(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 407 776 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **90111713.5**

(51) Int. Cl.5: **G08B 25/10**

(22) Date of filing: **21.06.90**

(30) Priority: **14.07.89 US 379939**

(43) Date of publication of application:
16.01.91 Bulletin 91/03

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(71) Applicant: **COLLMER SEMICONDUCTOR, INC.**
14368 Proton Road
Dallas, Texas 75244(US)

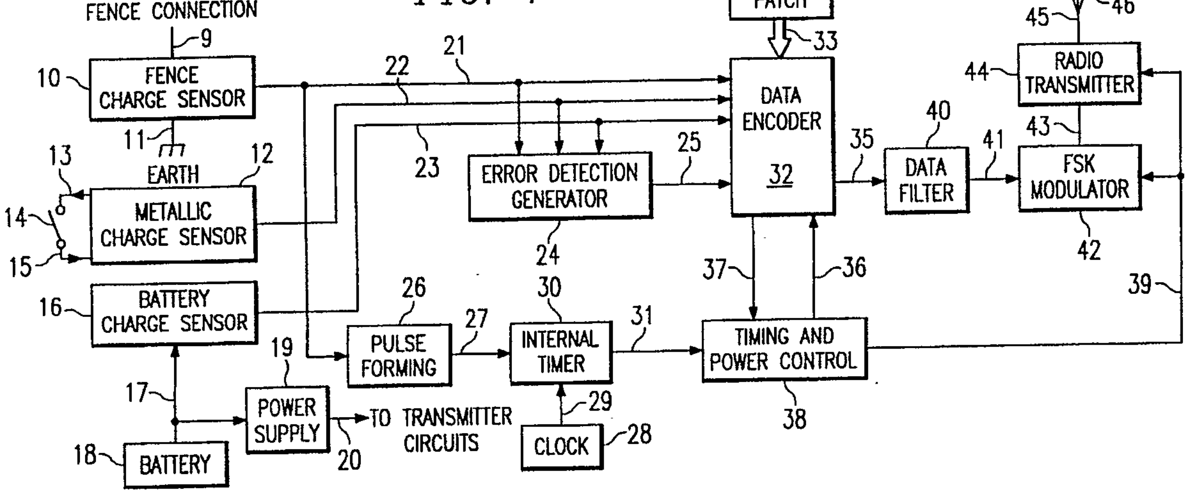
(72) Inventor: **Seals, David George**
6342 Lovers lane
Dallas, Texas 75214(US)
Inventor: **McDonald, Elzie Monroe, Jr.**
10021 Pensive Drive
Dallas,Texas 75229(US)
Inventor: **Blair, Herbert Woody, Jr.**
2509 Partridge Place
Carrollton, Texas 75006(US)
Inventor: **Tran, Christina Phan**
2911 Hunters Point
Carrollton, Texas 75007(US)

(74) Representative: **UEXKÜLL & STOLBERG**
Patentanwältelte
Beselerstrasse 4
D-2000 Hamburg 52(DE)

(54) **Radio telemetry monitoring system.**

(57) A system to monitor an electric fence or a secured area uses radio telemetry to report faults. The radio telemetry transmitter gathers data from a fence charge sensor, battery voltage sensor and/or switch contacts and encodes this information along with a unique address code in a serial data stream that modulates, by frequency shift keying (FSK), a radio frequency (RF) signal. A radio telemetry receiver intercepts the transmitted RF signal and compares the received address code to a preprogrammed unique address code. If code match occurs the received data is transferred to the appropriate displays. Various faults are reported visually and audibly. Fail-safe timers and error detector circuitry in the radio telemetry and transmitter receiver ensure the integrity of the radio telemetry link.

FIG. 1



EP 0 407 776 A2

RADIO TELEMETRY MONITORING SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to electric fence monitors, security systems and radio telemetry, and more specifically to improved techniques of reliably reporting faults or sensor changes in electric fence monitors and security systems using radio telemetry.

BACKGROUND OF THE INVENTION

Charged electric fences have frequently been used in rural areas for livestock containment and as such are usually located remotely from the operator's home. Fence failure occurs when the charging apparatus fails to provide adequate charge, or when the fence wiring is broken, short-circuited or poorly grounded. Operators of electric fences must make frequent inspections to determine proper operation. Inspecting fences is time consuming and costly. Providing the operator with a radio telemetry link that reliably reports fence faults to his home or vehicle reduces cost and time spent in needless fence inspections.

Similarly, secured areas require reliable monitoring for intrusions. Having the ability to use radio telemetry in conjunction with an area's security systems reduces limitations caused by direct wiring, allows easy monitoring of areas that are difficult to reach, and permits monitoring from a mobile vehicle.

SUMMARY OF THE INVENTION

This invention provides for apparatus and methods for reliably monitoring the condition of remote physical objects, such as charge on electric fences and intrusions into secured areas, by using a radio telemetry link Inputs to a transmitter may indicate, for example, the absence of charge on an electric fence, closure of a metallic switch, or a low battery charge condition. Other possible applications of the present invention include, but are not limited to, monitoring water tank and other liquid levels, closure of gates, engine operation, vehicle traffic across a point, vibration and sound levels, motion and velocity levels, and temperature and pressure limits; as well as the detection and reporting of fire, smoke, water, gas, physical movements, entry of people into buildings and the arrival of vehicles. Changes in the inputs of the transmitter are reliably reported to a receiver using radio telemetry techniques. The receiver, which may be mobile, receives and decodes the radio signal and thereby monitors the electric fence or secured area.

