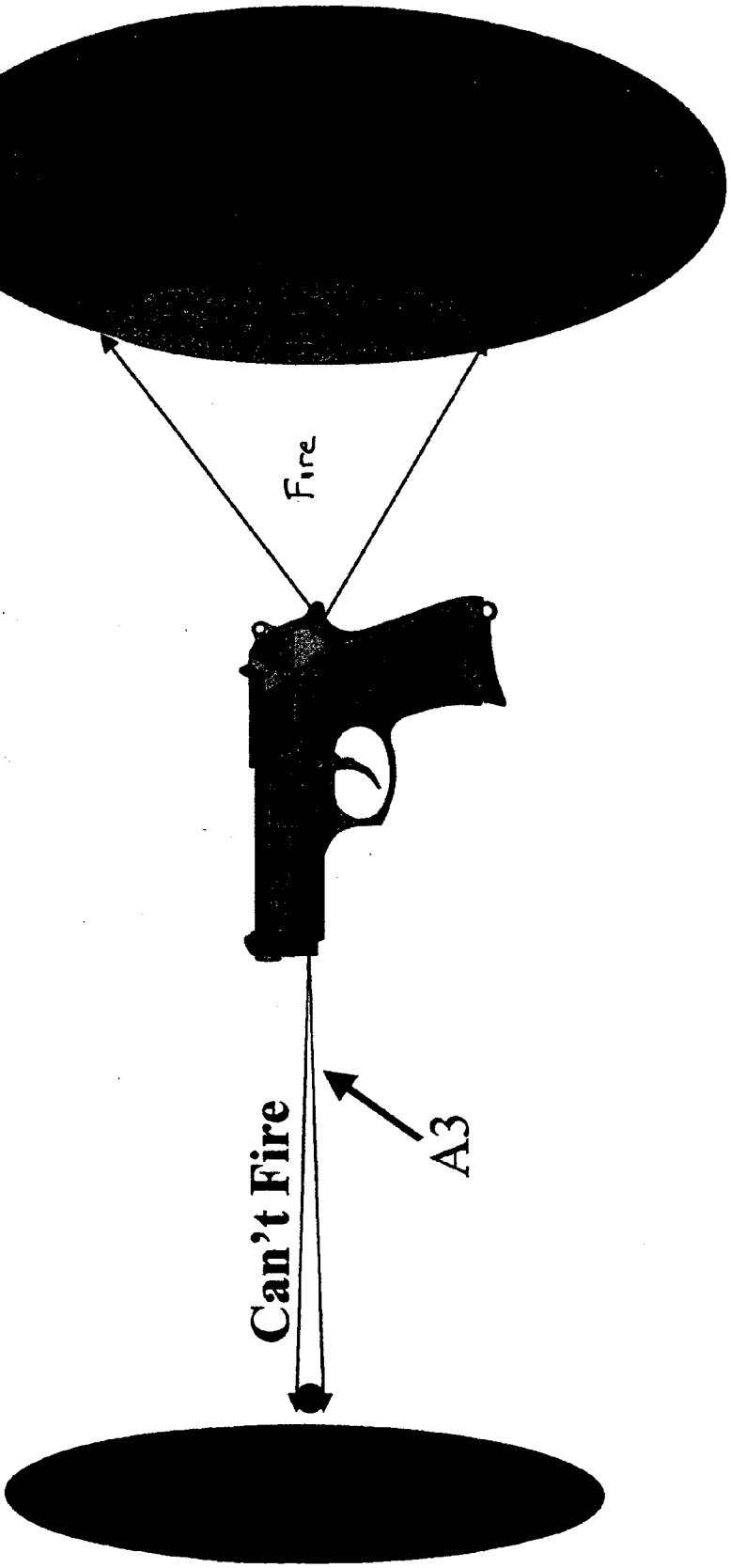


FIG. 8

APPARATUS AND METHOD FOR USER CONTROL OF APPLIANCES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation in-part of U.S. patent application Ser. No. 09/931,499, filed on Aug. 16, 2001, from which priority is claimed and which claimed priority from U.S. Provisional Application Ser. No. 60/227,623 filed on Aug. 18, 2000, both of which are herein incorporated by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

[0002] Not Applicable.

BACKGROUND OF THE INVENTION

[0003] This invention relates to access control, and more particularly to user control of appliances. The appliances include a wide range of appliances such as personal computers, firearms including handguns, rifles, shotguns, and other armaments, as well as other user controlled devices. An apparatus and method of the present invention facilitate usage of an appliance only by an authorized user or users. A particular example of the invention described herein relates to firearm safety by which only someone authorized to use a firearm can fire the weapon, and then only when that authorized person is in a preferred position (i.e., behind) with respect to the weapon. Further, the act of firing the weapon (or usage of the appliance) is recorded so data is subsequently available as to who fired the weapon and when it was fired. With respect to other appliances, the recorded information would indicate who used the appliance and when.

[0004] Referring to **FIG. 1** of the drawings, in the prior art, access control is a method or procedure by which entry into a facility F (whether it be a building or a portion thereof) can be limited only to persons authorized to have access. There are a number of conventional access control methods, one of which is referred to as radio frequency identification (RFID). Basically operation of an RFID system is such that a person P authorized for entry into the facility is given a badge ("tag") which includes a transmitter transmitting a radio-frequency signal of a given frequency. The signal is encoded. A radio-frequency receiver R is located at an entry E of the facility. As the person approaches the facility, the receiver receives the signal transmitted by the badge. If the signal is the proper one, the person enters the facility unimpeded. An unauthorized person is however blocked from entry.

