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(54) **CEILING FAN PROXIMITY SAFETY
APPARATUS**

(52) **U.S. Cl. 416/229 R**

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(57) **ABSTRACT**

(21) **Appl. No.: 11/002,567**

(22) **Filed: Dec. 1, 2004**

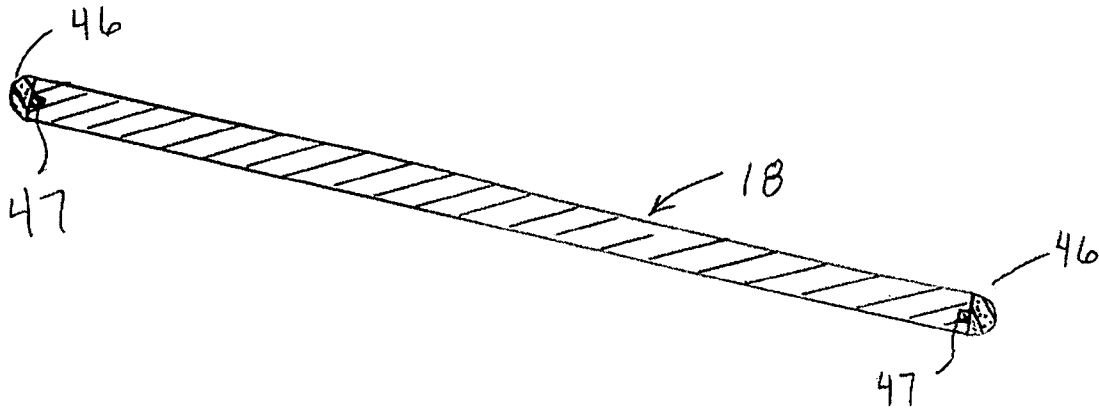
Related U.S. Application Data

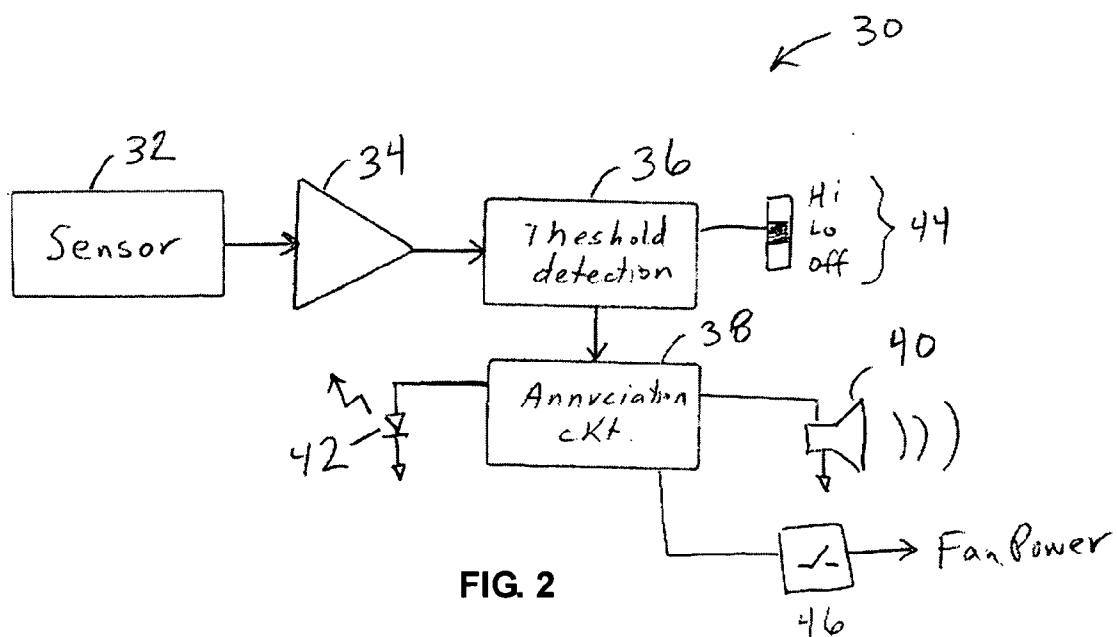
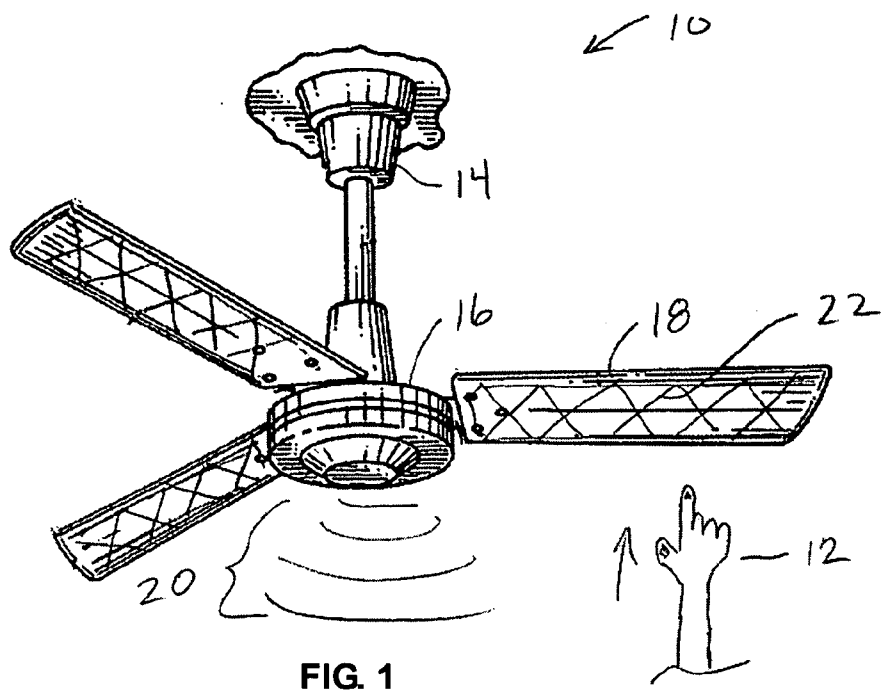
(60) **Provisional application No. 60/526,376, filed on Dec.
1, 2003.**

Publication Classification

(51) **Int. Cl.⁷ B63H 1/26**

A apparatus for preventing the incursion of persons (i.e. hands) or objects into the path of rotating ceiling fan blades. The apparatus may be embodied as an aftermarket device or integrated within an aftermarket device or more preferably within the fan electronics themselves. In one embodiment the sensors span at least a large portion of the length of one or more fan blades. The distributed sensor is configured to detect proximity of persons, or persons and objects. By way of example the sensor may comprise an inductive loop, or capacitive sensing circuit. In response to absolute and/or changes in proximity announcements are generated as audio and/or optical output thus alerting the individual to the incursion danger.





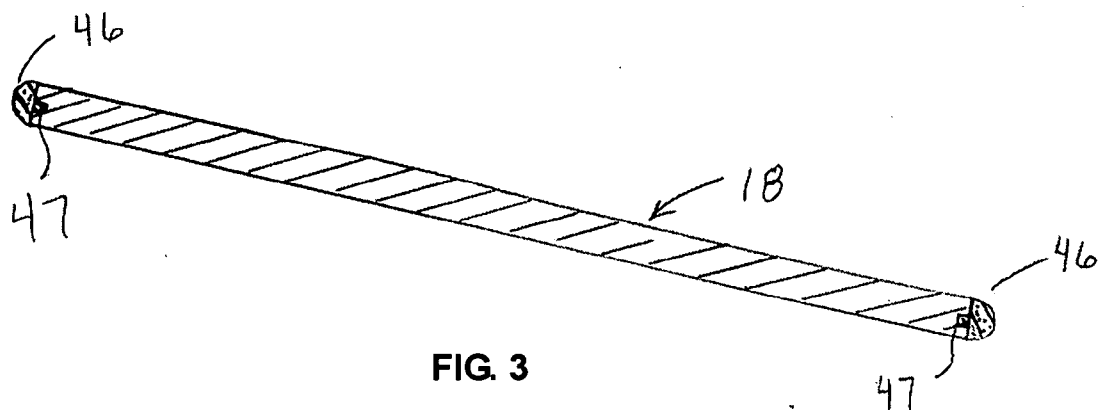


FIG. 3

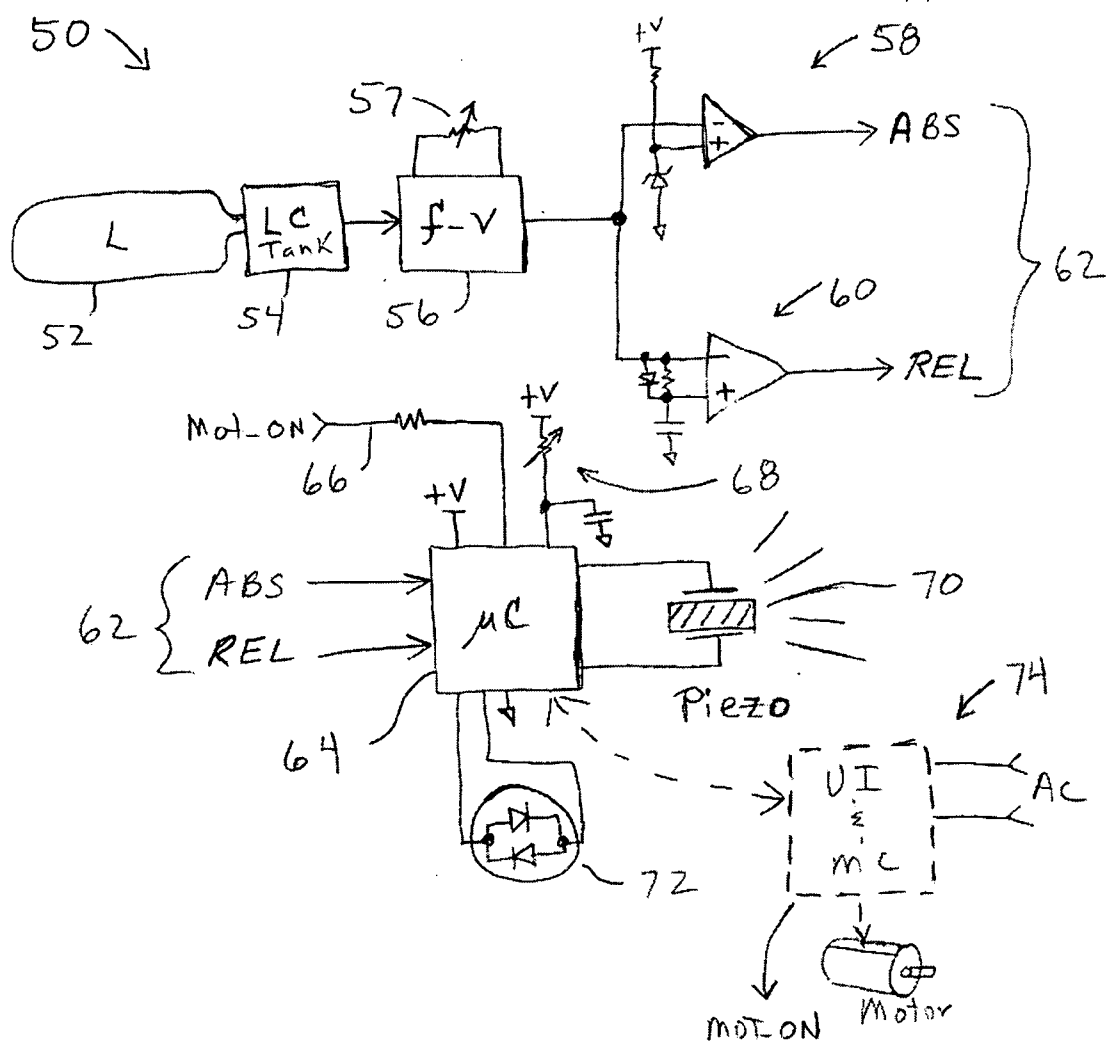


FIG. 4

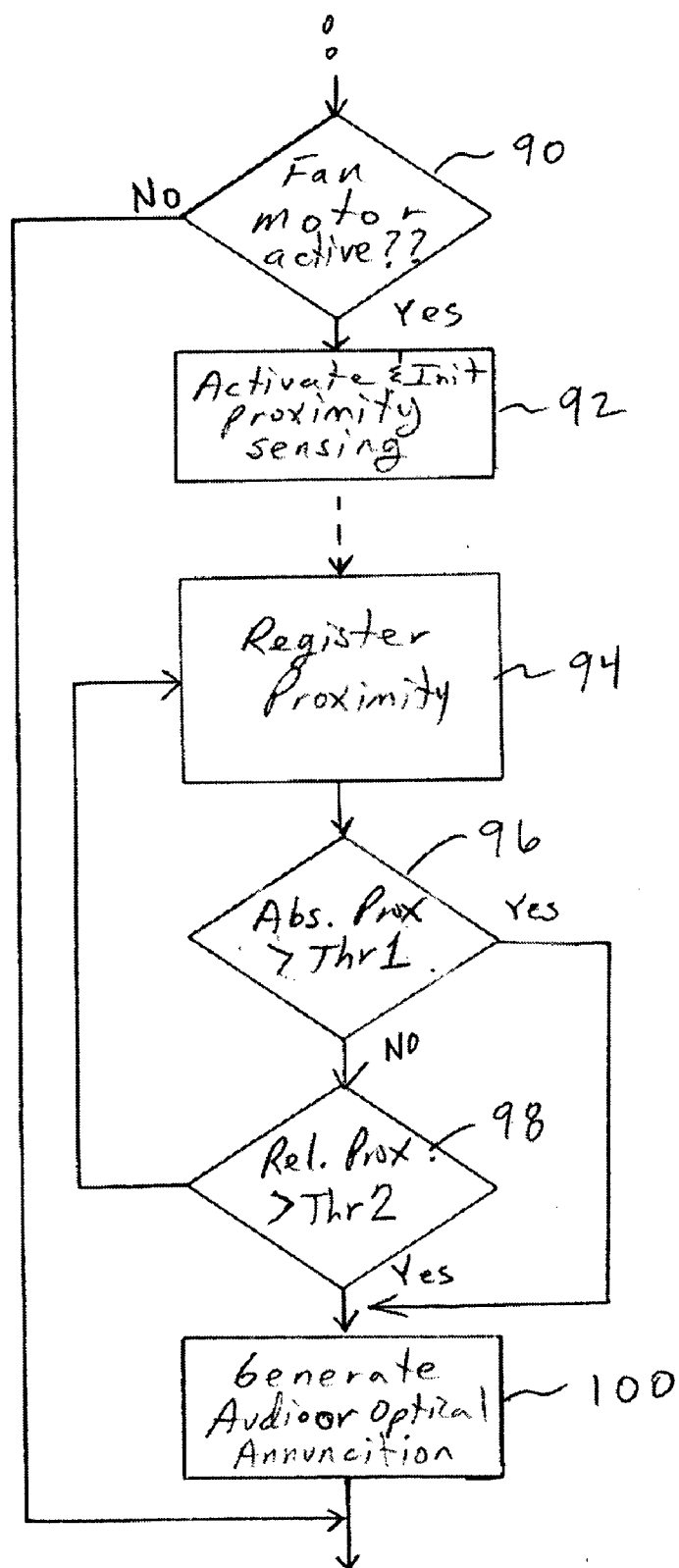
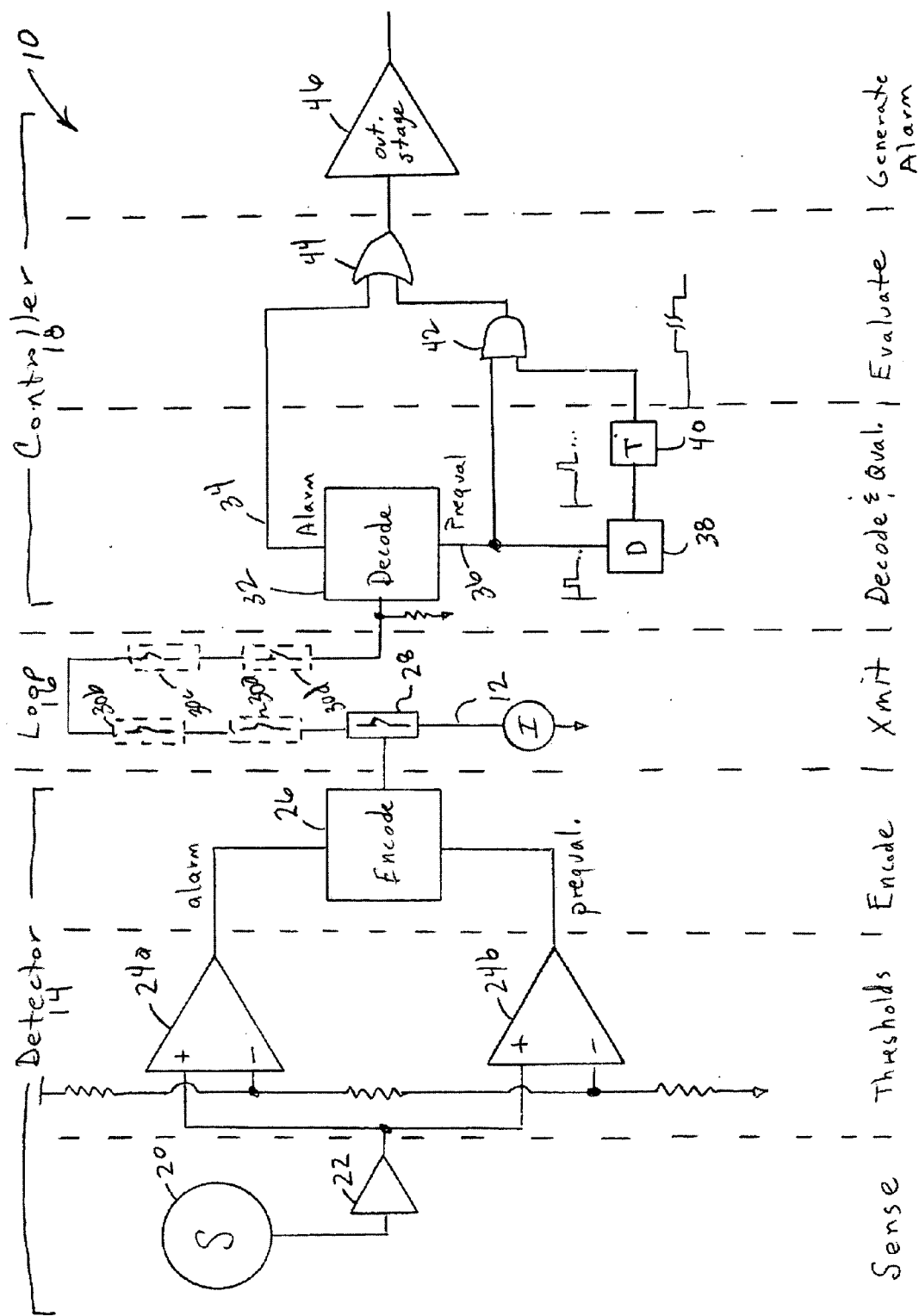


FIG. 5



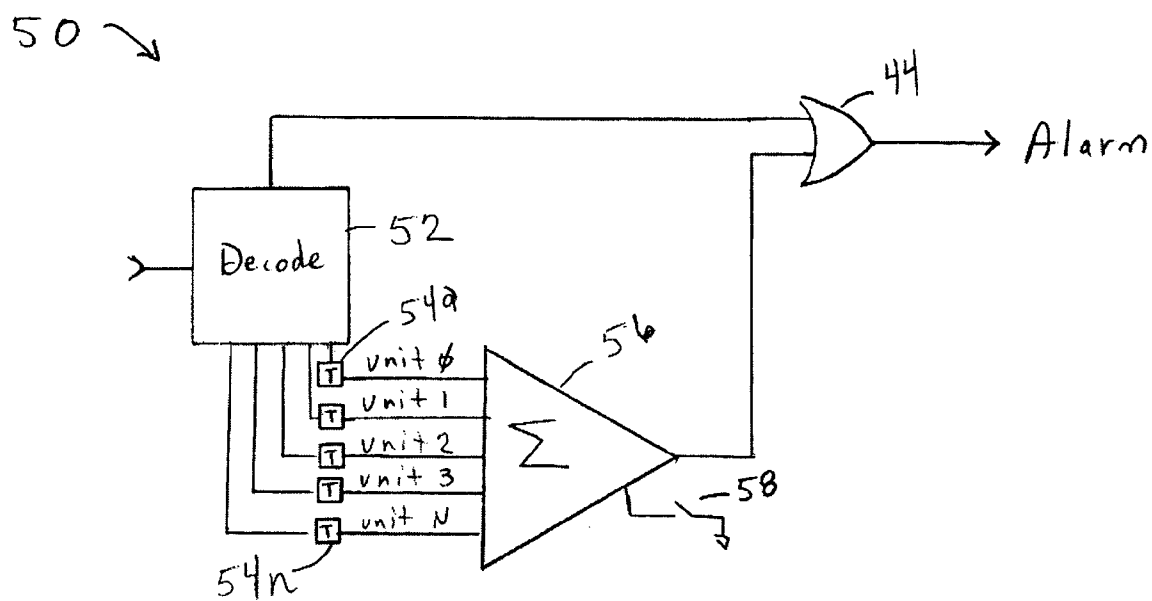


FIG. 7

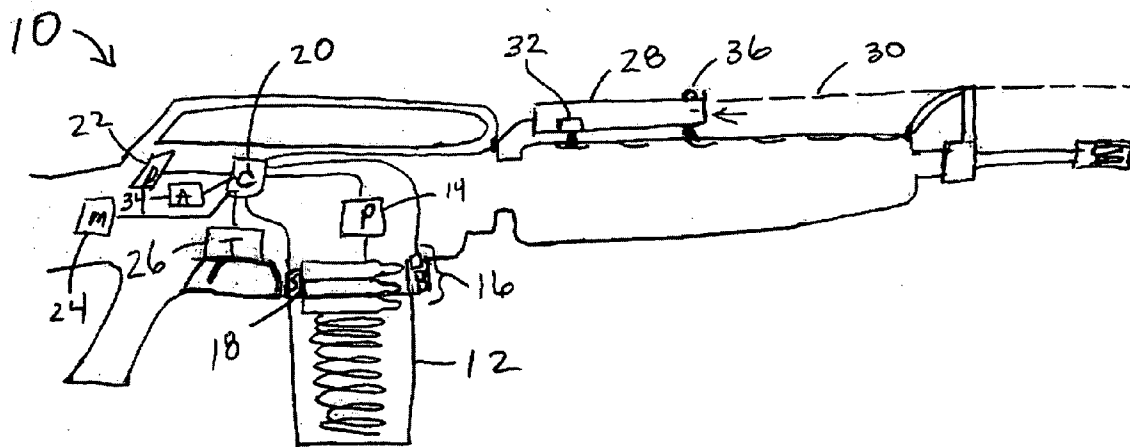


FIG. 8

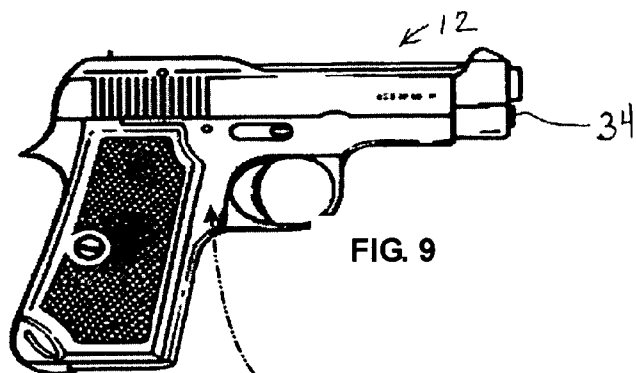


FIG. 9

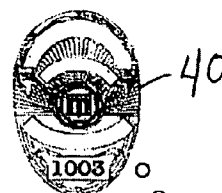


FIG. 12

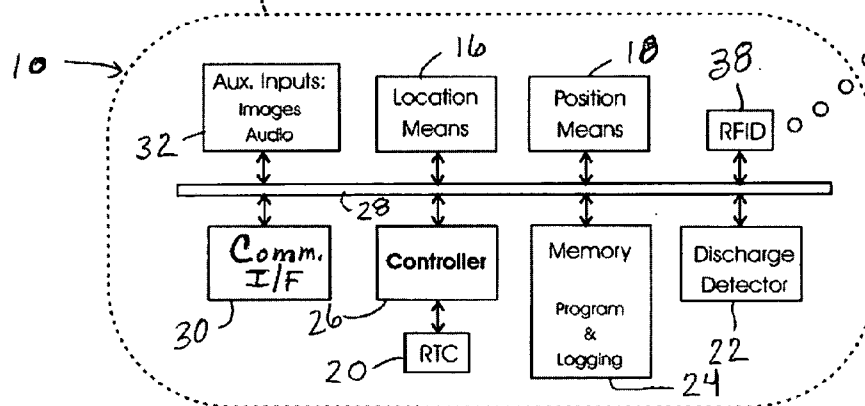


FIG. 10

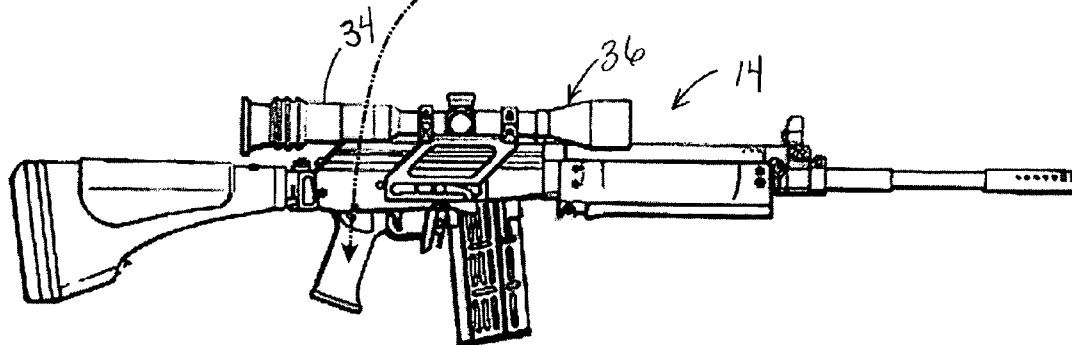


FIG. 11

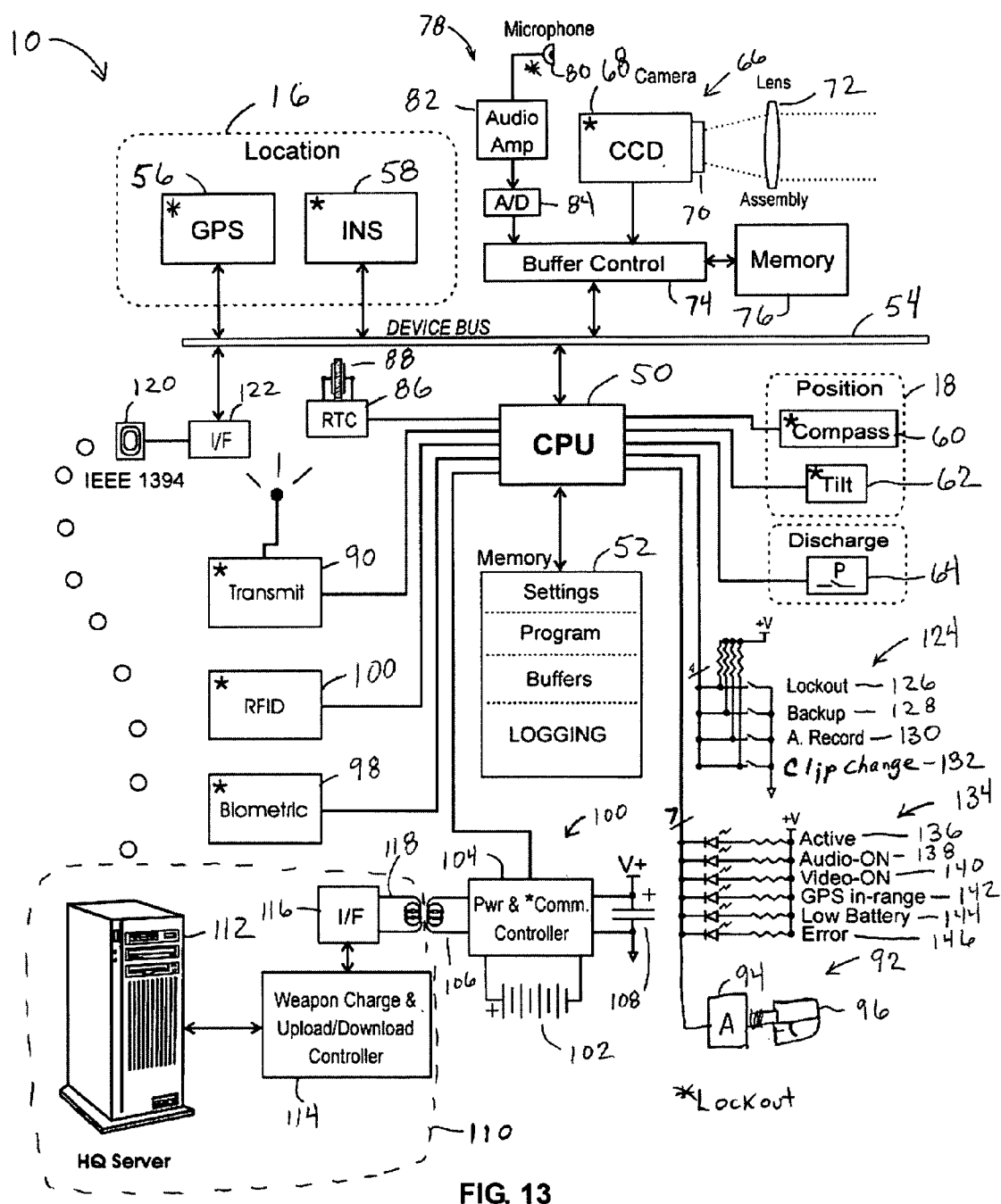
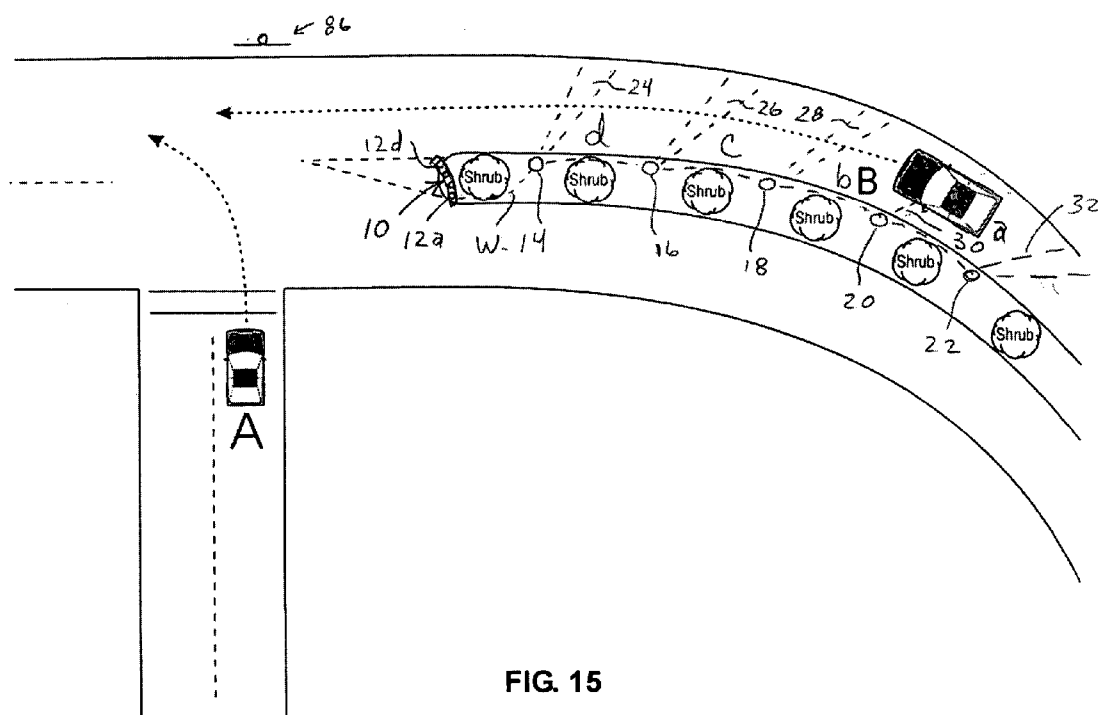
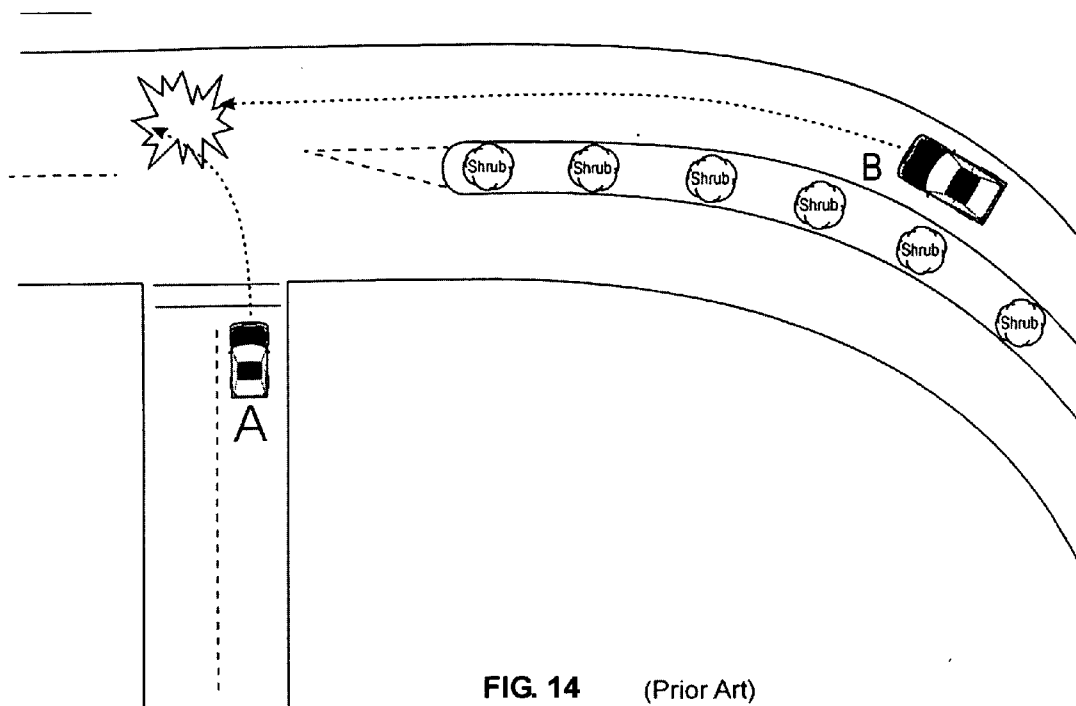


FIG. 13



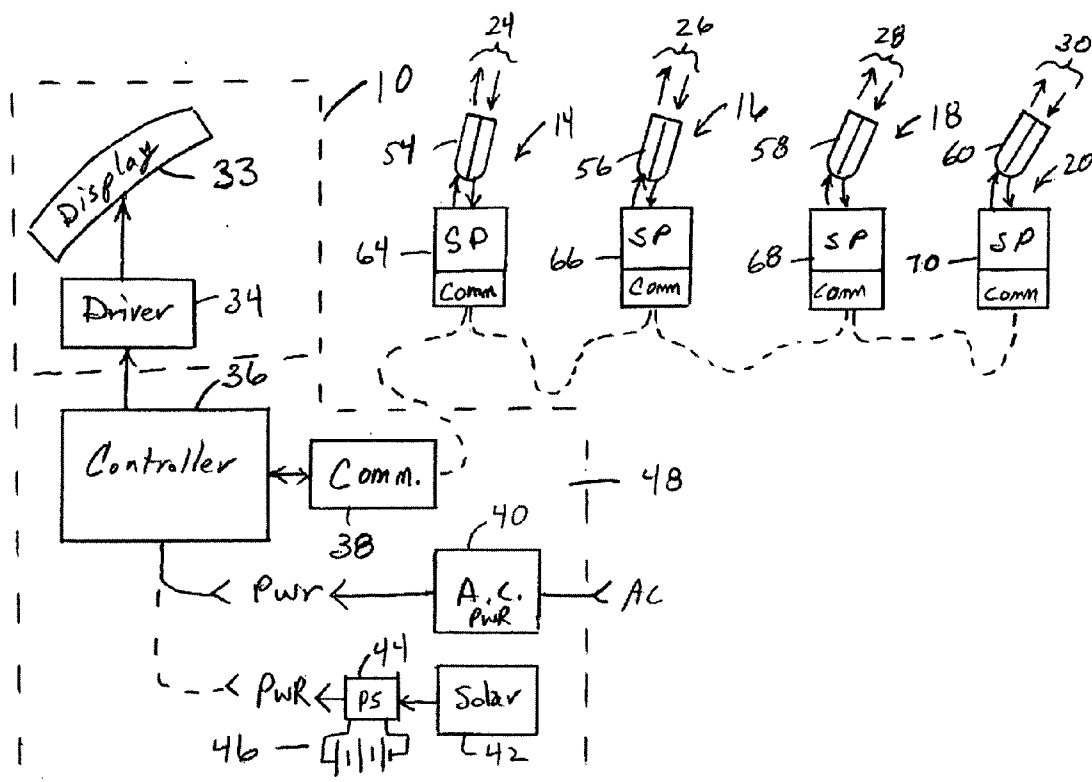


FIG. 16

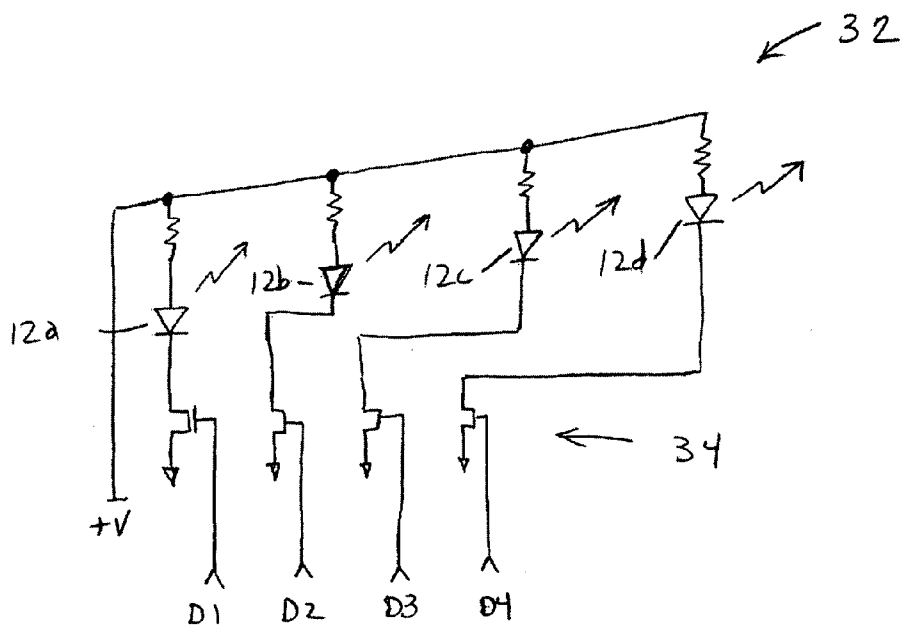


FIG. 17

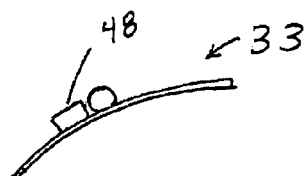


FIG. 18

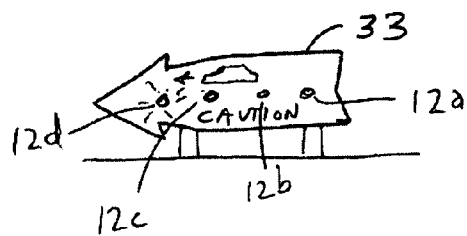


FIG. 19

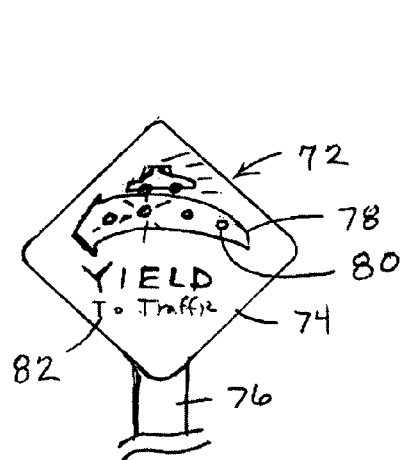


FIG. 20

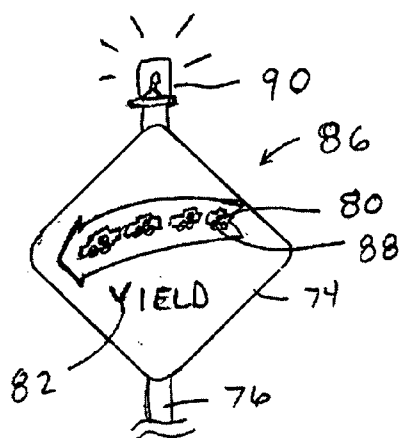


FIG. 21

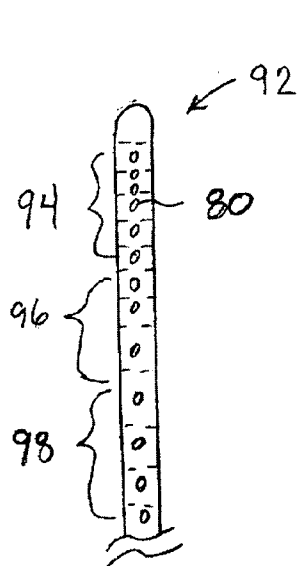


FIG. 22

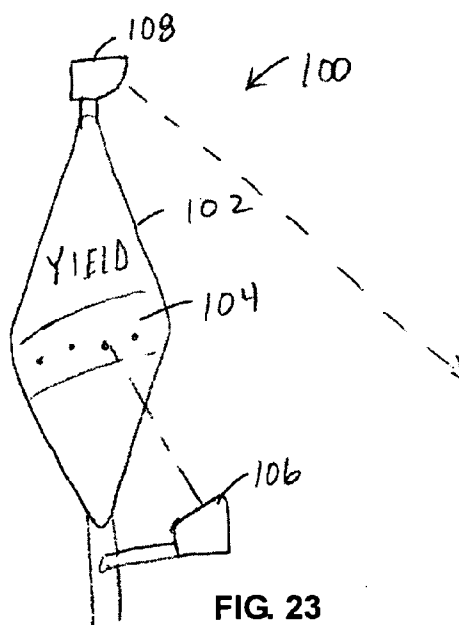
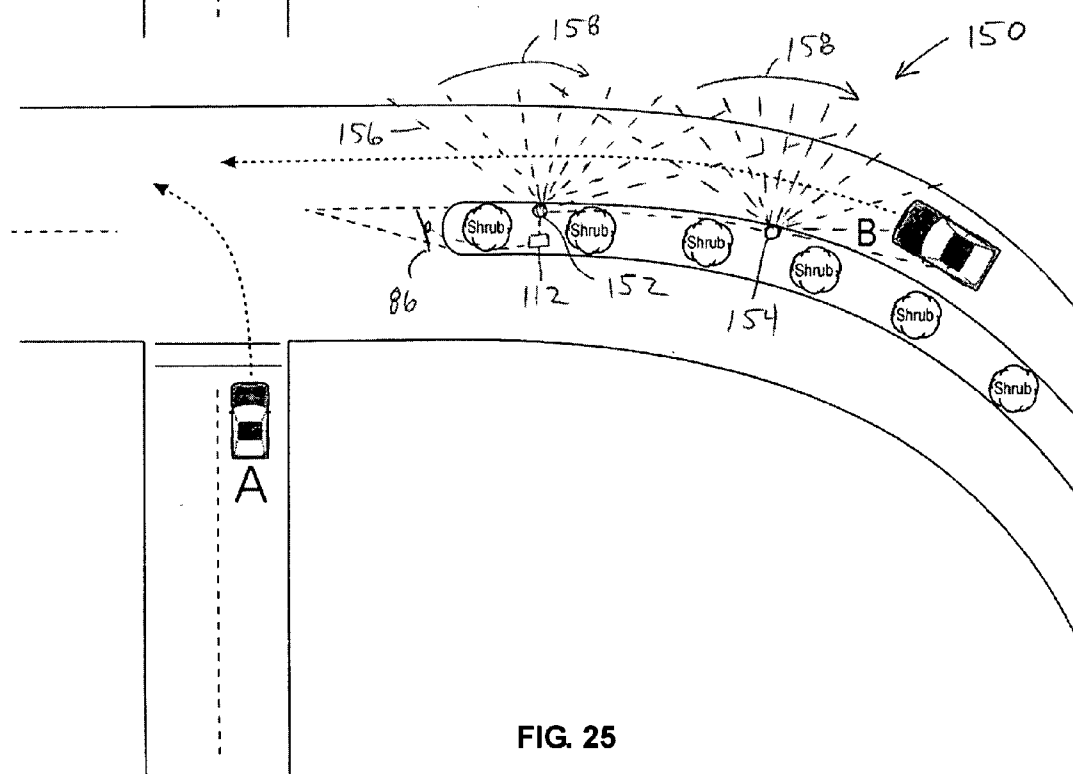
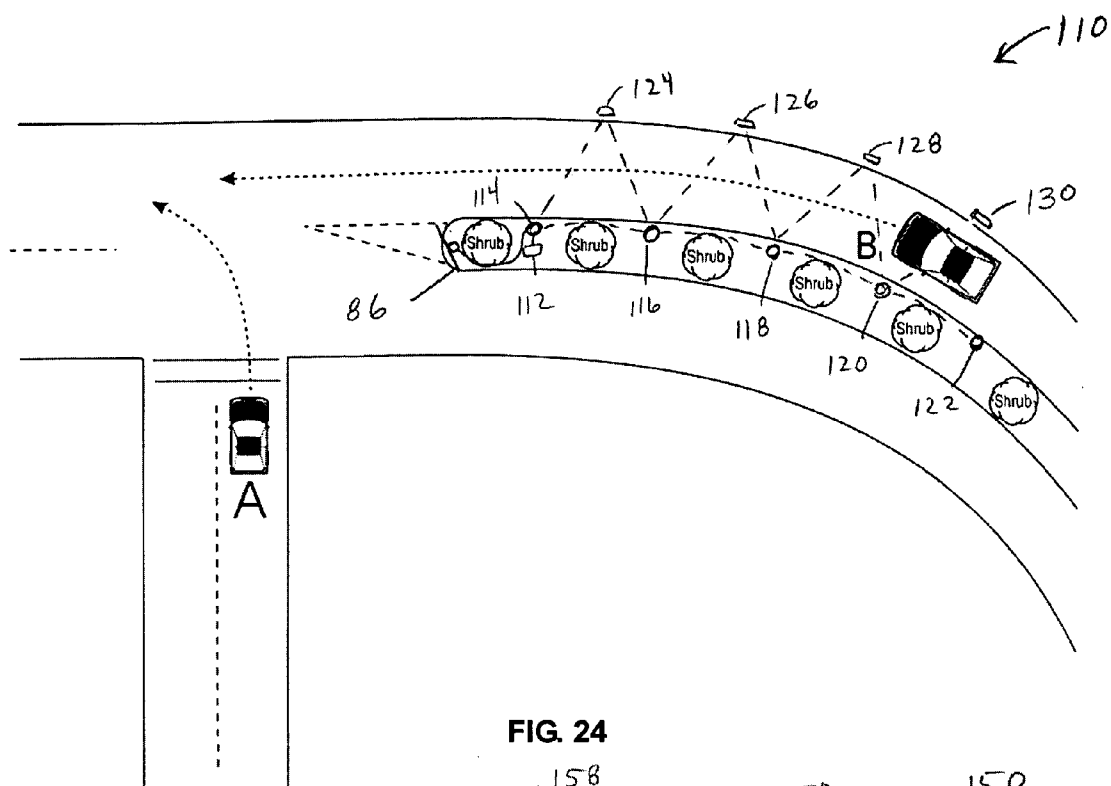