The present invention has several features which provide for more cost-effective and reliable monitoring and reporting than prior apparatus and methods: digital signalling techniques, frequency shift keying, low duty cycle timing, data filtering, data error detection, fail- safe techniques, special fence charge sensors, and instant fault reporting.

With digital signalling, a plurality of radio transmitters and receivers may share a common radio frequency. Each receiver and transmitter is assigned a unique address code, thereby permitting those receivers and transmitters in the system to ignore other radios or systems operating on the same radio frequency. Other systems in close proximity that share the same radio frequency create, however, the potential for interference. To greatly decrease the probability that transmitters sharing the same frequency in close proximity will cause interference, on-to-off duty cycle time of the transmitter is in milliseconds-to-minutes.

A reliable radio telemetry link is provided by the use of frequency shift keying (FSK) modulation of the radio frequency (RF) signal to transmit digital data containing the inputs to the transmitter. In FSK, an RF carrier signal is shifted between two frequencies within an allowed radio frequency spectrum. Frequency modulation, such as FSK, has the inherent ability to reject impulse noise associated with thunderstorms and automobile ignitions. As a result of the use of the RF signal, a radio telemetry transmitter and radio telemetry receiver may be subjected to noise generated by thunderstorms and automobile ignition. FSK provides a more reliable radio telemetry link.

In order to achieve faster data transmission rates, the data to be transmitted is filtered to change the fast-rising and fast-falling edges of the digital waveform to a trapezoidal waveshape. The trapezoidal waveshape requires a smaller transmission bandwidth spectrum than the normal digital waveform, thus permitting faster transmission data rates. To further reduce the probability of error in the transmission of digital signals via the radio telemetry link, digital error detecting circuits are used in the transmitter and receiver.

Important to having a reliable radio telemetry monitoring system is the monitoring of the radio link for conditions which compromise system integrity. The receiver has associated with it circuitry that monitors the time between which the remote radio telemetry transmitter transmits updates on the states of the monitoring sensors. If a transmitter fails to "check in" after a predetermined time, the remote transmitter is considered to be in fault. This fail-safe monitoring circuitry is comprised of a count-down circuit which is reset each time an address code is received that matches a transmitter code in the system. If a preset count-down time is allowed to elapse without reset, the user is alerted by visual and/or audio alarms that a system failure has occurred.

Another feature of this invention is a fence charge sensor. An electric fence is typically charged with high-voltage pulses of either positive or negative polarity at a constant rate or frequency. The fence charge sensor converts the narrow high-voltage pulse into a logic high or logic low level, depending upon whether the voltage magnitude of the pulse is above or below a predetermined voltage level. If more than a predetermined number of successive pulses are missed, the number of pulses being chosen to accommodate the occasional grounding by weeds blown against the fence, the fence charge sensor output goes low, indicating a fault condition in the electric fence.

Yet another feature of the invention is an antenna circuit comprising an antenna counterpoise wire in addition to the antenna so as to significantly improve system performance by increasing radio frequency energy coupling into and out of the atmosphere.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram of the radio telemetry transmitter:

FIGURE 2 is the schematic diagram for the fence charge sensor.

FIGURE 3 is a diagram of the on-to-off duty cycle timing of the radio telemetry transmitter.

FIGURE 4 is a diagram showing the composite serial address and data stream.

FIGURE 5 is the schematic diagram for the data filter in the radio telemetry transmitter.

FIGURE 6 is a block diagram of the radio telemetry receiver.

FIGURE 7 is the block diagram for the telemetry receiver data error detection and latch.

FIGURE 8 is a drawing of the transmitter antenna, case and antenna tail.

DETAILED DESCRIPTION

Referring to FIGURE 1, the radio telemetry transmitter block diagram is shown. Connected to the radio telemetry transmitter are fence charge sensor 10, metallic contact sensor 12 and battery charge sensor 16, though just one sensor need be connected.

In the metallic contact sensor circuit 12, current is supplied on line 13 to switch 14. When switch 14 is open, the voltage on line 15 is held to a logic low level with a pull-down resistor. When switch 14 is closed, current flows through line 13 and switch 14 to line 15, elevating the voltage on line 15 to a logic high level. The signal on line 15 is filtered and connected to line 22. A logic high voltage on line 22 represents a closed switch, and a logic low voltage an open switch.

The schematic of fence charge sensor circuit 10 is shown in FIGURE 2. Fence input 9 is connected directly to an electric fence. The voltage on the electric fence takes the form of a series of very high voltage pulses of either positive or negative polarity, and ranges from 0 to 10,000 volts. Special care, thus, must be taken to insulate fence input 9 from short-circuiting or arcing to nearby objects. Earth input 11 is connected to a ground rod driven sufficiently deep into the earth's soil to provide a return current path. Resistors 102 and 104 form a high impedance, high-voltage divider between fence input 9 and earth input 11. The resistance values for divider resistors 102 and 104 are selected to upset the steady state balance of the input circuit of comparator 111, comprised of high impedance reference voltage sources 1 and 2 and diodes 107 and 108, when a voltage of a predetermined, minimum magnitude is applied between fence input 9 and earth input 11.

When the input circuit of comparator 111 is in a steady state balance, reference voltage 2, connected to the non-inverting input of comparator 111, is slightly more positive than reference voltage 1, connected to the inverting input of comparator 111. This holds the voltages at the output line 112 of comparator 111 to a logic high. Voltage references 1 and 2 are each supplied by a high impedance voltage source, the voltage of which depends on the magnitude of the current supplied by them.