[0005] An advantage of this type access control system is that it is transparent to the authorized person since he or she has to do nothing other than approach the entry, while a barrier is otherwise imposed to block entry of an unauthorized person. Other RFID systems include toll roads where a subscriber is given a RFID tag to place in their car. As the car approaches a prescribed gate at a toll station, the radio-frequency signal transmitted by the tag is received by a receiver at the gate and the vehicle is allowed to pass unimpeded through the gate. If an unauthorized person drives through the gate, an alarm is given. RFID tags are also placed, for example, on inventory items in warehouses so movement of merchandise can be automatically tracked as the merchandise is moved into and out of the warehouse.

[0006] In certain access control situations, as described herein, it may not be sufficient, or even inappropriate, that someone has access to an appliance. This is particularly so where use of the appliance (a firearm) by an unauthorized person (a child) can be harmful to that person or others, or where use of the appliance by unauthorized person can have other detrimental effects (access to a personal computer or automobile by one not supposed to be using it, for example).

[0007] Firearm safety is currently a major health issue. There are constant reports of children coming across a firearm kept in their home with tragic results. Stolen firearms are often used in the commission of crimes. Law enforcement records indicate that the vast majority of police and other law enforcement officers are killed with their own weapons taken from them by a criminal. Currently, a number of lawsuits have been filed against firearm manufacturers because of the relatively large number of people killed or injured due to weapons (particularly firearms) accidentally discharged. In some locales there are now programs to distribute firearm locks to firearm owners, and some firearm's manufacturers now provide firearm locks with each weapon they sell.

[0008] Referring to **FIGS. 2A-2C**, different types of prior art firearm locks are shown. In **FIG. 4A**, a mechanical combination lock **102** is mounted on the grip **104** of pistol **100**. To use the weapon, the operator must enter a multi-digit code and turn a manual safety knob. This disengages a locking lever which otherwise blocks operation of the firearm's firing mechanism.

[0009] In **FIG. 2B**, an electro-mechanical lock **106** has an associated motor which blocks the firing mechanism of the weapon. The lock provides a series of operating modes including unlocked and ready, locked and secure, and time delay locked and secure. Again an operator must enter a multi-digit code to enable the weapon.

[0010] In **FIG. 2C**, a magnet **108** installed in the firearm blocks its firing mechanism. A potential user must wear a special ring **110** on one of his fingers, the ring also containing a magnet. By properly orienting the magnets, when ring **110** is brought into proximity with pistol **100**, the internal magnet **108** is pulled away from its blocking position allowing the weapon to be used.

[0011] In **FIG. 2D**, another prior art approach includes an attachment **112** incorporating a fingerprint scanner **114** and which attaches to handle **104** of the weapon. An electronic circuit installed in the weapon disables it from being fired. When the firearm is to be used, the user places the pad of his finger against scanner **114** which obtains an image of his fingerprint. If the scanned image compares with an image stored in the memory, the circuit enables the weapon to be fired.

[0012] Another prior art approach is a radio-frequency controlled weapon shown in **FIG. 2E** that includes a transponder **116** installed in a cuff **118** worn by the user on his wrist. A transmitter/receiver mounted in the weapon sends out signals. If the transponder is in proximity of the weapon, a reply signal sent by the transponder back to the weapon enables it for firing.

[0013] While each of these previous approaches has certain advantages, each also has disadvantages with respect to implementation, use, cost, and effectiveness. The most significant disadvantages, however, is with regard to safety. It has been shown, for example, that certain types of locks installed on weapons can be circumvented and the weapon fired with the lock still in place. A magnetic ring can be easily duplicated. In the case of a person wearing the transponder cuff and having his weapon taken away from him, if he is still close enough to the weapon, as would occur if he were struggling over the firearm with an assailant, the weapon will still be enabled and can be used to injure or kill him.

[0014] The firearm safety method described herein employs radio-frequency techniques combined with a directional control capability. It is particularly effective in controlling the use of firearms and is especially worthwhile for use by police and law enforcement officers so to eliminate incidents of harm to these individuals.

BRIEF SUMMARY OF THE INVENTION

[0015] Among the several objects of the present invention may be noted the apparatus and a method of controlling operation of a wide variety of appliances so the appliance can only be used by an authorized individual, and then only under certain specified conditions. The apparatus and method provide safe use of the appliance since presumably the person authorized to use the appliance is trained in its use, and where circumstances warrant, knows how to use the appliance safely. It is a particular advantage of the invention to prevent unsafe use of the appliance, even by an authorized user.

[0016] The apparatus and method of the invention are, in one application, used for firearm safety. The apparatus, when used with a firearm enables an authorized user to enable (authorize) the firearm, so it can be used while the person is on duty. Most importantly, the apparatus and method of the invention only enables the weapon to be fired when the authorized user is in a preferred spatial position with respect to the weapon; i.e., behind the firearm with the discharge muzzle pointed away from the authorized user. Thus, even if the firearm is taken away from the authorized user, and the authorized user remains in close proximity, the firearm cannot be used against the authorized user.

