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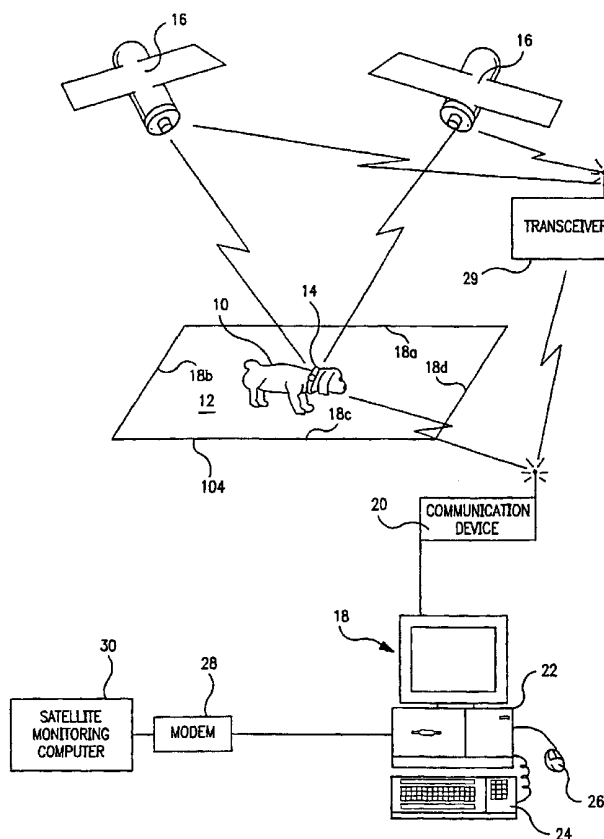
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(54) Title: **SATELLITE ANIMAL CONTAINMENT SYSTEM WITH PROGRAMMABLE BOUNDARIES**



(57) Abstract: An electronic containment system (18) using positional satellites (16) is provided for controlling the movement of animals (10) relative to a selected confinement area (104). A portable programming transceiver (29) is used to program the boundary of a selected confinement area as the device is moved along such boundary. A programmable collar transceiver (14) worn by the animal provides GPS signals from the satellite (16) to a remotely located control station (18). The control station (18) tracks the movement of the animal relative to the boundary. If the animal crosses the boundary, the station (18) transmits a stimulus activation signal to the collar (14) so that a corrective stimulus may be produced for the animal. Tracking and containment of objects are accomplished by providing GPS-defined, user-programmable containment areas.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

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## SATELLITE ANIMAL CONTAINMENT SYSTEM WITH PROGRAMMABLE BOUNDARIES

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### RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Application Serial No. 08/995,084, filed December 19, 1997 entitled Satellite Relay Collar and Programmable Electronic Boundary System For The Containment of Animals, incorporated herein by reference.

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### FIELD OF THE INVENTION

This invention relates generally to an electronic tracking and containment system for, but not limited to, animals and more specifically to an improved electronic containment system using positional satellites such as the GPS (Global Positioning System) in conjunction with a portable programming transceiver, a programmable collar transceiver, and a remotely located control station.

15

### BACKGROUND OF THE INVENTION

Conventional electronic animal containment systems have a subterranean transmission antenna shaped to define fixed boundaries of a confinement area. The transmission antenna transmits a unique electromagnetic signal which is received by a collar transceiver having a radio frequency receiver. The collar transceiver is typically attached to the neck of an animal and is used to stimulate that animal to, among other things, encourage or discourage certain behavior such as movement.

20

Electronic animal containment systems that can be installed with minimal disruption of the landscape and readily reconfigured to redefine the confinement area are in great demand. In the current practice, the installation of a subterranean transmission antenna requires excavation of the confinement area boundary which can entail disruption of plant root systems, damaging surrounding grass, flower beds and the like. Additionally, the installation may be hindered by obstacles such as trees, concrete walkways, and driveways.

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Beyond installation difficulties, the fixed location of the subterranean transmission antenna inhibits future alteration of the confinement area. Redefinition of the confinement area is advantageous as confinement needs change with, for example, the introduction of new animals or changes to the landscape. Moreover, at present, electronic animal containment systems are generally permanent to the location on the property in which the antenna is installed. This permanency denies its availability for use when traveling and can necessitate the purchase of an additional system upon relocation given the impracticality of excavating and salvaging an installed system.

Consequently, satellite global positioning systems which can be used to dynamically define a confinement area and also track animals are desirable for use in animal containment systems. An animal containment system based on the GPS obviates the need for the fixed subterranean antenna and eliminates the aforementioned disadvantages of the buried antenna.

## SUMMARY OF THE INVENTION

The present invention provides a satellite animal containment system that is not constrained to fixed confinement boundaries. The system provides a portable programming transceiver, or alternately a collar transceiver, each in communication with the global positioning system (GPS) for the purpose of programming one or more alterable confinement boundaries. The system may be used to program an outer perimeter boundary, such as around a yard, as well as internal exclusion zones, such as around gardens or swimming pools.

In a preferred embodiment, a portable programming transceiver receives a GPS signal representative of the transceiver's coordinates and transmits these coordinates to a remotely located control station. These coordinates are used by the control station to define a point on the boundary of a confinement area. The portable programming transceiver is moved along the perimeter of the confinement area and continually transmits additional coordinates to the control station thus contiguously defining the boundary of the confinement area. By this method the boundary is represented by any closed curve, often a simple closed curve, in addition to conventional rectilinear shapes. The area outside the boundary is designated as an

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exclusion area and the area within the boundary is designated as a permissible area, i.e. the confinement area. Optionally, additional boundaries may be defined within the established confinement area to create the inside exclusion zones through selected use of the portable programming transceiver. Further, a collar transceiver, attached to an animal, receives a separate GPS signal representative of the collar transceiver's coordinates. These coordinates are transmitted to the control station where they are compared to the definition of the confinement area. When the collar transceiver's location is determined to be too close to any boundary associated with the confinement area, a signal is transmitted by the control station to the collar transceiver which activates a stimulus generator, located in the collar transceiver, to correct the animal. The stimulus may be applied based on additional factors such as animal velocity toward a boundary as well as proximity to the boundary. Accordingly, the application of a stimulus may not be exclusively dependent on relative animal position to a boundary alone. For example, an animal that is asleep, or otherwise not moving, at a location within three feet of a boundary may not require any stimulus at all, whereas an animal moving at a rapid rate of speed toward the boundary at a location within three feet of the boundary may require an immediate stimulus to deter further movement toward the boundary.

In an alternate embodiment, the portable collar transceiver, prior to being attached to the animal, may be used in a programming mode, instead of using a separate programmable transceiver, to define the boundary of a confinement area in a manner similar to that of the portable programming transceiver. That is, when operated in a boundary programming mode, the collar transceiver receives a GPS signal representative of the transceiver's coordinates and transmits these coordinates to a remotely located control station. These coordinates are used by the control station to define a point on the boundary of the confinement area. The collar transceiver is moved along the perimeter of the confinement area, such as a yard, and continually transmits additional coordinates to the control station thus contiguously defining the boundary of the confinement area. By this method the boundary may be represented by any closed curve, often a simple closed curve, in addition to conventional rectilinear shapes. The area outside the boundary is designated as an exclusion area and the area within the boundary is designated as a permissible area,

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i.e. the confinement area. Optionally, additional inside boundaries may be defined within the established confinement area to create further inside exclusion zones, such as around a flower garden. The collar transceiver is then switched out of programming mode and into its operational mode. The collar is placed on the animal, where it functions in conjunction with the control station for the purpose of generating a stimulus when the animal approaches an exclusion area boundary.

### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the preferred embodiments of the present invention, will be better understood when read in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic diagram of the satellite animal containment system;

FIG. 2 is a flow chart of the data processing function of the satellite animal containment system of Figure 1;

FIG. 3 is a schematic diagram of the overall confinement geometry having multiple exclusion regions; and

FIG. 4 is a flow chart of the confinement area definition process of the satellite animal containment system of Figure 1.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An electronic containment system 18 is provided for tracking the movement of an animal 10, such as a dog, relative to a selected confinement area 104 such as along lines 18a, 18b, 18c, and 18d of Fig. 1. The confinement area is defined using a portable programming transceiver 29. The programming transceiver 29 receives a GPS signal from which the transceiver's coordinates can be determined. The programming transceiver computes its coordinates from the GPS signal and transmits these coordinates to the remotely located control station 18. Alternatively, the programming transceiver may function to transmit the original GPS signal, or a portion thereof, to the remotely located control station 28, which computes the coordinates of the programming transceiver. The coordinates are stored by the control station 28 to define a point on the boundary of the confinement area. Additional coordinates are generated as the programming transceiver 29 is moved

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along the boundary of the confinement area, and the additional coordinates are stored in the control station thus defining the boundary of the confinement area. The coordinates may be transmitted continually, in real time, to the remotely located control station or may be stored in the programming transceiver and subsequently downloaded to the remotely located control station.

A collar transceiver 14, attached to the animal, receives a GPS signal representative of the collar transceiver's coordinates. The collar transceiver transmits the coordinates to the control station 18 where they are compared to the programmably defined confinement area. If the control station 18 determines the collar transceiver's location to be within a predetermined distance from the boundary of the confinement area, a signal is transmitted by the control station 18 to the collar transceiver 14 which activates a stimulus generator located in the collar transceiver. A stimulus, such as an audible tone or mild shock, is delivered to the animal to correct the animal.

## PROGRAMMING OF BOUNDARIES

Referring now to Figures 1, 3, and 4, in a preferred embodiment, the programming transceiver is a portable programming transceiver 29 used to define an overall confinement geometry 100. The portable programming transceiver 29 incorporates a receiver for receiving GPS signals from a GPS source, such as positional satellites 16. The portable programming transceiver 29 computes its coordinates from the GPS signal and transmits the coordinates to a remotely located control station 18. The remotely located control station 18 defines a point on the boundary 104 of a main confinement area 108, as schematically shown in Fig. 3, corresponding to the coordinates of the portable programming transceiver 29. The portable programming transceiver 29 is moved along the boundary 104 of the confinement area 108 where the portable programming transceiver 29 continually transmits additional coordinates to the remotely located control station 18, contiguously defining the boundary 104 of confinement area 108. The external area 102 outside of boundary 104 is designated as an exclusion area, and the area within the boundary 104 of confinement area 108 is designated as a permissible area. Optionally, the portable programming transceiver

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29 may be used so that additional boundaries 110 may be defined inside the established confinement area 108 to create further inside exclusion regions 112.

For example, to begin the definition of the confinement area 108, an operator moves to a point on the main boundary 104, at step 80 of Fig. 4, and presses a  
5 "Record" button on the portable programming transceiver 29, at step 81. A GPS signal representing the portable programming transceiver's 29 coordinates is transmitted to the remotely located control station 18 via communication device 20 of the control station 18. The remotely located control station 18 stores this location in memory. The operator walks along the boundary 104 of the confinement area 108, at  
10 step 82, and the portable programming transceiver 29 continually transmits its coordinates to the remotely located control station 18 to provide a path or line of coordinates. The remotely located control station 18 stores the coordinates in memory and defines a curve corresponding to the path traversed by the operator, i.e. the boundary 104. After the boundary 104 has been traversed, the operator presses a  
15 "Stop" button on the portable programming transceiver 29, at step 83. The remotely located control station 18 stops recording the coordinates of the portable programming transceiver 29. The operator steps outside of the confinement area 108 into external area 102, at step 84, and presses an "Exclusion " button on the portable programming transceiver 29, at step 85. The remotely located control station 18  
20 defines external area 102 as an area of exclusion in which the animal is not permitted. The operator steps inside the boundary 104, at step 89, and presses a "Safe Zone" button on the portable programming transceiver 29, at step 87. The remotely located control station 18 defines the internal area 106 as a non-correction zone where the animal is permitted. In an alternate embodiment, the control station may be  
25 programmed to automatically define an area outside of the initial boundary 104 as an exclusion zone and the area inside as a permissible zone.

Optionally, at step 88, the operator may provide additional inside exclusion regions 112 located within confinement area 108. When desired, the operator walks to a selected boundary of an inside exclusion region 112, such as a rose garden,  
30 within the confinement area 108, at step 89, and presses the "Record" button, at step 90. The operator walks along the desired inside boundary 110 of the inside exclusion region 112 while the portable programming transceiver 29 continually transmits its



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coordinates to the remotely located control station 18, at step 91. The remotely located control station 18 stores the coordinates in memory and defines a curve corresponding to the path traversed by the operator, i.e. the inside exclusion boundary 110. The operator presses the "Stop" button after completing one circuit, at step 92.

5 The operator moves into the exclusion area 114, at step 93, and presses the "Exclusion" button, at step 94. The remotely located control station 18 defines the inside exclusion region 112 as an area 114 in which the animal is not permitted. Multiple inside exclusion areas 112 may be selectively defined in a similar manner.

10 In another embodiment of the present invention, a programming transceiver may be provided on or as an integral part of the programmable collar transceiver 14. The programmable collar transceiver 14 may function to configure a set of confinement boundaries 104 and, optionally, the exclusion boundary 110, when operating in a Program Mode. The programmable collar transceiver 14 includes a receiver for receiving a GPS signal. Programming of the confinement area 108 and  
15 optional inside exclusion regions 112 follows the above procedure using the portable collar transceiver 14 in the place of the portable programming transceiver 29. However, in order to minimize the weight and size of the collar, the use of the separate programming transceiver 29 may be preferred in various applications.

20 In yet another embodiment, the remotely located control station 18 may be programmed directly. In one specific example, the remotely located control station 18 includes a personal computer 22, where latitude and longitude coordinates defining the boundaries 104 of the confinement area 108 and the inner exclusion boundaries 110 of the inside exclusion regions 112 may be entered via keyboard 24, mouse 2, or other known input devices. For instance, the remotely located control station 18 may  
25 comprise a graphic display having an input for data entry that allows the overall confinement geometry 100 to be entered by drawing on the screen.

30 The remotely located control station 18 stores the confinement geometry 100, including boundaries 104 and 110, as a configuration file in either volatile or non-volatile memory. A plurality of configuration files each defining an overall confinement geometry 100 may be created and stored for use with different animals or different confinement locations. In a preferred embodiment, data configuration files are stored on non-volatile memory media, such as floppy disks, cd-roms, etc., for

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use with the collar transceiver 14 at alternate locations equipped with a remotely located control station 18. Accordingly, a first selected confinement geometry may be used for one pet, while a different confinement geometry is simultaneously used for another pet at the same time and the same location. Similarly, a first selected  
5 confinement geometry may be used when the pet is home and a second confinement geometry may be selected for use at a vacation home.

### SYSTEM OPERATION

As shown in Figure 1, an outer boundary 104 encloses an area 12, such as a yard, occupied by an animal 10, such as a dog. The animal 10 is equipped with a  
10 collar transceiver 14 which includes reception circuitry and transmission circuitry, preferably battery operated. The reception circuitry receives GPS signals from a GPS source, such as positional satellites 16, as well as update and stimulus signals from the remotely located control station 18. The transmission circuitry of the collar relays positional satellite data to the remotely located control station 18.

15 The positional satellites transmit precise positional information to the collar transceiver 14. When the distance between the collar transceiver 14 relative to three positional satellites 16 is known, the collar transceiver 14 can be located utilizing the three dimensional Pythagorean theorem. The distance from the collar transceiver 14 to the positional satellites 16 is determined by calculating the time between the GPS  
20 signal broadcast and collar transceiver 14 reception. Each positional satellite 16 signal includes a unique (PN) pseudonoise sequence so the collar transceiver 14 can differentiate between various positional satellites 16 and account for their specific orbital movement.

This positional information is relayed at a variable rate or preset rate by collar  
25 transceiver 14 at a selected radio frequency to the remotely located control station 18 via the RF communications device 20. The frequency of the signal transmitted by the collar transceiver 14 to the remotely located control station 18 can be different from the frequency of the signal received by the collar transceiver 14 from the positional satellites 16. The remotely located control station 18 determines the location and  
30 ground speed of the animal 10 equipped with the collar transceiver 14 relative to the programmed confinement area boundaries 104 and inside exclusion boundaries 110.

