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(71) Applicants (for all designated States except US):
KOREA ELECTRIC POWER CORPORATION [KR/KR]; 167, Samsung-1dong, KangNam-gu, Seoul 133-835 (KR). **E-PIA CO.LTD.** [KR/KR]; 3F, 315-55, SungSu2-Ga3-dong, SungDong-gu, Seoul 133-835 (KR).

(72) Inventors; and

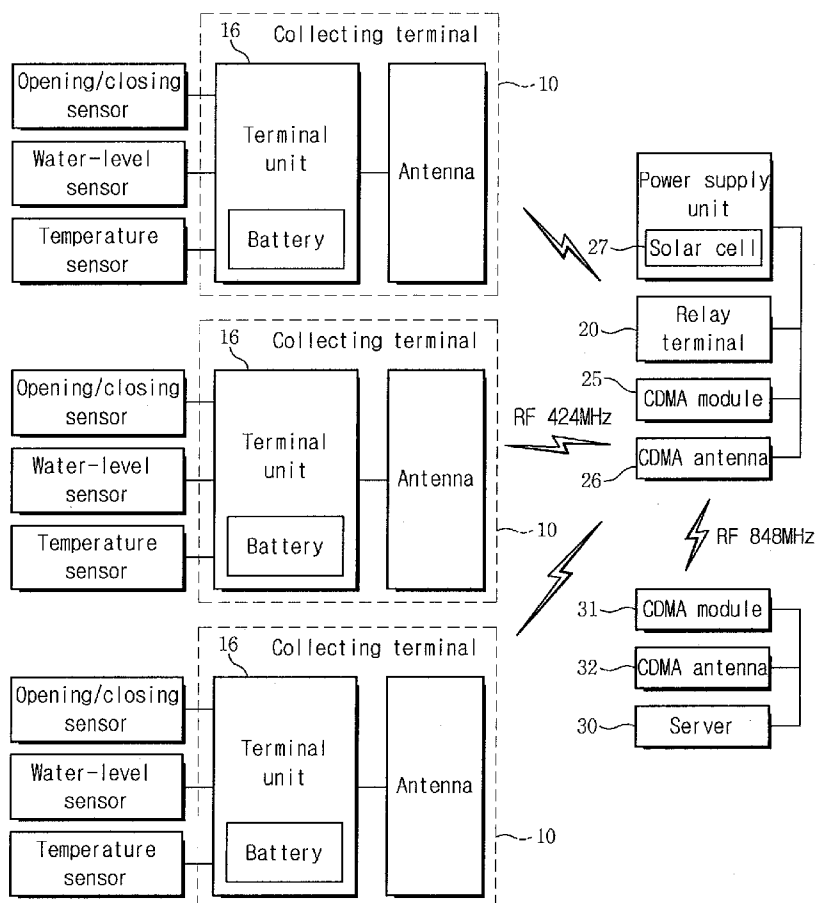
(75) Inventors/Applicants (for US only): **KIM, Young-Ro** [KR/KR]; 599, Sooib-ri, Seosong-myun, Yangpyung-gun, Kyungki-do 476-811 (KR). **CHO, Joong-Sam** [KR/KR]; 6-Dong 505-Ho, HangYang-Apt., 338-33, Ssangmun-dong, Dobong-gu, Seoul 132-741 (KR). **YOO, Jae-Sik** [KR/KR]; 201-Ho, 961-18, Daechi-dong, Gangnam-gu, Seoul 135-280 (KR). **KIM, Young-Min** [KR/KR]; 605-Ho, UJung-MaeSueR, 18-1, Karak-dong, Songpa-gu, Seoul 138-160 (KR).

(74) Agents: **LEE, Woo-Young** et al.; 2F, SongGangWon Bldg., 827-49, Yeoksam-1dong, Gangnam-gu, Seoul 135-935 (KR).

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(54) Title: A WIRELESS SYSTEM FOR MONITORING OF MANHOLE



(57) Abstract: The present invention relates to a system for monitoring the temperature and water level of the inside of a manhole and whether a manhole cover is opened or closed, and more particularly, to a wireless system for monitoring manholes, which detects current states of the manholes using sensors set inside the manholes and wirelessly transmits the current states of the manholes to allow a manager to remotely manage the internal states of the manholes in real time.

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A WIRELESS SYSTEM FOR MONITORING OF MANHOLE

Technical Field

The present invention relates to a system for monitoring the temperature and
5 water level of the inside a manhole and whether a manhole cover is opened or closed, and
more particularly, to a wireless system for monitoring manholes, which checks current
states of the manholes using sensors set inside the manholes and wirelessly transmits the
checking result to allow a manager to remotely manage the internal states of the
manholes in real time.