[0017] Another feature of the invention is that more than one individual can be authorized to use the same appliance. In law enforcement or military scenarios, this means one person can use a firearm configured with an apparatus of the present invention during one interval, and another person may use the firearm at another time.

[0018] A further feature of the invention is the use of encoded transmissions between the appliance and the authorized user. A coding scheme is employed which prevents spoofing so that an unauthorized user cannot authorize the appliance.

[0019] A method of the invention requires continuous, periodic re-authorization to maintain the appliance in an authorized state. The encoding of the signals sent back and forth between the appliance and authorized user is constantly changed to prevent tampering, or unauthorized use or duplication.

[0020] A further feature of the invention is that authorization of the appliance can be overridden in certain circumstances. For example, authorization to activate a firearm may be overridden in a schoolroom or courthouse.

[0021] Another provision of the invention is an apparatus and method in which a record of use of the appliance is maintained including information as to who was using the appliance at any particular time. The information is then readily accessible to one subsequently interrogating the appliance using a different code than that by which the appliance is authorized for use.

[0022] It is also a feature of the invention that the apparatus and method can be implemented as an original equipment (O.E.) feature, or can be retrofitted to an existing appliance.

[0023] Finally, it is a provision of the apparatus and method to be a reliable and relatively low cost safety and user control feature. One portion of the apparatus is easily incorporated into a weapon, personal computer, automobile, etc., with another portion incorporated into a badge, driver's license, or other device carried by the authorized user.

[0024] In accordance with the invention, generally stated in one embodiment an apparatus and method of the present invention render a weapon incapable of use unless authorized by a specified individual in proximity to the weapon. More than one person may be authorized to use the weapon, however only one person may be authorized to use it at any one time. Each authorized person carries a badge or other device which includes a radio-frequency transmitter capable of transmitting a coded signal to a receiver installed in the weapon in response to a coded query from a unit installed in the weapon. If a properly coded transmission is received by the weapon, and from within a predetermined limited spatial position relative to the firearm, it becomes capable of being fired by the person who authorized its use. However, the weapon will not fire unless the person using the weapon is also standing behind the weapon. This prevents the weapon from being turned on the person authorized to use it. A memory internal to the weapon retains a record of who is using the weapon at a given time, but if the weapon is discharged, how many times, when, and where.

[0025] Besides firearms, the apparatus and method of the invention are readily incorporated into other appliances whose use is to be controlled and/or which it is important to operate in a safe manner. Other objects and features will be in part apparent and in part pointed out hereinafter.

[0026] The foregoing and other objects, features, and advantages of the invention as well as presently preferred embodiments thereof will become more apparent from the reading of the following description in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0027] In the accompanying drawings which form part of the specification:

[0028] **FIG. 1** is a simplified representation of a prior art access control system using RFID; and,

[0029] **FIGS. 2A-2E** are simplified representations of prior art firearm safety technologies;

[0030] **FIG. 3** is a block diagram of the firearm safety mechanism of the invention;

[0031] **FIG. 4** illustrates a directional control capability by which a weapon can be discharged only when in a specified relationship to an authorized user of the weapon;

[0032] **FIGS. 5A-5C** illustrate use of the apparatus and method of the invention in controlling use of a firearm;

[0033] **FIG. 6** is a block diagram of an alternate embodiment of the present invention adapted for use on computerized devices;

[0034] **FIG. 7** illustrates spatial relationships of antenna gain patterns and a computerized device defining an spatial region within which an authorized user must be present to activate the computerized device; and

[0035] **FIG. 8** illustrates an embodiment of the invention for use with firearms.

[0036] Corresponding reference numerals indicate corresponding parts throughout the several figures of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0037] The following detailed description illustrates the invention by way of example and not by way of limitation. The description clearly enables one skilled in the art to make and use the invention, describes several embodiments, adaptations, variations, alternatives, and uses of the invention, including what is presently believed to be the best mode of carrying out the invention.

[0038] Referring to the drawings, and to **FIG. 3** in particular, an apparatus of the present invention for providing user control of an appliance is indicated generally **10**. A representative embodiment of the apparatus and method of the invention adapted for use as a firearm safety mechanism is described with respect to **FIGS. 3, 4**, and **5A-5C**.

[0039] As now described, a key feature of the apparatus is the communication and cooperation between a regulating means such as an electronic unit EU contained within a firearm **12**, and a separate, authorizing unit AU carried by an "authorized user" of the firearm. The authorizing unit is, for example, is incorporated into a badge **14** worn by a policeman when on duty. Electronic unit EU, which is mounted or otherwise installed within firearm **12**, first includes an electronic message generator EMG. Generator EMG generates a uniquely coded waveform which, as shown in **FIG. 3**, is transmitted by a transmitter TEU as a radio-frequency signal to authorizing unit AU to interrogate the authorizing unit. As further discussed hereinafter, apparatus **10** allows for more than one authorized user of the weapon.

[0040] Accordingly, the message embodied in the transmitted coded waveform can authorize more than one authorizing unit AU. However, the message will authorize only those authorizing units which are complementary to the particular apparatus.

[0041] Upon receipt of an interrogation message by a receiver RAU of an authorizing unit AU, the message is decoded by a decoding electronics section DAU of the authorizing unit. The decoded message is then compared in a comparator COMP with a message previously stored in a memory MAU within the authorizing unit to determine if this particular authorizing unit AU is one authorized for use with this particular firearm **12**. If it is, then a reply message generator RMG of the authorizing unit generates a reply message which also comprises a uniquely coded waveform. This reply message is then transmitted by a transmitter TAU as an radio-frequency signal back to electronics unit EU within firearm **12**.

