Title: ANTENNA METHOD AND APPARATUS

Abstract: An adjustable, directional antenna method and apparatus. The antenna (110) is coupled to a monitoring system (108) that monitors a utility meter (100), a vending machine, a parking meter, a traffic controller or an alarm system, among others. The antenna (100) is compactly shaped and possesses a radiation pattern with a maximum signal strength in one direction. The antenna is adjustable such that the maximum signal strength is directed to an available cell site. The antenna may be used to transmit operating conditions of the utility meter, vending machine, parking meter, traffic controller or alarm system to a cell site or central unit.
ANTENNA METHOD AND APPARATUS

Field of the Invention

The present invention relates to antennas. Specifically, the present invention relates to a user-adjustable directional antenna.

Description of the Related Art


Summary of the Invention

In one application of the present invention, a monitoring system is attached to a utility meter, such as an electric, gas or water meter, and transmits and receives information to and from a central control station. The monitoring system uses a user-adjustable directional antenna device to transmit and receive information via a two-way communication network or system, such as a cellular telephone system.

The information transmitted from the utility meter may include stored or instantaneous meter readings, power spikes, power outages, low battery power, time(s) of the day when usage is greatest or lowest, detected tampering or malfunction of the meter, opening of the meter compartment, etc. The central control station monitors this transmitted information and may record the transmitted information for later use. The central control station may send control signals to the utility meter and/or recommend a course of action to a user in response to the transmitted information. The transmitted information obviates the need to send an inspector into the field to inspect each utility meter on a monthly or other regular basis. This is particularly advantageous and cost-effective if there is a large number of utility meters to be inspected and if one or more of the utility meters are located at remote locations, such as residential utility meters.

In general, the antenna device of the present invention may be used in any application to transmit information from one or more remote sites to a central control station. Specifically, the antenna device may be used to transmit and receive information to and from monitoring systems on vending machines, parking meters, traffic light controllers, alarm systems, etc. The antenna device is particularly advantageous for applications with a fixed site or a fixed base, which is difficult to rotate to the direction of the nearest available cell site. For example, a utility meter on the side of a house (or other residence) has a fixed base because neither the house nor the existing utility meter can be rotated to the direction of the nearest available cell site. Removing the existing utility meter (and its associated attachments) and re-installing it to face the nearest available cell site may be cost prohibitive. Some existing utility meters are 20-40 years old.
The user-adjustable directional antenna device of the present invention provides a number of advantages over linear omni-directional antennas, such as those used on cellular phones. First, linear omni-directional antennas have a limited operating range because energy is dissipated 360 degrees in a horizontal plane. Certain physical structures or electromagnetic devices may interfere with the signals generated and received by omni-directional antennas. The farther the distance from a cell site, the weaker the signal of an omni-directional antenna. If the omni-directional antenna is too far from a cell site, no appreciable signal will be received.

Second, linear antennas may be difficult to install in certain applications because of their size and shape. For example, for many existing residential utility meters, a linear antenna will not fit underneath the protective glass covering of the utility meter. Thus, it may be necessary for a field operator to drill a hole in the glass covering or a wall of the residence in order to accommodate an external linear antenna. It may also be necessary for the field operator to mount the external linear antenna and its associated components around the utility meter or on the utility meter itself using adhesives or screws. The field operator may need to attach wires and cables for communication between the external antenna and the utility meter. In addition, the field operator must ensure that the external linear antenna and its associated components are weather-proof.

In other applications, there may not be sufficient space to install the linear antenna due to the size of the utility meter compartment, the size of the vending machine compartment, the size of the traffic light controller compartment, etc. There may be obstructive structures surrounding the compartment, such as other utility meters, the walls of the residence, windows, piping, support beams, trees, etc., which make it difficult, if not impossible, to install a linear antenna.

Third, linear antennas may be prone to tampering (by children, meddlers and animals) or destruction by forces of nature because of their obstructive shape.