When the steady state balance of the input circuit is upset by a voltage exceeding a minimum predetermined magnitude applied across the fence input 9 and the earth input 11, the voltage on output line 112 of comparator 111 goes to a logic low. Voltage reference 1 is set so that, when the voltage placed across fence input 9 and earth input 11 is positive and exceeds the minimum magnitude, diode 107 is forward biased and conducting. Diode 108 remains reverse biased and does not conduct. Current flowing through diode 107 has the effect of raising the voltage at the inverting input of comparator 111 higher than the voltage at the non-inverting input, thereby causing the output on line 112 of comparator 111 to go low. When a negative voltage exceeding the predetermined magnitude is placed across earth input 11 and fence input 9, diode 108 is forward biased and conducting. The current is supplied from reference voltage 2, thereby causing the voltage at the non-inverting input to drop below the voltage at the inverting input. The voltage on output line 112 of comparator 111 goes low. Whenever the voltage on output line 112 goes low, the fence is, therefore, either positively or negatively charged.

When the voltage on output line 112 is held to a logic low level, transistor switch 117 turns on and supplies current through resistor 119 to charge capacitor 121 at a rate much faster than it is discharged through a resistor 124, connected in parallel with capacitor 121. The voltage across capacitor 121 is supplied to the inverting input of comparator 128; voltage reference 4 is connected to the non-inverting input. When the output of comparator 111 is low, causing transistor switch 117 to charge capacitor 121, the voltage across this capacitor exceeds voltage reference 4, thereby holding the voltage on the output of comparator 128 to a logic low. When the voltage on output line 112 is held high, transistor switch 117 turns off, allowing resistor 124 to slowly discharge capacitor 121. When the voltage across capacitor 121 falls to less than voltage reference 4, the output of comparator 128 on line 21 goes to a logic high indicating a fault condition. Values for resistor 119 and capacitor 121 are selected to allow sufficient charging from a pulse which has a duration of less than 300 microseconds and repetition rate of 1 second. The value for resistor 124 is chosen so that several missed pulses, which occur when weeds contact charged fence wires during strong winds, will not cause incorrect fence fault reporting.

Referring back to FIGURE 1, battery charge sensor 16 monitors the voltage of battery 18. The output voltage of battery 18 is applied to the battery charge sensor circuit 16 on line 17. Battery charge sensor 16 is a threshold detector circuit and operates by raising the voltage on line 23 to a logic high when the voltage of battery 18 falls below a predetermined value. The output voltage of battery 18 is also connected to a power supply 19 via line 17. All radio telemetry transmitter circuits shown in FIGURE 1 obtain power from power supply 19 via line 20.

As previously explained, the radio telemetry transmitter sends sensor data to a receiver at regular intervals. To control the on/off duty cycle of the transmitter, an internal timer 30, driven by a clock 28 via line 29, controls the timing of the cycles. To generate the transmitter duty cycle, clock 28 provides, on line 29, a square wave pulse train at a frequency controlled by a resistor and capacitor timing circuit. A typical duty cycle is illustrated in FIGURE 3. The internal timer 30 includes a binary counter and reset circuit. The binary counter counts a predetermined number of clock pulses and resets itself to zero and starts the process again. The reset pulse generated by the reset circuit also appears on line 31 and initiates the data transmission sequence.

The reset pulse generated by internal timer 30 on line 31 is coupled to a timing and power control circuit 38. Timing and power control circuit 38, after receiving a pulse on line 31, switches on a radio transmitter 44 and FSK modulator 42 by placing battery voltage on line 39. After a preset delay to allow the transmitter and modulator circuits to stabilize, the logic signal from the timing and power control circuit 38 on line 36 changes states, triggering a data encoder 32 to transmit data to the modulator circuit. Upon completion of data transmission, the logic level of the voltage on line 37 from the data encoder 32 changes to indicate "end of transmission" and to reset timing and power control circuit 38. Resetting timing and power control circuit 38 causes battery voltage to be removed from line 39. By removing battery voltage from radio transmitter 44 and FSK modulator 42 the battery 18 is reduced to standby power consumption to maximize useful battery life.

The radio telemetry transmitter also transmits when a fault is indicated by one of the sensors. A pulse of short duration on line 27 from pulse forming circuit 26 overrides the normal duty cycle and causes internal timer to generate a reset pulse on line 31 and initiate a data transmission sequence for immediate transmission of data indicating a fence charge fault, metallic switch closure, or low battery charge condition. If, for example, as shown in FIGURE 1, the fence charge sensor 10 is connected to the pulse forming circuit 26 through line 21, the pulse forming circuit generates a narrow pulse in response to the rising edge of a voltage transition in the output of the fence charge sensor. The voltage transition indicates a failure in the fence charge. In response to the voltage transition, the internal timer circuit 30 causes the timing and power control circuit 38 to initiate the transmission of a fence charge fault condition on the instant of its occurrence. Although only shown connected to the fence charge sensor 10, the input of the pulse forming circuit 26 may also be connected to metallic contact sensor 12 to report switch closing for security applications.

As also shown in FIGURE 1, an error detection generator 24 receives data signals from the fence charge sensor 10, the metallic contact sensor 12, and the battery charge sensor 16. These data signals, on lines 21, 22 and 23, respectively, are evaluated by the error detection generator 24 to determine parity. If the data signals on these lines have data values of even parity, the error detection generator 24 produces an output voltage on line 25 at a logic high; otherwise, the voltage on line 25 remains at a logic low. Signals on lines 21, 22, 23 and 25 comprise data which is to be encoded in a data encoder 32 and transmitted to a remote receiver-decoder.