[0042] A reply message receiver REU within electronics unit EU receives the message and provides it to decoder electronics section DEU within the electronics unit. Decoder DEU decodes the reply signal. An output signal AS from decoder DEU, verifying that an authorized user of the weapon has responded to the query from the electronics unit, is now used to activate the weapon.

[0043] An important aspect of the method and apparatus of the invention is that more than one person can use the weapon. In a police or military environment, this means that one officer (or soldier) can use the weapon during one shift (tour of duty), and another officer (soldier) during another shift (or tour). Since there can be more than one authorized user for a given weapon, each authorizing unit AU includes a unique code within the reply message identifying which authorized user (police officer or soldier) is replying to the interrogation message. This information is stored within a memory MEU of electronics unit EU so a record is made as to which authorized user is controlling the weapon at a given time.

[0044] Referring to **FIG. 4**, receiver REU includes two separate antennas; a first antenna **A1**, and a second antenna **A2**. Antenna **A2** preferably has a gain of 3 dB in the horizontal plane, sufficient to provide approximately 180° of coverage in the horizontal plane, i.e., it provides directional sensitivity. Antenna **A2** is set up such that its principal axis is in the plane of a firearm barrel **16**, but is aligned backwards, away from the discharge direction of the firearm. The pattern of antenna **A2** shown in **FIG. 4** is for the horizontal plane. In the vertical plane, both antennas **A1** and **A2** preferably have 0 dB of gain.

[0045] Differencing the signals received at antennas **A1** and **A2** (**A2-A1**) and accepting only positive signals, ensures that only signals originating behind a plane BC of the firearm authorize operation of the firearm. By way of example, a signal S, from the right of plane BC, results in (**S1**×gain of **A2**)−(**S1**×gain of **A1**)=(**S1**×0)−(**S1**×1)=−**S1**. This is a negative signal. On the other hand, a signal **S2** from the left of the plane BC results in (**S2**×gain of **A2**)−(**S2**×gain of **A1**)=(**S2**×2)−(**S2**×1)=**S2**. This is a positive signal. Further, this positive signal is measured against a threshold such that authorizing unit AU not only has to be behind plane BC, but also within a certain distance of firearm **12** in order to authorize use of the weapon. The combined limited position relative to the firearm **12** and distance from the firearm **12** define a spatial region within which an authorized user of the firearm **12** or appliance must be located to authorize the operation of the firearm **12** or apparatus.

[0046] Upon receipt of a positive signal at receiver REU, the signal is decoded. If the decoded signal is from an appropriate authorizing unit AU, the decoder sends a message to a control unit CEU of the electronics unit. Upon receipt of this signal, the control unit deactivates a firearm restraint unit GRU which is interconnected with the firing

mechanism of the weapon. Deactivating the firearm restraint unit frees the firearm to fire. However, as discussed hereinafter, this is a controlled feature of the invention and the weapon must be re-authorized at predetermined intervals or else it will again be rendered unusable.

[0047] Since the firearm **12** or other appliance is normally maintained in a deactivated or restricted-use state prior to receipt of an appropriate authorizing signal from within a predetermined spatial volume, the apparatus **10** of the present invention is resistant to radio-frequency interference or jamming of the signals from the authorizing units AU. If a signal from an authorizing unit AU is jammed or corrupted by jamming or interference, the electronics unit EU will maintain the firearm or apparatus in the deactivated or restricted-use state until a clear and proper signal is received from an authorizing unit.

[0048] Control unit CEU performs a number of tasks. First, as described above, the control unit controls provides activation signals to the firearm restraint unit.

[0049] Second, the control unit effects a query and response cycle through message generator EMG. The query/response cycle is, for example, triggered once every second. If a correct response is received, and firearm **12** has already been activated, the firearm remains activated for another 1-2 seconds. In effect, firearm **12** remains continuously activated in the presence of continuous queries from the firearm's electronics unit and affirmative responses from the authorization unit carried by an authorized user of the weapon. If the weapon has been activated, but subsequently does not receive an affirmative response to a query, a second query and response cycle is immediately initiated. If an appropriate response is again not received, weapon **12** is rendered inactivate by firearm restraint unit GRU. The initial interrogation cycle (the one second query/response cycle) then recommences. It will be understood by those skilled in the art that the time intervals specified herein are exemplary only and that other timing can be used. It will further be understood by those skilled in the art that the codes used in practicing the method of the invention can be automatically changed at predetermined intervals, including each time an interrogation signal and response signal are sent. Changing the coding makes it extremely difficult for unauthorized users to enable the appliance.

[0050] Both electronics unit EU and authorization unit AU are battery operated by batteries BAT. Battery life is dependent upon operational life and all attempts are used to preserve the battery life. Typical operations should achieve a 10 year life. A similar 10 year life is anticipated for the separate battery that operates the authorization unit. In one embodiment, the battery that resides in the firearm is a rechargeable unit. However, issues of firearm safety during recharging outweighs certain advantages this might offer.