10

Background Art

Electric power facilities are increasingly installed underground in the downtown
area because of the beauty of the town, safety, and high-rise buildings. While researches
and development on utility-pipe conduits in which underground power lines and other
15 facilities are installed are carried out, manholes are managed by human control because
the environment is poor and it is difficult to go into manholes for confirming and
inspecting the states of the manholes. Accordingly, it is impossible to immediately
confirm the state of a manhole when a person intrudes the manhole or an accident
happens in the manhole.

20 To solve this problem and easily manage a manhole, development of a remote
alarm system for transmitting information detected by a sensor set in the manhole to a
management center and a system for easily confirming information currently detected by
the sensor are required.

A conventional system capable of easily confirming event contents of a manhole
25 is disclosed in Korean Patent No. 10-0545911, entitled "Manhole state monitoring
system", This system has a remote monitoring terminal for monitoring the state of the
inside of a manhole, which is located in the manhole, and a center server for receiving
state information sensed by the remote monitoring terminal to manage the manhole. The
manhole state monitoring system includes a communication network power extractor

connected to a communication network previously constructed in the manhole to extract power from current flowing through the communication network, a power stabilizer for stabilizing the power extracted by the communication network power extractor into a voltage used by the remote monitoring terminal and providing the voltage to the remote monitoring terminal, a sensor unit having a plurality of sensors for sensing the state of the inside of the manhole in order to monitor and manage the manhole, and a central processing unit for transmitting a value sensed by the sensor unit to the center server and receiving a command from the center server to drive the sensor unit.

The conventional system installs remote monitoring terminals for monitoring states of manholes located over a wide range using the power supplied from the existing PSTN and uses the existing communication networks as communication lines. Accordingly, the system construction cost can be minimized, communication manholes can be monitored and managed in real time, and an abnormal event occurring in a communication manhole can be rapidly handled. However, the conventional system has problems that the wired PSTN that is the dedicated communication network of Korea Telecommunications must be secured to operate the manhole monitoring system and the current state of a manhole cannot be remotely managed by wireless.

Disclosure of Invention

Technical Problem

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the conventional art, and a primary object of the present invention is to provide a wireless system for monitoring manholes, in which manhole information is transmitted and received through wireless communication among a collecting terminals for collecting the manhole information sensed by sensors, a server and a relay terminal.

Another object of the present invention is to provide a wireless system for monitoring manholes, in which wireless communication is performed among a server, a relay terminal and a collecting terminal in real time to allow a server manager to confirm

normal operating states of the manholes and whether a communication device is normally operated in real time.

A yet another object of the present invention is to provide a wireless system for monitoring manholes, which uses a relay terminal installed in a specific region to collectively manage manholes located around the specific region.

A still another object of the present invention is to provide a wireless system for monitoring manholes, which informs a manager of discharge of a battery to prevent a collecting terminal from being in an inoperative state due to the discharge of the battery.

A different object of the present invention is to provide a wireless system for monitoring manholes, which includes a relay terminal that uses a solar cell and a CDMA communication network so that its installation site is not restricted.

Another different object of the present invention is to provide a wireless system for monitoring manholes, which has a collecting terminal with improved waterproof and dustproof performances, which is located inside the manhole.

15

Technical Solution

To accomplish the objects of the present invention, there is provided a wireless system for monitoring manholes, comprising: a plurality of collecting terminals each including a terminal unit that has at least one of an opening/closing sensor, a water-level sensor and a temperature sensor and senses the internal state of a manhole using the sensor included therein, and an RF communication module for collecting information on the manhole, sensed by the sensor included in the terminal unit, from the terminal unit, and transmitting the collected information to a relay terminal using an antenna; the relay terminal collecting and arranging the information on a plurality of manholes, received from the plurality of collecting terminals, and wirelessly transmitting the collected and arranged information on the manholes to a server using a communication module; and the server wirelessly receiving the information on the manholes using a communication module and displaying current states of the manholes in real time using the received information.

30

Advantageous Effects

The wireless system for monitoring manholes according to the present invention
5 does not use a wired PSTN to detect the internal states of the manholes. The collecting
terminal collects information on a manhole, sensed by sensors, and transmits the
collected information to the relay terminal using an antenna, and the relay terminal
collects and arranges information on a plurality of manholes, received from a plurality of
collecting terminals, and wirelessly transmits the collected and arranged information to
10 the server using a CDMA module. In this manner, the present invention can remotely
monitor the states of the manholes using a wireless system more conveniently.

Furthermore, since wireless communication is performed among the server, the
relay terminal and the collecting terminal in real time, the server manager can confirm
normal operating states of the manholes and whether a communication device is
15 normally operated in real time.

Moreover, manholes located around a specific region can be collectively
managed using the relay terminal installed in the specific region.