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Referring now to Figure 2, the collar transceiver 14 periodically relays positional GPS satellite data as received from positional satellites 16 at a variable relay rate or preset rate, via RF transmissions, to the remotely located control station 18 as shown in step 40. At step 54, the system checks whether readable, usable data is being received in which event the system progresses to step 42 or whether there is inconsistent data or a lack of data in which event the system progresses to step 56. The rate of transmission of the relay information is either preset or determined by the speed of the animal 10 as calculated by the remotely located control station 18. In the case of a preset rate, steps 44 and 48 of Fig. 2 are bypassed. In a preferred embodiment, as an animal 10 moves within the boundary 104, the system computes the animal location at step 42 relative to boundaries 104 and 110. As the animal moves, the system also determines the velocity of the animal at step 44. At step 52, the change in position or velocity of the animal is monitored to ascertain whether such change is a logical change, i.e. within normal parameters.

As the animal approaches within a predetermined distance of a programmed boundary 110 or 104, the relay rate may be adjusted accordingly, increasing, for example, from one sample per second upwards to ten samples per second. An adjust enable signal, at step 48, is transmitted by the remotely located control station 18 if the movement of animal 10 is determined to be logical by step 52. The location of the animal 10 is determined to be logical if the current location is less than a predetermined displacement from the previous location. Repeated determinations of illogical animal 10 displacements in either distance or velocity, at step 54, which are not caused by a satellite malfunction, as determined at step 58, are accumulated up to a predetermined, operator-selected threshold at step 62. Exceeding the operator selectable threshold causes, at step 66, activation of an audible or visual indication at the remotely located control station 18 informing the operator.

Similarly, if a change in animal location and speed are detected, at step 44, to be above a selected threshold and determined, at step 52, to be within the ability of the animal 10, the collar transceiver 14 receives a transmission rate adjust enable signal at step 48 from the remotely located control station 18 increasing the rate of relay to ensure accuracy of the animal 10 location determination. The speed of an animal 10 is determined to be logical if it is within the animal's 10 capability of

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movement, i.e. if the speed is less than a predetermined value. Alternatively, if the animal 10 is dormant or if a decrease in speed is detected, at step 44, the collar transceiver 14 receives a transmission rate adjustment enable signal at step 48 from the remotely located control station 18 to conserve collar transceiver 14 battery power by decreasing the rate of relay.

If the animal's change in position and velocity are determined to be normal, the remotely located control station 18 determines, at step 46, whether the animal 10 is seeking to breach a boundary from, for example, analysis of the aforementioned displacement and speed data. If the animal 10 is seeking escape, a stimulus enable signal step 50 is broadcast from the remotely located control station 18 to the collar transceiver 14. The stimulus enable signal activates the collar transceiver 14 to provide a correction stimulus, such as a mild shock or audible signal, to the animal 10. An alarm or indication at the remotely located control station 18 may be activated to alert an operator of a breach or potential egress from permissible confinement area 106.

A group of animals subject to the programmable electronic boundary system may be equipped with independently addressable collar transceivers 14 such that a unique level of stimulus may be communicated to individual animals by the remotely located control station 18. In this way, the stimulus enabled by the remotely located control station 18 is programmable to conform to the physical characteristics of each preselected animal (i.e., size, weight, etc). Similarly, the level of stimulus enabled by the remotely located control station 18 may further correspond to that animal's proximity to a programmed boundary 104 or 110. Thus, an animal that is closer to a boundary than a second animal may be subject to a greater degree of stimulus as enabled by the remotely located control station 18. Likewise, when two animals are both the same distance from the boundary, one animal, such as an aggressive dog, may receive a higher level of stimulus than another non-aggressive animal. The unique levels of stimulus for preselected animals having independently addressable collar transceivers 14, as well as variable boundary proximity stimuli, are input at the remotely located control station 18 and saved in the data configuration file.

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### DATA PROCESSING

The remotely located control station 18 is preferably a general purpose computer, such as a personal computer 22, including a microprocessor for the processing of positional satellite 16 data to determine the location of an animal 10 relative to the signals of positional satellites 16. Additionally, the remotely located control station 18 includes a data storage device for the storage of configuration files and tracking software and a communication device 20 for communication with the collar transceiver 14.

In a preferred embodiment, the remotely located control station 18 is a personal computer 22 having a communication port adapted to communicate between the personal computer 22 and collar transceiver 14 through communication device 20. Additionally, the remotely located control station 18 may communicate with an existing home automation system. Further, the personal computer 22 includes a modem 28 for connection to a satellite monitoring computer 30 which monitors the status of positional satellites 16. Upon relay of an indecipherable signal to the personal computer 22 by the collar transceiver 14 or portable programming transceiver 29, the personal computer 22 may contact the satellite monitoring computer 30 to determine the status of the positional satellites 16. If the minimum number of positional satellites 16 are not available for tracking, the satellite monitoring computer 30 disables the stimulus enable signal of the personal computer 22 and activates an alarm located at the personal computer 22 to indicate the failure of the system.

Management and communication software compatible with known operating environments such as the Windows® operating system is provided for use with the personal computer 22. The software enables the visual display of the overall confinement geometry 100 coordinates and the animal's 10 location relative to the overall confinement geometry 100. Configuration data files can be adjusted and edited utilizing the software of personal computer 22 to expand, contract or completely reconfigure the overall confinement geometry 100 or otherwise alter the parameters of the configuration data file.

The memory device of remotely located control station 18 may include volatile and non-volatile forms of computer memory. Preferably, data configuration

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files are stored in a non-volatile mass storage device such as a hard disk drive. Copies of data configuration files may be transported via portable memory media such as floppy disks, CD-ROMS, DAT'S, etc.

5 In an alternative embodiment, the functions of the remotely located control station 18 are performed by the collar transceiver 14 eliminating the need for communication device 20 and remotely located control station 18. In this embodiment the collar transceiver 14 performs all calculations. Optionally, the remotely located control station 18 may be utilized to reconfigure or back-up configuration data files stored within the collar transceiver 14 through an optional  
10 serial or parallel transceiver or IR or optical communications port of collar transceiver 14. In this embodiment the collar transceiver 14 transmits an alarm enable to the remotely located control station 18 for audible or visual indication of a collar transceiver 14 failure or satellite system failure.

15 The terms and expressions which have been employed are used as terms of description and not of limitation. There is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof. It is recognized, however, that various modifications are possible within the scope of the invention as claimed.

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THAT WHICH IS CLAIMED IS:

1. An electronic containment system comprising:

(a) at least one GPS source for producing a first transmitted signal having a first predetermined characteristic,

(b) a portable transceiver, remote from the at least one GPS source, for receiving the first transmitted signal from the at least one GPS source, the portable transceiver having,

(i) a first receiver for receiving the first transmitted signal from the at least one GPS source;

(ii) a first controller for producing a first control signal in response to the first transmitted signal received by the portable transceiver;

(iii) a first transmitter for producing a second transmitted signal having a second predetermined characteristic in response to the first control signal produced by the first controller; and

(c) a control station, remote from the portable transceiver, having a second receiver for receiving the second transmitted signal produced by the portable transceiver;

wherein, the control station receives data from the portable transceiver so that at least one containment perimeter is established.

2. The electronic containment system according to claim 1 wherein the first transmitted signal represents locational data.

3. The electronic containment system according to claim 1 wherein the first controller is a microprocessor.

4. The electronic containment system according to claim 1 wherein the first controller is an analog circuit.

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5. The electronic containment system according to claim 1 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the portable transceiver location.

5 6. The electronic containment system according to claim 1 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the ground speed at which the portable transceiver is moving.

7. The electronic containment system according to claim 1 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of an undetectable first transmitted signal.

10 8. The electronic containment system according to claim 1 wherein the second transmitted signal is a re-transmission of the first transmitted signal.

9. The electronic containment system according to claim 1 wherein the second transmitted signal is representative of a portion of the first transmitted signal.

15 10. The electronic containment system according to claim 1 wherein the second transmitted signal is representative of the portable transceiver location.