FIG. 23



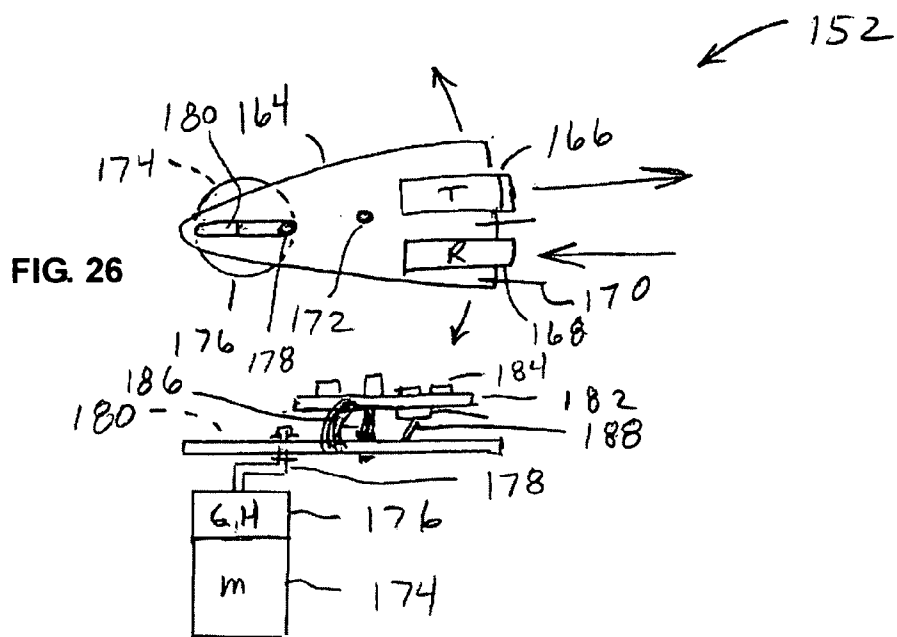


FIG. 27

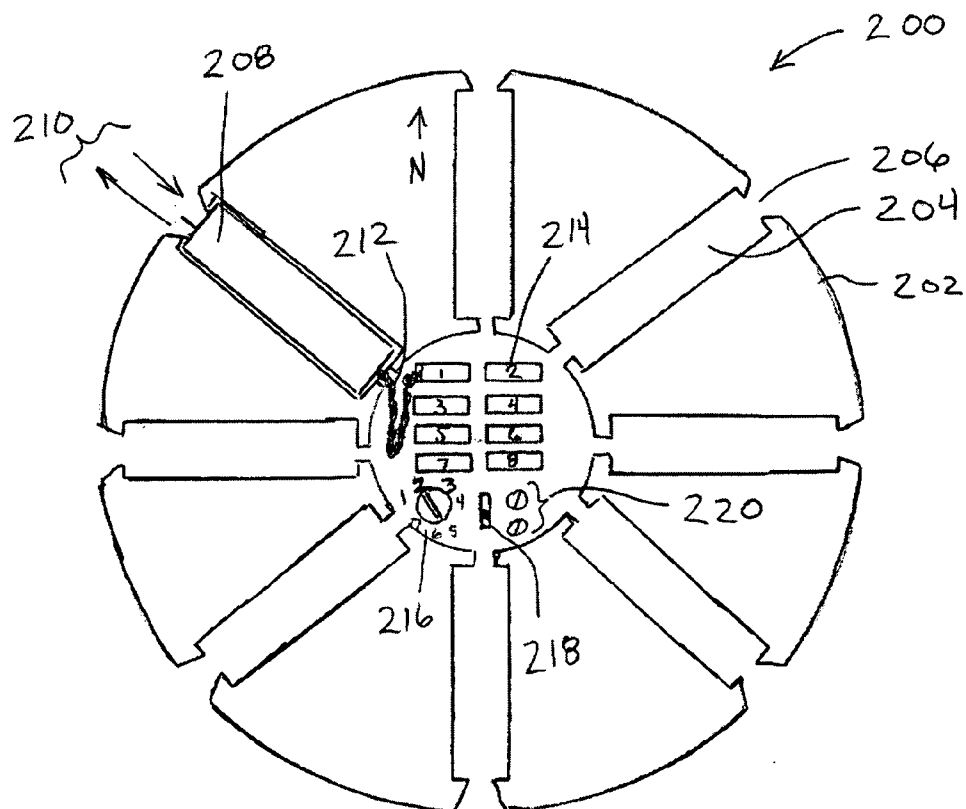
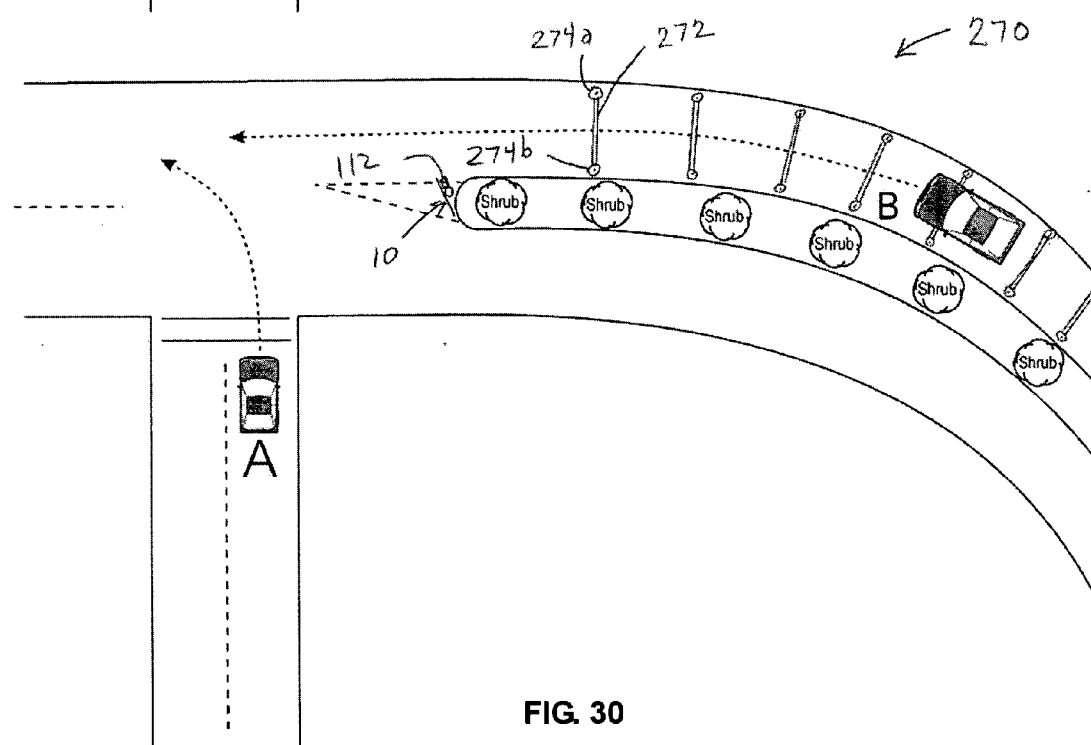
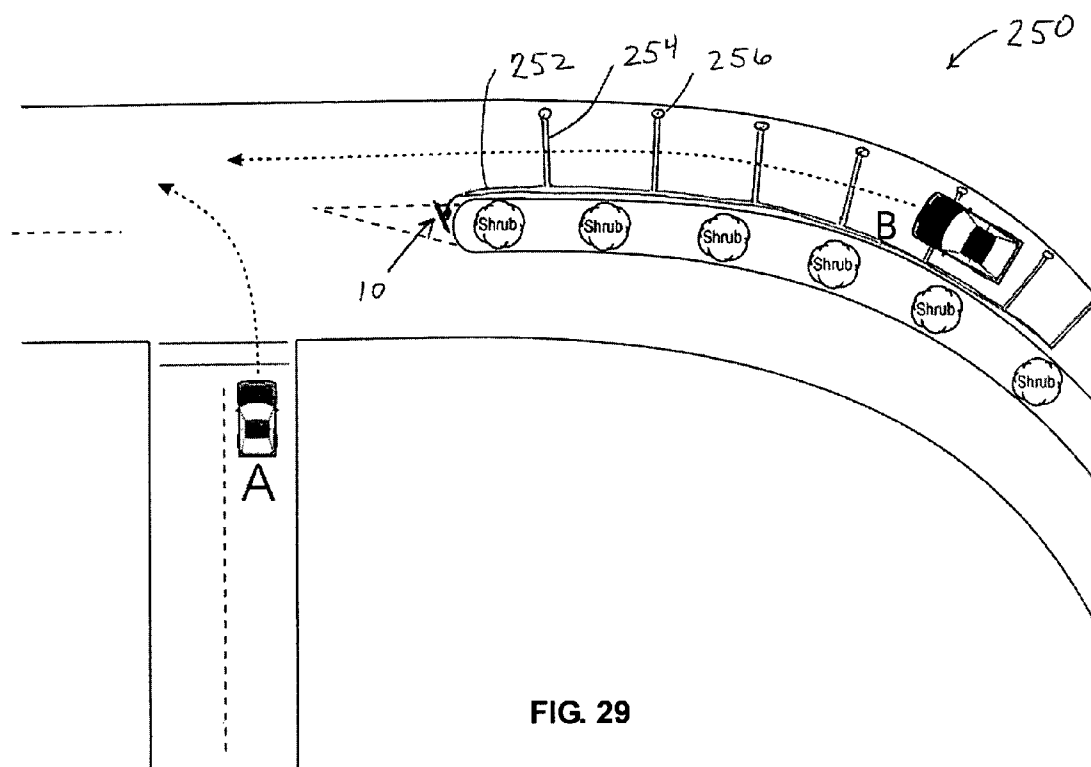
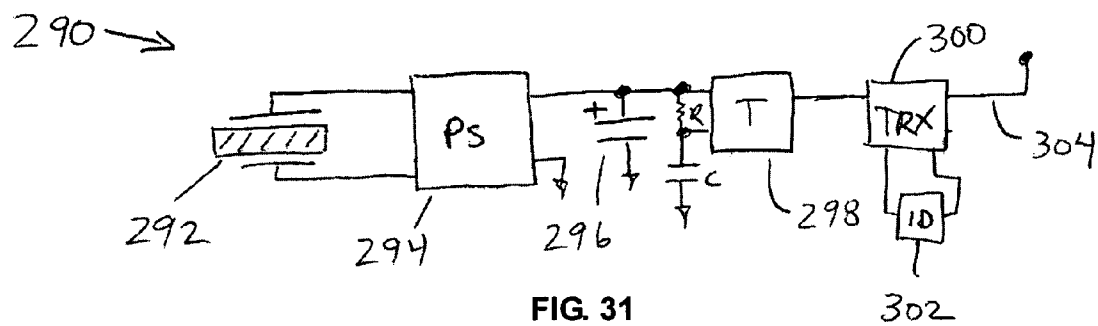


FIG. 28





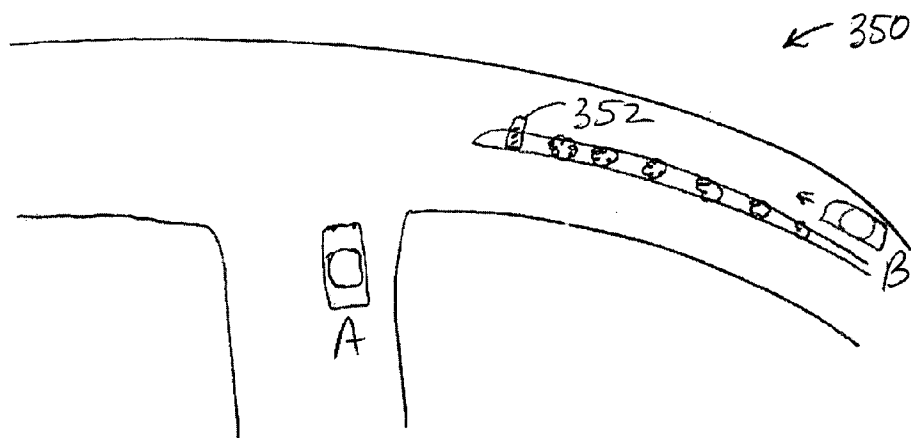


FIG. 32

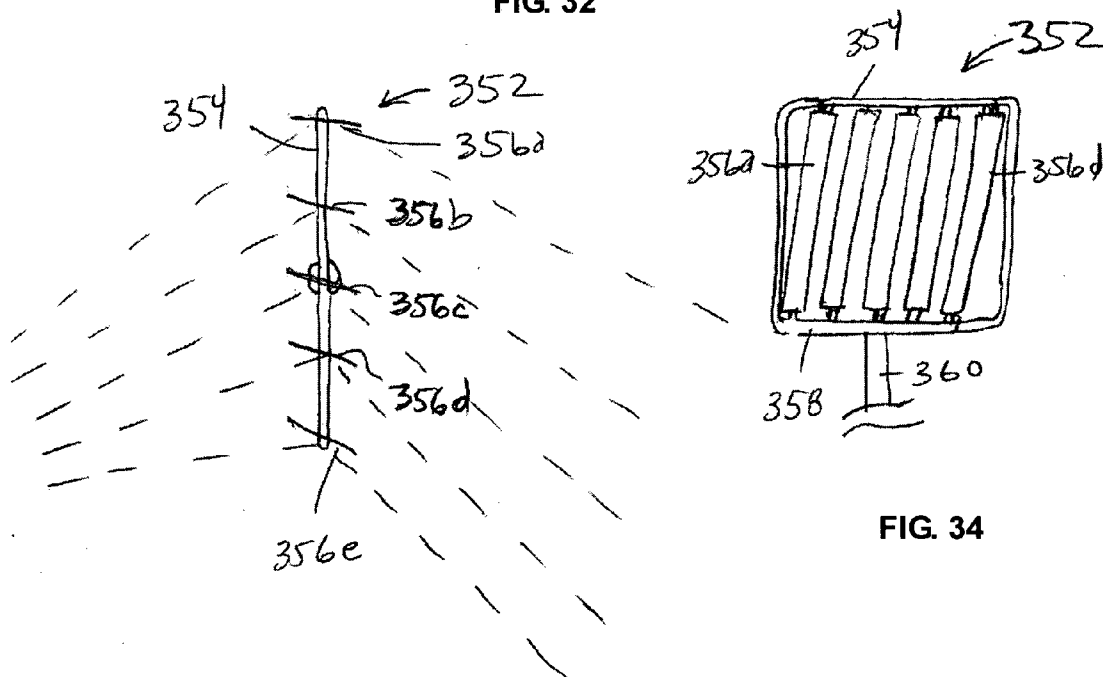


FIG. 33

FIG. 34

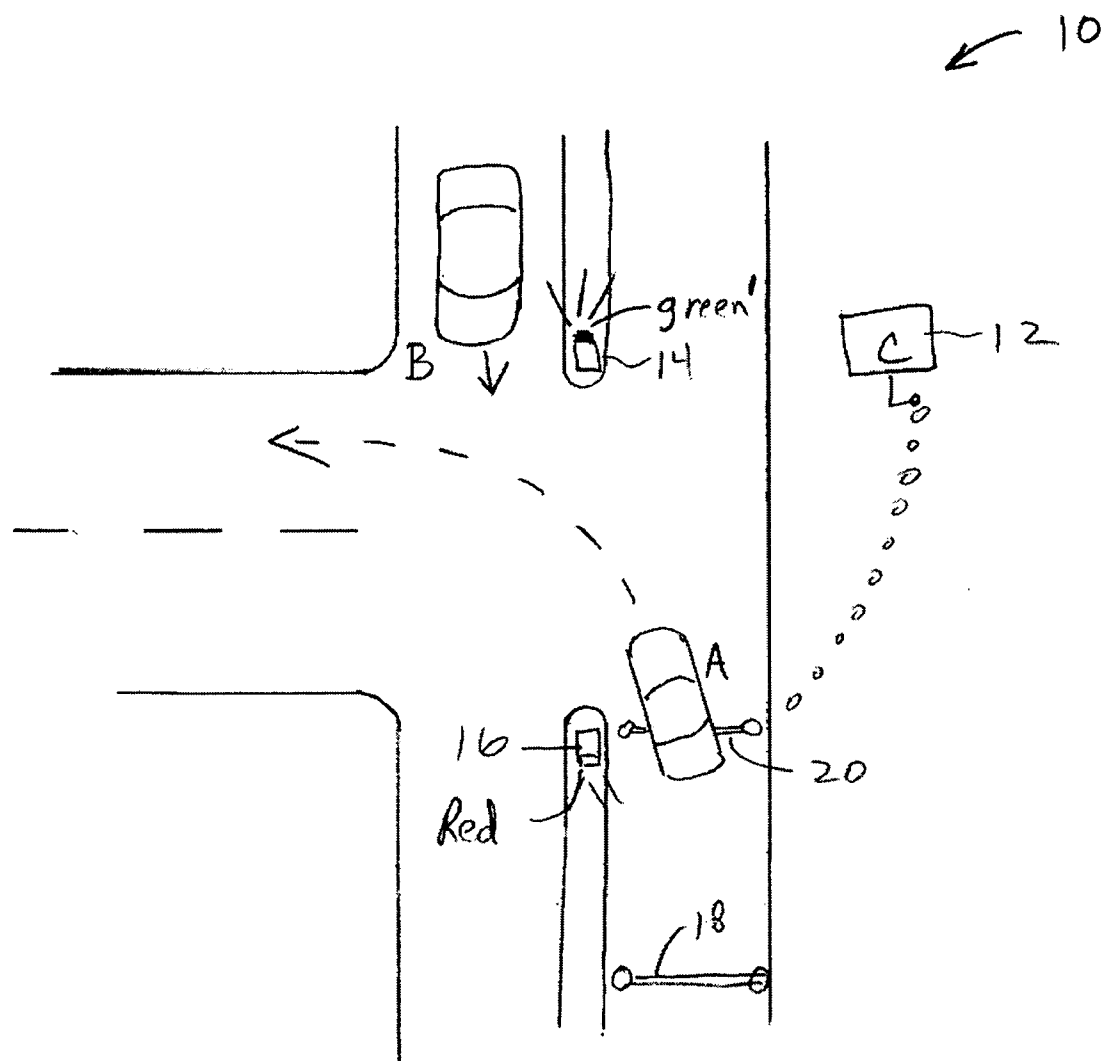


FIG. 35

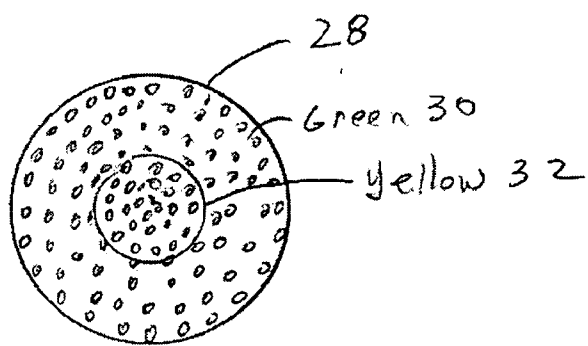
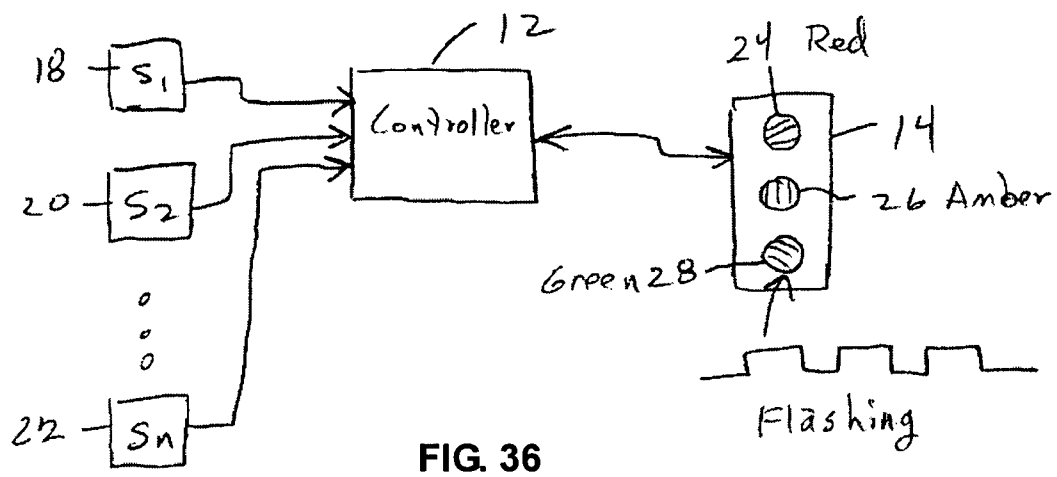