In addition, the manager is informed of discharge of the battery so that the
collecting terminal can be prevented from being in an inoperative state due to the
20 discharge of the battery.

Furthermore, the relay terminal uses the solar cell and the CDMA
communication network so that its installation site is not restricted.

Moreover, the collecting terminal has strength and a waterproof function
because it is made of stainless steel and acetalresin. Thus, the internal circuit of the
25 collecting terminal can be protected when an excessive load is applied to a manhole or
the manhole is flooded.

Brief Description of the Drawings

30 Further objects and advantages of the invention can be more fully understood
from the following detailed description taken in conjunction with the accompanying

drawings, in which:

FIG. 1 is a block diagram of a wireless system for monitoring manholes according to the present invention;

FIG. 2 is a block diagram of a collecting terminal of the wireless system for monitoring manholes according to the present invention;

FIG. 3 is a block diagram of a relay terminal of the wireless system for monitoring manholes according to the present invention; and

FIG. 4 is a block diagram of a server of the wireless system for monitoring manholes according to the present invention.

10

Best Mode for Carrying Out the Invention

FIG. 1 is a block diagram of a wireless system for monitoring manholes according to the present invention, FIG. 2 is a block diagram of a collecting terminal of the wireless system for monitoring manholes according to the present invention, FIG. 3 is a block diagram of a relay terminal of the wireless system for monitoring manholes according to the present invention, and FIG. 4 is a block diagram of a server of the wireless system for monitoring manholes according to the present invention.

Referring to FIGS. 1, 2, 3 and 4, the wireless system for monitoring manholes (referred to as a "system" hereinafter) according to the present invention includes collecting terminals 10 each having an opening/closing sensor 2, a water-level sensor 4, a temperature sensor 6 and a terminal unit, a relay terminal 20, and a server 30. Components other than these components can be added to the system.

Each of the collecting terminals 10 includes the terminal unit 16 that has at least one of the opening/closing sensor 2, the water-level sensor 4 and the temperature sensor 6 and senses the internal state of a manhole using the sensor, and an RF communication module 14 that collects information of the manhole, sensed by the sensor of the terminal unit 16, and transmits the collected information to the relay terminal 20 using an antenna 13.

The opening/closing sensor 2 senses whether a manhole cover is opened or closed. The opening/closing sensor 2 is configured in the form of a lever type limit

switch fixed to the manhole cover. The opening/closing sensor 2 is installed in a manner that the manhole cover pushes a roller lever and, when the manhole cover is opened, the roller lever is returned and a switch contact operates.

In addition, the opening/closing sensor 2 includes a hard case of die casting,
5 which absorbs external impacts, and a 2-circuit dual-terminal basic switch made of heat-resistant phenol.

The opening/closing sensor 2 has oil-proof, heat-resistance and dustproof functions and high mechanical strength. Furthermore, a set position indicator is attached to the opening/closing sensor 2 for the purpose of preventing the lever from
10 over-working and maintaining a long life span, and thus the opening/closing sensor 2 can be safely used for a long period of time.

The water-level sensor 4 senses the water level of the inside of the manhole and is configured in the form of a tumbler type level switch. The water-level sensor 4 is set at the bottom of the manhole and, when the manhole is flooded, the water-level sensor 4
15 stands erect according to buoyancy and an internal switch contact operates.

The water-level sensor 4 is light and corrosion-resistant because it is made of a synthetic resin. Furthermore, the water-level sensor 4 includes a float switch having a tack switch, and thus it is stronger than a conventional mercury switch.

The temperature sensor 6 senses the temperature of the inside of the manhole. In
20 general, TGA130B that is a diode thermistor whose resistance varies with temperature is used as a temperature sensor. However, the temperature sensor 6 of according to the present invention employs STH10 of SENSIRION of Swiss, which is a digital temperature sensor, in order to improve current consumption, linearity and accuracy. Accordingly, the temperature sensor 6 according to the present invention has high
25 accuracy, low power consumption and it can measure even relative humidity.

The collecting terminal 10 further includes a low power controller 11 for collecting state information sensed by the sensors and controlling the sensors with a small current, the antenna 13 for wirelessly transmitting the state information from the low power controller 11, and a microcontroller 12 wirelessly communicating with the
30 relay terminal 20 using the RF communication module 14.

The collecting terminal 10 collects information on the manhole using the sensors and immediately transmits the collected information to the relay terminal 20 to which the collecting terminal belongs with a low power by wireless. Specifically, when information sensed by the sensors is input to the microcontroller 12 through the low power controller 11 that controls the sensors with a small current, the microcontroller 12 arranges the information and transmits it to the relay terminal 20 using the RF communication module 14 and the antenna 13.