11. The electronic containment system according to claim 1 wherein the second transmitted signal is representative of the portable transceiver ground speed.

20 12. The electronic containment system according to claim 1 wherein the rate of transmission of the second transmitted signal is relative to the ground speed of the portable transceiver.

13. The electronic containment system according to claim 1 wherein the rate of transmission of the second transmitted signal is constant.



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14. The electronic containment system according to claim 1 wherein the rate of transmission of the second transmitted signal is variable.

15. The electronic containment system according to claim 8 or 9 wherein the control station computes from the second transmitted signal the location of the portable transceiver.

16. The electronic containment system according to claim 1 wherein the portable transceiver is programmable.

17. The electronic containment system according to claim 1 wherein the portable transceiver is programmed to store positional data representative of the containment perimeter.

18. The electronic containment system according to claim 15 wherein the portable transceiver uploads the stored positional data representative of the containment perimeter to the control station.

19. The electronic containment system according to claim 1 wherein the first controller produces a first control signal representative of the location of the portable transceiver relative to the containment perimeter within a predetermined level.

20. The electronic containment system according to claim 1 wherein the first controller produces a first control signal representative of both the location of the portable transceiver relative to the containment perimeter within a predetermined level and the ground speed of the portable transceiver.

21. The electronic containment system according to claim 1 wherein the second transmitted signal is representative of the portable transceiver location relative to the containment perimeter within a predetermined level.

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22. The electronic containment system according to claim 1 wherein the rate of transmission of the second transmitted signal is relative to the portable transceiver location relative to the containment perimeter within a predetermined level.

5           23. The electronic containment system according to claim 1 wherein the system produces a warning alarm, when the portable transceiver location is relative to the containment perimeter within a predetermined level.

24. The electronic containment system according to claim 21 wherein the system produces the warning alarm at a predetermined location.

10           25. The electronic containment system according to claim 1 wherein the control station is a personal computer.

26. The electronic containment system according to claim 1 wherein the control station is programmable.

15           27. The electronic containment system according to claim 1 wherein the control station is programmed to store positional data representative of the containment perimeter.

28. The electronic containment system according to claim 1 wherein the portable transceiver contains a stimulus generator for producing a stimulus.

20           29. The electronic containment system according to claim 1 wherein the portable transceiver is responsive to the first control signal for the purpose of generating a stimulus.

30. The electronic containment system according to claim 29 wherein the stimulus is an electrical shock or audible signal.

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31. The electronic containment system according to claim 1, the control station having,

- (a) a second controller for producing a second control signal in response to the second transmitted signal received by the control station; and
- (b) a second transmitter for transmitting a third transmitted signal having a third predetermined characteristic in response to the second control signal produced by the second controller.

32. The electronic containment system according to claim 31 wherein the second controller is a microprocessor.

33. The electronic containment system according to claim 31 wherein the second controller is an analog circuit.

34. The electronic containment system according to claim 31 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of an undetectable second transmitted signal.

35. The electronic containment system according to claim 31 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of the location of the portable transceiver.

36. The electronic containment system according to claim 31 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of the ground speed at which the portable transceiver is moving.

37. The electronic containment system according to claim 31 wherein the second controller produces a second control signal representative of the location of the portable transceiver relative to the containment perimeter within a predetermined level.

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38. The electronic containment system according to claim 31 wherein the second controller produces a second control signal representative of both the location of the portable transceiver relative to the containment perimeter within a predetermined level and the ground speed of the portable transceiver.

5 39. The electronic containment system according to claim 31 wherein the third transmitted signal is representative of the location of the portable transceiver relative to the containment perimeter within a predetermined level.

10 40. The electronic containment system according to claim 31 wherein the third transmitted signal is representative of both the location of the portable transceiver relative to the containment perimeter within a predetermined level and the ground speed of the portable transceiver.

41. The electronic containment system according to claim 31 wherein the portable transceiver further comprises a second receiver for receiving the third transmitted signal from the control station.

15 42. The electronic containment system according to claim 31 wherein the portable transceiver is responsive to the third transmitted signal for the purpose of generating the stimulus.

20 43. The electronic containment system according to claim 1 wherein the control station comprises a display for displaying the location of the portable transceiver.

44. The electronic containment system according to claim 43 wherein the display contains a graphical input device by which the containment perimeter is defined.

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45. The electronic containment system according to claim 1 wherein the control station comprises a nonvolatile memory for the storage of data defining the containment perimeter.

5 46. The electronic containment system according to claim 42 wherein the nonvolatile memory is portable.

47. The electronic containment system according to claim 1 wherein the portable transceiver further comprises a power source.

48. An electronic containment system according to claim 47 wherein the power source is a battery.

10 49. The electronic containment system according to claim 48 wherein the rate of transmission of the second transmitted signal conserves the battery life.

50. The electronic containment system according to claim 1 wherein the portable transceiver is hand-held.

15 51. The electronic containment system according to claim 1 wherein the portable transceiver is attached to an object to be tracked.

52. The electronic containment system according to claim 1 wherein the portable transceiver is a collar.

53. An electronic containment system comprising

- 20
- (a) at least one GPS source for producing a first transmitted signal having a first predetermined characteristic;
  - (b) a portable transceiver for programming confinement perimeters of a predetermined area, the portable transceiver having,
    - (i) a first receiver for receiving the first transmitted signal from the at least one GPS source;

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- (ii) a first controller for producing a first control signal in response to the first transmitted signal received by the portable transceiver;
  - (iii) a first transmitter for transmitting a second transmitted signal having a second predetermined characteristic in response to the first control signal produced by the first controller;
- (c) a second transceiver, remote from the portable transceiver, the second transceiver having,
  - (i) a second receiver for receiving the first transmitted signal from the at least one GPS source;
  - (ii) a second controller for producing a second control signal in response to the first transmitted signal received by the second transceiver;
  - (iii) a second transmitter for transmitting a third transmitted signal having a third predetermined characteristic in response to the second control signal produced by the second controller;
- (d) a control station, remote from the portable transceiver, the control station having,
  - (i) a third receiver for receiving the second transmitted signal produced by the portable transceiver;
  - (ii) a forth receiver for receiving the third transmitted signal produced by the second transceiver;
  - (iii) a third controller for producing a third control signal in response to the second transmitted signal and the third transmitted signal received by the control station;
  - (iv) a third transmitter for transmitting a forth transmitted signal having a forth predetermined characteristic in response to the third control signal produced by the third controller.

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54. The electronic containment system according to claim 53, the second transceiver further comprising:

- (a) a fifth receiver for receiving the forth transmitted signal from the control station; and
- (b) a stimulus generator for producing a stimulus in response to the forth transmitted signal received by the second transceiver.

55. The electronic containment system according to claim 53 wherein the first transmitted signal represents locational data.

56. The electronic containment system according to claim 53 wherein the first controller is a microprocessor.

57. The electronic containment system according to claim 53 wherein the first controller is an analog circuit.

58. The electronic containment system according to claim 53 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the portable transceiver location.

59. The electronic containment system according to claim 53 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of an undetectable first transmitted signal.

60. The electronic containment system according to claim 53 wherein the system produces a warning alarm in response to the first control signal.

61. The electronic containment system according to claim 60 wherein the system produces the warning alarm at a predetermined location.

62. The electronic containment system according to claim 53 wherein the second transmitted signal is a re-transmission of the first transmitted signal.

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63. The electronic containment system according to claim 53 wherein the second transmitted signal is representative of a portion of the first transmitted signal.

64. The electronic containment system according to claim 53 wherein the second transmitted signal is representative of the portable transceiver location.

5           65. The electronic containment system according to claim 53 wherein the control station is a personal computer.

66. The electronic containment system according to claim 53 wherein the third controller is a microprocessor.

10           67. The electronic containment system according to claim 53 wherein the third controller is an analog circuit.

68. The electronic containment system according to claim 53 wherein the third controller monitors the second transmitted signal and produces a third control signal that is representative of the portable transceiver location.

15           69. The electronic containment system according to claim 53 wherein the third controller monitors the second transmitted signal and produces a third control signal that is representative of an undetectable second transmitted signal.