The antenna device of the present invention overcomes these disadvantages. First, the radiation pattern of the antenna device is a focused beam (with a certain angular width) which can be directed to the nearest available cell site. The focused beam of the antenna device provides a stronger signal strength than omni-directional antennas, and is sufficient to penetrate a variety of physical structures, such as the residence to which the utility meter is attached. Because the focused angular beam of the antenna device is less susceptible to interference from physical structures and electromagnetic fields, the antenna device provides a greater operating range than a linear omni-directional antenna.

Second, the antenna device provides easier installation. The antenna device is sufficiently small and compact to fit within the compartment of existing residential utility meters. Also, the antenna device is easier to install for field operators with minimal technical knowledge or experience. With the antenna device of the present invention, it is not necessary for the field operator to drill a hole in the glass covering or a wall of the residence, to mount an external linear antenna and its associated components, to attach wires and cables for communication between the external antenna and the utility meter, or to ensure that the external antenna and its associated components are appropriately sealed and weather-proof.
Third, the antenna device of the present invention is less prone to tampering (by children, animals, forces of nature, etc.) because the antenna device fits within the utility meter compartment, such as the protective glass covering of one utility meter configuration.

Other advantages of the antenna device is that it is relatively inexpensive to manufacture, and it is adapted for use with existing mechanical residential utility meters.

**Brief Description of the Drawings**

Figure 1 illustrates a utility meter.

Figure 2 illustrates the utility meter of Figure 1 with an antenna device and meter monitoring system of the present invention.

Figure 3 illustrates a side view of the utility meter, antenna device and meter monitoring system of Figure 2.

Figure 4 illustrates the utility meter, antenna device and meter monitoring system of Figure 2 under a protective covering.

Figure 5 illustrates one configuration of a central board of the antenna device of Figure 2.

Figure 6 illustrates one configuration of the antenna device of Figure 2.

Figures 7A-7B illustrate various configurations of the antenna device of Figure 2.

Figure 8 illustrates one configuration of a handheld device used to set the optimum transmission and reception direction of the antenna device of Figure 2.

Figures 9-11 illustrate the antenna device of Figure 2 in another application.

**Detailed Description of the Preferred Embodiment**

The description below describes a preferred embodiment and application of a monitoring system and an antenna device of the present invention. The antenna device may be applied to other wireless communication applications, such as transmitting and receiving information to and from monitoring systems on vending machines, parking meters, traffic light controllers, alarm systems, etc.

The antenna device may transmit and receive information to and from one or more cellular sites (cell towers, repeaters or mobile stations), which communicate with a central control station via a two-way communication network or system. Examples of such two-way communication networks or systems include cellular (800-900 MHz), personal communication service (PCS)(1.8-1.9 GHz), cellular digital packet data (CDPD), Global System Mobile (GSM), personal digital telephone (PDC), Mobile Broadband Systems (20-60 GHz), etc.

**Overall Structure**

Figure 1 illustrates one configuration of a utility meter 100. In Figure 1, the utility meter 100 comprises a base compartment 102, a user-readable console 104 and a protective glass or plastic covering 106. The base compartment 102 is typically attached to a wall of a residence (home, apartment, etc.) or to a commercial building.

The utility meter 100 shown in Figure 1 is typically used for monitoring electric power consumption. Alternatively,
other utility meter configurations (not shown) for measuring electric power consumption may be used with the antenna device of the present invention. In addition, other meters which monitor water, gas, etc. may be used with the antenna device of the present invention.

Figure 2 illustrates the utility meter 100 of Figure 1 with an antenna device 110 and a meter monitoring system 108 of the present invention. Figure 3 illustrates a side view of the utility meter 100, antenna device 110 and meter monitoring system 108 of Figure 2. Figure 4 illustrates the utility meter 100, antenna device 110 and meter monitoring system 108 of Figure 2 under a protective covering 106. As shown in Figure 4, the antenna device 110 is advantageously configured to fit within the protective covering 106. The antenna device 110 shown in Figure 2 is circular, but other shapes, such as oval, rectangular or square, may be used in accordance with the present invention.

In Figure 2, the antenna device 110 is attached to an antenna base 112, which is attached to the top of the console 104. The antenna device 110 is adapted to rotate clockwise or counterclockwise with respect to the antenna base 112. The antenna base 112 comprises at least one screw, pin or shaft and at least one fastener (e.g., lock, nut, washer, etc.) which securely holds the antenna device 110 in place after the antenna device 110 is rotated to a certain user-selected position.