The terminal unit of the collecting terminal 10 includes a battery 17 that supplies power required for a sensor connected thereto and provides power required for blocks of the collecting terminal 10. The collecting terminal 10 can further include a power sensor 8 capable of sensing whether the battery is discharged. In this case, when the battery 17 is discharged, a manager is informed of it to prevent the collecting terminal 10 from being in an inoperative state due to the discharge of the battery 17.

The information on the manhole includes the ID number of the manhole, the inner temperature of the manhole, sensed by the temperature sensor, the water level of the inside of the manhole, sensed by the water-level sensor, and whether the manhole cover is opened or closed, sensed by the opening/closing sensor.

The operation of the collecting terminal is explained in more detail.

The microcontroller 12 checks the opening/closing sensor and the water-level sensor once per second and checks the capacity of the battery (when the battery capacity becomes lower than 2.7V, it is immediately transmitted to the relay terminal) once per minute using the power sensor. In addition, the microcontroller 12 reads temperature data from the temperature sensor once per ten seconds and transmits information indicating whether the opening/closing sensor and the water-level sensor operate to the relay terminal right after the opening/closing sensor and the water-level sensor operate. Furthermore, when the temperature sensed by the temperature sensor exceeds 60°C, the microcontroller 12 transmits information representing it to the relay terminal and, when more than 5°C changes for ten seconds, transmits information representing this temperature variation to the relay terminal. When any one of the sensors does not operate for 24 hours, the current state of the collecting terminal is automatically transmitted to

the relay terminal 20.

The sensors are set inside the manhole and the terminal unit including the battery that supplies power to the sensors is set in the manhole. Circuits (including the antenna) connected to the sensors through cables to control the sensors are included in a
5 housing of the collecting terminal 10, which is buried around the manhole in the ground.

The housing of the collecting terminal includes a bottom plate made of stainless steel and a cover made of acetalresin, and thus the housing can endure a pressed load of 21 ton without having any damage. Furthermore, the housing has waterproof of IP67 grade at which water is not infiltrated into the housing even when the housing sinks in
10 the water for 30 minutes so that the housing can protect the internal circuit of the collecting terminal even when the manhole is flooded in the rainy season.

The microcontroller 12 uses ATmega16 that is a low power CMOS 8-bit microcontroller based on AVR RISC structure. Accordingly, a command is executed within a single clock cycle and a processing rate of 1MIPS/MHz is achieved according to
15 ATmega16, and thus power consumption can be minimized.

Preferably, the RF communication module 14 for wireless communication between the collecting terminal 10 and the relay terminal 20 is constituted in a manner that a foundation of an RF transmitting/receiving apparatus is designed using CC1020 of CHIPCON and control firmware is constructed using ATMEAGE16 microcontroller of
20 ATMEL. The RF communication module 14 employs an unauthorized communication method using a frequency of RF 424MHz.

The relay terminal 20 wirelessly communicating with a plurality of collecting terminals 10 through the RF communication module 14 is located having a predetermined distance from the collecting terminals 10, collects and arranges
25 information on a plurality of manholes, which is received from the collecting terminals 10, and wirelessly transmits the arranged information to the server 30 using a communication module, preferably, a CDMA module. Preferably, the relay terminal 20 is designed such that it can manage 250 collecting terminals.

The relay terminal 20 includes an antenna 21 for receiving state information in
30 the form of a radio wave signal, sensed by each sensor, from each collecting terminal 10,

an RF communication module 22 and a microcontroller 23-1 for converting the radio wave signal into data, a CDMA module 25 connected to the microcontroller through a connecting means to wirelessly communicate with a CDMA module 31 of the server 30 using a CDMA antenna 26, and a power supply for supplying power to the
5 aforementioned components.

The radio wave signal input through the antenna 21 of the relay terminal 20 is converted into data by the RF communication module 22 and the first microcontroller 23-1. The data is immediately transferred to a second microcontroller 23-2 and then transmitted to the server 30 through a connecting means, that is, RS232, the CDMA
10 module 25 and the CDMA antenna 26. The first microcontroller 23-1 controls the RF communication module 22 and the second microcontroller 23-2 controls the CDMA module 25.

The multiple microcontrollers 23-1 and 23-2 are used in order to improve the reliability of data transmission.

15 External data input to the relay terminal 20 is interrupt-processed, and thus a data processing order is determined according to priority. However, since the priority of data input to the relay terminal 20 from the collecting terminal and the priority of data input to the relay terminal 20 from the server can compromise with each other, the data from the collecting terminal and the data from the server are respectively processed using
20 separate microprocessors and they are connected through parallel handshake communication.

The CDMA module 25 uses BSM-800/850 of BELLWAVE. The CDMA module is connected through dialing using a CDMA public communication network and it transmits data using AT command as a general module does.