70. The electronic containment system according to claim 53 wherein the control station is programmable.

20           71. The electronic containment system according to claim 53 wherein the control station can be programmed to store positional data representative of at least one containment perimeter.



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72. The electronic containment system according to claim 71 wherein the control station contains a graphical input device by which data defining at least one containment perimeter may be centered.

5 73. The electronic containment system according to claim 53 wherein at least one containment perimeter is programmed from the data sent by the portable transceiver in the second transmitted signal.

74. The electronic containment system according to claim 53 wherein the second controller is a microprocessor or an analog circuit.

10 75. The electronic containment system according to claim 53 wherein the third controller produces a third control signal representative of the second transceiver location relative to at least one containment perimeter within a predetermined level.

15 76. The electronic containment system according to claim 53 wherein the third controller produces a third control signal representative of both the location of the second transceiver relative to at least one containment perimeter within a predetermined level and the ground speed at which the second transceiver is moving.

77. The electronic containment system according to claim 53 wherein the forth transmitted signal is representative of the second transceiver location relative to at least one containment perimeter within a predetermined level.

20 78. The electronic containment system according to claim 53 wherein the forth transmitted signal is representative of both the location of the second transceiver relative to at least one containment perimeter within a predetermined level and the ground speed at which the second transceiver is moving.

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79. The electronic containment system according to claim 54 wherein the second transceiver is responsive to the forth transmitted signal for the purpose of generating the stimulus.

80. The electronic containment system according to claim 53 wherein the control station comprises a display for displaying the location of the second transceiver.

81. The electronic containment system according to claim 53 wherein the control station comprises a nonvolatile memory for the storage of data defining at least one containment perimeter.

82. The electronic containment system according to claim 81 wherein the nonvolatile memory is portable.

83. The electronic containment system according to claim 53 wherein the portable transceiver is hand-held.

84. The electronic containment system according to claim 53 wherein the portable transceiver is attached to an object to be tracked.

85. The electronic containment system according to claim 53 wherein the portable transceiver is a collar.

86. An electronic containment system for at least one animal comprising:

- (a) at least one GPS source for producing a first transmitted signal having a first predetermined characteristic;
- (b) a portable transceiver for programming at least one containment perimeter of a predetermined area, the portable transceiver having,
  - (i) a first receiver for receiving the first transmitted signal from the at least one GPS source;

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- 5
- (ii) a first controller for producing a first control signal in response to the first transmitted signal received by the portable transceiver;
  - (iii) a first transmitter for transmitting a second transmitted signal having a second predetermined characteristic in response to the first control signal produced by the first controller;
- 10
- (c) at least one transceiver, attached to at least one animal, the at least one transceiver having,
    - (i) a second receiver for receiving the first transmitted signal from the at least one GPS source;
    - (ii) a second controller for producing a second control signal in response to the first transmitted signal received by the at least one transceiver;
- 15
- (iii) a second transmitter for transmitting a third transmitted signal having a third predetermined characteristic in response to the second control signal produced by the second controller;
- 20
- (d) a control station, remote from the portable transceiver, the control station having,
    - (i) a third receiver for receiving the second transmitted signal produced by the portable transceiver;
    - (ii) a forth receiver for receiving the third transmitted signal produced by the at least one transceiver;
- 25
- (iii) a third controller for producing a third control signal in response to the second transmitted signal and the third transmitted signal received by the control station;
  - (iv) a third transmitter for transmitting a forth transmitted signal having a forth predetermined characteristic in response to the third control signal produced by the third controller.
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87. The electronic containment system for at least one animal according to claim 86, the at least one transceiver further comprising:

- (a) a fifth receiver for receiving the forth transmitted signal from the control station;
- (b) a forth controller for producing a forth control signal in response to the first transmitted signal received by the at least one transceiver; and
- (c) a stimulus generator for producing a stimulus in response to the forth control signal.

88. The electronic containment system for at least one animal according to claim 86 wherein the first transmitted signal represents locational data.

89. The electronic containment system for at least one animal according to claim 86 wherein the first controller is a microprocessor.

90. The electronic containment system for at least one animal according to claim 86 wherein the first controller is an analog circuit.

91. The electronic containment system for at least one animal according to claim 86 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the portable transceiver location.

92. The electronic containment system for at least one animal according to claim 86 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of an undetectable first transmitted signal.

93. The electronic containment system for at least one animal according to claim 86 wherein the system produces a warning alarm in response to the first control signal.

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94. The electronic containment system for at least one animal according to claim 93 wherein the system produces the warning alarm at a predetermined location.

95. The electronic containment system for at least one animal according to claim 86 wherein the second transmitted signal is representative of the portable transceiver location.

96. The electronic containment system for at least one animal according to claim 86 wherein the second transmitted signal is a retransmission of the first transmitted signal.

97. The electronic containment system for at least one animal according to claim 86 wherein the second transmitted signal is representative of a portion of the first transmitted signal.

98. The electronic containment system for at least one animal according to claim 86 wherein the control station is a personal computer.

99. The electronic containment system for at least one animal according to claim 86 wherein the third controller is a microprocessor.

100. The electronic containment system for at least one animal according to claim 86 wherein the third controller is an analog circuit.

101. The electronic containment system for at least one animal according to claim 86 wherein the third controller monitors the second transmitted signal and produces a third control signal that is representative of the portable transceiver location.

102. The electronic containment system for at least one animal according to claim 86 wherein the third controller monitors the second transmitted signal and

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produces a third control signal that is representative of an undetectable second transmitted signal.

103. The electronic containment system for at least one animal according to claim 86 wherein the control station is programmable.

5           104. The electronic containment system for at least one animal according to claim 86 wherein the control station can be programmed to store positional data representative of the at least one containment perimeter.

10           105. The electronic containment system for at least one animal according to claim 86 wherein the control station contains a graphical input device by which data defining the at least one containment perimeter may be entered.

106. The electronic containment system for at least one animal according to claim 86 wherein the at least one containment perimeter is programmed from the data sent by the portable transceiver in the second transmitted signal.

15           107. The electronic containment system for at least one animal according to claim 86 wherein the second controller is a microprocessor or an analog circuit.

108. The electronic containment system for at least one animal according to claim 86 wherein the third controller produces a third control signal representative of the at least one transceiver location relative to the at least one containment perimeter within a predetermined level.

20           109. The electronic containment system for at least one animal according to claim 86 wherein the third controller produces a third control signal representative of both the location of the at least one transceiver relative to the at least one containment perimeter within a predetermined level and the ground speed of the least one transceiver.

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110. The electronic containment system for at least one animal according to claim 86 wherein the forth transmitted signal is representative of the at least one transceiver location relative to the at least one containment perimeter within a predetermined level.

5 111. The electronic containment system for at least one animal according to claim 86 wherein the forth transmitted signal is representative of the location of the at least one transceiver relative to the at least one containment perimeter within a predetermined level and the ground speed of the at least one transceiver.

10 112. The electronic containment system for at least one animal according to claim 86 wherein the at least one transceiver is responsive to the forth transmitted signal for the purpose of generating the stimulus.

113. The electronic containment system for at least one animal according to claim 86 wherein the control station comprises a display for displaying the location of the at least one transceiver.

15 114. The electronic containment system for at least one animal according to claim 86 wherein the control station comprises a nonvolatile memory for the storage of data defining the at least one containment perimeter.

115. The electronic containment system for at least one animal according to claim 114 wherein the nonvolatile memory is portable.

20 116. The electronic containment system for at least one animal according to claim 86 wherein the third transmitted signal contains identification information.

25 117. The electronic containment system for at least one animal according to claim 116 wherein the controller produces a forth control signal in response to the identification information in the third transmitted signal received by the at least one transceiver.