Data encoder 32 combines the unique address code from an address patch 34 and data signals on lines 21, 22, 23 and 25 into a serial data stream. The typical bit pattern of the serial data stream is shown in FIGURE 4 and comprises address code bits 83 followed by the bits of data 84 from data signals on lines 21, 22, 23 and 25. When the signal from the timing and power control 38 on line 36 goes to a logic high, the serial data stream is gated out on line 35.

Referring now to FIGURES 1 and 5, the serial data stream output from data encoder 32 on line 35 connects to the input of the data filter 40. The serial data stream on line 35 connects to an integrator comprising a resistor 87, capacitor 91 and comparator 92. Voltage reference 5 on line 93 provides the reference voltage for comparator 92. Values for resistor 87 and capacitor 91 are selected to cause the fast rising and falling edges of the data stream to be reshaped into a ramped-square wave as shown in FIGURE 5. Zener diodes 88 and 90 limit voltage peaks in the data signals to the breakdown voltage characteristics of the diodes. The waveform of the output data signals, therefore, has an overall trapezoidal waveshape. Filtering each data signal into a trapezoidal waveshape limits the radio frequency (RF) modulation spectrum bandwidth to allow for faster transmitted data rates than would be possible without filtering.

Referring now only to FIGURE 1, the output of data filter 40 is connected by means of line 41 to the input of an FSK modulator 42. FSK modulator 42 is comprised of a voltage controlled crystal oscillator with its voltage input being the filtered serial data stream on line 41. The output of FSK modulator 42 is an RF signal modulated by the filtered serial data stream. The modulated RF signal is amplified and impedance matched to antenna 46. The amplified RF signal is connected to antenna 46 via line 45 for transmission to a remote receiver.

Referring to FIGURE 8, there is shown a detail of the antenna 46 comprising a transmitter antenna 129, case 130 and antenna counterpoise wire or antenna tail 131. Balancing high frequency energy between the antenna 129 and antenna tail 131 significantly improves the transmission of radio frequency energy from the antenna 46. The length of the antenna tail 131 is slightly less than one-fourth of the free space wavelength of the RF signal at its operating frequency, or some integral multiple of one-fourth of a wavelength. In a like manner, the performance of the receiver antenna to be described, is also improved by using a counterpoise wire.

Referring to FIGURE 6, there is shown a block diagram of the radio telemetry receiver. System power is supplied to all circuit components of the telemetry receiver from either a transformer-rectifier-filter circuit or an appropriate battery.

Antenna 47 intercepts the transmitted signal from the antenna 46 and supplies it via line 48 to a radio receiver and frequency shift keying (FSK) detector circuitry 49. The radio receiver and FSK detector receive and demodulate the RF signal, and produces on line 50 a replica of the filtered serial data stream signal along with unwanted noise.

Connected to line 50 is a Filter and Schmitt-Trigger waveshaping circuit 51 which contains an audio bandpass filter to bracket the data bandwidth spectrum and remove unwanted noise from the serial data stream signal. The Schmitt-Trigger waveshaping circuit removes the trapezoidal waveshape from the signal which had previously been added as a processing step in the telemetry transmitter. After filtering and reshaping, the serial data stream is transferred to a data decoder 53 via line 52.

Data decoder 53 compares a unique preprogrammed address code, supplied by address patch 55 via line 54, to the serial data stream on line 52. As the serial data stream is received, the address code bits are compared to the unique address code on line 54. If a match occurs, the signals corresponding to the data portion 84 of the serial data stream are transferred as data input to lines 62, 63, 64 and 65, and the voltage on line 66 goes to a logic high.

Data input on lines 62, 63, 64 and 65 is checked for correct parity by an error detection decoder and latch 70. Referring to FIGURE 7, there is shown a schematic of error detection decoder and latch 70. Parity is checked by parity decoder 99. Correct parity is indicated by a logic high on line 98. If the voltage on line 98 is a logic high and the voltage on line 66 is a logic high, indicating that a valid address was received, the voltage output of AND gate 94 on line 61 is a logic high. A logic high on line 61 indicates a valid address code was received and the correct parity was detected. Line 61 is connected to the enable input of a latch 100. A logic high on line 61 enables latch 100 to store the data appearing on lines 95, 96 and 97, which correspond to the data on lines 62, 63 and 64, respectively, and provide it to lines 75, 76 and 77, respectively.

Referring back to FIGURE 6, data line 75 is connected to a fence fault indicator 78 and indicates if a fault has occurred in the charged fence. Similarly, data line 76 is connected to a switch contact indicator 79 to indicate whether the switch

14 is opened or closed. Data line 77 is connected to a low battery indicator 80 which indicates whether the battery voltage has dropped below a predetermined level. These three indicators are visual and, in one embodiment, are lamp indicators.

Also connected to data lines 75, 76 and 77 is an alarm driver 74 having a fourth input connected to line 67 from a counter 60. If the voltage on any of these four lines goes to a logic high, the voltage on line 71, connected to the output of alarm driver 74, also goes to a logic high. When switch 72 is closed, thus connecting line 71 to line 73, the logic high will cause an audible alarm to sound thereby indicating that there is a fence fault, a switch contact closure, a low battery, or that the fail-safe timer has timed out.