25 The power supply of the relay terminal 20 includes a solar cell 27 for converting solar energy into electric energy, a power controller 28 for receiving the electric energy from the solar cell 27 and charging a battery 29, and the battery 29 supplying power to blocks of the relay terminal using the power charged by the power controller 28.

The relay terminal 20 is installed at an electric pole or on the rooftop of a
30 building to which electric power cannot be easily provided, and thus the relay terminal 20

needs its own electric power plant. Accordingly, the power supply uses an amorphous solar cell.

The relay terminal 20 constructed as above employs multiple processors (the first and second microcontrollers) so that communication with the collecting terminal 10 and communication with the server 30 do not collide with each other. Furthermore, the site where the relay terminal 20 is installed is not restricted because the relay terminal 20 uses the solar cell, the CDMA module and the antenna. Accordingly, the relay terminal can be installed at the best radio wave transmission position to secure an excellent communication relay function.

Moreover, the relay terminal employs a PRFA (Planer Inverting F antenna) to improve communication reliability.

The relay terminal periodically reports its own state and the states of the collecting terminals to the server. Specifically, when the relay terminal is not communicated with a collecting terminal for 24 hours, the relay terminal reports breakdown of the collecting terminal to the server. Furthermore, the relay terminal transmits time information thereof to the server once per 24 hours even when any collecting terminal does not transmit any information such that the server confirms that the relay terminal is normally operated.

In addition, the relay terminal receives time information from the server and corrects the time information thereof using the received time information. Furthermore, when the relay terminal receives a collecting command from the server, the relay terminal reports contents of final communication with collecting terminals to the server.

The server 30 that wirelessly communicates with the relay terminal 20 through the CDMA module 31 includes the CDMA module 31 receiving information on manholes from the relay terminal using the CDMA antenna 32, a storage unit 33 storing the information on the manholes received from the CDMA module 31, a map data storage unit 36 storing map data used to indicate the positions of the manholes on an electronic map, a central processing unit 35 for controlling the information on the manholes to be displayed using the electronic map of the map data storage unit 36, and an alarm unit 34 for generating an alarm sound corresponding to the information on the

manholes.

The relay terminal 20 and the server 30 wirelessly communicate with each other in a frequency band of 848MHz using the CDMA modules 25 and 31.

The CDMA module 31 of the server includes an RF transmitter, an RF receiver
5 and a mode converter. The RF transmitter collects data from a transceiver module and wirelessly transmits an acknowledgement signal corresponding to the collected data. The RF receiver collects data from the transceiver module, processes the collected data and transmits the processed data to a CDMA interface. The mode converter converts a receiving mode to a transmission mode and converts the transmission mode to a
10 receiving mode when RF transmission and reception are carried out.

According to the above-described configuration of the server, the central processing unit 35 displays information on manholes, received from the relay terminal, using a display unit 37 such as a monitor and generates an alarm sound using the alarm unit 34. The display unit 37 can display current positions corresponding to the ID
15 numbers of the manholes using the electronic map of the map data storage unit 36.

When the central processing unit 35 receives information obtained by the collecting terminal 10 from the relay terminal 20, the central processing unit 35 transmits and displays the position and information corresponding to the ID number of a corresponding manhole to a manager and generates the alarm sound.

20 The central processing unit 35 stores received information on manholes in the storage unit 33 and manages the history of the information. When communication between the server and the relay terminal is cut off for 24 hours, the central processing unit 35 recognizes that the relay terminal 20 is out of order and generates an alarm sound to notify a server manager of the breakdown of the relay terminal 20. Furthermore, when
25 time data transmitted from the relay terminal 20 is wrong for longer than 5 minutes, the central processing unit 35 instructs the relay terminal to correct the time data.

The operation of the wireless system for monitoring manholes according to the present invention will now be explained in more detail.

The opening/closing sensor 2, the temperature sensor 4 and the water-level
30 sensor 6 connected to each collecting terminal 10 sense whether a manhole cover is

opened or closed, the temperature of the inside of a manhole, and the water level of the inside of the manhole, and the power sensor 9 senses whether the battery 17 included in the collecting terminal 10 is discharged or not. The collecting terminal 10 collects information including the sensing results and transmits the information to the relay
5 terminal 20 through the RF communication module 14 and the antenna 15.

The relay terminal 20 collects and arranges the information on the manhole, received from the collecting terminal 10, and transmits the arranged information to the server 30 through a CDMA communication network using the CDMA module 25 and the CDMA antenna 26.

10 The server receives the information on the manhole from the relay terminal 20 through the CDMA module and displays the information in real time using a display means such as a monitor to inform the manager of the current position of the manhole and whether the manhole is normally operated in real time.

Any means capable of performing wireless communication other than the
15 CDMA module and the CDMA antenna can be used as a communication module that carries out wireless communication between the relay terminal 20 and the server 30.