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118. A method for containing an animal using an electronic containment system comprising the steps of:

(a) transmitting with at least one GPS source a first transmitted signal having a first predetermined characteristic;

5 (b) receiving with a first receiver the first transmitted signal from the at least one GPS source;

(c) transmitting with a first transmitter a second transmitted signal having a second predetermined characteristic;

10 (d) controlling with a first controller, in communication with the first receiver and the first transmitter, the transmissions of the first transmitter in response to the first transmitted signal received by the first receiver, wherein the second transmitted signal is transmitted in response to the first transmitted signal that is received by the first receiver, producing a first control signal in response to the first transmitted signal;

15 (e) receiving with a second receiver the first transmitted signal produced by the at least one GPS source;

(f) transmitting with a second transmitter a third transmitted signal having a third predetermined characteristic;

20 (g) controlling with a second controller, in communication with the second receiver and the second transmitter, the transmission of the second transmitter in response to the first transmitted signal received by the second receiver, wherein the third transmitted signal is transmitted in response to the first transmitted signal that is received by the second receiver, producing a second control signal in response to the second transmitted signal;

25 (h) receiving with a third receiver the second transmitted signal from the first transmitter;

(i) receiving with a fourth receiver the third transmitted signal from the second transmitter;

30 (j) transmitting with a third transmitter a fourth transmitted signal having a fourth predetermined characteristic;



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(k) controlling with a third controller, in communication with the third receiver, the forth receiver, and the third transmitter, the transmissions of the third transmitter in response to the second transmitted signal received by the third receiver and the third transmitted signal received by the forth receiver, wherein the forth transmitted signal is transmitted in response to the second transmitted signal that is received by the third receiver and the third transmitted signal received by the forth receiver, producing a third control signal in response to the second transmitted signal and the third transmitted signal;

(l) receiving with a fifth receiver the forth transmitted signal transmitted by the third transmitter; and

(m) producing with a stimulus generator a stimulus in response to the forth transmitted signal transmitted by the third transmitter.

119. The method according to claim 116 wherein steps (b), (c), and (d) are performed at a predetermined location.

120. The method according to claim 116 wherein steps (e), (f), (g), (l) and (m) are performed at a predetermined location.

121. The method according to claim 116 wherein steps (h), (i), (j), and (k) are performed at a predetermined location.

122. The method according to claim 116 wherein the first controller is a microprocessor.

123. The method according to claim 116 wherein the first controller is an analog circuit.

124. The method according to claim 116 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the portable transceiver location.

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125. The method according to claim 116 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of an undetectable first transmitted signal.

5 126. The method according to claim 125 wherein the system produces a warning alarm in response to the first control signal.

127. The method according to claim 126 wherein the system produces the warning alarm at a predetermined location.

128. The method according to claim 116 wherein the second transmitted signal is representative of the portable transceiver location.

10 129. The method according to claim 116 wherein the second transmitted signal is a re-transmission of the first transmitted signal.

130. The method according to claim 116 wherein the second transmitted signal is representative of a portion of the first transmitted signal.

15 131. The method according to claim 116 wherein the control station is a personal computer.

132. The method according to claim 116 wherein the second controller is a microprocessor.

133. The method according to claim 116 wherein the second controller is an analog circuit.

20 134. The method according to claim 116 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of the portable transceiver location.

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135. The method according to claim 116 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of an undetectable second transmitted signal.

136. A method for containing an animal using an electronic containment system comprising the steps of:

- (a) transmitting with at least one GPS source a first transmitted signal having a first predetermined characteristic;
- (b) receiving with a first receiver the first transmitted signal from the at least one GPS source;
- (c) transmitting with a first transmitter a second transmitted signal having a second predetermined characteristic;
- (d) controlling with a first controller, in communication with the first receiver and the first transmitter, the transmissions of the first transmitter in response to the first transmitted signal received by the first receiver, wherein the second transmitted signal is transmitted in response to the first transmitted signal that is received by the first receiver, producing a first control signal in response to the first transmitted signal;
- (e) receiving with a second receiver the first transmitted signal produced by the at least one GPS source;
- (f) transmitting with a second transmitter a third transmitted signal having a third predetermined characteristic; and
- (g) controlling with a second controller, in communication with the second receiver and the second transmitter, the transmissions of the second transmitter in response to the first transmitted signal received by the second receiver, wherein the third transmitted signal is transmitted in response to the first transmitted signal that is received by the second receiver, producing a second control signal in response to the second transmitted signal.

137. The method according to claim 136 wherein steps (b), (c), and (d) are performed at a predetermined location.

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138. The method according to claim 136 wherein steps (e), (f), and (g) are performed at a predetermined location.

139. The method according to claim 137 wherein steps (b), (c), and (d) serve to define a confinement area.

5           140. The method according to claim 136 wherein the first transmitted signal represents locational data.

141. The method according to claim 136 wherein the first controller is a microprocessor.

10           142. The method according to claim 136 wherein the first controller is an analog circuit.

143. The method according to claim 136 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the first transmitter location.

15           144. The method according to claim 136 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of the ground speed at which the first transmitter is moving.

145. The method according to claim 136 wherein the first controller monitors the first transmitted signal and produces a first control signal that is representative of an undetectable first transmitted signal.

20           146. The method according to claim 136 wherein the rate of transmission of the second transmitted signal is constant.

147. The method according to claim 136 wherein the rate of transmission of the second transmitted signal is variable.

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148. The method according to claim 136 wherein the rate of transmission of the second transmitted signal is relative to the ground speed of the first transmitter.

149. The method according to claim 136 wherein the second transmitted signal is representative of the first transmitter location.

5           150. The method according to claim 136 wherein the second transmitted signal is representative of the first transmitter ground speed.

151. The method according to claim 136 wherein the second transmitted signal is a re-transmission of the first transmitted signal.

10           152. The method according to claim 136 wherein the second transmitted signal is representative of a portion of the first transmitted signal.

153. The method according to claim 136 wherein the stimulus is an electrical shock or audible signal.

154. The method according to claim 136 wherein the second controller is a microprocessor.

15           155. The method according to claim 136 wherein the second controller is an analog circuit.

156. The method according to claim 136 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of the first transmitter location.

20           157. The method according to claim 136 wherein the second controller monitors the second transmitted signal and produces a second control signal that is representative of an undetectable second transmitted signal.

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158. A method for defining a containment area for use with a satellite animal containment system comprising the steps of:

- (a) positioning a portable transceiver on the perimeter of the containment area;
- (b) moving the portable transceiver along the perimeter of the containment area; and
- (c) storing positional data as the portable transceiver is moved along the perimeter of the containment area;

wherein the portable transceiver is in communication with a GPS source.

159. The method according to claim 158 further comprising the step of defining an off-limits boundary of an off-limits zone within the containment area.

160. The method according to claim 159 wherein defining the off-limits boundary comprises the steps of:

- (a) positioning a portable transceiver on the off-limits boundary of the off-limits zone;
- (b) moving the portable transceiver along the off-limits boundary of the off-limits zone; and
- (c) storing positional data as the portable transceiver is moved along the off-limits boundary of the off-limits zone.

161. The method according to claim 158 further comprising the steps of:

- (a) transporting the portable transceiver outside of the perimeter of the containment area; and
- (b) storing an "Off-limits" demarcation.

162. The method according to claim 158 further comprising the steps of:

- (a) transporting the portable transceiver inside of the perimeter of the containment area; and
- (b) storing a "Safe Zone" demarcation.

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163. The method according to claim 160 further comprising the steps of:

- (a) transporting the portable transceiver inside of the off-limits zone; and
- (b) storing an "Off-limits" demarcation.

5           164. The method according to claim 158 or 160 further comprising the step of transmitting with the portable transceiver the positional data to a remotely located processing station.

165. The method according to claim 164, wherein the positional data are transmitted at a preselected time.

10           166. The method according to claim 164, wherein the positional data are transmitted in real-time.

167. The method according to claims 164, 165, and 166, wherein the positional data are stored in a remotely located processing station.

15           168. A method according to claim 160 wherein steps (a) through (c) are repeated in order to define additional off-limits zones.

169. The method according to claim 158 or 160 wherein the storing of the positional data is initiated by actuating a predetermined switch on the portable transceiver.

20           170. The method according to claim 158 or 160 wherein the storing of the positional data is terminated by actuating a predetermined switch on the portable transceiver.

171. The method according to claim 164 wherein the transmitting of the positional data is initiated by actuating a predetermined switch on the portable

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transceiver.