The fail-safe timer comprises a clock 58 and counter 60. Clock 58 is a square wave oscillator whose frequency is controlled by a resistor and capacitor timing circuit. Line 59 connects the output of clock 58 to counter 60 so that counter 60 never stops counting during the operation of clock 58. Counter 60 is reset to zero and starts counting again only when a valid address code and correct data parity check is detected by the error detection decoder and latch 70 and indicated by the voltage on line 61 going to a logic high. A logic high on line 61, which is connected to the reset input of counter 60, causes counter 60 to restart its counting sequence. If counter 60 is allowed to count to a preprogrammed final count without being reset, the voltage signal on line 67 goes to a logic high. A logic high on line 67 is inverted by an inverter 68 and causes the voltage on line 69 to switch to a logic low. When the voltage line 69 switches to a logic low, a radio indicator light 82 turns off, indicating that either no signal has been received, data parity errors have occurred or that a valid code match has not occurred. If switch 72 is closed, an audible alarm will also occur when the signal on line 67 goes high, alerting a user that a failure has occurred in the system.

Although particular embodiments of the invention have been illustrated in the accompanying drawings and described in the foregoing detailed description, it is expected that alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it will be understood that the invention is not limited to the embodiments disclosed, but is intended to embrace all such alternatives, modifications and variations as fall within the spirit and scope of the invention.

Claims

1. A radio telemetry system for reporting faults indicated by a monitoring sensor comprising:

a radio telemetry transmitter coupled to a monitoring sensor, including means for generating a data signal corresponding to the output of the monitoring sensor and a means for modulating a signal in response to said data signal, and means for transmitting the modulated signal by a radio telemetry link; and

a radio telemetry receiver for receiving the modulated and transmitted signal, including means for detecting the data signal coupled to means for showing that the output monitoring sensor indicates a fault.

2. The radio telemetry system according to Claim 1 wherein said radio telemetry transmitter further includes means for generating a second data signal corresponding to an address code assigned to the radio telemetry transmitter.

3. The radio telemetry system according to Claim 2 wherein said radio telemetry receiver further includes means for matching a predetermined address code with the address code corresponding to the detected second data signal.

4. The radio telemetry system according to Claim 1 wherein said means for modulating includes means for frequency shift key (FSK) modulation.

5. The radio telemetry system according to Claim 4 wherein said radio telemetry transmitter further includes means for filtering said data signal to reduce the spectrum bandwidth of the modulated RF signal.

6. The radio telemetry system according to Claim 1 wherein the radio telemetry transmitter includes means for initiating the transmission of the modulated signal within a predetermined time interval measured from the last previous broadcast.

7. The radio telemetry system according to Claim 6 wherein the radio telemetry receiver includes means for measuring the time interval between transmissions of said modulated signal by said radio telemetry transmitter and for indicating that a predetermined time interval has lapsed between transmissions.

8. The radio telemetry system according to Claim 6 wherein the radio telemetry transmitter's on duty cycle time, during which the modulated RF signal is transmitted, is less than one second, and its off-duty cycle time is greater than one minute.

9. The radio telemetry system according to Claim 6 wherein the radio telemetry transmitter transmits the modulated signal when the monitoring sensor indicates a fault condition.

10. The radio telemetry system according to Claim 1 wherein said monitoring sensor comprises means for monitoring the presence of charge on an electric fence.

11. The radio telemetry system according to Claim 1 including a counterpoise wire antenna for transmitting the modulated signal to said radio telemetry

receiver.

12. A radio telemetry system for reporting faults indicated by a monitoring sensor comprising:

a radio telemetry transmitter, including means for generating a first data signal corresponding to the output of a monitoring sensor coupled thereto and a second data signal corresponding to an address code for the radio telemetry transmitter, means for modulating the frequency of a signal with said first and second data signals and means, coupled to the means for generating and to the means for modulating, for initiating transmission of said signal over a radio telemetry link within a predetermined time interval measured from the previous broadcast; and

a radio telemetry receiver including means for receiving the modulated signal, means detecting a replica of said first and second data signals, means for matching the address code corresponding to said second data signal with a predetermined address code, and means, coupled to the output of the means for detecting, for showing, if the address codes match, whether the output of the monitoring sensor indicates a fault.

13. The radio telemetry system for reporting faults indicated by a monitoring sensor as set forth in Claim 12 wherein said means for initiating transmission initiates transmission of the modulated signal when the monitoring sensor indicates a fault condition.

14. The radio telemetry system for reporting the status of a monitoring sensor as set forth in Claim 12 wherein said monitoring sensor comprises means for detecting a charge on an electric fence at a fixed pulse rate and means for indicating that a predetermined time interval has lapsed since the last charge pulse.

15. The radio telemetry system according to Claim 14 wherein said means for detecting detects both negatively and positively charged pulses.

16. The radio telemetry system according to Claim 12 wherein said radio telemetry transmitter further includes means for generating a third data signal corresponding to the parity of the bits of said first and second data signals, and wherein said radio telemetry receiver comprises means for detecting an error in transmission or detection of the said first and second data signals with said third data signal.

17. A method for reporting a fault indicated by a monitoring sensor with a radio telemetry link comprising:

generating a data signal comprising bits corresponding to a signal from a monitoring sensor and to an address code;

frequency modulating a signal with the data signal;

transmitting the modulated signal by means of a radio telemetry link;

receiving the modulated signal;

detecting in the modulated signal the data signal;

matching the address code corresponding to the detected data signal with a predetermined address code; and

determining, if the address codes match, whether a fault is indicated by the part of the detected data signal corresponding to the output of the monitoring sensor.