FIG. 37

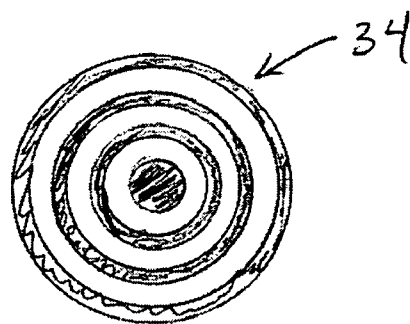


FIG. 38

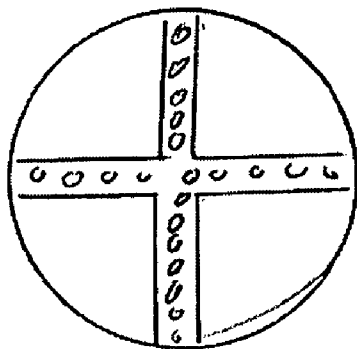


FIG. 39

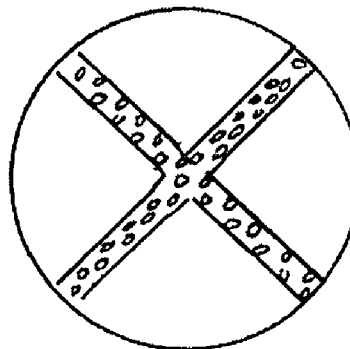


FIG. 40

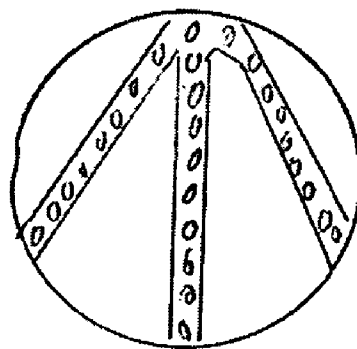


FIG. 41

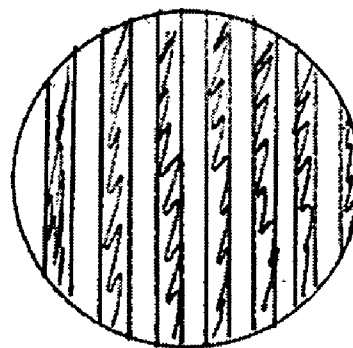


FIG. 42

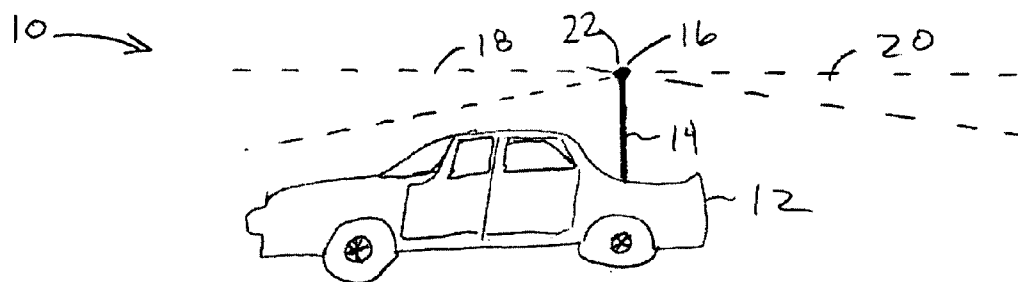


FIG. 43

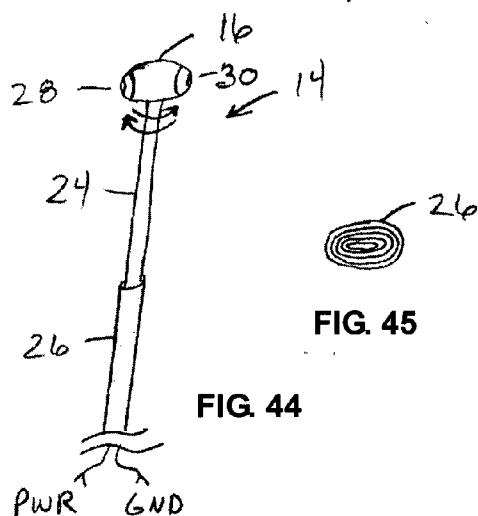


FIG. 45

FIG. 44

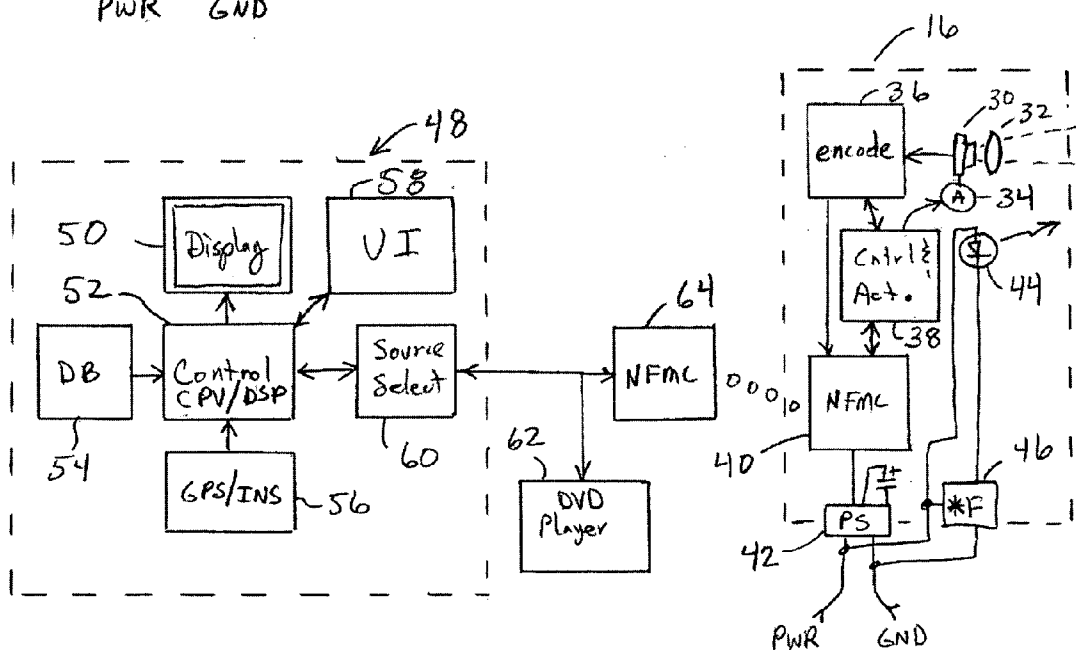


FIG. 46

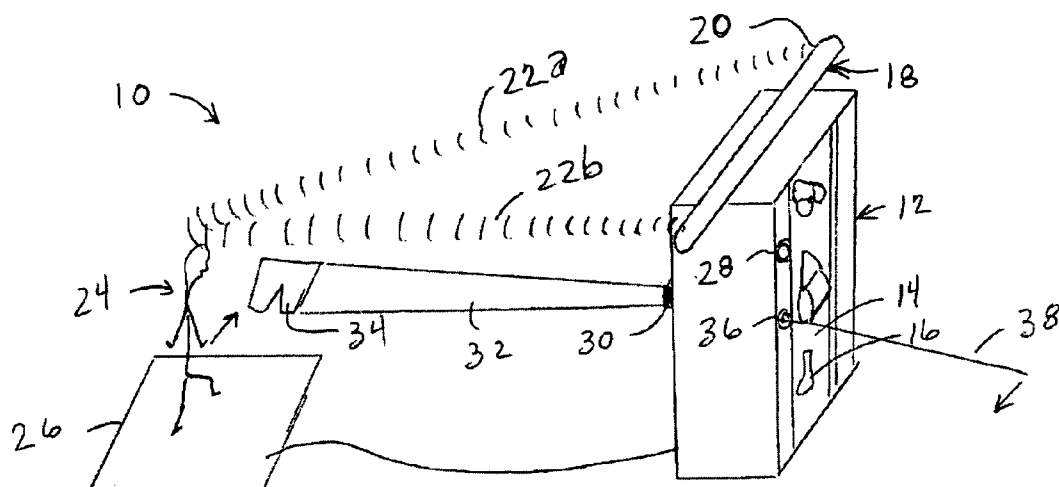


FIG. 47

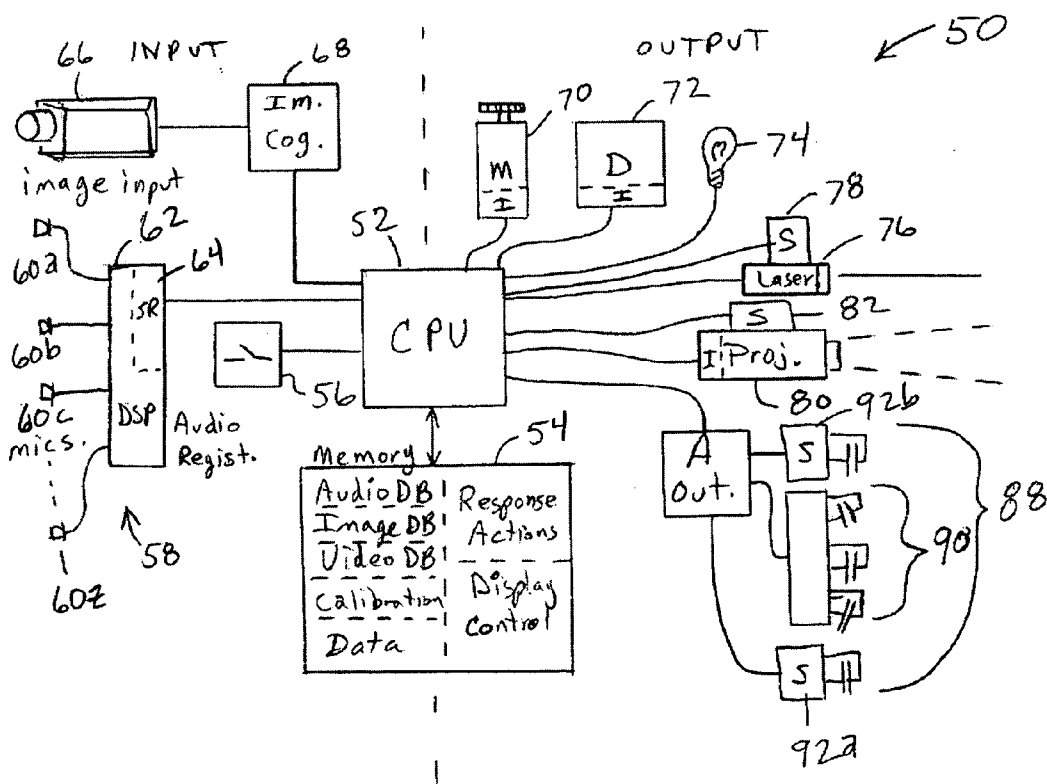


FIG. 48

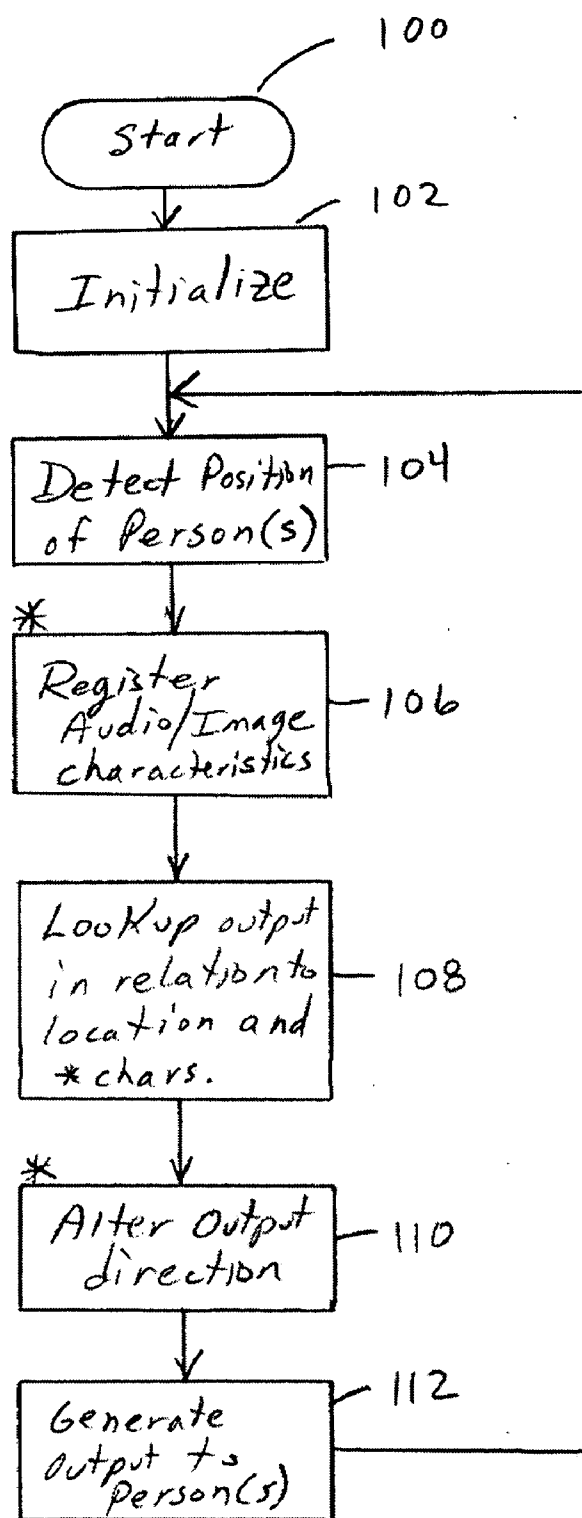


FIG. 49

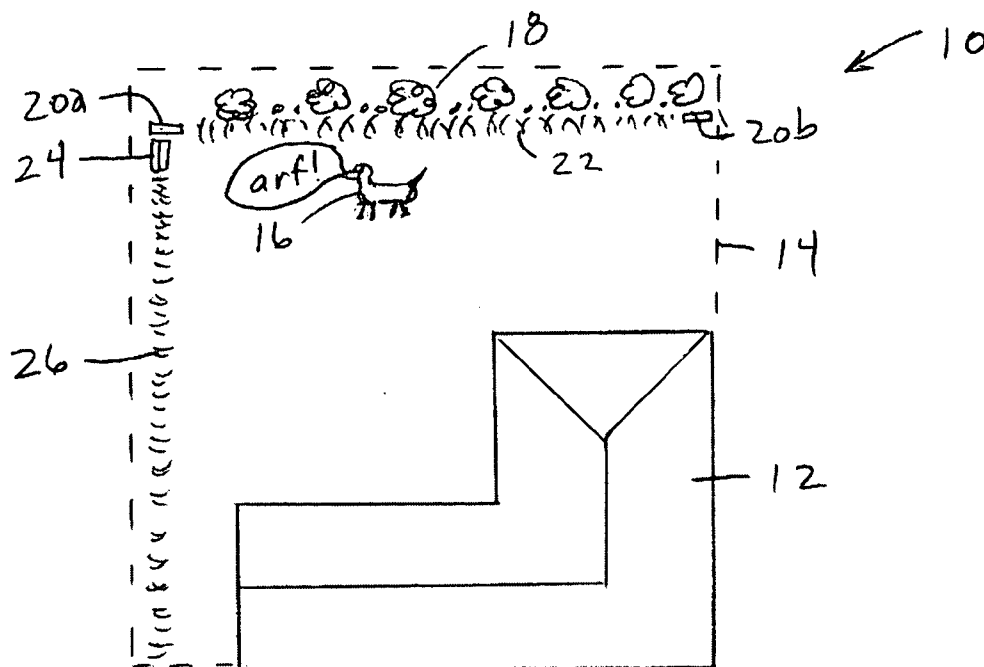


FIG. 50

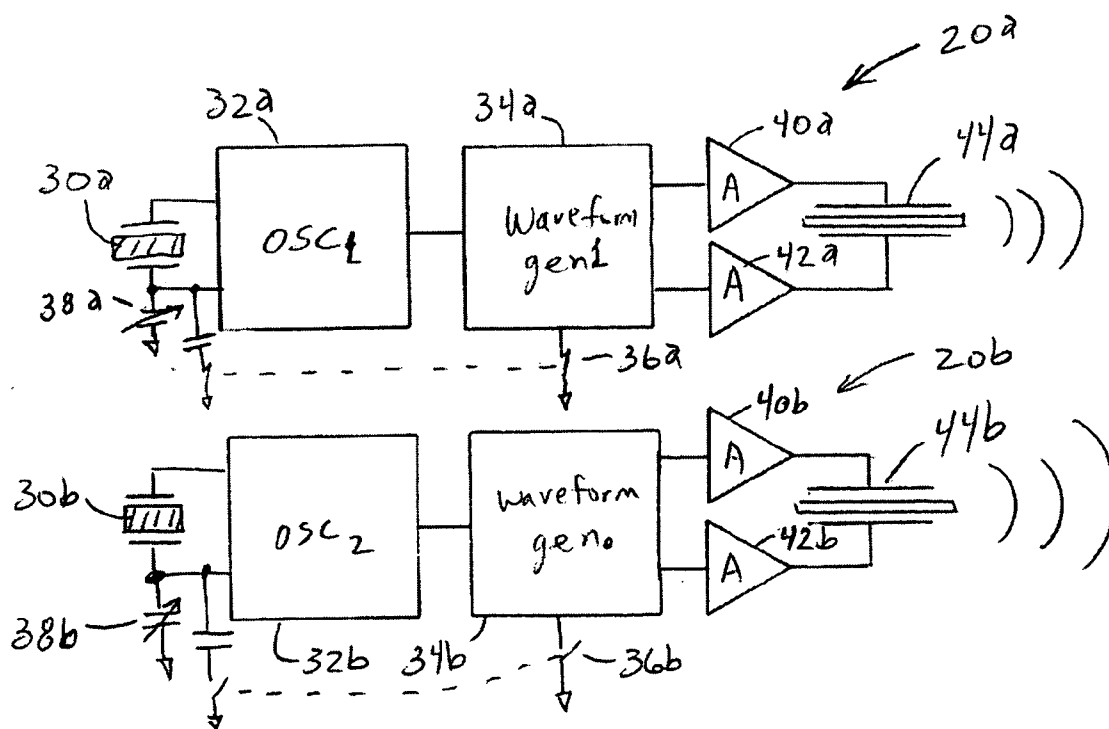


FIG. 51

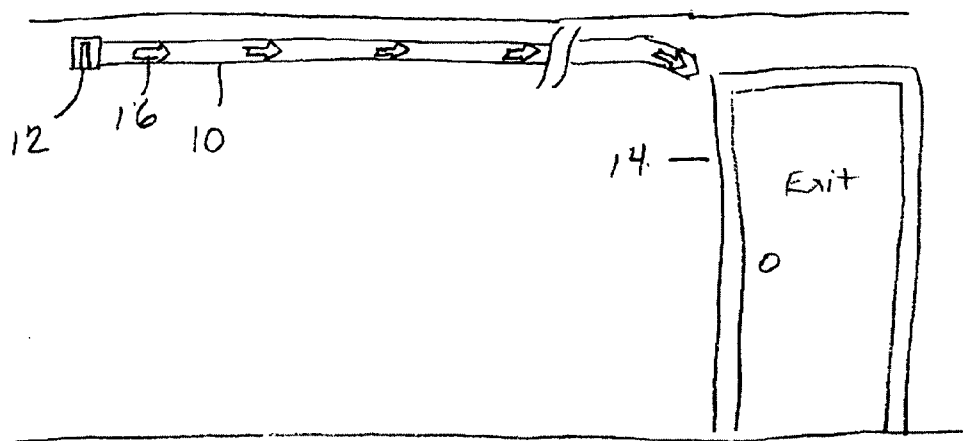


FIG. 52

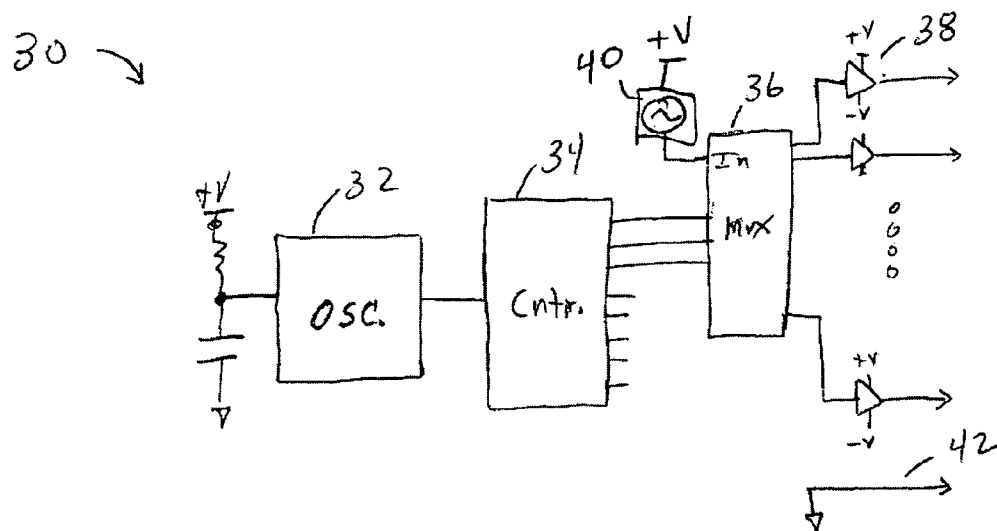


FIG. 53

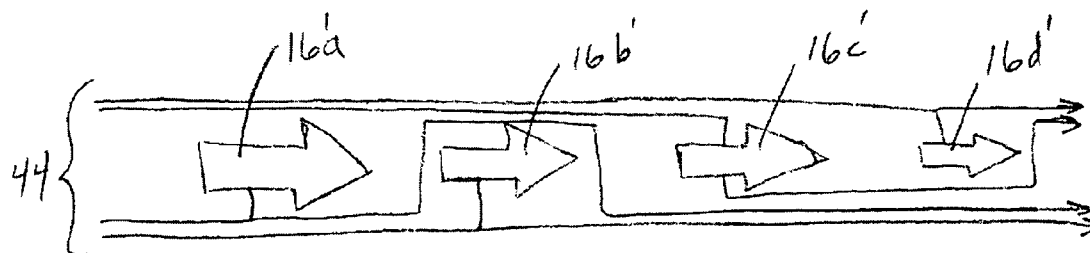


FIG. 54

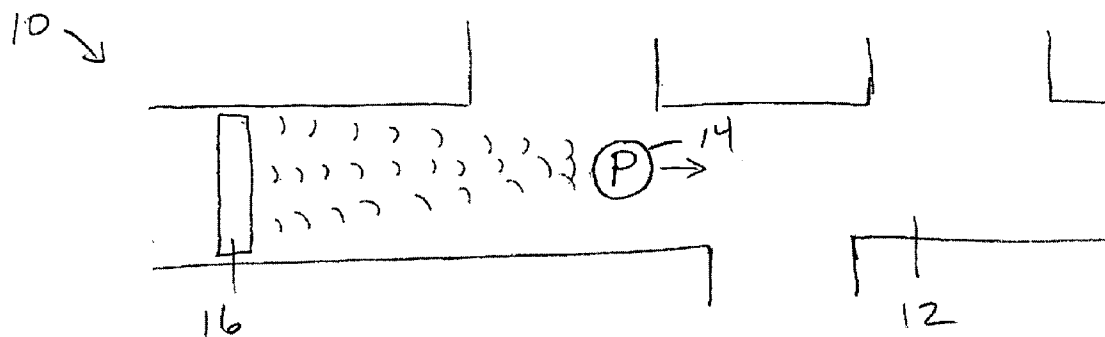


FIG. 55

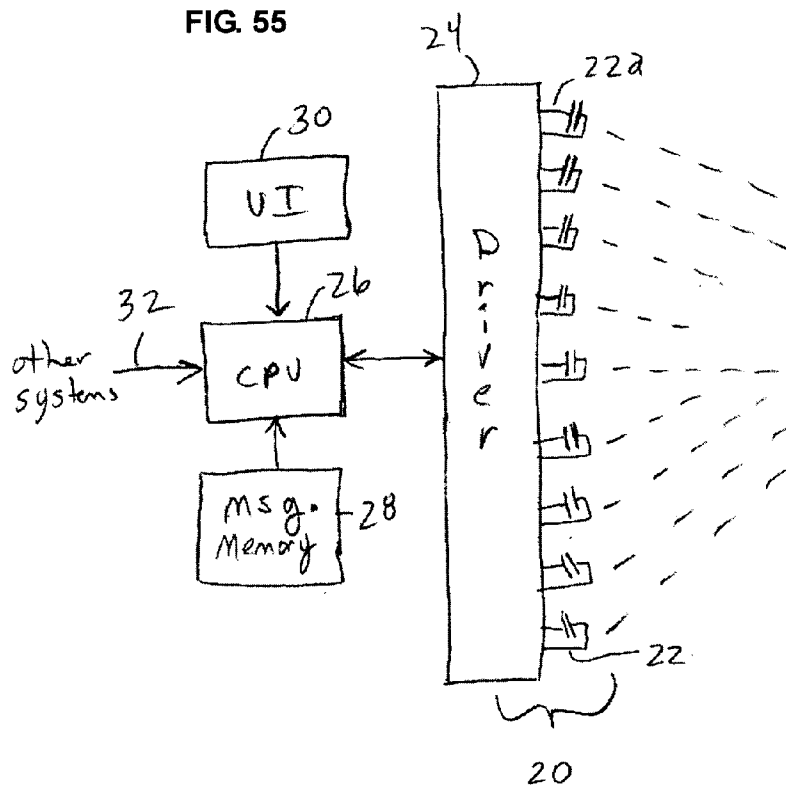


FIG. 56

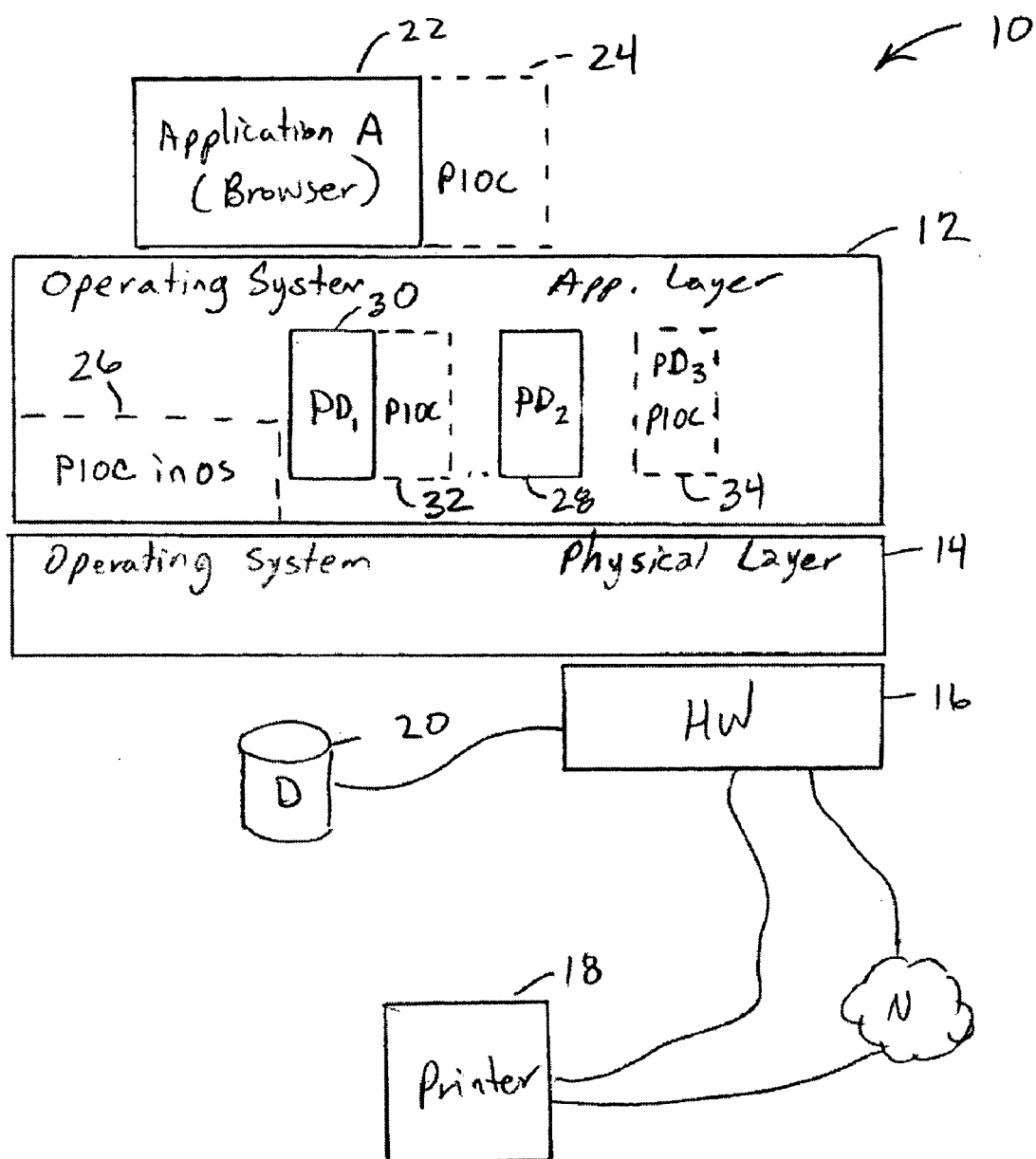


FIG. 57

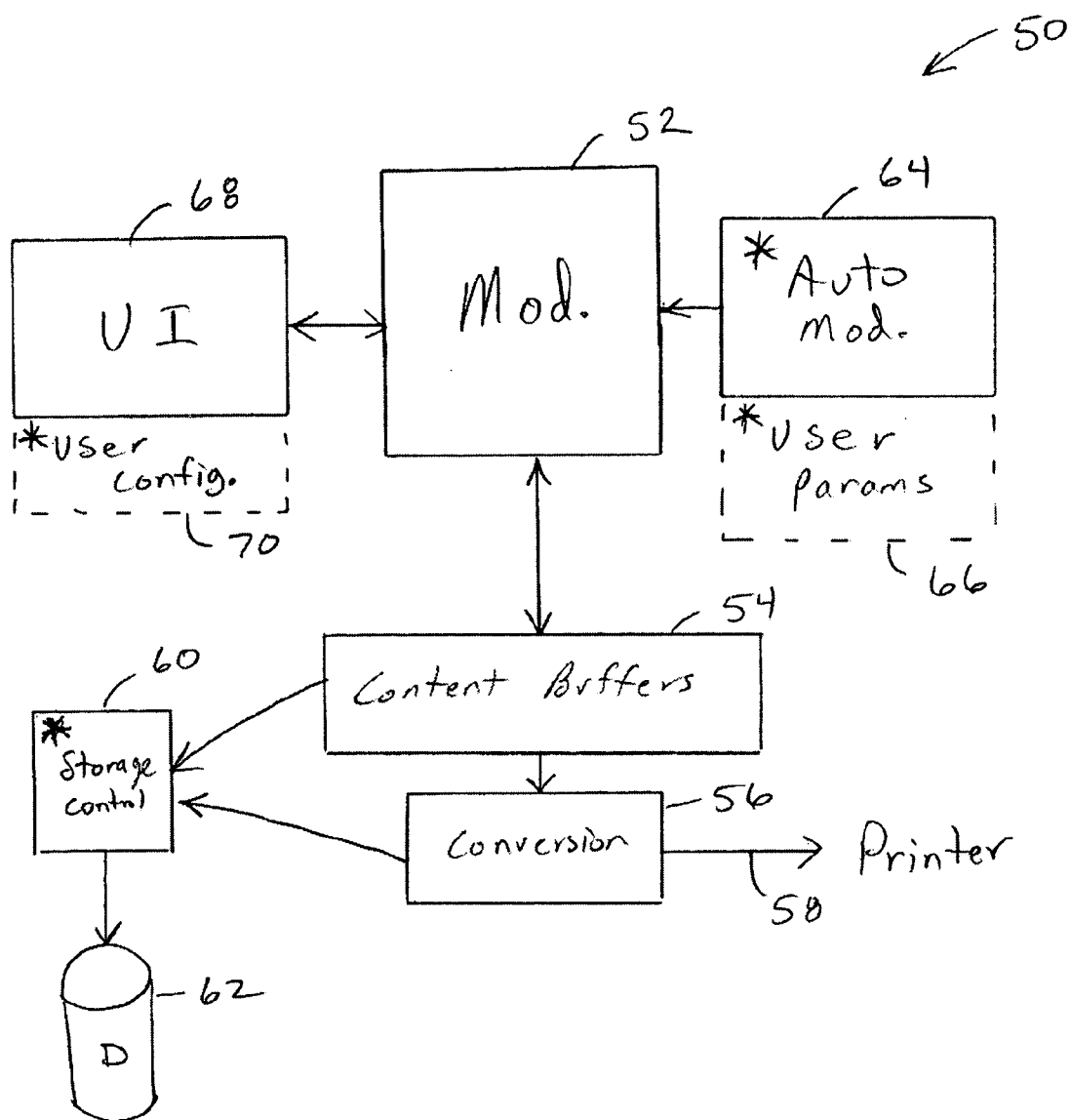


FIG. 58

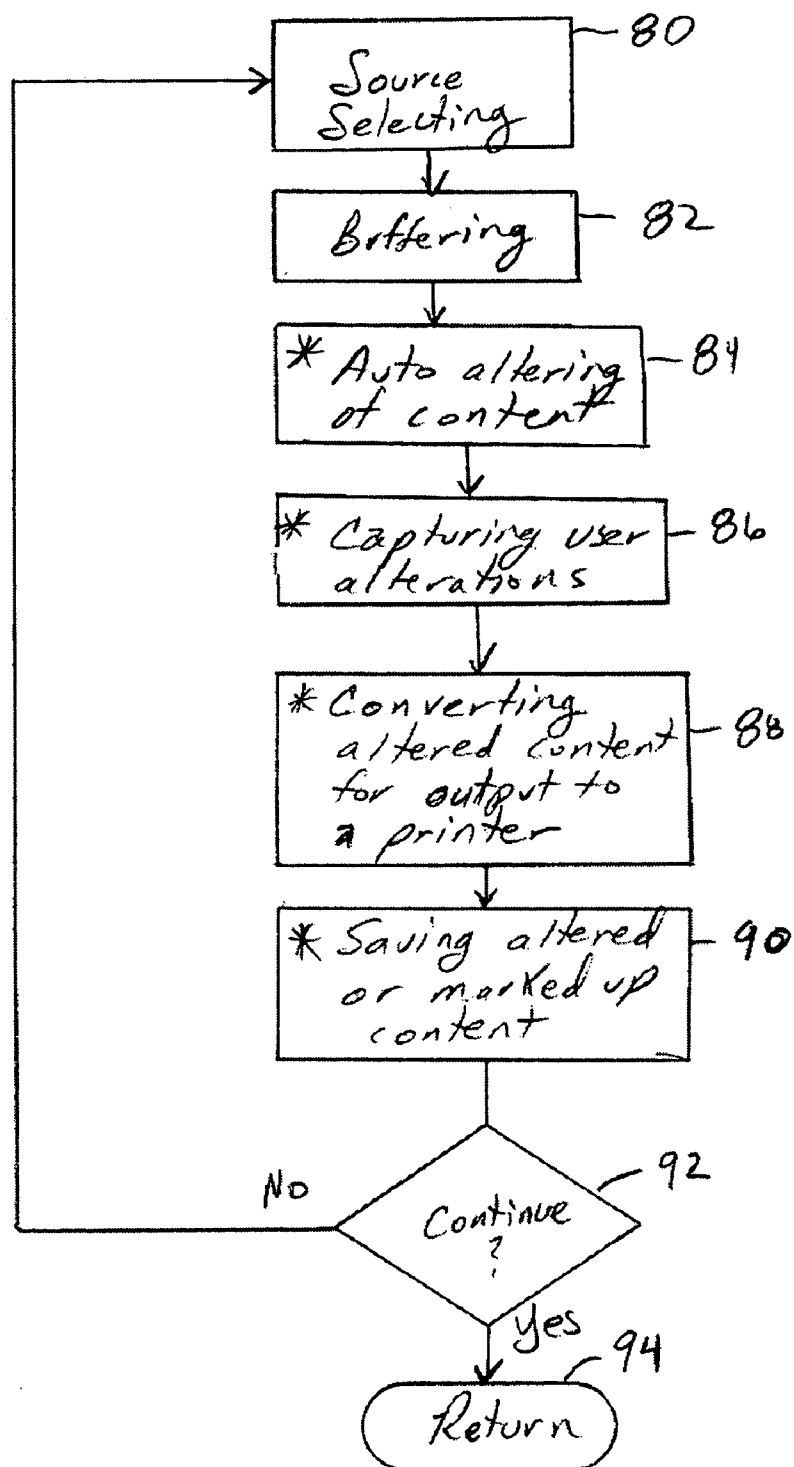


FIG. 59

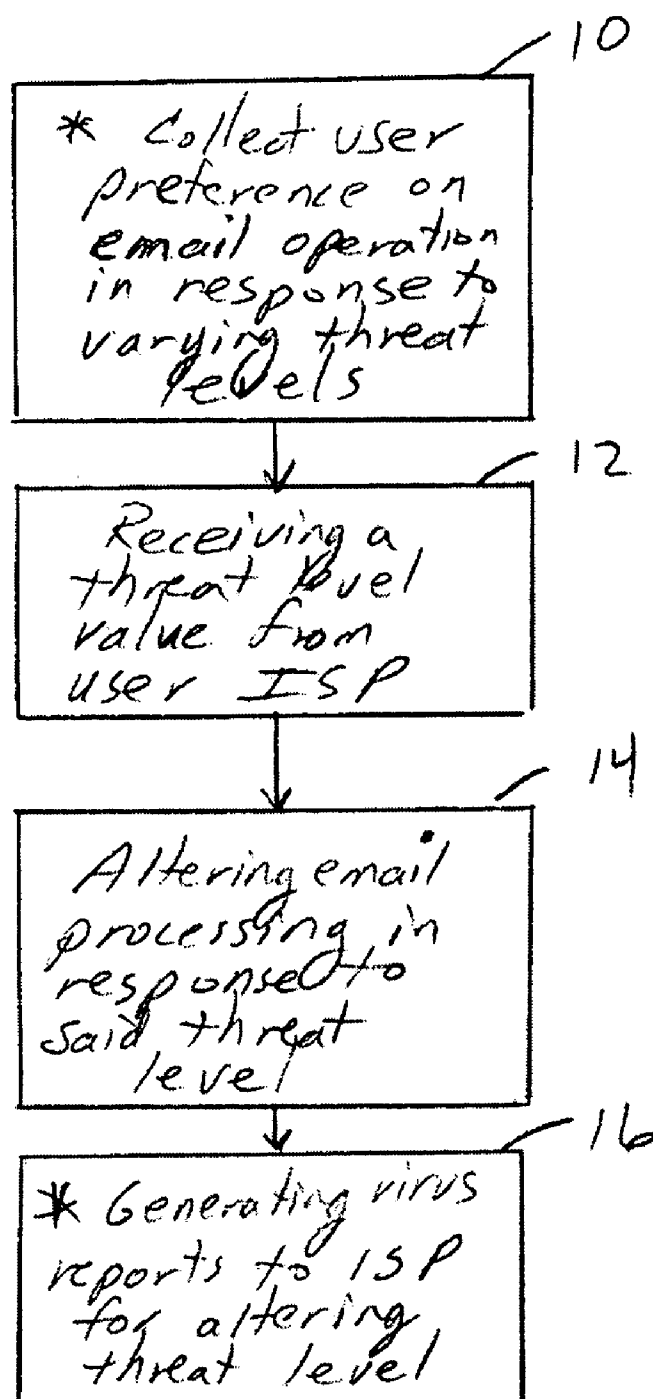


FIG. 60

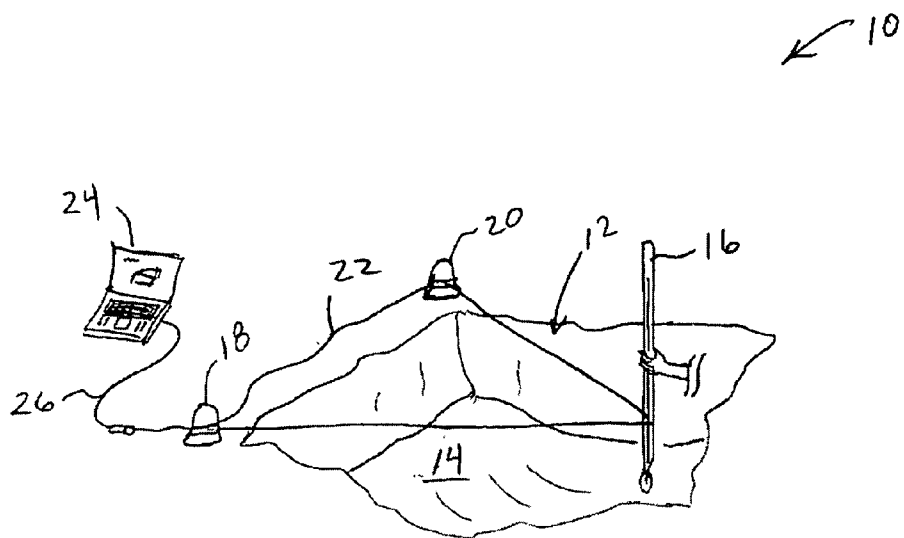


FIG. 61

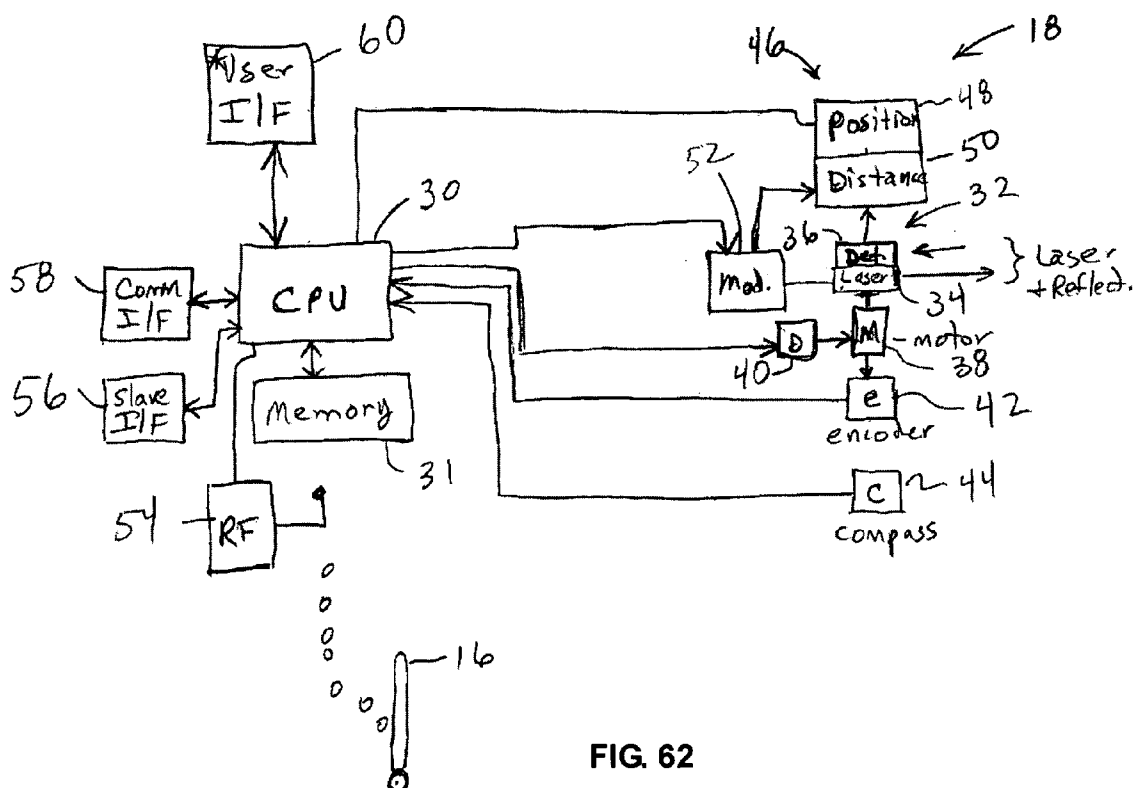


FIG. 62

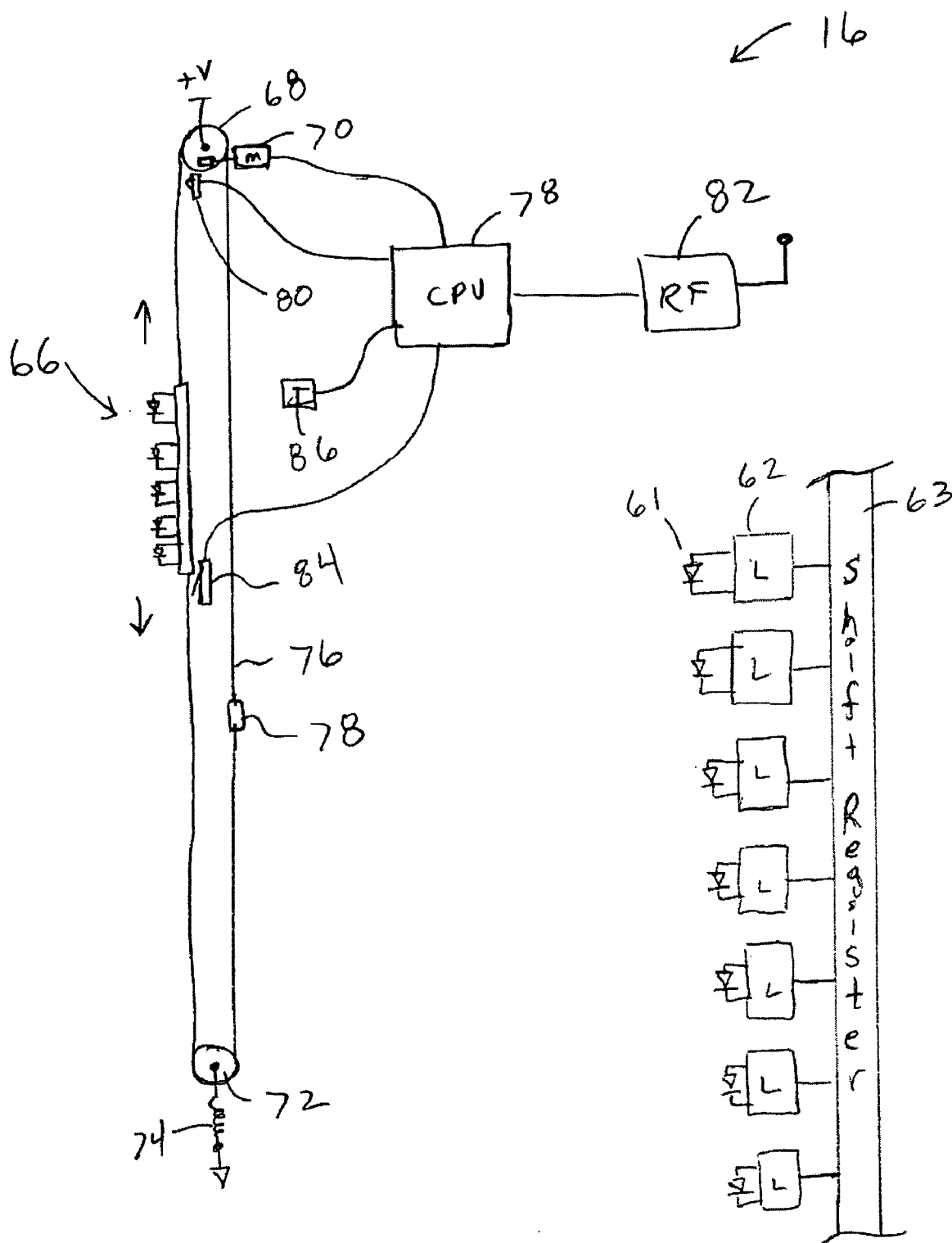


FIG. 64

FIG. 63

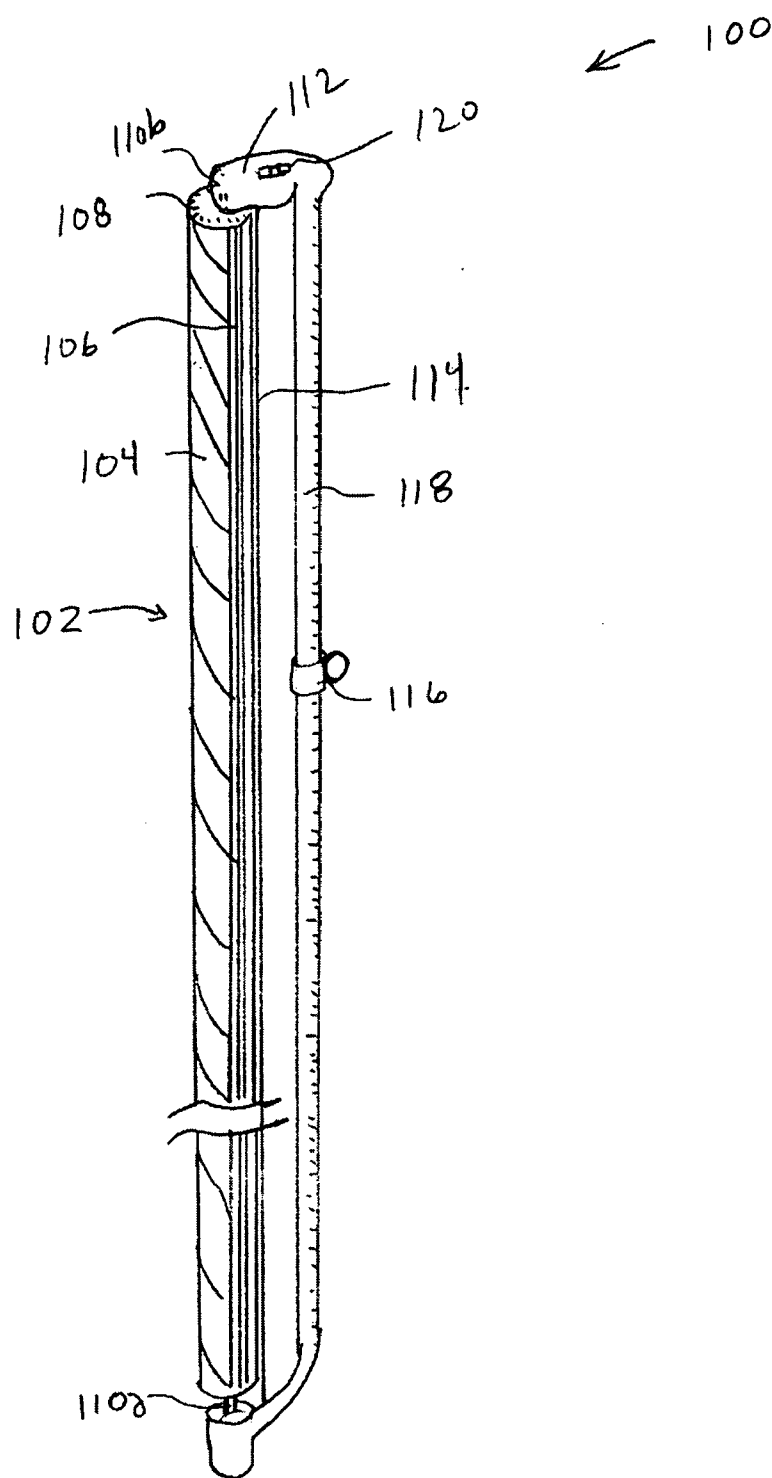
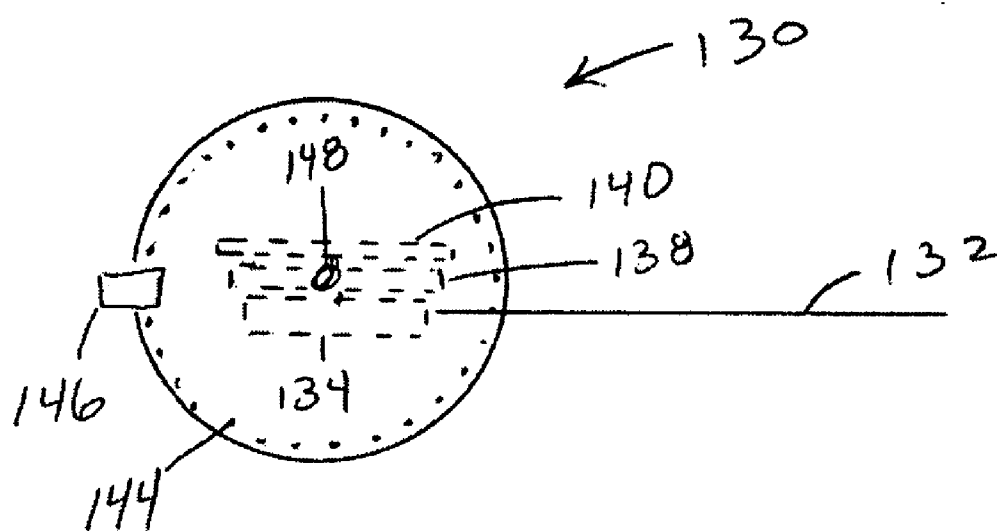
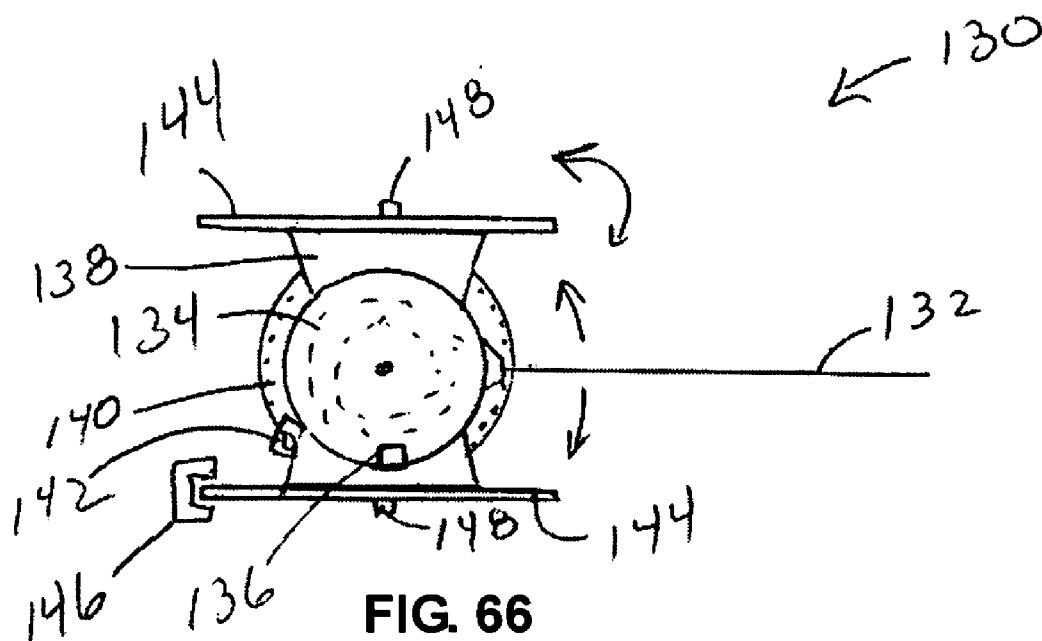


FIG. 65



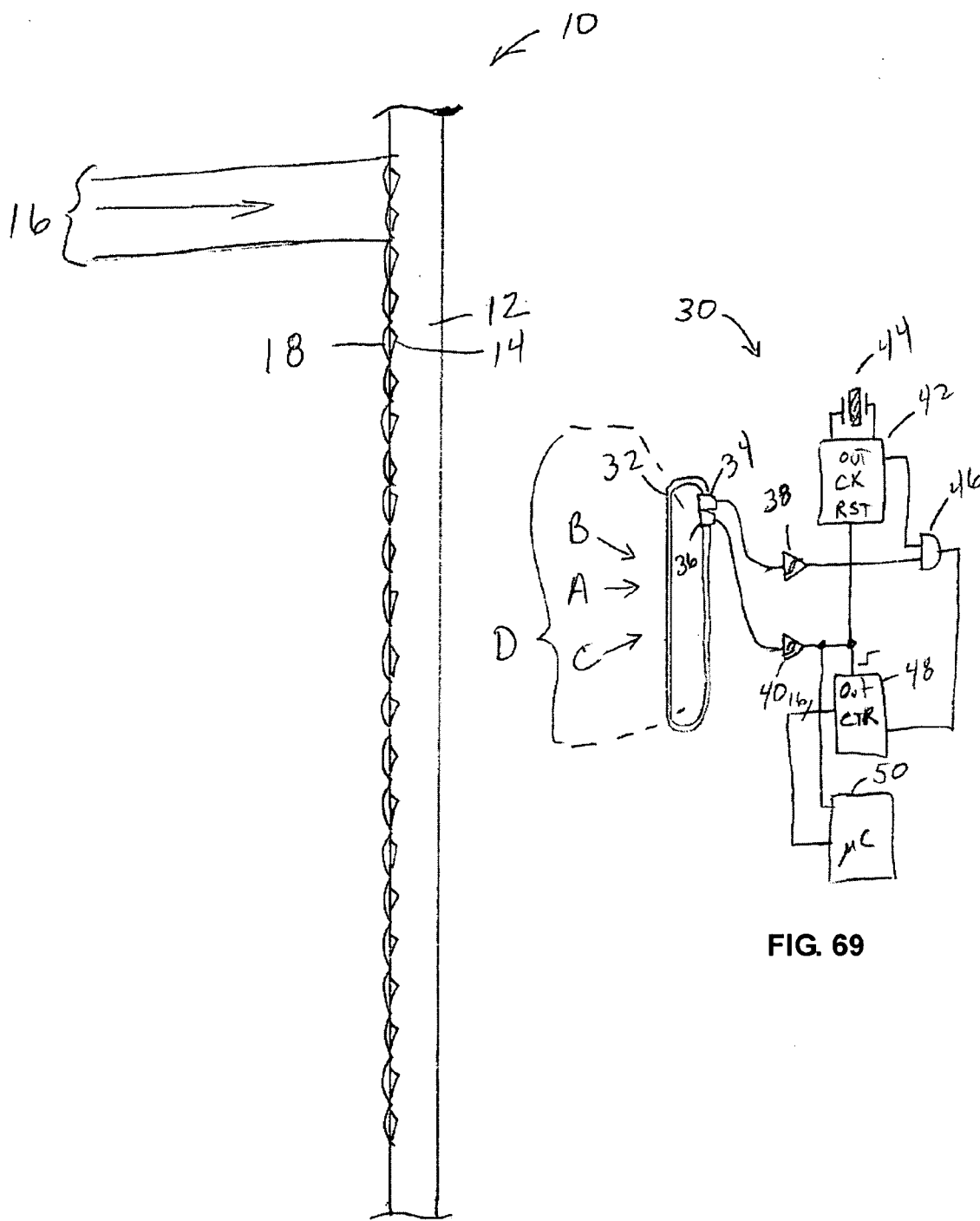


FIG. 68

FIG. 69

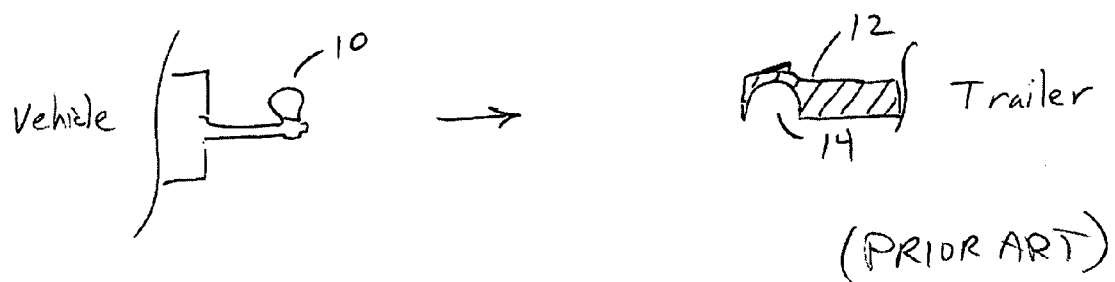
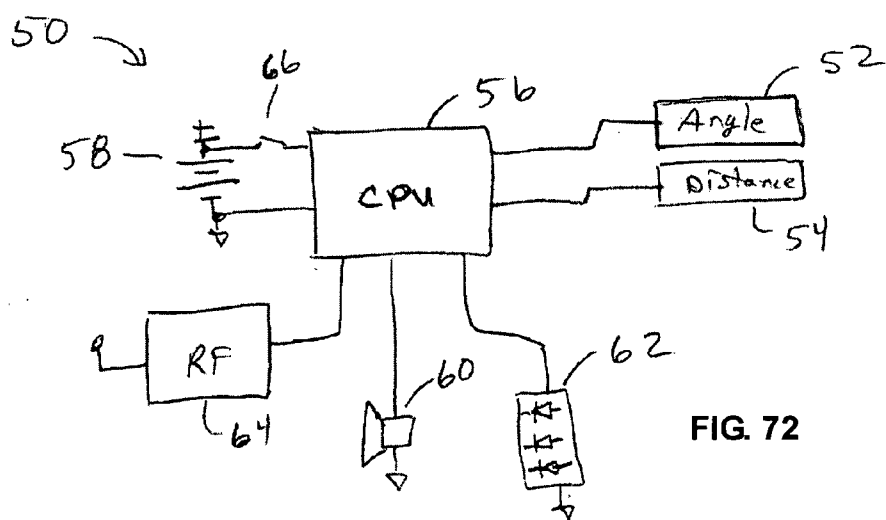
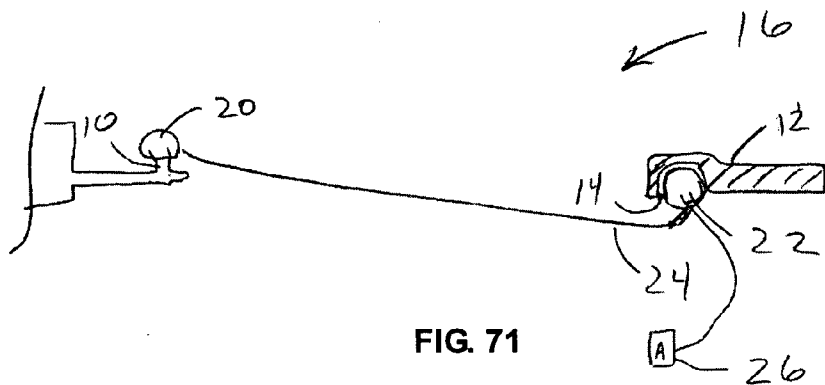


FIG. 70



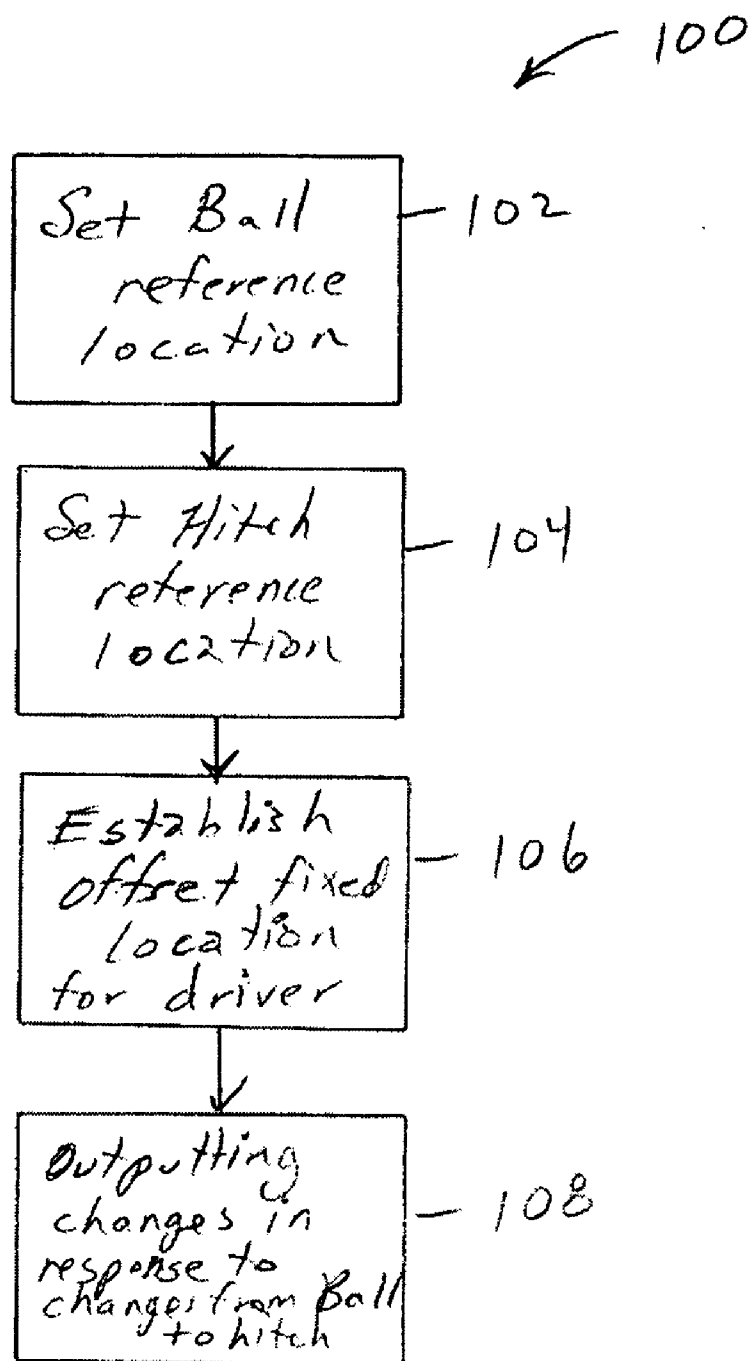


FIG. 73

CEILING FAN PROXIMITY SAFETY APPARATUS**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims priority from provisional patent application Ser. No. 60/526,376 filed Dec. 1, 2003; and incorporates by reference a description of a "ceiling fan with integral filter" within patent application Ser. No. 10/612,221 filed on Jul. 1, 2003; and provisional patent application Ser. No. 60/394,160 filed Jul. 1, 2002.

STATEMENT OF FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

REFERENCE TO A MICROFICHE APPENDIX

[0003] Not Applicable

BACKGROUND OF THE INVENTION

[0004] 1. Field of the Invention

[0005] This invention pertains generally to ceiling fan appliances and more particularly to generating audible alerts to prevent contact with the moving fan.