What Is Claimed Is:

1. A wireless system for monitoring manholes, comprising:

5 a plurality of collecting terminals each including a terminal unit that has at least one of an opening/closing sensor, a water-level sensor and a temperature sensor and senses the internal state of a manhole using the sensor included therein, and an RF communication module for collecting information on the manhole, sensed by the sensor included in the terminal unit, from the terminal unit, and transmitting the collected information to a relay terminal using an antenna;

10 the relay terminal collecting and arranging the information on a plurality of manholes, received from the plurality of collecting terminals, and wirelessly transmitting the collected and arranged information on the manholes to a server using a communication module; and

15 the server wirelessly receiving the information on the manholes using a communication module and displaying current states of the manholes in real time using the received information.

2. The wireless system according to claim 1, wherein each of the plurality of collecting terminals comprises:

20 a low power controller for collecting state information signals of a corresponding manhole, generated by sensors, from the terminal unit and controlling the sensors with a small current;

an antenna for wirelessly transmitting the state information signals of the manhole collected from the terminal unit;

25 a microcontroller controlling the collecting terminal to wireless communicate with the relay terminal using the RF communication module; and

a battery for supplying power to blocks of the collecting terminal

3. The wireless system according to claim 1, wherein the relay terminal
30 comprises:

an antenna for receiving state information signals of manholes from the collecting terminals;

an RF communication module and a microcontroller for converting the state information signals of the manholes, received by the antenna, into data;

5 a communication module connected to the microcontroller through a connecting means to wirelessly communicate with the server using an antenna; and

 a power supply for supplying power to the respective components of the relay terminal.

10 4. The wireless system according to claim 3, wherein the power supply comprises:

 a solar cell for converting solar energy to electric energy;

 a power controller for receiving the electric energy from the solar cell and charging a battery; and

15 the battery supplying power to the respective components using the power charged by the power controller.

 5. The wireless system according to claim 1, wherein the server comprises:

20 a communication module for receiving the information on the manholes from the relay terminal using an antenna;

 a storage unit for storing the information on the manholes received from the communication module and managing the history of the information;

 a map data storage unit storing map data used to indicate the positions of the manholes on an electronic map;

25 a central processing unit for controlling the information on the manholes to be displayed using the electronic map of the map data storage unit; and

 an alarm unit for generating an alarm sound corresponding to the information on the manholes.

30 6. The wireless system according to one of claims 1 through 5, wherein

information on a manhole includes the ID numbers of the manhole, the temperature of the inside of the manhole sensed by the temperature sensor, the water level of the inside of the manhole sensed by the water-level sensor, whether a manhole cover is opened or closed sensed by the opening/closing sensor, and whether the battery of the collecting
5 terminal corresponding to the manhole is discharged.

7. The wireless system according to claim 1, wherein the terminal unit further includes a power sensor for sensing whether the battery is discharged and transmitting the sensing result to the corresponding collecting terminal.