The antenna device 110 is coupled to the monitoring system 108 by a cable 114. In one configuration, the cable 114 is a RG-174U coaxial cable. In one configuration, the cable 114 is 7 inches in length. Alternatively, other lengths may be used.

The Monitoring System

In Figure 2, the monitoring system 108 preferably comprises a microcontroller, a transceiver, one or more memory units, such as a RAM or EEPROM, light-emitting diodes (LEDs), at least one infra-red sensor and a low power and power outage detector (not shown). The monitoring system 108 may also comprise its own power supply and/or a back-up power supply for the utility meter 100. The monitoring system 108 may also include one or more signal repeaters, for receiving and transmitting signals from nearby utility meters with low power transmitted signals, such as an underground water meter. At least one memory unit stores firmware which is executed by the microcontroller.

The firmware provides the functions of the monitoring system 108 described below.

In Figure 2, the monitoring system 108 detects and records the amount of power consumed by the residence as detected by the utility meter 100. The monitoring system 108 sends a periodic report to the central control station regarding the amount of power consumed by the residence. The monitoring system 108 may also comprise a tamper switch (not shown) which detects the removal of the protective covering 106 and sends a signal or message to the central control station if the covering 106 is removed.

The monitoring system 108 also detects power outages of the residence and low battery conditions of the utility meter 100 and/or the monitoring system 108. The monitoring system 108 may send a signal or message to the central control station if either of these two conditions occur. Alternatively, the monitoring system 108 may wait a predetermined time period for the power to be restored before sending a signal to the central control station. The
monitoring system 108 may also switch to a back-up power supply if the monitoring system 108 detects a low battery condition of the utility meter 100 and/or the monitoring system 108.

In one configuration, the transceiver of the monitoring system 108 outputs a 3-watt RF signal through the antenna device 110. Alternatively, other output levels instead of 3 watts may be used with the antenna device 110. The gain of the antenna device 110 may be custom set from about 1.5 dB to about 3 dB.

In other applications, such as vending machines, the monitoring system may comprise components in addition to or instead of the components described above. For example, a monitoring system for a vending machine may comprise components which detect and record the number of remaining units of each type of product in the vending machine. The monitoring system may also detect the amount of change (quarters, nickels, dimes) left in the machine and any malfunctions or tampering. The monitoring system then uses an antenna device to send periodic reports or events to a central control station.

Structure of the Antenna Device

Figure 5 illustrates one configuration of a central board 118 of the antenna device 110 of Figure 2. Figure 6 illustrates one configuration of the antenna device 110 of Figure 2. Figures 7A-7B illustrate various configurations of the antenna device of Figure 2.

In Figure 5, the board 118 comprises a 2-layer, circle-shaped epoxy glass material, NEMA grade FR-4, such as the type used for printed circuit boards. The board 118 is preferably sized to fit within the protective covering 106 of Figure 4 (or the compartment of some other device). For the utility meter 100 of Figure 2, the board 118 is 2 inches in diameter. The board 118 comprises a center hole 124 for attaching a screw, pin or shaft to enable the antenna device 110 to rotate with respect to the antenna base 112. The board 118 may comprise a passage hole 122 drilled or molded into the board 118 for passing a portion of the cable 114 from the bottom surface of the board 118 to the top surface, as shown in Figure 7B. The board 118 may comprise one or more other holes 120 drilled or molded into the board 118.

In Figure 7B, one portion 114' of the cable 114 is above the top surface of the board 118, and the end of this portion 114' of the cable 114 is attached to top surface of the board 118 (described below). The other portion 114'' of the cable 114 is below the bottom surface of the board 118, and the end of this portion 114'' is attached to a connector 126. The connector 126 is adapted to be attached to the monitoring system 108 of Figure 2. The cable configuration shown in Figure 7B, with a top portion 114' and a bottom portion 114'', provides stress and strain relief for the cable 114, particularly when the antenna device 110 is being installed and rotated.