[0006] 2. Description of the Background Art

[0007] Ceiling fans provide an efficient means for circulating air within the home and remain extremely popular. Typically these ceiling fans comprise a number of blades of from two to four feet in length which extend from and rotate in relation to a motorized hub. One drawback to these fans is the inherent danger presented by the spinning blades. When attached to a high ceiling the blades of the fan are typically placed out of reach of the occupants of the room to assure safety. However, conventional ceilings in homes, and some businesses, are typically at a height of about eight feet. Furthermore, the efficiency of a fan is significantly reduced when it is placed adjacent to the ceiling. Many fan manufacturers have recently stopped production of these "flush mounted" fans, although short mounting stems are still the default size of mounting stem provided, which is indicative of the popularity of mounting the units in rooms having a low ceiling. Ceiling fans regulations in some locales are required to be mounted at a minimum height of seven feet, which is still possible with the majority of ceiling fan kits using a short stem.

[0008] However, even mounted at a height of seven feet the fans pose a serious injury hazard. Although few persons have a height approaching seven feet, it is very common in the home for the occupants to raise their arms above their head or otherwise incur the path of the blades, such as during a stretch or yawn, expressing themselves and so forth. Making matters worse the injured parties are often guests of the homeowner, wherein the injury can lead to additional unpleasant issues. Being struck by ceiling fan blades moving at moderate to high speed poses a significant risk for bone breakage, lacerations, and extensive soft tissue trauma.

[0009] As can be seen, therefore, the development of a ceiling fan which can reduce blade incursion instances would result in fewer injuries, lowered levels of manufacturer liability, and greater peace of mind for homeowners

having ceiling fans in the home. The ceiling fan apparatus in accordance with the present invention satisfies that need, as well as others, and overcomes deficiencies in previously known techniques.

BRIEF SUMMARY OF THE INVENTION

[0010] The injuries sustained from ceiling fan blade incursions has not been fully appreciated in the industry. To prevent the blades from completely severing the fingers, or other body parts, ceiling fans blades are typically configured with blunt leading edges.

[0011] The blunt leading edges reduce fan efficiency, but only reduce the severity of injuries arising from ceiling fan blade incursions.

[0012] The present invention is a ceiling fan having a blade incursion alert so that occupants are less likely to allow body parts, or other objects, to cross the path of the fan. The incursion alerting device is preferably integrated with the electronics of the ceiling fan, however, an embodiment is also described in which the incursion alert can be added as an aftermarket device to an existing ceiling fan. Either embodiment of the present invention reduces the probability of a ceiling fan blade incursion event.

[0013] An embodiment of the present invention can be described as an apparatus for generating alerts when objects approach the blades of a ceiling fan, comprising: (a) means for sensing proximity, the means coupled to one or more blades of a ceiling fan;

[0014] (b) means for detecting a sufficient proximity, or sufficient change in proximity, as detected by the sensing means and generating an alert signal; and (c) means for generating an announcement from the ceiling fan in response to the alert signal.

[0015] In a preferred embodiment the proximity sensing is performed by a sensor distributed over an elongated portion of one or more fan blades. By way of example the sensor may comprise an inductive loop sensor, electric field sensor, capacitive sensor, and so forth. The sensor may span any portion of a blade, such as on the surface, or on one or more edges. One form of inductive sensor can be placed about the edging of the fan blade, for example as a conductive edging strip, which may also provide additional level of compliance. It should be appreciated that most fans can be operating in either direction depending on the desired direction of air circulation.

[0016] Embodiments of the present invention can provide a number of beneficial aspects which can be implemented either separately or in any desired combination without departing from the present teachings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention will be more fully understood by reference to the following drawings in **FIG. 1** through **73** which are for illustrative purposes only:

DETAILED DESCRIPTION OF EMBODIMENT(S)

[0018] Referring more specifically to the drawings for illustrative purposes, the present invention is embodied in the apparatus and methods generally described in **FIG. 1** to

FIG. 73. The following description is presented to enable one of ordinary skill in the art to make and use the invention as provided in the context of a particular application and its requirements. Unnecessary technical details, which extend beyond the necessary information allowing a person of ordinary skill in the art to practice the invention, are preferably absent for the sake of clarity and brevity. Furthermore, it is to be understood that inventive aspects may be practiced in numerous alternative ways by one of ordinary skill without departing from the teachings of the invention. Therefore, various modifications to the preferred embodiments will be readily apparent to those skilled in the art, and the principles defined here may be applied to other embodiments. Thus the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

[0019] 1 Ceiling Fan Safety Sensing.

[0020] 1.1 Introduction.

[0021] A preferred aspect of the invention is that of sensing proximity of objects or an individual, particularly the hands of an individual, approaching the rotating blades of the fan and annunciating an alert to the individual lessening the likelihood they will inadvertently contact the blades.

[0022] **FIG. 1** depicts a fan **10** according to the invention, having a securement base **14**, a motor housing **16** (which may be part of the securement base or housed separately as shown), and a set of blades **18** configured to rotate under the control in response to the operation of a motor, such as in motor housing **16**.

[0023] The fan may include lighting elements, be oriented in alternative directions, have a different number of blades or configuration, without departing from the teachings of the present invention. It should be also appreciated that the motor may be located remotely and coupled to the blades with a transmissive element, without departing from the teachings of the present invention.

[0024] The hand **12** of an individual is shown approaching fan **10**, wherein an audio annunciation **20** is generated to alert the individual to the danger.

[0025] By way of example a capacitive sensing approach is shown, wherein the facing portion of at least one fan blade has a conductive trace pattern **22**, for sensing capacitance with a portion of an individual moving in proximity with the blade. It should be appreciated that a conductive trace pattern or paint may be overlaid on the blade surface, and that conductive paints can appear and be utilized the same as conventional paints. It will further be appreciated that the trace pattern need not carry any significant levels of current and may have a relatively high impedance (i.e. 100 kohms to 1 Mohm from root to tip) without effecting the sensing of proximity.

[0026] A less preferred embodiment of the invention can be created by incorporating a sensor near the hub of the ceiling fan for detecting incursions. In one embodiment a proximity sensor can be incorporated in the hub to detect the incursion of objects near the hub. However, it should be realized that this approach is not readily amenable to accurately sensing when objects approach the blade path.

[0027] In an alternate embodiment an optical beam sensor, such as a LASER (i.e. preferably in the near IR or UV spectrum), in combination with a detection is configured to rotate with the fan projecting a beam path canted downward from the blade path. The light beam is reflected from objects that incur within the conical beam path and detected. Using a modulated transmission beam, the distance of the object from which the reflection arose can be determined, and objects beyond the radius of the blades discriminated against. An annunciation can thus be generated in response to movements toward the blades within the blade diameter. It should be generally appreciated that although workable, implementation of this embodiment would at this time be more costly to mass produce than utilizing an area sensor distributed across a lengthwise span of the fan blades.

[0028] 1.2 Example Circuit Embodiment.

[0029] **FIG. 2** illustrates an example of a controller circuit **30** for the present invention. A proximity sensing means **32**, preferably an electronic sensor **32**, is shown for detecting the proximity of an object to the rotating fan blades. Sensor **32** may be coupled to the fan blades for sensing changes in capacitance, inductance, field strength, or other characteristics from which proximity may be determined by the system. The proximity signals are shown being conditioned by a signal conditioning means **34**, such as filters and operational amplifiers. A thresholding means is shown **36** for detecting if the proximity, or rate of proximity change, warrants the issuance of an annunciation. If so, an annunciation means **38** is activated to generate an audio output **40** and/or a visual output **42**.

[0030] It is preferred that the circuit be configured to register both the proximity and the rate of change of proximity (velocity) v/dt . If an absolute proximity threshold is crossed (i.e. one to two feet), the audio may be generated. Additionally, audio may be generated in response to a sufficient reduction in proximity (even if it exceeds the absolute threshold). The rate of proximity change, velocity, can also be used to determine the extent (i.e. amplitude or sound profile or other output profile) of the response. For example fast motion toward the unit is met with a louder audio annunciation than slow (typically more controlled) motion toward the fan blades.

[0031] A selector **42** is shown with Hi, Lo, and off settings to allow the user to determine how the audio output is to be generated in response to proximity. It should be appreciated that other controls may be incorporated to allow the user to control the sensitivity of the system, whether relative and/or absolute sensing is utilized, the loudness of the audio output, whether visual indicators are to be generated (i.e. separate lighting, of modulating the intensity of attached light elements), the rate at which the unit should acclimate to steady user presence, and adaptation of other operational characteristics. It will be appreciated that since a simple system is often preferred the described embodiment is depicted by way of example with a single control **44**.

[0032] By way of example the signal conditioning and threshold detection means may comprise analog circuits which filter frequency response of the sensor output and differentiate the result, wherein only proximity changes exceeding a threshold, such as exceeding a fixed setting, trigger an output to the annunciator. Additionally the circuit can register absolute proximity and generate an annunciation

when it crosses a threshold. A differential amplifier circuit may be utilized by itself or in conjunction with an op-amp configured as a comparator. It should be appreciated that one of ordinary skill in the art can implement the present invention utilizing a number of alternative circuits without departing from the present invention. By way of further example, a microcontroller circuit may be utilized for performing the thresholding and annunciation, and less preferably the conditioning of the sensor.

[0033] As many fan units already incorporate an annunciator for generating audio in response to changes in fan or lighting settings. The present system may be implemented to utilize that same annunciator and audio and/or visual output device, thereby reducing implementation costs.

[0034] Upon sensing an item, such as a hand or arm, moving toward the fan blade the controller is configured to generate an annunciation such as an audio alert (or lighting).

[0035] Furthermore the circuit may be configured with a controller/switch **46** which shuts down or even reverses the fan motor in response to an absolute proximity, relative change in proximity, or combination which appears dangerous, thereby aiding further in preventing possible injury. In many cases the audio alert should be sufficient as the person is alerted as they move toward the fan blades, the intensity of the sound generated is preferably in accord with the proximity. If the person remains close then the alarm preferably dwindles off after the alert—in this mode the circuit adapts their presence and only detects changes toward striking the fan. In this way the fan will not remain generating an alert if a tall person remained standing under a low hung fan, or held their hands steady above their heads proximal to the fan blades, but would still alert them should they then reach up toward the fan.

[0036] Sensing Means Examples.

[0037] The sensing means may be comprise any device configured for sensing proximity of objects and/or persons. Preferred forms of sensing include capacitive sensing, inductive sensing, RF sensing, infrared sensing, and pyroelectric sensing, although other forms of proximity sensing may be utilized.

[0038] In capacitively sensing proximity, the lower face of blade **18** (or other portion oriented toward the direction of individuals) is preferably covered with a conductive coating, or a conductive mesh, which is electrically coupled to the circuit. This connection requires only a single conduction path, such as coupled through arms connecting the blade to rotating element, such as the motor. As the hand, arm, head or other portion of the individual moves closer to the conductive plate the apparent capacitance changes, in a manner as a non-linear variable capacitance. The capacitive sensing may utilize static sensing or oscillatory sensing of the capacitance.

[0039] In a similar manner, one or more inductive loops may be coupled to the fan blade, such as a conductive path about the exterior rim of the blade, wherein both ends of the conductive path are coupled to the circuit. The inductance changes as objects move closer to the fan blades which may be sensed by the circuit.

[0040] **FIG. 3** illustrates by way of example a cross section of fan blade **18** incorporating an inductive loop,

which by way of example comprises a polymeric material **46** which is conductive or configured with a conductor or conductive stripe disposed therein. The polymeric material surrounds the periphery of the fan blade forming a wire loop. Alternatively, a separate wire can be placed in a slot **47** into which a non-conductive plastic strip is attached. The wire loop (of any construction) can be utilized as the sensing element within an inductive sensor or electric field sensor. The ends of the conductor portion within the polymeric strip of at least one of the blades is coupled to a sensing circuit. It will be appreciated that proximity may be sensed in any one of the blades, or on multiple blades which decreases proximity response time but generally increases cost factors.

[0041] It is also beneficial that strip **46** comprise a compliant material, such as a soft polymeric material, so as to reduce the impact forces between the moving fan blade and objects in the path of the blade.

[0042] **FIG. 4** depicts an alternative inductive circuit block diagram **50** having inductive loop **52** feeding a tank circuit oscillator **54** which generates an output frequency that changes in response to changes in inductance. Objects moving proximal to blade **52** cause the inductance to increase thereby changing the output frequency. A frequency to voltage converter **56** is shown for converting the frequency to a voltage. An optional adjustment **57** can be configured to adjust the sensitivity of the proximity sensing, or to calibrate the output response to the conditions within the given ceiling fan implementations, or specific installation. Voltage to frequency converter **56** preferably includes signal processing circuitry, such as analog filtering, to eliminate unwanted transients.

[0043] Alternatively the impedance of inductance **52** can be registered in response to communicating a pulse train through it. In this case the pulses can be generated from a microprocessor or other circuit, wherein there is no need for an LC tank circuit or frequency to voltage converter.

[0044] The output voltage is shown being compared for both absolute and relative proximity changes. Comparator circuits **58** and **60** are shown diagrammatically to represent these functions, although it will be appreciated these are simplified representations for the sake of clarity. Circuit **58** is depicted as a comparator which compares the output voltage to a fixed reference and generates an output signal **ABS** when the proximity threshold is crossed. Circuit **60** is depicted as a comparator which compares the present signal against a recent RC average of the signal. It should be noted that a diode is shown in the circuit so that the output signal is generated when an object approaches the blade, but not as the object is removed from the blade. It should be appreciated that although both absolute and relative proximity sensing is depicted, the device may utilize either separately, or in combination with other sensing, without departing from the teachings of the present invention.

[0045] A pair of proximity signals **62** is registered by a control device **64**, depicted as a microcontroller, although other analog or digital circuitry may be alternatively utilized.

[0046] The operation of the blade incursion alert is activated within the controller circuit in response to the presence of a motor on signal **66** (**MOT_ON**). For example the motor on signal may comprise a drive signal being coupled to pulse

width modulation (PWM) transistors within the fan motor controller. In one embodiment the microcontroller is configured for detecting the amount of power applied to the fan motor, such as based on the pulse widths being applied to the motor driver section. The proximity detection circuit, and/or the intensity of response is modulated in this embodiment in response to the detection of motor speed.

[0047] Control of output intensity (i.e. audio amplitude) is shown provided by a selector **68** (i.e. potentiometer coupled to a capacitor at a controller digital input/output pin wherein the controller can detect the setting of the resistor by outputting a low state (ground), then switching to an input mode and determining the time required for the input threshold for the input to be crossed, which is a conventional microprocessor technique for registering an analog selector setting using a digital I/O pin. It should be appreciated that a number of other selector registration means may be utilized, such as A-D inputs, separate circuits and so forth, without departing from the teachings of the present invention.

[0048] Annunciation preferably comprises an audio output **70**, depicted as a piezoelectric transducer element (or speaker, buzzer, etc.), and may include an optical output **72**, depicted as a dual-color LED. In one embodiment of the invention, strip **46** is configured as a light pipe for conducting the light from optical device **72** about the periphery of one or more fan blades (preferably a separate optical output device for each fan blade). In this way the light is readily seen as the blade lights up. To increase visibility of the optical output is preferable that its output be modulated, such as between two different colors, or flashing.

[0049] It should also be appreciated that the fan blade incursion alert can be provided by adding circuitry to ceiling fan controller, or a separate set of circuitry may be coupled to an existing fan in an aftermarket manner. Considering the integrated approach, it will be appreciated that microprocessor **64** is already configured for receiving control signal and for controlling the operation and speed of at least one fan motor. In this diagram a combination circuit **74** comprising a user interface (UI) and a motor controller (MC) are shown optionally coupled to controller **64**. It should be noted that the UI typically receives AC power upon which the control signals are embedded, or alternatively the control signal can be received over a separate control wire or over a wireless communication link (i.e. radio-frequency (RF), optical, infra-red (IR), audio, ultrasonic, etc.). It should be noted that an audio annunciator **70** is typically already connected to a conventional fan blade controller **64** for indicating changes in speed, direction, lighting and so forth.

[0050] Although an inductive sensor is depicted, other forms of sensors are becoming readily available, such as electric field sensing devices, which may also be utilized by themselves or in combination with other forms of sensors.

[0051] FIG. 5 illustrates by way of example the method of preventing ceiling fan blade incursion according to the present invention. Represented by block **90** it is determined if the fan motor is active. If the fan motor is operating then the ceiling fan blade incursion sensing feature is initialized (i.e. previously collected data cleared, calibrations optionally performed, etc.) and activated as per block **92**.

[0052] Proximity is detected in block **94** and the data compared for proper alert conditions. Block **96** depicts an

absolute proximity detection, wherein an alert is generated if an object is brought within a predetermined distance from the ceiling fan blades. Alternatively the absolute level for the comparison need not be predetermined, and in one embodiment this value is responsive to the power input to the fan or the angular speed of the set of fan blades. Block **98** detects relative proximity, preferably proximity changes, specifically those brought about as an object approaches the sensor. This embodiment is configured so that if either condition is met, an annunciation will be generated at block **100**. It should be noted that annunciation can be generated in response to either absolute or relative sensing, or to other combinations of one or more absolute or relative sensing mechanisms.

[0053] Combination with a Fan Filter.

[0054] The ceiling fan incursion alerting device may be coupled to an existing fan, integrated within the design of a ceiling fan, or integrated within other equipment configured for coupling to a ceiling fan. For example, the present invention may be utilized in combination with the ceiling fan filter apparatus described in another application by the applicant. The filter apparatus is integrated with the blades, or coupled thereto for filtering the air passing over at least one portion of the blade, and thus through the filter element(s). The fan filtering can thus be embodied to contain a proximity sensing element according to the present invention, or work in combination with the fan blade incursion sensing of the present invention.

[0055] Manufacturing Considerations.

[0056] At the present time a simple audio output implementation of the present invention can be manufactured for less than about one or two dollars, and in ceiling fan designs containing annunciators the incremental cost should be less than fifty cents.

[0057] Another favorable aspect of the present invention, is that it is designed to protect consumers, where fewer injuries should result. This is beneficial to both the public at large and for lowering product liability premiums. It will be appreciated that even if a user elects to turn off the proximity alert, they made a conscious election to do so despite package warnings. Another distinct advantage is that the present invention provides a competitive advantage, and competitors may need to adopt the system from both a marketing and/or liability standpoint. Furthermore, new laws are enacted each year towards increasing consumer safety, wherein adoption of blade alerts may become mandatory for ceiling fans in the foreseeable future.

[0058] 1.3 Non-Electronic Aspects of the Invention.

[0059] Less preferably, the alert may be generated non-electrically, or the impact of a ceiling fan striking an individual may be lessened utilizing non-electronic means. These aspects of the invention may be utilized separately or in combination with the electronic sensing mechanisms described above.

[0060] A mechanical indicator of proximity may be utilized, such as suspending a flexible cord attached near the hub of the fan blades. Under rotation the centripetal force causes the cord to move out toward the horizontal, preferably parallel with the fan blade and a few inches beneath it. A person moving across the plane of the cord is struck as a warning. It should be appreciated, however, that such

mechanisms are subject to being entangled, broken off, striking a person (i.e. in the eye) as they move from a vertical to a horizontal position and so forth. Therefore, such devices are far less preferable than those described above.

[0061] The fan blade may be optionally configured with a conformal leading edge capable of absorbing some impact pressure. Although a stiff blade material is necessary to prevent flexing in response to air pressure, the leading edge (and optionally trailing edge or the entire periphery of the blade) may be adapted with a compressible material, such as high density foam, compliant tubing, or other shock-absorbing materials. In this way a person whose hand or other body part contacts the moving fan blade is less likely to incur a serious injury. The ceiling fan with integral filter described in an application incorporated herein by reference, may be configured with a soft leading edge as described above.

[0062] 2 Preponderance-of-Evidence (PROE) Intrusion Detection System and Method

[0063] 2.1 Introduction

[0064] Problem with Current Technology

[0065] Conventional security detection systems (intrusion, fire, flood, etc.) are configured with separate detector units that individually detect if an alarm condition exists, and in response to which an alarm signal is generated. To reduce subjectivity to false alarms, the sensitivity of the units must often be set fairly low (high alarm threshold), wherein measured conditions which are not absolutely indicative of an alarm are ignored. Consequently, an alarm may not be generated as an intruder with a low detection signature passes through a entire series of sensors in different detection zones of an alarm system without the alarm being activated. It will be readily recognized that if the system had taken into account that "near alarm" conditions arising at sequential zones—it would have correctly generated an alarm and foiled the intrusion.

[0066] This above situation is particularly problematic in security (alarm) systems wherein each zone or layer of detection is often similarly configured with a sloppy threshold, wherein the intruder can bypass each set of the detectors in turn to reach their objective. Also, in a number of installations, the zones of the detector units overlap but they only generate output based on individual consideration of alarm conditions, instead of the cumulative consideration from the sum of both detector units.

[0067] Cost and ease of installation and maintenance are a prime factor in designing security systems. Conventional sensors benefit from being low in cost and easy to install, while they do not require any programming as to the specific location or interdependencies between sensors.

[0068] It will be appreciated therefore that a detection system and method is required which takes into account registered conditions which by themselves are not sufficient to generate an alarm. The present invention fulfills that object and provides a number of additional benefits.

[0069] 2.2 Summary of Inventive Aspects.

[0070] This invention pertains generally to alarm systems and more particularly to a system and method for preconditioning sensor thresholds.

[0071] The present invention describes a system and method wherein sensors, in addition to having the ability to generate an alarm condition, it can generate a "prequalification" for an alarm. The prequalification being generally based on a lower threshold of the detector (more sensitive than threshold for directly generating an alarm). Conditions which cause the lower threshold to be crossed suggest the presence of an intruder, but are insufficiently conclusive evidence, in and of themselves, to warrant generating an alarm condition.

[0072] The prequalification signal is utilized for temporarily lowering the alarm output threshold which when crossed leads to outputting of an audible, optical and/or silent alarm. It should be appreciated that although alarm systems conventionally activate an alarm bell, or similar annunciator, in response to detecting an alarm; they may alternatively generate a number of other forms of output. Within the present invention the phrase "outputting an audible and/or silent alarm" is meant in a broad sense as any output from the controller which can alert personnel, such as annunciating an alarm condition with lights or sounds, generating an output that is registered by a remote system for alerting personnel, or other mechanisms in which people are directly or indirectly alerted to the condition.

[0073] The step of lowering the alarm detection threshold in response to one or more prequalification signals can be performed in a controller which registers inputs from more than one sensor, or sensors which receive prequalification from other sensors, such as neighboring sensors.

[0074] The present system is configured with a controller for generating an alarm signal upon the receipt of an alarm signal from any one sensor, OR upon the receipt of prequalification signals from multiple detector units within a given period of time. The prequalification signal from multiple detectors provides a Preponderance-Of-Evidence (PROE) that an alarm condition indeed has arisen although the conditions at any one sensor may not exceed the alarm threshold.

[0075] It should be appreciated that sensors (alarm condition detectors) manufactured for providing a prequalification signal can be easily integrated within conventional alarm systems in a number of different ways. The prequalification units can be utilized alongside of legacy alarm detection sensors, and/or alongside of legacy controllers, while providing enhanced functionality. By way of example a simple single current loop alarm communication link, can contain conventional switch sensors (i.e. magnet and reed relay switch combination to sense door and window operation), while also incorporating other detector units which can generate prequalification signals and are coupled to the same current sense loops. The ease with which the present PROE teachings can be incorporated within a detector unit which already contains some form of signal processing/thresholding circuitry should be readily appreciated.

[0076] 2.3 Detailed Description of PROE Aspects.

[0077] Prequalification Induced Threshold Lowering.

[0078] Prequalification can be sensed within any element of the alarm system which is capable of generating an alarm or of otherwise altering the conditions under which an alarm is generated. Two preferred approaches are generally described in the disclosure, although it should be appreci-

ated that the teachings may be applied to other forms of implementation without departing from the present invention.

[0079] (1) The prequalification may be detected within a controller which generates an alarm in response to a signal from any sensor indicating the alarm threshold is crossed, or multiple sensors generating a prequalification signal.

[0080] (2) The prequalification may be detected within other alarm detector units (i.e. sensor heads, etc.) wherein receipt of the prequalification signal temporarily lowers the threshold that must be crossed for generating an alarm, since the detected condition has already been prequalified.

[0081] Furthermore, in some applications it may be desirable to use the prequalification for prequalifying one or more given alarm signal outputs from select alarm detectors (or certain alarm detector outputs on an alarm detector) which are prone to false alarm, wherein a prequalification signal would need to first be received before an alarm indication from the selected alarm would be considered a valid alarm and a audible or silent alarm output from the system. It will be appreciated that an alarm detector may generate unreliable output or that the communication path to the controller may be subject to noise, especially with regard to the use of wireless detectors, which could erroneously appear as an alarm condition. The prequalification can allow for increasing the sensitivity of an alarm system while significantly reducing the occurrence of false alarms.

[0082] Synchronous and/or Asynchronous Prequalification.

[0083] The desired response to prequalification within the system can be configured as synchronous and/or asynchronous.

[0084] Synchronous response requires that the prequalification signal be active at the same time as another signal, such as a prequalification level signal, or other signal being qualified by the prequalification signal. This mode is most suitable when multiple sensors are directed at a given alarm zone.

[0085] Asynchronous response allows the prequalification signal to be temporally displaced from the other signal being prequalified. Receipt of the prequalification signal thereby alters the threshold for some period of time, which may be predetermined or a variable whose value is determined during alarm configuration for all or a single detector or set in response to detected conditions. This mode is suitable to all arrangements and it allows the benefits of prequalification to be applied to nested sensors.

[0086] Levels of Prequalification Information.

[0087] The prequalification information is described above as a binary value, either the conditions warrant prequalification or they do not. However, the prequalification may be extended into multiple levels (preferably discrete levels) of prequalification wherein the preponderance of evidence can require a sum of prequalification signals that exceeds a given threshold. For example consider a system in which each detector can generate four levels of prequalification (1, 2, 3, 4) and in which prequalification exceeding 5 or 6 is required to generate the alarm.

[0088] Furthermore, the prequalification signals may include "type of intrusion" information wherein the type is

factored into alarm prequalification, or multiple categories of prequalification information are generated. In this way the system can be balanced so that certain types of sensors, such as prone to a disturbance from RF sources, can require prequalification from alarm detectors which are not subject to the same false alarm condition.

[0089] These additional levels of signaling can be communicated over conventional wiring, such as utilizing embedded signal forms or using other communication methods.

[0090] It should be appreciated that the above prequalification signals can be utilized without the need to program the alarm controller for specific relationships between detectors or the like.

[0091] Communication of Prequalification.

[0092] A simple method of utilizing prequalification with conventionally wired detectors is that of embedding a recognizable characteristic in the signal. For example for detectors with a two-wire resistive output (i.e. closed switch=no alarm, open switch=alarm) the resistive contact can be modulated in response to prequalification allowing it to be distinguished from an alarm condition. For example, the switched output can be modulated at a high rate, preferably according to a predetermined pattern so that intermittent alarm output can be readily distinguished from prequalification.

[0093] On detectors which generate voltage outputs back to a controller, the prequalification can be generated as an opposing polarity signal, a specific voltage level, a signal superimposed on the voltage signal, or similar detectable variations which can be distinguished from non-alarm or alarm conditions. It should be appreciated that prequalification signals can be communicated by any convenient encoding means to a controller.

[0094] In many implementations it may be preferable that the detector units delay their output of a prequalification signal so that it does not overlap a prequalification signal sent by another unit. This involves merely delaying prequalification output until the no signal is detected on the alarm communication link.

[0095] Communication between the detector units and the alarm controller (or other detector units whose output is responsive to prequalification) may be performed over substantially conventional analog wiring as described, or it may be communicated over any form of electronic communication link, interface, or network, either wired or wireless. For example, the sensors could communicate according to CAN protocols utilized in the automotive industry, IP protocols, or any other communication mechanism for transmitting a prequalification signal from the detector unit to the alarm controller. Utilizing these more sophisticated communication links, additional information is more easily conveyed within the PROE signals, such as supporting levels of prequalification.

[0096] Controller Processing of Prequalification.

[0097] In one embodiment, the controller of the alarm system is configured to detect the alarm signals, a process which may be performed conventionally, as well as to sense prequalification signals which when combined indicate, based on a preponderance of evidence that an alarm condi-

tion exists. Typically, the separate detectors are spaced out over a distance, wherein the prequalification output of the detectors in response to an intruder movement would be temporally displaced. In a simple embodiment, the controller is configured to register the prequalification signal and mark the time of receipt. If another prequalification signal is received, preferably from another sensor, within a predetermined period of time then the controller takes this as being sufficient evidence to generate an alarm.

[0098] It should be appreciated that using this preponderance of evidence mode improves the sensitivity of the alarm system without making the alarm system subject to increased false alarms, as would arise if the sensitivity on the sensors were increased. Furthermore, the relationship between detectors is taken into account without the need to program an alarm system to recognize specific relationships between the detector units.

[0099] Requiring Prequalification from Different Detectors.

[0100] A number of alternative mechanisms within the invention can be utilized if it is desirable to prevent temporally proximal prequalification signals from a single detector from causing an alarm. By way of example two mechanisms are described (1) including detector unit information with the prequalification signal; (2) preventing a detector unit from generating prequalification signals with insufficient time separation.

[0101] (1) Encoding detector unit number within prequalification.

[0102] By including a detector unit number encoded within each prequalification signal, then the output of each detector unit can be distinguished by the controller, or alternatively by neighboring detector units, or other circuits on the alarm communication link. For example, the prequalification output signal may be modulated with a specific pattern, such as with a detector module ID that can be provided from an ID chip, switch setting, configuration data, or similar means of retaining an ID within the detector unit. These detector unit IDs can also be encoded with each alarm signal, wherein the controller can make more intelligent decisions about both prequalification and alarms, such as in high-end alarm applications, by considering the relationship between the signals received in view of system topology.

[0103] (2) Not encoding detector unit number within prequalification signals.

[0104] If the prequalification signal to the controller is not encoded with detector unit number, then it may be preferred in some cases that the system prevent multiple prequalification signals from a single source from generating an alarm. Alternatively, one may want to allow temporally separate prequalifications to generate an alarm, depending on the type of detector is being considered. Sequential prequalifications on the same sensor can provide extra evidence of intrusion, insofar as the type of sensor is not one prone to noise levels that cause sporadic triggering.

[0105] In this instance it is preferable that multiple detector units upon generating a prequalification signal not be allowed to generate another such signal for a period of time, such as equal to the time period the prequalification is being considered by the controller or other detector. For example

consider that the prequalification is to be considered valid at the controller for a period of 60 seconds after arrival of a short prequalification signal (i.e. approximately 1-100 mS on an analog current loop form of alarm communications link).

[0106] A first detector unit detects alarm conditions (i.e. intrusion) conditions that are significant and which exceed the prequalification threshold, but the conditions are not quite sufficient to generate an alarm as they do not exceed the alarm threshold. Thereby the first detector unit generates a prequalification signal to the controller and will lock itself out from generating additional prequalification signals for a period of time, such as for 60 seconds. In this case consider that the controller stretches internally (i.e. by analog or digital hardware means or by way of programming) each received prequalification signal as if it lasted for 60 seconds. In this way the controller could only elevate multiple prequalification signals to an alarm condition if the prequalification signals were received from two different detector units. The prequal lockout period need not be equal to the prequal period of consideration within the controller, depending on the characteristics of the specific detector and system, for example a 30 second lockout may be sufficient to prevent the false alarms.

[0107] Generating Unit ID from Detectors.

[0108] Detector units, preferably those configured for generating a prequalification signal, but applicable to any detector unit, may be adapted to periodically generate a short unit ID (which may be optionally encrypted) for indicating to the controller that it is still operational and connected within the system. This feature provides the benefit of testing the output of the sensors, and of detecting if any of the sensors have been disabled from the alarm system. The rate at which the detector unit ID should be transmitted depends on the type of communication link utilized, but by way of example may be configured so each unit generates an ID every 1-10 seconds. This increases the security of the unit while simplifying maintenance and testing. It will be appreciated that any convenient encoding technique for transmitting the ID signal may be selected, and many such techniques are known to those skilled in the art.

[0109] Combining Prequalification with Alarm System Configuration Information.

[0110] The use of unit numbering within the prequalification signals and optionally alarm signals can provide additional distinction of individual detector units, wherein the prequalification information (and optionally alarm information) can be utilized in combination with parameters set for the specific alarm installation. For example, selecting specific temporal relationships between prequalification signals, or even between specific detector units. The use of the prequalification signals can be extended to allow the installer/user to control how the alarm system uses prequalification in determining if an alarm is to be generated.

[0111] Separate Communication of Prequalification and Alarm Signals.

[0112] It should also be appreciated that the alarm signal output and prequalification signal output may be generated by different means. For example the alarm signal output may be generated conventionally over a current loop, while the prequalification signals are generated by wireless transmis-

sions. The prequalification signals can be received by all detector units, or selected detector units, which in response to the alarm being “prequalified” lower their alarm threshold, or by a controller that is configured to generate an alarm condition output upon receipt of sufficient prequalification information.

[0113] 2.4 Detailed Description of Drawings.

[0114] FIG. 6 depicts a block diagram of a preponderance of evidence system (PROE) 10 configured for operating over a single current loop. A generally conventional current loop 12 is shown, upon which a number of detector unit outputs are coupled. An example embodiment of a detector 14 according to the invention is shown connected to the current loop 16 which is connected to a controller 18 also according to an aspect of the present invention.

[0115] Detector 14 senses conditions toward recognizing that an alarm condition exists (i.e. intruder, fire, flood, etc.) by means of sensor 20 and conditioning circuitry 22. The sensed output is then checked against a threshold to determine if it indicates that an alarm condition exists; or if alarm conditions indicate that something may be occurring but it is not quite certain—wherein prequalification threshold conditions may be met. The thresholding is exemplified by two comparators 24a for sensing if the alarm condition threshold is exceeded, and 24b for sensing if the prequalification threshold condition is exceeded. It should be appreciated that the circuit is shown as a representation as numerous mechanisms exist for comparing the extent, or quality of signals, and processing may be performed with analog circuits, digital circuits, signal processing circuits, micro-processors, and combinations thereof without departing from the teachings herein.

[0116] An encoder 26 is utilized for encoding any detected alarm and prequalification conditions into the proper format for output on the communication link to the alarm controller, or alternatively to other detector units configured to register prequalification. The encoding in the present example would provide opening the current path in the current loop for a time $t_{\text{alarm}} > t_{\text{threshold}}$ to indicate an alarm condition, or modulating switch state for a period much less than $t_{\text{threshold}}$ to indicate a prequalification signal. It will be appreciated that the switch state can be modulated to encode a detector unit number and/or additional information such as a discrete prequalification level.

[0117] The encoded alarm or prequalification signal output is then transmitted from a switch 28 in series on current loop 12. It should be appreciated that numerous forms of communication links may be alternatively utilized instead of the simple current loop shown. The switch output stage from a number of other detector units is shown 30a-30d, which may be legacy devices (i.e. magnet-switch combinations, or other detectors without prequalification techniques) or devices according to the present invention.

[0118] Although it is preferred that at least two detector units providing prequalification output should be connected in the system to advance prequalifications from different detector units to an alarm state, a single detector unit with prequalification may be properly utilized so long as the system can advance multiple prequalifications from the same unit to an alarm state. The present invention in any case is compatible with legacy devices whether or not the prequalification signals are utilized.

[0119] A controller 18 receives the sensed alarm conditions at a decoder 32 which registers alarms, shown from output 34, and prequalification signals, shown from output 36. A simple mechanism is shown for advancing multiple prequalification signals to an alarm condition. A received prequalification signal is delayed by delay-timer 38 and then the duration of the prequalification is stretched to a desired length by monoshot 40. If another prequalification signal arrives while the output of monoshot timer 40 is active, then the prequalification is advanced to an alarm, by virtue of AND-gate 42. Alarms generated as a result of prequalification and regular alarms are combined with OR-gate 44 and then output as an alarm through output stage 46.

[0120] Another mechanism for summing prequalification signals is to input fixed duration prequalification signals onto an integrator, wherein if sufficient signals arrive within a given period then the conditions are met. Furthermore, the detector units can encode the level of prequalification into the duration of the prequalification signals which is sent over the communication link, received at the controller and integrated on the integrator. In this way levels of prequalification are readily supported. It should be appreciated that any of a number of ways may be utilized to detect multiple prequalifications and to advance those multiple prequalifications to an alarm.

[0121] FIG. 7 depicts an example of an alternate prequalification decoding mechanism 50 based on the inclusion of a detector unit ID within each prequalification transmission. In this example the decoder extracts the unit ID and generates a separate output for each detector unit which are stretched by monoshot timers 54a-54n to a desired prequalification interval. The stretched signals are then input to a summer 56, which preferably goes active in response to a sufficient level of prequalification. The level of prequalification may be fixed, or a selection input 58, may be provided to allow configuring how much prequalification is required before advancing an alarm. Alarms from prequalification and alarm signal detection are combined at OR-gate 44 to arrive at an alarm output signal for triggering audible alarms, silent alarms, monitoring systems, communication systems (i.e. communicating alarm over a modem), other alarm mechanisms and combinations thereof.

[0122] It should be appreciated that the described aspects of the invention may be implemented separately or in various combinations thereof.

[0123] 3 Apparatus for Increasing Handheld Weapon Effectiveness.

[0124] 3.1 References.

[0125] Portions of this aspect of the invention relate to the patent application entitled “Secure Visual Data Communication Methods” Ser. No. 10/612,221 filed Jul. 1, 2003 and provisional application Ser. No. 60/394,160 filed Jul. 1, 2002 which are each incorporated herein by reference. Furthermore, the related teachings within this application which describe an apparatus for monitoring the activity of handheld weapons is incorporated herein by reference.

[0126] 3.2 Introduction.

[0127] The following details a number of inventive aspects for enhancing weapon operations, these enhancements may be utilized in combat and/or civilian operations.

The aspects of the invention described may be utilized separately or in combinations thereof. The term rifle will be generally utilized to refer to a portable weapon capable of being utilized by a single individual, and includes, rifles, assault weapons, automatic weapons ("machine" guns), pistols, and some aspects of the invention can be applied to shoulder-mounted rocket launchers and similar devices.

[0128] 3.3 Summary of Invention.

[0129] Assault weapons, such as M16s, and similar devices utilized by the armed services, and occasionally police forces, of various countries are often configured with a short burst mode, wherein each trigger pull results in the gun firing a burst containing a fixed number of rounds at a fixed period between rounds. This is a marked improvement from earlier rifles in which selection of the automatic mode often resulted in all ammo being expended in a single burst. The present invention extends the benefits of this functionality by adding more fire control to rifles, or other weaponry.

[0130] Low Ammunition Alert/Depletion Prevention.

[0131] One drawback with automatic or burst mode is that a magazine can be depleted at a most inopportune time for reloading, the consequences of which can be dire. For example, in a firefight an infantry man being rushed by two parties squeezes off a burst to take down the first individual and turns toward the second assailant only to hear a clicking sound and realize that their weapon is empty. The problem stems from a combination of the user not being alerted to the number of rounds remaining and the inability to readily shift from automatic, or burst mode, to a semi-automatic mode. The present invention provides methods for annunciating state of the magazine which may be utilized separately or in combination.

[0132] (A) Visual round indication—a display near the sight provides an indication of the number of rounds remaining in the magazine. Preferably the display is self powered, such as utilizing piezo-electric transducers to generate operating power in response to mechanical cartridge advance motions (although batteries and other energy storage devices may be utilized). The display may comprise an LCD, OLED, electronic ink display, or similar forms of low power display technology. The display is preferably configured with minimal backlighting that adjust to ambient lighting wherein it can be seen only when the individual is sufficiently close to the display, such as when holding the rifle in the operating position.

[0133] (B) Tactile round indication—in this mode a low condition of rounds is indicated by tactile feedback, such as provided by a projection felt under the hands during operation, or more preferably vibration of the unit in a manner that conveys the level of remaining ammunition.

[0134] **FIG. 8** and **FIG. 9** illustrates examples of sensing the number of rounds within the magazine. In **FIG. 8** an M16 rifle **10** is shown with a partition cross section of a magazine **12** inserted having three rounds remaining. It should be appreciated that the upward feed pressure against the top round in the magazine is dependent on how many rounds remain in the chamber. This relationship arises because the tension on the spring advancing the rounds is a function of its compression. A pressure sensor **14** is shown for registering this pressure from the top round.

[0135] As different magazines can support a different number of rounds and different feed pressure characteristics, a magazine type sensor means **16**, such as shown with multiple switch segments that engage binary coded notches on the magazine. Any convenient means of sensing a coded value from the magazine may be alternatively utilized, and may be selected for use within an embodiment of the invention by one of ordinary skill in the art without departing from the teachings of the present invention.

[0136] A sensor, such as switch **18** is utilized to detect at least one ammunition threshold, in this case shown detecting the presence of at least four rounds. The switch is held closed so long as at least three rounds are present in the magazine (one considered chambered), and opens once ammunition is depleted such that only a predetermined number of rounds remain, for example three total rounds remaining. It will be appreciated that this threshold can be configured to determine the presence of any number of rounds. It should be appreciated that the accuracy of the pressure sensor in detecting rounds can be compromised due to the temperature, age of magazine, and so forth; wherein it may be counted on only for general detection purposes. Sensor **18** provides an absolute register when a threshold of rounds is passed.

[0137] Annunciating the number of rounds is shown performed by a microcontroller **20**, or other form(s) of electronic circuitry, which outputs information on display **22**, and/or a tactile sensor output **24**, such as whose activity may be felt under the grip in response to vibration, tactile contact, or other means for alerting the user. It is preferred that these means of alerting the user do not inadvertently alert the enemy as would generally arise when outputting audio signals.

[0138] Automatic Adjustment of Firing Mode in Response to Ammunition Status.

[0139] In this mode of operation the rifle is configured to shift from automatic, or burst mode, when the ammunition is nearly depleted. For example, the rifle shifts into semi-automatic mode, from automatic or three-round burst mode, for firing the last *n* rounds, for instance the last four rounds of each clip. It will be appreciated that the typical controls for an assault style rifle have three switch positions: "safe", "semi" (single shots), and "auto" (full automatic on M16A1 and A3) or "burst" (3 rounds bursts, on M16A2 and A4). In the latter case (on the M16A2 and A4 rifles), the trigger unit also includes the ratchet device to count the shots fired. The electronics can control the ratchet device in the trigger mechanism to alter the firing from burst to semiautomatic.

[0140] By automatically shifting to semi mode the user does not spend excessive rounds and is alerted to the status of the ammunition and is not left unarmed at a possibly critical time. They squeeze off a burst and the unit may shift during the burst into single shot mode, wherein at least one round is still fired at the target. The individual can then choose when to change cartridges as for example three shots will remain to be fired in semi-automatic mode. This can provide improved effectiveness during combat and eliminate subconscious concerns with the availability of ammunition which also reduce effectiveness.

[0141] Referring again to **FIG. 8**, when the round sensing means, switch **18**, detects that only three rounds remains,

then the operation of trigger control 26 is modulated to switch from burst mode, or automatic mode, to semi-automatic mode.

[0142] An optional user input 28 is shown for allowing the user to select rifle features, with the selections being registered by microcontroller 20 and stored in non-volatile memory therein.

[0143] Automatic Adjustment of Firing Rate in Response to Ammunition Status.

[0144] In another embodiment, or mode of the prior embodiment, the controller is configured for altering the available firing rate (time between successive shots in the automated modes such as fully automatic or a form of burst mode). The controller can change the firing rate based on one or more threshold levels, or following any desired profile. By way of example and not limitation, when X rounds remain the firing rate may be modulated according to a response table or given formula (i.e. linear, geometric, or logarithmic) which provides any changes to the desired rate of fire in response to ammunition levels. Typically, the firing rate would only be altered once a low ammunition condition was detected. It will be appreciated that this mode may also be utilized in combination with the controller automatically changing the firing rate from automatic to burst mode, but does not make sense when burst mode is changes to semi-automatic, since the firing rate is thus fully controlled by the shooter.

[0145] Registration of Target Distance.

[0146] Rifles and other weapons are being increasingly fitted with sighting lasers for providing alignment with the target. By electronically detecting reflections from an encoded laser output the distance to the target can be readily computed within the unit. FIG. 8 exemplifies a targeting laser 28 having a laser output 30 (i.e. visible, infrared, near-infrared, ultraviolet) and a reflection sensor 32. The laser output is preferably modulated at high frequency so that the distance to the target can be determined by the time required for the signal to reach the target and reflect back for registration by sensor 32. Time-in-flight as well as Doppler forms of laser detection are known in the art wherein a description more detailed than the following is not necessary.

[0147] Microcontroller 20, or a circuit under its control, preferably performs the necessary modulation and computation of target distance. It will be appreciated that if sequential numbers were periodically encoded on the laser output (at some specific modulo), then the numerical difference between the current modulation number and the reflected modulation value could be multiplied by a factor associated with the rate of modulation and the speed of light in air, wherein the distance to target is easily determined.

[0148] Other factors may also be taken into account along with the range to target. The declination angle of the rifle is important in accurately determining the range and ballistic trajectory of the round. Therefore, it is preferable that a means for registering tilt be incorporated, such as tilt sensor 34, which is read by microprocessor 20. In addition a means for registering wind speed can be incorporated, such as wind speed sensor 36.

[0149] In one embodiment digital signal processing techniques can be utilized for processing the reflected signals to

determine atmospheric factors (i.e. wind direction and speed, precipitation, humidity, etc.) techniques being generally available from laser-based meteorological test equipment.