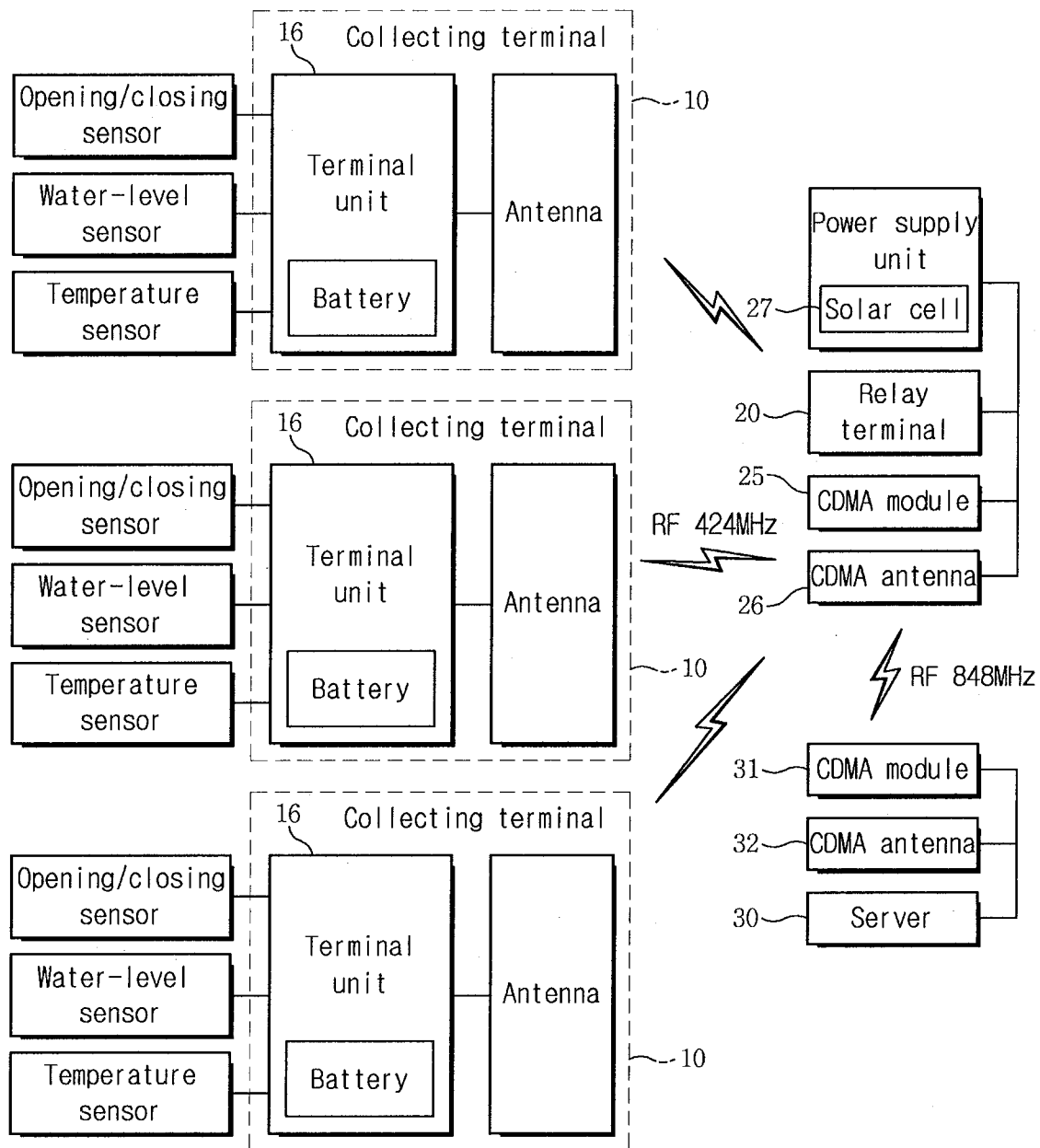
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8. The wireless system according to one of claims 1 through 5, wherein the communication module is a CDMA module.

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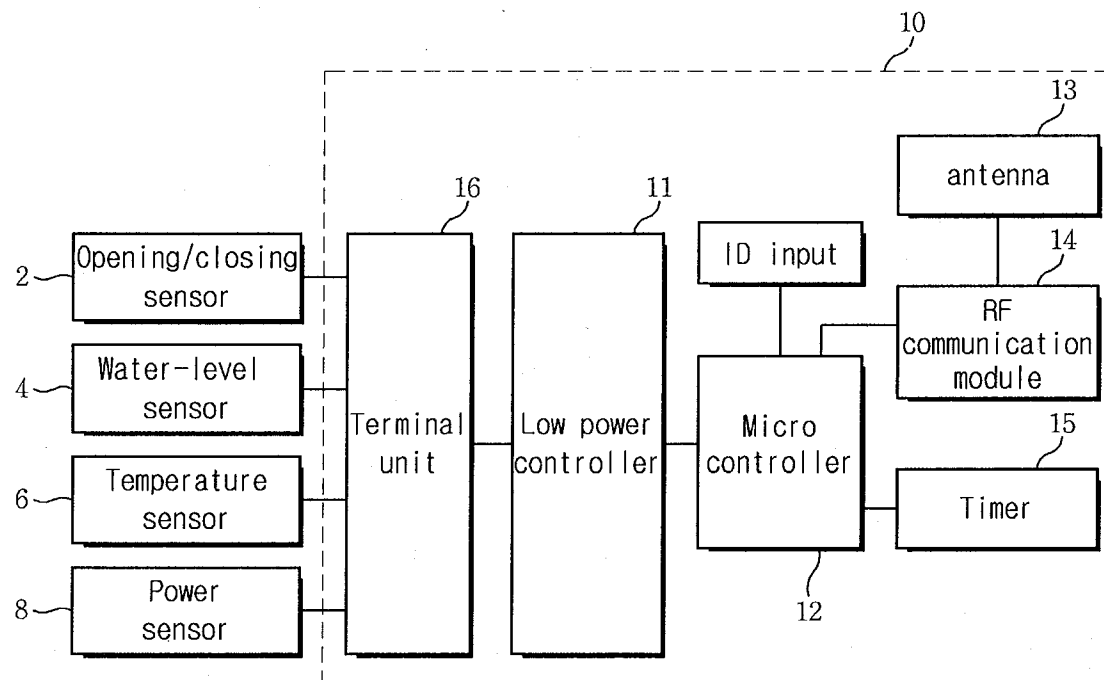
FIG 1