In Figure 6, both the top and the bottom surfaces of the board 118 are plated with 2 oz. copper in the configuration as shown. The various methods of plating or forming the copper on the board 118 are known to those of ordinary skill in the fabrication art. The copper configuration comprises a copper ground side 128, a first copper strip line 130, a second copper strip line 132 and a third copper strip line 134. The first strip line 130 is coupled to the second strip line 132, which is coupled to the third strip line 134. The outer circular edge of the board 118 is also plated with copper or other radiating material. Thus, the first strip line 130 on one surface of the board 118 is
coupled to a first strip line (not shown) on the opposite surface of the board 118. Similarly, the ground side 128 on one surface of the board 118 is coupled to a ground side (not shown) on the opposite surface of the board 118.

In one embodiment, the antenna device 110 further comprises trimmers 174 (Figure 2) for tuning or adjusting the strip lines 130, 132, 134. As shown in Figure 2, the antenna device 110 comprises two trimmers 174. Alternatively, the antenna device 110 may comprise less than two or more than two trimmers. In one configuration, the strip lines 130, 132, 134 are tuned to 50 ohms at 850 MHz. Alternatively, the strip lines 130, 132, 134 may be tuned to some other resistance at some other frequency.

The second and third strip lines 132, 134 are coupled to a first and second capacitors 136, 138, which are coupled to the hot/conductor lead of the cable 114. The third strip line 134 is coupled to a resistor 144, which is coupled to the ground side 128. The first strip line 130 is coupled to a third and fourth capacitors 140, 142, which are coupled to the ground side 128. The ground side 128 is coupled to the ground portion of the cable 114.

In one configuration, the first and third capacitors 136, 140 are adjustable, 2 to 10 pico-Farad (pF) capacitors, the second capacitor 138 is a 10 pF capacitor, the fourth capacitor 142 is a 33 pF capacitor and the resistor 144 is a 604 ohm resistor. In other configurations, the capacitance and resistance levels may vary.

As shown in Figure 2, the board 118 is preferably painted (e.g., in green) to prevent moisture from penetrating the board 118. Certain areas of the board 118 are preferably not painted, such as the resistor 144 and the capacitors 136-142. Lettering and other markings may be silk-screened (e.g., in white), painted or etched on the top and/or bottom surfaces of the board 118. For example, on the top surface of a preferred configuration of the board 118, there is a marker 116 which indicates the approximate direction of maximum signal strength for the antenna device 110. The marker 116 is shown as an arrow in Figure 2, but the marker 116 may comprise a variety of symbols and shapes.

Radiation Pattern and Angular Beam Width

The use and operation of the antenna device 110 will be described with reference to Figures 2-6. The antenna device 110 possesses a three-dimensional radiation pattern (not shown) with a main lobe and a plurality of minor lobes. The antenna device 110 is rotated and set (manually or by a motor) such that the main lobe of the radiation pattern (particularly in the horizontal plane) is in the direction of the nearest available cell site. In one preferred configuration, the angular beam width (e.g. half power beam width (HPBW) or 3-dB width) of the main lobe is approximately 45 degrees. An angular width of 45 degrees, as opposed to a angular width of 10 degrees for example, accommodates a modest amount of human or mechanical error when setting the direction of the main lobe of the antenna device 110 toward the nearest available cell site. Alternatively, the configuration and/or components of the antenna device 110 may be modified such that other widths greater than or less than 45 degrees may be achieved.

In one embodiment, the signal of the antenna device 110 is tuned or adjusted to 50 ohms, 850 MHz on a network analyzer (not shown) before being installed on a utility meter 100.
Installing, Rotating and Setting the Antenna Device

To install the antenna device 110 and the monitoring system 108, the field operator removes the protective covering 106 from the utility meter 100 of Figure 1. The field operator installs the monitoring system 108 under the console 104 and couples the monitoring system to the utility meter 100 such that the monitoring system 108 may monitor conditions of the utility meter 100. In a preferred embodiment, this installation does not substantially affect the components or operation of the console 104. The field operator attaches the antenna base 112 to the top of the console 104 and attaches the cable connector 126 to the monitoring system 108. The field operator then rotates and sets the antenna device 110.