[0051] In the electronics unit, control unit CEU minimizes power consumption. To save battery life, an auxiliary circuit AUX is employed which starts the query/response cycle. This circuit is activated, for example, when a person grips a handle of the firearm. Picking up the firearm by its handle closes a contact T which activates this interrogative and answer sequence. When the firearm is no longer being held, opening of the contact T activates the auxiliary circuit to commence an interrogation cycle and to continue the cycle for a specified interval; for example, 15 seconds. With a positive response, the weapon is activated as above described. Otherwise, after the interval, control unit CEU returns electronics unit EU to a quiescent state in which essentially no power is consumed and in which the weapon is deactivated.

[0052] The interaction between authorization unit AU and electronics unit EU is to establish whether firearm **12** is disabled or enabled. Firearm restraint unit GRU actually enables or disables the weapon. The firearm restraint unit is a fail safe device since in the event of loss of battery power, for example, the firearm is secured in a disabled state or condition.

[0053] Apparatus **10** is available in at least two models for firearm applications. In one model, the firearm is manufactured with apparatus **10** built in. In the other model, firearm **12** is retrofitted with the apparatus. The apparatus includes, for example, a solenoid **20** which, when its coil **22** is deactivated, blocks the mechanical motion of the firearm's hammer or trigger. When firearm **12** receives an authorization signal AS from control unit CEU, coil **22** is energized and solenoid **20** retracts to clear the firing mechanism. Solenoid **20** is a discrete solenoid which operates in conjunction with a semiconductor **24**. The hammer and/or the trigger are now free to operate normally. Apparatus **10** does not supersede, interfere with, or otherwise effect a mechanical safety with which the firearm is usually provided. Both apparatus **10** and the mechanical safety have to be disengaged before the weapon can be fired.

[0054] As shown in **FIGS. 5A-5C**, a method of the invention involves two steps. In step **1**, the firearm, in effect, transmits a coded signal. In step **2**, a coded reply signal is received back by the firearm. The firearm is then authorized to fire only if the reply signal is an appropriate response and if the reply signal is directed to the firearm from a predetermined direction relative to the firearm. Otherwise, the firearm is not enabled for use even though the reply signal is an appropriate response. Thus, as shown in **FIG. 5B**, if the authorized user is behind the firearm, the firearm is enabled to fire. However, if the authorized user is in front of the firearm, it is not enabled and cannot fire.

[0055] An additional feature of apparatus **10** is the provision of an electronic record of the use of the firearm. As noted, electronics unit EU includes a memory unit MEU. Each time firearm **12** is fired, data is provided to the memory which records the time, date and the authorized user employing the weapon at that time. A sensor N (see **FIG. 4**) senses movement of the firearm's hammer H. An internal clock built into the electronics unit provides time information. Additionally, an optional global positioning unit GPU can be used to provide location information. To download this information from memory MEU, electronics unit EU receives a specific interrogation code or codes (which codes are different than the authorizing code). In response, memory unit MEU provides its stored data to transmitter TEU of the electronics unit for transmission to data receiver. Included in this transmission is the license number of the weapon. It will be noted that while the authorizing codes are unique to the firearm they enable, the interrogating codes for data retrieval are universal codes available to the police and other law enforcement and other investigative agencies. Further, the activation code takes precedence over a data retrieval code and the downloaded data will not include the

authorizing code for the weapon. The use of codes allows for future developments in other areas. For example, in a courtroom or schoolroom setting, universal transmission of certain codes would override authorization of the weapon and inhibit the use of the firearm in these settings.

[0056] Both electronics unit EU and authorization unit AU are preferably fabricated in a very compact form which parallels a RFID-format circuit using thin film technology. Importantly, apart from details of their operation, and directionality, these units employ existing technologies and utilize radio frequencies standard within the industry; for example, they can be implemented using "Bluetooth" technology. Both units are acceptable to Class 15 services.

[0057] Again with respect to **FIGS. 5A-5C**, the importance of the apparatus and method of the present invention is that the weapon is authorized for use only when the authorized user is in a preferred position with respect to the weapon. That is, when the user is behind the weapon and the muzzle of the weapon is pointed away from him, the condition shown in **FIG. 5B**. In a law enforcement situation, if a police loses his weapon in a struggle with a criminal, the criminal cannot shoot the officer with the weapon because it will not fire, the condition shown in **FIG. 5C**. This is so, even if the assailant also has an authorization unit; because, as discussed, each unit is unique to a particular weapon. Were the person who got the weapon away from the policeman to try to use the weapon in commission of another crime, it would not fire. This does not mean that the fright effect caused by having the weapon pointed at someone would still not be there, but the victim could not be shot with the weapon.

[0058] In hunting situations, if the hunter were to drop a loaded weapon because of an accident or carelessness, the weapon would not discharge if the muzzle were to somehow come to be pointed at the user. Again, this is the condition shown in **FIG. 5C**. In home environments, a toddler or child who came across a weapon could not inadvertently shoot himself or another because the apparatus would not allow the weapon to fire.

[0059] While the foregoing discussion is directed to use of the apparatus and method of the invention in firearm's safety, those skilled in the art will appreciate that it can be used to effect user control of a myriad of appliances. These include home appliances such as televisions and VCR's, kitchen appliances such as stoves, laundry or bathroom items such as steam irons, hair dryers, curling irons, etc. That is, appliances where the ability to control when the device is turned on or off has safety implications and prevents injury, for example, to small children or senile adults who might otherwise inadvertently injure themselves. Alternatively, the invention prevents those who have no legitimate reason to be using someone else's property from using it.