172. The method according to claim 164 wherein the transmitting of the positional data is terminated by actuating a predetermined switch on the portable transceiver.

5           173. The method according to claim 161 or 163 wherein the entering an "Off-limits" demarcation is effected by actuating a predetermined switch on the portable transceiver.

10           174. The method according to claim 162 wherein the storing a "Safe Zone" demarcation is effected by actuating a predetermined switch on the portable transceiver.

175. A pet containment system comprising:

- 15           (a) a control station;
- (b) a portable transceiver receiving a first transmitted signal representing a GPS coordinate of the portable transceiver and transmitting the portable transceiver's GPS coordinate to the control station, wherein the control station defines a point of a containment boundary using the portable transceiver's GPS coordinate;
- 20           (c) a collar transceiver, attached to an animal, receiving a transmitted signal representing the GPS coordinate of the collar transceiver and transmitting the collar transceiver's GPS coordinate to the control station, wherein the control station determines the location of the collar transceiver relative to the containment boundary;
- 25           (d) a stimulus generator for producing a stimulus to the animal when the location of the collar transceiver is at a predetermined position relative to the containment boundary.



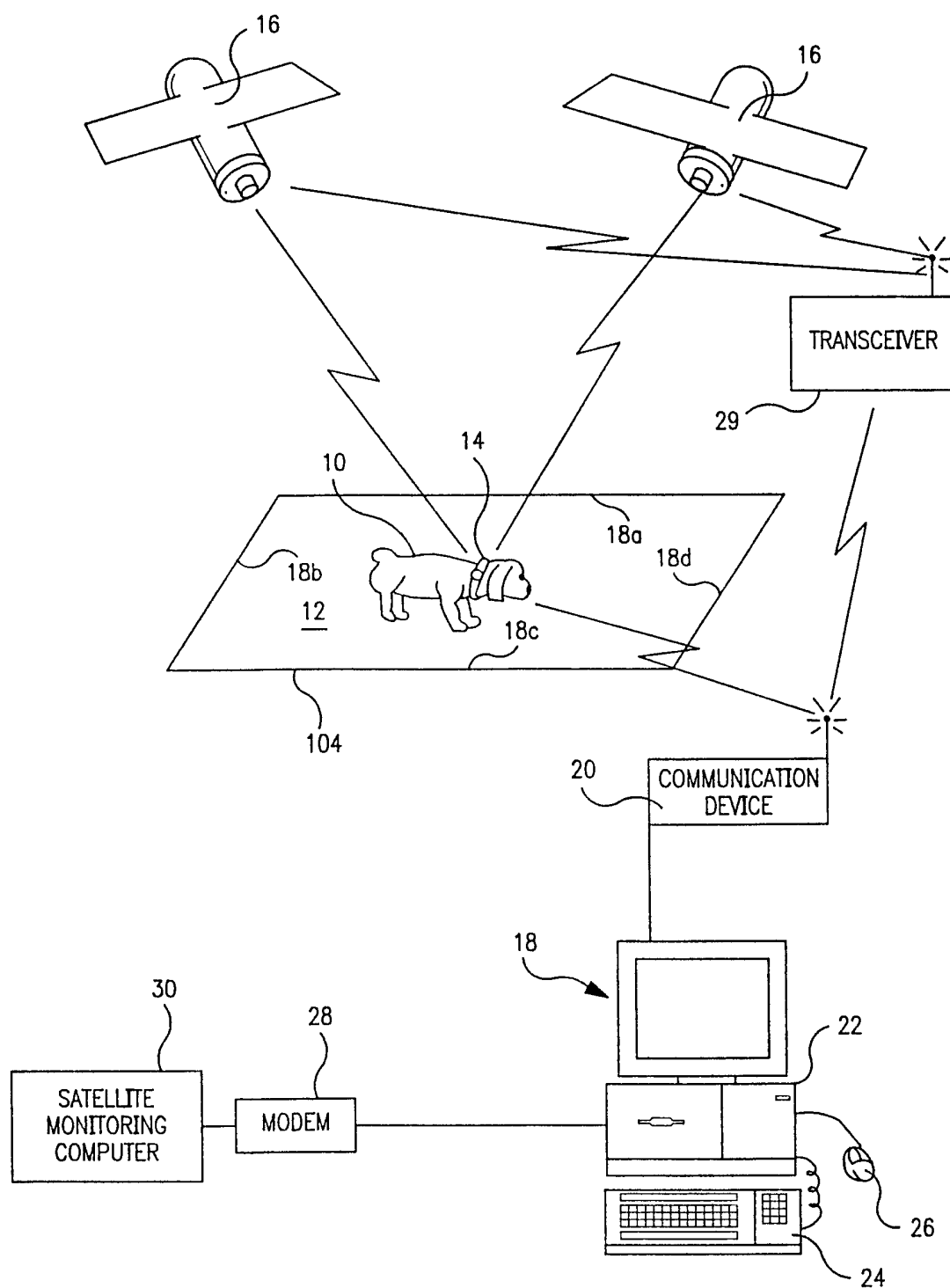


FIG. 1

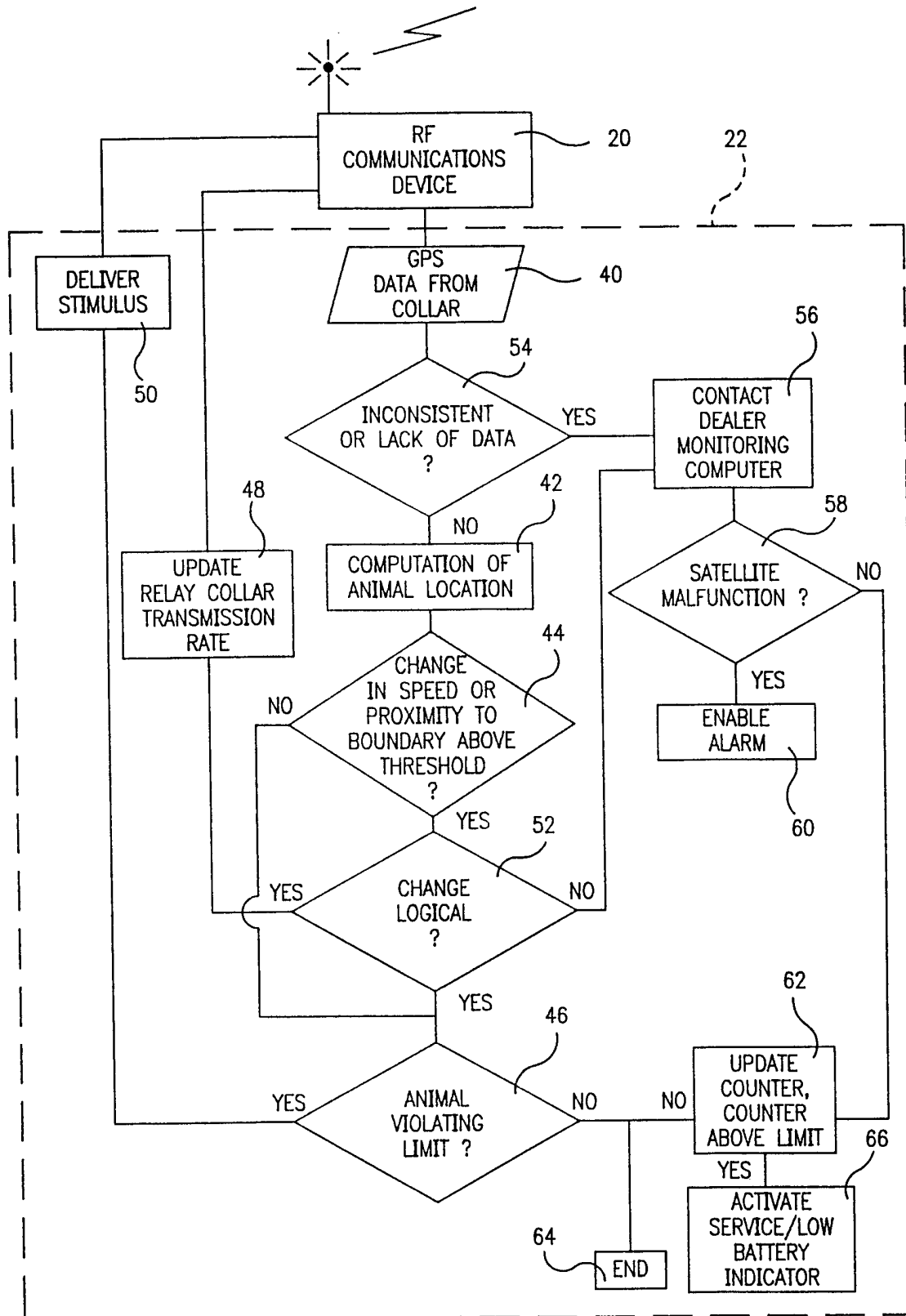


FIG. 2

SUBSTITUTE SHEET (RULE 26)