[0150] Additional factors may also be corrected for, such as the type of rounds deployed and so forth. Motion factors, although not very important for infantrymen, can be important when the weapon is utilized on a moving platform, such as from a Humvee, or from a gunship, wherein as the rifleman maintains focus on the target the focusing system is adjusted in response to inertial considerations, such as linear and angular accelerations. In this way the system can compensate for properly leading the target wherein the person firing the weapon need only maintain the targeting system on the target.

[0151] This distance can be read out, such as on a display unit, display 22, and/or utilized to control operational aspects of the rifle. The rifle according to the present invention, hereafter referred to as an "eRifle", configured with a distance-to-target system can provide the following features according to the present invention.

[0152] (A) Automatic sight adjustment in response to distance. A sight element such as sight pin, and/or actuator 32 for the laser sight can be adjusted for height in response to the registered distance to the target.

[0153] (B) Firing rate automatically adjusts to the target distance. It will be appreciated that the grouping of rounds within a burst or automatic mode is determined by the angular velocity of the rifle and the distance to the target. For targets at close range the grouping in a burst are typically positioned too close to one another, while at longer range the groupings can be too disperse. In one embodiment of the present invention, the rate of fire is modulated by the controller in response to the target distance so that an efficient grouping can be generated for any rifle to target range situation.

[0154] Microcontroller 20 is shown coupled to a firing control mechanism 26. It is preferred that firing control mechanism 26 be designed as a mechanical firing linkage that is adjusted into burst mode or automatic modes, and firing rate controls therein, in response to electronic control from microprocessor 20. In this way, regardless of the condition of the electronics the weapon will always be capable of firing in at least a semi-automatic mode. In addition, a mechanical cut-out can be provided to allow the user to select firing modes without the electronics being activated.

[0155] (C) FOF identification—the weapon may register optical encoding of far objects for determining friend or foe, such as described according to an aspect of copending patent application entitled "Secure Visual Data Communication Methods" Ser. No. 10/612,221 filed Jul. 1, 2003 and provisional application Ser. No. 60/394,160 filed Jul. 1, 2002 which are each incorporated herein by reference.

[0156] The weapon is configured according to this aspect of the invention to generate an indication in response to selected FOF status, for example when the sighting laser is activated, such as in response to contact with the trigger, and the weapon is directed at personnel or vehicles having a covering of an active reflector material (reflective in the sense that all material is reflective—even when the material

is adapted as camouflage and has a low coefficient of reflectivity). The system registers the modulation of the active optical material (or the portion containing optically active material) within the returned reflection and checks this against a FOF decryption mechanism. If the modulation corresponds to a proper FOF response then microcontroller **20** alerts the user, such as by way of display **22**, or tactile output **24**, or by any convenient visual, audible, tactile (protrusive sense, vibration, voltage, and so forth) output means. Although the FOF may be configured to prevent accidental discharge in combination with a “friend” identification this could lead to problem scenarios should the security of the FOF system be compromised. However, upon registering a FOF condition, the system could increase the pressure required to fire a round, prevent a round from being discharged in response to the first depression of the trigger and/or other changes that alert the user and reduce the risk of accidental fire against what appears to be a friendly.

[0157] 4 Apparatus for Monitoring Handheld Weapon Activity.

[0158] 4.1 References.

[0159] Portions of this aspect of the invention relate to the patent application entitled “Secure Visual Data Communication Methods” Ser. No. 10/612,221 filed Jul. 1, 2003 and provisional application Ser. No. 60/394,160 filed Jul. 1, 2002 which are each incorporated herein by reference. Furthermore, the related teachings within this application which describe an apparatus for increasing the effectiveness of a handheld weapon are incorporated herein by reference.

[0160] 4.2 Introduction.

[0161] The following details a number of inventive aspects for enhancing weapon operations, these enhancements may be utilized in combat and/or civil operations. The aspects of the invention described may be utilized separately or in combinations thereof. The term rifle will be generally utilized to refer to a portable weapon capable of being utilized by a single individual, and includes, rifles, assault weapons, automatic weapons (“machine” guns), pistols, and some aspects of the invention can be applied to shoulder-mounted rocket launchers and similar devices. The inventive aspects are divided into those which improve weapon effectiveness and those which improve weapon monitoring and control, although these general categories can overlap.

[0162] 4.3 Improving Weapons Monitoring and Control.

[0163] Registration of Activity for Weapons—(RAW).

[0164] The following aspects of the invention describe registering activity information about a rifle or other weapon, the system being referred to herein as “RAW”, as it provides raw information about weapon activity—information that can be relied upon beyond what are often considered subjective eyewitnesses. Typically, the information provided by the system will reinforce officer statements and situations which will help exonerate officers (MPs, SWAT members, etc.) and their associated police and government departments from wrongful action suits. As it is rare that officers perform wrongfully under-fire, it is anticipated that employing the present invention can mitigate some of the litigation to which police forces and governments are subjected, such as in response to so-called “wrongful death” claims and so forth. These cases often pit well-seasoned

defense attorneys hoping to pull in a multimillion dollar settlement against typically less experienced and often less motivated prosecuting attorneys. The present inventive system can also provide additional deterrent for less emotionally stable officers to become a “rogue officer” taking justice into his/her own hands and then attempting to cover-up the incident, wherein the public suffers and the credibility and trust accorded the entire department suffers.

[0165] The cost of implementing the present weapon system for a county, or small government agency can readily be offset by preventing even one adverse judgment. It will also be appreciated that with the present invention inaccurate claims can be more readily dispatched, and adverse publicity quashed before it can damage the reputation of departments or groups, because the actual conditions of the situation will be clearly known at the outset, and during litigation, if it arises at all, leaving less room for plaintiff attorneys to argue malicious intents and contort the testimonies based on conspiracy theories, and so forth. In addition, the present invention can aid in preventing the wrongful use of weapons, and allows for the detection of same. Consequently both the number of litigation instances and cost per instance should be reduced in response to instituting the described RAW system.

[0166] It will be appreciated that it is often very difficult to ascertain exactly what transpired after a weapon discharge event has occurred, and there is little recourse but to rely on witnesses to the event. The credibility of witnesses, however, is often attacked in a court procedure, in particular in view of the distrust shown by many juries for government agencies and the employees thereof. The ability to improve tracking of weapon movements and delivery made possible by the present invention are particularly suited to the civilian use of weapons such as by law enforcement personnel, or similar controlled situations. The following aspects of the invention introduce weapons activity registration.

[0167] General Aspects of Weapon Activity Logging.

[0168] FIG. 9 through FIG. 12 illustrate example embodiments of the RAW system **10** implemented on a handgun **12** of FIG. 9, and a rifle **14** of FIG. 11. The system preferably incorporates a weapon location sensing means **16**, a weapon positioning sensing means **18**, a time of day tracking means **20**, a weapon use sensing means **22**, and a logging means **24** which are all preferably incorporated within the weapon, although lesser functionality may be alternatively adopted. A controller **26**, such as a microcontroller circuit, controls a number of system elements, such as over a bus **28**. A communication interface **30** provides a means for communicating information logged in memory **24** from the system to a server, or similar, system such as at a headquarter location at the close of a shift.

[0169] A means **32** for collecting auxiliary information may be incorporated, such as for collecting audio and image data. For example, an imaging means **34**, such as still or video camera (i.e. CCD imaging device) may be integrated in the weapon such as at the front of pistol **12**, or mounted within a rifle, such as on the exterior or within a sight **36**. It should be readily appreciated that the exterior shell of the weapon may be slightly enlarged in some instances for accommodating the additional electronics of the system. It is preferable that the electronics be environmentally sealed and shock-mounted within the weapon to reduce environmental

impact in response to both weather, rough usage, and firing; while preventing unwanted access to the electronics for nefarious purposes.

[0170] Wireless communications may also be supported for communicating with fellow officers or their equipment, with communication repeaters such as in vehicles, with other items identifying the officer, and so forth. By way of example an RFID transceiver 38 is shown for sending challenges to an RFID transponder, for instance located in the badge 40 of FIG. 12. Responses from RFID transponder within badge 40 can alert the system when the weapon is no longer in the possession of the officer. Information is collected upon activation of the system, for instance during a duty shift when the weapon is removed from its standby rest, whereby the location of the weapon and weapon activity is tracked and logged.

[0171] Embodiment of System Electronics.

[0172] FIG. 13 illustrates by way of example the system 10 of the invention containing control electronics, logging facility, various data collection means, and interfacing mechanisms. The following sections describe aspects of the electronics of the invention. The installation of the sense elements within the weapons is dependent on the configuration of each weapon, and would generally follow conventional shielding and access practices for other forms of electronics, wherein it need not be described in detail herein.

[0173] It should be appreciated that the description of elements within the invention encompass a preferred configuration, however, the system may be manufactured with more or less circuits than described without departing from the teachings of the present invention. For example reduced functionality can be provided in systems configured to provide reduced activity logs; wherein the span of time covered in the log, positioning data, and the collection of audio near the time of weapon discharge may be dispensed eliminated. It will be recognized that the number of combinations that could be created from the following elements is nearly limitless, with the choice being dependent on weapon application, cost factors, size factors, and so forth. Wherein the present invention covers weapon systems providing these elements separately, or more preferably in selected beneficial combinations, including but not limited to those described herein.

[0174] Controlling System Elements.

[0175] The RAW system 10 is preferably controlled by one or more computer devices 50 operating in combination with memory 52 for containing executable programming, system settings, data buffers, and a log of sufficient size. The circuit elements of the system may be controlled over a bus 54, be directly controlled by processor 50, or controlled by other elements under the direction of processor 50. It should be appreciated that other circuitry may be utilized in place of computer 50, such as custom ASICs, and the like without departing from the teachings of the present invention.

[0176] Registering Weapon Location and Track.

[0177] It is beneficial for the weapon log to contain information about a present location of the weapon, and preferably the track of weapon movement. Collecting this information is especially important at and near the time of a weapon discharge. A locating means 16 is incorporated,

preferably to fully ascertain weapon location during a period of time, such as a duty shift (from the time weapon checked at the start of a shift, or assignment, to the time it is again checked at the end of a shift, or assignment). In a preferred embodiment the locating means comprises a GPS (global positioning system) circuit 56 in combination with an INS (inertial navigational system) 58. An asterisk appears next to elements which are largely optional in nature, although with reduced functionality.

[0178] The combination of GPS and INS can yield information about location within a few feet even for periods of time and locations during which a GPS signal is not available, such as within buildings. It should be appreciated that information relating to location may be provided with just the GPS, or the INS, or utilizing other location sensing means without departing from the present invention.

[0179] The inclusion of a GPS transmitter within an associated vehicle, such as a police vehicle, can provide increased accuracy from differential GPS sensing, which can reduce the location error to a matter of inches.

[0180] Registering Weapon Positioning and Discharge.

[0181] A position sensing means 18 is provided to ascertain weapon positioning (aim). By way of example and not limitation the position sensing means comprises at least one compass 60 and tilt angle sensor 62 to register the direction and angle of the weapon, which is particularly important during the time period just prior to and after weapons discharge events. It will be appreciated that the compass and tilt sensor may be configured for operating in different orientations should positioning information be desired in those orientations. For example the compass may be gimbaled or configured with sensing loops oriented in three separate axis, the selection of which axis is associated with the horizontal plane can be determined by a three-axis G-sensor having sufficient accuracy within the 0-1G range.

[0182] In one embodiment most suitable for a rifle, or other weapon whose length approaches the resolution of the available GPS signals, the system utilizes multiple GPS receivers which collect data from antennas at different locations on the weapon. The difference between the time of receipt of the signals providing a form of differential GPS for estimating weapon positioning. For example with a GPS receiver at each end of a rifle, the orientation of the weapon can be estimated by a triangulation means which compares the time of receipt of GPS data at each receiver. The GPS data may be utilized separately, or more preferably in combination with a 3-axis G sensor, thereby allowing for correlating the data to provide improved accuracy and system redundancy. It should be appreciated that this form of position sensing can be utilized on larger weapon platforms, such as missile launchers and even artillery pieces, tank barrels and so forth without departing from the teachings of the present invention.

[0183] A discharge sensor 64 registers a discharge event, wherein the event and time are logged. Discharge events are easily registered, a pressure sensor (i.e. switch) 64 being shown by way of example, such as may be coupled in fluid communication with the firing chamber of the weapon wherein upon pressure buildup during firing, the switch changes state, as registered by the electronics of the device. Alternative discharge sensing mechanisms can be provided

in response to pressure, force, movement, heat generation, electric field changes and so forth as will be recognized by one of ordinary skill in the art.

[0184] Incorporation of a Gun-Camera.

[0185] Another optional element of the present invention that can provide a wealth of benefits is the incorporation of a gun camera means **66** (video and/or still images) activated by the discharge event, or that more preferably operates continuously while primarily retaining image sequences (or video) occurring within a given interval before and after a weapon discharge event. The number of images stored, which are temporally proximal to a weapons discharge event, depends on the amount of memory available in the system. Images are preferably collected in still, or sequenced mode, by an imaging device such as charge-coupled device (CCD) receiving optical input into an objective **70** from a focusing lens **72** (optionally variable focus but not presently preferred due to cost and size constraints). Image collection is preferably handled by a buffering control circuit **74** in combination with local memory **76**. Data in memory **76** may also be moved to the memory log **52** under the direction of CPU **50**. It will be appreciated that providing a separate buffer controller for high data rate devices frees up processing by CPU **50**, although the system can be implemented with CPU **50** handling all of the data operations. The buffer control circuit takes direction from CPU **50** as to what data is most important for retaining in the buffer, as well as which information should be moved to the main log **52**.

[0186] Collected images or video can be extremely useful in ascertaining exactly what transpired during an event, and the value of it in capturing images of armed suspects regardless of the outcome of the situation is noteworthy.

[0187] Logged image information is filtered down (or uploaded as the opportunity arises—such as in combination with the communication mode described elsewhere) as more space is needed, so that at least images near the discharge event are registered. In addition transitional images can be saved which were captured in response to certain motions and activity of the weapon near the discharge event, such as on drawing the weapon to a nearly horizontal position and so forth. Images may be saved at other critical times as well such as saving images just prior to loss of a GPS signal, wherein the image should correspond to a particular building being entered. It will be appreciated that images may be stored for other times as well. It is preferred that the images be stored in a compact format such as JPEG or similar encoding to allow storing a number of images in a smaller amount of memory. It will be appreciated that collected images can be correlated with location and position information to ascertain the location of elements within the visual field of imaging means **66**.

[0188] Incorporation of Audio Registration.

[0189] Another optional element of the present invention that provides a number of benefits is the incorporation of an audio recording means **78**, which by example comprises a microphone **80**, coupled to the electronics, such as audio amplifier and conditioning circuit **82**, analog-to-digital converter **84**, for receipt by buffer control circuit **74** in combination with memory **76**. The audio events can be stored in the local log or moved to the main log **52**. Elements (image, audio) in the local log are preferably stored with time

references wherein the elements in the local log and elements in the main log may be correlated.

[0190] Audio information can be readily collected and has lower bandwidth needs than camera images. The audio is saved for periods of time surrounding a discharge event, or optionally saved at other times, such as based upon audio activity. For example, audio can be collected for the entire time the weapon is off of the rack and in the field, wherein speech and other events can be saved in the log while periods with little useful activity need not be stored in the log.

[0191] The audio data is preferably collected in a buffer at full quality and then older unwanted portions of the buffer can be flushed to make room. Upon a discharge event the portions of audio in the buffer are saved to the log. Storing audio information can allow detailing the interchange between persons, such as surrounding a discharge event, and can even provide assurance that parties were properly warned, read their rights upon arrest, and so forth. Preferably the user is provided with an interface allowing them to activate audio collection for a period of time, such as when arresting a suspect so that the conversations are duly recorded. Such a feature is not as amenable to the gun camera as the user would need to point the weapon at the individual to capture the image.

[0192] Time of Day and Logging Considerations.

[0193] A log (i.e. within memory **52**) within the weapon provides for registering important events and the time at which each event occurred. A timing means **20** is provided as a temporal reference to all events, and is preferably implemented as a time of day circuit, also referred to as a real-time clock or RTC. Preferably the RTC is configured for being externally synchronized to the actual time. It should be recognized that signals received on a GPS positioning unit include time, which may be utilized for synchronization, while other broadcast signals may also be utilized to aid the RTC in keeping accurate time. However, it would not be prudent to rely too heavily on external time sources, as the weapon may be used in situations where the signal is not available or the weapon is shielded from the source. It is also preferred that any time the RTC value this activity will be logged (delta time, location), and furthermore the RTC should resist being changed in the field beyond a fixed amount of time per day. If GPS signal strength is weak then RTC should not be updated from the obtained data.

[0194] A real time clock circuit **86** is shown with crystal time base **88** for supplying timing information to the controller. The timing means provides time markers for discharge events as well as a time reference for location and position information in the main log **52**, or other logs, such as under memory **76**, thereby allowing a trace of activity to be provided.

[0195] The log is preferably configured as a set of contiguous records, with each record comprises a series of fields populated from data obtained from the sensors on the weapon. The entries may be registered on a periodic basis, registered in response to events, or more preferably a combination approach wherein they are logged periodically at a low rate but at a faster rate in response to activity. It should be appreciated that the information may be logged in alternative formats without departing from the invention,

such as logging information from each sensor separately (i.e. in response to sufficient change) along with time references, wherein a record-field structure is not necessary. Due to the size and optional nature of audio and image data, it is preferred that these be logged in a separate log, wherein portions of the data area deemed relatively unimportant can be reclaimed for more current, or otherwise important, audio and image data.

[0196] The length of the data log within the device should be sufficient to retain a track spanning a typical period of use, such as spanning up to eight hours. As the duration expands the prior log entries can be made more sparse (drop entries to reduce resolution keep only important nodes (i.e. path changes). As the cost of memory has dropped significantly in the recent years it should be economically feasible to provide a minimum of 128 MB of NVRAM memory and more preferably up to 1 GByte or more depending on the current costs of memory. In this way a significant amount of information can be retained.

[0197] Radio Communications Signal Beacon.

[0198] The system may be optionally configured to generate a radio-frequency signaling beacon for communicating information and alerts to local personnel, off-site personnel, equipment, and so forth. A transmitter circuit **90** (implemented alternatively as a receiver, or more preferably transceiver) is shown coupled to CPU **50** for performing wireless communications. Preferably the wireless communication is encrypted to prevent unofficial monitoring.

[0199] By way of example the unit upon detecting a discharge event or a stolen event condition (separated from signed out user as determined by RFID, biometric scan, and so forth) can enter an alert mode or a retrieval mode. In alert mode backup officers/units can be alerted to the exact position of the officer, or officers, having discharged their weapons. At the same time data from the log can be uploaded including logged path to present location, collected audio, collected image sequence, and so forth. The uploading of information to a central repository assures that information is not lost even if the weapon becomes damaged, lost, or stolen.

[0200] Retrieval mode may provide any of a number of features, such as entering a non-operational mode, or generating an alertive radio beacon including coordinates. In this way the weapon is more likely to be recovered after having been stolen. The system is preferably configured to generate an encoded radio beacon (i.e. conventional channelized, spread spectrum, and so forth) when it is separated from its owner, overdue for check in by owner, triggered into beacon mode by remote communication with the unit from fellow officers or headquarters in response to a missing officer, or otherwise detects a lost or stolen condition.

[0201] Non-operational mode is shown being controlled by a lockout mechanism **92** shown comprising an electro-mechanical actuator **94** whose output is coupled to a trigger mechanism **96** adapted for having its trigger prevented from allowing the weapon to discharge in response to operation of the actuator. The lockout can be coupled to the trigger mechanism or safety system. It should also be appreciated that the weapon can integrate a switch or other sensing means as a trigger, wherein the actuator can be utilized for starting the firing sequence and locked out electronically by receipt of a lockout signal.

[0202] Communications from the weapon to a headquarters, or similar service location, can be generated in a manner like a walkie-talkie using a line of sight communication to the vehicle of the officer, which can relay the information to headquarters, optionally the signaling output can be directed to a headquarter location utilizing the cellular phone communications network. Engaging a user input on the weapon generates an automated signal beacon with information about position and so forth, along with an indication that the alert was manually engaged. In this way an officer can silently call for backup, and the backup will be directed to the exact coordinates of the officer.

[0203] User Information and Using Biometrics.

[0204] Additional information about the user of the weapon can be registered for controlling weapon operations and for entering in the weapon log. A biometric sensor **98** is shown coupled to CPU **50** for being read and having the data read compared against setting information within memory **52**, or other repository of retained biometric parameters. For example the weapon can be configured to register biometrics of an individual utilizing a weapon. Fingerprint scans, palm-print scans, other ridged skin areas, or other biometrics can be detected, for controlling device operations, and logging. One feature of the weapon system is that of preventing use of the weapon by an unauthorized user, wherein a correct biometric scan is required to activate the weapon. The biometric can be utilized to allow any one person, or group of persons, to utilize the weapon, such as officers within a department. The fingerprints of anyone utilizing the weapon, or attempting to do so are registered and logged.

[0205] By way of example and not limitation, upon taking the handgrip the officer logs in with a thumbprint (palm print, index finger print on trigger, etc.) to enter an active state, from which the weapon may be fired. If pressure on the handgrip is released for a period of time or in response to engaging the safety, the officer is logged out and the weapon can not discharge until another user within the identified group of officers is logged in with the biometric fingerprint scanner. This aspect of the invention can prevent weapons from being turned on the officer along with the use of stolen weapons. The use of biometrics, such as finger scanners, is known in the art and some attempts have been made at conditioning the use of weapons with a biometric scan, however, the present includes a number of aspects which enhance utility of biometric scanning in these instances. Biometrics are logged in the present invention, along with time and position of activation and preferably audio segments. In this way the use of the weapon is more preferably tracked and retained in a log for later review.

[0206] RFID-Based Weapon Communications.

[0207] Local communications from the weapon activity system, RAW, can provide a number of benefits, the following being described by way of example and not limitation.

[0208] (1) An RFID reader **100** located in the weapon that interrogates an RFID transponder **40** within a badge (**FIG. 12**) or similar identifying unit. When the weapon is within reading distance of the RFID transponder it reads a correct validation code to allow activation for use. Use of RFID has a number of advantages over a biometric scan, in that the RFID link between the officer and weapon is established

based on proximity, and the officer need not waste any time to "sign in" for activating the weapon. The weapon is already prepared for being activated because it is within the RFID read distance from the officer. In one embodiment, the weapon can not be utilized unless it is within about 3-4 feet of the officers badge, or other device containing the RFID element which is detected by the weapon. Optionally, or additional, another transponder may be carried by the officer such as in a holster. In another option, the RFID is a first line of defense that can be overcome with a fingerprint scanner, or other form of unlocking incorporated into the weapon. In this way even if an officer is stripped of items containing the proper RFID, they can still use the weapon once reaquired, however, they must identify themselves to prevent others from gaining use to the weapons.

[0209] (2) An RFID transponder may be located within the weapon for being interrogated by other reader units, such as located in other electronics equipment. The transponder may be alternatively configured for downloading data from a RAW unit within the weapon onto a reader device. Data from the weapon can be uploaded during a charging operation (i.e. inductively coupled) without the need for physical power connections.

[0210] System Power and External Communication Link.

[0211] The system may be powered from a variety of electrical power sources. A preferred arrangement is a secondary battery, although fuel cells, capacitors, primary batteries, and other sources may be alternatively utilized. A charge circuit 100 is shown in the weapon having a controller 104 which controls charging and optionally provides a communication path with external devices. Charge circuit is exemplified with a battery 102, such as lithium-ion or other reliable high-power density battery. Optionally two batteries may be utilized with a controller to provide power redundancy wherein a single battery is used unless it is depleted or goes partially or fully inoperable. Typically, the unit is charged at a central location, such as a headquarters (field office or so forth), although it may be charged with a charging system from within a vehicle. Charge current is shown received over an inductive coupling 106, although power may be received over a wired connection. A capacitor 108 is shown for smoothing device voltages and a large capacitor may be utilized for providing device power for a sufficient period to transmit alert beacon data, perform a lockout, or take similar action in response to inoperability of the battery or power controller.

[0212] A remote charging facility 110 is shown comprising a server 112, such as at a headquarters location or coupled to a headquarters location (i.e. from a vehicle). The charging is controlled by a weapons charge controller 114, which is optionally configured to communicate information over the charging pathway (i.e. as AC signals superimposed over a DC charging current), coupled to a power interface 116 having a inductive coupling 118 (or optional wired connection). Charging current is coupled between the inductors to charge battery 102.

[0213] When coupled to the charger it is preferred that the information from the log be uploaded to the server and that system diagnostics be performed. Communication over the charging connection may be provided through the power and communication controller 104, or external communication link may be established. Communication with the device

and the resetting of the logs should be a secure operation, preferably encrypted, reducing or eliminating the possibility of human error or intent towards corrupting the collected data or erasing data. The information is loaded onto a secure server and preferably maintained at more than one physical location.

[0214] By way of example a wired interface (i.e. IEEE 1394) is shown with a connector 120 and communication interface 122 that is adapted for communicating with CPU 50, such as over bus 54. The wired interface can also allow images and other elements to be read from the weapon (without ability to alter or erase), such as by coupling the device to a PDA, or PDA enabled walkie-talkie unit, wherein the user can view images collected from the gum camera or listen to audio to aid other officers in attaining quick apprehension of a suspect.

[0215] External Input/Output.

[0216] The utility of the RAW system can be enhanced by allowing selecting of functions and features by a user, and for displaying to that user conditions and information about the system.

[0217] Inputs 124 are shown exemplified as switches, including lockout selection 126 (added safety), a backup request switch 128, manually activated audio recording 130, clip change detector 132. The backup request switch allows the officer to call for backup and/or send an updated alert without releasing their grip from the weapon. The backup request generates a radio beacon with relevant information such as location, position, along with optional audio or video feeds. Although the inputs are represented as switches it should be recognized that various sensors, analog position registration devices, and so forth may be utilized for receiving user inputs without departing from the teachings of the present invention. It should also be appreciated that a number of other conditions can be registered or selected by the user.

[0218] By way of example, the system can be optionally configured to register the following events, drawing the weapon from a holster, removing weapon from a charger, contact with the trigger, cocking the weapon, detecting the size of the magazine and type of rounds, attempted disassembly of weapon, impacts or high accelerations (i.e. denoting officer perhaps in trouble), heat, sensing gun residues on a prospective shooter, and other both simple or sophisticated functionality.

[0219] Outputs 134 are shown exemplified as LEDs for indicating status, although it should be appreciated that small displays, audio annunciators, tactile feedback, and other forms of output may be similarly adopted without departing from the teachings of the invention. The outputs indicate activity of the system 136, audio recording activity 138, video recording active 140, GPS in range of location satellites 142, low battery 144, and system error 146.

[0220] Cost Factors.

[0221] It should be recognized that at present with the availability of low cost integrated GPS positioning chips, inertial references, compasses, tilt sensors, and so forth, the manufactured module could be provided at a reasonable manufactured cost. It will be appreciated, however, that less instrumentation may be utilized if less comprehensive infor-

mation is desired, for example compass, tilt sensor, time of day circuit, and discharge sensor can provide a significant amount of information to determine aspect of a situation, such as a shooting, which has just occurred.

[0222] 4.4 Summary Aspects of Invention.

[0223] The following is a partial summary list of inventive features which can be implemented singly, or in combinations, without departing from the teachings of the present invention.

[0224] Registering weapon location during a given period of time, such as during a shift.

[0225] Registering orientation (compass and optionally declination angle), location, and time when each round is fired.

[0226] Registering speed and acceleration of weapon at time of firing.

[0227] Registering audio on demand and near the time of a discharge event.

[0228] Registering images near the time of a discharge event.

[0229] Preventing use of the weapon by unauthorized persons.

[0230] Preventing the weapon activity log from being erased by field personnel attempting to stage a cover-up. A separate download unit is required to upload the information from the weapon into the computer system and reset the logs for the upcoming shift. In this way the activity of each weapon is maintained on a day-by-day basis.

[0231] Generating a signaling beacon to call for backup, upload discharge information, or enhance weapon retrieval.

[0232] Registering biometrics of an individual utilizing a weapon as logged with activity.

[0233] Generating local communications and weapon activation with RFID device.

[0234] 5 Approaching Vehicle Display System.

[0235] 5.1 Introduction.

[0236] Problems with Unseen Approaching Traffic.

[0237] **FIG. 14** illustrates an example of a traffic obscuration problem, wherein a first vehicle A is unable to see an approaching vehicle B due to obscurations, such as a curve, obstructions (i.e. bushes, trees, vehicles, buildings, etc.), elevation change (i.e. vehicle B approaching a rise), fog, lighting conditions, and so forth. In the scenario shown vehicle A may not see vehicle B and decide to pull out making their left turn. Vehicle B approaching at a high rate only see vehicle A as it appears directly in front and collides with vehicle A. It should be appreciated that countless such scenarios exist on our roadways.

[0238] Approaching Vehicle Display System—Summary.

[0239] The present invention provides a display system for indicating the presence of approaching traffic, and more preferably discrete indicators of the relative position of that traffic as it approaches. Preferably the system is configured for being permanently mounted at a location, wherein the active roadway sign output may be customized to the

location and specific forms of obscuration encountered. The active roadway sign allows a motorist to make an intelligent decision on whether to take a given action, such as pulling out, while being subject to reduced risks of collision.

[0240] In the scenario depicted in **FIG. 14**, the present invention appreciates that if the driver of vehicle A was aware of the motion of vehicle B along the obscured roadway section, they could prudently delay pulling out until vehicle B passes.

[0241] The present invention thereby provides a active roadway sign which indicates approaching vehicle traffic and announces the relative movement of that traffic to vehicles along the path of that traffic that can not see the approaching traffic; such as around corners, behind a rise, a tunnel, bushes, vehicles, behind a snow bank, in fog and so forth. The traffic can be sensed unidirectionally, for example wherein driver of vehicle A is alerted to movement of vehicle B, or bidirectionally wherein both vehicles can be alerted (with different roadway signs, or opposing sides of the same roadway sign) to the actions of the other vehicle.

[0242] A number of embodiments of the present invention are described, although these are not equivalent, they each provide some functionality for obscured traffic signage/indication. Described aspects of the invention may be implemented individually or in combinations thereof. The system generally comprises a traffic sensing means, a communications means, and a active roadway sign means preferably capable of displaying discrete positions through which traffic is passing. A number of mechanisms are described for the detection, communication, and display of approaching traffic—these elements being described separately below.

[0243] Vehicle Position Sensing

[0244] The traffic can be sensed by a number of methods, such as contacts, pressure sensing pads, noise sensors, broken path sensing (IR beam direct or via mirrors), IR lasers, ultrasonic sensing, radar, and so forth. A number of sensors may be utilized in different modes, such as lasers using Doppler techniques or time of flight techniques to determine both vehicle position and speed along sections of a roadway. These sensors may be separately mounted or directed at differing angles from the same location. Furthermore the sensor may scan a section and report traffic pattern. For example, a geared motor coupled to a cam to a lever which modulates back-and-forth the direction of a beam type sensor, such as laser, ultrasonic and so forth.

[0245] Vehicle Position Communication.

[0246] The position of vehicles can be communicated over a wired transmission, or a wireless transmission such as RF, optical, or audio. Communication may comprise each sensor acting independently to communicate with a controller/active roadway sign, or operating in cooperation with other sensor units.

[0247] Vehicle Position Output on Active Roadway Sign.

[0248] The output may indicate a simple state condition, such as go or no-go, for the motorists; however, it is preferable that discrete positioning information about the location of approaching vehicles be indicated. The position indications comprise optical changes such as changing illumination intensity, color, or reflective properties. Although the description below generally refers to activating illumi-

nation, it should be appreciated that color changing, and the changing of reflective properties, such as may be performed by modulating the position of electronic ink (elink) spheres embedded on a surface (or organic LED, organic EL, or other forms of optical output) or by otherwise altering the appearance of a surface.

[0249] Traffic signage capable of indicating the approach of traffic can be provided in a number of ways according to the present invention. A preferred method utilizes at least one row of light sources which are operated in response to traffic flow through portions of the roadway from which traffic is approaching. The signs may alternatively utilize, laser projections (on a sign, road, or other surface), mechanical output, or other forms of approach indication.

[0250] Examples of active roadway sign output includes a vertical post, with smaller lights at the top and larger ones near bottom (perspective), wherein the user can discern that top is far away while bottom indicates close items. Alternatively, a light bar can be oriented at an angle that has some relation to the area being sensed (may even be curved to indicate a section of curved road). The unit can be inclined so that the distance aspect is apparent from the inclination, wherein the drivers won't be readily mistaken about what is being registered. The display output can be on separate light bars; over signage; projected optical output on signs, roadway or objects; and so forth. Preferably the approaching vehicle display assembly is positioned so that it may be seen by a driver when looking for approaching traffic while not substantially obscuring the view of those oncoming vehicles.

[0251] Response to Detection Failures & Operational Indications.

[0252] Furthermore, the system preferably has a monitoring feature which upon detecting problematic system behavior, or failure, communicates system status to motorists—for example flashing all the indicators as a warning of oncoming traffic without indicating specific locations of traffic. For example, the system can generally assume that vehicles travel through the roadway section being monitored (unless being parked along the roadway), wherein if certain sensors register the motion of the traffic while other sensors do not register those same vehicles, then the system is malfunctioning and should be serviced. In this case the present system is configured to perform estimations based on the other sensors insofar as the accuracy will be sufficient, and to continue displaying information. If the estimates can not be performed properly or would render the unit of questionable value, or worse, the system should enter a failure mode, such as outputting a flashing warning beacon, but not displaying the vehicle motion lights, or other vehicle motion indications. Optical indicators may also be put into a blank state to indicate a system malfunction, however, it should be considered whether the lack of active indicators could be construed to indicate that no traffic is approaching. In one embodiment the approaching traffic indicator when in use displays optical indications that it is active. For example, graphic and/or textual portions of the sign can be selectively generated, such as using electronic ink which can be set into a first or second state, such as actively displaying the intended message, or being inactive, or alternatively displaying a different message.

[0253] One aspect of the invention is generating an “operational” indicator in response to a sweep of the road-

way and the registration of stationary objects in the correct position. In this way the unit can alert the driver that it is operating. If the unit is not properly sensing fixed objects along the path then the unit does not display a reading and may enter a flashing mode (i.e. a caution beacon) indicating caution. Signs may generate light, such as LED signs, and the like, or be reflective and positioned where vehicle headlights will illuminate the signage.

[0254] Operational Monitoring.

[0255] The AVD system is preferably configured to perform self-testing and to track any problems encountered. Additionally, it may log traffic patterns and other information collected during operation. This information can be collected by service personnel establishing a wired, or wireless link with the system. Service personnel could for example perform a “drive-by-download” wherein they travel over the roadways on an inspection trip while a coded transceiver in the vehicle interrogates (preferably automatically, or based on GPS coordinates and a database) the electronics along this path. The personnel can be immediately alerted if this unit, or other forms of units utilizing this same drive-by-download mechanism need service. Barring any significant error conditions, the other information collected can be uploaded to a central maintenance database which tracks the conditions of all equipment, service intervals, inspection intervals and the like.

[0256] Alternatively, the unit may periodically, or in response to an event, autonomously establish a communication link such as over a cellular phone connection, or other communication link. In this way data may be collected remotely and servicing dispatched automatically should problems arise with the units.

[0257] Flashing Caution Beacon.

[0258] The active roadway sign unit may be configured with a flashing beacon on the unit, such as to indicate a warning, whether or not the unit is functioning, or utilized only for indicating a failing status of the unit, wherein the active roadway sign would not be indicating traffic positions.

[0259] Inherent Drawbacks with using Video Based Displays.

[0260] The present system utilizes detecting vehicles crossing a path and displaying generally discrete positions (or estimated positions between known detected positions), as this is far simpler and more accurate than discerning vehicle position in relation to collected images, or the collection and display of video images. Detecting approaching traffic utilizing video displays coupled to video camera feeds is not described herein as a primary method of alerting motorists to approaching traffic, as it is a method which is subject to both cost and operational constraints. It will be appreciated that video displays are only capable of displaying the information from the camera vantage point, which does not coincide with the vantage point of the motorist (if it was the same vantage point then it would not convey additional information), which easily can lead to confusion. The video display itself also must be of sufficient size to convey both the approaching vehicle and sufficient contextual (i.e. background) information to recognize relative vehicle positioning along the roadway, wherein the display then blocks the view of the motorist. A video display must also be viewable under an assortment of lighting conditions.

In addition, so much information must be processed by the motorist in viewing a video display, that their attention is diverted from the roadway, wherein accidents of other types may easily arise. It will be readily apparent that the cost and maintenance factors for video display systems would far exceed the costs associated with any of the systems described herein. Although not generally necessary, the present embodiments of the approaching vehicle display system could, however, be augmented or used in combination with video display aspects to provide additional information in select applications.

[0261] 5.2 Description of Example Embodiments.

[0262] Outline of AVD System Input, Communication, and Output

[0263] The present invention provides a number of systems for displaying the approach of traffic in a manner that the motorist knows the relative location and movement of the approaching vehicle. The following illustrate a number of embodiments of the invention, which not being equivalent each have their own sets of benefits and costs. The following table outlines aspects of the invention covering input sensing, communication of vehicle positioning information, and display of vehicle positioning.

[0264] Input Sensing.

[0265] Sensing Electromagnetic spectrum (optical) (Signal Reflections, Directly from single transmitter (single path, multiple path); multiple transmitters.

[0266] Sensing Electromagnetic spectrum (optical) Signal Reflections, Indirectly.

[0267] Pressure Sensing of Remote Traffic

[0268] over roadway sense strip mesh over area of interest.

[0269] zigzag crossing sensors between Bot's dots terminal. (wired or wireless) bus with extensions to Bot's dot terminal.

[0270] Preferably Communicated Wirelessly. (preferred option)

[0271] Inductance sensing communicated wirelessly.

[0272] Audio Sensing.

[0273] Preferably Communicated Wirelessly.

[0274] Communication of Vehicle Positioning.

[0275] Wired communications link

[0276] buried wiring, on surface of roadway.

[0277] Wireless communications link

[0278] RF, optical, ultrasonic

[0279] encoded or unencoded

[0280] single transmitter, multiple transmitters

[0281] self-powered transmitters

[0282] Output Display.

[0283] (Power Options—wired power (AC, low voltage), solar cell, fuel cell, batteries)

[0284] (Communication options—wired, wireless, self-powered remote wireless units)

[0285] Elongate Roadmap Display.

[0286] (1) Straight on post, (2) Angled to match road, (3) Curved to imitate road

[0287] Contour Display within Sign.

[0288] Active Reflective Sign

[0289] posted directly opposite car so lights reflect from sign

[0290] Example: Elnk with reflective ink beads dark on other side.

[0291] Sweeping Laser Projection.

[0292] upon near or far signage, on roadway surface

[0293] Communicated to In-Vehicle Display.

[0294] heads-up display, GPS moving map, flashing light, etc. indicating situation (generated from in-vehicle system capable of receiving & annunciating alert)

[0295] Single Path Reflective Sensing (AVD) System.

[0296] FIG. 15 depicts an approaching vehicle display (AVD) system which directly senses approaching vehicle position. Display 10 is configured for generating an easily visible output in response to approaching traffic. Although a single output could be provided it does not connote the movement or speed of approaching traffic, and is thus less preferred than a multielement display. By way of example, display 10 is shown with four optical outputs, such as illumination elements (i.e. LEDs), 12a-12d. Electronic circuitry for communicating and processing vehicle signals and for controlling the display are preferably contained at or near display 10. Coupled to display 10 are one or more vehicle sensors. Four vehicle sensors 14, 16, 18, 20 are depicted, with each one registering a roadway position displayed on display 10. Sensors 14-20 may be coupled to the electronic circuits of display 10 by means of wiring 22, as shown, or using a wireless communication link.

[0297] Each of the one or more sensors, is shown configured to register the motion of a vehicle across a specific portion of the roadway (either a single lane or two lanes of traffic). This embodiment actively detects reflections from the vehicle as it passes through the roadway section. A source of electromagnetic radiation (EMR), such as optical energy in the infrared, visible, or ultraviolet range is output from each sensor, and a detector in the sensor registers the amount of energy output which is reflected back to the detector. The source of EMR is preferably modulated, wherein the reflected energy may be readily discerned from background sources of EMR in the same wavelength range.

[0298] Furthermore, the EMR source can be modulated with a serial encoding, wherein the path length of the reflected energy can be detected, allowing direct measurement of distance and velocity of approaching objects. Additionally, the Doppler shift in frequency of the modulated energy can be used directly detecting the component of vehicle velocity along the beam path. It will be appreciated however, that direct speed measurements taken on an angle to the direction of travel which may intersect different

portions of vehicles during traversal and depending on lane positioning, would preferably not be relied upon to yield accurate speed information.

[0299] FIG. 16 and FIG. 17 illustrate examples of the AVD system of FIG. 15 shown in a block diagram. The display assembly 10 is shown in FIG. 16 with a display head 32 coupled to a display driver 34 and controlled by controller 36, preferably containing a computer processor. A communication circuit 38 provides a communication link with remote sensor units, such as sensor 14, 16, 18, 20. Depicted as a wired communication path, it will be appreciated that wireless communication links may be substituted. Power is provided to the system by any convenient means, such as by way of an AC power-supply 40 if AC power is available, by a solar collector 42, with a controller 44 and energy storage system (i.e. battery), although fuel cells, batteries and other forms of power may be provided. Preferably low voltage power is provided to the controller, driver, and display, while being routed to the sensors 14-20. In this way each sensor need not provide its own operating power.

[0300] Each sensor head 14-20 is shown by way of example having a sense transceiver 54, 56, 58, 60 (i.e. optical head) which is coupled to control circuitry 64, 66, 68, 70 configured for signal processing and communication of vehicle signals. Detailed descriptions of reflective sensing of objects is known in the art and therefore need not be described herein.

[0301] It will be appreciated that passive forms of sensing may be performed, such as detecting changes in background optical characteristics, infrared sensing or pyroelectric detection of engine heat, and so forth. However, it should be appreciated that active reflection sensing is generally preferred over passive methods in that it is often easier to provide accurate detection, while allowing for sequential modulation of the output to obtain signal transit time information and Doppler shift information.

[0302] The present invention also preferably incorporates circuitry, or more preferably the programming of a micro-controller, for estimating vehicle position between discrete vehicle detectors, and for using that information to more accurately represent the movement of vehicles when more than one display element is provided per each discrete vehicle detector. It will be appreciated that the speed of a vehicle can be determined by registering the time between arrival at different detectors, directly utilizing trip time, detecting and interpreting Doppler shifts, or estimating speed based on a predetermined value. The speed value multiplied by the elapsed time since leaving a detector provides an estimate of the new location. Lighting, or other display elements, for indicating intermediate positions between the vehicle detectors are then activated in response to the estimated location, therein providing a smoother, less granular, view of the motion of approaching traffic.

[0303] FIG. 17 illustrates an example of a simple display head 32 with driver 34, comprising four LEDs 12a-12d (i.e. High intensity LEDs, LED clusters, or other convenient illumination devices). The illuminators may be color coded in response to the distance of the oncoming vehicle, such as the most advanced segment along the path outputting red light, wherein the first segment along the path could output a green light indicating that sufficient distance probably exists at this time. Intermediate distances can be configured

with other colors between red and green, such as amber and other shades. In addition, the speed of the traffic may be taken into account, wherein the color output (or alternatively other characteristic such as activity is changed in response to the speed of oncoming traffic). The display driver is shown as switching elements such as VFET transistors for interfacing the illumination devices to controller 36.

[0304] Approaching Traffic Displays.

[0305] FIG. 18 through FIG. 21 illustrates additional example embodiments of AVD system displays according to the present invention.

[0306] FIG. 18 and FIG. 19 depict an approaching traffic sign 32 is shown in a curved configuration in a top and facing view respectively. The curve (or curves, and/or angling) of the sign, provide indications of the roadway curvature to which it corresponds, wherein the display output provided is more intuitive to motorists. The sign at the position shown in FIG. 15 is preferably positioned so that it does not obstruct the view of the drivers, such as positioned between ground level and up to two feet in height. In some instances, wherein even a small sign would obstruct the view, the sign may be placed on the horizontal, such as in a portion of the roadway, like a section of island. A control unit 48 is shown attached to the back of the sign for controlling the illumination, and/or non-illuminated active display elements such as regions of electronic ink.

[0307] In FIG. 19 it is easy to see a series of four indicators spanning the sign for indicating the movement of approaching vehicles, although any number of indicators may be utilized in the sign. The background of the sign preferably is illustrative of the meaning of the indicators, such as provided by the vehicle shown on the sign and the arrows indicating travel direction, although text, icons, and other signage may be provided. Keeping with our original scenario of FIG. 15, the four indicators comprise four LED lighting elements 12a-12d. A vehicle in region a (detected by sensor 22) is indicated by activating LED element 12a, a vehicle in region b (detected by sensor 20) is indicated by activating LED element 12b, and so forth for each region detected. It will be appreciated that additional display element may be supported without the need of adding additional sensors, such as by calculating or estimating additional positions, as will be described in more detail. The indicators may be of different colors, such as transitioning from green or alternating green/yellow at the 12a end and changing through yellow to red at the 12d end, indicating the approaching danger as the car approaches. Other forms of display elements may be utilized, such as organic LED illuminations strips, EF strips, electronic ink sections, or other displays capable of depicting movement of a vehicle, preferably on discrete locations of the display to reduce cost of implementation.