[0060] In industrial settings, machine tools can similarly be controlled so that only persons having the "right" to the use the equipment can turn it on and use it. If the person's position relative to the equipment can be such that they can be injured by the equipment, the apparatus and method of the present invention will insure that the equipment is activated only so long as the user remains in a safe position relative to the equipment; i.e., a position where he cannot be injured by it.

[0061] The apparatus and method may also be employed for theft prevention. Movable items such as automobiles, carts such as golf carts, trucks, vans, etc. can be effectively prevented from being started and driven away by incorporating the apparatus and method of the invention with the ignition or fuel delivery system of a vehicle, including those which are battery powered.

[0062] Also included in this category of appliances are computer related appliances such as personal computers, portable computers, associated computer peripherals, cellular phones, and other portable equipment. Here, while it may be possible to steal the appliance, the appliance is rendered unusable to the thief. In each of these applications, the authorized user wears a badge or tag **14** and a regulating means or electronic unit EU is installed in the appliance. The apparatus further includes the two antennas **A1** and **A2**, the antenna **A1** being the omni-directional antenna, and antenna **A2** providing the directional sensitivity.

[0063] Turning to **FIG. 7**, an alternate embodiment **100** of the present invention is shown as configured to restrict the use of an appliance or computerized device **102** such as a laptop computer, desktop computer, or computer terminal which contains or accesses sensitive and/or confidential information. As now described, a key feature of the apparatus **100** is the communication and cooperation between a regulating means such as an electronic unit EU contained within the computerized device **102**, and a separate, authorizing unit AU carried by an "authorized user" of the computerized device **102**. The authorizing unit is, for example, is incorporated into an identification badge **104** worn by an employee.

[0064] The regulating means or electronic unit EU, which is mounted or otherwise installed within computerized device **102** includes an electronic message generator EMG. Generator EMG generates a uniquely coded waveform which, as shown in **FIG. 7**, is transmitted by a transmitter TEU as a radio-frequency signal to any authorizing unit AU in proximity to the computerized device **102** to interrogate the authorizing unit AU. The message embodied in the transmitted coded waveform can authorize more than one authorizing unit AU. However, the message will authorize or enable only those authorizing units AU which are complementary to the particular computerized device **102**.

[0065] Upon receipt of an interrogation message by a receiver RAU of an authorizing unit AU, the message is decoded by a decoding electronics section DAU of the authorizing unit AU. The decoded message is then compared in a comparator COMP with a message previously stored in a memory MAU within the authorizing unit AU to determine if the particular authorizing unit AU is one authorized for use with the computerized device **102**. If it is, then a reply message generator RMG of the authorizing unit generates a reply message which also comprises a uniquely coded waveform. This reply message is then transmitted by a transmitter TAU as an radio-frequency signal back to electronics unit EU within computerized device **102**.

[0066] Those of ordinary skill in the art will recognize that any of a variety of encoding schemes may be utilized to encode the transmitted waveforms. For example, these encoding schemes may include randomly selected codes, cyclical codes, and/or non-repeating predetermined codes.

[0067] A reply message receiver REU within electronics unit EU receives the message and provides it to decoder

electronics section DEU within the electronics unit. Decoder DEU decodes the reply signal. An output signal AS from decoder DEU, verifying that an authorized user of the computerized device **102** has responded to the query from the electronics unit, is now used to activate or enable the computerized device **102**, or to enable access thereto.

[**0068**] An important aspect of the method and apparatus of the invention is that more than one person can use the computerized device **102**. Since there can be more than one authorized user for a given computerized device **102**, each authorizing unit AU includes a unique code within the reply message identifying which authorized user is replying to the interrogation message. This information is stored within a memory MEU of electronics unit EU so a record is made as to which authorized user is controlling the computerized device **102** at a given time.

[**0069**] Preferably, as previously described, the receiver REU preferably includes two separate antennas. A first antenna A**1**, and a second antenna A**2**. Antenna A**2** preferably has a gain in a horizontal plane which is sufficient to provide a predetermined arc of coverage in the horizontal plane, i.e., it provides directional sensitivity. For example, antenna A**2** may be aligned such that its principal axis is aligned with a viewing axis of a display screen **106** associated with the computerized device **102**. In the vertical plane, both antennas A**1** and A**2** preferably have 0 dB of gain.

[**0070**] Differencing the signals received at antennas A**1** and A**2** (A**2**-A**1**) and accepting only positive signals, ensures that only signals originating in front of a plane BC of the computerized device authorize operation of the computerized device. By way of example, a signal S, from the right of plane BC, results in (S**1**×gain of A**2**)−(S**1**×gain of A**1**)=(S**1**×0)−(S**1**×1)=−S**1**. This is a negative signal. On the other hand, a signal S**2** from the left of the plane BC results in (S**2**×gain of A**2**)−(S**2**×gain of A**1**)=(S**2**×2)−(S**2**×1)=S**2**. This is a positive signal. Further, this positive signal is measured against a threshold such that authorizing unit AU not only has to be in front of plane BC, but also within a certain distance of computerized device **102** in order to enable use thereof. The combined limited position relative to the computerized device **102** and distance from the computerized device **102** define a spatial region within which an authorized user must be located.