18. The method for reporting a fault condition indicated by a monitoring sensor according to Claim 17 wherein the data signal is generated and the modulated signal is transmitted within a predetermined time interval measured from the last previous transmission or upon the monitoring sensor sensing a fault.

19. The method for reporting a fault condition indicated by a monitoring sensor as described in Claim 17 wherein the step of generating a data signal further includes generating parity a bit corresponding to the parity of the data transmitted by the modulated signal.

20. The method for reporting a fault condition indicated by a monitoring sensor according to Claim 19 further comprising the steps of checking the parity of the detected data signal for comparison with the value of the parity bit.

21. An electric fence charge sensor for indicating a charge fault condition of the electric fence, comprising:

means for sensing charge pulses repeating at a fixed rate on the electric fence;

means coupled to the means for sensing for determining that a predetermined number of charge pulses have not been sensed thereby indicating a fault condition on the electric fence.

22. The electric fence charge sensor according to Claim 21 wherein:

said means for sensing charge pulses includes a voltage comparator coupled to the electric fence for comparing the magnitude of the voltage of the charge pulses with a first predetermined reference level, the comparator generating a first logic level when the voltage of the charge pulses is above the first predetermined logic and, when the magnitude of the voltage of the charge pulses is below the first predetermined level, generating an output of the comparator at a second logic level; and

said means for determining includes means for charging a capacitor at a first rate when the output of the comparator is at the first logic level, and for discharging the capacitor at a second rate when the output of the comparator is at the second logic level, said means for determining including a second comparator connected to said capacitor such that when the voltage across the capacitor drops below a second voltage level, said second comparator generates an output at a logic level indicating a fence fault.

23. The electric fence charge sensor according to Claim 22 wherein the first rate and second rate are chosen such that the voltage across the capacitor drops below the second predetermined voltage only when the predetermined number of charge pulses on the electric fence have gone undetected.

24. The electric fence charge sensor as described in Claim 20 wherein said means for sensing charge pulses on the electric fence responds to charge pulses of negative or positive polarity having a magnitude exceeding a predetermined voltage level.

25. A means for transmitting an RF signal by means of a remote radio telemetry transmitter comprising:

an antenna; and

an antenna tail, coupled to said antenna, having a length equal to less than one-fourth of the wavelength of an RF signal, or an integral multiple thereof.