In a preferred embodiment, there are at least three methods for rotating and setting the direction of the maximum signal strength (main lobe) of the antenna device 110 toward the nearest available cell site for optimum signal transmission and reception. One method of setting the antenna device 110 comprises a field operator using a street map and manually rotating the antenna device 110 such that the marker 116 (Figure 2) points in the approximate direction of the nearest available cell site.

Another method of setting the antenna device 110 comprises using a portable handheld device, such as the handheld device 160 shown in Figure 8. The handheld device 160 comprises a liquid crystal display (LCD) 162, a keypad 164, at least one outlet 166 which can be coupled to the antenna device 110 or monitoring system 108 via a cable (not shown). The handheld device 160 detects and displays (on the LCD 162) the strength of any signals received by the antenna device 110 from any nearby cell sites. As the field operator rotates the antenna device 110, the field operator observes the LCD 162 to ascertain the direction of the strongest received signal. The direction of the strongest received signal is most likely the direction of the nearest available cell site. This is the direction in which the antenna device 110 should be set for optimum signal transmission and reception.

Another method of setting the antenna device 110 comprises using the portable handheld device 160 with a motor (not shown) to automatically rotate the antenna device 110. The motor may be a part of the handheld device 160. Alternatively, the motor may be attached to the antenna base 112. The motor rotates the antenna device 110 until the direction for optimum signal transmission and reception is found by the handheld device 160.

After the field operator sets the antenna device 110, the field operator re-installs the protective covering 106 to cover the console 104, the antenna device 110 and the monitoring system 108.

Another Application As Shown in Figures 9-11

Figures 9-11 illustrate the antenna device 110 of Figure 2 in another application. In Figure 9, the antenna device 110 is mounted inside a circular mount 172 with a removable top cap or cover 170. In Figure 10, the circular mount 172 is mounted on top of a compartment 176. The antenna device 110 is coupled to a monitoring system 178 which is housed inside the compartment 176. In Figure 11, the cover 170 is screwed or snapped onto the top of the mount 172.

The compartment 176 may house an apparatus or circuit to be monitored and/or a power supply (not shown). The compartment 176 may also be attached to second compartment (not shown) which houses an apparatus
or circuit to be monitored. For example, the compartment 176 may be attached to a traffic signal light controller box or compartment. In this application, the monitoring system 178 detects if the traffic light controller experiences a power failure or malfunction and sends this information to a central control station. Alternatively, the monitoring system 178 may wait a predetermined time period for the power to be restored before sending a signal to the central control station.

While embodiments and applications of this invention have been shown and described, it will be apparent to those skilled in the art that various modifications are possible without departing from the scope of the invention. It is, therefore, to be understood that within the scope of the appended claims, this invention may be practiced otherwise than as specifically described.
WHAT IS CLAIMED IS:

1. An adjustable, directional antenna coupled to a monitoring device, said antenna adapted to transmit and receive signals to and from a cell site, said antenna comprising:
   a board;
   a radiator formed on at least one side of said board, said radiator having a radiation pattern; and
   a base rotatably supporting said board such that a maximum signal strength of said radiation pattern may be directed toward said cell site.

2. The antenna of Claim 1, wherein said board is substantially circular.

3. The antenna of Claim 1, wherein said antenna transmits and receives signals via a two-way communication network.

4. The antenna of Claim 1, wherein said monitoring device monitors a utility meter, and wherein said antenna is connected to transmit data related to said meter to said cell site.

5. The antenna of Claim 4, wherein said antenna is sized to fit within a protective cover of said utility meter.

6. A utility meter monitoring system comprising:
   a sensor configured to monitor a utility meter; and
   an adjustable, directional antenna coupled to said sensor and sized to fit within an enclosure of said meter, said antenna configured to transmit and receive signals between said sensor and a cell site, said antenna further configured to be adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

7. A vending machine monitoring system comprising:
   a sensor configured to monitor a vending machine; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and receive signals between said sensor and a cell site, said antenna further configured to be adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

8. The monitoring system of Claim 7, wherein said antenna is sized to fit within an enclosure of said vending machine.

9. A parking meter monitoring system comprising:
   a sensor configured to monitor a parking meter; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and receive signals between said sensor and a cell site, said antenna further configured to be adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

10. The monitoring system of Claim 9, wherein said antenna is sized to fit within an enclosure of said parking meter.

11. A traffic light controller monitoring system comprising:
a sensor configured to monitor a traffic light controller; and
an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
receive signals between said sensor and a cell site, said antenna further configured to be adjusted such that
a maximum signal strength of said antenna may be directed toward said cell site.