[0308] FIG. 20 depicts a yield sign 72 configured according to the present invention with a background 74, preferably reflective, mounted to a post 76 or other stationary structure. An illustration of the roadway condition 78, typically depicting the danger for which the approaching traffic sign is put in place, and which preferably illustrates bumps or curvatures in the roadway associated with the approaching traffic. Indicators 80 on the sign may comprise lighted, reflective, or color changing sections controlled by the

system. A preferred indication being LEDs, or LED clusters. A traffic message **82** is preferably shown to enhance recognition of the traffic scenario.

[0309] **FIG. 21** is an approaching traffic sign **86** which is configured with lighted elements **80** along with color changing indicator segments **88**, which for example may be implemented as vehicle patterns displayed at selected positions on the sign to correspond with the illuminated elements **80**. In this way the “little car” icons are activated in combination with activating the illumination elements. In this way the user may more readily recognize the sign, while the daylight readability is also increased. It will be appreciated that electronic ink spheres may be embedded in the sign between electrode layers which establish the “inks” in the electronic ink spheres in either a first or second state to display an indicia. The spheres can be made to change color, or by utilizing a reflective “ink” the reflectivity may also be changed in response to electrode activity. The control of electronic ink display, or other suitable display technologies is known in the art and need not be discussed in further depth. A beacon **90** is shown on sign **96**, which can generate a generalized warning, or activate when it unsafe to enter the intersection, or in response to error conditions detected by the unit or service personnel.

[0310] **FIG. 22** is an embodiment of an approaching traffic display **92** shown with illumination elements shown in three sections **94**, **96**, **98**. By way of example the top elements **94** are configured to activate when the approaching traffic is too near for a vehicle to attempt pulling out into traffic, wherein these lights preferably have a light output which is red, or close to red. A lower section **96** are preferably implemented as yellow lights, while a lower section **98** preferably includes green lights, some of which remain lit even though no traffic is detected, wherein the light flash to indicate moving traffic and preferably shift to an amber output in response to traffic that is moving at a sufficient rate of speed to warrant caution. It will be appreciated that all lights may be the same color, or other colors, and that the pole section may be bent at an angle to convey additional information about the roadway. Furthermore the lights at the top of the post may be of a larger candela output for greater visibility due to their higher importance. Similar to the sign of **FIG. 21**, the background of this post sign may comprise a low power daylight readable display, such as electronic ink, wherein the state of sign can be determined at any time of day or night to indicate the approach of traffic.

[0311] **FIG. 23** depicts an approaching traffic display **100** utilizing laser projection, or other forms of illuminated projection. A sign **102** is shown with a path **104** within which a path or discrete positions are indicated by laser **106**, which may utilize a number of fixed positions, or a mirror array or other actuator for scanning the beam across the sign.

[0312] Similarly, the laser projections may be scanned across a roadway surface, building or other viewable surface, such as from laser element **108**.

[0313] **FIG. 24** illustrates an example of an registering vehicle position in response to breaking the path of light beams, such as laser beams, directed across a roadway surface from a transmitter to detector, or more preferably from a transmitter to a reflector and back to a detector, wherein power only need be routed on one side of the roadway.

[0314] Approaching vehicle display sign **86** is conveniently placed for viewing by motorists, such as vehicle at position A and coupled to a controller **112**. The controller is connected to a series of sensors **114**, **116**, **118**, **120**, and **122** and a series of reflectors **124**, **126**, **128**, **130**. In this scenario the reflectors are shown spaced on a diagonal, although they may be placed with reflectors directly across from the sensor, or at any convenient angle. Each sensor may transmit a single beam, such as from sensor **112** off of reflector **124** to be detected by an optical sensor at sensor **116**. It should be appreciated however that breaking either half of the beam still results in detecting a vehicle passing through the section. The sensors are shown wired to one another wherein power is distributed and signals bussed to controller **112**. Preferably the communication link utilizes a standard 2-4 wire communication link, although the signals may be passed over the power bus, communicated wirelessly or otherwise.

[0315] Multiple Path Reflective Sensing (AVD) System.

[0316] Each sense head can be configured to sense multiple reflective paths or even to scan across a range of paths in discerning vehicle activity. The scanning methodology will be described below and the use of sense heads supporting multiple independent paths described later.

[0317] **FIG. 25** illustrates an example of multipath sensing **150** in which the sense units each sense multiple paths, herein shown in response to scanning. A controller **112** is coupled to a roadway sign **86** and one or more sense heads **152**, **154**. It will be appreciated that the controller may alternatively be collocated with display **86** or one of the sensors. Each sense head emits a signal, preferably optical, in a number of different directions and similarly is configured to detect reflections from those transmissions. A number of transmit-receive pairs can be configured within the heads, or a single transmit-receive path may be modulated using electronically controlled, mirrors or mechanical beam directing assemblies. A scanning path **158** is shown along which the units detect vehicle positions and optionally utilize registration of transmit to receive time differential for determining reflective path length, or detect frequency shifts to detect speed according to the Doppler shift. It should be appreciated that simple reflective scanning is very inexpensive, and can provide proper sensing of vehicles without the need to directly determine vehicle speed from the reflected optical signal.

[0318] **FIG. 26** and **FIG. 27** illustrate a top view and side view of the scanning portion of a scanning optical sensor **152**. One printed circuit **164** contains at least one transmitter **166** (optical emitter) and at least one receiver (optical detector) **168** which is preferably shrouded to prevent cross-talk effects from light reflections of transmitter. PCB **164** is shown mounted on a pivot **172**, and being driven by a motor **174** with gear head **176**. The output of the geared motor is shown with a ninety-degree elbow **178** which engages a cam-slot **180**. As the motor operates the emitter and detector is scanned back and forth covering a desired angular range of motion. It will be readily understood that a number of alternative scanning mechanisms, such as other mechanical scanning techniques, active mirrors and so forth may be employed for directing the outgoing beams and incoming light. A second circuit board **182** is retained in a stationary position with a housing (not shown) and coupled through a

pivot to PCB 164. (Circuit board 182 is not shown in FIG. 26 for the sake of clarity) The stationary PCB 182 preferably carries control and communication electronics 184 for the sensor head, and is shown wired with flexible wiring 186 coupling it to the moving head portion 164. A position sensor 188 is also coupled to the circuit for detecting the position of the transmitted signal, allowing the received optical energy to be correlated to the pattern of light emissions. Although not shown in FIG. 26, 27, it is preferred that the range of scan angle is preferably adjustable (such as different pivot points, cam outputs, and so forth) wherein the sense head can be set to match the surroundings.

[0319] It is preferred that the angular scanning rate be much higher than the angular velocity of the vehicles in relation to the sense head, wherein the position of the vehicle is detected through a number of sweeps during its transition past a given sense head.

[0320] Although mechanical scanning may be utilized, faster scanning can be provided utilizing an active mirror assembly.

[0321] If the angular scan rate may be controlled, then the unit may also be configured to lock into a transition, such as at a first end of detectable sector and to maintain the scan on the edge of the vehicle (like a surfer riding a wave) wherein it follows the vehicle as it moves through its detection zone. One drawback of "scan lock-in" on the target is that a single vehicle in a given detection zone will be detected unless additional sensors are operating simultaneously. For that reason and in view of typically higher costs for controlled rate scanning, this technique although useful, is somewhat less preferred than high rate scanning.

[0322] Calibration.

[0323] Unlike a fixed path unit, the reflective response from a scanning unit changes in response to both the background elements and the foreground elements because the beam is being swept through a range. Therefore, calibration of the scanning sense heads can be beneficial. During setup the scanning unit is calibrated in a no traffic situation wherein it registers the reflective response over the scan path to use as a base-line of comparison. Fixed obstructions are thereby registered, which preferably can be tagged in software as part of the unit's self test. The unit may also rely on comparing information patterns collected from recent scans against new scans wherein it can detect vehicle position without generating errors in response to fixed obstructions, temporary obstructions, lighting conditions, weather conditions and so forth.

[0324] Pulsed Outputs and Differentiating Reflections.

[0325] To reduce the amount of data collected, the sense heads are preferably configured to provide a periodic pulsed output wherein discrete detector signals are processed instead of signal streams, it will be appreciated that high accuracy or resolution is not required. Assuming a fixed modulation of emitter 166, the receiver circuits coupled to receiver 168 demodulate the reflective response to eliminate ambient contributions and then preferably digitizes the resultant amplitude along with positioning information for each pulse. This data can be sent from each sense head to the controller for processing. It is preferable that the optical pulses emitted by the sensor heads do not overlap on

adjacent emitters, wherein it is easy to discern which reflection signal belongs to which emitter.

[0326] When registering reflection energy it is beneficial to discern which emitter sourced the given energy being registered in a reflection, otherwise the complexity and accuracy in determining vehicle position can be compromised. A number of methods can be utilized for discerning the reflections.

[0327] One method of discerning emitter output is to encode an identifier into the output of each emitter, then the reflective energy can be checked for the identifier. One form of identifier can be provided by modulating emitters at slightly different frequencies, wherein the detectors are configured to filter out all frequencies except that of a given emitter, or to have an adjustable pass-band allowing the checking of energy received from a number of emitters—thereby yielding increased amounts of information.

[0328] A preferred method of discerning emitter output is to allow only one emitter in the system (or a local portion of the system) to be in operation at any given time. In this way it is very easy to determine which emitter sourced the given reflection. It is still generally preferred to modulate the emitter output and filter the detected energy, wherein changes in ambient conditions do not contribute to sense error. Each sensor output can be preferably modulated according to a desired pattern, such as a sinusoidal at a given frequency. It may be encoded with any time-variant pattern, which may be monotonic or sequentially variant. Pulsed and modulated output allows the system to perform more sophisticated processing, such as determining time-in-flight (distance of object from which reflection arises) or Doppler information (closing rate speed of object toward/away from sense path) is to be collected.

[0329] The sensor heads can sequence their output in response to information from the controller, unit information within the sense head, negotiation strategies, or combinations thereof. The present invention considers that roadway regions being sensed may be thought of as a network, upon which the emitters gain access—wherein strategies adopted for gaining access to a network may be utilized herein (and are to be considered incorporated herein by reference) for preventing overlap (collision) between emitter outputs. Taking the analogy further, when a large number of sense heads is utilized (sense output near a first end of a row of sensors not able to be detected by sense heads toward the opposite, second end, of the row of sensor heads); portions of the row of sensors may be considered to comprise virtual networks, wherein simultaneous emitter activity is prevented within the virtual network, but not over the entire row of sensors (physical network).

[0330] A simple preferred method of preventing emitter overlap is for each sense head to have a user selectable bank and ID number (i.e. bank 0-3, ID numbers 0-7) which is set in reference to position in the string of sense heads. The banks allow for long strings of sense heads to be supported. In a first bank 0 the ID number are preferably arranged with first sense head ID=0, next head ID=1, and so forth. Subsequent banks would then preferably follow the same pattern. Emitter output timing on a given sense head is then controlled by the ID number, wherein for example the time is divided into eight time periods within which sense heads can operate in response to their unit IDs. In the case of

multiple emitter-detector sense heads, the emitters on the sense head are sequenced within the period provided for the unit ID. Sequential banks arranged in the same pattern as the original can utilize the same eight slots, since each sense head is located a distance equal to eight times the distance between sense heads from a sense head operating under the same timing. Setting a unit code has the benefit of allowing the installer to easily control how the units are to use the bandwidth while being uncomplicated. If fewer than eight sense heads exist in a row, then they may be set for nonadjacent time slices if desired. It should be appreciated, however, that a setup time is preferably assured on each end of every time slice which prevents adjacent sense heads from colliding with one another in terms of optical emissions, commands from the controller, or data results being sent back to the controller. It is generally presumed in the above that banks of devices are located in a series and not established on opposing sides of a roadway where their output would interfere.

[0331] The controller then preferably provides a clocking signal to all sense heads, wherein the clocking provides a framing pattern. For example 500 kHz clocking (2 μ s), with framing rate of 100 Hz (10 ms). The first unit (ID=0) can emit during the first $\frac{1}{8}$ th portion of the 10 ms frame period, the next unit (ID=1) can emit during the second $\frac{1}{8}$ th portion and so forth. Each sense head utilizing a digital counter, or more preferably a microcontroller counter, for determining the position of its bandwidth slice in relation to the framing signal wherein counts are advanced by the clocking signal. The clocking signal provides a timebase to keep all units synchronized, for both emitter operation and for communicating results back to the controller. It will be appreciated that the results are then preferably returned to the controller from each sense head during the $\frac{1}{8}$ th time slice accorded each head, wherein no collision of results will arise. Similarly, the controller may send commands to a given unit by sending data during the time slice (along with bank number), or by sending commands asynchronously wherein each unit must read and check each command against its own bank number and unit ID.

[0332] A number of alternatives may be utilized, for example an ID chip may be utilized within each sensor head to differentiate the units from one another. The ordering of emitter outputs is then determined in response to the ID or a portion thereof. Another alternative is negotiating for time slots, wherein the units sense for other emitter activity and grab slots when others are not using them. The same framed clocks are preferably provided wherein once negotiation is completed the units can safely remain synchronized without overlapping one another. If conflicts arises the units preferably do a random backoff, before attempting to gain a slot. Negotiation would arise at the beginning of initialization, and perhaps on a periodic basis. Once they have a clear slot, the number of clocks into the framing period is used so that maintain their slot without further negotiation. It will be appreciated that a number of alternative mechanisms may be utilized for synchronizing the operations of the sense heads.

[0333] Sense Heads: Local Versus Remote Intelligence.

[0334] The majority of the intelligence of the system may be either toward the sense head or the controller, to which all sense heads connect. It is preferred that the sense heads have sufficient intelligence to determine whether a vehicle is

present or not, and optionally to perform time-in-flight measurements (distance), or optionally Doppler registration (closing speed on beam), but that the correlation of information be performed by the controller which is able to make more accurate conclusions in response to gathering information from a number of heads.

[0335] A microcontroller (CPU, DSP, or other circuit configured to execute programmed instructions) is configured in the controller system for processing the information and communicating with the sense heads. Each sense head also preferably incorporates a microprocessor, such as an 8 pin PIC[™] microcontroller from Microchip Corporation in Chandler Ariz. The sense head controller can rely on inexpensive on-board timing or even RC timing, as its output is synchronized by the framed clocking from the main controller. It is preferred to minimize sense head cost as these are more subject to environmental factors, collision, vandalism, and so forth.

[0336] Preferred Discrete Multipath Sense Heads.

[0337] It will be generally appreciated that emitters-detector pairs at the present time are generally less costly and maintenance-prone than mechanical or mirror based scanning mechanisms. Furthermore data collected from fixed position scanning is easier to process. Another advantage is that multiple emitter-detectors provide redundancy, wherein the system can detect if one or more emitters or detector is malfunctioning and can still continue useful operations.

[0338] It will be understood that a number of different approaching traffic sensing arrangements may arise over a roadway section, in some instances only one or two detection paths are necessary while in other it is preferred that a number of sense paths be provided. Furthermore, some installations (i.e. narrow median) may warrant sensing traffic on two opposing sides of the sense head. A sense head may be implemented which allows the installer to select the number of detection paths provided by each sense head and the directions of the paths.

[0339] FIG. 28 illustrates by way of example a cutaway view of a fixed position sense head 200 having a housing 202 configured with multiple recesses 204 and optically transparent openings 206 (apertures or covered by transparent material), into which emitter-detector modules 208 may be inserted. Each emitter-detector module is configured for both emitting optical energy and detecting optical energy along a path 210. The housing may contain connections within the recess which are established upon inserting the module, however a simpler use of wired connections is shown with a pigtail 212 from each emitter-detector module 210 being connected to a plug 214 within a plug block. The installer need only populate the sense head with the desired number of sensors, although spares may be inserted into open slots and left unconnected.

[0340] Preferably opening 206 of unused recesses 204, or inactive modules, is blocked or covered. It will be noticed that the emitter-detector pairs may be directed to any side of the unit making it adaptable to any situation. Although the sense head 200 of FIG. 15 is shown for accepting up to eight emitter-detector modules, it will be appreciated that it may be configured for any number of modules, although having at least eight modules yields a reasonable number of angular paths. In situations in which better positional resolution is

desired, more modules recesses may be provided, such as twelve, fifteen, or sixteen etc. The modules may be retained in a single stack or in multiple stacks. The use of fixed positions as shown can simplify the operations of the controller, in that it knows the angle between paths from each sense head. The units may be arranged with a given module direction facing north wherein the controller can even discern the overall sense pattern without any intervention from the installer.

[0341] In an alternative sense head, the modules may be mounted at any desired angle within the head, such as utilizing fasteners, or other means of attachment. In this way the exact number and angle of emitter-detectors is provided. However, a drawback to this approach is that the controller must be calibrated to, or otherwise set to recognize the angles provided to maximize vehicle position detection accuracy. Calibration may be performed by driving one or more vehicles at fixed speeds through the system wherein the relative patterns of the system may be mapped out by the controller in its calibration mode. More accurate calibration can be achieved by driving the vehicle at fixed speeds on either side of the roadway, wherein a range of reflections can be correlated.

[0342] In addition to the plugs 214, a unit ID selector (i.e. 0-7) is shown along with a bank selector switch (0-3) 218, and other controls and adjustments 220. The sense head is preferably configured to be weatherproof, such as arranged with a cover in a manner similar to outdoor yard lighting or similar elements. In areas subject to snow, the sense heads may be configured for being supported on high lane reflector posts, while in more moderate climates the housing may be mounted low to the ground. The sense heads may optionally incorporate lighting elements, wherein they serve the dual purpose of lane/landscape lighting as well as detecting and communicating vehicle position to a remote roadway sign.

[0343] On-Road Vehicle Position Sensing.

[0344] The above describes the use of sensing beams for detecting vehicle position, while this section will describe alternative mechanisms for sensing traffic position based on sensors placed on the roadway itself.

[0345] FIG. 29 illustrates an example embodiment 250 in which a series of roadway sensors are interconnected for sensing traffic position. These sensors more preferably sense increases in pressure in response to vehicle tires passing over them, although they may sense inductance, capacitance, or other characteristics that change in response to vehicles passing over them. The following will describe the use of pressure sensing although the other sense methods may be utilized without departing from the teachings of the present invention.

[0346] A wired path is shown interconnecting a series of roadway sense bars 254 which are preferably securely held at a distant end 256, such as with a fastener that may be configured to appear as a Bot's dot with a central fastener. Pressure sensing may be provided using a sensor or switch within the strip 254 attached to the roadway surface. A contact switch provides a simple on-off sensing, while the use of a piezoelectric strip (or other variable output sensor) can provide additional information as to the size or number of wheels of the approaching vehicle. Circuits may be incorporated with the wiring or interconnections along the

path of the sensor to serialize the outputs for communication to the controller 112, shown attached to roadway sign 10. Alternatively each sense bar 254 may be connected to controller 112 wherein no intermediate electronics are necessary.

[0347] It should be appreciated that the sense strips may be placed on the roadway according to other patterns, such as a zigzag, or S-shaped, pattern across the roadway, wherein the sense strip and communication path are integral.

[0348] FIG. 30 illustrates an example embodiment 270 in which sense strips wirelessly communicate with controller 112, that is configured to receive the wireless signals. Preferably controller 112 is configured for receiving RF signals and has a directional antenna directed over the portion of the roadway configured with the sensors. Each sense strip 272 is shown with secure hold down ends 274a, 274b (i.e. a Bot's dot circuit housing—preferably with an integrated secure fastener hold down). The units need not be interconnected as each sense strip is preferably configured with an RF transmitter (or other form of wireless communication). A preferred method of implementing the system is utilizing piezoelectric elements within said sense strips 272 which upon being driven over by a vehicle produce sufficient electrical power for powering a coded RF transmitter for communicating with controller 112. It will be remembered that piezoelectric elements generate a voltage in response to the deflection. Alternatively other forms of power generating sensors may be utilized, or less preferably the system may be powered by batteries or other forms of power storage.

[0349] Each RF transmitter preferably transmitting an ID code to the controller 112 so that it may discern which strip has been activated. Preferably each sense strip sends the signal multiple times with different time periods between each transmission, so that signal collisions do not prevent registering the transmitted signals. For example a simple timing circuit may be utilized having an RC that is responsive to drive voltage, wherein upon being activated the timing circuit activates in an astable mode and triggers multiple transmissions of the unit ID so long as operating power is available. The time between successive transmissions will change in response to voltage depletion, and finally stop after preferably at least two to three transmissions are generated. The unit ID may be as defined on a user-selector or in response to a unit ID chip attached to the circuit.

[0350] FIG. 31 depicts a block diagram of the piezoelectric transmitter 290, whose simplicity should be appreciated. It should also be recognized that more complex transmitter circuits may be utilized without departing from the teachings of the present invention. A voltage-generating sensing means 292, such as a piezoelectric strip having one or more sections of piezoelectric material within a strip configured for attachment to the roadway. The voltage from the piezoelectric is conditioned in a power-supply 294, which in a simple case may comprise merely a pass diode and a voltage limiter (i.e. zener). If higher power transmitter output is required then the voltage from the piezo element may be multiplied by a voltage converter circuit which forms the power-supply 294. An energy storage device 296 smoothes the supply and stores energy for transmissions even after the vehicle has passed over. When capacitor 296 is sufficiently

charged then timer **298** activates into an astable mode with a frequency determined by the supply voltage and the RC time constant. Time **298** gates the activity of transmitter **300** which encodes unit ID **302** (shown as a chip, but could comprise a user settable selector), wherein a series of transmissions are generated by transmitter **300** through an antenna **304**, which may be placed within the Bot's dot housing and/or along the roadway strip.

[0351] The RF circuitry may be included within the terminus **274a**, **274b** of each strip such as within a Bot's dot hold-down within which is circuits attached to the piezoelectric strip. If redundancy is desired to lower failure rates, a pair of adjacent piezoelectric sense strips may be utilized, one strip being connected to each RF transmitter located in the Bot's dot (other housing, or right in the strip). In this way a section continues to operate so long as one transmitter and piezoelectric strip is functioning. Presently each circuit may be manufactured in quantity for a few dollars.

[0352] Preferably the transmitter circuit, such as shown in **FIG. 31** is configured to readily attach and detach from the voltage generating sense strip, wherein transmitters may be easily replaced with the need of removing strip **272** from the roadway surface.

[0353] Passive Sensing of Audio.

[0354] The position of traffic may also be discerned utilizing audio techniques, such as described in the copending patent application describing traffic motion detection within an application describing anti-collision systems, Ser. No. 09/730,327 as filed Dec. 5, 2000. A number of audio sensors may be placed alongside the roadway which detect the sound of the approaching vehicles, for example as a combination of engine sound, tire-roadway noise, and so forth. Preferably the sound detection is augmented by placing raised strips, or cutting indentations into the roadway, wherein a pattern of discernable tire sounds is produced. By altering the pattern of grooves or ridges, each audio pickup can discern motion over multiple sections of roadway. However, for this application of approaching vehicle signage this form of sensing is generally somewhat less preferred, in that it requires more sophisticated software to prevent the audio signal of a small vehicle from being swamped by audio generated by high noise conveyances (i.e. powered skateboards, large trucks, and so forth).

[0355] 5.3 Alternative Embodiments.

[0356] (1) Segmented Mirrors—segmented pass-through view mirrors may be utilized to allowing strips of view directed down a short curved path. Drivers draw their own conclusions from what is seen. The segmented mirrors are preferably spaced wherein the view is not obstructed from certain angles, while providing a view of reflected images from another roadway vantage point.

[0357] **FIG. 32** through **FIG. 34** depict a segmented traffic viewing mirror according to an aspect of the invention. In **FIG. 32** a roadway situation **350** is shown wherein a segmented mirror **352** allows the driver of vehicle **A** to see approaching vehicle **B**. **FIG. 33** illustrates a top view of segmented mirror **352** containing a housing **354** upon which are retained a plurality of mirrors **356a-356d**, although any number of mirrors may be utilized. It can be seen that housing **354** is preferably configured to allow the mirrors to be individually adjusted to any desired angle when the

mirror assembly is installed. The angles though can not be adjusted without specific tooling provided to the installers.

[0358] **FIG. 34** illustrates a facing view of segmented mirrors **352**, wherein it can be seen that the mirrors are angled from the vertical within housing **354** to allow accommodating curving the plane of view in either a downward or upward direction to better suit the roadway conditions. The lower portion of housing **354** is configured to be mounted near a roadway, such as on sign post **360**.

[0359] By way of example, one or spring loaded rods may extend from the ends of said mirrors for engaging apertures in the housing. The housing is separated to allow altering the vertical mirror angle and the horizontal rotation of each mirror.

[0360] (2) RF xmitter (broadband) coupled to a piezoelectric strip for sensing traffic passing over the caution stripes and for sending the information to the controller. Preferably at least two transmitters (preferably three are incorporated within each Piezo strip, wherein redundancy provided, fewer maintenance calls, and so forth. Form factor—small Bots dot anchored on the ends of a piezo electric strip. Unit configured to allow the circuit under either dot to be easily swapped out. A post (preferably threaded) fastener extends through MicroBot into the pavement, can only be removed through the use of a special tool (preferably engaged on an unusual head). Strip between dots is glued down and preferably anchored with fasteners at intervals to assure is does not separate. The above transmissive strip may be utilized for the above application, or for a number of alternative sensing applications. Examples include sensing traffic over a section of roadway, parking in spaces (i.e. for automated meters), and other applications wherein remote sensing of vehicle movement is desired.

[0361] (3) Signs for Automatically Annunciating Roadway conditions. The display signage of the present invention may modified for generating other forms of roadway alerts. For example the signs may be utilized to indicate conditions such as slippery, wet, icy, foggy and so forth.

[0362] A sensor is utilized at a first location which preferably communicates with the sign at a second location. By way of example, the strips **254**, **272**, shown in **FIG. 29**, and **FIG. 30** respectively, may include sensors for detecting slippery or wet roadway conditions.

[0363] 6 Intersection Transgression Alert.

[0364] 6.1 References.

[0365] Portions of this aspect of the invention relate to the patent application entitled "Approaching Vehicle Display System" described above, which is incorporated herein by reference.

[0366] 6.2 Introduction.

[0367] It will be appreciated that a number of collisions occur within intersections every day as a driver enters the intersection under the green light only to be struck by a vehicle traveling under the red light (transgressing the legal boundaries of intersection use). Severe injuries and often fatalities arise from these accidents.

[0368] 6.3 Summary of Inventive Aspects.

[0369] The present invention therefore describes an enhanced mechanism for controlling the traffic control lighting at an intersection for indicating such transgressions to approaching vehicles. These signals primarily comprising green, amber, and red lights directed to each direction of traffic. The present invention detects the nature of the transgression and alters the pattern of indication on the traffic lights in response to dangerous vehicle operation, such as crossing into intersection under RED light. For example the green light may flash, elements of it may strobe, or portions change to other colors in response to the detected danger of a vehicle that has or may enter under the red light a portion of the intersection controlled by the green light being modulated.

[0370] An apparatus for alerting drivers to dangerous intersection conditions is described, although more particularly the apparatus is preferably directed at alerting motorists under a green light to vehicles traversing the intersection under a red light. The apparatus generally comprises: (a) at least one traffic light for displaying a green, amber, or red light to vehicles at or approaching said intersection; (b) a traffic light controller configured for sequencing lights at an intersection, including said at least one traffic light; and (c) means for detecting vehicles passing illegally into said intersection under a red light, or that have a high probability of passing illegally into said intersection under a red light; (d) wherein said traffic light controller is coupled to said detecting means and modulates light output from said traffic light in response to a signal received from said detecting means to warn to drivers of dangerous conditions in said intersection.

[0371] An apparatus for controlling traffic at an intersection, comprising: (a) a traffic light element for displaying either green, amber, or red; (b) wherein said traffic light element is configured with a plurality of light sources which may selectively activated individually or in groups; (c) means for activating segments in said traffic light following a predetermined pattern in response to receiving signals from a sensor detecting dangerous vehicle conditions.

[0372] 6.4 Description of Embodiment.

[0373] The system generally comprises a sense means for detecting traffic transgression, preferably vehicles which are or may be traversing into the intersection, along with circuits or programming on an intersection lighting controller for modulating the intersection lighting in response to the transgression. Special lighting may be installed at the intersection, which is capable of indicating additional states beyond the traditional red, yellow, green lighting, for example of displaying an amber bulls-eye in the midst of the green, of modulating on and off rings of the green color, or otherwise indicating by colors, flashing, patterns, and so forth that a danger exists although the light is indicating green.

[0374] Traffic movement is detected by any of the means described above in relation to the approaching traffic sensor. One easy to install mechanism is the wireless piezoelectric strips described above. The ID code of the strip identifies where the transgression is occurring.

[0375] The sensors may be placed at the entrance to the intersection, although more alert can be provided to motor-

ists if the sense strip is placed back from the intersection, such as 15-30 feet behind the hold line (often a crosswalk). In this way the controller can estimate the seriousness of the threat. For example, as the front wheels cross the sensor a transmission is sent to the controller, when the back wheels strike the sensor a second transmission is sent. The time between the two sets of wheels can allow roughly determining the speed of the vehicle and whether it can stop or will enter the intersection. If speed appears high then controller modulates the appearance of the green light to which the intersection incursion will prove a danger.

[0376] Another sensor at the boundary to the intersection can verify if the vehicle actually incursed into the intersection, if not then the green light can display a normal condition, else it continues to display the alert until the threat is passed. Sense strips may also be placed in parallel wherein speed can be more readily discerned. Other means may be alternatively, or additionally, utilized for detecting incursions or possible incursions, such as audio signatures (i.e. is the vehicle braking), optical sensors using Doppler effects to detect speed changes in vehicle (i.e. braking or speeding?).

[0377] A receiver module is coupled to the signal light control unit for receiving these transgression signals. The software, or circuits, of the control unit is adapted so that upon detecting traffic motion under the red light, that aspects of a conflicting green light (conflicting in that if driver proceeds at this time he may strike driver traversing the intersection illegally) are modulated, such as flashing the display, or changing which segments light, or the colors of segments. It will be appreciated that these features may be readily implemented by one of ordinary skill in the art, wherein further details are not necessary herein.

[0378] Although flashing of the green light, or holding it off for a period, may be utilized with any lighting system, the use of LED light elements having a plurality of discrete LEDs allows different patterns and colors of light to be used for alerting the driver. For example the rings of LEDs may be separately controllable by the controller, or by a local circuit on the LED unit in response to receiving a mode signal. Also lights on the LED may have multiple elements within at least some LEDs, wherein this portion of the light may be toggled from green to amber thereby alerting drivers. A green outer ring with an amber bull's-eye (off, red, or other non green portion), would readily alert drivers entering the intersection of the possible danger that awaits them. It should also be appreciated that other patterns may be likewise utilized, such as an "X" pattern displayed in optical contrast to the remaining elements and so forth.

[0379] Furthermore, the pattern on one or more of the red, green, and/or amber light elements can be utilized for indicating trouble with the light. For example, instead of simply flashing the lights to indicate trouble, a pattern can be displayed such as the "O" pattern or "X" pattern and so forth to provide trouble indications, or to otherwise alert drivers to adverse conditions.

[0380] FIG. 35 illustrates an example embodiment 10 of the intersection transgression alert system according to the present invention. An intersection is shown with vehicles A and B. The intersection is controlled by an intersection lighting controller 12 wired to lights 14, 16. The light 16 for vehicle A is red, however, they are "running" the light and entering the intersection under the red light, while vehicle B has a green light and is proceeding into the intersection. It

will be appreciated that often the vehicle with the green light may still be traveling at a significant speed when the light transitions to green wherein their visibility of car B is impaired and they may be carrying significant speed into the intersection when striking vehicle A.

[0381] The present invention provides additional information to the driver of vehicle B wherein they will be alerted to the incursion by vehicle A, wherein an accident may be diverted. Two sensors 18, 20 are shown for detecting vehicle position approaching the intersection, the detection being wirelessly communicated to controller 12. Aside from its conventional operation, the programming within the controller according to the invention is additionally configured for, (a) registering signals from intersection incursion sensors (i.e. RF equipped roadway sensors 18, 20); (b) determining that vehicle is incursing into the intersection, or optionally that it has a high probability of incursing into said intersection (i.e. sensor 20 detects actual incursion, but from sensor 18 a high probability of incursion may be detected); (c) modulating intersection signal light output in response to said incursion or anticipated incursion. In addition the controller may need to determine which lane or lanes of traffic under a green light would be affected (impacted) by incursion, wherein a particular green signal light may be modulated. In addition, the programming can deactivate the incursion alert after a given period of time has elapsed. Furthermore, the incursion alert can be deactivated if based on an estimation, and then it is detected that the vehicle did not actually incurse into the intersection.

[0382] FIG. 36 depicts a block diagram of the system, with controller 12, modified for the present invention for receiving communications from the sensors 18, 20, 22, for determining incursion and for modulating the signal light 14, shown with three elements, red 24, amber (also referred to as yellow) 26, and green 28. It will be appreciated that the system may be utilized with lights in other configurations as well, such as for lights not in the standard vertical configurations, and lights which traverse from red to yellow and then to green, instead of the standard green, yellow, red, green . . . sequence. It should also be appreciated that the controller can also modulate the output of crosswalks and other signage in response to detecting the incursion, or probable incursion. The green light 28 is FIG. 36 is shown being modulated according to a square wave, wherein the controller is just toggling the light on an off to alert the approaching driver of the danger.

[0383] FIG. 37 illustrates an LED signal light element having a plurality of indicators. According to the present invention, these may be grouped in one or more ways wherein the light can indicate more than an on and off state. For example the signal light element 28 may have an outer ring 30 of conventional LEDs and a bulls-eye 32 comprising green/yellow LEDs (two elements—light color output depends on polarity of input). The controller can turn the light 28 green or modulate the bulls-eye with yellow in response to an incursion or probable incursion. The elements within the light may be divided in a number of alternative ways for indicating to motorists that a danger exists. The elements need not be of different colors, but may be divided into sections that are simply turn on or off at different times, thereby being indicative of an alert.

[0384] FIG. 38 illustrates a light element 34 in which rings of elements are alternatively activated, dark unactivated rings are shown, which will alternate between on and off.

[0385] It should be appreciated that a number of additional visual affects may be adopted by modulating the light intensity, modulating the color of the light, modulating which elements are activated, and combinations thereof without departing from the teachings of the present invention. It should also be appreciated that any light pattern may be created according to the above, such as the concentric "O" pattern shown, or patterns having lines, "X", "+", "-", "=", and any other desired pattern, without departing from the teachings of the present invention. FIG. 39 through FIG. 42 depict by way of example a few of these alternative patterns.

[0386] 7 Pop-Up Traffic Information System.

[0387] 7.1 References.

[0388] Incorporated herein by reference is patent application describing a system for communicating hard braking and other conditions on a roadway environment, Ser. No. 09/730,327, filed Dec. 5, 2000 and provisional Ser. No. 60/153,084 filed Sep. 9, 1999.

[0389] 7.2 Introduction.

[0390] One problem encountered in high traffic situations is that of visibility, especially that of seeing in front of the vehicle you are following. This problem is especially problematic for medium to small vehicles following a truck or SUV. With the large number of these huge vehicles on the road, the risk of collision is increased because drivers are unable to anticipate actions because their view of the road is often totally blocked. In addition, such a system can aid in seeing over obstructions whether they be vehicles, terrain, buildings, and so forth, thereby communicating to a motorist (i.e. driver or passenger) information which otherwise would be hidden.

[0391] Accordingly a system is needed to allow a driver to easily see ahead (behind, or to sides) of their position, such as over other vehicles, the present system provides for this and solves additional problems.

[0392] 7.3 Embodiments.

[0393] The present invention provides a camera mounted to an extending mount, preferably allowing it to be raised for seeing over roadway traffic. The increasing functionality and lowering cost of miniature cameras along with the increasing utilization of in-vehicle displays make this system increasingly attractive. A number of variations are described herein.

[0394] FIG. 43 depicts the present invention 10 implemented on a vehicle 12 with an extended mount 14, upon which is mounted a camera 16 directed for registering forward images 18, and/or alternatively rearward images.

[0395] Although mount 14 may be a fixed height mount, it will be appreciated that a fixed mount having any significant height above that of the drivers normal field of view, will typically be subject to vertical clearance limitations, such as when parking in garages, underground parking, and so forth. Wherein it is much preferred that mount 14 be configured to extend from a low position that does not cause

a vertical clearance problem, to one or more working heights that provide enhanced views of the surrounds and allowing seeing over cars and other obstructions.

[0396] The extended mount for example may comprise an antenna configured with a sufficient height, or being raised to a sufficient height for improving forward visibility, or visibility in other directions. It should be appreciated that the extending mount may comprise any element coupled to the vehicle which extends sufficiently upward to provide a sufficient roadway view, or otherwise provides an enhanced view in relation to traffic or environmental obstructions.

[0397] Additionally, or alternatively, a light source 22 (i.e. Flashing LED) may be coupled to the extended mount 14 to increase the visibility of a small vehicle as seen in the rear view mirror of a larger vehicle. Although permanent mounting is preferred, it will be appreciated that a small light source, such as an LED may be powered by a battery source as a position indicator. The light source is preferably shrouded wherein the light being output is primarily directed forward of the vehicle.

[0398] Camera 16 may also be permanently or removably retained on an extending mount, such as the antenna as described, or other raised structure. Although the camera system may be powered by a battery source it is preferable that vehicle power be routed to the camera, or that it be powered inductively/magnetically. One or more communication signals may also be routed to the camera (and/or light source), although more preferably a wireless link utilizing RF/magnetic/optical may be more preferably established between the camera and a receiving unit.

[0399] FIG. 44 depicts a camera assembly 16 coupled to mount 14 which is configured for telescoping with section 24 shown for retracting into section 26, although only two sections shown, any convenient number of sections may be utilized. The camera is preferably enclosed in a waterproof aerodynamic housing that is securely attached or integrated with mount 14. Alternatively it may be formed for easy removal and storage preferably and may be configured with an integrated power connector for deriving power from mount 14.

[0400] FIG. 45 shows a preferred cross-section of mount 14 shown as concentric ovals. Other cross-sections may be utilized, such as the popular circular cross-section, however, a circular cross section in some cases can allow the camera to accidentally rotate away from the desired direction. Camera 16 of FIG. 44 is shown with a first image capture element, and optionally a second image capture element.

[0401] Other structures may be implemented such as a helical structure in which the camera is held at a first position, such as rearward, when retracted and which faces forward upon extension, in this way the camera could be directed in any direction in response to its height, preferably at least 540° of rotation from retracted to extended. Although mount 14 need not be a telescoping mount, as it may alternatively be configured for lever extension or other manual or automatic methods of extending camera position.

[0402] Actuators may be placed in mount 14 to allow the direction of the camera to be controlled by a user, or the circumstances. For example placing a small motorized turnstile within the camera mount; utilizing memory material

such as “muscle wire” for moving the camera in one or more axis; or utilizing other known actuation mechanisms.

[0403] In a preferred embodiment power is routed via mount 14, for example a nonconductive shell (i.e. carbon fiber, Kevlar, etc.) with power and ground conductive traces on the halves to route power up mount 14. Or having insulated sections with a grounded exterior and power routed on the interior wherein continuity is provided between exterior sections and respectively between interior sections. A number of alternative choices exist, such as grounding the exterior shell and extending a wire through the middle for power.

[0404] while near-field magnetic communication (NFM) is utilized for communicating streaming images back from the camera, and for communicating control information to the camera unit. It will be appreciated that NFM communication can easily be implemented with a range of 2-4 meters, while it is not subject to unwarranted signal dispersal, or interference from other devices.

[0405] FIG. 46 illustrates by way of example a pop-up traffic viewing system according to the invention. Camera system 16 is shown with at least one imaging sensor 30 coupled to optical elements 32, preferably one or more lenses. An optional actuator 34 is shown for positioning the rotational angle and/or azimuth angle of the camera. Streaming data from imager 30 is encoded by encoder 36, such as into an MPEG format and a controller 38 is configured for selecting aspects of the encoding as well as other system attributes, such as when the camera should be activated, controlling positioning, framing rates, image resolution, and so forth. A near-field magnetic communication (NFM) module is shown for wirelessly communicating streaming data and control signals to the remote location of the passenger, although less preferably RF signaling may be utilized, or even a wired communication linkage.

[0406] It has been seen that moving map displays may be adapted for use with the present camera system, while other forms of systems may also display the information. Laptop computers, or other electronic equipment, may be adapted for communicating with and controlling the camera. For example an adapter in the vehicle (which communicates with the camera in any manner—wired or wireless) is configured with an interface, preferably a wireless interface, that communicates with a laptop computer, PDA, display equipped phone or other item or can wireless having display capability. It should also be appreciated that the present system may be configured as an adapter for a moving map utilized with an base module which communicates with the camera

[0407] A power supply 42 is shown for regulating power from the vehicle and distributing it to the camera system 16. Energy storage devices are preferably coupled to the power supply, such as capacitors, ultracapacitors, dual-layer capacitors, batteries, and so forth for smoothing power fluctuations and to supply power in case of intermittent connections. Alternatively, an energy storage device may be utilized that only intermittently receives power, such as a battery that charges when mount 14 is retracted, a small fuel cell, or an indicative system that receives power remotely—such as from the NFM system, primary batteries, or other power sources.

[0408] An illumination source 44 is shown with optional flasher 46, which may be integrated with the camera system, or implemented separately from the present camera system with supplied power or self contained power source.

[0409] A vehicle display system 48 is shown which typically would comprise a moving map system, entertainment system, communication system, or combinations thereof. The camera system of invention is configured to interface to conventional vehicle display systems to allow viewing images from the camera. By way of example the vehicle display system in this case is considered a moving map display wherein a display unit 50 (i.e. in-dash, heads-up, ocular, etc.) is coupled to a controller 52 (i.e. CPU and peripherals) which executes commands and operates on data from a memory 54, which preferably contains mapping files and the like as well. A positioning element, such as a global positioning unit (GPS) and/or inertial navigation system (INS), is coupled to the control unit for controlling the center of the displayed map. A user interface allows the user to control aspects of system operation. A source selector 60 allows the unit to interface to auxiliary equipment, such as a DVD player 62. The source selector is also coupled to a near-field magnetic communication module 64 configured for communicating with camera assembly 16.

[0410] Programming on the vehicle display system allows the user to control the use of camera 16, the following features being described by way of example and not of limitation.

[0411] Extend mount

[0412] Select height—if mount is adjustable select its height (i.e. Hi/Lo)

[0413] Select view—rotation and/or azimuth, selecting from multiple camera sources.

[0414] Select sentry mode—camera rotates, or otherwise follows surveillance pattern.

[0415] Select camera feed—display images from selected camera.

[0416] Select image mode—PinP, split, background, etc.

[0417] Image processing—encoding images to a select size, quality, and/or rate, etc.

[0418] Image processing—image feature extraction mode, etc.

[0419] Image processing—event generation

[0420] (i.e. numerous brake lights detected=caution event)

[0421] Image processing—issue warning in response to braking, view changes, etc.

[0422] Image storage—log images on impacts, possible theft activity, etc.

[0423] Remote access—stream communicated externally, i.e. to cell phone/ PDA.

[0424] Image Mode.

[0425] Image mode determines how the image is displayed, such as how it shares the display screen with other information and/or images. For example picture in picture

modes, tiling, overlays, move to foreground in response to event, change size in response to event (i.e. brake lights detected ahead).

[0426] Image Feature Extraction.

[0427] A full color video stream is full of unimportant details. The signal processing within the system or an attached vehicle display system can be configured according to the invention for extracting valuable information from the images and repressing less important vehicle information. For example edge detection algorithms may be utilized for displaying vehicles and/or the roadway as sets of outline images, wherein the image may be more readily discerned by the motorist, and can be more easily displayed in the background in relation to other information—such as textual information displayed in the center of the one or more outlines.

[0428] Image Event Generation.

[0429] Image processing can be performed on the image stream to detect conditions that the motorist should be warned of, for example braking ahead, cars swerving, vehicles merging, traffic slowing, and so forth. In response to detecting these events the system in the vehicle is preferably configured to generate visual and/or audio annunciations to alert the motorist.

[0430] Other events can include detecting possible intruders when the system is configured in a burglar alarm mode. For example the camera is activated by the alarm system and remains stationary or rotates to collect images from all surrounding directions, while collecting a series of images. The images may be processed to detect unusual and possibly dangerous conditions, such as parties venturing too close to the vehicle, attempting to access vehicle, and so forth.

[0431] Image Storage and Communication.

[0432] Images and/or image streams may be stored within the vehicle display system or attached subsystem to increase the utility of the collected information. The image stream from the camera, or cameras, is preferably buffered for a period of time in a circular buffer, such as 3 minutes, or other convenient time period. If no events arise, then after three minutes the old data is being rewritten. However, in response to an event, such a crash being detected, all or a portion of the buffer may be saved to a memory log. The data from the memory log may be communicated at any time to remote devices, such as a cell phone, PDA, security monitoring device/company, and so forth.

[0433] 8 Scrollster—Light and Audio Enhancements.

[0434] 8.1 References.