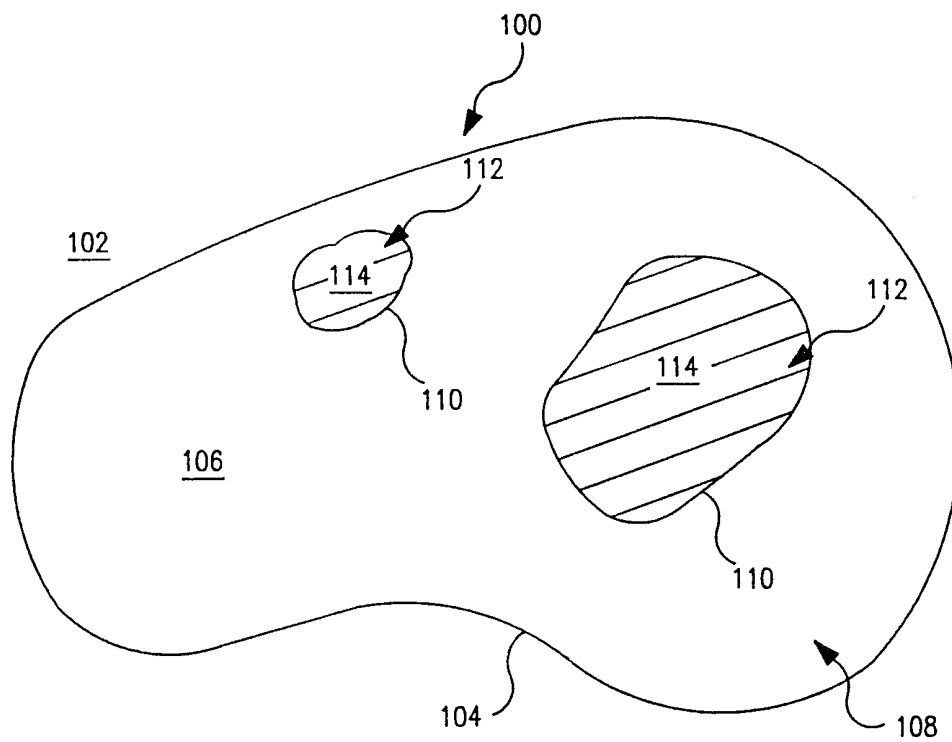


FIG. 3

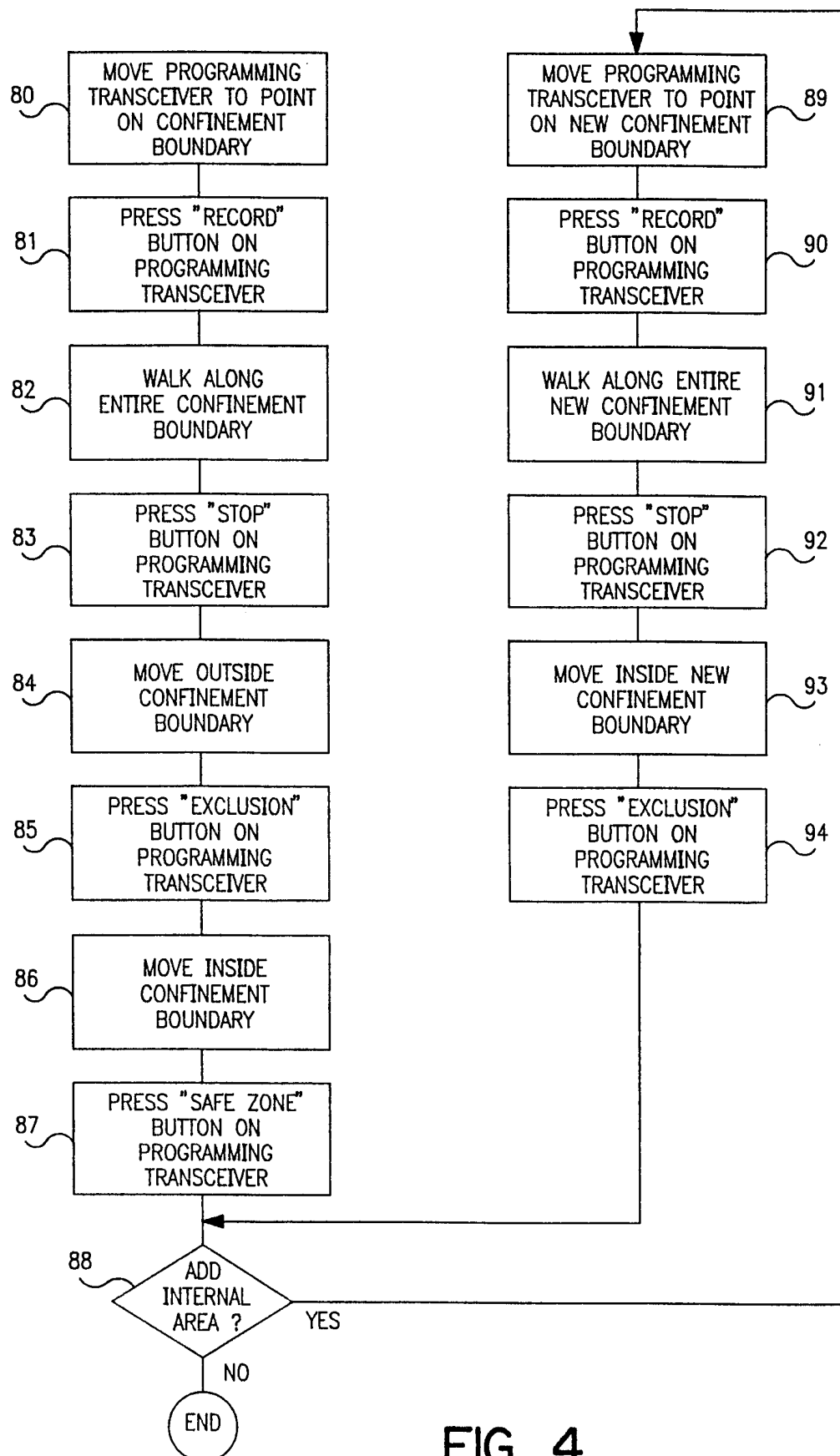


FIG. 4

## INTERNATIONAL SEARCH REPORT

 International application No.  
PCT/US00/18931

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(7) : G08B 23/00 US CL : 340/573.3 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : Please See Extra Sheet. Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EAST		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,868,100 A (MARSH) 09 FEBURARY, 1999; FIG.3	1-175
Y	US 5,794,174 A (JANKY ET AL.) 11 AUGUST 1998, COL.4 LINES 31-34.	1-175
A	US 5,791,294 A (MANNING) 11 AUGUST 1998, ABSTRACT	1-175
A,P	US 6,038,510 A (LEE) 14 MARCH 2000, ABSTRACT	1-175
A	US 5,594,425 A (LADNER ET AL.) 14 JANUARY 1997, COL.7 LINES 55-60	1-175
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 23 AUGUST 2000		Date of mailing of the international search report 19 SEP 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer NINA TONG <i>James R. Matthews</i> Telephone No. (703) 305-4831

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/18931

## B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

340/573.3, 573.1, 573.2, 573.4, 539, 825.49, 825.54,  
119/721, 908, 720, 859,  
342/357, 457