12. The monitoring system of Claim 11, wherein said antenna is sized to fit within an enclosure of said
traffic light controller.

13. An alarm unit monitoring system comprising:
a sensor configured to monitor an alarm unit; and
an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
receive signals between said sensor and a cell site, said antenna further configured to be adjusted such that
a maximum signal strength of said antenna may be directed toward said cell site.

14. The monitoring system of Claim 7, wherein said antenna is sized to fit within an enclosure of said
alarm unit.

15. An antenna for communicating with a cell site, said antenna comprising:
a board;
a radiator formed on at least one side of said board, said radiator having a maximum signal
strength in one direction; and
a base supporting said board, said base configured for mounting near a monitoring device and for
rotating said board relative to said base to align said one direction toward said cell site.

16. A monitoring system comprising:
a sensor coupled to a device, said sensor monitoring one or more operating conditions of said
device; and
an adjustable antenna coupled to said sensor, said antenna transmitting data related to said one or
more operating conditions of said device.

17. The monitoring system of Claim 16, wherein said sensor transmits said data periodically via said
antenna.

18. The monitoring system of Claim 16, wherein said sensor transmits said data via said antenna when
at least one of said operating conditions changes.

19. The monitoring system of Claim 16, wherein said device is a utility meter, and said operating
conditions comprise:
an amount of resource consumption detected by said utility meter; and
a power level of said utility meter.

20. A method of transmitting and receiving data between a cell site and an adjustable, directional
antenna coupled to a stationary device, the method comprising:
mounting said antenna near said stationary device;
adjusting said antenna relative to said device such that a maximum signal strength of said antenna is directed toward said cell site; and
transmitting data from said device to said cell cite through said antenna.

21. The method of Claim 20, wherein said act of adjusting said antenna comprises using a map to locate said cell site.

22. The method of Claim 20, wherein said act of adjusting said antenna comprises using a sensor coupled to said antenna to detect the strength of signals received by said antenna from said cell site.

23. The method of Claim 20, wherein said act of transmitting data occurs periodically according to a predetermined time period.

24. The method of Claim 20, wherein said act of transmitting data occurs when at least one operating condition of a monitored device coupled to said antenna changes.

25. The method of Claim 20, wherein said act of transmitting data occurs when said control unit sends a request to said antenna.
AMENDED CLAIMS

[received by the International Bureau on 29 September 2000 (29.09.00);
original claims 1 - 25 replaced by amended claims 1 - 25;
(3 pages)]

WHAT IS CLAIMED IS:

1. An adjustable, directional antenna coupled to a monitoring device, said antenna adapted to
transmit and receive signals to and from a cell site, said antenna comprising:
   a board;
   a radiator formed on at least one side of said board, said radiator having a radiation pattern; and
   a base rotatably supporting said board such that said board may be rotated so that a maximum
   signal strength of said radiation pattern may be directed toward said cell site.

2. The antenna of Claim 1, wherein said board is substantially circular.

3. The antenna of Claim 1, wherein said antenna transmits and receives signals via a two-way
   communication network.

4. The antenna of Claim 1, wherein said monitoring device monitors a utility meter, and wherein said
   antenna is connected to transmit data related to said meter to said cell site.

5. The antenna of Claim 4, wherein said antenna is sized to fit within a protective cover of said utility
   meter.

6. A utility meter monitoring system comprising:
   a sensor configured to monitor a utility meter; and
   an adjustable, directional antenna coupled to said sensor and sized to fit within an enclosure of
   said meter, said antenna configured to transmit and receive signals between said sensor and a cell site, said
   antenna further configured to be mechanically adjusted such that a maximum signal strength of said antenna
   may be directed toward said cell site.