[0435] Incorporated herein by reference is patent application Ser. No. 10/008,662 filed Nov. 3, 2001; provisional patent application 60/246,120 filed Nov. 6, 2000; provisional patent application 60/246,119 filed Nov. 6, 2000.

[0436] 8.2 Introduction.

[0437] The invention describes additional aspects of a scrolling display unit, as described in patent application Ser. No. 10/008,662 incorporated herein. These aspects are particularly well suited when utilizing an embodiment of the scrolling poster device for advertising, although it has numerous applications.

[0438] 8.3 Projective Light Sources.

[0439] One or more of the activity lights within the system may be implemented with a projective light source. By way of example and not limitation, a laser light is sufficiently bright to be seen through most generally opaque material and will shine a beam of light through transparent and semi-transparent areas, and cutouts in the material, which provides a dramatic effect.

[0440] Further the direction of the laser light may be modulated, such as by using a motion stage or reflecting the light from a moving mirror surface, for instance a rotating mirror spindle. By synchronizing the light with the transparent portions of the screen the laser can shine through any desired portions.

[0441] In addition, the projective light source can be configured as a projector that is coupled to a computer with database of video and/or still images. The images can be projected at fixed or variable locations within the area, such as at the floor, ceiling, walls, or other structures within the vicinity.

[0442] Furthermore, a holographic light source may be utilized to display a three-dimensional image, or video stream in space, typically the result of using two lasers projecting through imaging reticules although any convenient techniques may be selected for projecting the holographic source from the scrolling display unit.

[0443] The technology for generating laser beams, and holographic images is known in the art and need not be described herein.

[0444] 8.4 Directed Audio Annunciators.

[0445] Audio annunciation of the unit optionally incorporates a directional array of ultrasonic transducers wherein the sound can be directed to a given point, or points, in space about the unit. At least two ultrasonic transducers (about 100 kHz) are configured for directing audio output which overlaps at a point in space. The audio to be heard by passersby is encoded into at least one of the ultrasonic outputs, wherein the beat frequency between the two ultrasonic transducers is the audio which is heard by the user. Ultrasonic sound energy is very directional, wherein the sound is only heard where the beams overlap and the beat frequency is heard in the human audio range. The technology for generating directed audio annunciations is known in the art and need not be described herein.

[0446] 8.5 Combined Projective Light and Directed Audio Annunciators.

[0447] By combining the directed audio annunciation with a projective light source, the unit can attract attention by a combination of light and sound which is directed at locations (single fixed spot, multiple fixed spot, moving spot(s)) about the exterior of the housing. For example directing a beam, in any desired pattern, on the floor and directing the audio to a location above that laser pattern wherein passersby get the message when standing on the laser image. The sound can be directed to the location near or even within the holographic image. This aspect of the invention is well suited for use in shopping malls, or other locations where people gather or travel through.

[0448] 8.6 Combining Vicinity Sensing with Projective Light and/or Directed Audio Annunciators.

[0449] Sensors can be coupled to the control circuit wherein the projective light and/or audio annunciation is directed to locations in response to motion information registered by the vicinity sensing means.

[0450] By way of example, the sensors may comprise motion detection sensors such as pyroelectric sensors, and other infrared sensors. The sensors may be responsive to backscatter, such as from an ultraviolet source wherein persons are detected.

[0451] 8.7 Combining Cameras with Projective Light and/or Directed Audio Annunciators.

[0452] A camera can be coupled to the control circuit wherein the projective light and/or audio is directed at one or more specific individuals whose positions are registered by the camera. Furthermore, the camera can be coupled to a signal processing means, such as a microprocessor, for determining appearance characteristics of an individual or group, wherein the directed audio can address those characteristics to better grab their attention.

[0453] For example, as part of focused advertising a mall display unit with camera may process images of patrons walking through the mall and responsively generate selected visual and/or audio messages. The following are provided by way of example only, it will be appreciated that numerous campaign alternatives can be supported with the present invention. (1) Patron is walking with small child—an audio message can be directed to them about a sale on children's clothing at Macy's™, visual accompaniment can be generated as well, such as images of items on sale. (2) A group of teenagers wearing a certain style of dress are detected—the system generates images of a rock group in that genre and advertises a record store, clothing store, body piercing or other product fitting in with that image. (3) A business-man walks by wearing a suit and toting a briefcase—the system can generate in response an ad for similar clothing, executive items, electronics, or books which might be of interest.

[0454] Furthermore, to garner attention the audio portion, or graphics displayed may mirror the individual or group. In the example of the businessman the system may call out to him "That's a nice blue tie with the grey suit; you should check out the new ties at Nordstrom's, . . . from Italy with an Egyptian cotton blend (display images)". On registering the group of young people dressed with a certain style, the system generates images that fit in with that style and therefore gets their attention, wherein they may be informed about items which may be of interest.

[0455] 8.8 Combining Audio Registration with Projective Light and/or Directed Audio Annunciators.

[0456] Audio may be registered by the system for triggering audio, video, and/or projected light annunciators. In a simple implementation the presence of audio above a given threshold can be utilized for triggering audio, video, and/or projected light annunciation such as advertising, warnings, alerts, and the like. Registration of audio may also comprise the detection of audio position, and other metrics of the audio, such as movement of the audio, determination of audio character (i.e. conversational voice tone, voice of a child, gender, angry voice, anxious voice), or even detailed

information generated from a speech recognition system that determines what is being said to increase the selectivity of the projected light and/or directed audio annunciations.

[0457] 8.9 Auto-Response with Directed Audio Annunciators.

[0458] Directed audio output may be generated in response to registered audio that is translated to speech and parsed into intelligible pseudo-queries. For example an individual in the mall voices the question "Where can I find the toys?". The system registers the audio if it is within the audible range of the system and converts it to text, wherein it parses the text to understand that they are searching for Toys. The database is searched for information on stores selling toys. The system then orients (or selects appropriate transducers) to direct an audio response to the person voicing the pseudo-query, wherein they can continue their shopping. Additionally, the system can generate directions, such as projecting pointing arrows, images, or voiced directions. This aspect of the invention may be utilized in close (single user) proximity without the directed audio (which is only heard near the overlap of the ultrasonic beams).

[0459] 8.10 Example Embodiments of Environmentally Responsive Advertising.

[0460] FIG. 47 exemplifies a display system 10, such as a scrolling display, which is configured with environmentally responsive features as described above. The display housing 12 is configured with a display 14 on which advertising 16 (or other information) may be displayed, which is preferably active (i.e. capable of changing images, animation, video, scrolling to new scenes, flipping scene, and/or otherwise changing appearance and/or message). For generating localized audio, or registering audio position, an audio bar 18 is shown which preferably extends past the housing 12 to increase the angular displacement between audio generators, or sensors. Audio 22a, 22b is shown being generated by at least two ultrasonic transducers for convergence at the head of the person(s) 24 whose position (and optionally direction, and characteristics) are registered by a position registration means 26 by the display unit. Position registration means is depicted as detection mat 26, although it may additionally, or optionally comprise audio position detection, proximity sensors, optical sensors, cameras, and so forth.

[0461] Advertising display 14 preferably incorporates optical projection means 28, 30, such as an image projection system for projecting light beams 32, and/or images 34 directed near the person(s) that walk by the unit. Other forms of projective light output may be utilized such as a laser 36 with beam 38, which preferably can form a trace in response to articulating laser 36 direction within housing 12.

[0462] FIG. 48 is a block diagram of a display system 50 according to this aspect of the invention. The operation of the unit is determined by a controller, exemplified as CPU 52 shown in combination with memory 54 for retaining programming, databases, and operating data. Sections of the memory 54 are depicted as providing an audio database (i.e. sounds, music, voice strings, speech recognition parameters, etc.), an image and video database (i.e. advertising images, video clips, sound-video synchronization data, projection control data, etc.), response actions for determining what is to be output in response to inputs, such as user position and characteristics of users, display control routines for controlling all displays and outputs of the unit.

[0463] A number of inputs are shown to the unit, although it should be appreciated that these may be utilized either separately or in various combinations thereof. A simple position detector sensor 56 (i.e. foot triggered switch, proximity sensor, or other convenient form of sensing) is shown which can provide simple position data. A number of these position sensors allows the unit to simultaneously or alternatively project audio and/or light/video in response to multiple detections of persons. An audio detection module 58 is shown for detecting location of individuals without the need of remote (wired or wireless) sensors. Additionally the audio detection subsystem 58 is shown with multiple audio transducer inputs 60a-60z (microphones) wherein the location and characteristics of the motion can be better determined. Audio processing is exemplified with digital signal processing (DSP) 62 and speech recognition (SR) 64, which may provide additional information about the parties traversing near the unit, such as keywords and the like.

[0464] A camera 66 is depicted for registering the position of persons, along with any desired additional information as extracted by image cognition module 68, such as group composition, age, mode of dress, styles, and other characteristics that may be determined according to image recognition as known in the art.

[0465] The display unit is configured to output information to the user in one or more ways. A motor with interface 70 is shown for driving position of the display, such as scrolling, or other image manipulation. A display screen 72 may provide large screen or localized display of changeable images or video, such as when the customer approaches the unit. Lighting 74 is shown with an interface allowing the computer to control the lighting of the unit (light sensor may be utilized for registering how much light needed).

[0466] Projective output is represented by laser 76, preferably coupled to motion stage 78, wherein the location of the light may be controlled by the computer, and optionally allow vector image generation if the stage has sufficient angular speed. Another projective display is represented by an image/video projector 80, preferably whose position is controlled by stage 82 for placing an image at a desired location in relation to a person, such as a passerby, detected by the system.

[0467] Directed audio annunciation is exemplified as an audio transducer array 88, shown with fixed direction transducers at different directions 90 (sufficient transducers should be provided at proper angles to allow selecting overlap of ultrasonic outputs) and shown controlled by motion stages 92a, 92b.

[0468] FIG. 49 illustrates a general flowchart of operation of the display unit. After CPU reset, the unit begins program execution at block 100 and performs initialization as per block 102 (it is presumed that the unit contains image, video, and audio elements and data (i.e. proper poster scrolls, video segment data, image data, response data, sequence data, and so forth). The position/motion of a person(s) is detected sufficiently proximal to the unit as represented by block 104. Additional characteristics of the person or person(s) may be optionally collected, such as by audio and/or image processing, as per optional block 106. The data about the person, or person(s), is used to lookup data for output to that person or person(s) as given by block 108. Directional elements such as projective lights, lasers, projective images, sound,

directed sound, and/or other moving elements are positioned in relation to the person, or person(s), as given by optional block 110. Finally, output is generated to the person, or person(s) as given by block 112, wherein the process repeats. It will be appreciated that the sequence shown would be preferably implemented on a number of separate processor tasks, allowing the unit to process the position and movement of a number of individuals and control a number of independent outputs. It should also be appreciated that although the output is shown as a single action, it typically would comprise a sequence of operations over a period of time as the person passes by.

[0469] The unit also preferably distinguishes persons that remain nearby the unit, and so for example does not annoyingly deliver the same message to them, while it preferably directs more attention to those who pass by the unit.

[0470] 9 System for Discouraging Animal Encroachment

[0471] 9.1 References.

[0472] This invention is related to the above display apparatus invention which is incorporated herein by reference.

[0473] 9.2 Introduction.

[0474] A related invention can be created for discouraging animal encroachment, such as the presence of animals within one or more given locations. The inventive method can be practiced outside of the described scrolling display apparatus and may be incorporated within various apparatus. The method and system may be practiced in a number of different embodiments.

[0475] The use of multiple ultrasonic transducers is described for projecting a beam of audio to a human passerby and is known in the art. The utility of directing the audio has been that a message can be directed to a user while a different message is directed to another user.

[0476] The present invention utilizes the technology to project an audio beam that is above the range of human hearing for discouraging the presence of animals in a given vicinity. It will be appreciated that by constraining the beam to a localized area the intensity of the audio can be increased, while keeping the intense sound contained within a desired area and thus not disturbing animal in neighboring areas, such as the pet next door which could be driven crazy by sound generated indiscriminately. The invention may practiced in a number of alternative ways.

[0477] Fixed Location.

[0478] Multiple beams are directed to one or more fixed locations to discourage animals (i.e. dogs, cats, etc.) from moving into that location. The localized nature of the sound provides useful discouragement because as the animal moves toward a given location the annoying sound patterns become more intense, wherein the animal remains at bay. The beams can be utilized at spot locations, such as around gateways, along fence lines, planters and the like. This can be particularly useful when discouraging dogs from digging, discouraging dogs and cats from "marking" their territory and so forth. The beams can be directed to intersect over an intersecting line, such as along a fence line or similar. The beams may be placed over one another, astride, or even from opposing directions (down the barrel) overlapping in an area.

[0479] This technique can be utilized for discouraging the presence of animal about an area being monitored by an intrusion detection system, wherein the sound is intended to discourage the presence of the animal.

[0480] Down the Barrel Orientation.

[0481] The transducers may be directed at the ends of a line, wherein a line of sound is produced. This method may be practiced with the present invention, or in the application of communicating audio to humans, such as advertising or providing a warning, such as to watch their step as they approach an obstruction.

[0482] Moving Location.

[0483] The beam(s) can be directed over an area to provide a roving discouragement to animals, wherein a larger area can be covered by a smaller number of transducers. One advantage of this approach is that the intensity of the beam remains sufficiently intense to really be annoying to the creature, whether it is a dog, cat, crow, rat, or other pest, while not disturbing the neighborhood.

[0484] 9.3 Embodiments of Inventive Aspects.

[0485] FIG. 50 depicts an example 10 of utilizing the present system for discouraging animal encroachment. A top view of a suburban home 12 is shown with a property/fence line 14, a very discouraged dog 16, and a number of plantings 18.

[0486] A pair of transducers according to the present invention 20a, 20b are depicted directed toward one another wherein their ultrasonic audio output overlaps along a line 22. The dog 16 stepping near line 22 is met with very unpleasant noise that is above the human hearing range but quite obnoxious to the pooch. The noise is generated as the beat frequency between two overlapped ultrasonic signals at a frequency preferably about or above 100kHz, and modulated to produce the beat frequency. A second set of transducers 24 are mounted in parallel to create a second constraint line 26. The dog will be discouraged from venturing into the plantings or attempting to dig under the fence.

[0487] FIG. 51 depicts a schematic of 20a, 20b with an oscillator crystals 30a, 30b, such as between 80 kHz and 200 kHz, (higher frequencies may be utilized and divided down into the ultrasonic acoustic range by the waveform generator) coupled to oscillator driver 32a, 32b, whose output signal drives a waveform generator 34a, 34b which can produce any desired waveform output so that the beat frequency result can be set as very unpleasant sounds to the animals for which the device is configured (i.e. dogs, cats, crows, squirrels, rabbits, and so forth).

[0488] Double pole switches 36a, 36b are shown coupled to waveform generator 34a, 34b and a load capacitor on the oscillator, for selecting which output (A or B) for the unit is to be produced. It will be appreciated if both units generated the same frequency and waveform, then only ultrasonic sound would be available which could not be heard by either humans or animals. The switches allow changing oscillator frequency and pattern between the two units, allowing replacements to be purchased and set as either A or B units.

[0489] Amplifiers 40a, 42a and 40b, 42b, are configured in differential driver pairs for maximizing the drive potential on ultrasonic transducers 44a, 44b, such as piezoelectric transducer elements.

[0490] 10 Intrusion Detection Enhancement.

[0491] 10.1 References.

[0492] This invention is related to the display apparatus and animal intrusion apparatus described above, those aspects of the invention being incorporated herein by reference.

[0493] 10.2 Introduction.

[0494] A number of challenges arise on the use of intrusion systems. Methods of utilizing directed sound energy are described to alleviate a couple of those problems.

[0495] Alerting Humans to Alarm.

[0496] The intrusion detector is fitted with a source of directed audio from overlapping ultrasonic transducers with a beat frequency between them containing the audio. The audio preferably incorporates a voiced message, such as indicating that the individual is trespassing, or that authorities are being called and the like. It will be appreciated that the trespasser does not hear the message until they are within a given range or boundary, at which time it seems that the sound is being generated in response to their presence. In fact the sound beam may be generated continuously but is only heard as the individual reaches close to the vicinity wherein they are trespassing. The system has the advantage that it cannot be heard by neighbors keeping the distraction factor to a minimum.

[0497] Detecting Pets.

[0498] Detecting human intruders while discerning non-human activity, such as pets, is often challenging. Typically, the sensitivity of the system to human intrusion is compromised in the process. The present methods allow for enhancing the operation of detection systems.

[0499] Animals are very sensitive to sounds and a sudden loud sound sends animals scurrying. In this aspect of the invention, directed audio sound, as described above for the system for discouraging animals, can be generated by the intrusion system in response to detecting motion in the detection field. This audio is generated as a very annoying sound that is outside of the range of human hearing, wherein animals will dash away or otherwise change their pattern of motion, while human motion will not be disturbed.

[0500] In this way the intrusion detection system can generate the animal discouragement audio to the localized area, or even directed at the exact location where the intrusion is detected, and if a change in the movement pattern is detected the intrusion can be considered that of an animal. This has advantages over generating continuous sound to discourage animals as their startle reflex can be triggered.

[0501] 11 Scrolling Exit Signage.

[0502] 11.1 References.

[0503] Incorporated herein by reference is patent application entitled "KeyboardRAST070103" Ser. No. 10/612,777 filed Jul. 1, 2003; provisional patent application Ser. No. 60/394,160 filed Jul. 1, 2002 which each describe visually cueing individuals to destinations.

[0504] 11.2 Introduction.

[0505] The technology of visual cueing is applied to directing persons toward the exits, or specific services within a building. It will be appreciated that in a large building the emergency exit may be difficult to locate, especially if associated with stairwells that are normally locked and not utilized. The present invention provides a low cost moving display capable of directing parties to an exit. In addition the visual cueing provided by the present invention may be utilized for directing parties toward other building elements, such as bathrooms, these directions may be provided constantly, automatically, or in response to user input, such as pressing a button to locate a men's or lady's bathroom.

[0506] An elongated low power display "border" (referred to as a border as it preferably has a width like a decorative display border and may be utilized as same) is fabricated for attachment to a wall or ceiling surface. The display preferably comprises a low power display such as electronic ink, OLED, or similar low power technology from which displays of substantially arbitrary length may be fabricated. The display border comprises at least one row of segmented directional indicators. The segments may be driven separately, yet are more preferably driven in a modulo-N fashion, wherein indications are being displayed simultaneously on each region of the display.

[0507] FIG. 52 depicts a safety border 10 on a wall surface (or alternatively a ceiling or floor) and configured to display direction arrows in response to emergency conditions. The safety direction border is depicted as coupled to an emergency flasher 12, light or other emergency element containing a drive circuit for the border. The border may be fabricated to require minimal power from the emergency element, as it preferably utilizes electronic ink display or other form of very low power and low cost display.

[0508] The border is shown for directing building personnel to an exit 14 in the case of emergency. It should be appreciated that it may be difficult to follow the directions on the placard when one is disoriented or unaccustomed to the building layout and the location of exits, such as emergency stairwells.

[0509] In response to an emergency the power from emergency flasher 12 is utilized for driving a segmented drive circuit, exemplified in FIG. 53 which activates alternating arrows 16 along the length of safety border 10. The arrows are activated in a sequence that appears to move in the direction of the exit, thereby directing persons to the exit, the flashing of the arrow elements draws attention to the emergency condition as well.

[0510] This example considers a display border with eight (8) segments per section and a plurality of said sections along the length of the border. It should be appreciated that static arrows can be less preferably displayed in response to the emergency. Furthermore, a single section with multiple arrows may be displayed, or any number of segments with each segment containing any desired number of arrows. In this example the eight segments are sequentially activated within each section of the display wherein an animated direction arrow is shown pointing in the direction of the arrows. A driver circuit is connected to the display borders which upon receiving an alarm signal from the building

emergency systems, sequentially activates the display border segments wherein the animated arrow, or similar indicator, directs occupants toward the nearest exit.

[0511] FIG. 53 depicts a simple eight phase driver circuit 30, having an oscillator 32 whose digital output operates a counter 34, three bits of which drive a multiplexer 36 to couple a signal to one of eight outputs 38. The signal source is shown with optional modulator 40, whose use is described later. Each output is preferably configured to swing to a sufficient positive or negative voltage in reference ground for changing the optical state of an electronic ink arrow. For example a positive voltage applied to the electrodes between which the electronic ink spheres are sandwiched turns changes the color (and/or reflectivity) of the arrow portion so it stands out from the background of the strip. Applying a negative voltage to the electrodes resets the electronic ink back to a match with the background.

[0512] FIG. 54 depicts a set of four electrodes 16a'-16d' (instead of the eight described, for the sake of simplicity) interconnected by four drive lines 44. This represents a single plane of electrode, with the alternate plane disposed on the opposite side of the material containing the electronic ink. The alternate plane may comprise a single conductive layer containing ground 42 to which the positive and negative display signals are referenced. The conductors may be applied over and under the material of the display strip as thin, substantially transparent, conductors of nickel or other form of conductor. Alternatively, drive wires may be embedded within the strip which contact the outward facing electrodes, while the rear electrode need not be transparent. It will be appreciated that sequenced drive output may be generated in a wide variety of ways, which are known to those of ordinary skill in the art, without departing from the teachings of the present invention.

[0513] Due to the low power requirements a strip of extensive length, spanning even more than a hundred yards may be utilized. The strip can be manufactured so that it may be cut to any length with a first end, at an emergency light or similar being crimped into a connector for coupling to the drive circuit that the coupled to the power from the emergency device.

[0514] Optionally, the strip may be incorporate audio transducers, such as piezoelectric elements, wherein "audio" directions may be generated by following the direction of the moving sound. For example an oscillator 40 is activated feeding the multiplexer wherein the output along each of the eight lines could drive a low power transducer. Obviously adding audio output increases the cost, complexity, and power requirements.

[0515] The strip of the present invention may be utilized for directing individuals to other services. For example a switch panel, such as near an elevator, may have buttons associated with different needs, such as bathrooms, lunch rooms, conference room, and so forth. Wherein upon pressing a button an associated strip is activated that directs the individual from their current location to their desired destination. The strip itself may be configured to display an icon associated with the desired end point, such as bathroom or so forth. Example, a user may press a button to be directed to the men's bathroom, wherein the system activates and displays an appropriate symbol on the display border and scrolls that item toward the men's bathroom.

[0516] 12 Audio Cueing of Individuals to Destinations.

[0517] 12.1 References.

[0518] Incorporated herein by reference is the description of Scrolling Exit Signage within this application along with the patent application entitled "Keyboard RAST070103" Ser. No. 10/612,777 filed Jul. 1, 2003; provisional patent application Ser. No. 60/394,160 filed Jul. 1, 2002 which each describe visually cueing individuals to destinations.

[0519] 12.2 Introduction

[0520] Directing persons to emergency exits or to other services may be accomplished, or augmented by the use of positional audio output, such as produced by ultrasonics which overlap at a given location allowing the user to hear the beat frequency between the two (or more) ultrasonic audio sources.

[0521] 12.3 Embodiments of Aspect of Invention.

[0522] The system may utilize a plurality of transducers at different fixed angles, or at least two transducers coupled to a motion stage, or a moving reflection stage, or combinations thereof, wherein the overlapped position of the audio signals can be controlled. The system is configured to operate in either blind mode or position detection mode.

[0523] In blind mode the motion of the overlapped audio is moved at a generally fixed rate under the assumption the user is maintaining their location within the sound field for optimal hearing.

[0524] In position detection mode, the position of the person, or persons, is registered wherein the motion of the overlapped audio is controlled to maintain human audible audio for the person or persons. The position may be registered by using any convenient position sensing mechanism including but not limited to audio detectors, optical detection sensors, cameras, proximity detection sensors, floor sensors, capacitive sensors, pressure sensors, ultrasonic distance sensors, and pyroelectric detectors, and similar devices. It should be appreciated that the same or a similar transducer array may be utilized for registering the motion of the individual in response to audio signal reflections being received. For example modulating the audio output at a high rate and registering audio reflections during the off period in which the transducer array that transmitted the signal, or another transducer array, registers the response and the timing of the response in relation to the transmitted signal, thereby allowing position to be registered by a circuit or processor in relation to the signal timing.

[0525] Once a target person or group is identified, the ultrasonic transducer angle, or alternatively the selection of transducers at an appropriate angle, is selected to correspond with the position of the person or persons, preferably plus or minus an offset corresponding to their speed of travel and the time between distance measurements so that the audio heard by the person, or persons, remains relatively constant.

[0526] The audio being generated and the direction of travel of the audio path to a destination may be determined in response to direct user input, such as an input on a control panel, or indirect user input, such as audio feedback registered by the system.

[0527] FIG. 55 illustrates an example 10 of using the present system wherein a corridor 12 having a plurality of

doors or connecting corridors is shown with an individual **14** attempted to navigate to a given door or corridor. Audio unit **16** is configured to direct the party to the correct door by utilizing parametric audio emissions. The parametric audio emissions are generated at highly directional ultrasonic frequencies and are set to overlap at select distances, wherein the user hears the beat frequency between at least two emitters, within which is carried the information about which corridor or door will take them to their destination. The system may be combined with visual signage, such as described elsewhere or in patents incorporated by reference.

[0528] FIG. 56 illustrates a block diagram of the audio unit having a series of ultrasonic transducers **22a-22i** (although any number may be utilized), and controlled by driver circuit **24**. The driver is coupled to a processing unit **26** which can select audio patterns, spoken content and so forth from a message memory **28**. The determination of which output to generate may be determined by a user interface **30**, such as a panel where the user enters a desired destination. Information **32** from other systems, such as badge readers, and the like, may be received by the system toward determining the audio output of the system. The transducers **22a-22i** and driver **24** are preferably configured to operate in alternating transmit and receive modes, wherein they provide communication with a person at a given location (i.e. distance from the transmitter head in this example) and can also detect the movement of persons in response to reflected ultrasonic audio.

[0529] 13 CopyCats—PowerSave Mode Control.

[0530] 13.1 References.

[0531] Incorporates by reference copending application(s):

[0532] Utility patent application describing enhanced copy machine features Ser. No. 10/612,777 filed Jul. 1, 2003; and

[0533] Provisional patent application Ser. No. 60/394,160 filed Jul. 1, 2002.

[0534] 13.2 Background.

[0535] Since copy machines often consume a substantial amount of power, in particular large industrial machines, they typically are configured with a power-saving mode. The power saving mode may be manually activated, but then the machines are often left overnight without power saving mode being activated and excess power is wasted. To save energy companies often design the machines to automatically enter power saving mode in response to a sufficient period of inactivity. However, this option is often not well received because, the machine may enter power saving mode a number of times during the day, requiring individuals wanting to copy material to wait for often a number of minutes while the machine warms up to operating temperature.

[0536] Accordingly a system and method are need to eliminate wasted energy from operating a copy machine at full power during period of inactivity, yet to prevent entering power-saving mode at times when the machine may be utilized.

[0537] 13.3 Summary.

[0538] This aspect of the invention is configured to control the power-saving mode of a copy machine (optionally other printing devices), in response to changes in ambient lighting. It will be appreciated that when users are not copying they should turn the lights off in the copy room, in particular at night. Furthermore, many building are configured with systems that automatically turn off the majority of lights subject to inactivity.

[0539] The present invention therefore, detects when non-operational lighting conditions exist and enters power-down mode, thereby saving power and extending the life of the machine. Users are not frustrated by needing to wait for the machine to when they do need to run a copy, because the machine commences leaving power-saving mode when the copy room lights are turned on again.

[0540] The present invention is preferably also coupled with sensing the presence of an individual utilizing a machine, wherein the printer selections, such as number of copies, and other settings are not automatically reset in response to a timeout interval, if the system optically senses the person is still in the vicinity operating the copy machine. The same optical sensor can be utilized to drive both of these features. The unit is preferably configured to differentiate between unmodulated natural light and the room lighting which contains a 60 Hz flicker. Furthermore, the unit is configured to adapt to the lighting conditions at a given location, for establishing its power-saving mode threshold conditions. The system may be configured to allow the user to program the light level for power-savings.

[0541] PhotoCopy app—detects drop in light intensity in combination with a period of non-use. Preferably beeps in response to a rapid drop in light intensity (let the person know it recognized the change) prior to it actually entering power-down mode.

[0542] When rapid light intensity increase occurs, the machine can automatically revert to normal mode. This option can be set to depend on time, or circumstance. If the machine is not used within a given period of time it can revert to a power-saving mode.

[0543] 14 Printer Intermediary Output Control:

[0544] 14.1 Introduction.

[0545] A computer user often has insufficient control over what is being output as the result of a print operation, such as from a given computer application, a web browser, or a mail program. This is particularly true in the case of printing from a web browser, wherein the user wanting a hardcopy is often forced to print the whole page with all the advertisements and other unwanted information.

[0546] Although in many instances, a user can select an area of the screen for output, the content providers typically break up the content with a number of embedded elements so that an article or other content is mixed with the advertising or other elements, thereby preventing the user from capturing only the desired material.

[0547] Currently a great deal of paper is wasted along with colored inks and storage space. Users are not fully in control of on what they wish to expend paper and ink for printing.

[0548] The present invention allows the user to have final control over the printer output, and overcomes drawbacks with previous solutions.

[0549] 14.2 Summary of the Inventive Aspect.

[0550] The present aspect of the invention provides intermediate level printer control, allowing the user to select what portions are to be output from the printer. The invention is implemented as software executable on a computer configured to communicate with a printer either over a wired connection, wireless connection, or a network connection (wired or wireless). Printer I/O control (PIOC SW) according to the invention is preferably configured to operate in a combination of automatic mode and manual mode. Wherein the user configures defaults so that certain aspects of the output can be handled automatically without user intervention, yet the user is allowed to manually adapt aspects of the invention to the given circumstance.

[0551] The inventive software may be (1) embodied in an application, such as a browser; (2) extend the functionality of printer drivers, (3) be executed by, or include, screen capture functions; (4) be configured as a standalone application (or special printer driver) which takes the output from the operating system or application, and allows user control of what is actually directed to the printer. Less preferably the software can be coupled to the operating system, wherein all printer outputs are routed through the mechanism.

[0552] The PIOC SW can be configured for manipulating a printer preview of content, or an application-specific image, such as a decoded web page rendering. The following lists a number of preferred features of the invention, which may be present singly or in combinations:

[0553] Auto Ad detect (exclusion). Can detect what appear to be ads and automatically exclude those sections according to user preference settings. The user can preferably select the level of "fit" that must be achieved prior to excluding the suspected ad content. The elements are marked upon detection, and the user can elect to continue exclusion or to change exclusions prior to output.

[0554] Auto control detect (exclusion). Can detect web page controls embedded in the content, allowing those sections to be excluded from the printer output.

[0555] Auto header/footer/frame detect (exclusion). Can detect the header, footer, and frame which surrounds the content; wherein these may be automatically excluded from the output.

[0556] Auto icon detect (exclusion). PIOC SW can detect icons within the content, such as buttons, helpers and so forth, wherein these can be automatically excluded from the printer output. These may be detected easily in response to their relative link addressing.

[0557] Multiple section selection. The user can make multiple selections of areas to include or to leave out from the output. These sections may be selected as a table cell (i.e. with a single click), or by placing a selection enclosure (i.e. typically a rectangle) about the element to be specifically excluded (or included). In typical operation, elements are included unless automatic detection has marked them for exclusion. Wherein the user can act to exclude additional elements, or to re-include elements which were excluded but for which the user would like included in the printer output. This selection mechanism allows multiple selections, and the selections need not be of sequential cells. Currently, a user can only select one portion of a web page for output, but

that form of selection is of sequential cells (i.e. like holding down the shift key in a browser and pressing a cursor direction to select horizontally or vertically), which is necessarily inclusive of interspersed content, such as ads, icons, link lists, and so forth. The present invention allows the user to select precisely the desired elements and exclude any undesired elements.

[0558] Eraser Mode. The system preferably supports an eraser mode, wherein certain portions of a content element may be eliminated, (i.e. such as an offensive word, graphic element, or so forth) without the need to eliminate the entire element. All elements can be edited as a graphic (i.e. after conversion from a native format), or altered in their native format (i.e. HTML, JPEG, etc.).

[0559] Comment Mode. The user can enter comments into the content, and can select automatic insertion of content information, such as link location, date of capture, name of person capturing the information, and so forth. This feature is especially useful in conjunction when used as a blogging front end.

[0560] Layout configuration. The PIOC SW system preferably allows the user to determine how the content elements are to be laid out, and formatted. In many instances the elements remaining (not excluded from output) will be fragmented, wherein this feature allows those elements to be pulled together automatically into a space saving printer output. The user can move elements about the page and text elements rendered from a browser page or other interpreted content source can have their block aspect ratio, font, pitch, or other characteristics altered by the user for output on the printer. The sizing, quality, color composition (color, monochrome, etc), of graphic elements may be altered by the user to suit the available space and the printer in use. When full-size images are available, such as through a link from the smaller image, then the layout configurator of the PIOC SW allows the user to select the larger image to replace the smaller image, or to select a reduced size or quality depiction of the larger image for use. For example the user may want a larger image than the thumbnail, but not a full page image, wherein they elect the size and quality to which the full size image is reduced for inclusion in the output. Aspects of layout configurator may also operate automatically, such as the user may select defaults for which images to use, a maximum and minimum size for included images and so forth.

[0561] Storage of Content element. The PIOC SW preferably allows the user to save the marked up content in a final form, or as a source document with the markings (markings which select which content printed and how to be printed). In this way the user can save the content for later printing, or direct reference from the computer. Furthermore, by storing the source with markings the user can return later and change what elements are sent out from the original source content. The source content can span one or more pages, and may comprise any given website branch, or an entire website.

[0562] BLOGGING Support. The software of the invention can support blogging features, thereby simplifying content movement into a web log, such as for keeping other employees in a company up to date on the latest company related news, competition, and so forth. The system preferably supports all blogging functionality, including:

[0563] Blog title: The name of your blog.

[0564] Blog description or tagline: An optional sub-heading or description of your blog.

[0565] Entry date: The date the post was uploaded.

[0566] Entry title: The title for the post.

[0567] Entry body: content of post including text, images, links or any combination.

[0568] Time stamp or permalink: The time the post was uploaded.

[0569] Author's name: Important for multi-author blogs.

[0570] Comments: readers can leave own comments and reactions to a post.

[0571] Archives: Links to older entries.

[0572] Links: Often a list of other bloggers but can be anything.

[0573] Ads: Powered by MT, your host, etc.

[0574] The present invention, therefore, can act as both a front end and a backend to a blog, as it can be used for selecting content for entry into a user selected blog (thereby making the content printer-friendly), or for conditioning the content in a blog prior to output to a printer.

[0575] 14.3 Implementation.

[0576] It should be appreciated that the above feature elements can be implemented by one of ordinary skill in the art from the descriptions above, wherein there is no necessity to provide flowcharts, code sections, or the like to illustrate implementation details.

[0577] FIG. 57 depicts different locations within the programming of a system 10 upon which the PIOC SW of the present invention may be configured. An application layer of an operating system is shown 12 over a physical layer 14 connected to the physical hardware 16 which controls a printer 18 (either directly or through a network), and a content storage repository 20 such as a hard disk drive. An application 22, such as a web site browser, is shown being executed by the operating system 12.

[0578] The PIOC SW 24 may be embedded within, or coupled to, the application programming. It may be embedded within the operating system 26 such as an intermediate interface to the printer drivers. Example when selecting printing, the OS can call the PIOS routine (preferably only if user settings indicate the desire to do so) such as prior to the printer driver being called. A conventional printer driver 28 is shown, which may control a printer to which the PIOC output is directed. The PIOC 32 may be integrated with, or coupled to, a printer driver 30 wherein the content alteration is performed prior to printing. A special printer driver may be installed 34 which contains the PIOC and which is configured to call other printer drivers for directing output to the printer. Each of these mechanisms for implementing the present invention may be configured for saving marked-up content or altered content to a storage repository 20 such as on a resident disk, non-local storage, or for sending the content via a network.

[0579] FIG. 58 depicts an example block diagram of PIOC SW 50 according to the present invention. A modification processing engine 52 is configured to operate on one or more content buffers 54, preferably configured to retain both content and mark-ups of that content. A conversion routine operates for processing the marked up content into a printer-friendly version of the content which may be output to a printer 58 (either directly output or more preferably through a printer specific driver. The buffered content, preferably including markups, or the output from the conversion routine 56 (or intermediate within conversion routine as typically do not want to store a printer specific output) can be directed by a storage control routine 60 (i.e. from an OS API) for storage on a disk driver 62 or other local or remote storage device.

[0580] An optional automatic modification routine 64 is shown coupled to modification engine 52, wherein it can automatically perform content markups, and/or deletions, preferably in response to user parameters 66 established for controlling how the content is to be automatically modified.

[0581] A user interface 68 is provided for allowing the user to manually intervene in the content alterations, as described above. A set of user configuration parameters 70 are preferably included to allow the user to set default behaviors on how the user interface is to modify the content in content buffer 54.

[0582] Automatic detection features can operate in a number of ways, or combinations. The following example presumes operation of the PIOC SW when attempting to print out web based content. The link properties of an element may be checked, wherein addresses that are not associated with the content provided, or that link with a known advertiser are identified as ad content, or other non-content related elements. In addition, the nature of the element may be determined, such as animated elements, wherein the user can have such non or poorly printable elements removed. The size and placement of the elements is also indicative of its use. For example most ads follow certain size criterion, and placement from one web page to another on a given site is generally standardized. In this case the PIOC SW checks other pages of content and determines common elements, and may refer to information stored previously, about the layout of the content.

[0583] Manual features can be implemented with similar user interfaces and with similar programming as utilized in web content editing programs, photo-editing packages, word processors, video editing packages, and so forth. It will be appreciated that the aspects of the invention may be implemented in countless ways, without departing from the teachings of the present invention.

[0584] FIG. 59 depicts a general flow for the PIOC SW of the invention, wherein a source of content is selected at block 80, which is buffered as per block 82 (buffering may part of PIOC SW or part of an OS or printer driver function). Upon buffering the content, any automatic modification processing is activated at block 84 to mark up content, or perform automatic selection operations such as deletions. The automatic modifications being preferably controlled according to user selections. At the direction of the user a manual modification and/or review phase is entered at block 86, allowing the PIOC software to capture user input on how to modify the buffered content. The user at any time may

have the output converted as per block 88 for output to a printer, or may save the altered content, or marked-up content, as per block 90 to a storage device. The user may perform these functions in multiple iterations if desired, as shown by the continue decision block 92, wherein they may make more modifications or return to the calling routine as per block 94.

[0585] The present invention may be referred to generally as a system and method for altering content being directed to a printer, comprising

[0586] (a) Selecting source content to operate upon.

A content source is selected, such as by selecting a link or file, being the target location of a browser, sending output toward a printer wherein it is captured by a driver containing the PIOC SW, and other methods of selection a content element.

[0587] (b) Buffering said content source in a source buffer. This provides a scratchpad within which a copy of the content source can be modified by the system.

[0588] (c) Automatically altering said content in said source buffer in response to user selected criterion. The buffered content is automatically marked up for the user according to these selections. The user can elect to show the elements in a final form or all source content with the markings wherein the user can more readily determine what content is available and what content is preferred in the output.

[0589] (d) Capturing manual interventions by said user on said content in said content source buffer. The user can override automatic selections, include or exclude other portions or select aspects of content display, formatting, layout, and so forth.

[0590] (e) Converting content designated for output, and in the designated format, for output to a printer. The conversion may convert it fully so that it may be directed to a printer (i.e. if the PIOC SW is part of a printer driver, or similar), or it may convert it to an intermediary format (which may match the original source, or other desired format) prior to being sent to a printer control application, such as a printer driver.

[0591] 15 Additions for Searching by TM:

[0592] 15.1 References.

[0593] Incorporates by reference copending application(s):

[0594] Provisional patent application entitled "WWW Searching by TM Owner" Ser. No. 60/487, 295 filed Jul. 14, 2003.

[0595] 15.2 Alternate Embodiments

[0596] Ranking of search results for the invention described may be performed by alternative methods.

[0597] Ranking by Specificity.

[0598] Ranking in response to specificity of results. For example a site dedicated to, for example "mountaineering" should be ranked higher than one which is dedicated to "mountaineering", "traveling", "sports", "bike riding" and so forth. This distinction are preferably made based on the

information from the META name tags, although the decision can also be made based on the content of the site, wherein sites with greater specificity are accorded greater weight.

[0599] Generally presumed that greater specificity increases the chance of having sufficient information to meet the desires of the user search, while definitely being easier to determine the fit since less content need be perused.

[0600] The amount of specificity can be in relation to the size of the target site instead or simply a count of matches.

[0601] Ranking by Inverse "Ranking":

[0602] Downgrade ranking of "link" sites—Many sites provide links to specific forms of content. However, during a search the user may or may not want multiple sets of link sites, but want the actual content instead. The user is preferably provided with selections that allow pushing "link sites" down or up in the rankings depending on their need.

[0603] Sites utilizing "deceptive" practices ranked lower than other sites. The rankings can include information from consumer protection organizations as a user preference, or based on the textual approaches of the site.

[0604] 16 Additions for Individualized Dosing:

[0605] 16.1 References.

[0606] Incorporates by reference copending application(s) describing temporal patient dosing Ser. No. 10/009,041 filed Nov. 8, 2001.

[0607] The iDose application describes a method and system or ordering supplements and medications over the internet or from a system, wherein the doses are fulfilled from a remote location and packaged in individualized doses. The system describes performing drug interaction checking as well as checking the stated physical conditions of the person ordering the supplements against the set of supplements being selected, wherein the system can advise the party about whether certain supplements are not suggested for their given conditions, and so forth.

[0608] 16.2 Alternate Embodiments

[0609] This adds an aspect to the iDose application, wherein information regarding the DNA of the patient (person ordering the doses of supplements and medications, or for which the doses are being prepared) is check against a database of contraindications so that it can be determined if the selected items are suitable.

[0610] It is being increasingly found that the suitability of certain medications can be determined in response to the DNA of the patient. With increasing research the suitability or unsuitability of supplements and the amount to be taken should also be traceable to characteristics of the patient's DNA, for example the production of select enzymes.

[0611] Therefore, the interaction checking of the iDose system preferably incorporates a means for capturing DNA information from the patient, such as from downloading it from a lab or physician, or otherwise making it accessible to the system. Alternatively, rather than downloading the entire sequence, known elements which are recognized in the sequence can be loaded into the database for the user.

[0612] In the case where the entire sequence of the patient is to be available, the system is configured with a DNA database which details specific relationships between DNA and the suitability, or efficacy, of the supplements, medications, and treatments in general. This additional level of checking provides a number of advantages to the user, wherein they can better select the optimum supplements and dosing levels. They can also use the information to better understand what has been prescribed by their physicians, wherein they can intelligently discuss the situation.

[0613] 17 NewEProtect—Method of Protecting Users from New EMail Viruses.

[0614] 17.1 References.

[0615] Incorporates by reference copending application(s) utility patent application “Postal Service Package Indirect” Ser. No. 10/066,495 filed Feb. 2, 2002.

[0616] 17.2 Introduction

[0617] A user can download fixes and virus definitions that will circumvent problems arising from a new virus ONCE IT IS WIDELY KNOWN AND IDENTIFIED. This however, may take days after the virus hits the network, during that time many computers can be infected. The following describes a method for protecting computers from new viruses as they arise. A series of implementation “Stages” are described which may be implemented individually or more preferably in one or more combinations.

[0618] (0) Detecting program code within emails, attachments, and multimedia.

[0619] (1) Detecting cookie and other forms of information gathering within said email.

[0620] (2) Displaying information about content for each email. (allowing users to intelligently decide on whether to open)

[0621] (3) Providing a selection wherein the user can choose to prevent previewing of emails containing selected content forms, singly or in combination. (the user can set the level of protection desired)

[0622] (4) Configuring the email reader program to allow selection of a “non-program” mode for emails, wherein all scripts, JAVA code, and so forth are unconditionally or conditionally bypassed. Allowing the user to set the mode in which they are to be protected.

[0623] (5) Providing a quarantined folder, wherein the user can elect to have all email containing selected elements, such as programming, to be held in quarantine for a period of time, such as 48 hours. During the quarantine period the user will have the opportunity to be alerted to virus threats and download new detection and correction SW. In this way the user is protected. The user can be allowed to view the non-programmatic content, such as for emails sent by a friend. One preferred implementation is to strip out all programmatic (and/or other dangerous content types) from an email place in quarantine and to place the stripped down version, appropriately marked, in the normal in-basket, wherein the user can at least read the text content and decide what level of risk they wish to take.

[0624] (6) Configuring the email reader program to receive information from the user’s ISP regarding the virus

threat level (i.e. RED, ORANGE, YELLOW, GREEN) and type. Upon user connection, and subject to periodic updates for continuous connections, the threat level is reported to the email reader program and that information can be utilized in response to user settings to control the display of email.

[0625] (7) Displaying the virus threat level within the email reader program, preferably upon activation or upon opening the screen. Information is also preferably displayed as to new virus updates available for the email reader (or a particular email reader or readers as selected by the user). The user can then elect to receive the downloads prior to opening up access to their emails.