[**0071**] Upon receipt of a positive signal at receiver REU, the signal is decoded. If the decoded signal is from an appropriate authorizing unit AU, the decoder sends a message to a control unit CEU of the electronics unit. Upon receipt of this signal, the control unit CEU deactivates a restraint unit RU which is interconnected with the computerized device **102**, for example with the display of the computerized device **102**, or with the keyboard. Deactivating the restraint unit enables the authorized user to operate the computerized device **102**, for example, by activating a display screen or enabling command entry through the keyboard. However, as discussed hereinafter, this is a controlled feature of the invention and the computerized device **102** must be re-authorized at predetermined intervals or else it will again be rendered unusable, such as by shutting down the display screen and/or by locking associated data entry devices such as a keyboard or mouse.

[**0072**] Since the computerized device **102** is normally maintained in a deactivated, secured, or restricted-use state such as with the display turned off, prior to receive of an appropriate authorizing signal from within a predetermined spatial volume, the apparatus **100** of the present invention is resistant to radio-frequency interference or jamming of the signals from the authorizing units AU to enable unauthorized use of the computerized device **102**. If a signal from an authorizing unit AU is jammed or corrupted by jamming or interference, the electronics unit EU will maintain the computerized device **102** in the deactivated, secured, or restricted-use state until a clear and proper signal is received from an authorizing unit.

[**0073**] Control unit CEU performs a number of tasks. First, as described above, the control unit controls provides activation signals to the restraint unit. Second, the control unit effects a query and response cycle through message generator EMG. The query/response cycle is, for example, triggered once every second. If a correct response is received, and computerized device **102** has already been enabled or activated, the computerized device **102** will remain enabled or activated for another predetermined period of time. In effect, computerized device **102** remains continuously activated in the presence of continuous queries from the regulating means or electronics unit and affirmative responses from the authorization unit carried by an authorized user located within the predetermined proximity.

[**0074**] If the computerized device **102** has been activated, but subsequently does not receive an affirmative response to a query, a second query and response cycle is immediately initiated. If an appropriate response is again not received, computerized device **102** is rendered inactivate by the restraint unit RU. The initial interrogation cycle (the one second query/response cycle) then recommences. It will be understood by those skilled in the art that the time intervals specified herein are exemplary only and that other timing can be used. It will further be understood by those skilled in the art that the codes used in practicing the method of the invention can be automatically changed at predetermined intervals either in a predetermined manner, such as a cyclical manner, or in a random manner. Changing the coding makes it extremely difficult for unauthorized users to enable the computerized device **102**.

[**0075**] In an additional embodiment of the present invention, as shown in **FIG. 8**, a third antenna A**3** is employed by the apparatus **10**. As with antenna A**2**, this antenna A**3** is also a directional antenna. Antenna A**3** is, however, pointed in a direction in which, for example, use of the appliance may cause injury to a person. Further, antenna A**3** has a very narrow cone for directionality, for example, 5°. In the above described firearm example, antenna A**3** points in the direction of the muzzle of the firearm. Now, operation of the apparatus and method of the invention is such that the weapon is authorized for use in the manner previously described. However, if another authorized person, a policeman for example, moves in front of the weapon and into the detection region of antenna A**3**, the weapon is disabled for so long as he is there, and is enabled as soon as he moves away from in front of the muzzle and exits the detection region of antenna A**3**. This feature prevents injury due to "friendly fire".

[**0076**] Those skilled in the art will recognize that this feature has significant military implications for combat. In industrial settings, this feature protects co-workers from

inadvertent injuries if they come too close to the operating portion of a piece of equipment while it is in use. The advantage that this feature provides is that the authorized user actually operating the appliance does not need to be aware of the presence of the other person for the safety feature to work.

[0077] Finally, in all of the above described applications, the apparatus and method of the invention have involved a person interacting with the appliance. Those skilled in the art, however, will recognize that there are applications where one appliance may be able to interact with one or more other appliances. Here, the user control issue is that it may desirable, or in some circumstances necessary, for the first appliance to interact with only one of the other appliances, and then only so long as the other appliance is in a preferred spatial orientation with respect to the first appliance. The apparatus and method of the present invention provide a way for accomplishing this.

[0078] The present invention can be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The present invention can also be embodied in the form of computer program code containing instructions embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or an other computer readable storage medium, wherein, when the computer program code is loaded into, and executed by, an electronic device such as a computer, micro-processor or logic circuit, the device becomes an apparatus for practicing the invention.

[0079] The present invention can also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. When implemented in a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

[0080] In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results are obtained. As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

1. An apparatus for limiting usage of an associated appliance to an authorized user, comprising:

a regulating means configured to regulate operation of the associated appliance;

at least one authorizing unit associated with an authorized user, said authorizing unit configured to transmit a signal representative of a unique message;

wherein said regulating means is further configured to receive said signal;

wherein said regulating means is further configured to calculate a differential strength of said signal to identify a spatial relationship of said at least one authorizing unit relative to said regulating means; and

wherein said regulating means is further configured to enable the associated appliance only in response to said unique message corresponding to a predetermined message and said identified spatial relationship establishing a presence of said at least one authorizing unit within a predetermined spatial relationship to said associated appliance.

2. The apparatus of claim 1 where said regulating means is further configured to active the associated appliance for a predetermined period of time in response to said unique message corresponding to said predetermined message and said identified spatial relationship establishing a presence of said at least one authorizing unit within said predetermined spatial relationship.