7. A vending machine monitoring system comprising:
   a sensor configured to monitor a vending machine; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
   receive signals between said sensor and a cell site, said antenna further configured to be mechanically
   adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

8. The monitoring system of Claim 7, wherein said antenna is sized to fit within an enclosure of said
   vending machine.

9. A parking meter monitoring system comprising:
   a sensor configured to monitor a parking meter; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
   receive signals between said sensor and a cell site, said antenna further configured to be mechanically
   adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

10. The monitoring system of Claim 9, wherein said antenna is sized to fit within an enclosure of said
    parking meter.
11. A traffic light controller monitoring system comprising:
   a sensor configured to monitor a traffic light controller; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
   receive signals between said sensor and a cell site, said antenna further configured to be mechanically
   adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

12. The monitoring system of Claim 11, wherein said antenna is sized to fit within an enclosure of said
   traffic light controller.

13. An alarm unit monitoring system comprising:
   a sensor configured to monitor an alarm unit; and
   an adjustable, directional antenna coupled to said sensor, said antenna configured to transmit and
   receive signals between said sensor and a cell site, said antenna further configured to be mechanically
   adjusted such that a maximum signal strength of said antenna may be directed toward said cell site.

14. The monitoring system of Claim 7, wherein said antenna is sized to fit within an enclosure of said
   alarm unit.

15. An antenna for communicating with a cell site, said antenna comprising:
   a board;
   a radiator formed on at least one side of said board, said radiator having a maximum signal
   strength in one direction; and
   a base supporting said board, said base configured for mounting near a monitoring device and for
   rotating said board relative to said base to align said one direction toward said cell site.

16. A monitoring system comprising:
   a sensor coupled to a device, said sensor monitoring one or more operating conditions of said
   device; and
   a mechanically adjustable antenna coupled to said sensor, said antenna transmitting data related
   to said one or more operating conditions of said device.

17. The monitoring system of Claim 16, wherein said sensor transmits said data periodically via said
   antenna.

18. The monitoring system of Claim 16, wherein said sensor transmits said data via said antenna when
   at least one of said operating conditions changes.

19. The monitoring system of Claim 16, wherein said device is a utility meter, and said operating
   conditions comprise:
   an amount of resource consumption detected by said utility meter; and
   a power level of said utility meter.

20. A method of transmitting and receiving data between a cell site and an adjustable, directional
    antenna coupled to a stationary device, the method comprising:
mounting said antenna near said stationary device;
mechanically adjusting said antenna relative to said device such that a maximum signal strength of
said antenna is directed toward said cell site; and
transmitting data from said device to said cell site through said antenna.

21. The method of Claim 20, wherein said act of adjusting said antenna comprises using a map to
locate said cell site.

22. The method of Claim 20, wherein said act of adjusting said antenna comprises using a sensor
coupled to said antenna to detect the strength of signals received by said antenna from said cell site.

23. The method of Claim 20, wherein said act of transmitting data occurs periodically according to a
predetermined time period.

24. The method of Claim 20, wherein said act of transmitting data occurs when at least one operating
condition of a monitored device coupled to said antenna changes.

25. The method of Claim 20, wherein said act of transmitting data occurs when said control unit sends
a request to said antenna.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

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<th>IPC(7)</th>
<th>H04B 7/14; G01S 13/00, 5/04, 15/00; H01Q 1/24</th>
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<td>US CL</td>
<td>343/700MS, 702, 750, 848, 342/443, 188,147, 155; 455/20, 9</td>
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

| U.S. | 343/700MS, 702, 750, 848; 342/443, 188,147, 155, 455/20, 9 |

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

| NONE |

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

| NONE |

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
<td>US 4,924,237 A (HONDA et al) 08 May 1990 (08.05.1990), entire document.</td>
<td>1-19</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of mailing of the international search report: 10 AUG 2000

Date of the actual completion of the international search: 25 JULY 2000

Authorized officer: CHUC TRAN

Telephone No.: (703) 306-5984

Form PCT/ISA/210 (second sheet) (July 1998)