[0626] (8) Providing a standardized virus reporting mechanism, wherein viruses detected by the user or virus detection programs are reported to the ISP. The ISPs are preferably configured to accept reports from other ISPs as to virus threats. These threats can be initially reported on occurrence and then followed up once information about the infection are confirmed. In this way ISPs can quickly get the word out on the new viruses, wherein user activation of possible virus containing emails can be limited.

[0627] The ISPs may take steps to localize the spread of the virus by not communicating target emails.

[0628] 17.3 Embodiment of the Invention.

[0629] This aspect of the invention is preferably implemented as additional programming within electronic mail programs, such as Netscape Mail, or Microsoft Outlook, and so forth. Certain aspects of the invention are also implemented to cooperate with programming executed within servers of internet service providers (ISPs), or similar service providers.

[0630] FIG. 60 is a flowchart of system operation. The user can optionally set preferences on email operations, and optionally select web site operations, in response to the prevailing threat level, as represented by block 10. The user typically would establish the preferences when first activating the program or setting up the program, and may modify it at other times thereafter. On activating the email program (or web program) the user receives a threat level value, and optionally other information regarding threats from their ISP from which email is to be downloaded, as depicted in block 12. The email program (or web program) then modifies how it processes the emails at block 14 received from the ISP in response to the threat level and/or other information regarding the state of threats and other condition information about the internet. Then the email program (or web program) can generate alerts back to the ISP at block 16 when viruses or other problems are detected, allowing the ISP to use this information along with information collected from other users on the same ISP and preferably information collected from other ISPs to determine the relative level of threat.

[0631] It will be appreciated that the above provides a closed loop mechanism for reducing the vulnerability of network users, especially the internet, to a variety of email threats or web site based threats. It should also be appreciated that the programming may be implemented by one of ordinary skill in the art based on the description above.

[0632] 18 Tools: VolumeEst—Simple Volume Estimation System.

[0633] 18.1 References.

[0634] Incorporates by reference copending application(s):

[0635] Utility patent application “DataTools” within docket “Display_RAST092303” Ser. No. 10/670,432 filed Sep. 23, 2003, and provisional application Ser. No. 60/413,199, filed Sep. 23, 2002;

[0636] Utility patent application entitled “TapeMeasure” within docket “TransportRAST070103” Ser. No. 10/612,225, filed Jul. 1, 2003 and provisional patent application Ser. No. 60/394,160 as filed Jul. 1, 2002; and

[0637] Utility patent application entitled “Secure Visual Data Communication Methods” within docket “DisplayRAST070103” Ser. No. 10/612,221 filed Jul. 1, 2003, and associated provisional patent application Ser. No. 60/394,160 filed Jul. 1, 2002.

[0638] Utility patent application entitled, docket “PSPID_02” Ser. No. 10/066,495 as filed Feb. 2, 2002, and provisional patent application Ser. No. 60/267,115 as filed Feb. 7, 2001, describing forms of electronic ink displays.

[0639] 18.2 Background.

[0640] In various trades, especially construction, it is often difficult to determine with any accuracy the volume of material needed for filling or to be removed. Often the top surface of the volume to be filled is flat, although it may comprise any shape. The problem is in estimating the amount of material needed to fill in (or be removed from) an area. For example being dug out from the earth up to a given reference line. Although the following description may largely focus on filling a volume, it is to be appreciated that the present invention relates estimating fills, removals, or other forms of volume estimating out in the field over distances spanning numerous feet, or yards. The present invention is particular well suited for use on residential and small commercial projects projects.

[0641] On large area projects it is typically necessary to survey the land and map the topography in order to properly plan construction and material needs. On small sites, however, such as pouring the foundation of a home, these techniques are not practical and they do not duly correct for the small perturbations in the underlying hardscape. Current methods do not readily provide information as to material volumes needed for filling or removal.

[0642] Therefore, a need exists for a method and system for quickly determining the volume of material to be added or removed, and optionally provides a rapid means of mapping the terrain and volume to be added or removed.

[0643] 18.3 Summary of Invention.

[0644] General Embodiment.

[0645] Volume measurements are performed by moving a vertical stick (i.e. preferable with a roller on the bottom) about the area to be filled. The position of the stick is automatically tracked at each position as it is moved about the periphery circumscribing the area and then at important

changes in depth within the area of the fill. A computer then determines volume estimates of material to be filled, or removed.

[0646] Using a Positioning System for Detecting Location.

[0647] A number of positioning systems may be utilized for determining a position of a stick within an area to be filled or removed. These system may be electronic or electromechanical.

[0648] A global positioning system (GPS), inertial navigation system, combination thereof or other positioning system configured for detecting the position of a reference within less than one foot may be utilized for making the estimates. The positioning system is coupled to (i.e. within a stick device being used as a reference), and the positions are communicated to a computer processing element for storage and later computation of volume. The position information can be generated continuously, or may be generated in response to triggers, such as a user pressing a button to register one or more measurements for the estimate.

[0649] A less expensive mechanism for determining position comprises at least two spools of line biased toward retraction of the line and which have a sensor for detecting the amount of line played out from the spool (i.e. such as registering the revolutions of the spool from a reference position). The sensor then transmits the amount played out in response to triggers, such as electrical signals, wireless signals, sound signals, or light signals. Information on depth can be determined by the stick or the angle of the lines interconnecting the spools to the stick. The collected data is then correlated to determine volume. A drawback to this technique is that the spools must be weight or otherwise sufficiently anchored so that the played out line is held taut with the stick, while obstructions can snag the played out lines when moving the stick.

[0650] A preferred method of determining position is by using at least one scanning laser whose output is modulated with a compass position heading value, or that registers the compass position at which the stick is located. In a preferred configuration the stick is configured with optical receptors that register both the height of where the laser light strikes the stick and the compass position that the stick is being held in relation to the laser emitter. The use of two such laser emitters allows the system to triangulate the position of the stick and automatically determine fill information.

[0651] Alternatively, the stick may be configured to reflect a portion of the spectrum of the impinging laser, or have an exterior surface whose reflectivity is being modulated, wherein a detector on the scanning laser can detect the direction at which the laser has struck the stick. The scanning laser can then keep the laser scanning nearby the stick position, keeping it synchronized with the stick. In addition, the laser scanner can register the compass direction to the stick and optionally, the distance to the stick. The distance can be determined by registering time of flight of the laser signal based on registering aspects of the time variant output that is reflected back to the detector in the laser scanner. One simple method is to pulse the laser output, wherein time at which the reflected energy is received is compared with the time sent to determine the time of flight. For example

transmission gates on a high speed oscillator to a counter wherein the receipt of the reflection gates off the counter. After compensation with an offset to account for processing and delay times the number of counts on the counter corresponds to the time of flight, wherein distance may be determined.

[0652] Detecting Vertical Fill Depth.

[0653] The vertical fill depth at each position may be determined in a number of alternative ways. Although the use of an INS can detect the vertical displacements of the stick to within a one inch accuracy, the desired top of the fill (as selected by a user) is preferably registered as well. A number of methods are described herein for automatically or manually having the top of the fill registered, or alternatively the depth of material at that spot to be removed, by the computer.

[0654] Manually Detecting Depth.

[0655] The user can manually indicate the top of the fill for each position to be registered, or amount at that location to be removed. By way of example this may be performed by a sliding selection input knob, or more preferably a threaded spool on the lower portion of the stick from which a line is extended to the desired "top of fill" position. A loop, or ring, in the end of the line allows the user to slip the ring onto a finger and then slide their hand to a position on the stick wherein the ring has extended the string the desired distance from the spool, the play out of the line being registered by the device. It will be appreciated that other forms of user input for registering a position on the stick may also be adopted without departing from the teachings of the present invention.

[0656] It should also be appreciated that the user may want to indicate an amount of material to be removed, wherein the user selects a removal mode on the computer, wherein the user manually selects the amount of material at each position, such as by sliding the ring with attached line to a desired number of inches below a selected reference mark on the stick. The computer then tracks the difference between the reference position and the selected position by the user as the desired depth of material to be removed.

[0657] Automatic Detection of Depth.

[0658] The system can be utilized for automatically detecting the top of the fill. In the case of a flat fill, the top can be determined by using scanning optics at one or more fixed reference positions with an optically sensitive stick configured for detecting the position on the stick at which the optical energy impinges, and transmitting information about where the laser struck the stick.

[0659] Computing the Fill/Removal Volume.

[0660] The data on stick position and depth is preferably communicated to a computer device for processing of the data. The computer may comprise a laptop computer, PDA, dedicated embedded system computer, or other computer enabled device configured to process the collected data and perform estimations of the volume. The elements in the system may communicate by any desired means, wired, wireless, audio, optical and so forth.

[0661] 18.4 Embodiment of Invention.

[0662] The following describes by way of example illustrative embodiments of the invention. A first embodiment utilizes two scanning lasers which communicated with one another, a reflective stick that registers the impinging laser and communicates the registered position as well as any manually input directions from the user (a vertical position reference, such as relative position of the ring) in reference to the laser line. The laser head is configured with a USB connection for connection to a laptop or PDA which can perform the estimations and even show graphs of the volume allowing the user to manipulate the volume to tweak it to suit their needs.

[0663] FIG. 61 depicts a scenario **10** of using the present invention for determining the volume within a dug out hole **12** having irregular bottom surface **14**. An individual holds a vertical registration stick **16** configured for the present invention. Two laser based scanners **18**, **20** are shown interconnected by a communication link **22** (preferably a wired communication link), with one scanner shown coupled to a portable computer device, shown as a laptop computer **24**, by another communication link **26**. The laptop display is shown optionally displaying textual and graphical information collected by system **10**.

[0664] FIG. 62 illustrates an example embodiment of a laser scanning head **18** shown configured for registering reflections from the vertical registration stick **16**, as well as receiving wireless transmissions from stick **16** such as RF, or alternatively near field magnetic communication (NFM), optical communications, and other communication link forms.

[0665] A controller **30** in conjunction with memory **31** is shown for coordinating the information collection. A rotating laser head **32** is shown with a laser transmitter **34** and laser detector **36**, the rotation being preferably driven by motor **38** and motor drive controller **40**. More preferably a rotating mirror element is utilized for directing optical output and input from a stationary laser and optical detector. The position of the laser output is registered by an encoder **42**. Preferably the encoded direction can be correlated with output from a compass sensor **44** allowing the system to use actual compass direction information. Optical signals received by the optical detector are processed in a circuit **46** which contains programming or circuits for determining the position **48** of stick **16** in relation to encoder position, and the distance **50** from the laser transmitter to stick **16**. The distance can be determined from a time of flight measurement, such as generated by a modulation source **52** which modulates the laser output and allows comparing the timing of the reflected energy with the timing of the laser output.

[0666] Information as to where the laser beam strikes stick **16** is received from the stick by an RF receiver **54**, although the signal may be alternately received optically, as near-field magnetic communication, or other communication mechanism. Controller **30** is configured to communicate with a slave laser transmitter/receiver through a slave port **56** (wired, or wireless). A communication interface **58**, such as USB, firewire, or other, is preferably provided for coupling the device to a laptop, PDA, or other computation device which is preferably configured to allow displaying (and storage) of collected information and optionally graphical representations of the information collected at the site.

[0667] The device preferably has a simple user interface **60** which allows the unit to be controlled without the need of an external computational device, although with less available output options. The system is preferably configured with sufficient memory to retain information about the volume measuring session, wherein the information may be later processed on a personal computer. Specialized software applications can operate on the remote computer for performing an assortment of data cataloging, data analysis, data representation and data storage.

[0668] A means for registering the location of an impinging optical beam provides for determining the height on the stick at which the optical beam strikes stick **16**. From this reference position the user can also input one or more offsets, such as indicating how much material is to be removed at the location, or added, these being in reference to the base (where the stick touches the ground) or the position at which the optical beam strikes stick **16**. This means for registering where the beam strikes stick **16** may be implemented in a number of alternative techniques and embodiments, only a few which are described by way of example.

[0669] **FIG. 63** depicts utilizing an array of optical detectors spanning the length of stick **16**. However, this approach as implemented currently with discrete detectors and circuits spanning the length of the stick is presently somewhat costly if high accuracy is desired, due to the expense in integrated and interconnected a large number of detectors, in particular for a stick having a significant length. A string of photo detectors **61** is shown that senses the impinging beam and is coupled to a latch **62** (which may include amplification, thresholding and filtering prior to latching a digital signal representing presence or absence of signal) feeding a parallel-to-serial shift register **63**, wherein the data can be read by a single serial line into the computer. Preferably, the impinging laser beam is modulated at a rate that can be detected by the circuit which reads the detectors at sufficiently frequency to detect the modulation, wherein any other impinging light sources may be ignored. If desired, each latch can be extended to latch multiple bits wherein any number of bits of information is generated (i.e. logarithmic, linear, or other scaling) in relation to the intensity of the light being detected, wherein groups of bits are shifted in the shift register for each detector position. This mechanism would also allow the system to distinguish from multiple light sources.

[0670] If the detector is implemented as an elongated strip as in **FIG. 63**, then it is preferable manufactured using organic polymer circuit techniques, which can be practiced by printing the layers of the circuits, such as in an ink-jet printer using special inks. The technique is well suited because a simple photocell can be produced using a simple P-N junction, and the other circuit elements like the shift register have a low gate count and are simple to manufacture in an organic form. This mode of manufacture can significantly reduce the cost of elongated circuits of this nature making such an arrangement very practical. For example having a photodiode area in the polymer that is coupled with a latch and a shift register circuit distributed across the set of photodiodes, wherein optical information is collected into the latch at a given time, then shifted out of the array bit by bit to a processing element, preferably a microprocessor. An elongated detector fabricated in this manner is flexible and

can be rolled up for sale or distribution in a number of other applications that require sensing a position along a path.

[0671] Typical stick length is anticipated to be from four feet to eight feet, although other sizes may be utilized depending on application. Furthermore the stick may be preferably configured to telescope, or otherwise be extendable.

[0672] **FIG. 64** depicts an embodiment of the elements within measurement stick **16**, and said means for registering the location of the impinging light. An optical detector, or more preferably a linear optical detector array **66** is shown coupled to an actuator that allows the position of the optical detector to be moved along the length of the stick until it intercepts the light being received from the laser transmission. The actuator is shown comprising a first reel **68** coupled to a drive motor **70**, and a tensioning reel **72** that may be biased toward retaining tension in the cable by spring **74**. Optical detector **66** is attached to a cable, or more preferably a ribbon **76** passing between the reels. The tensioner may also comprise the use of a compliant ribbon or a biasing device placed on the ribbon. In operation, the optical detector "hunts" for the laser light as the CPU **78** moves the motor and checks for response from the optical detector **66**.

[0673] Output from optical detector **66** may be coupled to CPU **78** through ribbon **78** which preferably is configured to supply power to the detector array, wherein the one reel is coupled to a positive voltage and the other reel coupled to a ground, and in which ribbon **76** has a first and second half separated by the detector circuit board and in insulator **78**. Signals from the detector array may be alternatively communicated using encoded audio output (which is helpful to the user in that they get audio feedback on the hunt and centering of the detector, or detector array), transponders, RF output, inductive communication, or any other convenient communication.

[0674] It is preferred that a detector be configured as an array of multiple detector elements (i.e. preferably 3-7 detector elements) wherein precise positioning in the center of the field for the optical detector yields highly accurate results while the beam is less likely to become "lost" and require reacquisition of the laser beam. The CPU software controls motor **70** to alter the positioning of detector **66** until it gets responses from the detector that it is being impinged by the laser output, wherein it centers the optical detector on the received laser beam, and registers the position of the detector in response to the motion of the motor (i.e. number of steps taken from a calibrated position detected by switch **80**) wherein the position data is output by an RF transmitter **82**. Any other convenient form of modulating detector position may be utilized without departing from the teachings of the invention.

[0675] It should be appreciated that the above mechanism, shown in **FIG. 64**, can be made much less expensive by providing a manual selector that the user positions to match the location of where the laser strikes stick **16**. For example, the detector in **FIG. 64** is replaced with a ring or other selector input means by which the user slides to match the point of light impingement. Wherein the motor can be replaced with sensor which registers the rotations of the spools to provide information for determining the position of the slider. Furthermore, a single spool, such as spool **68**, can be utilized if it is biased toward a retracted position.

[0676] Furthermore, more than one slider input can be utilized. For example, a first slider for marking where the laser is striking the stick and a second slider for indicating a relative position, such as the top of the fill, or the amount to be taken out at this location. An input, such as a button can then be activated to register the two positions. Alternatively, a single slide control can be utilized for both registering where the laser strikes and one or more relative positions, when used in conjunction with a multiple phase selector, which allows the user to designate that the current position of the slider represents. The position of the slider can be detected by registering the amount that a cord is played out from a retractable take up spool, or by any other convenient method.

[0677] The position of a user control is registered by the stick for indicating where the user wants the top of the material at that location, or to specify how much material is to be removed. Preferably a sliding element on the exterior of the stick is coupled to a switch 84 or sensor, wherein the position of the slider can be detected by moving detector assembly 66 until it strikes switch 84 and registering the position. It will be appreciated that other forms of sensing may be utilized for sensing the height at which the laser beam scan strikes the stick.

[0678] An inclinometer 86, acceleration sensor, electronic level, or other means for detecting the angular displacement of the stick from vertical is preferably incorporated. Departures from vertical are automatically corrected for in the software calculations. Additionally, or less preferably alternatively, a visual level may be utilized allowing the party to keep the stick level.

[0679] Another mechanism for detecting the height where the light strikes the stick is a fiber optic that is configured with facets which couple the impinging light onto the fiber optic and circuits which detect the position where the light entered the path based on wavelength shifting and/or timing relationships. This form of detection is described elsewhere in this application, entitled "Position Registration Apparatus and Method", which is incorporated herein by reference. In this invention, the position of light impingement or blockage is registered in relation to the side of one or more optic fibers. The optic fiber(s) is located along the side of the stick and can determine at which point the light is being received. The technique may also be utilized for registering any location selected by a user, such as in response to moving a slider, or the position of the top of their hand, and so forth, wherein information about the top of the fill or the amount of material to be removed can be easily registered.

[0680] FIG. 65 illustrates another embodiment 100 of stick 16 which provides an optically active exterior that communicates information reflectively back to the laser reflection detector. A first element 102 is configured having an exterior upon which height information is encoded by modulating the reflectivity of the exterior 104. For example, a laser beam sweeping from left to right across first element 102 will register a reflection from the exterior of element 102 that can be converted to height information. Furthermore a portion, such as a vertical strip 106, can be modulated in response to variable information, such as the height of slider 116 along slider pole 114.

[0681] The first element 102 may be a flat or curved element for reflecting light back to the laser. The reflective

encoding may comprise areas that digitally encoded with reflective paint or alternatively flat black paint. The use of mirrored surface may be utilized but however, is rather directional, making response subject to movements of stick 16.

[0682] A preferred configuration of first element 102 is as a cylinder, wherein a reflection is received by the laser from only one portion of the element at a given time. The reflections back to the laser detector are modulated without the need of laser movement. Two axes 110a, 110b are shown at ends of first element 102, and a motor housing 112 which for example may be coupled with gearing 108 to the end portion of element 102.

[0683] This rotation also can facilitate outputting information non-statically along first element 102, such as on a vertical section 106. By way of example electronic ink may cover the section 106 with at least a first buried electrode, such as a fixed potential (i.e. ground) and a second electrode 114, such as a wire, is retained proximal to the surface of the rotating element 102. In response to modulating the potential on wire 114 with a sufficient positive or negative voltage swing in reference to the electrode buried behind the electronic ink in section 106 covering the first electrode, strips can be turned on or off as element 102 rotated. Electronic ink display techniques are described in copending application docket PSPID described in the reference section above, which is incorporated herein by reference in its entirety. This allows data collected from the unit to be optically communicated back to the laser unit.

[0684] In the present example a slider 116 is shown slidably engaged on a pole 118, preferably having height markings. The position of the slider is determined by the circuits, such as using a reel with cord played out in response to the position of the slider. The circuit then modulates the voltage on wire 114 to control the optical properties of section 106, such as turning electronic ink spheres between a non-reflective black ink and a highly reflective metallic ink. It will be appreciated that the electronic ink may be utilized to convey changes in reflectivity in other ways. A set of controls 120 on the unit, shown in top, may provide a mechanism to allow the user to select when a reading is to be registered by the unit, such as the slider position and the information on position and height as registered by the laser. Optionally, user activation of a selector can alter the output on strip 106 indicating to the laser when to take a reading. It will be appreciated that variables could also be communicated easily utilizing RF instead of the electronic ink, although the first element 102 may be still be encoded with static information to indicate height.

[0685] FIG. 66-FIG. 67 depicts a simple alternative to the use of the lasers, which was briefly referred to in the summary. A reel 130 is shown configured with sensors for registering (a) the amount of line 132 extending from reel 130; (b) vertical angle (inclination/declination) at which line 132 is oriented toward stick 16; (c) horizontal angle (can be mapped to a compass direction as desired) of line 132 to the stick. It will be appreciated that using two such spools with a line attached to stick 16 (as depicted in FIG. 61 using laser beams for detecting stick position instead of line 132).

[0686] Reel 130 is shown comprising a line spool 134 with sensor 136 for detecting amount of line played out. The line is preferably of a high strength, non-stretchy material such

as Kevlar, wherein a thin strand may be utilized and accordingly a small line spool. Spool **134** is rotatable on a base **138**, the position of which is detected by an encoded plate **140** by a detector **142** to yield inclination/declination of the played-out line **132**. Base **138** attaches to a rings **144**, the lower of which has an encoded plate for determining rotational position by detector **146**. These rings pivot about axis **148** held in a reel housing, not shown.

[**0687**] Information on the direction at which the lines are played out is collected by a circuit, preferably a microcontroller. The data from both units may be utilized locally for computing stick positioning, or more preferably by an external computer device coupled to the reels, thereby reducing the cost of the reels. Preferably stick **16** in this embodiment has the strings attached to it, such as on a rotating collar, and has a means for signaling the reel units when to take a measurement. For example an audio or RF signal generated in response to the user activating a measurement selector (once the stick is in a desired position) from the stick can be received by the reel, wherein both reels take a measurement at that time. Furthermore, the signal from the stick (RF, audio, or other form) can include additional information, such as offset values indicating the depth of material to be removed, or filled.

[**0688**] Once the information is collected, such as within a PDA, laptop, or other device configured for executing programming, then a routine is executed which triangulates the position of the stick and the relative height of the stick in relation to the spools. From this information the volume to be removed or filled is determined. Furthermore, a map is preferably generated showing the regions according to the measurements taken. The software preferably allows the user to adjust curves and/or add points to the map to increase accuracy.

[**0689**] 19 Position Registration Apparatus and Method.

[**0690**] 19.1 Introduction.

[**0691**] Position is often very difficult to properly register, in particular when low cost position sensing over an elongated distance is desired (i.e. long straight or curving path). The present aspect of the invention solves that problem.

[**0692**] 19.2 Summary of the Invention.

[**0693**] The system and method utilizes a fiber optic into which light is coupled from the elongated distance being sensed. Two basic configurations are described, herein with variations. (1) A wavelength-shifting fiber is utilized to change the wavelength of the light in response to the distance over which the optical signal has traveled along the wavelength shifting portion of the optical fiber (i.e. that portion following the path over which position is to be detected). (2) A non-wavelength shifting fiber with a first a second end and in which the light is coupled in both direction onto the fiber, wherein the time differential of receipt of the signal traveling in the different directions along the fiber is used to determine where the light entered said optical fiber.

[**0694**] 19.3 Detailed Description of Embodiment.

[**0695**] **FIG. 68** illustrates a method **10** of registering where the laser beam strikes a linear sense element **12**. The sense element preferably comprises a "rainbow" fiber-optic **12** is a fiber optic which produces wavelength shift as light

passes through it. It should be appreciated that although this technique is described for the present application, it may be utilized in a number of other distance registration applications.

[**0696**] In this example a rainbow fiber is configured with a plurality of optical light coupling facets **14** on at least one side for coupling external light **16**, from a laser, down at least a first direction on the fiber optic. An optional lens element **18**, such as plastic or epoxy, is shown attached over the facet for increasing light coupling into the fiber. At least one end of the fiber is then coupled to a means for registering the light wavelength or change in wavelength (not shown). When light is (coupled) received from a known frequency source (fixed frequency or calibrated to that frequency) then the distance that the light passed through the rainbow fiber toward the detector can be determined in response to the frequency shift that arose over that distance.

[**0697**] Alternately, by collecting the light without the shift (similar appearing fiber would be shown alongside fiber **12**) and comparing to the light with the shift, the location of light impingement may be determined. A second fiber without the wavelength shifting property, but capable of coupling the light and directing it along the fiber path may be run alongside the rainbow fiber, wherein a means for registering an optical frequency detects the frequency shift that occurred and knowing the wavelength shift per unit length can determine very precisely where the light was received across both fibers. It will be appreciated that with a scanning detector, that the location of multiple impinging illumination sources can be registered as it strikes the fiber.

[**0698**] This technique may be utilized for registering position in other ways. For example, it can be used for detecting where along the fiber that light is not being received. For instance assuming that the length of the fiber is being bathed by a light source, then the position of an item which blocks the light can be registered. By placing an object, such as a finger, covering a portion of the fiber then a portion of the bandwidth being detected from the rainbow fiber will be missing. Example: presume a light source of frequency f_x is being uniformly coupled across the rainbow fiber, wherein in response to the wavelength shifting in the fiber a span of frequencies is registered f_{x-y} wherein the intensity of each frequency between x and y are equal. When the light is blocked from one spot along the rainbow fiber, then a corresponding portion of the frequencies between x and y will no longer be produced.

[**0699**] It will be appreciated that the system can detect multiple locations along the fiber length. Furthermore it will be appreciated that even white light sources, or pseudo white light sources (ambient lighting indoor or outdoor) can be utilized to illuminate the rainbow fiber, because blocking the light from one section will still alter the magnitude of the frequency constituents. The system may calibrate itself based on conditions when no light is blocked, or may register the actual composition of the light for improving detection of blockages, since it can compare the amplitudes across the spectrum with the actual spectrum.

[**0700**] Each end of the detector may be coupled to a detector or to a means for detecting a frequency difference (i.e. by generating a beat frequency equal to the difference in frequency), wherein a given location along rainbow fiber may be detected.

[0701] FIG. 69 depicts another method 30 of detecting positions along an elongated path. A fiber 32 is shown which is configured with a faceted face for collecting light from a first direction A and more preferably over a short range of directions spanning A, B, C. In this instance the impinging light is directed in both directions on the optic fiber, which does not need to be a wavelength shifting fiber. Two detectors 34, 36 are coupled to the ends of the fiber, these are shown adjacent one another for simplicity of laying out a circuit. A means is provided for detecting the time difference between the arrival of a change on one detector and the arrival at the other detector.

[0702] This may be performed in a number of alternative ways. In a highly changeable situation with varying light levels and the like, one could perform optimum processing by collecting all waveforms above a trigger level in a buffer and performing digital signal processing on significant data regions, wherein the same waveforms could be found on each branch and their relative times of arrival and thereby position of entry on the fiber may be determined in relation to the speed of light through the fiber and the distance traversed to the detector.

[0703] The present embodiment of FIG. 69 describes a simple detection mechanism which presumes simpler conditions, for example the impinging laser described in the related invention which describes a tool for registering volumes and uses a form of survey stick which registers impinging laser light.

[0704] In this embodiment output from detector 34, 36 is coupled to an thresholding device, such as Schmitt trigger circuits 38, 40, which control a start/stop counting means. A clock 42 is shown with a quartz crystal 44. In a steady state condition, with no signals arriving, the output of the clock is gated off by AND gate 46, while the RESET line is held inactive. The detectors are arranged so that an impinging light coupled into the facing fiber section D, always arrives at detector 34 before it reaches detector 36 (although by modifying the gating of the counter circuit the fiber setup need not be subject to this constraint). In response to arrival of the light, AND gate 46 is activated and high frequency pulses are passed through the gate and counted on counter 48. It will be appreciated that with a 100 mHz clock the position accuracy is roughly 2 mm. After the short delay in response the light makes it around the longer path and is detected at detector 36 triggering Schmitt trigger 40 to reset the clock output holding it constant and gating on the output of counter 48, while also generating an interrupt to a microcontroller 50 which reads the data from the counter, such as over the 16 output lines from the counter (or a serial interface). Each time the light is interrupted which is being coupled to fiber 32 the unit will take another measurement. It will be appreciated, therefore, that by modulating the output of the laser at a sufficiently long period, (long enough to allow worst case difference in path to have reached both detectors), that continuous measurements of position can be achieved even with such a simple circuit.

[0705] It will be appreciated that the above methods can be utilized in a wide variety of situations for registering positions along a path, detecting object, movement of items, and so forth. For example the fiber optic can be routed along a path in an industrial machine for registering the movement of items, which are generally located perpendicular to the

path of the optical fiber, along the fiber optic path. The system and methods described above can be utilized for detecting both the presence or absence of objects in response to received light which can be natural lighting, conventional lighting, or be specific lighting configured to illuminate the path, or across the path. The lighting may be of a visible wavelength or extend into the infrared or ultraviolet portions of the spectrum depending on the characteristics selected for the optical fibers, the detectors, and of course the light source.

[0706] 20 Portable Trailer Hitch Alignment Guide.

[0707] 20.1 Introduction

[0708] Problems with Current Mechanisms

[0709] It is often difficult to back a vehicle so that the ball on the trailer hitch properly aligns with the tongue of the trailer allowing the tongue to be lowered onto the ball to make the connection. FIG. 70 depicts a ball 10 on a vehicle hitch which is to be driver under the receptacle 14 on trailer hitch 12. Typically this process is one of trial and error, or one enlists another party to guide them as they back up. In either case the process is frustrated and prone to problems. It should be appreciated that although a "trailer" hitch is spoken of in the text, this is to mean a hitch for any towable assemblage, such as boats, wagons, carts, motorcycle carriers, airplane carriers, horse trailer, travel trailers and any other form of towable elements to which a vehicle must be aligned to couple the vehicle with the assemblage to be towed.

[0710] Many alignment devices have been created in the art in attempts to satisfy this problem. These solutions fall into four general classes.

[0711] The first class are flags which extend up, typically from both hitch portions allowing the user to see the relationship of the two items as one is backing up. unfortunately it is very difficult to perceive the depth between flags with a great deal of precision. Additionally, with many vehicles such as trucks, especially those with campers, one cannot see this area. Furthermore, these flags must be stored when not in use and rigidly mounted and extended during the backing up process.

[0712] The second class is similar to the first and provides mirrors, or similar viewing elements, wherein the user is provided a better view of the hitches. However, it should be appreciated that this view suffers from positioning limitation with trucks and with resolution difficulty due to the distance involved and the limitations on mirror size.

[0713] The third class are mechanical couplings which extend between the hitch portions to guide them together. This class typically suffers from weight and storage difficulties, as the unit must be sturdy enough to withstand forces applied by the two tons or more of vehicle whose forces may oppose the device.

[0714] The forth class of devices are electronic devices which provide visual indicators of hitch positioning which is sensed by the electronics. This class of devices appear to hold the greatest long term promise of a workable solution, however, the devices presently proposed for trailer alignment suffer from a number of limitations. A number of devices types and drawbacks are mentioned briefly in the following.

[0715] Embedding magnetic sensors in the trailer hitch ball. Requires specially manufactured hitch balls while the mass of metals at the hitch and on the vehicle and trailer tongue make measurement difficult. Furthermore, the magnetic flux can not be easily sensed at a distance and does not provide information beyond distance.

[0716] Optical positioners such as converging laser beams can provide information on the point where the trailer hitch aligns with the vehicle hitch, however, the method is only applicable to travel trailers with a high front face upon which the beams can be seen. The technique does not work well with trucks and some cars due to limited rearward visibility, and it requires that the laser devices be mounted to the vehicle at a fixed location which must be calibrated for the particular trailer, vehicle, and mounting position. Mounting of the devices requires modification of the vehicle, while the laser devices must be readily removable as they are popular with children and would be a target for theft.

[0717] Other forms of RF or optical sensing can be utilized wherein the relative positions are registered and transmitted to an optical direction indicating panel retained within the cab. One such device uses an optical bulls-eye ring surrounding the trailer hitch that registers a light emitted from a laser retained in the center of the hitch ball. It will be readily appreciated that this form of sensing can only provide guidance along the last foot and requires extremely expensive sense components and a display for the user in the cab.

[0718] One class of alignment devices allows connecting the vehicle and trailer hitches with a flexible cable the extension and direction of which is sensed and transmitted via a cable routed up to the driver containing a meter or visual display unit to depict distance and relative sideways positioning. This class of devices has been available for nearly thirty years and rely on a simple mechanical link from which distance and angle can be discerned. The class of devices is less expensive to manufacture than other forms of sensor arrangements and can provide sufficient alignment feedback. These units, however, require permanent mounting arrangements and generally significant setup prior to use, such as supplying power and routing cabling to the driver for viewing a meter or a display unit. These units require that the user back up directly in line with the trailer, wherein it is often more convenient or necessary considering the confines of parking spaces to back at an angle to the trailer. Furthermore few features are offered within this class of devices to simplify use.

[0719] It will be appreciated that an trailer hitch alignment guide is needed that is small, easy to mount, inexpensive, works with all combinations of vehicles and trailers, and that provides sufficient feedback to allow the driver to confidently and accurately back up their vehicle to the tongue of the trailer. The present invention provides a portable trailer alignment solution that is low cost and easy to manufacture and use while overcoming the drawbacks of previous solutions.

[0720] 20.2 Detailed Description of Embodiment.

[0721] The present invention provides a number of mechanisms for solving the trailer backing problem in an inexpensive easy-to-use unit. Two main embodiments are described, a first comprising an electromechanical means for

alignment and an alignment mechanism that relies upon high accuracy positioning information, such as provided by an inertial navigation (INS) device, or a GPS in coordination with an INS.

[0722] The first embodiment preferably is friction fit or magnetically attached between the trailer and vehicle hitch. For example with a cup placed over the trailer ball and a ball retained within the trailer hitch ball retainer. Or the unit magnetically attached on either end as desired. Alternatively a fastener using snap or pin release, or other removable means of attachment may be utilized. The unit preferably generates an audio and/or visual output at the rear of the vehicle facing forward. Audio output directly from the device (i.e. two sets of audio annunciations which indicate relative position and distance, such as beeps at different frequencies that vary with respect to motion, or voiced audio and so forth). Optionally the audio output may be from a separate extended cable with an audio transducer mounted away from the housing, wherein sound can be directed toward the cab. Optionally the unit can output information in the form of RF output to be picked up on the radio in the cab, wherein an audio transducer is not necessary. The information collected may also be coupled to a moving map display within the vehicle, or a PDA held by the user.

[0723] FIG. 71 depicts a simple mounting electromechanical device 16 having a first end 20, shown configured for snapping over ball 10 and a second end 22 shown for inserting within the ball receptacle 14 of the trailer hitch 12. Preferably, the portion of second end 22 which inserts into ball cup 14 may be inserted into the cup portion of first end (thereby keeping any grease that gets on end 22 trapped within the first end). A cord extends between the two ends 20, 22 which is shown as being played out from a take-up reel integrated within second end 22, although it may be configured for being attached to first end 20. The cord is preferably a thin lightweight by high strength cord such as Kevlar. The reel is configured with sensors for detecting the amount of line played out and the direction of that line. Second end 22 is configured with a directional output from which line is played out, that is set at a specific position or registers an initial position from which direction and distance information are annunciated to the driver. Incorporated herein by reference is the information describing the mechanical reel in the invention "VolumeEst—Simple Volume Estimation System Example embodiment".

[0724] A circuit with the ball converts the information on direction and amount of line played out into an annunciation to the driver, for example using RF to a remote control receiver, or visual and/or audio from an annunciator 26 placed to allow the driver to easily hear or see the information. A visual display may comprise LEDs, or more preferably an electronic ink display, while audio information can be output as to direction (angle between hitch and ball) and distance.

[0725] For example, the unit itself may emit audio, such as beeps, with a frequency depending on the direction of the cord and a beep rate depending on distance. For example low rate when at four feet apart such as 0.75 Hz and increasing as it moves closer, within one foot at 2 Hz, and reaching a solid tone with they are over one another. Angular information can be generated as shifting frequency (preferably with a fixed frequency marker generated at least

occasionally as a reference to the driver). It will be appreciated that other simple audio output may be utilized or more sophisticated voice prompts generated. The unit output can be configured to generate annunciation in relation to a fixed angle such as orientation of second end 22 within hitch 14, or in relation to the initial angle, wherein the unit reports changes from the initial configuration allowing the user to keep on the same line as initially established between the hitch and ball.

[0726] In one annunciation scheme, the device outputs RF as an FM stereo broadcast and alters the intensity of the right and left channels to alert the driver for the need to steer more in either direction, equal sounds from each indicating alignment. The beep frequency then being indicative of closeness of the ball to the hitch. When alignment is reached a special audio annunciation is preferably produced.

[0727] FIG. 72 is an example of a circuit 50 for providing the annunciations in response to angle and distance. Sensors for angle 52 and distance 54 (angle of line played out and amount of line played out) are shown coupled to a circuit, preferably a microcontroller 56 which converts the information into an annunciation by audio 60, visual output 62, or by radio-frequency communication (or NFMC near field magnetic communication) or similar output for being received remotely by a radio, walkie-talkie, PDA, GPS unit, vehicle map display or similar. Power is shown provided by battery 58 coupled through power switch 66 that is activated after coupling the first and second ends to the respective trailer hitch and vehicle sides. It should be appreciated that that line may be alternatively played out from the first end with circuits located on that side, wherein power could be supplied from a hitch electrical connection, however, that is less preferable in that the unit then needs to be configured with power adapters to suit a number of different vehicle power couplings.

[0728] 20.3 Alternate Embodiments.

[0729] Using a GPS and/or inertial positioning for aligning the trailer with the hitch. This can be implemented with dedicated devices, provided as a feature executed on programming executing on generic positioning devices, or utilizing features of a device according to this method.

[0730] With new satellite deployments and relaxed regulation by the government, GPS positioning accuracy has extended below the 10 foot range and is now in the 1-3 foot range. At the same time inertial positioning systems are dropping in cost, and can detect very small angular and positioning shifts. Similarly electronic compass circuits are quite inexpensive yet accurate.

[0731] The present aspect of the invention can utilize accurate positioning information from these devices to provide feedback to a driver for steering a vehicle so that the trailer hitch can be connected to the ball with a minimum of difficulty. Any form of positioning system may be utilized (or combinations), insofar as it provides sufficient accuracy to provide alignment of the trailer hitch. By way of example presume that an inertial positioning system is utilized in conjunction with a GPS unit, wherein positioning accuracy to within an inch is practical.

[0732] Preferably, the method of the invention is programmed as a mode of operation for the positioning unit, wherein a graphical representation of the alignment between

the trailer hitch and the ball is shown, allowing the user to readily drive the vehicle toward an aligned position so that coupling the trailer to the hitch can be performed. In general terms a vector representation of the distance and direction between hitch and ball are registered. This vector representation is then utilized as a target for intended vehicle displacement in relation to the position of the positioning unit within the view of the driver. It will be appreciated that the positioning is preferably positioned in a fixed alignment, such as in a fixed support, within the vehicle so that a fixed relation between the location of the positioning device in relation to the position of the ball is maintained.

[0733] FIG. 73 depicts a method of aligning a vehicle trailer ball, or similar, with a trailer hitch, utilizing a positioning device, said method comprising: (a) registering a first position on said trailer ball or said hitch as shown at block 102; (b) moving to a second position at the alternate element of said hitch or said trailer ball and registering a second position, as represented by block 104; (c) moving to a driving position and establishing a reference location for said positioning device aligned with the vehicle, as per block 106; (d) activating a mode in which the motion target for the vehicle is displayed in relation to the angle and direction between said vehicle trailer ball and said trailer hitch, as per block 108.

[0734] The difference between the first and second positions may be registered in relation to accelerations and motion, wherein this relative motion is then the target of the motion as registered by the positioning device when placed in the cab.

[0735] The above may be readily implemented in a number of alternative forms, for example in software within a portable GPS unit (preferably incorporating INS, if GPS accuracy is otherwise insufficient). This may also be implemented as software in a PDA (or other computing device) to which a positioning system such as GPS (INS) may be coupled.

[0736] 21 Interpretation of Specification.

[0737] The aspects, modes, embodiments, variations, and features described are considered beneficial to the embodiments described or select applications or uses; but are illustrative of the invention wherein they may be left off or substituted for without departing from the scope of the invention. Preferred elements of the invention may be referred to whose inclusion is generally optional, limited to specific applications or embodiment, or with respect to desired uses, results, cost factors and so forth which would be known to one practicing said invention or variations thereof.

[0738] Moreover, according to the various embodiments of the invention may be provided with all with all of features described herein, or only portions thereof, which combinations may be practiced and/or sold together or separately. For example, elements may be manufactured and sold without certain desired equipment for later assembly, such as for example without limitation with respect to their later assembly. In this regard, such elements may be "adapted to" include or otherwise couple to such equipment without departing from the intended scope hereof.

[0739] It should be appreciated that each aspect of the invention may generally be practiced independently, or in

combinations with elements described herein or elsewhere depending on the application and desired use. Modes may be utilized with the aspects described or similar aspects of this or other devices and/or methods. Embodiments exemplify the modes and aspects of the invention and may include any number of variations and features which may be practiced with the embodiment, separately or in various combinations with other embodiments.

[0740] Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Thus the scope of this invention should be determined by the appended claims and their legal equivalents. Therefore, it will be appreciated that the scope of the present invention fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." All structural, chemical, and functional equivalents to the elements of the above-described preferred embodiment that are known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention, for it to be encompassed by the present claims. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. 112, sixth paragraph, unless the element is expressly recited using the phrase "means for."

1. An apparatus for generating incursion alerts when objects approach the blades of a ceiling fan, comprising:

means for electrically sensing proximity of objects to one or more blades of a ceiling fan;

means for generating an electrical alert signal in response to detecting a sufficient level of proximity, or sufficient level of proximity change, as detected by said sensing means; and

means for generating an annunciation from said ceiling fan in response to said alert signal.

2. An apparatus as recited in claim 1, wherein said annunciation comprises an optical annunciator, audio annunciator, or a combination of optical and audio annunciators.

3. An apparatus as recited in claim 1, wherein said means for sensing proximity comprises a proximity sensor.

4. An apparatus as recited in claim 3, wherein said proximity sensor comprises a conductive pathway on at least one said blade of said fan, which is coupled to a sense circuit configured to generate a proximity signal in response to motion toward said fan blade.

5. An apparatus as recited in claim 4, wherein said proximity sensor is configured for sensing a change in capacitance, inductance, or electric field intensity.

6. An apparatus as recited in claim 1, wherein said means for detecting a sufficient level of proximity comprises a

threshold detection circuit configured to generate an alert signal in response to a sufficient level of absolute proximity, or a sufficient change in proximity.

7. An apparatus as recited in claim 6, further comprising a signal conditioning circuit for preparing the proximity sensor signals for said threshold detection circuit.

8. An apparatus as recited in claim 6, wherein said threshold detection circuit includes is configured to compare signals relating to absolute proximity, changes in proximity, or a combination with threshold values.

9. An apparatus as recited in claim 1, further comprising a user control coupled to said means for detecting proximity or said means for generating an annunciation to alter annunciative output in response to the setting of said user control.

10. An apparatus as recited in claim 9, wherein said user control comprises a sensitivity adjustment.

11. An apparatus as recited in claim 9, wherein said user control is configured to adjust the intensity of an optical annunciation, the volume of an audio volume adjustment, or a combination.

12. An apparatus as recited in claim 1, wherein said means for generating an annunciation comprises an audio signal source coupled to an audio transducer, configured for generating audible alerts.

13. A ceiling fan with blade incursion sensor, comprising:

at least one plurality of fan blades coupled to a hub;

a fan motor coupled for rotating said hub;

a motor controller circuit electrically coupled to said motor and configured for controlling the speed of said fan motor;

a proximity sensing element distributed over a portion of at least one of said ceiling fan blades;

a proximity threshold detection circuit coupled to said proximity sensing element configured to generate an alert signal in response to an absolute or relative proximity which exceeds a desired threshold; and

an annunciator coupled to said proximity detection circuit and configured for generating an audible alert, optical alert, or combination of optical and audible alert in response to receiving said alert signal.

14. A system for generating intrusion alarms in response to registered conditions, comprising:

an intrusion detector configured for registering conditions indicative of intrusion;

an alarm detection circuit within said intrusion detector for generating an alarm signal in response to a condition, or conditions, which exceed a first threshold;

wherein said alarm detection circuit is configured to generate a prequalification signal in response to conditions which exceed a second threshold but which does not exceed said first threshold, and

a controller circuit configured for coupling to at least two said intrusion detectors and configured to generate an audible and/or silent alarm in response to detecting an alarm signal from any detector, or in response to the receipt of more than one prequalification signal.

15. A system as recited in claim 14, wherein said more than one prequalification signal must be generated from different intrusion detectors as a condition for generating said alarm.

16. A system as recited in claim 15, wherein said intrusion detector comprises means for unit identification within said system, allowing said controller circuit to distinguish which intrusion detector transmitted a given prequalification signal.

17. A system as recited in claim 14, wherein said controller circuit is configured to register the receipt of said prequalification signal and to extend the applicability of the prequalification over a predetermined or variable period of time when determining if more than one prequalification signal is being received.

18-203. (canceled)

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