3. The apparatus of claim 1 wherein said regulating means is further configured to disable the associated appliance responsive to receipt of a predetermined disabling command transmission.

4. The apparatus of claim 1 wherein said regulating means is further configured to disable the associated appliance responsive to a calculated differential signal strength of a subsequent signal from said at least one authorizing unit establishing a presence of said at least one authorizing unit outside to said predetermined spatial relationship.

5. The apparatus of claim 1 wherein said regulating means is further configured to periodically emit a signal representative of a unique interrogation message; and

wherein said at least one authorizing unit is configured to receive said signal representative of said unique interrogation message and to emit said signal representative of said unique message responsive to a received unique interrogation message corresponding to a predetermined interrogation message.

6. The apparatus of claim 1 wherein said associated appliance is a firearm; and

wherein said regulating means is operatively coupled to said firearm to inhibit discharge of said firearm in a first state, and to permit discharge of said firearm in a second state responsive to said unique message corresponding to a predetermined message and said identified spatial relationship establishing a presence of said at least one authorizing unit within said predetermined spatial relationship.

7. The apparatus of claim 6 wherein said firearm includes a barrel having a muzzle defining a discharge axis and a discharge direction; and

wherein said predetermined spatial relationship includes a limited spatial volume disposed about said discharge axis for a predetermined distance opposite said discharge direction from said firearm muzzle.

8. The apparatus of claim 1 wherein said regulating means further includes a first antenna having a first signal detection region and a second antenna having a second signal detection region; and

wherein an intersection of said first and second signal detection regions defines said predetermined spatial relationship, and said regulating means being configured to calculate said differential signal strength utilizing a signal received at said first antenna and a signal received at said second antenna.

9. The apparatus of claim 8 wherein said second antenna is a directionally sensitive antenna configured with a gain of at least 3 dB in the horizontal plane.

10. The apparatus of claim 8 further including a third antenna, said third antenna a directionally sensitive antenna having a third signal detection region which is pointed in a different direction than said second signal detection region.

11. The apparatus of claim 10 in which said third antenna has a range of coverage in the horizontal plane narrower than that of said second antenna.

12. The apparatus of claim 10 wherein said regulating means is configured to disable the associated appliance even though an appropriate response signal directed to the interrogation means is received by from the second antenna, if another appropriate response signal directed to said regulating means is received by said third antenna.

13. The apparatus of claim 12 wherein said regulating means is configured to enable the associated appliance when an appropriate response signal is no longer received by said third antenna but an appropriate response signal continues to be received by said second antenna.

14. The apparatus of claim 1 further including recording means recording usage information associated with activation of the associated appliance.

15. The apparatus of claim 14 wherein said regulating means is configured to enable access to said recorded usage information responsive to receipt of a predetermined interrogation code transmission.

16. The apparatus of claim 1 wherein said associated appliance is a computerized device; and

wherein said regulating means is operatively coupled to said computerized device to secure said computerized device in a first state, and to permit usage of said computerized device in a second state responsive to said unique message corresponding to a predetermined message and said identified spatial relationship establishing a presence of said at least one authorizing unit within said predetermined spatial relationship.

17. The apparatus of claim 16 wherein said computerized device includes a display having a viewing axis; and

wherein said predetermined spatial relationship includes a limited spatial volume disposed about said viewing axis.

18. A method for limiting usage of an appliance to at least one authorized user, comprising:

regulating activation of the appliance from a deactivated state with an electronic control unit having first and second signal receivers;

emitting a signal representative of a unique message from an at least one authorizing unit;

receiving said signal at said first and second signal receivers;

calculating a differential strength of said signal received at said first and second signal receivers;

identifying a spatial relationship between said at least one authorizing unit emitting said signal and said electronic control unit; and

responsive to said identified spatial relationship establishing a presence of said at least one authorizing unit within a predetermined limited spatial volume relative to said electronic unit, and to said unique message corresponding to a predetermined message, activating the appliance for a predetermined interval.

19. The method of claim 18 further including periodically repeating said steps of emitting, receiving, identifying, and activating.

20. The method of claim 18 further including the step of deactivating the appliance responsive to said identified spatial relationship establishing a presence of said at least one authorizing unit external to a predetermined limited spatial volume relative to said electronic unit.

21. The method of claim 18 further including the step of deactivating the appliance responsive to said unique message not corresponding to a predetermined message.

22. The method of claim 18 further including the step of recording usage information associated with an authorizing unit upon activation of the appliance, said usage information including at least an identification of said authorizing unit and a time of activation of the appliance.

23. Apparatus for use with an appliance to enable usage of the appliance by at least one authorized user, comprising:

an interrogation means and an authorizing means, one of which is associated with the appliance to be used and the other of which with a person authorized to use the appliance, the interrogation means providing an interrogation signal to the authorizing means, the authorizing means providing a response signal in reply to the interrogation signal, and the interrogation means enabling the appliance for use by the person only if the response signal is an appropriate response and if the response signal is directed to the interrogation means from within a predetermined spatial region;

said interrogation means including a first antenna by which the interrogation signal is transmitted and a second antenna through which the response signal is received; and,

a third antenna aligned in a different direction than said second antenna, the authorizing means disabling operation of the appliance for so long as a response signal is received from said third antenna.

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