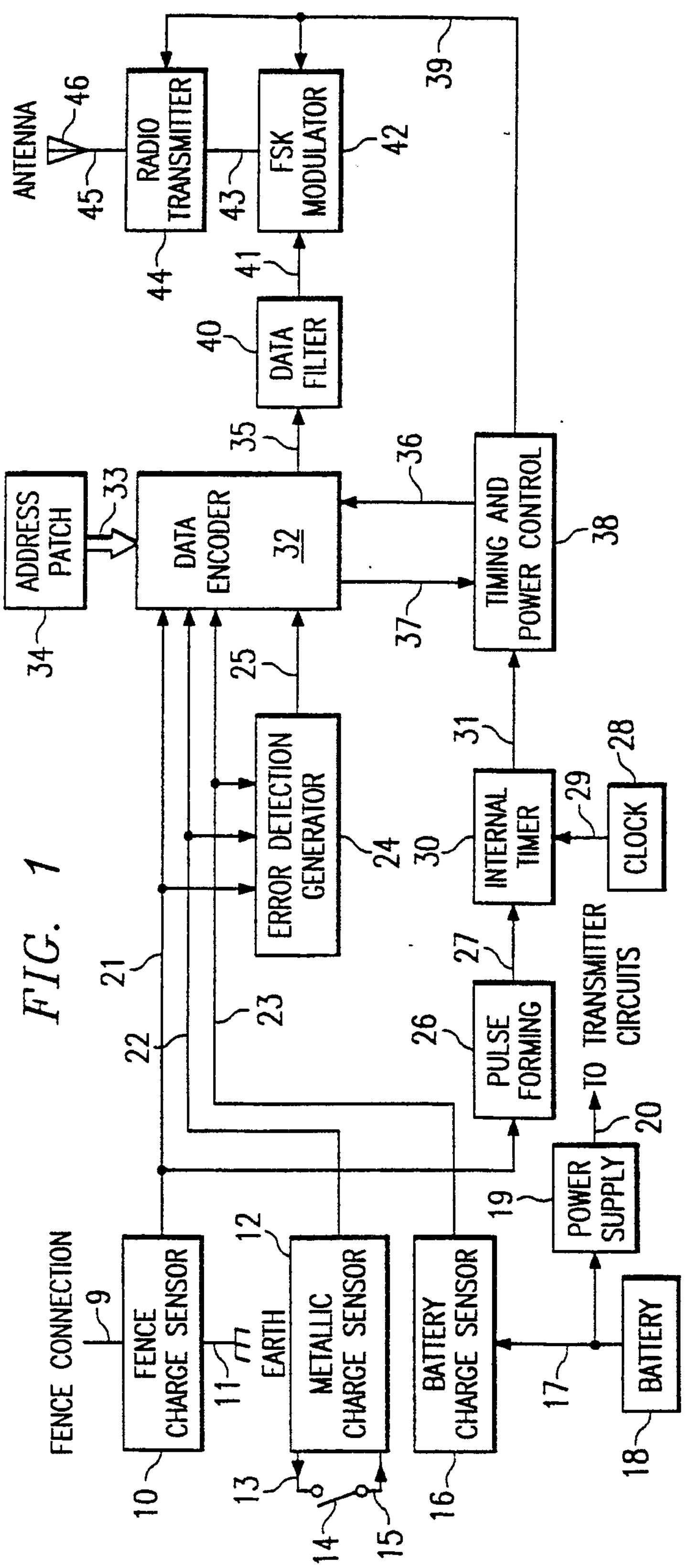

FENCE CONNECTION
FENCE CHARGE SENSOR
EARTH
METALLIC CHARGE SENSOR
BATTERY CHARGE SENSOR
BATTERY
POWER SUPPLY
TO TRANSMITTER CIRCUITS
PULSE FORMING
INTERNAL TIMER
CLOCK
ERROR DETECTION GENERATOR
DATA ENCODER
32
ADDRESS PATCH
TIMING AND POWER CONTROL
DATA FILTER
FSK MODULATOR
RADIO TRANSMITTER
ANTENNA
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
33
34
35
36
37
38
39
40
41
42
43
44
45
46

FIG. 1

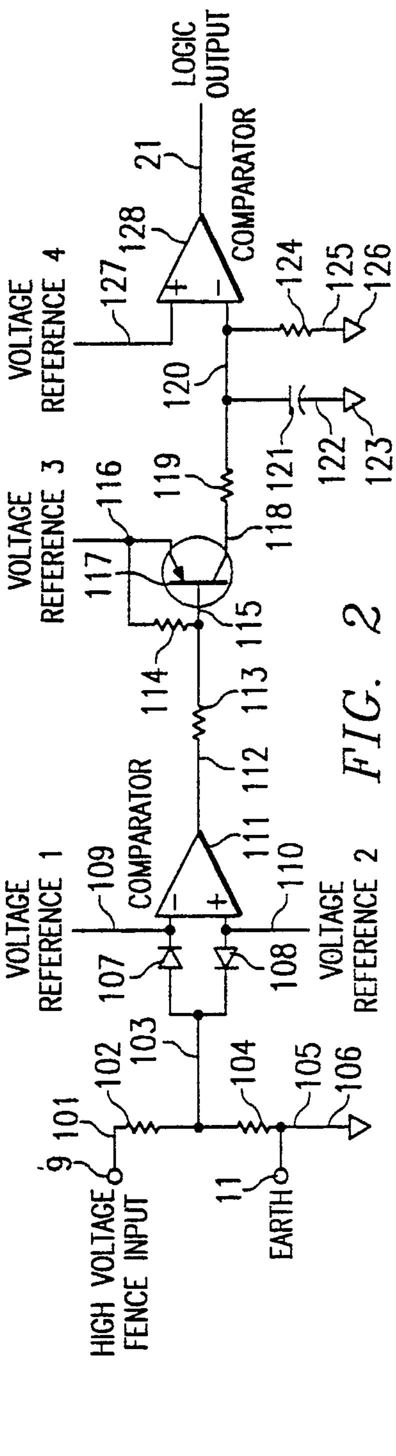

HIGH VOLTAGE FENCE INPUT
EARTH
VOLTAGE REFERENCE 1
VOLTAGE REFERENCE 2
COMPARATOR
VOLTAGE REFERENCE 3
VOLTAGE REFERENCE 4
COMPARATOR
LOGIC OUTPUT
9
11
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
21