Fig. 1



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Fig. 2



3 / 3

Fig. 3

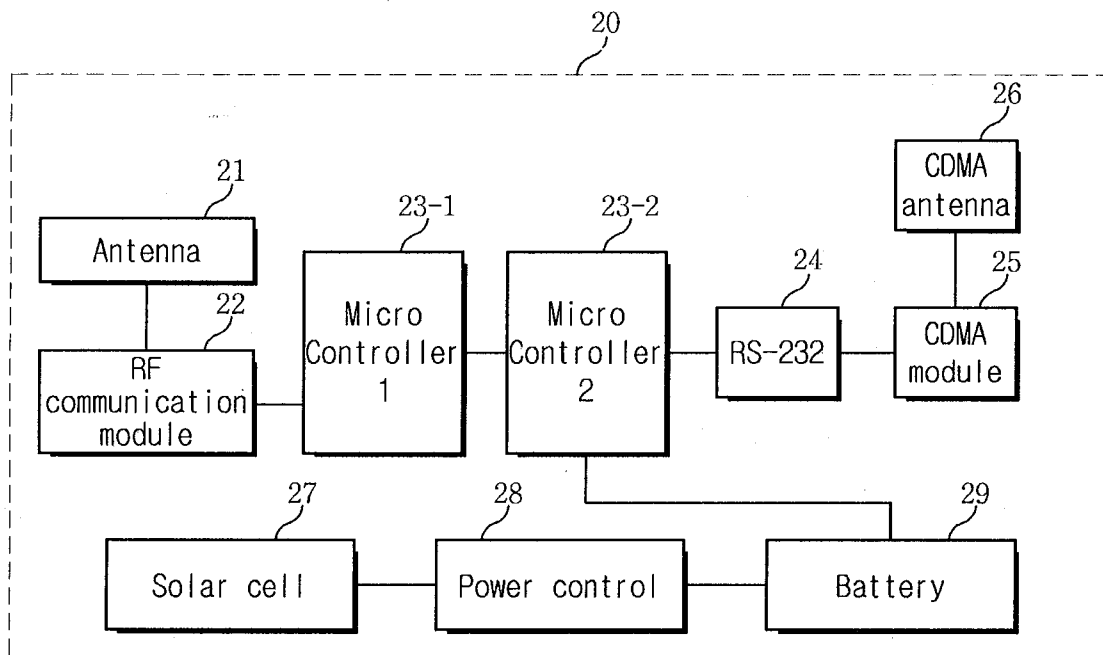
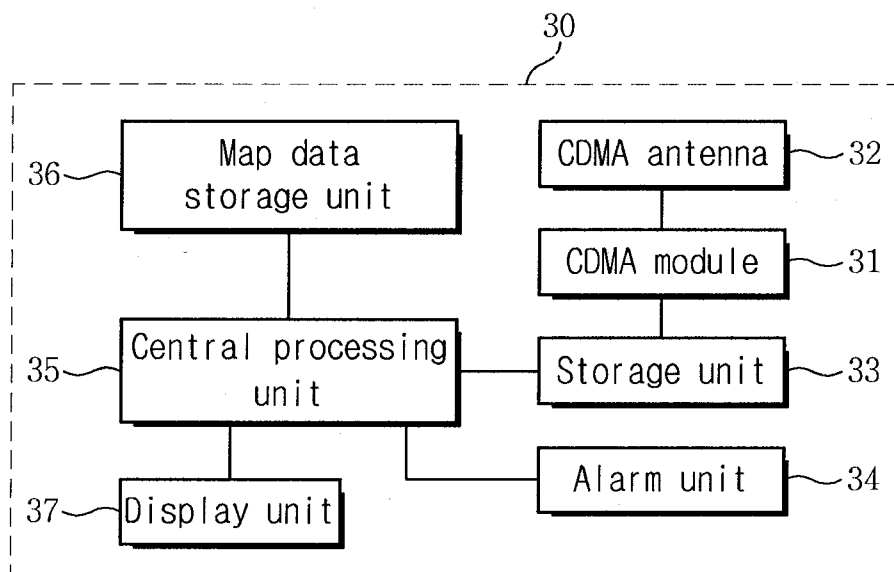


Fig. 4



A. CLASSIFICATION OF SUBJECT MATTER**G08C 17/02(2006.01);**

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)

IPC8 G08C 17/02; G08B 23/00; G08B 21/00

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

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKIPASS "MANHOLE, MONITORING"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 7002481 B1 (Patrick R. et al.) 21 February 2006 See the abstract; claims 1, 16-17; figures 1, 5.	1 2-8
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A	US 6414605 B1 (Brent Walden; Ivan P. DaSilva) 02 July 2002 See the abstract; claim 1; figure 1.	1-8



Further documents are listed in the continuation of Box C.



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

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

LEE, Jae Hoon

Telephone No. 82-42-481-5791



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