FIG. 2

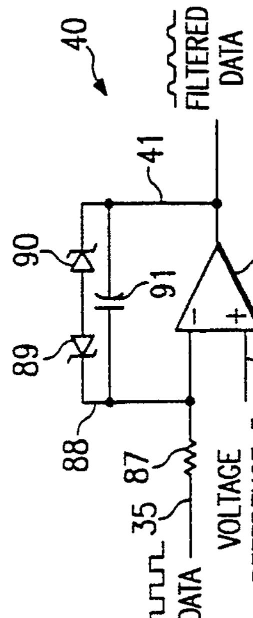


FIG. 5

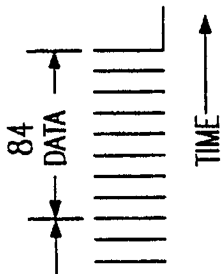


FIG. 4

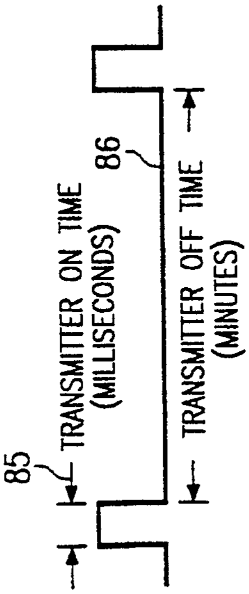


FIG. 3

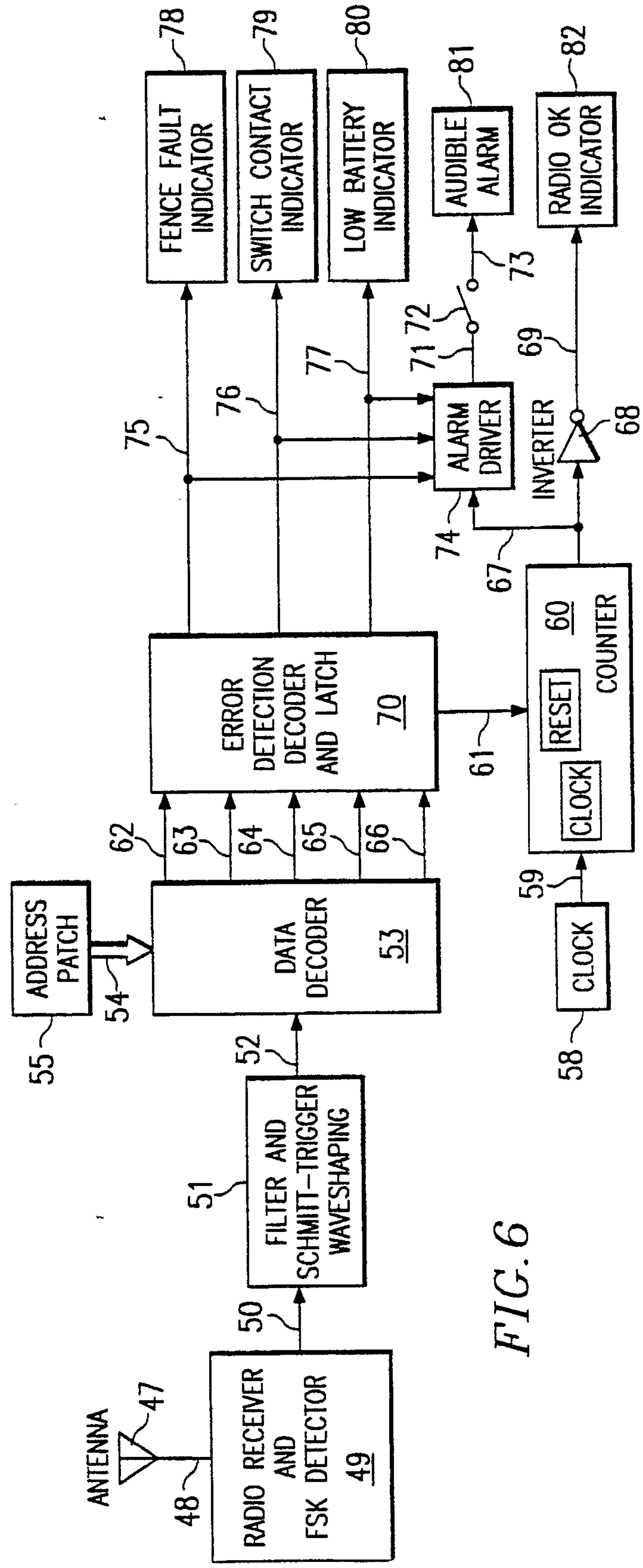


FIG. 6

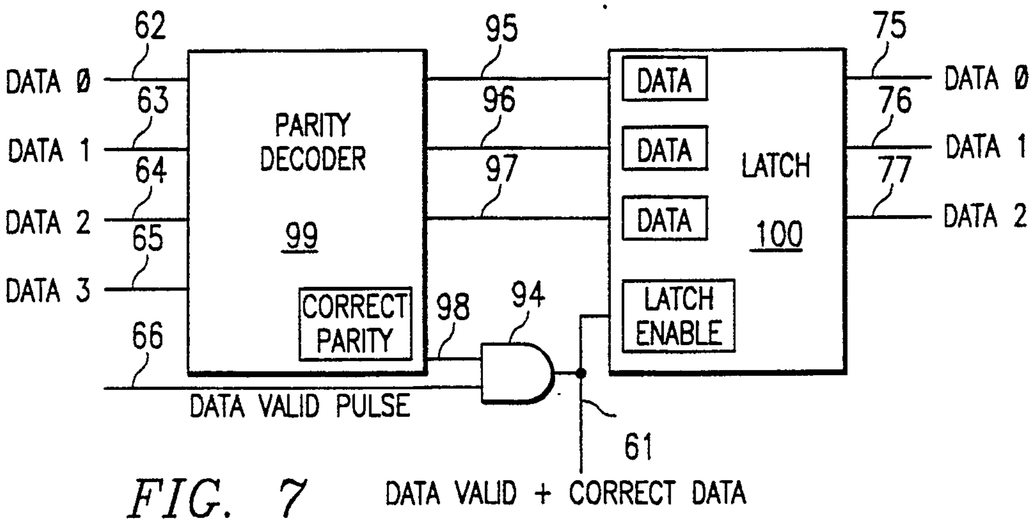

62
DATA Ø
63
DATA 1
64
DATA 2
65
DATA 3
66
PARITY
DECODER
99
CORRECT
PARITY
95
96
97
98
94
DATA
DATA
DATA
LATCH
100
LATCH
ENABLE
75
DATA Ø
76
DATA 1
77
DATA 2
DATA VALID PULSE
61
DATA VALID + CORRECT DATA

FIG. 7

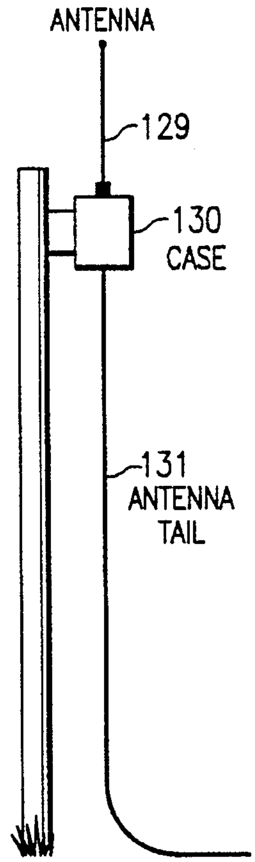

ANTENNA
129
130
CASE
131
ANTENNA
TAIL

FIG. 8